PRESSURE MEASUREMENT

Measurement Control and Instrumentation

Classroom rules

- All cell phones switched off.
- Be on time after breaks.
- No noise outside during breaks.
- Respect the training facilities
- Respect each others views
- Class attendance forms filled in?

Muster Point

- In case of any Emergency muster in front of the KTC Reception
- Muster Officer: Catherine de Wee @ ext: 4064

Safety Talk

- **Electrification:**
- The calibration bench makes use of a 220 V AC power supply to function.
- Take care when you use these instruments not be electrocuted, because 50 mA can kill you !
- Check all plugs and cables for damage before you use it.
- Do not plug the 220 V AC extension into the supply before it is connected to the instrument.

Objectives

Terminal Objectives(s)

Maintain equipment associated with pressure measurement.

Enabling Objectives(s)

1. Describe what safety precautions must be adhered to
2. Describe: How pressure is measured; The different types of reference pressures; The relationship between density and specific gravity.
3. Describe: What factors affect liquid pressure in a tank; The units of pressure; How to convert pressure units.
4. Describe what types of pressure isolation valves and other accessories are used
5. Describe how pressure is measured with manometers and typical errors that can be encountered
6. Describe how pressure is measured using a comparator or a deadweight tester
7. Describe how pressure switches operate
8. Describe how pneumatic relays operate
9. Describe how mechanical pressure sensors operate
10. Describe how electro-magnetic pressure sensors operate
11. Describe how electronic pressure transducers operate
12. Describe the different types of errors that can occur on a pressure measuring device
13. Relate to the relevant Operating Experience

Lesson Plan

Program for Level Measurement Training

Day 1: Theory

Day 2: Theory and Practical

Day 3: Theory and Practical

Day 4: Practical

Day 5: Theory and Practical Assessments

Fundamentals of Maintenance

- Reactor Safety
- Conventional Safety
- Radiological Safety
- Electrical Safety
- Human Error Prevention
- Procedure Adherence
- Pre-job and Post-job Briefs
- Personal Responsibility and Accountability

Fundamentals of Maintenance

Cont.

- Training and Qualification
- Team Work
- Continuous Performance Improvement
- Foreign Material Exclusion
- Proper use of Tools and Equipment
- Material Standards and Practices
- Work Management

HP Error Prevention Tools

1. Self Checking / STAR
2. Peer Checking
3. Procedure Use
4. Place Keeping
5. Questioning Attitude
6. Effective Communication (3-Way)
7. Pre Job Brief
8. Handover
9. Coaching
10. Authorizations and Knowledge

Fundamentals of Maintenance

Reactor Safety

- Maintain a bias towards conservative decision-making.
- Maintain the plant in accordance with procedures.
- Maintain component measurements and clearances within specification.
- Recognise and adhere to regulatory and environmental requirements.

Fundamentals of Maintenance

Cont.

- Understand plant consequences of every action taken.
- Maintain a questioning attitude.
- Report safety concerns to your supervisor.

Back to Presentation

Fundamentals of Maintenance

Conventional Safety

- Be responsible for your own safety.
- Adhere to sign postings and barriers.
- Use appropriate PPE for work to be performed.
- Ensure equipment is in a safe condition prior to beginning work.
- Know your personal limits both physically and mentally.
- Do not bypass required equipment safeguards.
- Store tools and equipment properly when work is completed.
- Maintain walkways and equipment access free from obstruction.

Fundamentals of Maintenance

Cont.

Maintain work area cleanliness to protect personnel and prevent FME.

- Keep workshop areas clean, neat and professional.
- Leave work areas cleaner than when work began.
- Know hazards of chemicals and comply with chemical MSDS requirements.
- All chemicals used on the plant needs a CRACK assessment
- Stop and correct unsafe behaviour or conditions.
- Report all near misses and injuries.

Back to Presentation

Fundamentals of Maintenance

Radiological Safety

- Ensure you are on the correct RPC.
- Maintain strict compliance with the RPC.
- Know work area dose rates and contamination levels.
- Know your accumulated dose.
- Ensure that personnel dosimetry is working properly.
- Properly respond to dosimeter and area alarms.
- Adhere to radiological boundaries, do not alter.

Fundamentals of Maintenance

Cont.

- Practice ALARA using time, distance and shielding.

- Know and follow radiological work instructions and sign posting.

- Minimize and control the spread of contamination.

- Actively participate in radiological briefings to ensure understanding of work to be performed and applicable precautions.

Back to Presentation

Fundamentals of Maintenance

Electrical safety

• Before commencing work on any live equipment, including workshop testing, remove all jewellery and loose metal objects from your person.

• When performing electrical switching, ensure that the electrical protective clothing prescribed in the working procedures is strictly adhered to.

• Know your boundaries :
  - Flash Protection Boundary
  - Limited Approach Boundary
  - Restricted Approach Boundary
  - Prohibited Approach Boundary

Fundamentals of Maintenance

Cont.

Comply with procedures :

KGM-014:

- Guide for the Control and Testing of Live Line Tools and Electrical Equipment

KSM-028:

- Standard for Electrical Safe Work Practices

Back to Presentation

Fundamentals of Maintenance

Human Error Prevention

- Know your human performance tools.
- Use self-check for component identification and equipment manipulation.
- STAR
  - Stop, Think, Act, Review
- Use STAR when conditions have changed
- Use three-way communications to provide clear, concise direction or to exchange critical information
- Use peer checks as directed
- Use independent and double verification as required by procedure or work package

Fundamentals of Maintenance

Cont.

