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MASTER MEMORY
Electronic
Instrumentations and Systems

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THEME

Conception Of a Professional Mobile Workshop for Industrial Instruments

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University year: 2022-2023

DEDICATION

To our parents

To allfamily members

To everyone who has supported us…

With words or deeds

We dedicate this work

Toufik&Isshak

THANKS AND APPRECIATION

First of all, we would like to thank Allah the almighty for the will and the courage he gave us to be able to finish this work.

Also,we would like to express our sincere thanks to our supervisor Dr.Smahi Mokhtar for his advices and the trust he has placed in us.

We would like to express our sincere thanks to our professors in our department *'ELECTRONICS and COMMUNICATIONS'*, who helped and supported us in the pursuit of our studies. We warmly thank the jury members of agreeing to evaluate this work. Than our parents, brothers, sisters and friends for their moral support, encouragement and patience during the difficult stages of our studies.

Without forgetting to thank all the members of our respective families for their support and encouragement, especially our dear parents.

Finally, these thanks would not be complete without sincere thought to our close friends and all those who have supported us from near or far, throughout this year in particular to our '*INSTRUMENTATIONS and SYSTEMS'* promotions.

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General introduction

Instrumentation maintenance, in a general sense, refers to the set of activities and practices aimed at ensuring the proper functioning, reliability, and longevity of instruments and related equipment. It involves various tasks such as inspections, calibrations, repairs, replacements, and overall upkeep of instruments used in different industries and applications.

The objective of instrumentation maintenance is to maintain the performance and accuracy of instruments, prevent failures or breakdowns, extend their lifespan, and ensure the safety of personnel and processes. By regularly maintaining and servicing instruments, organizations can minimize downtime, optimize productivity, and reduce costs associated with repairs and replacements.

Instrumentation maintenance encompasses a range of instruments, including sensors, transmitters, controllers, analyzers, meters, gauges, and other measuring or monitoring devices. These instruments are utilized in diverse fields such as manufacturing, energy, healthcare, research, and process control industries.

The specific tasks involved in instrumentation maintenance may vary depending on the type of instrument, its application, and industry standards. Common activities include calibration to ensure accurate measurements, inspections to identify issues or damage, cleaning to remove contaminants, repairs to address malfunctions, and documentation to maintain records of maintenance activities.

Overall, instrumentation maintenance plays a critical role in optimizing the performance, reliability, and safety of instruments, thereby supporting efficient operations in various industries.

CHAPTERI

INSTRUMENTATION MAINTENANCE

I.1 Introduction

I.2 Maintenance

Maintenance is defined as the entirety of technical, administrative, and managerial tasks performed during the life of a machine, according to AFNOR X 60-000 (Association française de normalisation).

The life cycle of an asset is intended to maintain or restore it to a state in which it can perform the required function **[1].**

I.2.1Importance and role of maintenance

The importance and role of maintenance are demonstrated by the need to ensure the continuous availability and proper operation of manufacturing equipment.

Finally, the role of maintenance would be to allow other business services to perform their functions while achieving the best possible return on investment **[2].**

I.2.2 Maintenance goals

The nature of the business defines the maintenance department's objectives, which are clearly stated by a well-defined policy.

clearly defined by a well-defined policy based on three key factors:

Technical factor, economic factor, human and environmental factor **[2].**

a) Technical (operational) goals: Ensure optimum availability of plant and equipment at a reasonable cost; and provide a service that eliminates breakdowns at any time and at any cost.

- Push the installation's lifespan to the limit (notion of durability).
- Maintain high-quality performance.
- Maintain a spotless installation at all times.

b) Economic goals: Minimize maintenance costs while increasing earnings.

Provide maintenance services on time and within budget.

To ensure that maintenance expenses are focused on the service required by the installations, as well as the age and utilization rate.

c) Human and environmental goals: Reduce operational accidents (safety concept) and enhance working conditions.

Examine any equipment modifications or protection that should be implemented to reduce the possibility of accidents.

Combat nuisance and protect the environment (gas emissions, noise, oil spills, and so on).

I.2.3 Maintenance types

There are two kinds of it :

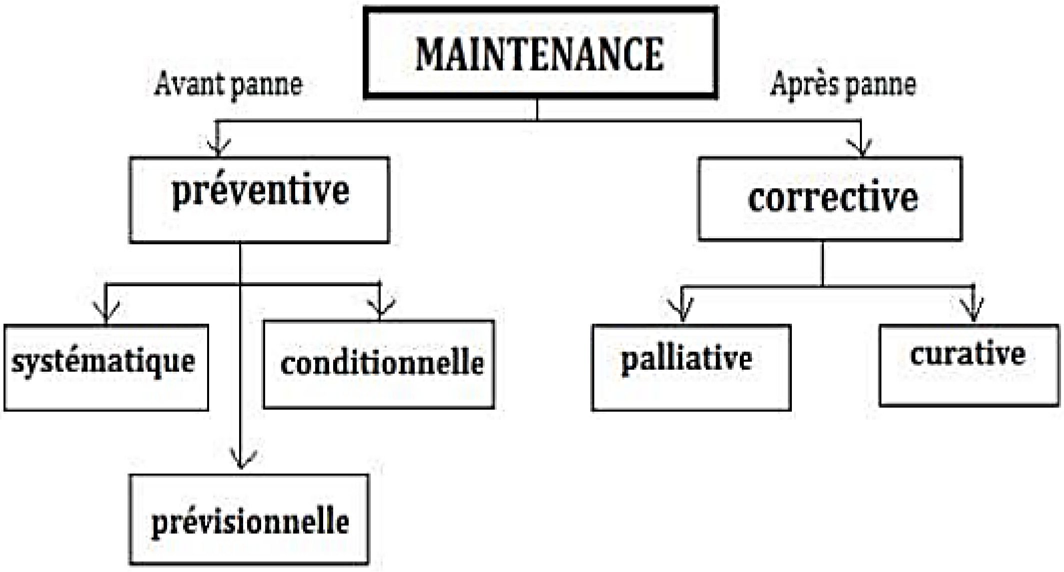


Figure.I.1 Maintenance Types

I.2.3.1 Preventative maintenance

This is intended to prevent device failure while in use. According to AFNOR, "preventive maintenance is maintenance aimed at reducing the possibility of an asset failing or degrading."

There are three types of preventive maintenance **[1].**

1) **Routine maintenance:** "Maintenance carried out according to a schedule established over time or a predetermined number of usage units," according to AFNOR.

2**) Conditional support:** "Preventive maintenance subject to a predetermined type of event," according to AFNOR. In general, these indicators include vibrations, pressure, noise, temperature, and so on.

3) **Predictive maintenance:** According to AFNOR, predictive maintenance is "maintenance carried out in accordance with forecasts extrapolated from the analysis and evaluation of significant parameters of the asset's degradation." It is based on an analysis of the evolution of technical characteristics, which allows us to measure the asset's state and detect possible deterioration as soon as it arises. It allows us to predict and estimate the most appropriate time for intervention.

I.2.3.2 Corrective maintenance:

The AFNOR standard defines corrective maintenance as "all activities carried out after the failure of an asset or degradation of its function, to enable it to perform a required function, at least temporarily, including locating and diagnosing the fault."

These activities involve detecting and diagnosing the problem, returning it to its original condition, with or without modification, and ensuring that it works properly.

Corrective maintenance is classified into two types **[1]:**

a) Palliative care (troubleshooting):

This is an in-situ repair that can occasionally be done without disrupting the operation of the item in question. It is "temporary" in nature and must be followed by a more permanent corrective procedure.

b) Curative maintenance:

Repairs performed on-site or at a central workshop, sometimes after troubleshooting. Maintenance is "definitive" in nature.

I.2.4 Maintenance operations

Are outlined in the standards FN X 60-010 and NF EN 13306) [12].

I.2.4.1Operations for corrective maintenance

This is a corrective maintenance procedure or operation performed on damaged equipment with the goal of restoring it to operating order.

a) Troubleshooting: This is a corrective maintenance action or operation performed on malfunctioning equipment to return it to operational status.

Troubleshooting may be performed under temporary conditions and outside of the standards of method, cost, and quality, and will be followed by repair.

Troubleshooting interventions are frequently brief, but they can be numerous, and they do not necessitate understanding of equipment behavior and deterioration processes.

b) Repair: This is a decisive and limited corrective maintenance intervention performed in the aftermath of a breakdown or failure. Repaired equipment must perform to the specifications for which it was intended.

I.2.4.2 Operations and procedures for preventive maintenance

a) Inspections: These are monitoring operations that consist of finding anomalies and performing basic modifications that do not require specific tooling or the shutdown of the production tool or equipment **[3].**

b) Visits: These are monitoring activities that are performed at predefined intervals as part of routine preventative maintenance.

c) Inspections: These are inspections for conformity against pre-established data, followed by a decision.

I.3Instrumentation Maintenance(Definition):

Instrumentation maintenance is a comprehensive set of activities and practices aimed at ensuring the optimal performance, reliability, and longevity of instruments and related equipment. It involves a systematic approach to inspect, calibrate, repair, replace, and overall upkeep of instruments used in a wide range of industries and applications.

The primary objective of instrumentation maintenance is to maintain the accuracy and reliability of instruments, preventing failures or breakdowns that could lead to downtime, production losses, or compromised safety. By implementing regular maintenance procedures, organizations can minimize the risk of instrument malfunction, optimize productivity, and reduce costs associated with repairs and replacements.

Instrumentation maintenance encompasses a diverse range of instruments used in various fields, such as manufacturing, energy, healthcare, process control, and many others. These instruments include sensors, transmitters, controllers, analyzers, meters, gauges, and other devices that are critical for measuring and monitoring parameters such as temperature, pressure, flow, level, conductivity and more.

The maintenance tasks involved in instrumentation maintenance can vary depending on the type of instrument, its application, and industry standards. However, there are several key activities that are commonly performed:

Calibration: Calibration is the process of verifying and adjusting instruments to match known standards or reference values. It ensures that instruments provide accurate and reliable measurements or readings. Calibration is typically carried out at regular intervals to maintain the integrity of measurements and to comply with industry regulations.

Inspection: Regular inspections are conducted to visually and functionally assess the condition of instruments. This includes checking for signs of wear, damage, or other abnormalities that may affect performance. Inspections can help identify potential issues early on and facilitate prompt corrective actions.

Cleaning: Instruments can accumulate dirt, dust, or other contaminants over time, which can affect their accuracy and performance. Cleaning involves removing these contaminants and ensuring that instruments are free from obstructions. Proper cleaning techniques and suitable cleaning agents are used to avoid damage to sensitive components.

Repairs: If an instrument is found to be malfunctioning or damaged during inspections or as a result of inaccurate readings, repairs are undertaken. This may involve component replacements, adjustments, or troubleshooting to rectify the issue and restore the instrument's functionality. Repairs are carried out by trained technicians using appropriate tools and spare parts.

