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Islamabad

PRECISION INSTRUMENTATION

LEARNER GUIDE

National Vocational Certificate Level 3

Version 1 - November, 2019

NAVTTC

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PRECISION INSTRUMENTATION

LEARNER GUIDE

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- This section will include examples, photographs and illustrations relating to each learning outcome

- **Summary of modules**:
  - This contains the summary of the modules that make up your learner's guide
- **Frequently asked questions**:
  - These have been added to provide further explanation and clarity on some of the difficult concepts and areas. This further helps you in preparing for your assessment.
- **Multiple choice questions for self-test**:
  - These are provided as an exercise at the end of your learner's guide to help you in preparing for your assessment.

Frequently Asked Questions

1. What is Competency Based Training (CBT) and how is it different from currently offered trainings in institutes?	Competency-based training (CBT) is an approach to vocational education and training that places emphasis on what a person can do in the workplace as a result of completing a program of training. Compared to conventional programs, the competency-based training is not primarily content based; it rather focuses on the competence requirement of the envisaged job role. The whole qualification refers to certain industry standard criterion and is modularized in nature rather than being course oriented.
2. What is the passing criterion for CBT certificate?	You shall be required to be declared "Competent" in the summative assessment to attain the certificate.
3. How can I progress in my educational career after attaining this certificate?	You shall be eligible to take admission in the National Vocational Certificate Level-4 in Precision Instrumentation; and take admission in a level-5, DAE or equivalent course after that. In certain case, you may be required to attain an equivalence certificate from The Inter Board Committee of Chairmen (IBCC).
4. What is the importance of this certificate in National and International job market?	This certificate is based on the nationally standardized and notified competency standards by National Vocational and Technical Training Commission (NAVTTC). These standards are also recognized worldwide as all the standards are coded using international methodology and are accessible to the employers worldwide through NAVTTC website.

5. Which jobs can I get after attaining this certificate? Are there job for this certificate in public sector as well?	You shall be able to take up jobs in the Pipe fitting Industries in the functions of installation of different water pumps, pipe fixtures, testing of pipe system and maintenance of pipe system.
6. What are possible career progressions in industry after attaining this certificate?	You shall be able to progress up to the level of supervisor after attaining sufficient experience, knowledge and skills during the job. Attaining additional relevant qualifications may aid your career advancement to even higher levels.
7. Is this certificate recognized by any competent authority in Pakistan?	This certificate is based on the nationally standardized and notified competency standards by National Vocational and Technical Training Commission (NAVTTC). The official certificates shall be awarded by the relevant certificate awarding body.
8. Is on-the-job training mandatory for this certificate? If yes, what is the duration of on-the-job training?	On-the-job training is not a requirement for final / summative assessment of this certificate. However, taking up on-the-job training after or during the course work may add your chances to get a job afterwards.
9. What is the examination / assessment system in this program?	Competency based assessments are organized by training institutes during the course which serve the purpose of assessing the progress and preparedness of each student. Final / summative assessments are organized by the relevant qualification awarding bodies at the end of the certificate program. You shall be required to be declared “Competent” in the summative assessment to attain the certificate.
10. Does this certificate enable me to work as freelancer?	You can start your small business as a precision instrumentation professional. You may need additional skills on entrepreneurship to support your initiative.

PRECISION INSTRUMENTATION

Module-2
LEARNER GUIDE
National Vocational Certificate Level 3

Version 1 - November, 2019

Modules

Module 2: 0714001033 Perform bench work

Objective of the module: The aim of this module is to develop advanced knowledge, skills and understanding to perform bench work.

Duration: 90 Hrs **Theory:** 18 Hrs **Practical:** 72 Hrs

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Perform sawing	**The trainee will be able to:** Select appropriate blade according to the material and set in hacksaw frame Perform marking as per drawing Clamp the work piece properly Perform sawing as per standard procedures Verify the final job with the given drawing	Identify different types of hacksaw blades and its uses. **Types**: High Carbon Steel, high speed steel Interpret basic engineering drawings Understand the types & application of clamping devices **Types**: bench vice, machine vice, parallel clamp, C-clamp Understand types & properties of material (M.S,S.S,BRASS,COPPER etc) Standard procedure for Sawing i.e. gesture, griping, stroking etc.	MS flat / Round Vernier Caliper (0-150mm) Steel Rule (0-300mm) Tri Square (0-100mm) Scriber Marking Ink Hacksaw blades (18-24 TPI) Hacksaw Frame Bench vices 4 inches Divider Computer Speakers

			Multimedia Projector Logbook Handbooks Design Books/ Sheets Pencils Erasers Pencil Sharpeners Paper Cutter Scissors Color Pencils Different Tags and Locks WD-40
LU 2: Perform filing	**The trainee will be able to:** Select file type according to the job & profile Select marking tool and mark the job as per drawing Clamp the workpiece properly Perform filing as per standard procedures Verify the final job with the given drawing	Identify different file types according to length, cross-section, roughness and their uses. **Types:** (Roughness) bastard, second cut, smooth (cross-section) Flat, square, round, triangular. Understand filing operation for different materials. Standard procedure for filing i.e. gesture, griping, stroking etc.	MS flat bar Vernier Caliper (0-150mm) Steel Rule (0-300mm) Tri Square (0-100mm) Bevel protector Files of different shapes, size, cut and coarseness Scriber Marking Ink Bench vices 4 inches Emery paper (200-400)

			Computer Speakers Multimedia Projector Logbook Handbooks Design Books/ Sheets Pencils Erasers Pencil Sharpeners Paper Cutter Scissors Color Pencils Different Tags and Locks WD-40
LU 3: Perform drilling	**The trainee will be able to:** Select drilling bit according to the material Select marking tool and mark the job as per drawing Clamp the work piece properly Set the machine RPM according to the drill size and work piece material Perform drilling & post drilling operation as per standard procedures	Types of drill machines i.e. bench type, pillar type, column type, radial type etc. Major functional parts of a drill machine. **Parts:** machine head, worktable, speed pulley, feed lever, spindle / quill, drill chuck, sleeves etc. Identify Types of metal i.e. Ferrous and non-ferrous. Types of drill bits: straight shank and taper shank. Cutting speed of common engineering materials. **Materials:** aluminum, mild steels, cast iron, carbon steels, copper, brass etc. Calculation method for RPM. Steps to perform drilling.	MS flat bar Steel Rule (0-300mm) Tri Square (0-100mm) Centre & Dot Punch Scriber Marking Ink Hammer (Ball Peen 250gm) Hand vices 4 inches Bench type drill machine Drill chuck

	Verify the final job with the given drawing	Post drilling operations i.e. chamfering, bur removing etc.	Coolant Computer Speakers Multimedia Projector Logbook Handbooks Design Books/ Sheets Pencils Erasers Pencil Sharpeners Paper Cutter Scissors Color Pencils Different Tags and Locks WD-40
LU 4: Perform hand taping	**The trainee will be able to:** Select tap according to the job specification Select marking tool and mark the job as per drawing Clamp the work piece properly Perform drilling & taping according to job Verify the final job with given drawing	Knowledge and understanding of thread terminology Identify the types of thread. **Types:** Metric, British Withworth, American National, Gas pipe thread, NPT Types of taping: machine taping and hand taping Utility of taps: • Internal threading • Cleaning threads • Maintenance of threads • Extraction of tap Process steps for hand taping.	MS flat bar Vernier Caliper (0-150mm) Steel Rule (0-300mm) Tri Square (0-100mm) Centre & Dot Punch Scriber Marking Ink Hammer (Ball Peen 250gm) Drill bits of different sizes (4-20mm)

			Bench vices 4 inches Bench type drill machine Drill chuck Wire brush Coolant Tap set with handle (M3-M12) Computer Speakers Multimedia Projector Logbook Handbooks Design Books/ Sheets Pencils Erasers Pencil Sharpeners Paper Cutter Scissors Color Pencils Different Tags and Locks WD-40
LU 5: Perform hand reaming	**The trainee will be able to:** Select marking tool and mark the job as per drawing Clamp the work piece properly Perform drilling according to the size of reamer Select reamer and perform	Understand drill size for reaming. Understand reaming operation. Types of reamers. • **Hand Reamer** • **Machine Reamer** Purpose of reamers: • Size as per tolerance	Vernier Caliper (0-150mm) Steel Rule (0-300mm) Inside/ outside caliper Tri Square (0-100mm) Centre & Dot Punch Scriber

	reaming as per job Verify the final job with given drawing	• Roundness of holes • Surface finish of holes Process steps for hand or machine reaming Knowledge of tolerances and fits.	Marking Ink Hammer (Ball Peen 250gm) Drill bits of different sizes (4-20mm) Bench vices 4 inches Bench type drill machine Drill chuck Hand reamers with handle (8-16mm) Computer Speakers Multimedia Projector Logbook Handbooks Design Books/ Sheets Pencils Erasers Pencil Sharpeners Paper Cutter Scissors Color Pencils Different Tags and Locks WD-40
LU 6: Perform Counter boring	**The trainee will be able to:** Select required counter boring tool according to the drawing Select marking tool and	Understand counter boring operation Understand counter boring tools. • **Counter boring Tool** • **Flat Drill**	MS flat/ round bar Vernier Caliper (0-150mm) Micrometer (0-25mm) Steel Rule (0-300mm)

	mark the job as per drawing Clamp the work piece properly Perform drilling operation as per drawing Set the machine RPM according to the bore size and work piece material Perform drilling and counter boring as per standard procedures Verify the final job with the given drawing	Process steps for counter boring Calculation method for RPM. Steps to perform drilling. Post drilling operations i.e. chamfering, bur removing etc.	Tri Square (0-100mm) Centre & Dot Punch Scriber Marking Ink Hammer (Ball Peen 250gm) Drill bits of different sizes (4-20mm) Bench vices 4 inches Bench type drill machine Drill chuck Counter boring tools (10-20mm) Coolant Computer Speakers Multimedia Projector Logbook Handbooks Design Books/ Sheets Pencils Erasers Pencil Sharpeners Paper Cutter Scissors Color Pencils Different Tags and Locks WD-40

LU 7: Perform Countersinking	**The trainee will be able to:** Select counter sinking tool according to the drawing Select marking tool and mark the job as per drawing Clamp the work piece properly Set the machine RPM according to the counter sink size and work piece material Perform drilling and counter sinking as per standard procedures Verify the final job with the given drawing	Understand countersinking operation Understand counter sinking tools. Drill Bit with 90-degree lip angle Process steps for counter sinking Calculation method for RPM. Steps to perform drilling. Steps to perform counter sinking. Post drilling operations i.e. chamfering, de-buring.	MS flat/ round bar Vernier Caliper (0-150mm) Steel Rule (0-300mm) Tri Square (0-100mm) Centre & Dot Punch Scriber Marking Ink Hammer (Ball Peen 250gm) Drill bits of different sizes (4-20mm) Bench vices 4 inches Bench type drill machine Drill chuck Countersinking tools (10-20mm) Coolant Computer Speakers Multimedia Projector Logbook Handbooks Design Books/ Sheets Pencils Erasers Pencil Sharpeners Paper Cutter Scissors
			Color Pencils Different Tags and Locks WD-40

Examples and illustrations

Bench work and Layout Operations" provides a detailed overview of the various bench work and layout processes that operators often need to perform during manual machining. Layout is the process of marking a work piece prior to cutting in order to have a visual guideline during cutting operations. Bench work includes various cutting processes that machinists complete by hand rather than on a machine when creating part features that require less power and force. Common bench work operations include hand tapping, hand reaming, hand filing, and engraving.

Manually machined work pieces often require bench work and layout operations. As a result, bench work and layout are essential skills to have for any manual mill operator. A knowledge of not just how, but also when and why to perform bench work and layout operations is key to becoming a skilled manual machinist and producing precise, accurate manually cut parts.

https://www.toolingu.com/class/280130/benchwork-and-layout-operations-241#targetText=Benchwork%20includes%20various%20cutting%20processes,%2C%20hand%20filing%2C%20and%20engraving.

Pictures:

https://www.quora.com/What-is-a-pedestal-drill

https://kit.com/KrankEngineering/benchwork-metal-working-with-handtools

https://www.dreamstime.com/many-hand-tools-work-you-may-find-metal-workers-toolbox-image116451750

https://draganddropcreator.weebly.com/bench-tools.html

Hand Hacksaw: 

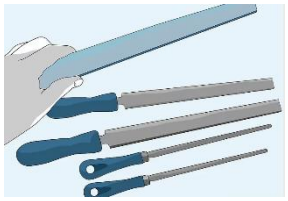
Perfect for cutting metals, pipes and tubing, the hacksaw is one of the most common saw types. They are lightweight and versatile, able to cut through wood, metal, plastic and other materials using material-specific cutting blades with a tooth count ranging from about 18 to 32 per inch.

Reference: https://www.garagetooladvisor.com/hand-tools/different-types-of-saws-and-their-uses/

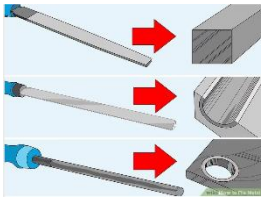
Filling:

Metal files are relatively inexpensive and effective tools for reshaping and smoothing metal and hard plastics, offering the potential for high precision and many years of trouble-free use. Be sure to select the right kind of file for the job, and keep it clean and oiled. You can straight file, cross file, or draw file, depending on whether you want to remove material, do detail work, or create a smooth surface.

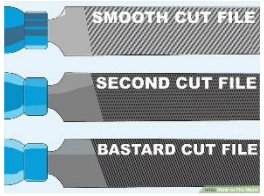
Choosing and Preparing Your File:

Select a file size: 

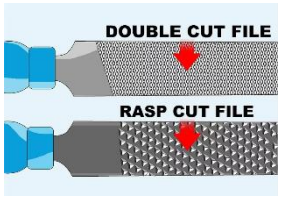
In general, large files are relatively coarse. They leave a rougher finish, but remove more stock. Conversely, smaller files are finer. They remove less stock, but leave a smoother finish.

Choose a file shape: 

Use a flat file for general purpose work, a square file for enlarging rectangular holes, and a round file for enlarging round holes. Use a triangular file on acute angles, and a half-round file to smooth curved faces of grooves.

Determine the degree of coarseness needed: 

A bastard-cut file has the highest degree of coarseness, while a second-cut file has a medium degree of coarseness. A smooth-cut file is the least coarse option.

Pick the right tooth geometry: 

For fast removal of stock, choose a double-cut file. For finishing, use a single-cut file. Choose a rasp-cut for rough cuts of soft materials, and a curved-cut file for automotive body work.[4]

- Use a double-cut file to file brass, bronze, copper, and tin. These tough metals should be filed with a double-cut file as they are strong enough to withstand the metal and/or alloy.[5]
- Rasp-cut files can be used for wood as well as lead and aluminum. This file has a series of individual teeth and produces a rough cut.

Check the quality of the file: 

Be sure that the file you choose to use is whole, rather than broken or chipped. Ensure the handle is intact and not loose. Check the teeth to be sure they aren't broken, and look for rust, which should be removed before using the file.

- Soak your file in distilled white vinegar overnight to remove the rust. Then wipe off any residue and thoroughly dry the file before using it.