•Demonstrate a questioning attitude.
• Check your actions and those of your co-workers.
• Be aware of surroundings, potential hazards and their impact on the plant.
• Communicate clearly.
• Follow procedures, work instructions and sign posting.
• Stop when faced with uncertainty.

Back to Presentation

Fundamentals of Maintenance

Procedure Adherence

- Confirm correct procedure revision.
- Ensure procedure is appropriate to accomplish desired task.
- Use procedures per specified usage category.
- Adhere to procedures as written.
- Stop and revise identified procedure errors prior to continuing use.
- Use place keeping.
- Take ownership for procedure quality.

Back to Presentation

Fundamentals of Maintenance

Pre job and post job Briefs

- Use pre-job or post job briefs to cover :
  - Safety talks
  - Critical task procedures
  - Risk Assessment
  - Radiological requirements
  - OE
  - HP tools

- Answer 4 key questions :
  - Identify Critical Steps
  - Identify Error likely situations and potential human error traps

Fundamentals of Maintenance

Cont.

- Identify worst thing (event) that could happen
- Identify specific error prevention defences to be used
- Conduct post job briefs to identify follow up actions or lessons learned

Back to Presentation

Fundamentals of Maintenance

Personal Responsibility and Accountability

- Exhibit personal accountability and integrity
- Report problems to your supervisor.
- Expect and be receptive to feedback from job observations.
- Review your work – sign to verify quality and content
- Provide and seek timely and specific feedback to improve performance
- Know your developmental areas and take action to improve
- Take responsibility for your actions and hold peers accountable.

Fundamentals of Maintenance

Cont.

- Involve supervisor in questions, safety concerns, problems and work status.
- Know your roles and responsibilities with plant process and procedures.
- Perform work only when trained and authorized to do so.
- Apply self checking, peer checking, procedure place keeping, questioning attitude and other HP tools effectively.

Back to Presentation

Fundamentals of Maintenance

Training and qualification

- Participate in training – Come to learn
- Report to training by the scheduled starting time and return from breaks by time designated by instructor.
- Be accountable for your training performance and professional conduct.
- Learn the fundamentals

Fundamentals of Maintenance

Cont.

- Provide mentoring to those in need
- Provide meaningful feedback on the quality of training.
- Own and maintain the current qualifications
- Verify authorization prior to performing work
- Identify training needs to improve performance

Back to Presentation

Fundamentals of Maintenance

Team Work

- Openly communicate and encourage active participation.
- Invite and respect team members input and ideas.
- Foster a questioning attitude.
- Share and apply personal lessons learned and industry OE

Fundamentals of Maintenance

Cont.

- Address issues with data and/or technical rationale
- Solve problems by involving others.
- Constructively challenge ideas, actions and decisions of team members
- Prevent group think and poor decisions by using devils advocacy

Back to Presentation

Fundamentals of Maintenance

Continuous Performance Improvement

- Initiate a Problem Notification for problems and concerns, and notify your supervisor.

- Perform thorough root cause evaluations.

- Identify and implement timely corrective actions to prevent recurrence.

- Accurately describe condition of equipment in equipment history records.

- Prevent complacency by identifying opportunities for improvement.

Fundamentals of Maintenance

Cont.

- Reinforce desired behaviours and correct weaknesses.
- Monitor for and take action for any adverse performance trend.
- Be self critical
- Review and learn from OE

Back to Presentation

Fundamentals of Maintenance

Foreign material exclusion (KSA-069)

- Determine specific FME recommendations using pre-job walk downs.
- Take necessary actions to maintain system/component cleanliness.
- Foreign material exclusion Zones will be established to control and prevent the introduction of material in systems, structure and components

Back to Presentation

Fundamentals of Maintenance

Proper Use of Tools and equipment

• Use proper tools to ensure worker safety, to protect plant equipment, and ensure equipment reliability.

• Inspect and test portable electric equipment for damage or frayed wires prior to use, to prevent electric shocks.

• Inspect all welding equipment prior to and periodically during use.

• Ensure that earth leakage protection is marked ‘tested’.

Fundamentals of Maintenance

Cont.

• Wear proper safety lines and harnesses when working at heights.

• Ensure M&TE has the appropriate range, accuracy and test medium.

• Ensure the M&TE has a valid calibration certificate.

• Use tool inventory list to control tools on the job site.

Back to Presentation

Fundamentals of Maintenance

Maintenance standards and practices

• Have work package or copy available at work location, and refer to them often.

• Conduct pre-job walk downs to ensure equipment readiness prior to work.

• Identify and use approved spares required.

• Supervisors shall perform frequent job observations to ensure work progresses safely and efficiently.

Fundamentals of Maintenance

Cont.

• Clearly communicate work plans and statuses during briefings, and shift handovers to avoid error and unnecessary delay in returning equipment to service.

• Provide feedback to improve work instructions, procedures and processes.

• Verify that completed work packages values are within specification and contain required documentation and signoffs.

Back to Presentation

Fundamentals of Maintenance

Work management

Participate in and be accountable to our work control process.

Review schedule for conflicts, challenge job duration, preparation and interferences.

• Perform pre-job walkdowns to verify required support, preparation and equipment staging.

• A work package should contain the following as a minimum:

- Work order
- KSM-006 check list
- Procedure
- Pre-job Brief form

Fundamentals of Maintenance

Cont.

- Obtain latest rev procedure and review EHR for latest rev.
- Any disconnections on plant should be documented on a disconnection sheet.
- Hold points in procedures can only be bypassed if there is a threat to personnel, plant and nuclear safety.
- Witness points can only be bypassed if a ‘QC Bypass’ has been issued.
- Verify equipment is properly taken out of service and isolated.
- Incorporate lessons learned to improve future job performance.