Replacements: Over time, instruments may become outdated or reach the end of their lifespan. In such cases, it may be necessary to replace the instruments with newer models that offer improved performance, accuracy, or additional features. Instrumentation maintenance includes the planning and execution of instrument replacements to ensure seamless continuity of operations.

Software Updates: Many instruments incorporate software or firmware to control their operations and provide advanced functionalities. Regular updates to instrument software help ensure compatibility, address known issues, and incorporate security patches. Software updates are typically performed as part of maintenance to optimize the performance and security of the instrument.

Documentation: Accurate and detailed documentation is a crucial aspect of instrumentation maintenance. This includes maintaining records of maintenance activities such as calibration certificates, repair logs, inspection reports, and other relevant documentation. Documentation helps track the maintenance history of instruments, enables analysis of trends, supports compliance with regulatory requirements, and assists in audits or quality control processes.

In addition to these activities, preventive maintenance strategies are often employed to proactively identify and address potential issues before they result in instrument failure. This may include scheduled preventive maintenance tasks such as lubrication, adjustments, or routine checks to ensure instruments are operating within specified parameters.

Furthermore, instrumentation maintenance also encompasses adherence to safety standards and protocols. Instruments used in industrial processes are often integrated into critical systems where safety is paramount. Maintenance activities help identify and rectify any safety-related issues, ensuring the safe operation of equipment and the protection of personnel.

Overall, instrumentation maintenance is a vital discipline that ensures the continued accuracy, reliability, and safety of instruments used in various industries. By implementing regular maintenance practices, organizations can maximize the lifespan of their instruments, optimize performance, minimize downtime, and enhance overall operational efficiency.

I.3.1 Types(Fields) of Instrumentation Maintenance

- **Biological Instrumentation Maintenance:** Biological instrumentation maintenance involves the upkeep and repair of instruments used in biological research, healthcare, and diagnostics. These instruments can include microscopes, centrifuges, DNA sequencers, and spectrophotometers. Regular maintenance ensures that these instruments are operating correctly, calibrated accurately, and free from contamination. It helps to maintain the integrity of biological samples and ensures accurate experimental results.
- **Environmental Instrumentation Maintenance:** Environmental instrumentation maintenance focuses on the upkeep of instruments used to monitor and analyze environmental parameters such as air quality, water quality, and weather conditions. These instruments can include gas analyzers, water quality sensors, weather stations,

and remote sensing devices. Regular maintenance ensures that these instruments are functioning properly, providing accurate and reliable data for environmental monitoring and research.

- **Industrial Instrumentation Maintenance:** Industrial instrumentation maintenance involves the maintenance and calibration of instruments used in industrial processes and manufacturing facilities. These instruments can include pressure gauges, flow meters, temperature controllers, and control valves. Regular maintenance ensures that these instruments are operating within specified parameters, optimizing process efficiency and minimizing downtime. It helps to prevent equipment failure, ensure product quality, and maintain safety standards.
- **Energy Instrumentation Maintenance:** Energy instrumentation maintenance focuses on the upkeep of instruments used in energy production and distribution systems. These instruments can include power meters, energy analyzers, voltage regulators, and transformers. Regular maintenance ensures accurate measurement of energy parameters, identifies potential faults or inefficiencies, and helps to optimize energy usage and reduce waste. It plays a critical role in ensuring reliable and efficient energy supply.
- **Laboratory Instrumentation Maintenance:** Laboratory instrumentation maintenance involves the maintenance and calibration of instruments used in research laboratories and testing facilities. These instruments can include balances, pH meters, chromatography systems, and incubators. Regular maintenance ensures the accuracy and reliability of laboratory measurements, safeguards the quality of experimental results, and prolongs the lifespan of instruments. It helps to maintain high standards of scientific research and analysis.

These instrumentation maintenance fields are essential for specific applications within the biological, environmental, industrial, energy, and laboratory sectors. They ensure the proper functioning, accuracy, and reliability of instruments, enabling researchers, professionals, and industries to effectively monitor, measure, and analyze critical parameters.

I.3.2 Entry on Industrial Instrumentation Maintenance (Oil & Gaz Field):

In the oil and gas industry, industrial instrumentation refers to the specialized instruments and control systems used to monitor, measure, and control various parameters in exploration, production, refining, and distribution processes. These instruments play a critical role in ensuring safe and efficient operations, optimizing production, and maintaining environmental and safety standards.

key areas where industrial instrumentation is used in the oil and gas field:

- **Flow Measurement:**
  Accurate measurement of flow rates is crucial in oil and gas operations. Flow meters, such as orifice plates, ultrasonic flow meters, and Coriolis flow meters, are used to measure the flow of oil, gas, and other fluids in pipelines and processing facilities. This information is essential for monitoring production rates, allocating resources, and optimizing process efficiency.
- **Pressure and Temperature Monitoring:**
  Pressure and temperature sensors and gauges are utilized to monitor the operating conditions of equipment and processes. They ensure that pressure and temperature remain within safe and optimal ranges. Instruments such as pressure transmitters and temperature transmitters provide real-time data for control systems and safety shutdowns.
- **Level and Tank Gauging:**
  Level measurement instruments are used to monitor the level of liquids in storage tanks, vessels, and separators. This information is critical for inventory management, preventing overflows, and optimizing production. Instruments like level transmitters, float switches, and radar level gauges are commonly used for level measurement in the oil and gas industry.
- **Gas Detection and Analysis:**
  In the oil and gas industry, the presence of toxic or flammable gases poses a significant safety risk. Gas detectors, such as combustible gas detectors and toxic gas monitors, are used to continuously monitor the air quality in and around facilities. Additionally, gas analyzers are employed to analyze the composition of natural gas, ensuring compliance with quality specifications.
- **Safety Systems and Emergency Shutdowns:**
  Safety instrumented systems (SIS) and emergency shutdown systems (ESD) are crucial in the oil and gas industry to protect personnel, equipment, and the environment. These systems use various instruments, such as safety valves, pressure switches, and emergency stop buttons, to monitor critical process parameters and initiate shutdown procedures in case of abnormal conditions or hazards.

CHAPTERII

INSTRUMENTATION MAINTENANCE

II.1 Introduction

II.2 What is a mobile instrumentation maintenance workshop:

A mobile instrumentation maintenance workshop refers to a portable facility or service that provides maintenance and repair capabilities for instrumentation equipment on-site or in remote locations. It is designed to bring the necessary tools, equipment, and expertise directly to the location where the instrumentation is installed, eliminating the need for equipment to be transported to a fixed maintenance facility.

A mobile instrumentation maintenance workshop typically includes a specialized vehicle or trailer equipped with all the essential tools, diagnostic equipment, spare parts, and supplies needed for conducting maintenance, calibration, troubleshooting, and repairs on instrumentation equipment. The workshop may be staffed by qualified technicians or engineers who have expertise in instrumentation maintenance and are capable of performing a wide range of tasks.

II.3 Benefits and advantages of a mobile instrumentation maintenance workshop include:

On-site Convenience: With a mobile workshop, maintenance and repair services can be carried out directly at the location of the instruments, saving time and effort associated with transporting the equipment to a separate facility.

Reduced Downtime: On-site maintenance minimizes downtime since the instruments can be serviced promptly, allowing operations to resume quickly.

Rapid Response: Mobile workshops can be dispatched quickly to address urgent maintenance needs or equipment failures, ensuring a swift response and minimizing disruptions to production or operations.

Cost-Effectiveness: Eliminating the need to transport equipment to a separate maintenance facility can reduce costs associated with transportation, disassembly, and reinstallation.

Customization and Flexibility: Mobile workshops can be customized to meet specific maintenance requirements and can accommodate a variety of instrumentation types and sizes. They can be deployed to different sites as needed, providing flexibility in servicing multiple locations.

This particular type Mobile Workshop is particularly useful in industries such as oil and gas, petrochemical, power generation, and manufacturing, where instruments are installed in remote or challenging environments. They enable efficient and timely maintenance and troubleshooting, ensuring the optimal performance and reliability of the instrumentation equipment.

II.4 Conception

II.4.1 Requirements Determination

II.4.1.1 Calibration Equipment

- Multifunction calibrators(multimetre): for calibrating various parameters such as pressure, temperature, electrical signals, and flow.
- Deadweight testers: Used for calibrating pressure instruments.
- Temperature calibrators: calibrating temperature sensors and transmitters.
- Flow calibration equipment: Including flow meters and flow controllers for calibrating flow instruments.

II.4.1.2 Diagnostic Tools

- Portable data loggers: Used for recording and analyzing instrument measurements over time.
- Digital multimeters: Used for measuring voltage, current, and resistance in electrical circuits.
- Oscilloscopes: analyze electrical signals and waveforms.

II.4.1.3 Testing Instruments

- Pressure gauges: Used for measuring and verifying pressure in systems.
- Temperature sensors: Including thermocouples and resistance temperature detectors (RTDs) for measuring temperature.
- Gas detectors: Used for monitoring and detecting hazardous gases in the environment.
- Vibration analyzers: Used for diagnosing and analyzing vibration levels in rotating equipment.

II.4.1.4 Hand Tools

- Screwdrivers, pliers, and wrenches: Basic tools for disassembling, assembling, and adjusting instruments.
- Torque wrenches: Used for applying precise torque during installation or maintenance.
- Cable crimpers and cutters: For working with electrical cables and wiring.

II.4.1.5 Safety Equipment

- Personal protective equipment (PPE): Including safety glasses, gloves, helmets, and protective clothing.
- Fire extinguishers: Essential for fire safety.
- Gas detectors: To ensure the safety of the maintenance technicians when working with hazardous gases.

II.4.1.6 Added Tools and Equipment:

- Portable power supply: Ensures a reliable power source for the workshop.
- Ladders and scaffolding: For easy accessing instruments located at heights.
- Toolboxes and storage solutions: To organize and store tools and equipment securely.

II.4.2 Instruments

II.4.2.1 PSV (Pressure Safety Valve)

The safety valve is a safety device intended to protect the capacities against overpressure. It has a predetermined value higher than the working pressure under the pressure action of the fluid alone without any input from any other source of energy and which evacuates a flow of fluid sufficient to prevent the pressure from exceeding the maximum working value by a predetermined quantity, it closes by the counter-action of the spring (Ressort) by stopping the flow of the fluid when the service conditions are restored.

II.4.2.2 Safety Valve Definition:

A Pressure Safety Valve (PSV) is a device protection against over pressure, in installations which have to withstand high pressures which could be damaged, or even destroyed, if the pressure became too high.