Clean the file: 

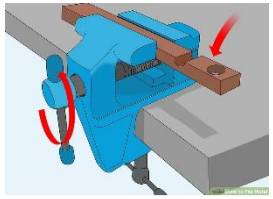
There should not be any pins (bits of filed metal) stuck in the teeth. If there are, clean them out with a file card, stiff wire brush, or a piece of skinny wire or sheet metal. You can also use a scrap piece of hardwood to clean your file by pressing the wood against the file and scraping it along the grooves.[8]

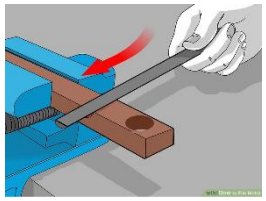
- You should clean your file often while you are working as well. Aim to stop and clean your file every 15 strokes or so to prevent pinning.

Apply chalk, oil, or lard to the file: 
Liberally rub chalk, or a small amount of lard or general-purpose oil, into the teeth of the file. This makes the file less likely to become clogged with pins in the future, as well as reduces the amount of metal dust when filing, and also protects the file.

- You may want to wear gloves when applying chalk, oil, or lard to your file to keep your hands cleans.

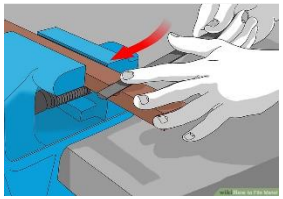
Using the Right Filing Technique:

Secure your work: 
It is important to secure your work with a vise or other clamp to keep it from moving around while you are filing. Mount the vise so that the stationary jaw extends slightly beyond the edge of your workbench, and be sure to place bolts in all the holes on the base of the vise and secure them with locking washers. Then, place the workpiece in the vise so that it is supported by the full clamping surface.

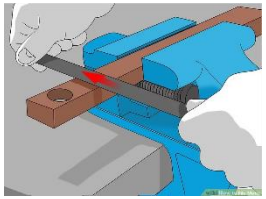
File in only one direction: 
You don’t want to use a back and forth motion with your file, as this will damage the file and likely your workpiece as well. Instead, only apply pressure on the forward stroke and lift the file away from the workpiece on the return stroke.

Cross file to remove material: 

For heavy cross filing, grab the handle of the file with the dominant hand and place the palm of the other hand on the end of the file. Angle the file diagonally to the work and press down firmly so that the file digs in and cuts the metal. Make long, slow strokes away from your body. Lift the file away from the surface on the return stroke to prevent dulling the file

Straight file for detail work: 

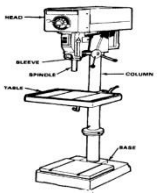
For straight filing, use a small file rather than a large one. Grab the handle of the file with the dominant hand and place the fingers of the other hand on the end of the file. Point the file away from you and press it down firmly on your workpiece. Make long, slow strokes away from your body, and only file in one direction, rather than back and forth.

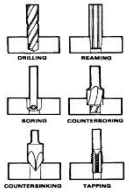
Draw file to finish a surface: 

For draw filing, place your hands on either side of the file with a gap slightly larger than your workpiece. Hold the file horizontally and make long, slow strokes away from your body with a firm pressure. Remember to only apply pressure on the forward stroke, and to remove the file on the backward stroke.

Reference:

https://www.wikihow.com/File-Metal





Drilling

A drilling machine, called a drill press, is used to cut holes into or through metal, wood, or other materials. Drilling machines use a drilling tool that has cutting edges at its point. This cutting tool is held in the drill press by a chuck or Morse taper and is rotated and fed into the work at variable speeds. Drilling machines may be used to perform other operations. They can perform countersinking, boring, counterboring, spot facing, reaming, and tapping. Drill press operators must know how to set up the work, set speed and feed, and provide for coolant to get an acceptable finished product. The size or capacity of the drilling machine is usually determined by the largest piece of stock that can be center-drilled. For instance, a 15-inch drilling machine can center-drill a 30-inch-diameter piece of stock. Other ways to determine the size of the drill press are by the largest hole that can be drilled, the distance between the spindle and column, and the vertical distance between the worktable and spindle.

Reference:

https://smithy.com/machining-handbook/chapter-6/page/1

Hand Tapping:

Tapping is the process of cutting a thread inside a hole so that a cap screw or bolt can be threaded into the hole. Also, it is used to make thread on nuts.

Tapping can be done on the lathe by power feed or by hand. Regardless of the method, the hole must be drilled with the proper size tap drill and chamfered at the end.

HAND TAPPING PROCEDURE

1. Select drill size from chart.

When choosing a tap size, the Tap and clearance drill sizes chart is the first place to look or calculate the hole size for tapping through this formula.

$$\text{Outside diameter of thread} - \frac{.01266 \times \%\text{ of thread depth}}{\text{number of threads per inch (TPI)}} = \text{hole diameter}$$

To calculate the hole size for a 1-in. 12-thread fastener with a 70 percent thread depth:

$$1.0 - \frac{.01266 \times 70\%}{12} = .926$$

2. If necessary, add chamfer to the hole before tapping. Chamfers and countersinks are additional features that are sometimes desired for screws. For best results, the speed of the spindle should be between 150 and 250 rpm.

3. Get a tap guide. The hole is now ready to tap. To do this, use the taps and guide blocks near the manual mills. The guide blocks will have several holes for different sized taps. Select the one closest to the size of the tap being used and place it over the drilled hole.

4. Tap the block. Peck tap using the tap wrenches. Apply gentle pressure while turning the wrench a complete turn in, then a half-turn out. Peck tap to the desired depth.

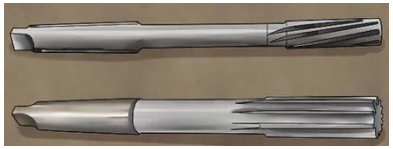
5. Complete the tap. If the tap does not go any further or the desired depth has been reached, release pressure on the tap; it has likely bottomed out. Remove the tap from the hole.

Applying any more pressure is likely to break the tap. The smaller the tap, the more likely it is to break.

Reference:

https://openoregon.pressbooks.pub/manufacturingprocesses45/chapter/unit-5-tapping/

Hand Reaming:

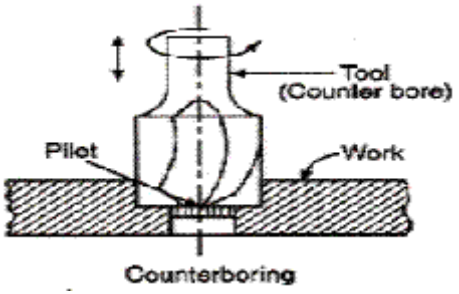


Procedure:

Step 1: Get a tap wrench or T-handle wrench and a hand reamer
Step 2: Attach the wrench to the squared end of the reamer
Step 3: Ensure perpendicularity between work and reamer with a square. As an alternate method you can use a reaming guide or a spring loaded center guide.
Step 4: Evenly turn the reamer in the hole to ensure alignment with the hole. (The bevel on the end of the reamer will help.) A rule of thumb for feeding rate is one quarter of the reamers diameter per revolution. Never rotate the reamer backwards as you would in a tapping operation as this would dull the reamer quickly.
Step 5: Ideally pass the hand reamer through the hole, if not possible, remove the reamer from the top by continuing the rotating motion.

Reference:

http://thevms.net/2cutting_tools/6cutting_tools_reamer_h/cutting_tools_reamer_h_02.html

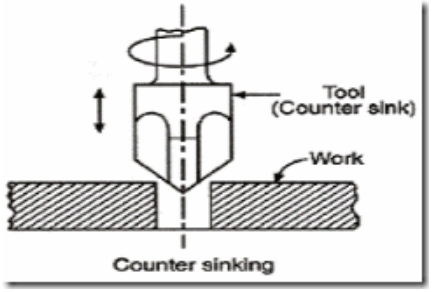


Counter boring:

Counter boring is the operation of enlarging one end of an existing hole concentric with the original hole with square bottom. It is done to accommodate the heads of bolts, studs and pins. The cutting edges of the counter-bore (tool used for counter boring) may have straight or spiral teeth.

Reference:

http://engineering.myindialist.com/2009/drilling-operations-counter-boring/#.XYvdbPAzZdh



Counter sinking:

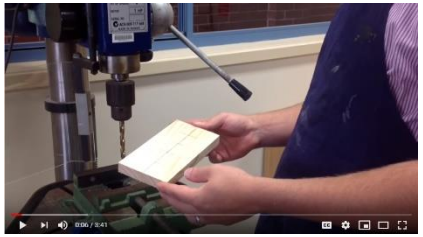
Counter sinking is the operation of making a cone shaped enlargement at the end of a hole to provide recess for a flat head screw or a countersunk rivet. The counter-sunks (tools used for counter sinking) carry included angles of 60°, 82° or 90° and the cutting edges of the tool are formed at the conical surface.

Reference:

http://engineering.myindialist.com/2009/drilling-operations-counter-sinking/#.XYvdifAzZdg

Video:

	Topic	Hyperlink
	BENCH WORK	https://www.youtube.com/watch?v=8Df0cx8HkRg
	How to use metal handsaw	https://www.youtube.com/watch?v=9zM8lBpOQcM

	How to tap and die	https://www.youtube.com/watch?v=rHY53Fj5uN8
	How to use a reamer to make a precise hole in metal	https://www.youtube.com/watch?v=0nZvhsggJBA
	Pedestal drill	https://www.youtube.com/watch?v=_7ExYx3KY9A

PRECISION INSTRUMENTATION

Module-3
LEARNER GUIDE
National Vocational Certificate Level 3

Version 1 - November, 2019

Module 3: 0714001034 Fabricate piping & tubing system

Objective of the module: The aim of this module is to develop advanced knowledge, skills and understanding to join pipes.

Duration: 150 Hrs **Theory:** 30 Hrs **Practical:** 120 Hrs

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU1: Interpret Drawings/ Layout	**The trainee will be able to:** Interpret symbols from the given drawing/ layout Read scale of the given drawing/ layout Interpret different types of abbreviations from the given drawing/ layout Take measurements from the given drawing/ layout Determine material from the given job specification/ drawing/ layout Interpret different section views/ coordinated sections from the given drawing/ layout Interpret revisions in drawings/ layouts	Interpret basic engineering drawings Interpret P&ID. Interpret different drawing views. **Views:** Isometric, orthographic Interpret drawing projections **Projections:** 1st angle, 3rd angle	Computer Speakers Multimedia Projector Printer Logbook Handbooks Design Books/ Sheets Pencils Erasers Pencil Sharpeners Paper Cutter Scissors Color Pencils Different Tags and Locks WD-40
LU 2: Prepare work area	**The trainee will be able to:** Inspect work area for potential hazards	Understand potential hazards in work area. **Hazards:**	Cotton Gloves/ leather gloves Goggles Safety mask

	Arrange material according to the given drawing/ specifications Arrange the required tools/ equipment to perform fabrication of piping system Ensure electrical & water supply to the work area Disconnect/ remove previously existing services from the work area if required Coordinate with coworkers according to the job	• Fire • Inflammable Material • Explosive gases • Toxic Chemicals Understand the selection of power & utilities supply to the work area. • Compressed Air • Electric Power • Natural Gas	Helmet Safety belt Safety Shoes Ear plug / Earmuff Measuring Tape Combination Pliers Vernier Caliper Cold Chisel Ball Peen Hammer Pipe Wrench 12” to 24” Pipe Vise 6” with tripod Hand Hack Saw Adjustable Wrench 8” to 12” Phillips Screwdriver Set Flat Screwdriver Set Allen Key Set Pipe Cutter ½” to 2” Combination Spanner Set (Matric) Hand Drill Machine Twist Drill Set Masonry Drill Set Gas Cutter Set with Torch, Pipe and Cylinders Magnet Sprit Level Soldering Machine Flaring Tool Set Swaging Tool Set

			Tube Cutter Bench Vise 6” Tri Square 12”, 24” A ladder Chalk Liner Baby Grinder 4” Grip Pliers Laser Level Computer Speakers Multimedia Projector Logbook Handbooks Design Books/ Sheets Pencils Erasers Pencil Sharpeners Paper Cutter Scissors Color Pencils Different Tags and Locks WD-40
LU 3: Bend/ Cut pipes & tubes	**The trainee will be able to:** Perform measurement of pipe according to the drawing/ job specification Mark the job piece according to the drawing/	Understand types of pipe/tube joints **Types:** • Welded Pipes • Seamless Pipes Understand the purpose and necessity of pipe/tube	Cotton Gloves Goggles Safety Shoes Measuring Tape Vernier Caliper Hand Hack Saw

	job specification Select tools/ equipment according to the given material Bend/ Cut the pipe as per job requirement	joints' application according to the material Understand joining methods of pipe/tube according to the pipe specification. Identification of different pipe/tube joints Understand use of cutting & bending tool. **Tools:** Pipe cutter, hacksaw, pipe bender, tube cutter	Pipe Cutter ½" to 2" PVC tape Tube Cutter Tube bender Cable tie Computer Speakers Multimedia Projector Logbook Handbooks Design Books/ Sheets Pencils Erasers Pencil Sharpeners Paper Cutter Scissors Color Pencils Different Tags and Locks WD-40
LU 4: Perform threading	**The trainee will be able to:** Perform measurement of pipe according to the given drawing/ job specification Mark the work piece according the given drawing/ job specification Select tools/ equipment	Understand types of thread. **Types:** • Metric, • Wit worth, • American National • Gas pipe thread • NPT	Goggles Safety Shoes Measuring Tape Pipe Vise 6" with tripod Ratchet die set ½" to 2" Hand Hack Saw Pipe Cutter ½" to 2" Multi-purpose grease Tube Cutter

	to bend the given pipe. Perform threading of pipes as per standard	Understand thread nomenclature. Understand application of thread plug gauge and ring gauge.	Bench Vise 6” Computer Speakers Multimedia Projector Logbook Handbooks Design Books/ Sheets Pencils Erasers Pencil Sharpeners Paper Cutter Scissors Color Pencils Different Tags and Locks WD-40
LU 5: Braze pipes	**The trainee will be able to:** Arrange tools/ equipment/ material as per job requirement Ensure safety precautions Measure, mark, cut and clean surface of pipe as per job requirement Perform brazing according to standard	Understand selection of tool for brazing operation.**i.e.** Acetylene cylinder, Oxygen cylinder, welding torch, filling material etc. Set of Gas welding equipment including oxygen, DA filled cylinders. • Wire brush • Chip hammer • PPEs • Tong Understand preparation of metal surface for brazing.	Leather Gloves Goggles Safety mask Helmet Safety Shoes Face Shield and Holder with cable Measuring Tape Cold Chisel Straight Peen Hammer 2 lbs Brass & Copper rods for brazing Gas welding Set with

		• Emery paper • Wire brush • Chipping hammer Setting up brazing equipment	Torch, Pipe and Cylinders Pin Grinder Computer Speakers Multimedia Projector Logbook Handbooks Design Books/ Sheets Pencils Erasers Pencil Sharpeners Paper Cutter Scissors Color Pencils Different Tags and Locks WD-40
LU 6: Make welded joints through arc welding	**The trainee will be able to:** Arrange tools/ equipment/ material as per job requirement Ensure safety precautions & use PPEs Measure, mark and cut pipe as per job requirement Ensure bevel on pipe edges as per standard Align pipes & pipefittings	Describe the requirements of a workplace for welding specific job Understand types & importance of electric arc welding **i.e.** MIG, TIG and SMAW etc. Describe the preparation of welding machine including • Type of current (AC/DC) • Current polarity Describe the importance of joint preparation, cleaning and tacking	Leather Gloves Goggles Safety Shoes Overall Face Shield and Holder with cable Welding Gloves Measuring Tape Combination Pliers Pointing chisel Insulation tape Cold Chisel

	as per standard Adjust electric current for welding plant Perform welding	Understand joint types for welding • Butt joint • Angle joint • Corner joint • Lap joint • Tee-joint • Edge joint Understand importance of alignment of pipes and pipefittings	Straight Peen Hammer 2 lbs Pipe Vise 6” with tripod Portable Welding Machine 3 Phase 300 Amps. Electrodes of different specifications Pipe Cutter ½” to 2” Tube Cutter Bench Vise 6” Baby Grinder 4” Grip Pliers Fusion Machine (PE Pipe Set) Butt Fusion Computer Speakers Multimedia Projector Logbook Handbooks Design Books/ Sheets Pencils Erasers Pencil Sharpeners Paper Cutter Scissors Color Pencils Different Tags and Locks WD-40