Back to Presentation

Self Check Tool 1

Use The Finger to point to the label/component.

BEFORE taking action:

- **STOP** everything you are doing.
  - 2M Rule
    Take 2 minutes - Observe 2 meters around you.
  - Eliminate any current or potential DISTRACTIONS.
- **THINK** through what you are going to do, and what you want to achieve.

DURING your action:

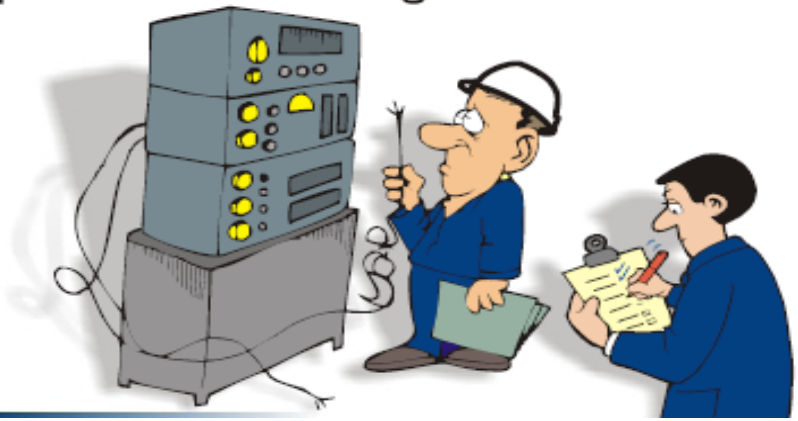
- **ACT**
  - Take the action

AFTER your action:

- **REVIEW** what happened.
  - Verify the desired indication/response/outcome.
  - If the action/outcome is not as expected, take action as previously anticipated/determined.

Peer Check **Tool 2**

- Because two heads are better than one.
- To provide a second-check to make sure you are going to do the **RIGHT** thing to the **RIGHT** component, **BEFORE** you take any action.
- To allow us to learn from one another.
- To minimise the potential for making mistakes.



Procedure Use **Tool 3**

- To ensure that the right actions are performed in the right sequence.
- To avoid repeating the mistakes of others.
- To minimise the potential for making mistakes.

What if you are UNSURE, or the Procedure doesn't seem right?

- **STOP**
- Place the system/component in a safe condition (as appropriate).
- Notify your supervisor.
- Resolve the issue.
- Get the procedure fixed.

Place Keeping Tool 4

- To minimize the potential for being distracted while implementing procedure steps.
- To prevent performing procedure steps out of sequence.
- To prevent missing/skipping/duplicating procedure steps.

By some positive mechanical means.

The PREFERRED METHOD is:

CIRCLE the step number to be performed (2.3)
Read and Understand the step in its entirety.
Perform the step as written.

Mark the step as complete by placing a SLASH through the circled step number (2.3)

Questioning Attitude Tool 5

- **QUALIFY, VALIDATE and VERIFY all facts presented in doc**

STOP WHEN UNSURE!

QU

- **Consi**
- **Is it TI**

To ensure you have all the necessary information to perform the job safely the first time.

(a state **ote)**

VALID

- **Consi**

To minimise the potential for making mistakes.

- **Does it match what you already know / experienced or would have expected?**

If you still have concerns regarding the accuracy of the facts, then…

VERIFY

Consult an independent, controlled source

Eskom

Effective Communications Tool 6

ALL THE TIME

THREE-WAY COMMUNICATIONS is used when:

The Sender provides clear and concise direction / information.

Communicating an important plant condition or information.

Critical safety related plant manipulations

Communicating instructions from a formal work document

When there is high background noise.

Acknowledgement:

The Receiver repeats back the message to the Sender.

With:

- **If the message is direction – it is repeated back verbatim (word for word).**
- **If the message is information – it can be paraphrased (put into own words).**

•Confirmation of Acknowledgement:

The Sender confirms that the Receiver understands the message.

(Usually by saying “that is correct”)

•Send the Message:

THE PHONETIC ALPHABET is used when:

- **Communicating alpha designations (like trigram's) for plant equipment.**
- **Communicating technical information such as AHP / APP / ABP.**

Pre-Job Briefs Tool 7

The more complex or potentially significant the job or consequences of an error, the more extensive and detailed the Pre Job Brief will be.

An Effective Pre-Job Brief:

- Is attended by **ALL** staff involved with the task.
- Is held as close to the time of execution as practical.
- Is held in as quiet an area as practical.

All Pre-Job Briefs shall include:

S ummarizes critical steps.
A nticipates error-likely situations (using OE).
F oresees consequences.
E valuates defenses.

Handovers Tool 8

- **TAKE THE TIME** necessary to do it right.
- **THINK – "If I were taking this over, what would I want to know?"**
- **WRITE IT DOWN:**
  - Shift Log book
  - Memo's
  - Notes
- Use **EFFECTIVE COMMUNICATION** in the discussion (Three-way communication)
- **DON'T ASSUME ANYTHING! – Rather over-communicate than miss something out.**
- **ASK QUESTIONS** to ensure that the information handed over is received and understood.

Coaching Tool 9

How do I coach?

- Observe the activity. Focus on BEHAVIOURS.
- Compare the behaviours to expectations and standards.
- Enforce high standards.
- Engage the worker in timely feedback on what went well, and how to improve.
- Keep it positive! Have a spirit of caring and an attitude of helpfulness.
- Listen. What issues does the worker have that require follow-up?
- Follow-up. Address / resolve the noted deficiencies.
- Document your observations in the On Job Observation and Coaching database .