II.4.2.2.1 Classification of Pressure safety valve:

1. **Standard safety valve:** a valve in which the opening reaches the degree of lift only necessary to be discharged within a pressure rise of not more than 10% (The valve is characterized by a pop type action and is sometimes known as high lift).
2. **Fulllift safety valve:** a safety valve that opens rapidly within a 5% pressure rise up to the full lift as limited by the design. The amount of lift up to the rapid opening (proportional range) shall not be more than 20%.
3. **Direct loaded safety valve:** a safety valve in which the opening force underneath the valve disc is opposed by a closing force such as a spring or a weight.
4. **Proportional safety valve:** a safety valve that opens more or less steadily in relation to the increase in pressure. Sudden opening within a 10% lift range will not occur without a pressure increase. Following opening within a pressure of not more than 10%, these safety valves achieve the lift necessary for the mass flow to be discharged.
5. **Diaphragm safety valve (or membrane valves):** a directly loaded safety valve in which linear moving and rotating elements and springs are protected against the effects of the fluid by a diaphragm.
6. **Bellows safety valve:** a direct loaded safety valve where sliding and (partially or fully) rotating elements and springs are protected against the effects of the fluids by a bellows. The bellows may be of such design that they compensate for the influences of backpressure.
7. **Controlled safety valve:**This type of pressure safety valve consists of the main valve and a control device. It also includes direct acting safety valves with supplementary loading in which, until the set pressure is reached, an additional force increases the closing force.

II.4.2.2.2 Safety valve components:

The components of the different valves still resemble those of the plant shown here;even if each version of safety valves varies. The optimal design of the series is not than achieved only by simulating the fluid by careful functional tests.

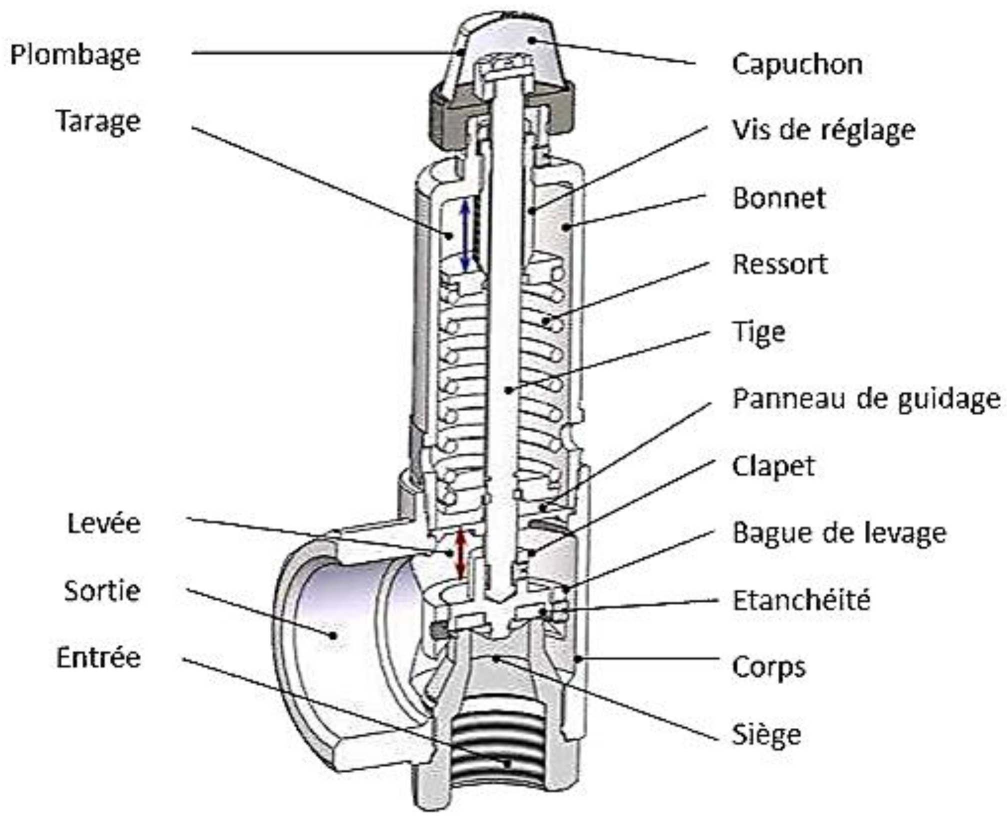
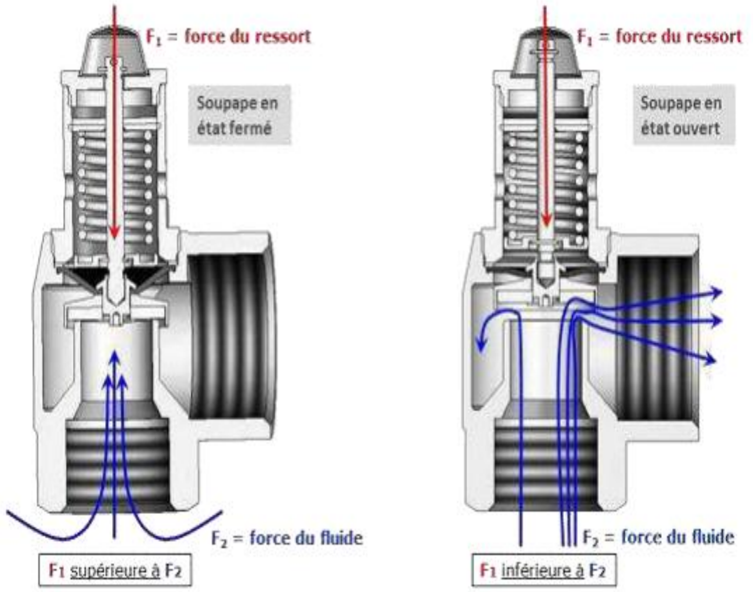


Figure. Erreur ! Utilisez l'onglet Accueil pour appliquer 0 au texte que vous souhaitez faire apparaître ici..**II.1** Diagram of safety valve components

II.4.2.2.3 Operation of a valve (Functioning):

The operation of a valve is based on a simple balance between the force of the spring and the fluid. The spring force of the valve in a state of rest and applied under service conditions standard is superior to that of the fluid and the valve closes/sealed state. As soon as the pressure of valve calibration is attracted by high working pressure, the valve opens and admits a discharges by evacuating fluid. The valve closed (sealed state) following a pressure reduction in the system at a pressure lower than the closing pressure. [4]



FigureErreur ! Utilisez l'onglet Accueil pour appliquer 0 au texte que vous souhaitez faire apparaître ici.**.III.2**Safety valve fonctionDiagram

II.4.2.2.4 Pressure Relief Valve Failure and Troubleshooting

Pressure relief valves and safety valves in the manufacturing industry can sometimes fail. Failure causes the valve to release pressure before the system reaches the maximum pressure or causes leakage and chattering. Troubleshooting the valve and the system for what's causing the issues is a safe practice. This article explores the causes of pressure relief valve failure in a system and how to test the valve to repair or replace it.

A properly maintained pressure relief valve can last up to thirty years. However, the pressure relief valve can fail over time. It's essential to recognize the signs to solve the problem quickly and keep the facility safe. There are multiple signs of pressure relief valve failures to watch out for while troubleshooting the system.

A properly maintained pressure relief valve can last up to thirty years. However, the pressure relief valve can fail over time. It's essential to recognize the signs to solve the problem quickly and keep the facility safe. There are multiple signs of pressure relief valve failures to watch out for while troubleshooting the system.

II.4.2.2.5 The system cannot reach a certain pressure:

A system that cannot reach its designed pressure can be a sign of pressure relief valve failure that can cause a production slowdown. Checking the pressure relief valve can help determine the problem, and it is possible to fix the issue in some cases.

- **Wrongcalibration**: If the pressure relief valve was calibrated to the wrong set pressure, it can release the media early. This can happen when there are design changes to the facility's plant design and the pressure relief valve is not recalibrated to the system's new normal operating pressure. Adjust the valve's set pressure to address this issue.
- **Wearingout**: If the pressure relief valve is calibrated correctly and all other aspects of the system are functioning optimally, then it's time to change the pressure relief valve. The valve can become damaged after years of service, and the dirt and dust from the environment can prevent the valve from closing fully. This often causes chattering in pressure relief valves, where the valve opens and closes rapidly, preventing it from operating correctly
- **Pressure relief valve leaking:**

A valve can leak for multiple reasons:

- ➢ Not fully closed: Dusty industrial environments can leave debris in the pressure relief valve, preventing it from closing fully which leads to leakage.
- ➢ Damage: Extreme temperatures and wear can deteriorate the pressure relief valve, causing damage (like a broken spring) over time. This affects their ability to close properly, causing leakage.
- ➢ Wrong size: A poorly sized valve doesn't function properly and often leaks.

II.4.2.2.5 Operation Maintenance:

Valve setting (Tarage des soupapes):

Application Domain:

This procedure applies to all types of safety valves (gas or liquid) with a nominal diameter between 1/2" and 24".

Principe of setting:

- Before setting the safety valves, the choice of test fluid depends on the nature of the valve
- Air or azote for valves intended for gas or steam services.

- Water for valves intended for liquid service.
- The setting of the safety valves is based on Ref: API 576 version 2017

To fix a leaking pressure relief valve:

1. Shut down the system when the pressure relief valve leaks.
2. Determine the cause of the leak by carefully examining the pipelines and the valve. It is difficult to troubleshoot a leaking pressure relief valve as there are multiple potential causes. Perform quality in-line leak testing to determine the root cause of the leak.
3. For the initial repair of the safety valve, tighten or replace the bonnet bolts and tighten the packing gland nuts. Ensure to follow the valve manufacturer’s guidelines.
4. If the valve doesn’t work properly after the initial repair, perform any additional repairs if needed. If nothing works, replace the valve as final and fundamental solution.**[4].**

II.5 Procedure:

II.5.1 Primary operation

The operator must be fully informed of the safety instructions mentioned in the test bench user manual before tightening or pressurizing the valve to be tested.

Valve loading on the clamping table of VC50CC test unit:

- Before loosening the valve on the clamping table of the test bench check that electricity, the compressed air and the installed safety systems are connected. In case the unit is equipped with a main switch (units with the computer) Always put the main switch to activate the security systems.
- Measure or determine the size of the safety valve inlet

- Place the sealing disc corresponding to the size of the inlet on the clamping table.
- Charge the safety valve and center it on the clamping table.

- Slide the three bites towards the center using the manual lever at the front of the clamping station. exceed the flange with a minimum of 25 mm/ 1".