LU 7: Install pipelines	**The trainee will be able to:** Obtain drawing for given task Adopt necessary PPEs according to the task Select tools/equipment/ material as per given task Figure out the placement of pipes (hot & cold) as per drawing Locate and mark anchor/ support points as per requirement Cut and clean pipe as per requirement Thread the pipe and apply seal tape Fix accessories in loop as per given drawing Ensure installed pipeline loop for being leveled and plumbed Clean & store work area & tools to ensure good housekeeping	Define different types of flanges i.e. • Slip-On Flanges • Lap joint Flanges • Welded neck flanges Explain procedure to make flange joint. State use of angle grinder • **Right Angle Cut-off Wheel** • **Depressed Center Wheel** • **Small Diameter Reinforced** • **Chop Saw Reinforced** Explain procedure to perform grinding of pipe Interpret pipe drawing Understand types of thread. **Types:** • Metric, • Wit worth, • American National • Gas pipe thread • NPT Understand thread nomenclature.	Cotton Gloves Goggles Helmet Safety Shoes Measuring Tape Insulation tape Combination Pliers Vernier Caliper Cold Chisel Ball Peen Hammer Pipe Wrench 12” to 24” Pipe Vise 6” with tripod Ratchet die set ½” to 2” Hand Hack Saw Adjustable Wrench 8” to 12” Phillips Screwdriver Set Cable tie Flat Screwdriver Set Allen Key Set Pipe Cutter ½” to 2” Combination Spanner Set (Matric) Combination Spanner Set (Imperial) Hand Drill Machine Twist Drill Set Masonry Drill Set Magnet Sprit Level

			Water Level 12 meter Soldering Machine Flaring Tool Set Swaging Tool Set Tube Cutter Bench Vise Tri Square 12”, 24” Baby Grinder 4” Computer Speakers Multimedia Projector Logbook Handbooks Design Books/ Sheets Pencils Erasers Pencil Sharpeners Paper Cutter Scissors Color Pencils Different Tags and Locks WD-40

Examples and illustrations

The installation of pipe systems follows its fabrication and is very frequently a part of it. The installation of pipe can be accomplished in the following two primary ways, or combinations thereof:

1. Field fabricate and install
2. Shop fabricate and field erected

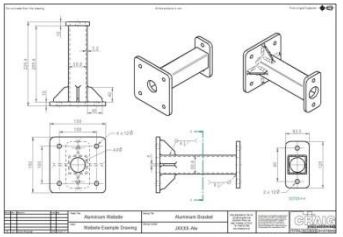
Some contractors prefer to do most, if not all fabrication in the shop, others prefer to set up at the job-site, while others are flexible enough to utilize the best of both methods.

Field fabrication and installation is exactly what it means. The pipe is fabricated on-site, either directly at the place where it is mounted, or in a temporary accommodation in the field.

A number of factors will determine whether it is profitable to fabricate pipe on site:
Type of project, size and scope of the project, pipe size and material, accessibility of the equipment, surface treatment after fabrication, weather conditions, availability of qualified

http://www.wermac.org/documents/fabrication_field.html

ENGINEERING DRAWING https://aluminiumfabs.co.uk/fabrication-design#PhotoSwipe1568745224511



The engineering drawing is a type of technical drawing, created within the technical drawing discipline, and is used to define the requirements for engineered items.

It is usually created in accordance with standard conventions for layout, nomenclature, interpretation, appearance, etc. One such standard convention is called GD & T.

The purpose of engineering drawing is to capture all the geometric features of a product or a component accurately and unambiguously. Its end goal is to convey the information that will allow a manufacturer to produce that component.

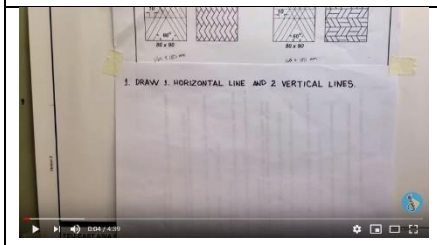
Different types of projections:

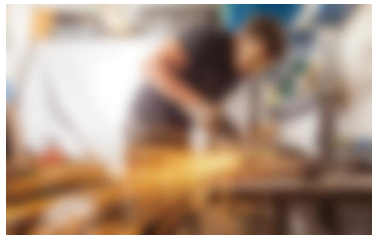
- Orthogonal projection
- Auxiliary projection
- Isometric projection
- Oblique projection
- Perspective projection

Reference:

https://www.ukessays.com/essays/engineering/different-views-on-engineering-drawing.php

Video:

	Topic	Hyperlink
	ENGINEERING DRAWING | BASIC	https://www.youtube.com/watch?v=FEju-hA5Peo



Fire Hazards in the Workplace https://www.travelers.com/resources/facilities-management/fire-hazards-in-the-workplace

Every year workplace fires cause not only serious damage to property but also injury and death. In the UK there were 22,200 non-residential fires reported in 2013/4, with a significant proportion of these fires occurring in the workplace.

Although there are a number of reasons why these fires break out, many are due to negligence and could be prevented with more care and attention. As well as ensuring your business is compliant with fire legislation by having a Fire Risk Assessment completed, you can also minimize risk by identifying potential fire hazards in the workplace.

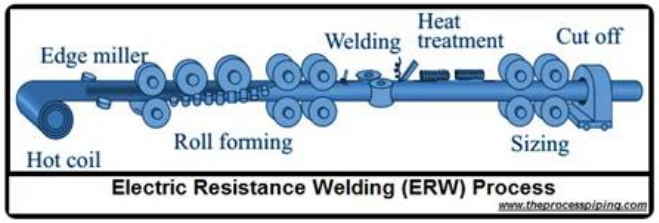
Whilst all working environments are different, here are some common fire hazards in the workplace to look out for to reduce the risk of accidental fire.

Reference:

https://www.assured-ltd.co.uk/blog/examples-of-fire-hazards-in-the-workplace/

Video:

	Topic	Hyperlink
	Workplace Fire Safety	https://www.youtube.com/watch?v=Ytyg5Ep2R0M



Manufacturing welded pipe https://www.theprocesspiping.com/introduction-to-welded-pipe-manufacturing/

Welded pipe starts out as a long, coiled ribbon of steel called a skelp. The skelp is cut to the desired length, resulting in a flat rectangular sheet. The width of that sheet's shorter ends will become the pipe's outside circumference, a value that can be used to calculate its eventual outside diameter.

The rectangular sheets are fed through a rolling machine that curls the longer sides up toward one another, forming a cylinder. In the ERW process, high-frequency electrical current is passed between the edges, causing them to melt and fuse together.

An advantage of ERW pipe is that no fusion metals are used and the weld seam cannot be seen or felt. That's opposed to double submerged arc welding (DSAW), which leaves behind an obvious weld bead that must then be eliminated depending on the application.

Welded pipe manufacturing techniques have improved over the years. Perhaps the most important advancement has been the switch to high-frequency electric currents for welding. Prior to the 1970s, low-frequency current was used. Weld seams produced from low-frequency ERW were more prone to corrosion and seam failure.

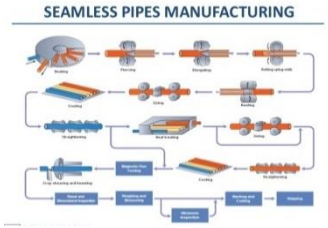
Most welded pipe types require heat treatment after manufacture.

Reference:

https://www.theprocesspiping.com/introduction-to-welded-pipe-manufacturing/

Video:

	Topic	Hyperlink
	Pipe Manufacturing Process for Welded Pipe (SAW & ERW)	https://www.youtube.com/watch?v=8vIoxzYnYXw

Manufacturing seamless pipe 

https://www.slideshare.net/AlirezaNiakani/piping-components-materials-codes-and-standards-part-1-pipe

Seamless piping begins as a solid cylindrical hunk of steel called a billet. While still hot, billets are pierced through the center with a mandrel. The next step is rolling and stretching the hollow billet. The billet is precisely rolled and stretched until it meets the length, diameter and wall thickness as specified by the customer order.

Some seamless pipe types harden as they're manufactured, so heat treatment after manufacturing is not required. Others do require heat treatment. Consult the specification of the seamless pipe type you're considering to learn whether it will require heat treatment.

References:

https://www.theprocesspiping.com/introduction-to-seamless-pipe-manufacturing/
https://www.quora.com/What-is-a-seamless-pipe-What-are-its-functions

Video:

	Topic	Hyperlink
	SEAMLESS STEEL PIPE MANUFACTURING PROCESS	https://www.youtube.com/watch?v=lueB6RvgMSo

Electric Resistance Welding (ERW) Process

In Electric Resistance Welding (ERW) process, pipe is manufactured by cold-forming a flat sheet of steel into a cylindrical shape. Then current is passed between the two edges of the steel cylinder to heat the steel to a point at which the edges are forced together to form a bond without the use of welding filler material.

Several Electric Resistance Welding (ERW) processes are available for pipe production. The two main types of ERW are:

- High Frequency Welding
- Rotary Contact Wheel Welding.

Reference:

https://en.wikipedia.org/wiki/Electric_resistance_welding

Videos:

	Topic	Hyperlink
	Resistance Welding And Types Of Resistance Welding	https://www.youtube.com/watch?v=ToIT-WFBm_w

Arc welding  **https://weldinghelmetpros.com/different-types-of-welding-processes**

Uses an electrical arc to melt the work materials as well as filler material (sometimes called the welding rod) for welding joints. Arc welding involves attaching a grounding wire to the welding material or other metal surface. Another wire known as an electrode lead is placed on the material to be welded. Once that lead is pulled away from the material, an electric arc is generated. It's a little like the sparks you see when pulling jumper cables off a car battery. The arc then melts the work pieces along with the filler material that helps to join the pieces.

Feeding the filler into the welding joint takes steady hands and an eye for detail. As the rod melts, the welder must continuously feed the filler into the joint using small, steady, back-and-forth motions. These motions are what gives welds their distinctive appearance. Going too fast or slow, or holding the arc too close or far away from the material can create poor welds.

Reference: https://science.howstuffworks.com/welding3.htm

Video:

	Topic	Hyperlink
	How to Arc Weld | Welding	https://www.youtube.com/watch?v=CoHVA7nr82A

Thread Cutting:  

https://local.ecollege.ie/Content/APPRENTICE/liu/pipefitting/pdf/M3_U6_Pipe%20Threading%20and%20Testing.pdf

Cutting the Thread Secure the pipe in the pipe vice and cut to the desired length. Then, fit the threading die over the end of the pipe. The cutting starts with a fine thread on the die, cutting fluid must be used to lubricate the pipe and die. Turn the handle of the die clockwise half a turn at a time, and then back it off a bit in order to eject the metal chips. The dies are run up on the pipe until the pipe extends through the face of the dies one thread. Oil is put on the pipe and the dies at least twice during the cutting. Ensure that the die is kept perpendicular to the pipe at all times to ensure the thread is square and even. The inner threads or those away from the pipe end are not cut as deep, providing a taper that creates a tighter joint. Remove the pipe from the wise, stand it on end, and tap to remove any metal chips or particles that may be lodged inside.

Assembling the Threaded Joint:

The threaded pieces are then joined together using couplings or fittings. A sealing material must be used on the threads at each joint. This can be either Teflon tape, or a pipe thread sealing compound. Teflon tape or pipe thread sealing compound is placed on the threads. With the sealing material in place, hand-tighten the pipe and coupling or fitting. Then, using pipe wrenches, one on the pipe and one on the fitting, tighten one and a half more turns.

Steel or galvanized piping is heavy and it must be well supported, especially at each joint or coupling. Use pipe clips at regular intervals and close to threaded joints to ensure that the pipe is well supported and does not sag. CAUTION: It is extremely important to test all joints for leaks. Use a bit of water mixed with dish detergent and a soft brush to coat the solution over all joints. Any bubbles produced indicate a leak. Shut off the gas, retighten the joint and retest.

Understanding Thread Gauges: GO and NO-GO Gauges, Precision Measurement

https://www.cutwel.co.uk/measuring-tools/small-tool-instruments/thread-gauges/metric-fine-thread-gauges/calibrated-metric-fine-thread-ring-gauge-6e-no-go-johs-boss-jbo

https://mybikeshop.com/products/fsa-bb30-bearing-id-go-nogo-gauge.html

In production shops, the inspection of cylindrical parts (shafts or holes) for acceptance is quickly done using simple GO and NO-GO snap/ring gauges (for checking shafts) and plug gauges (for checking holes). They are mostly simple and easy to comprehend.

In the case of (screw/bolt) threaded parts, thread gauges are used in production shops where the “screws” (externally threaded parts) or the “nuts” (internally threaded parts) are to be quickly checked for acceptance. But when you consider the metrology (the science of measurement) of threaded parts as a whole, more than a couple of thread gauge types are involved; a novice in metrology may become somewhat confused with the terminology of the threaded gauges, their application, and their usage.

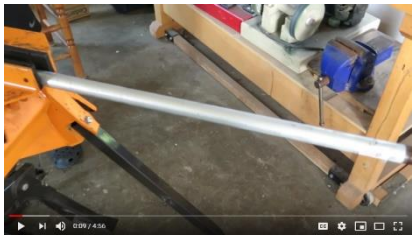
In this article, we shall try to understand the various types of thread gauges and their applications. This article deals with thread gauges used primarily in the shop for acceptance gauging of threaded parts.

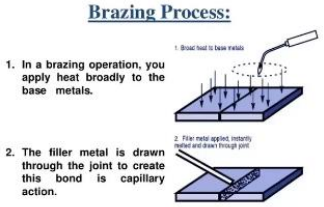
Reference:

https://local.ecollege.ie/Content/APPRENTICE/liu/pipefitting/pdf/M3_U6_Pipe%20Threading%20and%20Testing.pdf

http://conradhoffman.com/metricthreading.htm

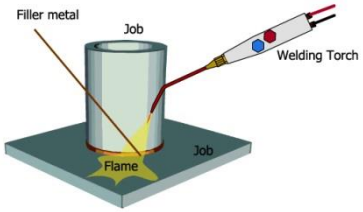
Video:

	Topic	Hyperlink
	How to Thread Steel Pipe	https://www.youtube.com/watch?v=_E4dSuLti38



HOW DOES BRAZING METAL WORK? https://weldguide.com/brazing/

Brazing essentially joins working parts by heating the parts to 840°F or more & potentially adding a filler metal that melts at a temperature under that of this base metal. Filler metal flows into the joint via a capillary liquid that rises. This process is called capillary attraction.



HOW IS BRAZING DONE? techminy.com/brazing-techniques/

Brazing is usually done utilizing a torch or brazed in a furnace. Some other uncommon modes are dip brazing, resistance brazing and induction brazing.