Authorizations and Knowledge Tool 10

- Ensure that you are authorised to do the task before you do the task
- Ensure all Authorisations are valid and up to date.
- Ensure you meet all re-qualification requirements for the Authorisations.
- Ensure your Authorisations do not lapse.
- Take advantage of all sources of Knowledge.
- Know what you know.
- Be aware of what you don't know, and seek additional training / knowledge whenever appropriate.
- Seek opportunities to share your knowledge with others through Coaching and Mentoring.
- Provide appropriate feedback for all training received.

PRESSURE MEASUREMENT

Safety precautions

PRESSURE MEASUREMENT OBJECTIVES

Terminal Objectives(s)

Maintain equipment associated with pressure measurement.

Enabling Objectives(s)

1. Describe what safety precautions must be adhered to
2. Describe: How pressure is measured; The different types of reference pressures; The relationship between density and specific gravity.
3. Describe: What factors affect liquid pressure in a tank; The units of pressure; How to convert pressure units.
4. Describe what types of pressure isolation valves and other accessories are used
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11. Describe how electronic pressure transducers operate
12. Describe the different types of errors that can occur on a pressure measuring device
13. Relate to the relevant Operating Experience

Topic 1: Safety precautions

Objective: **Describe what safety precautions must be adhered to.**

Introduction: **Good safety practices must be exhibited at all times if accidents are to be prevented. In this objective the risks associated with high pressures, various liquids or plant conditions are described.**

Topic 1: Safety precautions

Topic	*Comments*
Personal Protective Equipment (PPE)	According to Eskom safety standards and job requirements
Handling of heavy equipment	Save lifting and rigging practices
Hazardous chemicals	Always contain and clear spills and leakages. Wash hands and affected body parts after working with hazardous substances.
High pressures	• Be aware of potential steam leaks. • High pressures can be present when removing pressure gauges, switches, etc
Compressed air	Do not misuse
Chemicals or radioactivity	Contents of a process can be discharged
Isolations	Check all electrical and mechanical isolations
Foreign material exclusion (FME)	Take the appropriate precautions
Environmental awareness	Any environmental event must be reported immediately.
Electricity	Electricity can kil!!!!

Topic 1: Safety precautions (continued)

Personal Protective Equipment (PPE)

All appropriate PPE must be worn according to Eskom safety standards and job requirements. e.g.

- Safety boots
- Appropriate Overall
- Safety spectacles
- Appropriate Gloves
- Hard hat
- Ear protection
- Appropriate respirator
- Safety harnesses

Handling of heavy equipment

When working with heavy equipment and pipe work ensure that the following is kept in mind:

- Safe lifting practices
- Ensure that heavy loads are properly rigged, supported and secured.
- Rigging: Make sure that all rigging is carried out by authorised persons.

Topic 1: Safety precautions (continued)

Hazardous Chemicals

Pipe and container contents need to be taken into account and the following precautions need to be in place:

- Hazardous chemicals

  Care needs to be taken with respect to HAZCHEM, Material Safety Data Sheet (MSDS) contents. e.g..

  - Oil.
  - Cyanide.
  - Sulphuric acid.
  - Nitric acid.
  - Freon.
  - etc.

Always contain and clear spills and leakages.

Always wash hands and affected body parts after working with hazardous substances.

Topic 1: Safety precautions (continued)

Mercury

The use of mercury is **prohibited at Koeberg** because it easily amalgamates with any known metal. In other words it easily combines with other metals and can 'soften' them. However, it is still used in other industries. Metallic mercury is poisonous to the human body in very small amounts and must not be absorbed by mouth or inhaled. It is important that hands must be washed with soap and water after coming into contact with the metal. Clothes that may have come into contact with mercury should be removed and washed. If mercury is spilled, it should be cleaned up immediately and the area washed with water.

Zeal Oil

This also is a dangerous liquid and is poisonous so it must be handled with great care. It is red in colour and exhibits a strong oil based odour. If spilled (e.g. on a floor) the floor will become very slippery. If zeal oil is spilled, it should be cleaned up immediately. Always wash your hands after handling the oil.

Topic 1: Safety precautions (continued)

Compressed Air

Dangers involved and misuses:

- Blowing out equipment with compressed air can blow dust into your eyes.
- Rust and foreign objects are usually found in a pipeline. Blowing your clothes clean with compressed air can cause serious injuries.
- Do not place paper or metal balls in any pneumatic pipe. This could cause serious injury if blown out of the pipe.
- Blowing compressed air into the rectum or anywhere else in the human body will cause serious internal injuries.

Chemicals or Radioactivity

When removing or replacing instrumentation from systems it is possible that the contents of the process can be discharged. The contents could be dangerous chemicals and (at Koeberg) contain radioactive contamination. The appropriate safety precautions must be exhibited at all times.

Note: Before removing equipment from a chemical plant, make sure you know where the nearest shower is located. Make sure the shower is in working condition. If it should happen that you come in contact with acid, take off your overall and get under a shower as soon as possible.

Topic 1: Safety precautions (continued)

Isolations

Before working on any pipe system make sure that all necessary electrical and mechanical isolations have been affected.

Foreign Material Exclusion (FME)

- When working on equipment make sure that all system openings are clear of any foreign material and then cover with FME covers.
- Make sure that all pipes and components are properly cleaned internally before fitting.
- Make sure that all FME covers are removed and accounted for before replacing components.
- Report any accidental FME incidents.