- Operate the hydraulic clamping system by tilting the control panel selector lever to the clamping position.
- Turn the clamping regulator clockwise, manually use the clamping lever to move the bites upwards or the foot pedal to apply a pre-tightening force
- Turn the clamping regulators clockwise to apply the required level of clamping pressure. The clamping pressure can be read from the clamping pressure gauge. The required clamping pressure can be taken from a clamping chart that describes the necessary pressure levels related to the size of the valve and the pressure test level. The selector lever shall be left in the clamping position during each test procedure.
- Remove the valve from the Vc 50cc test unit.
- Release the pressure test by opening the pressure relief valve on the control panel. If necessary, support the valve in the clamping system by the hoist lift
- Turn the clamping regulator clockwise to the < Zero > position.
- Activate the hydraulic clamping system by opening the selector lever to decompress. Turn the clamping regulator clockwise to move the bites upwards.
- Separate the three dead outside, using the manual lever. Remove the test valve.

- Turn the clamping regulator clockwise to the < Zero > position.

Note:

- ✓ Before running a test always note the data mentioned on the valve signal plate to be tested.
- ✓ Also check that the test unit pressure is sufficient.

Maintenance Tools:

- Bench Test
- Air Pompe (Process Simulation)
- Polir

II.5.2 Leak test (test d'étanchéité):

Steps to Follow:

- Connect the output adapter of the safety valve outlet
- Connect the blue hose to the "bubble counter" at the quick coupling.
- Be sure to fill the bottle to the level indicated on the tube.
- Increase the test pressure, using the regulator, up to 90-90% (depending on the test standard) of the set pressure found and check the leak with the bubble counter.

Figure II.3 Bubble Counter

II.5.3 Liquid test procedure

The liquid test system is a gas/liquid test system designed to test safety valves with the system is designed with sufficient capacity to generate a detectable lift of the safety valve. The maximum pressure is equal to the maximum available pressure of the gas and is provided by the same source

1. Close vent (D) and drain valve. (The drain valve is installed on the side of the panel)
2. Fill the system and test it with liquid by starting the filling pump, pressing the button on the control panel. The filling pump stops automatically when the system is full, or needs to be shut down when fluid can be seen on the level indicator of the control Panel.
3. Pressurize the valve as described in the following steps(Gaz Prociddure):
    - Close vent (D), insulation (C) and drain valve. The drain valve is installed on the side of the panel
    - Turn gas regulator (8) fully counterclockwise, open (one inch) isolation valve (C).
    - Turn on the gas supply by pressing the art switch (A) The pressure level of the gas supply can be read on the pressure gauge installed.
    - Start the pressurization by slowly operating the gas regulator (B) and read the pressure test on the pressure gauges of the control panel
    - Increase the pressure level until the safety valve has reached its set pressure
    - Shut off the pressure supply to the test circuit by deactivating the stop switch (A).
    - Level of replenishment/bleed pressure can be read on gauges or on fonfinator screen
    - When the test is complete, open the vent valve (D) to relieve the test pressure from the system

Remarks:

For pressure testing up to 200 bar/2000 psi, the high pressure supply to the storage system is sufficient to reach the requested test pressure.

For pressure tests above 200 bar / 2900 psi up to a maximum of 300 bar / 4350 psi), the installed booster must be activated. This can be done using the manual lever which is mounted on the control cabinet. Rrest of the test procedure remains the same.

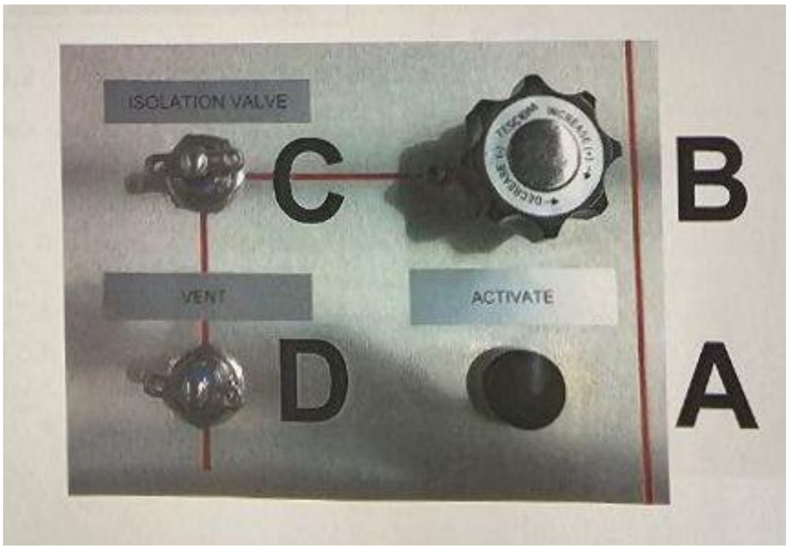


Figure.II.4 Control Panel

II.5.4 Temperature Transmitter:

II.5.4.1 Resistance Temperature Detectors (RTDs):

An RTD Sensing element consists of a wire coil or deposited film of pure metal. The element’s resistance increases with temperature in a known and repeatable manner. RTD’s exhibit excellent accuracy over a wide temperature range.

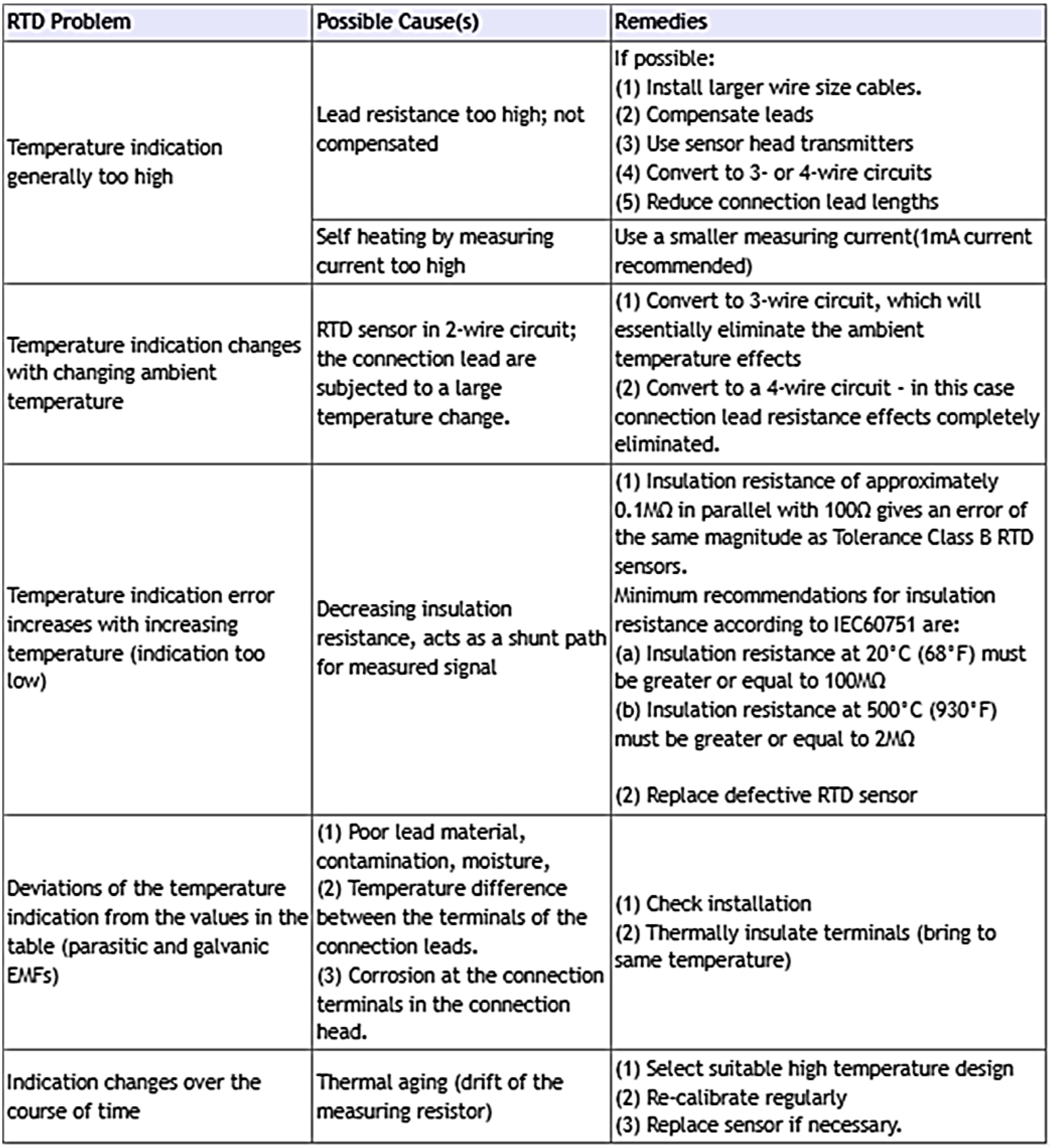
- Temperature range: -200 to 700ºC

- Sensitivity: the voltage drop across an RTD provides a much larger output than a thermocouple.

- Linearity: Platinum and copper RTD’s produce a more linear response than thermocouples or thermistors. RTD non-linearities can be corrected through proper design of resistive bridge networks.

RTDs are widely used across several industries- power, food and beverage for temperature measurement. In using them, different types of application problems occur once in a while. To help resolve these problems, the table below shows a list of the common problems encountered in RTD applications and possible remedies or corrective measures. This list is by no means exhaustive:

Common Failures on RTD Sensors:[5]



RTD Problem	Possible Cause(s)	Remedies
Temperature indication generally too high	Lead resistance too high; not compensated	If possible: (1) Install larger wire size cables. (2) Compensate leads (3) Use sensor head transmitters (4) Convert to 3- or 4-wire circuits (5) Reduce connection lead lengths
	Self heating by measuring current too high	Use a smaller measuring current(1mA current recommended)
Temperature indication changes with changing ambient temperature	RTD sensor in 2-wire circuit; the connection lead are subjected to a large temperature change.	(1) Convert to 3-wire circuit, which will essentially eliminate the ambient temperature effects (2) Convert to a 4-wire circuit - in this case connection lead resistance effects completely eliminated.
Temperature indication error increases with increasing temperature (indication too low)	Decreasing insulation resistance, acts as a shunt path for measured signal	(1) Insulation resistance of approximately 0.1MΩ in parallel with 100Ω gives an error of the same magnitude as Tolerance Class B RTD sensors. Minimum recommendations for insulation resistance according to IEC60751 are: (a) Insulation resistance at 20°C (68°F) must be greater or equal to 100MΩ (b) Insulation resistance at 500°C (930°F) must be greater or equal to 2MΩ (2) Replace defective RTD sensor
Deviations of the temperature indication from the values in the table (parasitic and galvanic EMFs)	(1) Poor lead material, contamination, moisture, (2) Temperature difference between the terminals of the connection leads. (3) Corrosion at the connection terminals in the connection head.	(1) Check installation (2) Thermally insulate terminals (bring to same temperature)
Indication changes over the course of time	Thermal aging (drift of the measuring resistor)	(1) Select suitable high temperature design (2) Re-calibrate regularly (3) Replace sensor if necessary.