Torch Brazing fuses relatively small parts made from substances that do not oxidize at 840 degrees or at your brazing temperature. The most prevalent fillers would be your aluminum, silver and copper alloys. Some form of flux is necessary if you are going to use these fillers. Torch brazing is usually performed in air and is the most common brazing process.

References:

https://weldguide.com/brazing/

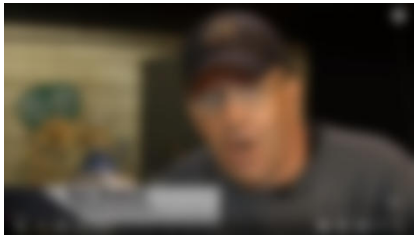
https://en.wikipedia.org/wiki/Wire_brush

http://www.abmtools.com/product/welding-chipping-hammer-spring-handle/

http://www.hse.gov.uk/toolbox/ppe.htm

https://en.wikipedia.org/wiki/Tongs

VIDEOS:

	Topic	Hyperlink
	Gas Brazing Technique	https://www.youtube.com/watch?v=OL-2yNndGC0

PRECISION INSTRUMENTATION

Module-4
LEARNER GUIDE
National Vocational Certificate Level 3

Version 1 - November, 2019

Module 4: 0714001035 Install & Commission Instruments

Objective of the module: The aim of this module is to develop advanced knowledge, skills and understanding to install & commission instruments.

Duration: 180 Hrs **Theory:** 30 Hrs **Practical:** 150 Hrs

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU1: Install & commission temperature instruments	**The trainee will be able to:** Perform site inspection as per drawing. Analyze process instrument to be installed. Apply standard techniques necessary for installation procedures as per manual. Inspect installed components for damage. Ensure that the installed instrument is intact and working properly Generate an output report as per standard. Ensure good housekeeping and safe working practices at all time	Define types of hazard. • Fire • Inflammable Material • Explosive gases • Toxic Chemicals Understand and implement P & ID. Understanding a Process Control Loop. Understanding of IFCD (Interface Control Diagram) Understand safety regulations. Understand Electrical/ Electronic/Instrumentation symbols Understand the functional parameters of Temperature instruments i.e. Thermometer, Temperature Gauge etc. Understand the SOP of instrument commissioning process.	Digital First Aid Box Hand glove Flat Screwdriver set Philips Screwdriver set Tweezers Tagging marks Hand drill machine Insulation tape Lugs punch (up to 10mm) Computer Speakers Multimedia Projector Logbook Handbooks Design Books/ Sheets Pencils Erasers Pencil Sharpeners Paper Cutter Scissors Color Pencils

			Different Tags and Locks WD-40
LU 2: Install & commission pressure instruments	**The trainee will be able to:** Perform site inspection as per drawing. Analyze process instrument to be installed. Apply standard techniques necessary for installation procedures as per manual. Inspect installed components for damage. Ensure that the installed instrument is intact and working properly Generate an output report as per standard. Ensure good housekeeping and safe working practices at all time	Define types of hazard. • Fire • Inflammable Material • Explosive gases • Toxic Chemicals Understand and implement P & ID. Understanding a Process Control Loop. Understanding of IFCD (Interface Control Diagram) Understand safety regulations. Understand Electrical/ Electronic/Instrumentation symbols Understand the functional parameters of Pressure instruments i.e. Manometer, Pressure Gauge, D.P Cell etc. Understand the SOP of instrument commissioning process.	Bourdon tube pressure gauge (0~20 Bar) Bourdon tube pressure gauge (0~400 Bar) Bourdon tube pressure gauge (0~200 Bar) Combination plier electrical Nose plier Hacksaw Tape measures (0~3m) Safety shoes Safety goggles Hearing protection Respiratory mask First Aid Box Hand glove Flat Screwdriver set Philips Screwdriver set Insulation tape Open end spanner set (5~32mm) Ring spanner set (5~22mm) Tagging marks Computer Speakers Multimedia Projector Logbook

			Handbooks Design Books/ Sheets Pencils Erasers Pencil Sharpeners Paper Cutter Scissors Color Pencils Different Tags and Locks WD-40
LU 3: Install & commission level instruments	**The trainee will be able to:** Perform site inspection as per drawing. Analyze process instrument to be installed. Apply standard techniques necessary for installation procedures as per manual. Inspect installed components for damage. Ensure that the installed instrument is intact and working properly Generate an output report as per standard. Ensure good housekeeping and safe	Define types of hazard. • Fire • Inflammable Material • Explosive gases • Toxic Chemicals Understand and implement P & ID. Understanding a Process Control Loop. Understanding of IFCD (Interface Control Diagram) Understand safety regulations. Understand Electrical/ Electronic/Instrumentation symbols Understand the functional parameters of Level instruments i.e. Digital Level Gauges, Manual Level Gauges etc. Understand the SOP of instrument commissioning process.	Wire striper Digital multimeter Digital clamp meter (0~400A) Tape measures (0~3m) Safety shoes Safety goggles Hearing protection Respiratory mask First Aid Box Insulation tape Cable tie Hand glove Flat Screwdriver set Philips Screwdriver set Open end spanner set (5~32mm) Ring spanner set (5~22mm) Allen key set (1~10mm)

	working practices at all time		Tagging marks Hand drill machine Lugs punch (up to 10mm) Computer Speakers Multimedia Projector Logbook Handbooks Design Books/ Sheets Pencils Erasers Pencil Sharpeners Paper Cutter Scissors Color Pencils Different Tags and Locks WD-40
LU 4: Install & commission flow instruments	**The trainee will be able to:** Perform site inspection as per drawing. Analyze process instrument to be installed. Apply standard techniques necessary for installation procedures as per manual. Inspect installed	Define types of hazard. • Fire • Inflammable Material • Explosive gases • Toxic Chemicals Understand and implement P & ID. Understanding a Process Control Loop.	Pipe vice Combination plier electrical Nose plier Wire striper Side cutter Pipe cutting tool Tube flaring tool Hacksaw Center punch Digital multimeter Digital clamp meter (0~400A)

	components for damage. Ensure that the installed instrument is intact and working properly Generate an output report as per standard. Ensure good housekeeping and safe working practices at all time	Understanding of IFCD (Interface Control Diagram) Understand safety regulations. Understand Electrical/ Electronic/Instrumentation symbols Understand the functional parameters of Flow instruments i.e. Volumetric Flow Meters, Mass Flow Meters, Orifice Type Flow Meters Understand the SOP of instrument commissioning process.	Tape measures (0~3m) Cable tie Safety shoes Safety goggles Hearing protection Respiratory mask First Aid Box Insulation tape Hand glove Flat Screwdriver set Philips Screwdriver set Open end spanner set (5~32mm) Ring spanner set (5~22mm) Allen key set (1~10mm) Tagging marks Hand drill machine Lugs punch (up to 10mm) Pitot tube Computer Speakers Multimedia Projector Logbook Handbooks Design Books/ Sheets Pencils Erasers Pencil Sharpeners

			Paper Cutter Scissors Color Pencils Different Tags and Locks WD-40
LU 5: Recommission process loop	**The trainee will be able to:** Make visual inspection for faults in the system Verify installation as per SOPs. Ensure that the connections/ terminations are secure Perform test run and sensory inspection Verify accurate signal transmission Identify modifications required in the system Validate as per manual/ SOP Finalize documentation and report to relevant personnel	Understand Electrical/ Electronic/Instrumentation symbols Understand the functional parameters of Instruments &Sensors related to: • Temperature Instruments • Flow Instruments • Pressure Instruments • Level Instruments Understand assembling & dismantling techniques. Understand testing techniques of connections. Understand electronic fault diagnosis. Understand the documented data and data sheet for Instruments & sensors. Understand the component parameter, ratings and application of sensors. Understand and interpret technical drawings. Understand different techniques necessary for installation procedures.	Digital thermometer (-10~400 Co) Infrared thermometer (0~2000 Co) Bourdon tube pressure gauge (0~20 Bar) Bourdon tube pressure gauge (0~400 Bar) Insulation tape Bourdon tube pressure gauge (0~200 Bar) Surface level gauge (2 feet) Surface level gauge (8 feet) Capacitance type level instrument Cable tie Work Bench (4x8 feet, height 3 feet) Bench vice Pipe vice Combination plier electrical Nose plier Wire striper Side cutter

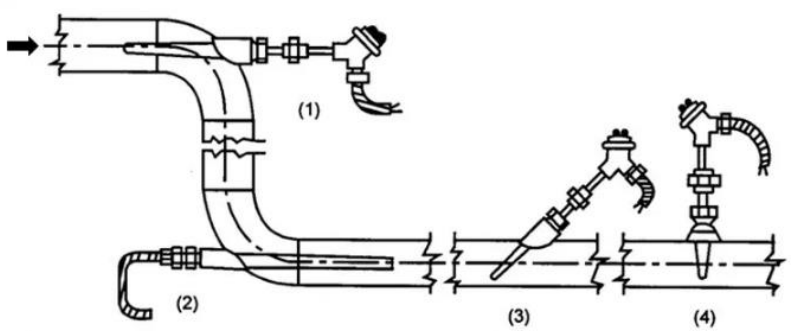
		Prepare report for final results	Pipe cutting tool Tube flaring tool Hacksaw Chisel (8'') Pin punch set Hole punch set (5~ 20mm) Center punch Soldering / de soldering station Digital multimeter Digital RPM meter (0~10000 RPM) Digital clamp meter (0~400A) Frequency meter (0~20MHZ) Digital Micrometer set (0~200mm) Phase tester Tape measures (0~3m) Tape measures (0~50m) Protection suite Safety shoes Safety goggles Hearing protection Respiratory mask First Aid Box Hand glove Flat Screwdriver set Philips Screwdriver set Watchmaker Screwdriver set

			Tweezers Open end spanner set (5~32mm) Ring spanner set (5~22mm) Allen key set (1~10mm) Tagging marks Hand drill machine Lugs punch (up to 10mm) Computer Speakers Multimedia Projector Logbook Handbooks Design Books/ Sheets Pencils Erasers Pencil Sharpeners Paper Cutter Scissors Color Pencils Different Tags and Locks WD-40

Examples and illustrations

The instrumentation on a process plant represents a significant capital investment, and the importance of careful handling on site and the exactitude of the installation cannot be overstressed. Correct installation is also important to ensure long-term reliability and to obtain the best results from instruments that are capable of higher-order accuracies because of advances in technology. Quality control of the completed work is also an important function. Installation should be carried out using the best engineering practices by skilled personnel who are fully acquainted with the safety requirements and regulations governing a plant site. Prior to commencement of the work for a specific project, installation design details should be made available, which define the scope of work and the extent of material supply and which give detailed installation information related to location, fixing, piping, and wiring. When instruments are received on a job site, it is of the utmost importance that they are unpacked with care, examined for superficial damage, and then placed in a secure store, which should be free from dust and suitably heated. To minimize handling, large items of equipment, such as control panels, should be programmed to go directly into their intended location, but temporary anti-condensation heaters should be installed if the intended air-conditioning systems are not commissioned.

https://www.sciencedirect.com/science/article/pii/B9780750671231500314



https://automation.isa.org/temperature-sensor-installation-best-response-accuracy/

Temperature Measuring Instrument Installation

It is very important to install the instrument correct for accurate temperature measurement

Four Consideration -

1.Thermowell Installation

The proper Thermowell instillation starts by finding a measurement point that accurately represents the process temperature and that is easily accessible.

Verify the thermowell provided has the correct insertion length for the pipe or vessel.

Additional Dimension to Confirm - Insulation thickness, Lagging and extension lengths.

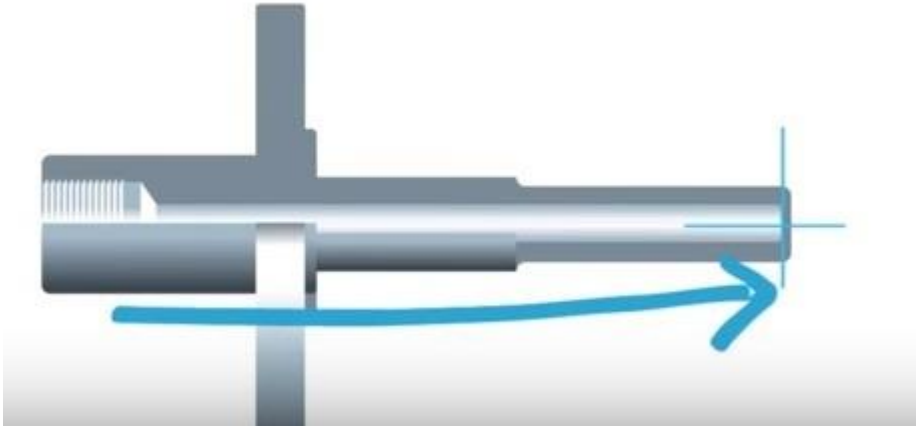
Verify material of construction of the thermowell compatible with the

https://www.emerson.com/en-us/automation/measurement-instrumentation/temperature-measurement/about-temperature-sensors

https://www.emerson.com/en-us/automation/measurement-instrumentation/temperature-measurement/about-temperature-transmitters

pipe or vessel and the process.

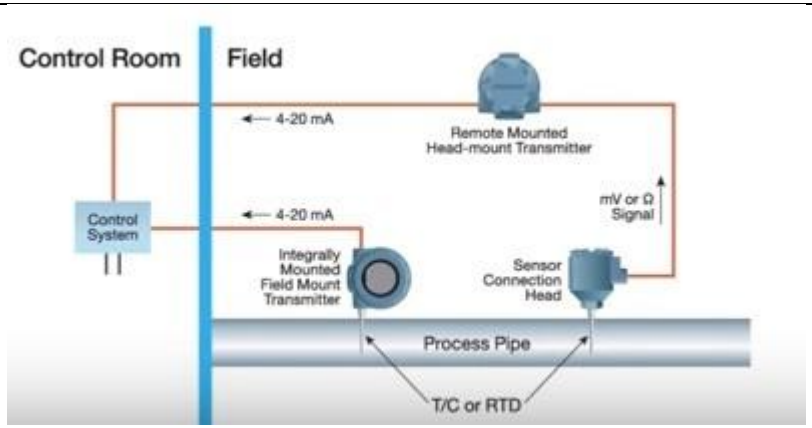
2. Sensor Installation



It is important to make sure that when sensor is inserted to thermowell it should make contact with bottom of the thermowell to ensure accurate measurement.

Connect the sensor wire to the terminal block

3.Transmitter installation



The preferred instillation is to integrally mount to the sensor and thermowell, commonly referred to as direct mounting. Direct mounting will increase noise immunity due to sensor leads being shorter and less exposed to environmental interference.

Transmitters can also be mounted remotely. When selecting the mounting location consider the ease of access to the measurement point including the LCD display and environmental issues such as vibration, corrosion, and ambient temperatures.