Environmental Awareness

- Spillages and leaks can and will affect the environment in a number of different ways. Utmost care should be taken to prevent any such event happening.
- Should there be any incidents they must be reported immediately.

Topic 1: Safety precautions (continued)

Electricity

- Note that all the three pin bench sockets are connected to the 220 V ac mains supply.
- Do not push any metal or other objects into the holes of a bench socket.
- Make sure all the electric cables connected to the mains supply are installed correctly.

ELECTRICITY IS SOMETHING NOT BE FOOLED WITH. IT CAN KILL YOU!

Safety is everybody's business and is not negotiable.

Topic 2: Pressure Measurement

Objective:

Describe:

- **How pressure is measured.**
- **The different types of reference pressures.**
- **The relationship between density and specific gravity**

Introduction

In this training objective the different types of pressure measurements, density and specific gravity are described. The learner must be familiar with the terminology and understand the different references

Topic 2: Pressure Measurement

To understand the objective, remember the following

Parameter	*Comments*
Pressure measurements	• Atmospheric pressure • Gauge pressure • Absolute pressure • Vacuum pressure • Differential pressure • Static pressure
Density	Mass Volume
Specific gravity	Density of a material Density of water

Topic 2: Pressure Measurement

Definition of Pressure

Pressure is defined as the action of a force acting against some opposing force; a force in the nature of thrust, distributed over a surface of a force acting against a given surface within a closed container. Usually, it is the amount of force applied to a unit of area thus

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}} = \frac{\text{Mass x Gravity}}{\text{Area}}$$

Example: A force of 50 kg applied over an area of 1 cm2 gives a pressure of 50 kg /cm2. 50 kg applied over an area of 0,5cm2 gives a pressure of 100 kg /cm2.

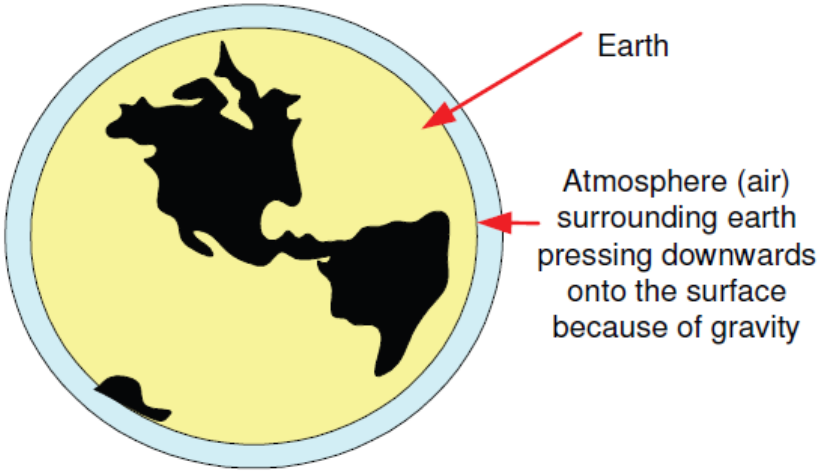
Note that as the area becomes smaller, the pressure increases

Topic 2: Pressure Measurement

Types of Pressure

Atmospheric Pressure

This is the pressure exerted by the earth's atmosphere. At or near sea level, the value of this pressure is close to 760 mm mercury (101,3 kPa) and decreases as the height increases. It is important that atmospheric pressure be taken into account when calibrating pressure gauges.



Atmospheric pressure

Topic 2: Pressure Measurement

Types of Pressure

Absolute Pressure

This is a pressure measured with absolute zero pressure as its reference point. When the value of the absolute pressure is above the local atmospheric pressure, it can be regarded as the sum of the local atmospheric pressure and the gauge pressure. A barometer is an example of a device that is used for measuring the absolute pressure.

Absolute pressure = atmospheric pressure + gauge pressure

Gauge Pressure

Pressure gauges that are calibrated from zero to measure a pressure, actually measure the difference between the actual pressure and atmospheric pressure. This difference is called the gauge pressure.

Topic 2: Pressure Measurement

Types of Pressure

Vacuum Pressure

This pressure lies between atmospheric pressure and absolute zero pressure with atmospheric pressure as reference but, unlike gauge pressure, it is always less than atmospheric pressure.