II.5.2 Calibration Procedure:

- Isolate the sensor from the process.
- Fully immerse the sensor into a precision temperature source, such as a dry-well or bath capable of covering the required temperature range.
- For best accuracy, also fully immerse a temperature standard into the drywell or bath for comparison.
- To check the calibration of the RTD separately from the control system temperature indicator, disconnect the RTD from the electronics / transmitter.
- Connect the RTD to a precision instrument capable of measuring resistance like Decade Resistance box or multi function calibrator.
- Adjust the temperature of the bath or dry-well to each of the test points. Say 25C, 50 C, 75 C, 100 C etc insteps.
- At each test point record the readings of the temperature bath readings and RTD output for each test point.

If measuring the RTD separate from its measurement electronics, compare the measured resistances to the expected resistance from the applicable RTD temperature table. Otherwise, compare the reading on the instrument display to the reading of the temperature standard (which may be the dry-well).

Note: Above procedure is same for 2 wire 3 wire or 4 wire RTD’s. We just connect the RTD respective wiring in the decade resistance box or multi-function calibrator which is used to measure the RTD resistance.

Thermocouples:

Thermocouples, devices used to measure temperature, are composed of specially-made wires of two dissimilar metals that produce a small voltage when joined together at one end (the hot junction) and connected at their other ends to a colder point, known as the cold junction. This small voltage can be used to determine the difference between a known reference temperature and a second unknown point. The voltage is used to determine the temperature of the unknown point. Thermocouples are made from numerous metal combinations that are used over several ranges that typically fall between -200 and 1250°C. Depending on the types of metals in the thermocouple, the specific temperature range will vary. Thermocouples are employed extensively in industry as well as in many other non-industrial settings such as in household appliances. They are rugged, inexpensive, and can operate over a wide temperature range and in an assortment of environments. Thermocouples do not measure temperature directly—they merely produce a voltage when exposed to a temperature gradient. Hence, calibration is necessary to correlate this voltage to the temperature difference

Calibration:

For Thermocouple calibration at Comparison method, we have required:

1. Stable temperature source
2. Calibrated master sensor
3. Calibrated meter

The device with the known or assigned correctness is called the standard Sensor and the secd device is the unitunder Calibration, test instrument, or any of several other names for the deve being calibrad

Calibration Procedure:

1. The Thermocouple under calibration is physically checked for tts hot and cold junction to be intact.
2. Each Test Thermocouple is attached with an identification sticker using a tag.

3. The Standard Thermocouple and the test thermocouple are inserted in the holes of equalizing block inside the HT furnace in such a way that the hot junctions of all TC's on the same place in the block.
4. Set the HT Furnace to desired temperature and wait until the temperature is not stable.
5. Observation on thermo-emf is recorded at each set temperature for both standard as well as test thermocouple when the temperature in the furnace is stable for both (Standard and Test Thermocouple)
6. Minimum 5 measurements are recorded for each calibration points.
7. Similar procedure is followed for all other calibration temperature points say, as 400, 700 & 1000 Deg C.
8. When the calibration is completed, the thermocouples are not removed immediately, but left to cool down to ambient slowly to avoid the sudden change is temperature.
9. The readings are recorded systematically for all thermocouples with readings of reference junctions if placed at ambient temperature.
10. The environment data for room temperature and relative humidity (RH) are also measured and recorded.
11. At each mean value of Thermo-emf measured for standard thermocouple in the furnace, the actual temperature is calculated from its calibration certificate.
12. The mean valued of corresponding emf of TC under calibration also calculated from the reference table if the reference temperature is maintained at 0 Deg C
13. In case the reference junction is maintained at ambient, the emf at each temperature is calculated by adding the emf corresponding to measured reference junction to the emf of measured temperature.

Differential Pressure Level Measurement:

Differential Pressure Transmitter Calibration Procedure:

Definition:

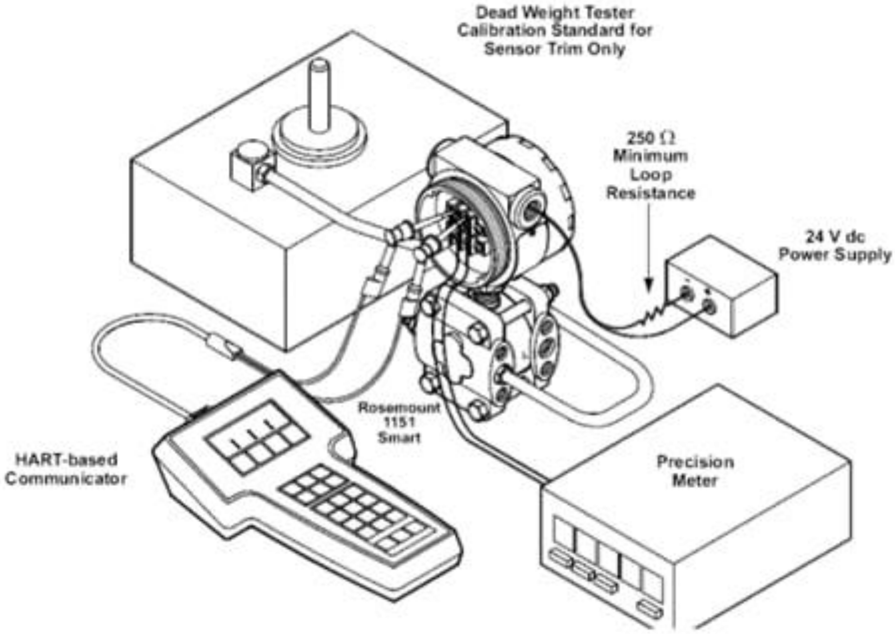
Differential Pressure (DP) Level Measurement uses pressure readings and specific gravity to output level. DP Level is a common measurement technique that is used in a wide variety of applications. Solutions include standard transmitter connections and integrated transmitters with direct or remote mount seals that can be configured in tuned, balanced, and electronic systems. Additional Wireless options are also available.

Steps to Calibrate a Pressure Transmitter:

1. Calibrate the 0%, Lower Range Value (LRV) of the transmitter to the LRV of the calibration range. Calibrate the transmitters span to 100%, Upper Range Value (URV) of the calibration range. For example: If you are using Differential Pressure transmitter with power output 4-20mA to measure pressure in the range 0-300 PSIG, then the transmitter's 0% LRV is 4mA, and is calibrated to 0PSIG. Similarly, the 100% URV is 20mA, and will be calibrated to 20 mA.
2. Locate the ZERO and SPAN/RANGE screws of the transmitter by referring the instruction manual. These screws are each connected to the potentiometer and can be turned easily.
    a. The potentiometer allows up to 20 turns between the maximum and minimum resistance. This means 20 clockwise or anticlockwise turns of ZERO and SPAN screw will cause the potentiometer to be at maximum or minimum. In many brands of DP transmitters, the ZERO and RANGE adjustments are interconnected. This means adjusting one screw may affect the other.
3. Turn the RANGE and ZERO screws clockwise 20 times. Next, turn the screws 10 times in the counter clockwise direction to adjust the potentiometer between the maximum and minimum resistance. This step is performed to set the mid resistance point at 50%.
4. Apply the LRV 0% on the high side of the transmitter, and low vented side. This helps diminish the differential pressure across the DP cell of the transmitter.
5. Adjust the ZERO screw on the transmitter by observing the 4mA indication in the current meter. This is the LRV output of your transmitter. At times, this value may not be 4 mA, but you should get a value closer to that.
6. Next, apply pressure on the high side of the transmitter to increase the value to the 100% higher value (URV) of the calibration range.
7. Adjust the RANGE Screw by observing the meter's current indication, which should show 20 mA, which is the 100% URV output of the transmitter.
8. In ideal situation, 100% of the transmitters input should correspond to the set standard readings of transmitters 100% output (4-20 mA). Accurately calibrated pressure is the

one, where the values of input equals to the output for all values between 0-100percent.

Note that the steps mentioned above may differ from the actual steps mentioned in the manufacturer’s guide, however this the common procedure with most of differential pressure transmitter types.



Float Level Sensor:

Definition:

Float level switches provide a low-cost general-purpose solution for single point monitoring of liquid level in a variety of applications. Designed for shock and vibration resistance, ProSense float level switches ensure long and trouble-free service.

- Available in several material constructions for compatibility with many liquid types
- Vertical and horizontal mounting styles offer flexible mounting with a variety of process connections
- Operating temperature ratings up to 482°F
- Suitable for a wide range of system pressure requirements
- Reed switches offer both AC and DC voltage ratings
- Most models are field configurable for N.O. or N.C. operation

Ref: Float Level Switches (automationdirect.com)

A float level sensor is used to detect the liquid level of a fluid. The most ideal scenario is a fluid inside a tank, but it can also be used in plenty of other applications. It is suited for industrial use and can withstand harsh environments. A float level sensor can be used to control the height of the fluid for safety, practical, or economical purposes.

How Does a Float Level Sensor Work?

The sensor probe acts as a path for the float to travel up and down due to the buoyancy of the fluid. Inside the float is a sealed magnet, which triggers a location specific reed switch depending on its location. Each reed switch represents a different location and the electrical circuitry will send and receive the appropriate resistance depending on which reed switch is active. Once the sensor sends the resistance, then the transmitter can proportionally convert that to a 4-20mA signal. A 4-20mA current signal transmitter uses a small amount of current from the loop to function, but as it is significantly less than 4mA, it has no effect on the total measurement. There are 4 connections from the sensor to the transmitter and the wire colors are printed on the side of the transmitter. It is always best to refer to the user manual of the transmitter for wiring.