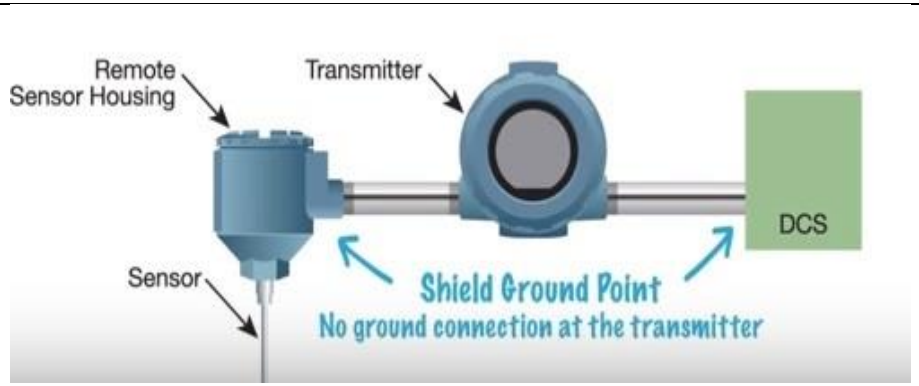
4.Grounding the system

3 most common installation guidelines are

Remote mount with two separate grounding points

Remote mount with Continuous shield

Integral mount

	 **Grounding of Temperature Transmitter.jpg** 502×189 19.4 KB **Reference:** https://automationforum.in/t/how-to-install-temperature-measurement-instrument-properly/953

Videos:

	Topic	Hyperlink
	How to install a Temperature Transmitter	https://www.youtube.com/watch?v=EIxYlpbKE5k

	How to install a temperature probe into a thermowell	https://www.youtube.com/watch?v=eyYEOWMR-4w

 https://instrumentationtools.com/category/erection-commissioning/	**Pre Installation Checks:** Before installation, commissioning and operation ensure that the appropriate pressure gauge has been selected in terms of design, measuring range and corrosion for the specific measuring conditions. In order to guarantee the measurement accuracy and long-term stability specified, the corresponding load limits must be observed. Pressure gauges should be selected considering media and ambient operating conditions. Improper application can be detrimental to the gauge, causing failure and possible personal injury, property damage or death. This information is offered as a guide in making the proper selection of a pressure gauge. Only qualified persons are permitted to install, maintain and service the pressure gauges. For hazardous media such as oxygen, acetylene, flammable or toxic gases or liquids, and refrigeration plants, compressors, etc., in addition to all standard regulations, the appropriate existing codes or regulations must also be followed. Non-observance of the respective regulations can cause serious injuries and/or damage to the equipment **Installation:** **Location –** Gauges should be located to minimize the effects of vibration, extreme ambient temperatures and moisture. Dry locations away from very high thermal sources (ovens, boilers etc.) are

http://www.bkwinstruments.co.uk/

preferred. If the mechanical vibration level is extreme, the gauge should be remotely located (usually on a wall) and connected to the pressure source via flexible tubing.

Gauge reuse – BSEN 837 recommends that gauges not be moved indiscriminately from one application to another. The cumulative number of pressure cycles on an in-service or previously used gauge is generally unknown, so it is generally safer to install a new gauge whenever and wherever possible. This will also minimize the possibility of a reaction with previous media.

Tightening of gauge – This should be done in accordance with the general technical regulations for pressure gauges (EN 837-2). When screwing the instruments in, the force required to do this must not be applied through the case, but only through the spanner flats provided for this purpose, and using a suitable tool. For parallel threads, use flat gaskets or lens-type sealing rings at the sealing face. With tapered threads (e.g. NPT threads), sealing is made in the threads using additional sealing materials, e.g. PTFE tape (EN 837-2) or Teflon tape and must be tightened very securely to ensure a leak tight seal. The torque depends on the sealing used. In order to orientate the measuring instrument so that it can be read as well as possible, a connection with clamp socket or union nut should be used. When a blow-out device is fitted to a pressure gauge, it must be protected against being blocked by debris and dirt. With safety pressure gauges there must be a free space of > 15 mm behind the blow-out back.
Process isolation – A shut-off valve should be installed between the gauge and the process in order to be able to isolate the gauge for inspection or replacement without shutting down the process.

Surface Mounting – Also known as wall mounting. Gauges should be kept free of piping strains. The gauge case mounting feet, if applicable, will ensure clearance between the pressure relieving back and the mounting surface.

	Pressure Gauge Installation: Correct sealing of pressure gauge connections with parallel threads is achieved by means of a suitable sealing ring, sealing washer or WIKA profile seals. The sealing of tapered threads (e.g. NPT threads) is made by the thread itself, with additional sealing material such as, for example, PTFE tape (EN 837-2). Parallel and tapered thread connection In order to simplify the correct orientation of the gauge, connecting the gauge by means of a union nut or a LH-RH adjusting nut is recommended. When screw-fitting or unscrewing the pressure gauge, the torque must not be applied to the housing, but only to the spanner flats on the stem. **Reference:** http://www.trentinstruments.co.uk/files/ww/Gauge%20Operation%20and%20Maintenance%20Manual.pdf

Videos:

	Topic	Hyperlink
	How to Inspect Pressure Transmitter Installation	https://www.youtube.com/watch?v=gPoYRLtFes0

	Differential Pressure Gauge Installation	https://www.youtube.com/watch?v=kIjMzpzQ6wo

https://automation.isa.org/a-closer-look-at-process-instrument-commissioning/

Process Instrument Commissioning (Level & Flow)

Process instrument commissioning is an essential part of an overall plant's commissioning program and is necessary for ideal plant performance. It requires an allocated budget, time, and trained personnel, and must be considered within the scope of the overall program. Typically the most common activities that affect time and cost in a conventional process instrument commissioning program are:

Learning and familiarizing of field devices

Physically installing the field device

Connecting to and identifying the field device

Configuring the required parameters and testing the configuration and

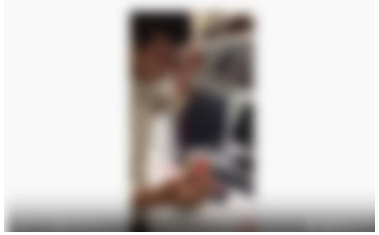
interface to other systems.
With all of these activities, it is obvious that detailed planning is necessary to complete the process. A schedule must be established with benchmarks and monitoring activities in order to keep track of progress. This post will focus on tracking the rate of process instrument commissioning, which is possible to measure (e.g. number of loops or sequence of steps tested per day). For example, a new chemical facility may have a project with 150 loops to check out for a total of 375 instruments (2.5 instruments per loop, on average). Using

	a conventional calibration work method, testing/checkout is 30 minutes per instrument and there is an additional 30 minutes per loop of checkout required, the total estimate man-hours would be 263. This equates to one person working 10 hour days, non-stop for nearly a month. Let's ass ume that this process was appropriately planned for and the correct amount of time, money and man hours were allocated to the project. That is a hefty budget. Now imagine they were using highly automated and paperless work methods. For example, during commissioning, instrument details are readily available from the design engineer. Typically, smart instrumentation is used and smart calibrators can obtain set-up details via HART/FF/PA. By combining this data with system features, instrumentation can be easily checked out prior to start-up and all testing documented in electronic format. Having the field commissioning team organized with test tools that lead them through detailed testing is a tremendous benefit. When power is finally provided to loops, there will be far less issues and less troubleshooting will be required. If there is an issue, test history is readily available for much quicker analysis and solution resolution. Recently, an experienced I&C Engineer told me he estimated the savings in troubleshooting and gain in loop check efficiency saved him "on the order of several man-weeks." Eliminating as many of the "moving parts" involved in this critical activity as possible directly correlates to lower cycle time for loop checks. Using a workflow that replaces paper-based records with electronic records reduces the man-hour requirements inherent with handling paper, both in planning and particularly when a contracted technician in the field also has to manage the equipment required to accomplish the task. Ideally, the equipment required for loop checks and instrument configuration is also providing the technician electronic data when needed and documenting the results. Elimination of hardcopy records also mitigates the risk associated with human error. This risk, if realized, has potential to become extremely costly indeed. All in all, automating the calibration process during commissioning can save

	time, lower risk and reduce costs. The long-term performance of a plant is directly impacted by the care with which the control system is commissioned. Establishing control loop tuning is an important part of the work needed to commission a new plant or an area of the plant in which measurement or control changes have been made. Such work can be rewarding since the impact of a change made in control setup and tuning is immediately seen in the plant operation. However, loop tuning can, at times, also be challenging because of problems in establishing tuning and stable operation of the plant when there is a failure or degraded performance of field devices. To resolve these problems, some investigation and often a trip to the field are required to observe valve movement or the physical condition of a field device and its associated wiring installation. Even when commissioning a new installation, it is common to encounter many problems. A person who does this type of work quickly learns some valuable lessons about commissioning. In Chapter 14 of Control Loop Foundation – Batch and Continuous Processes I address this topic in some detail. Some of the lessons learned that are address in this chapter may be summarized as follows: **Lesson 1 – Be aware of problems in field installation**. Many of the problems associated with control system commissioning have nothing to do with the setup or tuning of the PIDs. It is important to be aware of problems in field installation that may prevent a control loop from working correctly. **Lesson 2 – Observe loop response.** Establish an understanding of the process gain and dynamics by trending the control block PV and OUT using trend screens that are standard in most control systems and by introducing a small step change in the manipulated parameter while the loop is in Manual mode. **Lesson 3 – Validate loop setup.** It is never a good idea to just place a control loop in automatic mode using the default tuning and setup. The positive feedback caused by

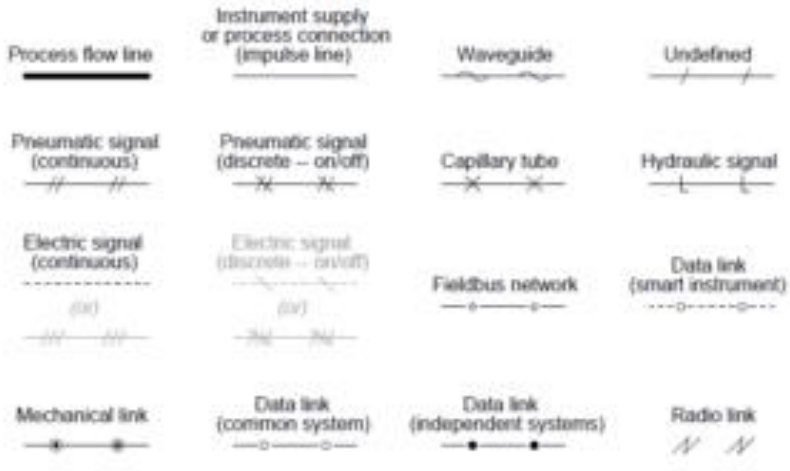
	any unaccounted- for reversals in the transmitter and control system output can cause the manipulated valve, damper drive, variable speed drive to quickly go to a full open or closed position. In an operating plant, such a mistake can cause a process disruption or even a plant shutdown. Whether the PID option for Direct acting and the AO block option for Increase to Close are correctly set can be quickly determined by changing the PID output in manual mode and observing the response. Over the next month I will go into more detail on some aspects of control system commissioning. **Reference:** https://automation.isa.org/a-closer-look-at-process-instrument-commissioning/

Video:

	Topic	Hyperlink
	Calibration Level Transmitter (Instrumentation & Control)	https://www.youtube.com/watch?v=EwfBQC7gMhI

P&ID symbols and abbreviations:

Process lines:



https://automationforum.co/basics-pid-process-instrumentation-diagram/

Instrument Bubbles:

https://automationforum.co/basics-pid-process-instrumentation-diagram/

What is P & ID?

A Process and Instrumentation Diagram (P & ID) shows the process flow and interconnection of process equipment which is used control a process. The P & ID includes every mechanical aspect of the plant except stream flows, pipe routing, pipe lengths, pipe fittings, supports, structure & foundations.

A P&ID provides information to begin planning for construction of plant. There are different Sets of symbols are used to depict mechanical equipment, piping, piping components, valves, drivers and instrumentation and controls. A P&ID diagram contains following information regarding the equipment: size, rating, throughput, and utility usage.

Uses of P & ID:

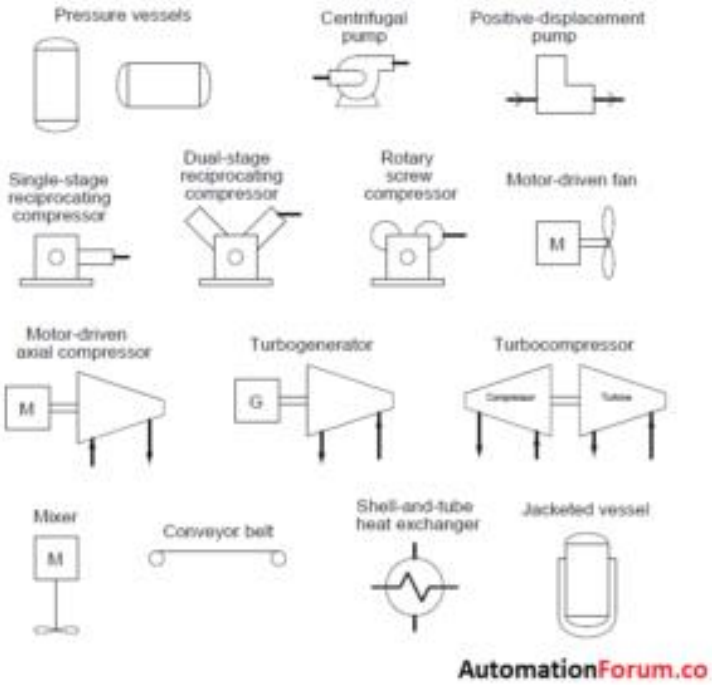
- Used for planning & construction of plant
- Used to operate the process
- Used for maintenance & modification of the process
- Used by mechanical technicians & safety personnel
- Used for HAZOP study of plant
- The controlled document formally issued at various stages of the project

How to create a P&ID?

Different software is available to create or draw a P&ID diagram. Only a few steps to follow to create a p&id diagram, but one who does it should know well knowledge about the plant process.

- Create the full list of instruments and equipment required for the process. Check the symbols used for each equipment from the library.