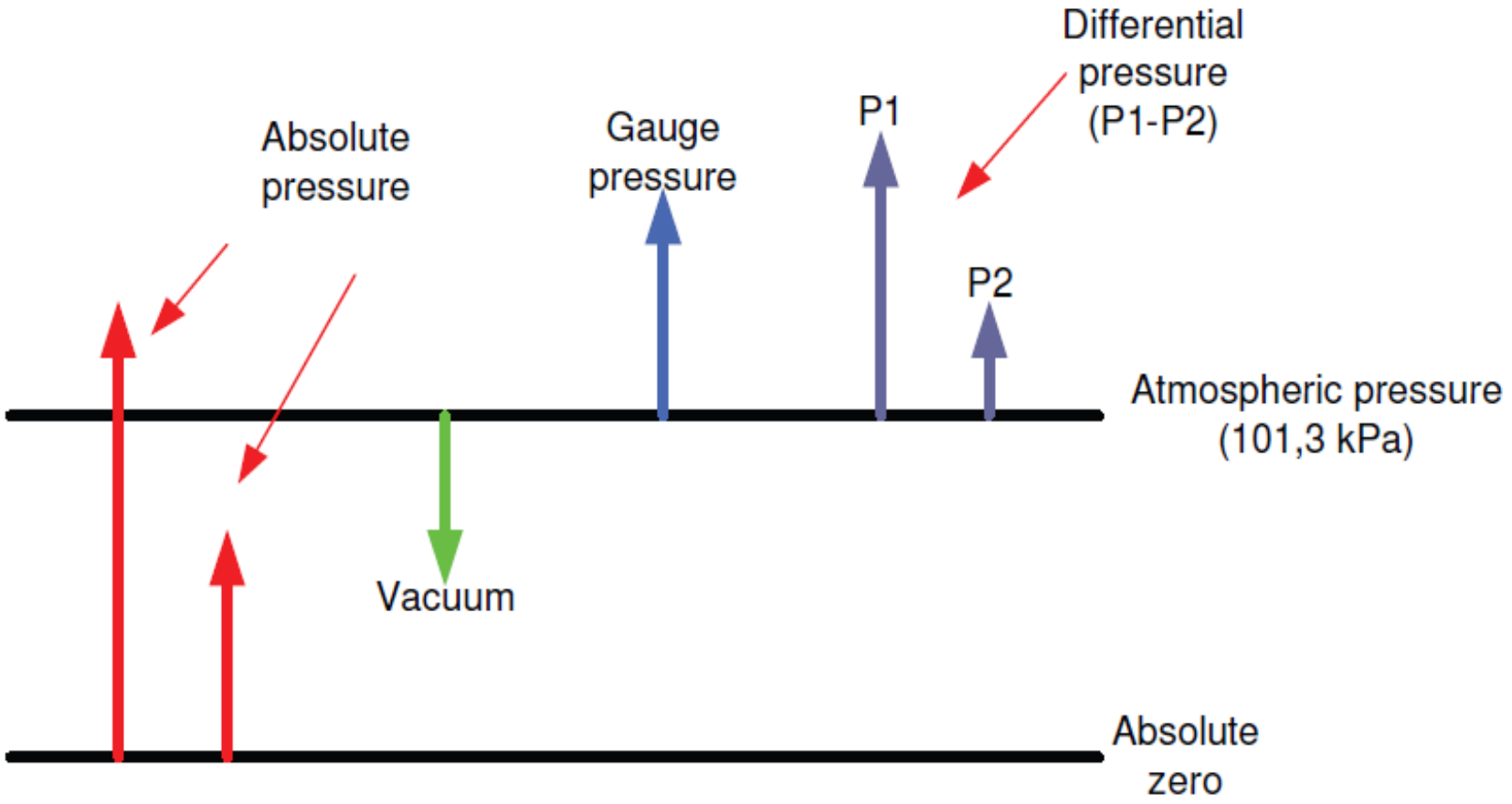
Vacuum pressure = atmospheric pressure - absolute pressure

Differential Pressure

This is the difference between two measured pressures such as the inlet and outlet of an oil filter. The increase in difference should give information of how dirty the filter is.

Topic 2: Pressure Measurement

Types of Pressure



Pressure relationships

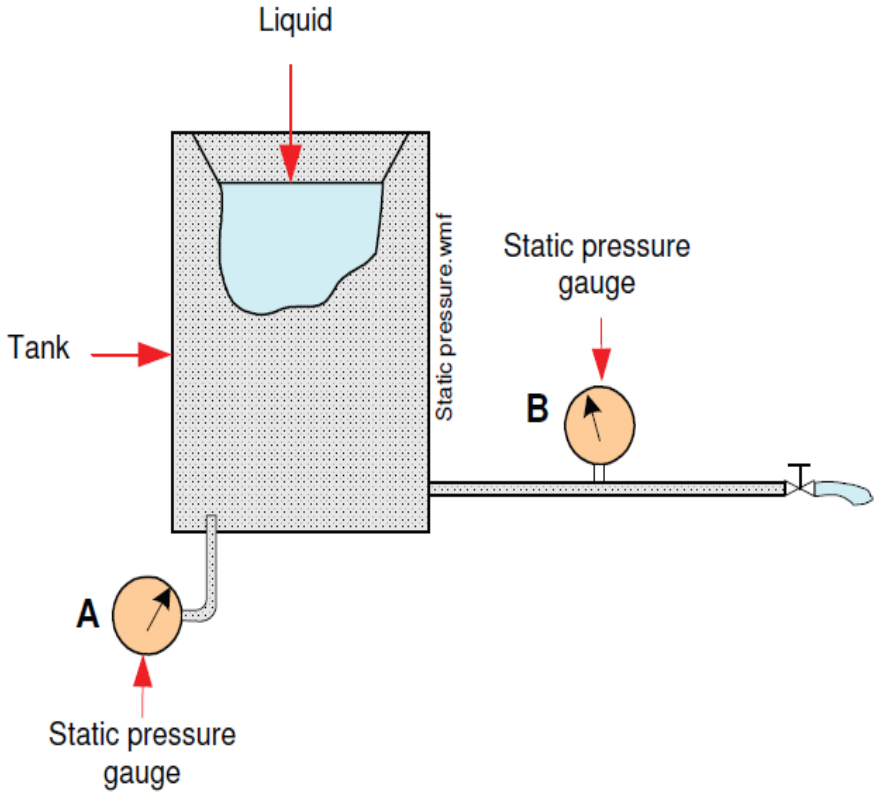
Topic 2: Pressure Measurement

Types of Pressure

Static Pressure

This is the force per unit area acting on a wall by a fluid at rest or flowing parallel to the wall.

The diagram below shows these two forms of static pressure, namely the fluid at rest (A) and the fluid flowing parallel to the wall (B).