What causes a float switch to fail:

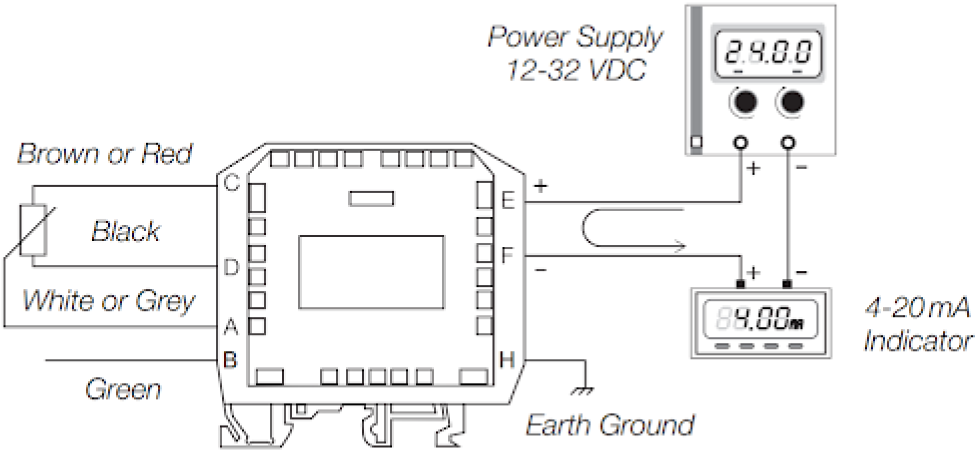
- **Incorrect configuration:** Always refer to the float switch manual and the equipment used in conjunction with it (like a sump or sewage pump). The manual contains details regarding the wiring and the various configurations to make the float switch function in the ON and OFF states.
- **Poor maintenance:** A poorly maintained float switch can fail over time due to the debris that accumulates on its surface.
- **Insufficient rating:** A float switch has a rating to indicate the electrical load that it can handle. The float switch manual gives the switch's technical specifications like the cable length, the maximum temperature of operation, and the power rating. Using a load that exceeds the float switch rating can generate heat at the switch contacts, causing it to malfunction.
- **Incorrect design:** Float switches are made from different materials or specific mechanical configurations based on their application. The wrong switch type may function in the short term, but it is more likely to fail or malfunction.
- **Stuck float switch:** A float switch stuck in the 'on' position may be due to the system clogging or the float switch getting tangled up. The motor may not start or won't be able to stop at certain times if the float switch gets stuck. This can eventually burn out the motor.
- Vertical float switches are less likely to become stuck. Tethered float switches have a tendency to become stuck on the sump pit's side walls, resulting in a flooded basement. Use vertical float switches wherever possible; check the basement area during every major storm if using tethered float switches.
- If the sump pump has expelled a lot of air or there is water sloshing all around, the float switch may get stuck on the sides of the sump pit.
- Debris in a sump basin can cause the float switch to remain stuck. Ensure to clean the sump basin periodically. Also, the float switch can rust over time and needs replacement.

Calibration Procedure:

How to Calibrate a 4-20mA Current Loop Transmitter:

SETUP:

The transmitter is hooked up to a variable power supply, with an ammeter in series with the circuit. Attached to the sensor head is the transmitter that converts that resistance into a 4-20mA current signal. To ensure proper setup and calibration of the probe a zero-point and span correction is required.



Step 1: Connect the Positive and Negative Loops:

Use a precision ammeter for proper calibration. Connect the positive of the supply to the positive input of the transmitter. This is “Loop Positive”.

Then, connect the output of the transmitter, “Loop Negative”, to the input of the ammeter. Next, connect the negative of the ammeter to the negative of the supply in order to complete the circuit.

Step 2: Adjust the Zero-Point (Z):

The “Z” point stands for “Zero-Point” or in other words the lowest possible reading. With a 4-20mA signal, the Z-point is 4.00mA.

To begin, place the float at the lowest point on the sensor probe. You should not have to press hard, just let it sit on the bottom. The ammeter will give a reading that will be very close to 4.00mA, but may not be 4.00mA. It is your job to adjust the value to bring it to 4.00mA

To adjust the current reading, we will be adjusting a potentiometer. The adjustment potentiometer is located on the din rail transmitter, and is labeled “Z”, as in “zero-point”.

To adjust the zero point (Z), use a small flat head screwdriver and turn it either clockwise or anti-clockwise depending on whether your signal needs to be increased or decreased. Adjust it until you reach 4.00mA.

Step 3: Adjusting the Span (S):

The next step is to adjust the span (S). By doing this, you are correcting the full range of level readings. To do this, move the float to the top position; and allow the ammeter to stabilize. The reading should be very close to 20.00mA. Adjust the (S) potentiometer until it is exactly 20.00mA.

Now, return the float to the zero position, and ensure that the indicated current level is 4.00mA. You might have to go back and forth a few times until both points are correct.

After Calibration:

Once the device is calibrated, it will not drift. The float sensors use magnetic reed switches that are designed for that they cannot drift at all.

The only possibility of drift is within the 4-20mA transmitter, and by using a quality Intempco transmitters that drift risk can be minimized. This will ensure the reading will stay stable.

Ref: How to Calibrate a Float Level Sensor with a 4-20mA Current Loop Output (intempco.com)

Maintenance Tools:

-

Ultrasonic Level Sensors and Switches:

Flowline ultrasonic liquid level sensors emit a sound impulse and measure the echo's return time from the material's surface. Unaffected by environments with dirty, sticky or scaling media, these sensors are available in contact and non-contact versions, with models designed for hazardous or high-condensation locations. Level switches detect the presence of liquids at a specific level.

An ultrasonic level instrument measures the time between sound energy transmitter from the sensor, to the surface of the measured material and the echo returning to the sensor.

As the speed of sound is known through the travel medium at a measured temperature, the distance to the surface is calculated. Level can be calculated from this distance measurement.

Echo Processing built in to the instrument can allow the instrument to determine the material level of liquids, solids or slurries even in narrow, obstructed or agitated vessels.

Limitations:

Ultrasonic is seldom used in upstream hydrocarbon process stream for level measurement; it might be used in atmospheric utilities applications. In applications which are susceptible to vapour density variation, compensation reference pin should be used.

Maximum measurement distance should be checked against the technology (above 30 m the reflectivity may be reduced and might cause a measurement error/problem).

Ultrasonic sensors have, as physical limitation, a blocking distance (close to the sensor) where they cannot measure reliably, e.g. 0.25 metres.

Vessel pressure limitation should approximately be, e.g. 0.5 bar or less. Higher pressure may introduce uncertainty in the level measurement.

Vapour, vacuum or temperature gradients can influence the speed of sound and consequently can cause incorrect measurements.

Presence of foam or heavy turbulence on the surface of the measured material can cause unreliable measurement.

Ref: [Ultrasonic Level Transmitter Principle, Limitations, Calibration (instrumentationtools.com)]

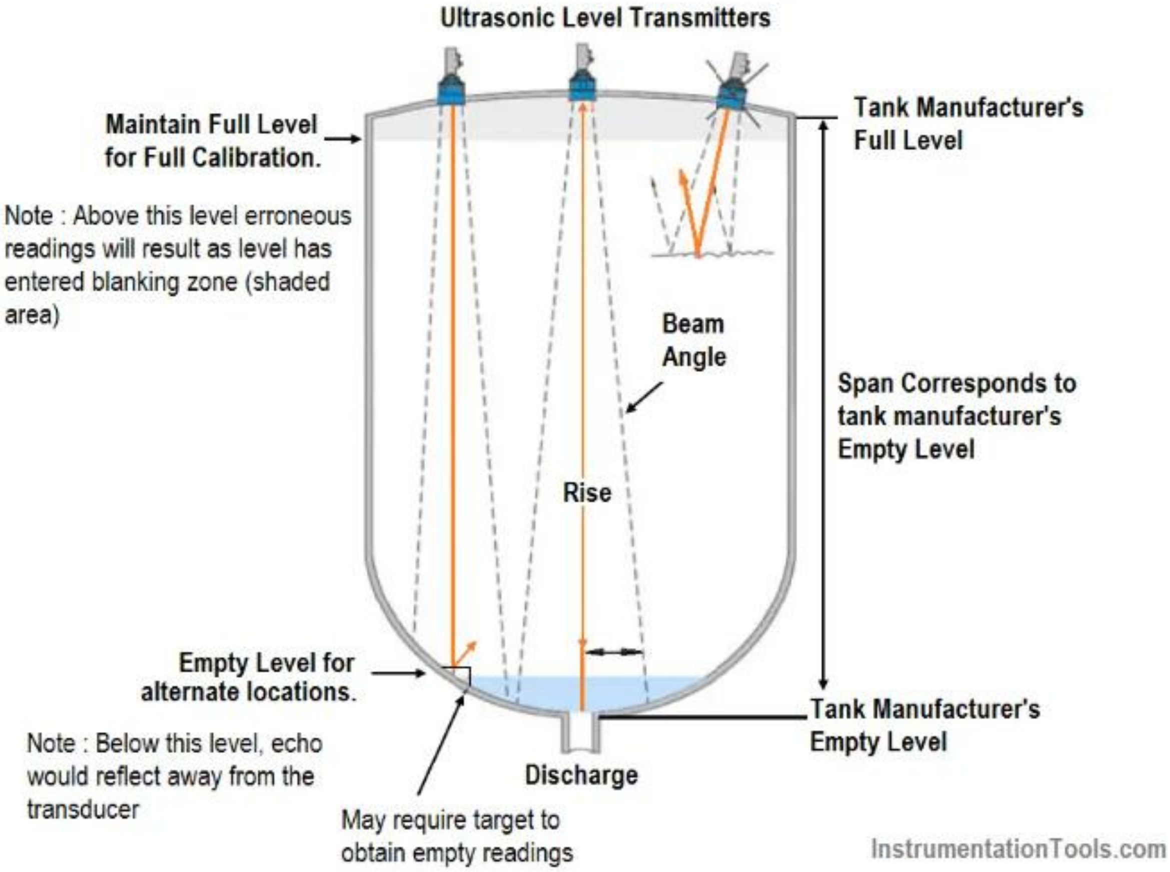


Figure – Ultrasonic Liquid Measurement Arrangement.

Calibration and configuration:

Performing an initial or ‘empty calibration’: In this principle, ‘enter’ the distance E from the sensor face to the minimum level (zero point). It is important to note that in vessels with parabolic roofs or bottoms, the zero point should not be more distant than the point at which the ultrasonic wave reflects from the tank bottom.

When possible, a flat target plate that is parallel to the sensor face and directly below the sensor mounting position should be added to the bottom of the vessel for best empty tank performance.

Once the empty distance has been set, the high calibration point or 100% full point can be set. This is done either by setting the distance from the sensor face to the 100% full level or by entering a span (level) from the 0% or low calibration point to the 100% full level.

During commissioning, ensure that the 100% full or high calibration point does not enter the ‘blocking distance’ or ‘blind zone’ of the respective sensor. This will vary from sensor to sensor. Blocking distances or blind zones can be extended to avoid false high-level reflections caused by obstructions, but they can only be reduced to a certain distance due to the physical limitations of the sensor itself. The minimum level (distance E/zero point) should be configured. This zero point should be above any dished boiler heads or conical outflow located at the bottom of the tank/vessel.

The maximum level (distance F/full span) should be configured. This distance F should take into account both BD ‘blocking distance’ and SD ‘safety distances’.

Where BD represents a dead zone in which the wave cannot make any measurement and SD corresponds to a warning or an alarm zone.

Advantages of Vortex Technology

Vortex flow meters offer many advantages for flow measurement including easy installation without impulse lines, no moving parts to maintain or repair, less leak potential and a wide flow turndown range. Vortex meters also offer very low power consumption, allowing for use in remote areas.

Additionally, Vortex meters are unique in that they can accommodate liquids, gasses, steam and corrosive applications. Vortex flow meters are also able to withstand high process pressures and temperatures.