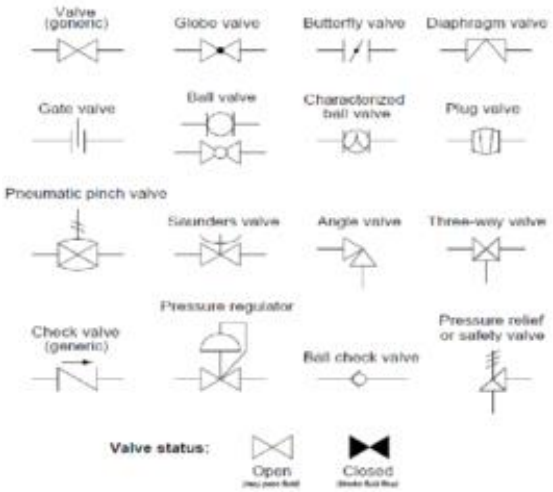
Process equipment's:



https://automationforum.co/basics-pid-process-instrumentation-diagram/

- Arrange all equipment in the process order and do the connection.
- Then review the details with a trusted colleague. Walk through the process several times and search for inefficiencies.
- Discuss with the collates

Valve types:



https://automationforum.co/basics-pid-process-instrumentation-diagram/

VS — Gate Valve
VD — Globe, Needle or Angle Valve
VR — Plug Valve
VB — Ball or 3-way Plug Valve
VDR — Check Valve
VF — Butterfly Valve
VM — Diaphragm Valve
VP — Piston Valve

Temperature:

These symbols are represented in the respective instrument bubbles:

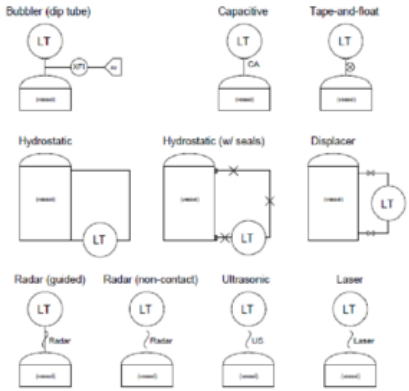
TE = Temperature sensing element
Th = Thermometer Indicator
TRC = Recorder-controller
TR = Recorder

Pressure:

These symbols are represented in the respective instrument bubbles:

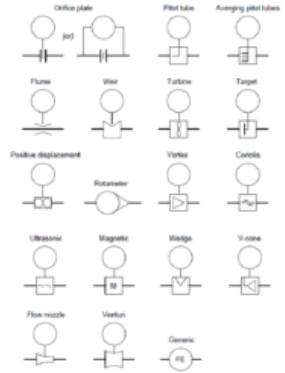
PC = Controller
PI = Indicator

Level:



https://automationforum.co/basics-pid-process-instrumentation-diagram/

Flow:

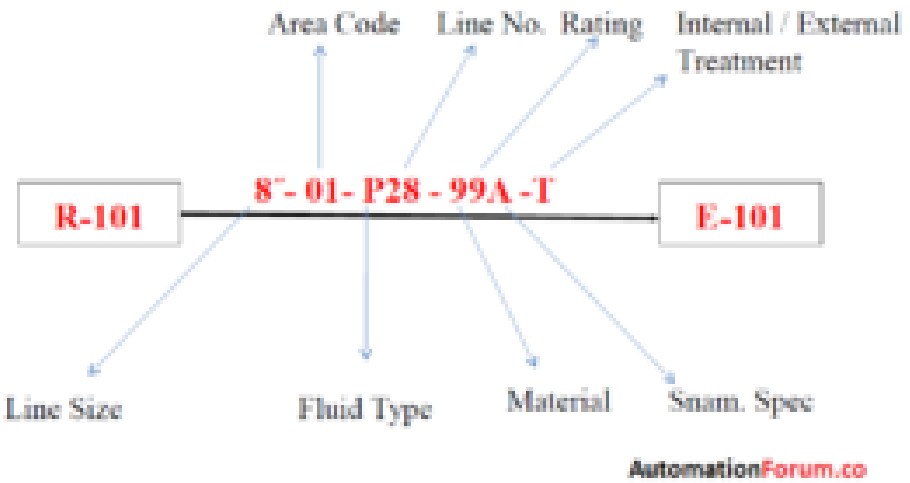


https://automationforum.co/basics-pid-process-instrumentation-diagram/

PIC = Indicator-controller
PR = Recorder

LC = Controller
LG = Glass
LI = Indicator
LR = Recorder

FC = Controller
FE = Test orifice plate
FI = Indicator
FR = Recorder



https://automationforum.co/basics-pid-process-instrumentation-diagram/

How to read a P&ID?

Each instrument in the process and their connections are drawn in a P&ID diagram. Thus the process is simply described in the diagram. Specification of the instruments is written with the instrument symbol. The specification of the line is code in the line or above the line as shown in the below picture:

Area Code:

01 : Urea
02 : Reforming Section
03 : CO2 absorption Section
04 : Synthesis gas compression
05 : Ammonia Synthesis
06 : Steam Generation
07 : Power Generation
08 : CW circulation

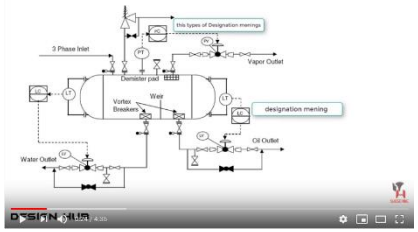
Fluid Type:

KS : Very High-Pressure Steam
HS : High-Pressure Steam
LS : Low-Pressure Steam
P : Process Fluid
IA : Instrument Air
UA : Utility Air
UN : Utility Nitrogen

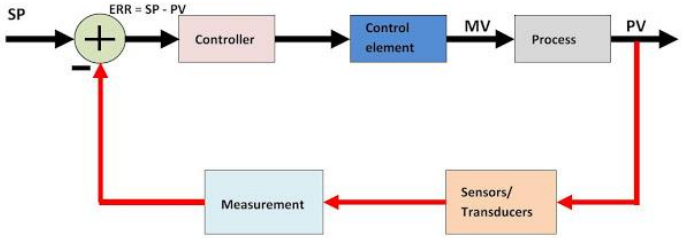
	Material: **1** : Carbon Steel **3** : Austenitic Stainless Steel **4** : Reinforced Thermal Resin Pipe **5** : Si Killed Carbon Steel or CrMo steel **6** : Ferritic Alloy Steel **7** : Cast Steel **8** : Austenitic SS or Ferritic Alloy Steel **9** : Urea Grade SS References: https://automationforum.co/basics-pid-process-instrumentation-diagram/ https://automationforum.co/pid-common-abbreviation/

Videos:

	Topic	Hyperlink
	How to Read Piping and Instrumentation Diagram(P&ID)	https://www.youtube.com/watch?v=kv-nHNa-tYU

	How to read p&id(pipe & instrument drawings)	https://www.youtube.com/watch?v=6Z9521_zUSE

Shown below is the block diagram of a typical process



control loop with feedback control:

https://1.bp.blogspot.com/-idaLrtge5Vc/Tx4HTC4KIGI/AAAAAAAAAOc/q6rOmZo6iVc/s1600/Process+control+loop.jpg

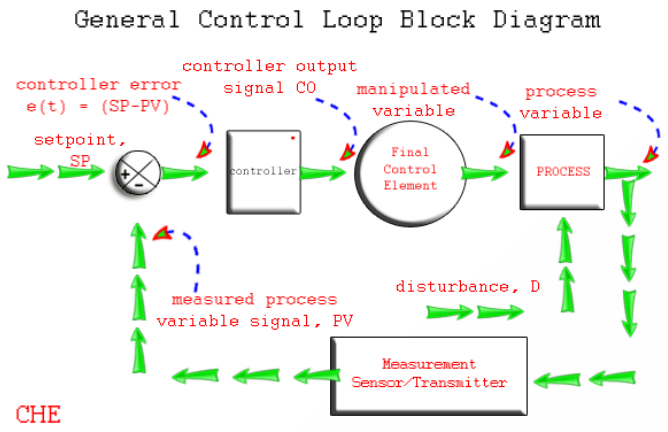
Process Control Loop

In today's modern plants, processes are controlled to achieve desired objectives. The term **control** means methods or means used to force parameters in the environment to have specific or desired values. To achieve control, several elements are coordinated together to achieve the control objective. All the elements necessary to accomplish the control objectives, including the instrumentation systems, are usually described by the term **control system.**

Control can either be **manual** or **automatic**. Manual control involves human intervention and it often entails forcing a given parameter to specific value with the human factor actually carrying out the control function. For example, suppose we want to control the level of water in an open tank which has an inlet valve through which water passes, all we simply do is to station an operator who basically uses his judgement to close the valve when the tank has become full or open the valve when the tank is almost empty.

In automatic control, no human intervention is required rather sensors, controllers, actuators and other control elements are used to automatically control a system to force the system parameters to desired levels.

Elements of an Automatic Control Loop:



https://instrumentationtools.com/understanding-process-control-loop/

An automatic control loop is made up of the following elements:

The process:

In general, a process can consist of a complex assembly of phenomena that relates to some manufacturing sequence or any system we wish to control. Many variables may be involved in such a process, and it may be desirable to control all these variables at the same time. There are **single-variable** processes, in which only one variable is to be controlled, as well as **multi-variable** processes, in which many variables, perhaps interrelated, may require regulation.

Measurement:

To achieve the control of a variable in a process, we must have information on the variable itself. Such information is found by measuring the variable. In general, a measurement refers to the conversion of the variable into some corresponding analog signal of the variable, such as a pneumatic pressure, an electrical voltage, or current. The result of the measurement is a conversion of the variable into some proportional information in a useful form required by the other elements in the process control operation.

Sensors/Transducers:

A **sensor** is a device that performs the initial measurement and energy conversion of a variable into analogous electrical or pneumatic information. Sometimes further transformation or signal conditioning may be required to complete the measurement function. The sensor used for measurement may also be called a **transducer**. The word sensor is preferred for the initial measurement device, while a ***"transducer***" represents a device that converts any signal from one form to another. Thus, for example, a device that converts a voltage into a proportional current would be a transducer. In other words, all sensors are transducers, but not all transducers are sensors.

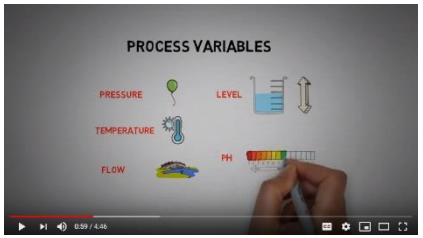
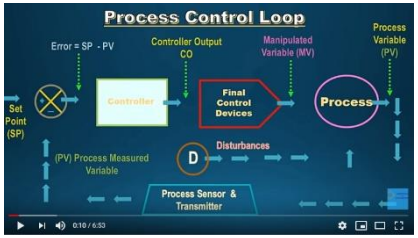
Error Detector:

This is the device that determines whether the variable we desire to control, often

	called the **process variable** is above or below the desired level called the **Set point** or **reference value**. If the process variable is above or below the set point, an error signal proportional to the error is generated. This error signal is then used by the controller to generate a control action. So before any control action takes place, an error signal must be generated. It is worthy to note that the error detector is often an integral part of the controller device; however it is important to keep a clear distinction between the two. **Controller**: The device that acts on the error signal generated to determine what control action, if any, to be taken is called a controller. The evaluation performed to determine control action can be done by electronic signal processing, by pneumatic signal processing, or by a computer. Computer use is growing rapidly in the field of process control because computers are easily adapted to the decision-making operations and because of their inherent capacity to handle control of multivariable systems. The controller requires an input of both a measured indication of the controlled variable and a representation of the reference value of the variable, expressed in the same terms as the measured value. The reference value of the variable, you will recall, is referred to as the set point**.** Evaluation consists of determining action required to bring the controlled variable to the set point value. **Control Element**: The final element in the control loop is a control element that exerts a direct influence on the process; it is the device that provides those required changes in the controlled variable to bring it to the set point. This element accepts an input from the controller, which is then transformed into some proportional operation performed on the process. In most process control loops, the final control element is a valve which is often referred to as the **final control element**. **The Control Loop**: In a control loop, the signal flow forms a complete circuit from the process through measurement, error detector, controller, and final control element. This is called a **loop***,* and in general we speak of a process control loop. In most cases this is

	called a **feedback loop**, because we determine an error and feedback a correction to the process. We also have **open loop**. In open loop, there is no feedback from the process. Here, the control action does not depend on changes in the process variable. Control action is usually based on changes in the input to the process. **How a Process Control Loop Works**: To understand how a process control loop works, I took some time to explain what control is and what a control system does. I also explored the various elements that make up a control loop. Having now understood these basic concepts, how then does a process control loop works? To understand how it works, we refer to the above block diagram of a feedback control loop. The first point of interest for any process control endeavour is the process variable, **PV**. It is the variable we have chosen to control or maintain at a given reference value or set point. So as shown in the process control loop above, the process variable, **PV** is measured with the aid of sensors/transducers. This measured signal is then fed into a controller incorporating an error detector device. Here, the Process variable, PV is compared with the desired value of the process variable or the set point, **SP** and an error signal with a specific magnitude and polarity is generated and further processed within the controller. Based on the processed error signal, the controller initiates a control action with the aid of the control element or final control element as it is often known. The final control element, initiates a change in the process by changing the manipulated variable, MV, which then alters the process until it settles at the set point. In this way, the process variable is taken back to its desired value or set point. This is essentially how a process control loop works. Most complex process plants are operated with this simple underlying principle of process control. **References:** https://www.quora.com/What-is-the-difference-between-Systems-and-control-Control-Engineering-and-Process-control-if-any

Videos:

	Topic	Hyperlink
	Process Control Loops and Instrument Techs	https://www.youtube.com/watch?v=2EpFIhUHm28
	What is Process Control Loop in Instrumentation?	https://www.youtube.com/watch?v=4N5TDC_2xc4

PRECISION INSTRUMENTATION

Module-5
LEARNER GUIDE
National Vocational Certificate Level 3

Version 1 - November, 2019

Module 5: 0714001036 Calibrate instruments

Objective of the module: The aim of this module is to develop advanced knowledge, skills and understanding to calibrate instruments.

Duration: 180 Hrs **Theory:** 30 Hrs **Practical:** 150 Hrs

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU1: Calibrate temperature instruments	**The trainee will be able to:** Plan and set standard/master calibrator necessary for calibration. Check and verify instrument reliability or any damage. Ensure proper working of temperature calibration apparatus. Install and set-up standard/master calibrator Perform calibration tasks as per standards. Verify performance of instrument as per standards and calibrate if necessary. Document test results as per SOP	Define types of hazard. • Fire • Inflammable Material • Explosive gases • Toxic Chemicals Understand and implement P & ID drawing. Understanding a Process Control Loop. Understanding of IFCD (Interface Control Diagram) Understand safety regulations. Understand Electrical/ Electronic/Instrumentation symbols Understand the functional parameters of temperature instruments. Understand the SOP of instrument commissioning process. Prepare a technical report Understand the functions of Temperature master calibrator	Temperature Calibrator (0~600Co) Temperature Calibrator (400~2000Co) Digital multimeter Millivolt source (-10~10v) Milliampere source (0~20mA) Safety shoes Safety goggles First Aid Kit Test probes Hand glove Digital Thermometer (0~400Co) Screwdriver set Tweezers Wire Cutter Combination Plier Nose pliers Watch makers screwdriver set Allen key set

			Spanner set metric / imperial Adjustable spanner set Computer Speakers Multimedia Projector Logbook Handbooks Design Books/ Sheets Pencils Erasers Pencil Sharpeners Paper Cutter Scissors Color Pencils Different Tags and Locks WD-40
LU 2: Calibrate pressure instruments	**The trainee will be able to:** Plan and set standard/master calibrator necessary for calibration. Check and verify instrument reliability or any damage. Ensure proper working of pressure calibration apparatus. Install and set-up	Define types of hazard. • Fire • Inflammable Material • Explosive gases • Toxic Chemicals Understand and implement P & ID drawing. Understanding a Process Control Loop. Understanding of IFCD (Interface Control Diagram)	Pressure Calibrator (0~20bar) Pressure Calibrator (100~600bar) Pressure Calibrator (-1~0bar) Digital multimeter Digital Leak tester Millivolt source (-10~10v) Milliampere source (0~20mA) Safety shoes

	standard/master calibrator Perform calibration tasks as per standards. Verify performance of instrument as per standards and calibrate if necessary. Document test results as per SOP	Understand safety regulations. Understand Electrical/ Electronic/Instrumentation symbols Understand the functional parameters of Pressure instruments. Understand the SOP of instrument commissioning process. Prepare a technical report Understand the functions of Pressure master calibrator	Safety goggles First Aid Kit Test probes Hand glove Screwdriver set Tweezers Wire Cutter Combination Plier Nose pliers Allen key set Spanner set metric / imperial Adjustable spanner set Computer Speakers Multimedia Projector Logbook Handbooks Design Books/ Sheets Pencils Erasers Pencil Sharpeners Paper Cutter Scissors Color Pencils Different Tags and Locks WD-40
LU 3: Calibrate	**The trainee will be able**		Level Calibrator