Topic 2: Pressure Measurement

Density and Specific Gravity

Water is used as a reference liquid in measuring and calculating liquid pressures. The pressure of a liquid may be stated in terms of the depth of water required to produce the same pressure. For example, the pressure at the bottom of a tank of petrol (1,828 m deep) may be stated as 1,206 m of water (if gravitational acceleration is taken as 9.8 metres per second).

Water is also used as a reference in comparing the density of materials. Density is defined as the mass per unit volume of material.

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

Water has a density of 1 000 kg per cubic metre (1 000 kg/m3). Petrol has a density of 660 kg/m3, and lead has a density of 11 300 kg/m3.

Topic 2: Pressure Measurement

Density and Specific Gravity

You can use the ratio of density of a material to the density of water to compare densities. This ratio is called the *specific gravity* of a material.

For example, the specific gravity of petrol is 0,66. To calculate this value, divide the density of petrol by the density of water.

$$\frac{600\ kg/m3}{1000\ kg/m3} = 0,660\ (specific\ gravity)$$

Topic 2: Pressure Measurement

Density and Specific Gravity

Table of densities and specific gravities

Substance	*Density kg/m³*	*Specific gravity*
Liquids		
• Water	1 000	1,00
• Methyl alcohol	810	0,81
• Nitric acid	1 500	1,50
• Petrol	660	0,66
• Mercury	13 600	13,6
Solids		
• Aluminium	2 700	2,70
• Lead	11 350	11,35
• Wood (average)	570	0,57

Topic 3: Factors affecting liquid pressure in a tank, units of pressure and pressure conversion

Objective

Describe: What factors affect liquid pressure in a tank. The units of pressure. How to convert pressure units.

Introduction

In this training objective, various aspects that affect pressure are addressed that the learner must understand.

Topic 3: Factors affecting liquid pressure in a tank, units of pressure and pressure conversion

To understand the objectives, refer to the following table:

Topic	*Comments*
Factors affecting liquid pressure in a tank	• Depth • Density • Static pressure
Static head correction	A head of fluid exists that must be subtracted from the instrument reading when the instrument is below the tapping point. The static head of fluid must be added to the reading of the instrument when it is above the tapping point
Unit of pressure	A pressure of one Newton per square metre is called a Pascal (Pa)
Derived unit of force	The kilogram metre per second and is known as the Newton (N)
Pressure unit conversions	Refer to the conversion table

Topic 3: Factors affecting liquid pressure in a tank, units of pressure and pressure conversion

Factors Affecting Liquid Pressure in a Tank

Depth

The pressure at a point is directly proportional to the depth of the point below the surface. Doubling the depth doubles the pressure (after subtracting the pressure acting on the surface).

Density

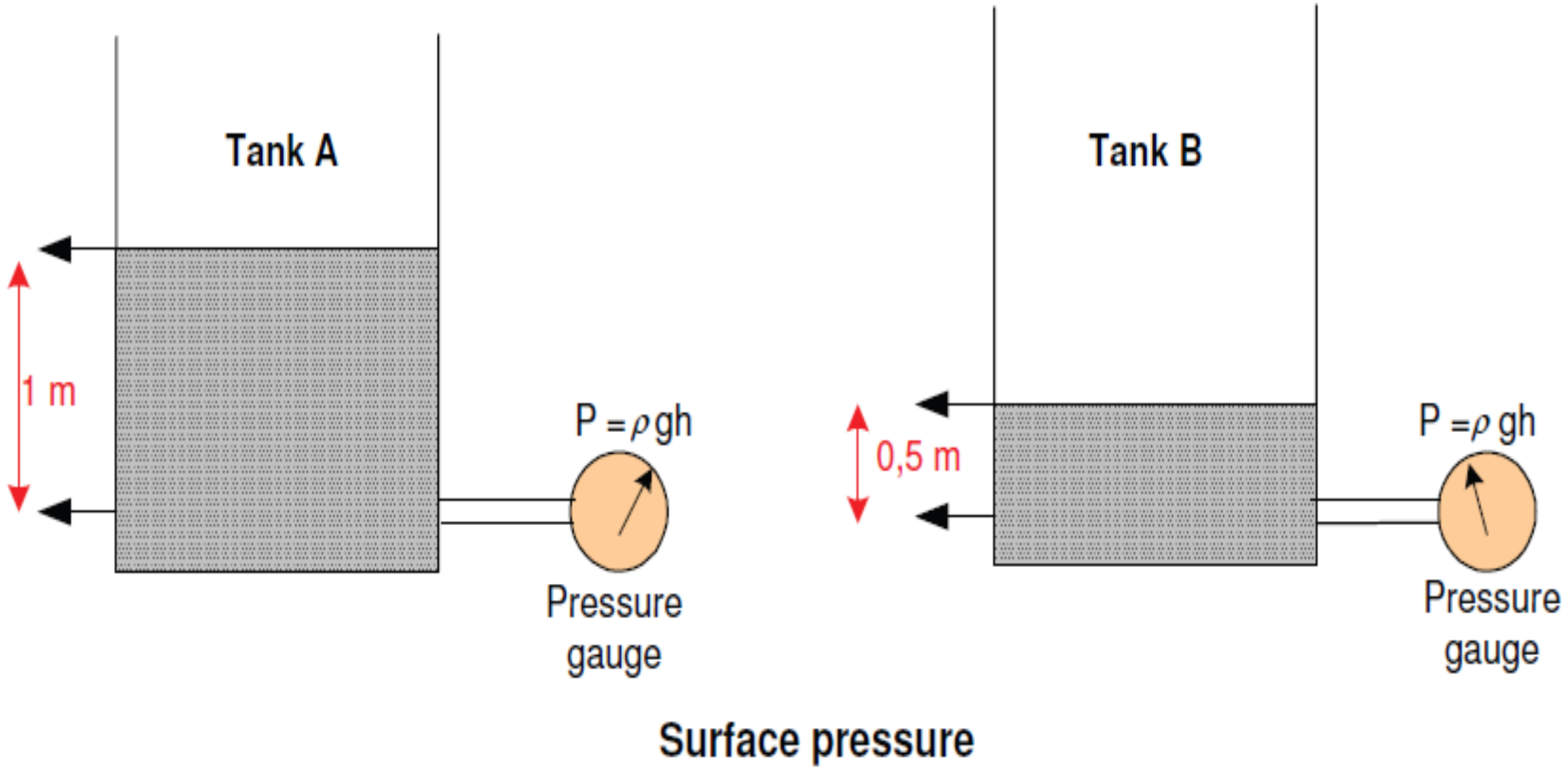
The pressure is directly proportional to the density of the liquid. Doubling the density doubles the pressure at a point below the surface (after subtracting the surface pressure).