How It Works:

Von Kármán Effect:

Vortex flow meters measure fluid velocity using a principle of operation referred to as the von Kármán effect, which states that when flow passes by a bluff body, a repeating pattern of swirling vortices is generated.

In a Vortex flow meter, an obstruction in the flow path, often referred to as a shedder bar, serves as the bluff body. The shedder bar causes process fluid to separate and form areas of alternating differential pressure known as vortices around the back side of the shedder bar.

Common system failures and treatment / Troubleshooting:

The types of failures can be divided into two categories: system failures and instrument failures. After a failure occurs, the system failure should be checked first, and if the problem cannot be found, then check whether it is an instrument failure.

System failures include: incorrect installation and wiring, mismatched caliber, inconsistent flow range, vibration, electromagnetic interference, power supply problems, improper sensitivity adjustment, etc.;

Instrument failures include: detection probe failure, detection amplifier failure, internal short-circuit, meter body leakage, etc.

1. There is fluid flowing in the pipeline after power on, but no signal output:

- Check whether the wiring of the meter is correct and whether there is any disconnection.
- Check whether the installation direction of the meter is correct.
- Check whether the flow rate is lower than the normal flow rate range.

2. There is no fluid flow in the power-on pipeline, but there is a signal output:

- Check the grounding of the meter, whether it is a bad grounding that introduces interference.
- Check whether the pipeline has strong mechanical vibration.
- Check whether there is strong electromagnetic interference in the environment, such as high-power electrical appliances or inverters and other strong electrical equipment.
- Check whether the sensitivity is too high, adjust the two potentiometers counterclockwise until there is no output.

3. The flow of fluid in the pipeline is stable and meets the flow requirements, but the output changes too much and is unstable:

- Poor grounding may cause interference.
- It may be that the pipe vibration is too strong to introduce interference.

- It may be that the sensitivity is too low and there is a leakage trigger phenomenon, just increase the sensitivity.

4. The displayed flow does not match the actual flow, and the error is large:

- It may be that the instrument parameter settings are incorrect.
- It may be that the measurement error of the temperature and pressure instrument is too large.
- It may be that the flow rate is lower or higher than the normal flow rate range.
- It may be that the installation does not meet the requirements, such as inconsistent installation, obstacles in the pipeline, and insufficient straight pipe sections.

Inspection of instrument failure

- Simple judgment for detecting amplifier failure

In the absence of special equipment, use the display instrument to observe the signal, and use the hand to detect the induced signal at the probe lead input end of the detection amplifier.

can roughly judge whether it is a detection amplifier failure. If there is a signal, it means that the detection amplifier is basically normal, otherwise, the detection amplifier may be faulty.

- Simple judgment of detection probe failure

If the instrument has no signal reflection but the detection amplifier has signal reflection, it can be considered that the detection probe may be faulty. To check the quality of the detection probe, use a multimeter to measure the insulation resistance of the two signal wires. When the temperature is lower than 200 degrees, the insulation resistance should be greater than 2MΩ; when the temperature is higher than 200 degrees, the insulation resistance should be greater than 10MΩ. If the insulation resistance meets the requirements, the detection probe is basically normal, otherwise there may be a malfunction.

Ref :Vortex flow meter trouble shoot (flow-meter.cc)

Turbine Flow Meters:

Turbine flow meters measure the rate of flow in a pipe or process line via a rotor that spins as the media passes through its blades. The rotational speed is a direct function of flow rate and can be sensed by a magnetic pick-up, photoelectric cell, or tachometer.

Mechanics:

Turbine flow meters work analogous to a windmill, a turbine spins on a rotor with an axis of symmetry that is parallel to the flow direction. The flow of media through the flow meter causes the turbine to rotate. As the turbine rotates, each blade of the turbine passes a sensor. The speed at which the turbine rotates is directly proportional to the volumetric flow as well as the rate at which the blades of the turbine pass the sensor.

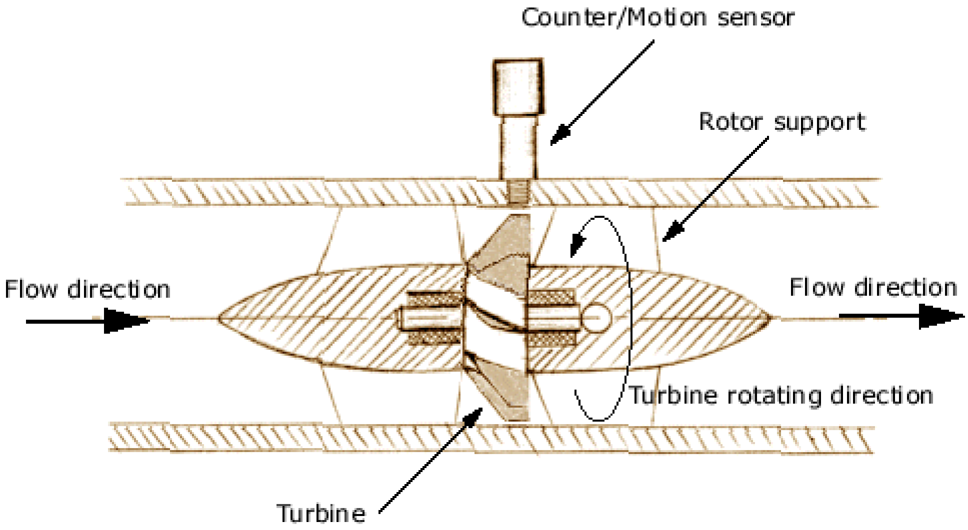


Figure : Turbine Flow Meters

Signal

The sensor used to provide a signal can either be a magnet pick up, photoelectric cell or tachometer.

A **magnetic pick-up** sensor is excited as each blade of the turbine passes, causing an alternating current (AC) to form. The frequency of the alternating current (AC) is proportional to the rate at which the blades of the turbine pass the sensor and ultimately the flow of media through the meter.

A **photoelectric cell** also senses the motion of the turbine blades. Instead of indirectly measuring an implied current, the sensor produces electrical pulses as the blades pass the sensor. The pulses are counted or totalized over a time period to sense the rotational velocity of the turbine.

A **tachometer**, like the photoelectric cell, also directly senses the presence of the turbine blades. A tachometer is most often an electromechanical device that produces electrical pulses as the blades pass the sensors and ultimately sense the rotational velocity of the turbine.

Ref: Turbine Flow Meters Selection Guide: Types, Features, Applications | GlobalSpec

What is a vibration sensor/detector?

A vibration sensor, or vibration detector, measures vibration levels in machinery for screening and analysis. Maintenance teams use industrial vibration sensors for condition monitoring, giving them insight into the magnitude and frequency of vibration signals. Vibration sensors often provide overall vibration levels, indicating whether your asset is under stress, but they can also give more sophisticated readings

Vibration sensors are ideal both for monitoring applications – getting instant notification when faults occur – and more in-depth analysis that vibration experts can do with trended vibration data, often to diagnose complex vibration patterns or mysterious faults.

What is a vibration detector?

A vibration detector is a device that measures changes in the vibration levels of your rotating equipment. Some vibration during operation is normal, and every piece of equipment has a certain vibration baseline or signature. However, changes to an equipment's normal vibration pattern is often the first indication of a problem.

Even relatively small changes in vibration frequency can point to an imbalance, looseness, premature wear, or other fault. Vibration detectors are sensitive enough to pick up on changes that a human might miss.

Vibration detectors are an integral part of condition monitoring and predictive maintenance. Done right, vibration monitoring can help you identify machine faults early so that your maintenance crew can resolve small maintenance issues before they become bigger problems. Over time, this can create a major shift throughout your plant. You'll see an overall improvement in asset health, as well as increased uptime and productivity.

How does a vibration sensor work?

Vibration sensors capture vibration data with the help of sensing components like accelerometers. The most precise accelerometer technology is piezoelectric crystals: when the crystal is under stress, the signal from the sensor modulates, recreating the vibration occurring on the equipment under test. Vibration analysis software parses these signals for the frequency and intensity of vibration

What are the types of vibration detectors :

- **Accelerometers:** An accelerometer measures changes in velocity and converts them to electronic signals. The most popular type of vibration sensor.
- **Handheld Vibration Analyzers:** A vibration analyzer is handheld meter that often incorporates other vibration sensor technology to provide instant readings, perform measurements in the field, and take readings for later vibration analysis.
- **Eddy Current / Capacitive Displacement:** Eddy current sensors allow you to measure displacement without touching an asset. The sensor measures displacement by generating magnetic fields to measure relative motion.
- **Laser Displacement:** Laser displacement is another no-contact method for measuring vibration, triangulating the displacement of an asset with laser beams.
- **Strain Gauges:** A strain gauge is a foil with a conductive grid. When the asset under test vibrates, the grid’s resistance changes – undergoing “strain.” This strain helps to measure vibration
- **Microphones:** Microphone sensors detect vibration with advanced acoustic techniques, measuring frequencies of vibration that might otherwise be difficult to detect. They are generally not sophisticated enough to measure values or determine sources of vibration.
- **Gyroscopes (MEMs):** A gyroscope determines velocity and is often used in conjunction with an accelerometer for vibration measurement.

Pressure Gauge (Manomètre) :

The devices that are used for measuring pressure are called pressure gauges. Gauge pressure is the pressure relative to atmospheric pressure. For the pressures above atmospheric pressure, gauge pressure is positive. For the pressures below atmospheric pressure, gauge pressure is negative. The pressure gauge is also known as pressure meters or vacuum gauges. A device that uses the surface area and weight of a liquid column to measure and indicate pressure is known as a manometer.

Most gauges calculate the pressure relative to atmospheric pressure as the zero point. Hence, this form of reading is known as gauge pressure. Pressure gauges are analog as well as digital.

The pressure difference between the system and the atmosphere is given by the formula:

$P=P_a+ \rho gh$

Where is:

P= pressure at any point

Pa = atmospheric pressure

From this, we can make out that the pressure at any point is always greater than the atmospheric pressure by ρgh amount.

When $P-P_a=\rho gh$

Where is:

P =pressure of the system

Pa=atmospheric pressure

$(P-P_a)$ = pressure difference between the system and atmosphere.

$h\rho g$ = Gauge pressure

The difference between two pressures measured using the gauge is known as gauge pressure. Now, let us know more about the types of pressure gauges.

Pressure Gauge Types:

There are many types of pressure : absolute pressure, gauge pressure, differential pressure, and sealed pressure or vacuum pressure.For that we have multiple types of pressure gauges: Bourdon Tube Pressure Gauge, diaphragm Pressure Gauge, Capsule Pressure Gauge, Absolute Pressure Gauge, Differential Pressure Gauge, Bellows Pressure Gauge, Manometer Pressure Gauge.