Level instruments	**to:** Plan and set standard/master calibrator necessary for calibration. Prepare standard/master calibrator necessary for calibration Check and verify instrument reliability or any damage. Ensure proper working of level calibration apparatus. Install and set-up standard/master calibrator Perform calibration tasks as per standards. Verify performance of instrument as per standards and calibrate if necessary. Document test results as per SOP	Define types of hazard. • Fire • Inflammable Material • Explosive gases • Toxic Chemicals Understand and implement P & ID drawing. Understanding a Process Control Loop. Understanding of IFCD (Interface Control Diagram) Understand safety regulations. Understand Electrical/ Electronic/Instrumentation symbols Understand the functional parameters of Level instruments. Understand the SOP of instrument commissioning process. Prepare a technical report Understand the functions of Level master calibrator	(0~20feet) Digital multimeter Millivolt source (-10~10v) Milliampere source (0~20mA) Safety shoes Safety goggles First Aid Kit Test probes Hand glove Screwdriver set Tweezers Wire Cutter Combination Plier Nose pliers Watch makers screwdriver set Allen key set Spanner set metric / imperial Adjustable spanner set Computer Speakers Multimedia Projector Logbook Handbooks Design Books/ Sheets Pencils

			Erasers Pencil Sharpeners Paper Cutter Scissors Color Pencils Different Tags and Locks WD-40
LU 4: Calibrate flow instruments	**The trainee will be able to:** Plan and set standard/master calibrator necessary for calibration. Prepare standard/master calibrator necessary for calibration Check and verify instrument reliability or any damage. Ensure proper working of flow calibration apparatus. Install and set-up standard/master calibrator Perform calibration tasks as per standards. Verify performance of instrument as per standards and calibrate if necessary.	Define types of hazard. • Fire • Inflammable Material • Explosive gases • Toxic Chemicals Understand and implement P & ID drawing. Understanding a Process Control Loop. Understanding of IFCD (Interface Control Diagram) Understand safety regulations. Understand Electrical/ Electronic/Instrumentation symbols Understand the functional parameters of Flow instruments. Understand the SOP of instrument commissioning process. Prepare a technical report Understand the functions of Flow master calibrator	Gas Flow Calibrator ($0\sim10m^3$) Liquid Flow Calibrator ($0\sim10m^3$) Digital multimeter Digital Leak tester Millivolt source (-10~10v) Milliampere source (0~20mA) Safety shoes Safety goggles First Aid Kit Test probes Hand glove Screwdriver set Tweezers Wire Cutter Combination Plier Nose pliers Watch makers screwdriver set Allen key set

	Document test results as per SOP		Spanner set metric / imperial Adjustable spanner set Computer Speakers Multimedia Projector Logbook Handbooks Design Books/ Sheets Pencils Erasers Pencil Sharpeners Paper Cutter Scissors Color Pencils Different Tags and Locks WD-40

https://in.omega.com/technical-learning/calibrating-temperature-measurement-devices.html

Calibrate temperature instruments

The simplest way to calibrate a temperature sensor is to check how it reads the temperature of two physical constants: the temperature at which ice melts and the boiling point of water (although the latter should be corrected for atmospheric pressure). While quick and inexpensive, one weakness of this method is that it is typically not a NIST traceable calibration.

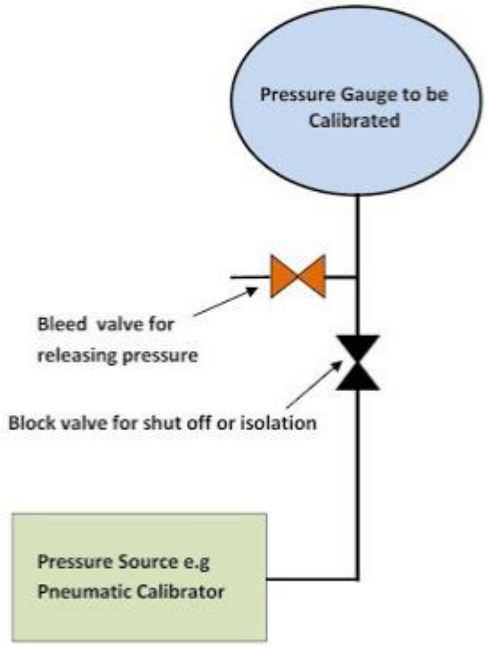
Dry block probe calibrators overcome this problem and provide a quick and accurate means of calibrating thermistor, thermocouple and RTD probes. A calibrator like OMEGA's hot point® Dry Block Probe Calibrator is used to heat a thermocouple to a chosen temperature and the reading on the indicator compared with that on the Calibrator. Next, an ice point® Reference Cell such as the OMEGA TRCIII is used to provide the 0oC comparison temperature. Again, the indicated reading is compared with that on the calibrator. Corrections can be determined from these two measurements.

Thermocouple operation can also be verified by simulating the electrical signal produced by the probe and checking the expected reading against that indicated.

Infrared Blackbody Calibrators are used for calibrating noncontact temperature measurement equipment such as thermal cameras and pyrometers. These use a surface of "perfect" emissivity (between 0.95 and 0.98) that is heated to a known temperature and compared with the reading from the device. (Note that while accuracy depends on the quality of the temperature measurement within the Blackbody Calibrator, and may only be with 1%, repeatability should be very high).

Reference:

https://in.omega.com/technical-learning/calibrating-temperature-measurement-devices.html



https://www.instrumentationtoolbox.com/2013/02/how-to-calibrate-pressure-gauge.html

Pressure Gauge Calibration Procedure:

Verify that the calibrator has been currently calibrated in accordance with manufacturer's specification.

Step1: Before applying any pressure to the gauge set

the pointer to read zero on the scale.

Step2: Apply full range pressure to the gauge. Adjust the linkage so that the pointer is at the scale.

Step3: Reduce the pressure to zero and check that the pointer reads zero on the scale. Adjust pointer if necessary.

Step4: Repeat step2 and 3 until both readings are correct.

Step5: If the pressure gauge has a linearizing adjustment, set the applied pressure to 50% of the maximum scale reading. Adjust the linearizing adjustment so that the pointer reads at 50% of the maximum scale reading.

Step6: Check the pressure gauge reads correctly at 0, 50% and maximum scale reading. May need to adjust the gauge many times before the gauge is correct. Must be patient and careful.

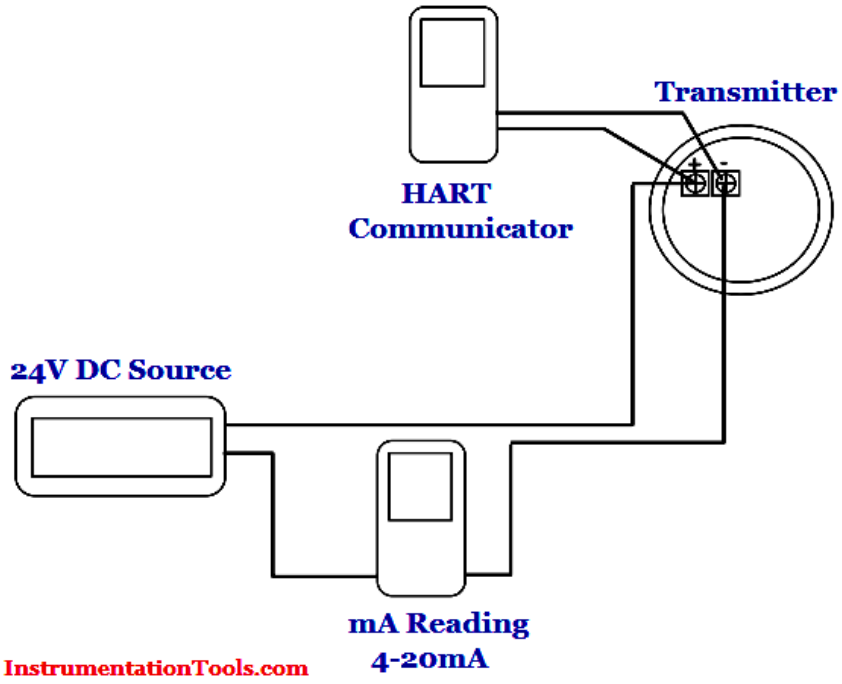
Step7: When step6 is completed, write down the reading on the gauge for the applied pressure reading on a calibration sheet.

Step8: Draw a graph of the gauge readings and the applied pressure (Increasing and Decreasing). This is important if you are doing a bench calibration and intend to generate a calibration certificate after the calibration exercise.

Reference:

	https://www.instrumentationtoolbox.com/2013/02/how-to-calibrate-pressure-gauge.html

Calibration Setup Diagram:



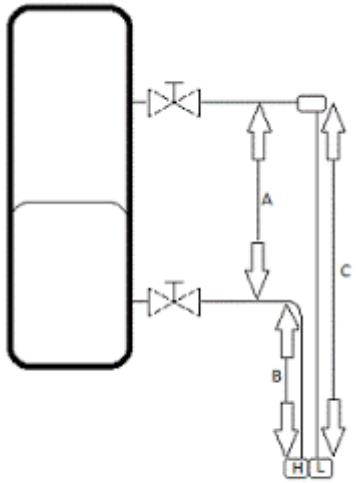
Level Transmitter Calibration Procedure

Calibration Procedure

1. Set up the guided wave radar level transmitter, HART communicator, power supply, and the multimeter as below (see below calibration setup Diagram).
2. Check the configuration of the lower range value (0% level, 4 mA) and high range value (100% level, 20 mA). Make sure that the inputted data is as per datasheet. For example, the lower range value is 10 inch and the high range value is 35 inch (both of it are measured from the bottom of level transmitter probe)
3. Fill the level transmitter chamber with water up to the 0% level. Read the level measurement in the transmitter LCD (or in the HART communicator). Set this condition as 0% level through HART communicator.
4. Read the mA output of the transmitter by using a multimeter. Adjust (if any) through the HART communicator so that the output of the transmitter (on multimeter) is 4 mA.
5. Fill the level transmitter chamber with water up to the 100% level. Read the level measurement in the transmitter LCD (or in the HART communicator). Set this condition as 100% level through HART communicator.
6. Read the mA output of the transmitter by using a multimeter. Adjust (if any) through the HART communicator so that the output of the transmitter (on multimeter) is 20 mA.

Typical tools required:

1. 24 VDC power supply
2. Multimeter digital
3. Water Supply Connection
4. HART communicator



https://2.bp.blogspot.com/-FRp77XuHCn8/T5vPne7UWUI/AAAAAAAAAM0/Qtm1F9XI1r8/s1600/diiferential_pressure_level_transmitter.gif

5. Screwdriver set
6. Wrench set

Optimal performance of a level transmitter is critical in any industrial operation that involves storing bulk quantities of fluids or fluidized solids. To maximize the performance of their systems, companies must understand – and utilize – leading calibration techniques.

Calibrating level transmitters will help protect against problems related to the accounting of materials and against damage to tanks and pumps that incorrect measurement can cause.

Let's outline some best practices for calibrating level transmitters.

Calculate the Differences between Your Test Fluid and Your Process Fluid

For the vast majority of applications, companies will not be using their process fluid to complete the calibration work. In some cases, the process fluid is unsuitable for testing. In other cases, the fluid might be wasted during the testing procedure, and so the company will use water or another less expensive fluid to complete their calibrations.

Each level transmitter will be set by its manufacturer for a fluid-specific gravity. This means companies must calculate the difference in buoyancy between the fluid they use in their processes and their test fluid. The typical calculation for this range would be the following:

process fluid specific gravity / water specific gravity x transmitter level range

	Determine Acceptable Tolerance Level In beginning the calibration work, it's important to understand the acceptable tolerance level for the process. One of the benefits of specifying a tolerance level at the inception of calibration work is that it allows team members to work within these parameters. This can help eliminate many of the mistakes made when calibrating level transmitters and can act as a guide for equipment performance moving forward. **Use a Leading-Class Isolation Valve** A high quality isolation valve enables operators to ensure optimal process effectiveness during their calibration work. It's important that the isolation valve chosen has the ability to clean the process lines between the tank and the transmitter both before and after calibration has taken place. This helps maximize timing efficiency during calibration and ensures that results of the calibration meet the highest standards of measurement accuracy. For pulp and paper mills running calibration processes according to ISO certification standards on a regular basis, it's also imperative that the isolation valve can be closed during calibration work. **Skilled Technicians Must Assess All Factors That Can Affect Measuring** Accurate level measurement is absolutely crucial. Incorrect measurement can cause all manner of problems – overflow, pump problems, pump failure, leak of hazardous materials into the environment, etc. To measure and calibrate correctly, an industrial organization must be confident it has

	skilled technicians who will always make the correct calculations allowing for the many possible variables. Measurements can vary wildly according to the physical state of the substance – liquid, slurry or solid – and be affected by temperature changes, pressure changes, agitation levels, density, vibration, shock, noise, even by the shape of the tank. Best practice demands that the best technicians be used. Effective level transmitter calibration empowers a broad range of industrial organizations to improve the performance of their systems. By following these guidelines, and speaking with trusted calibration specialists, firms can secure their process integrity over the long-term. **Calibration procedure: Differential pressure level transmitter** **How to calibrate Dp level transmitter at field** **Material Required** Data sheet Pressure calibrator (std) Multimeter (std) Hart communicator **Step** *Ask panel man to put the controller in manual mode for control loop and to put it on MOS for ESD loop. *Hook up HART Communicator and verify some parameters by refer to data sheet. Typical parameters are, tag number, PV, LRV and URV. *Isolate the instrument from the process. *Release both pressure and drain low and high side liquid throughout manifold drain. *Open both plug at seal pot *Top up seal liquid for low side until half of seal pot. *Remove tubing at high side of manifold

	*Hook up pressure calibrator at high side and isolate the vent valve *Hook up a multimeter in series with the signal to the DCS to measure current signal. *Apply pressure as per calculation when level equivalent to zero *Multimeter should show 4mA *If not, do zero adjustment at transmitter using HART Communicator *Apply pressure as per calculation when level equivalent to 100%Multimeter should show 20mA If not, do span adjustment at transmitter using HART Communicator *After completion of the job ask panel operator to put loops back in normal mode or normalize the MOS *Fill the calibration form and file it for future reference. Note: There is many way to perform calibration for DP level but the important thing is the DP reading at HART communicator should same with the LRV and URV **Reference:** https://indu-tech.com/how-the-indu-tech-valve-will-benefit-you/ https://www.iso.org/committee/45674/x/catalogue/

https://www.flowcontrolnetwork.com/flowmeter-calibration-and-recalibration/

Methods of Flowmeter Calibration

Flowmeters measuring liquid and gas flow are tested or calibrated using somewhat different methods. This article focuses mainly on calibration of flowmeters measuring liquid flow.

There are several main methods for calibrating and recalibrating flowmeters:

- Master Meter
- Piston Prover
- Gravimetric

Master Meter Calibration

A master meter is a calibrated flowmeter that is used as a calibration standard. The master meter is placed in series with the flowmeter under test, and the results are compared at different flowrates. A master meter must be compatible with the fluid being tested. So, a magnetic flowmeter would not work as a calibration standard for hydrocarbon liquids, but it can potentially work well with water and industrial liquids. Positive-displacement meters are often used as master meters for hydrocarbon liquids.