Note: Temperature changes can also change the density

Surface Pressure

Any pressure acting on the surface (for example, atmospheric pressure if the tank is open) is transmitted throughout the liquid and contributes to the pressure at any point beneath the surface.

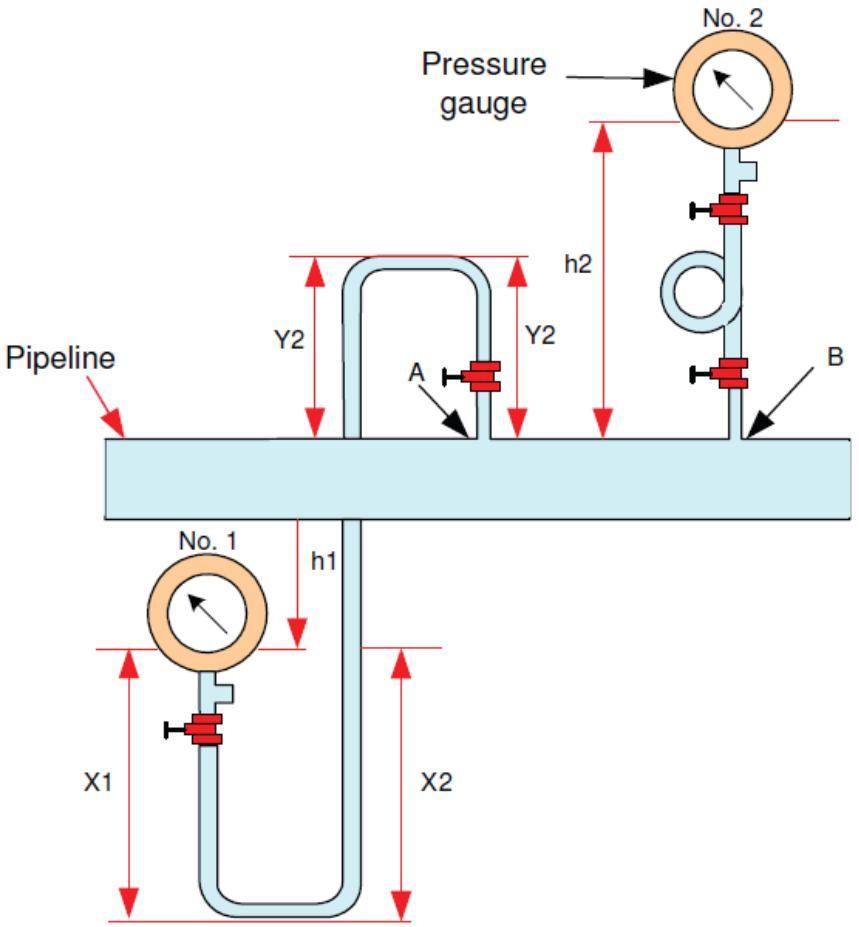
Topic 3: Factors affecting liquid pressure in a tank



Topic 3: Factors affecting liquid pressure in a tank, units of pressure and pressure conversion

Static Head Correction

When measuring a fluid pressure, the instrument used could be situated either below or above the tapping point of the pipe as illustrated in the following diagram. A static head of fluid exists which must be subtracted from the instrument reading when the instrument is below the tapping point. This head of fluid must be added to the reading of the instrument when it is above the tapping point. This head exerts a pressure of ρgh and must be corrected for



Static head correction

Topic 3: Factors affecting liquid pressure in a tank, units of pressure and pressure conversion

Using the diagram that illustrates the effect of static head, suppose pressure gauge No 1 is 2 metres below the point of measurement. The error will then be ρgh.

Where h = height (metres)

ρ= density (kg/m3)

g = gravitational acceleration

9,81 metres/second

P = pressure (Pa)

Therefore, P = ρgh

= 1 000 x 9,81 x 2

=19 620 kPa

Topic 3: Factors affecting liquid pressure in a tank, units of pressure and pressure conversion

Pressure Units

The unit of pressure is the pressure produced when a force of one Newton acts over an area of one square meter (N/m2). The name given to 1 N/m2 is the **Pascal (Pa)** but, because the unit is very small (100 000 N/m2 being equal to approximately 1 atmosphere) the **kiloPascal (kPa)** is used as the practical unit of pressure.

The End