For a master meter to serve as a calibration standard, its calibration must be traceable back to some national or international standard. This means there is an unbroken chain of measurements back to the primary standard. For example, a master meter might be calibrated with a flowmeter that was calibrated at the national standards laboratory. According to the VIM, traceability is “the property of a measurement result whereby the result can be related to a reference through a documented unbroken chain of calibrations, each contributing to the measurement uncertainty.”

https://www.flowcontrolnetwork.com/flowmeter-calibration-and-recalibration/

Piston Prover Calibration

Piston provers are a primary standard for flow calibration. A piston prover consists of a round cylinder with a known internal diameter. The cylinder contains a sealed piston. The piston strokes through known and measured lengths to produce volumetric flow. Flow volume is determined by multiplying the cross sectional area of the piston by the length travelled by the piston. Flowrate is derived by dividing the volume by the time it took the piston to move through the distance it travelled.

The known volume of liquid as determined by the piston prover is passed through the meter under test, and the results are compared. Since the volume of liquid has been accurately measured, this provides a very good indication of the accuracy of the meter under test. This method works for water, industrial liquids, and petroleum-based liquids. In some cases, it is necessary to take temperature and pressure values into account when making the measurements.

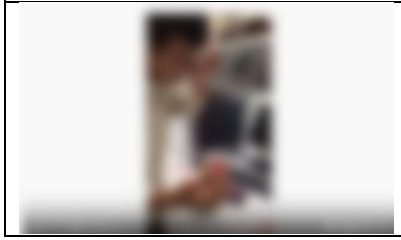
Gravimetric Calibration

Another highly reliable method of calibrating liquid flowmeters is to weigh the liquid that passes through the meter under test in a specified period of time, such as 1 minute. In order to obtain an accurate reading of the weight, a calibrated weigh scale is generally used. Actually implementing this method requires a little creativity. Since this is a timed measurement, the piping needs to be filled with flowing liquid before the test begins. At this point, the flow should be going into a discharge container.

To start the test, simultaneously switch the flow into the weighing container and start timing the flow. Once the desired time is reached, simultaneously divert the flow from the weighing container and into the discharge chamber and stop timing the flow. You can derive flowrate by converting the weighed volume to the desired units and then dividing by the time. Now compare this flowrate to the flowrate recorded on the flowmeter. This is a description of a manual process, but automated

	versions of this process also exist, and they are no doubt more reliable. **Reference:** https://www.flowcontrolnetwork.com/flowmeter-calibration-and-recalibration/

Videos:

	Topic	Hyperlink
	Instrumentation Pressure Calibration Training	https://www.youtube.com/watch?v=Up2ZvNVTugE
	Temperature Transmitter calibration	https://www.youtube.com/watch?v=NCC3LSlRUaY
	Calibration Level Transmitter	https://www.youtube.com/watch?v=EwfBQC7gMhI

	What is Calibration of instruments	https://www.youtube.com/watch?v=RsdCVs-gquc&list=PLyjJ8wslOMk_a_UvO0oRwWzgtejYrS87v

Module summary

Module	Learning Unit	Duration
Module1: Ensure Health, hygiene and safety of other individuals at work **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to ensure health, hygiene & safety of the trainee and others at work.	**LU 1:** Identify what can harm people in your workplace **LU 2:** Identify who might be harmed **LU 3:** Ensure health, hygiene and safety of individuals at work	40 Hrs
Module 2: Perform Benchwork **Aim:** The aim of this module is to develop knowledge, skills and understanding to perform bench work.	**LU 1:** Perform sawing **LU 2:** Perform filing **LU 3:** Perform drilling **LU 4**: Perform hand taping **LU 5:** Perform hand reaming **LU 6:** Perform counter boring **LU 7:** Perform countersinking	90 Hrs

Module	Learning Unit	Duration
Module 3: Fabricate piping & tubing system **Aim:** The aim of this module is to develop knowledge, skills and understanding to fabricate piping & tubing system.	**LU 1:** Interpret drawings/ layouts **LU 2:** Prepare work area **LU 3:** Bend/ Cut pipes & tubes **LU 4:** Perform threading **LU 5:** Braze pipes **LU 6:** Make welded joints through arc welding **LU 7:** Install pipelines	150 Hrs
Module 4: Install & Commission Instruments **Aim:** The aim of this module is to develop knowledge, skills and understanding to install & commission instruments.	**LU 1:** Install & commission temperature instruments **LU 2:** Install & commission pressure instruments **LU 3:** Install & commission level instruments **LU 4:** Install & commission flow instruments **LU 5:** Recommission process loop	180 Hrs
Module 5: Calibrate Instruments **Aim:** The aim of this module is to develop knowledge, skills and understanding to calibrate instruments.	**LU 1:** Calibrate Temperature Instruments **LU 2:** Calibrate Pressure Instruments **LU 3:** Calibrate Level Instruments **LU 4:** Calibrate Flow Instruments	180 Hrs
Module 6: Communicate at workplace **Aim:** The aim of this module is to develop knowledge, skills and understanding to communicate at workplace	**LU 1:** Communicate within the organization **LU 2:** Communicate outside the organization	40 Hrs

Level-3 Short Questions/Answers

Module-1 Ensure Health, hygiene and safety of other individuals at work

Questions	Answers
Write OSHA guidelines for a first supplies inside a first aid kit?	OSHA doesn't specify strict guidelines on what exactly these first aid kits should contain outside of the minimum because there are numerous different working environments with varying needs.
How can I improve my workplace safety?	Workplace safety should be a continuous effort for any company. It will most likely never achieve perfect safety, so there will always be areas for improvement. Here are some ways which we can start improving the safety on facility: • Organize workplace • Form a safety committee • Perform a Job Safety Analysis • Go visual • Take a Gemba walk
What are common safety hazards in a facility?	This list is just a few of the most common safety risks found in a facility: • Slips, Trips, and Falls • Electrical hazards • Chemical hazards • Crane and forklift safety
What are different types of workplace safety?	OSHA has identified five different types of hazards that most workplaces. These are hazards that can be found in nearly every type of facility and should be addressed to keep workers from injury or health problems. • Safety hazards • Biological hazards • Physical hazards

	• Ergonomic hazards • Chemical hazards
What is the role of PPE in workplace safety?	Personal protective equipment, or PPE, is any type of equipment or clothing worn by a person to protect them from a specific hazard and minimize exposure to the hazard. Industrial workplaces can often be a dangerous place, and PPE is an effective and proven way to improve the safety of a facility.

Module-2 Perform Bench work

Questions	Answers
Why we use hacksaw?	It is a basic hand cutting tool used for cutting unwanted material. It is used for cutting metals and making recesses priper to filing or chipping. It is also used for cutting slots and contours.
Write down the name of common types of file, cross sectional wise.	The files of different cross section or types are needed to suit the various job operations. The most commonly used files are (a) Flat file (b) (b) Square file (c) Round file (d) Half round file (e) Triangular file
Why we use reamer?	A drill does not produce accurate hole and it must be finished by finishing tool called reamer. When an accurate hole with a smoother finish a required a reamer is used
How many types of threading dies, write the name?	These are mainly two types 1. Solid Die 2. Adjustable Die.

Module-3 Fabricate Piping & Tubing System

Questions	Answers
What is difference between orthographic and pictorial views?	Orthographic projection is commonly used because it gives 100% details of an object by drawing different views e.g. Elevation, Plan, side views, section views auxiliary views etc. It is 2-D, whereas Pictorial views are 3-D and don't give full details. Yes pictorial projection can be understood by a layman easily, but orthographic projection can be understood by an engineer or concerned person only.
What is orthographic projection and why it is called so?	An orthographic projection is called so because projectors drawn from the corners of an object are parallel to each other and perpendicular to the plane of projection.
Which type of pipe is commonly used for water, steam, oil, and gas?	Steel or wrought iron type of pipe is commonly used for water, steam, oil, and gas.
Which tool is generally used to cut threads on G.I. pipe?	Generally die and stock is used to cut threads on G.I. pipe.
In brazing what is the melting point of filler metal.	The filler metal melting point is 420°C in brazing.
Which physical property is responsible for weld metal cracking?	The stresses which get developed in welding during shrinkage are of importance. These stresses are considered to be an important factor which is responsible for the cracking that occurs in metal welds.

Module-4 Install & Commission Instruments

Questions	Answers
What is operational principle of Resistance temperature detectors (RTD)?	RTDs operate on the principle that the electrical resistance of a metal increases as temperature increases, a phenomenon known as thermos resistivity.
What is fluid expansion system?	Fluid expansion system is a method for measuring temperature, in which expansion of liquid is measured with temperature.
What is the difference between water and transformer oil as a manometric liquid?	Both water and transformer oils are used in small pressure differential applications, but the difference is that water has problems related to relatively faster evaporation.
Which devices convert pressure to displacement?	Diaphragm and capsule both convert pressure into displacement which can be measured using indicating instruments. Displacement will be proportional to applied pressure.
Where a Centrifugal force element is used for?	Centrifugal force element for measuring flow rate is only applicable for high flow rate, below which it doesn't produce any recognizable change.

Module-5 Calibrate Instruments

Questions	Answers
In a measurement, what is the term used to specify the closeness of two or more	Closeness of two or more measurements is termed as precision. For example, if two measurements gives 3.1kg as output, then the

measurements?	measurement is said to be more precise.
Accuracy and Precision are dependent on each other?	Accuracy is the closeness of a measured value with a standard value. Precision is the closeness of two or more measured values. Hence they are not dependent with each other.
During a measurement, for a measure value “B”, absolute error is obtained as “A”, what will be the relative error of measurement?	Ratio of absolute error to measured value is called relative error. i.e. Relative error = (Absolute error) / (Measured value).
In a measuring system what is the term used to specify a difference between higher and lower calibration values?	Span is the difference between higher and lower calibration values. For an instrument with a range 100 units to 250 units span are 150 units.

Level-3 (Multiple Choice Questions)

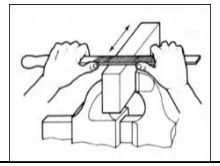
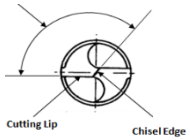
Module-1 Ensure Health, hygiene and safety of other individuals at work

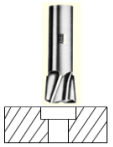
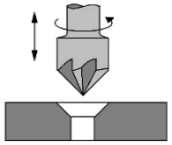
Question	Answer
Ref to figure the given sign is used for _____ . 	**a) Emergency exit** b) Fire alarm c) Not to run d) First aid
_____should be used when working in a dusty environment.	**a) Dust mask** b) Face shield c) Goggles

	d) Respiratory mask
Good housekeeping helps prevent workplace from _____.	a) People b) Games **c) Fire and Accident** d) Noise and Fume
RPE stands for_____.	a) Real protective equipment **b) Respiratory protective Equipment** c) Respiration protective engineering d) Resistance to protective environment
A place where any flammable gases, vapours, dust, fumes, scrap or waste etc. occur, known as:	a) Garden b) Workshop **c) Hazardous place** d) Safe place
Which sign presents warning?	**a) Triangular sign in yellow colour** b) Circular sign in green colour c) Circular sign in black colour d) Triangular sign in blue colour
_____are used for toe protection against	**a) Safety shoes**

falling objects.	b) Goggles c) Gloves d) Overall

Module-2 Perform Bench work

Question	Answer
For Hacksaw, TPI stands for_____.	a) Taper per inch. b) Teach per instruction. c) Tool per inch **d) Teeth per Inch.**
Which filing technique is shown in the figure? 	**a) Draw filling.** b) Cross filling. c) Taper filling. d) Straight filling.
Identify the angle which is shown in figure. 	a) Clearance angle. **b) Wedge angle** c) Rack Angle d) Secondary Angle
Before carried out the reaming operation _____operation must be done.	a) Threading. **b) Drilling.** c) Boring Drill. d) Taper Drilling.
The tool which is shown in figure is _____. 	a) Die nut. **b) Split die.** c) Tapping Die. d) Ring Gauge.

The process shown in figure is called _____. 	a) Reaming. **b) Counter boring** c) Drilling d) Chamfering
Identify the type of Operation in given figure. 	a) Counter boring operation. **b) Counter Sink operation.** c) Drilling. d) Reaming.
_____fluted reamers generally used when extreme accuracy required.	a) Helix. **b) Straight.** c) Long. d) Inclined.
Ear plugs and defenders are used _____.	a) To save hairs from entanglement b) To save hands from chemical or debris. **c) To avoid noise pollution** d) To save eyes from flying objects

Module-3 Fabricate Piping & Tubing System

Question	Answer
In 1st angle projection, the front view will be below the top view.	a) True **b) False**
The measured size of a finished part is?	**a) Actual size** b) Basic size c) Production size

	d) Dimensioned size
What is the size of A2 drawing paper in engineering drawing?	a) 210 x 297 b) 297 x 420 **c) 420 x 594** d) 594 x 841
The pipes will expand considerably when the product temperatures are high and during cleaning.	a) **True** b) False
The filler metal used in brazing has melting point of above.	a) 200°C b) 300°C **c) 420°C** d) 520°C
In metal arc welding, the filler material required is.	a) Iron b) Copper c) Aluminum **d) No filler is required**
Which among the following methods is generally used to cut threads on G.I. pipe?	a) By centre lathe b) By thread rollers c) By tap sets **d) By die and stock**
Which among the following is used to block up the pipe on one end.	a) Union **b) Plug** c) Socket d) Cross

Module-4 Install & Commission Instruments

Question	Answer
The most rugged temperature sensing	**a) Thermocouple** b) Orifice plate

element listed here is a/an:	c) RTD d) Filled bulb
The negative lead of a thermocouple is always coloured:	a) Blue b) Yellow **c) Red** d) White
Which of the following is not a type of pressure sensing element?	a) Bellows b) Bourdon tube c) Manometer **d) Orifice plate**
Another word for “pressure” is:	a) pH **b) Force** c) Flow d) Density
The main advantage of a “dip tube” or “bubbler” system for level measurement is that:	**a) It isolates the pressure transmitter from the process fluid** b) It always elevates and never suppresses the calibration range c) It is less expensive to operate than a direct-connected transmitter d) It compensates for changes in liquid density
Suppose a storage vessel holds a liquid of unpredictable density. Identify which level measurement technology will not maintain accurate measurement of liquid height in the vessel as the liquid density changes:	**a) Differential pressure transmitter** b) Guide wave radar c) Ultrasonic d) Float and tape
As an incompressible fluid moves through a restriction.	a) Velocity decreases and pressure increases b) Velocity increases and pressure increases

	c) Velocity increases and pressure remains the same **d) Velocity increases and pressure decreases**
A magnetic flowmeter will not properly measure the flow rate of:	a) Dirty water b) Milk **c) Oil** d) Caustic

Module-5 Calibrate Instruments

Question	Answer
A time-honoured standard for low-temperature industrial calibrations is pure water.	**a) Pure water** b) Pure air c) Pure oil d) Pure caustic
The RTD resistance will change with respect to the temperature. So temperature will be measured by using the RTD resistance.	**a) True** b) False
A substance or device used as a reference to compare against an instrument's response is called a calibration standard.	**a) True** b) False
In order to calibrate an instrument, we not need to know the input and/or output quantities associated with the instrument under test.	a) True **b) False**
Accuracy of an measuring instrument indicates the:	**a) Closeness of the output reading to the true value** b) Ratio of output value to the input value c) Change in output with each change in input

	d) Degree of freedom from random errors
If a pressure gauge of range 0-10 bar has a quoted inaccuracy of ±1.0 % of full scale reading, then it means.	a) Minimum expected error in any reading is 0.1 bar **b) Maximum expected error in any reading is 0.1 bar** c) Maximum expected error in any reading is 1 bar d) Minimum expected error in any reading is 1 bar
Which of the following error is caused by poor calibration of an instrument?	a) Random error b) Gross error **c) Systematic error** d) Precision error

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