Ref:Pressure Gauge - Definition, Types of Pressure Gauges, Applications, and FAQs (byjus.com)

Common Failures :

Several common causes of pressure switch malfunction include:

Ruptured diaphragms

Flue obstructions

Damaged pressure switch hoses

Water in pressure switch houses

Calibration Procedure:

Calibrating a pressure gauge is done with pressure calibration equipment like a deadweight tester, standard pneumatic calibrator, or any other pressure gauge calibrator with an accurate reading. No matter the tool, the general principles and steps to calibrate a pressure gauge are very similar, whether it’s mechanical or digital gauge calibration. The following steps describe the use of a hand pump calibrator, as seen in Figure 2.

1. Connect the hand pump calibrator to the pressure gauge to be calibrated using the appropriate adapter or fitting.
2. Set the desired pressure on the hand pump calibrator.
3. Slowly pump the hand pump calibrator until the desired pressure is reached.
4. Observe the pressure gauge and ensure that it reads the same pressure as the hand pump calibrator.

5. If the gauge does not read the correct pressure, adjust it according to the manufacturer's instructions.
6. Repeat the process at multiple pressure points to ensure the gauge is accurate throughout its range.
7. Record the results of the calibration and make any necessary adjustments.
8. Once calibration is complete, disconnect the hand pump calibrator and store it properly.

Pressure switch:

Pressure switches are commonly used in the process industry for a wide range of applications. A pressure switch is a form of sensor that closes or opens an electrical contact when a certain pressure has been obtained either through a pressure rise or a pressure drop. Pressure switches are used to monitor, control, or provide a caution or warning for a pressure related process. The repeatability, accuracy, and functionality of a pressure switch often tie directly into the safety or efficiency of a process and thus it becomes important that pressure switches are verified and calibrated to ensure their proper function in the process.

Common Failures :

Signs of potential malfunctions:

- Threshold offset or area of insensitivity out of range
- Random operation of the switch
- Corrosion at the process connection and membrane
- Process leakage
- Excessively curved capillary
- Damaged housing or wiring

In all of the above situations, systematic replacement of the switch is required.

Operations:

1. **Inspection :**

Industrial inspection refers to the process of examining and evaluating various components, systems, and processes in industrial settings to ensure compliance with quality standards, safety regulations, and operational efficiency. It involves systematic observation, measurement, testing, and documentation of equipment, machinery, structures, and production processes.

The steps involved in industrial inspection can vary depending on the specific industry and the nature of the inspection. Here is a general overview of typical steps involved in industrial inspection:

- **Planning**: This step involves defining the objectives and scope of the inspection, determining the inspection techniques and tools to be used, and establishing the inspection schedule.
- **Gatheringinformation**: Before conducting the inspection, relevant documentation, such as blueprints, specifications, maintenance records, and safety regulations, should be collected and reviewed.
- **Visualinspection**: The inspection team visually examines the equipment, structures, or processes to identify any visible defects, damage, wear, or irregularities.
- **Measurements** and **testing**: Precise measurements and testing are conducted using appropriate instruments and equipment to assess factors such as dimensions, tolerances, performance, functionality, and safety parameters.
- **Analysisandevaluation**: The collected data and inspection results are analyzed and compared against established standards, specifications, and regulations. Any deviations or non-conformities are identified and assessed for their impact on safety and quality.
- **Reporting**: A comprehensive inspection report is prepared, documenting the findings, observations, measurements, test results, and recommendations. The report may include photographs, diagrams, and charts to provide a clear understanding of the inspection outcomes.
- **Correctiveactions**: If any defects, deficiencies, or non-conformities are identified, appropriate corrective actions are recommended and implemented to rectify the issues and ensure compliance with standards.

- **Follow-up** and **verification**: After the corrective actions have been taken, a follow-up inspection may be conducted to verify the effectiveness of the implemented measures and ensure that the necessary improvements have been made(Loop Of Inspection).

2. Cleaning (Nettoyage):

Cleaning refers to the process of removing dirt, contaminants, residues, or impurities from industrial instruments to maintain their cleanliness, functionality, and performance. It is an essential part of industrial instrument maintenance

- **Cleaning Types :**

  a. Dry Cleaning: Dry cleaning involves the removal of loose dirt, dust, or particles from the surface of industrial instruments using methods such as compressed air, brushes, or vacuuming. This method is commonly used as an initial step to prepare the instrument for further cleaning or maintenance procedures.

3. Calibration:

Every instrument has at least one input and one output. For a pressure sensor, the input would be some fluid pressure and the output would (most likely) be an electronic signal. For a loop indicator, the input would be a 4-20 mA current signal and the output would be a human-readable display. For a variable-speed motor drive, the input would be an electronic signal and the output would be electric power to the motor. Calibration and ranging are two tasks associated with establishing an accurate correspondence between any instrument’s input signal and its output signal

- **Calibration versus re-ranging:**

To calibrate an instrument means to check and adjust (if necessary) its response so the output accurately corresponds to its input throughout a specified range. In order to do this, one must expose the instrument to an actual input stimulus of precisely known quantity. For a pressure gauge, indicator, or transmitter, this would mean subjecting the pressure instrument to known fluid pressures and comparing the instrument response against those known pressure quantities. One cannot perform a true calibration without comparing an instrument's response to known, physical stimuli. To range an instrument means to set the lower and upper range values so it responds with the desired sensitivity to changes in input. For example, a pressure transmitter set to a range of 0 to 200 PSI (0 PSI = 4 mA output ; 200 PSI = 20 mA output) could be re-ranged to respond on a scale of 0 to 150 PSI (0 PSI = 4 mA ; 150 PSI = 20 mA). In analog instruments, re-ranging could (usually) only be accomplished by re-calibration, since the same adjustments were used to achieve both purposes. In digital instruments, calibration and ranging are typically separate adjustments (i.e. it is possible to re-range a digital transmitter without having to perform a complete recalibration), so it is important to understand the difference.

- **Calibration procedures:**

As described earlier in this chapter, calibration refers to the adjustment of an instrument so its output accurately corresponds to its input throughout a specified range. This definition specifies the outcome of a calibration process, but not the procedure. It is the purpose of this section to describe procedures for efficiently calibrating different types of instruments. 18.6.1 Linear instruments The simplest calibration procedure for an analog, linear instrument is the so-called zero-and-span method. The method is as follows:

1. Apply the lower-range value stimulus to the instrument, wait for it to stabilize
2. Move the "zero" adjustment until the instrument registers accurately at this point
3. Apply the upper-range value stimulus to the instrument, wait for it to stabilize
4. Move the "span" adjustment until the instrument registers accurately at this point
5. Repeat steps 1 through 4 as necessary to achieve good accuracy at both ends of the range

An improvement over this crude procedure is to check the instrument's response at several points between the lower- and upper-range values. A common example of this is the so-called five-point calibration where the instrument is checked at 0% (LRV), 25%, 50%, 75%, and 100% (URV) of range. A variation on this theme is to check at the five points of 10%, 25%, 50%, 75%, and 90%, while still making zero and span adjustments at 0% and 100%. Regardless of the specific percentage points chosen for checking, the goal is to ensure that we achieve (at least) the minimum necessary accuracy at all points along the scale, so the instrument’s response may be trusted when placed into service.

Yet another improvement over the basic five-point test is to check the instrument’s response at five calibration points decreasing as well as increasing. Such tests are often referred to as Updown calibrations. The purpose of such a test is to determine if the instrument has any significant hysteresis: a lack of responsiveness to a change in direction. Some analog instruments provide a means to adjust linearity. This adjustment should be moved only if absolutely necessary! Quite often, these linearity adjustments are very sensitive, and prone to over-adjustment by zealous fingers. The linearity adjustment of an instrument should be changed only if the required accuracy cannot be achieved across the full range of the instrument. Otherwise, it is advisable to adjust the zero and span controls to “split” the error between the highest and lowest points on the scale, and leave linearity alone.

Instrumentation Equipment:

Test Bench:

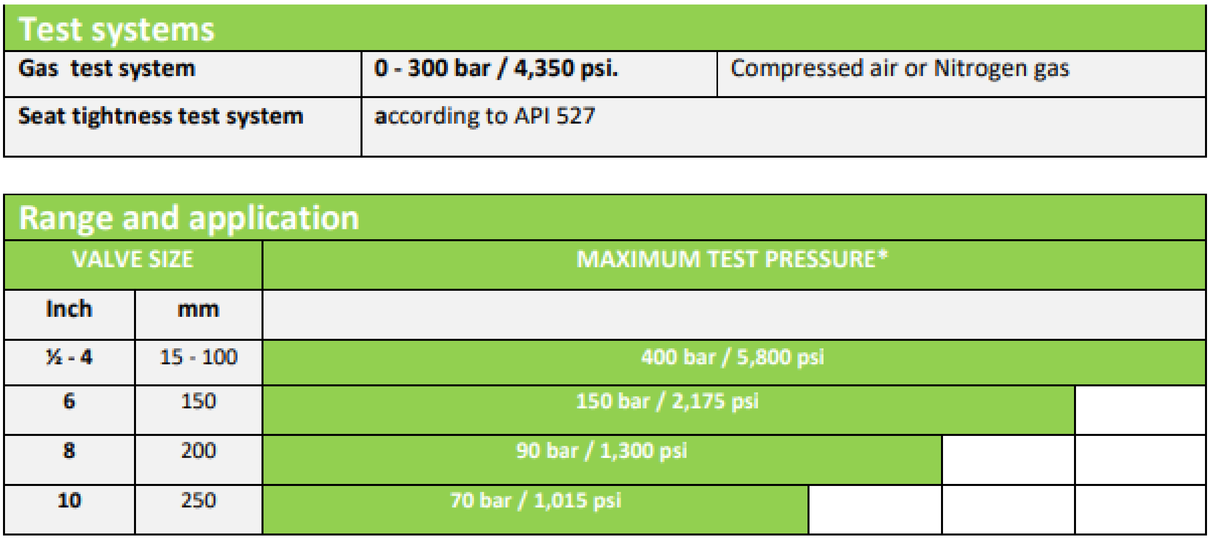
In general, test benches are used for regular and periodic inspections of pneumatic and hydraulic instruments such as: safety valves, regulation, with the aim of maintaining functional and/or safety performance in compliance with the requirements of the installations in the standard configuration. In our work,we are interested in safety valves

Safety valves are in different sizes:

- Threaded PSV: from 1/8" to 2" NPT male and female without the clamping unit
- Flanged valves: from 3/4" to 10" RF or RTG.

A test bench is a physical system for putting a product in condition of use configurable and controlled in order to observe and measure its behavior. The bench of test is widely used in industry, The tests are essentially intended to verify the functionality of the produced in the state of electronic card but also in the final form (finished product), these are then functional test benches. The testing needs are very different depending on the final format of the product to be tested.

Figure03: Bench Test Mark VENTIL



Test systems

Gas test system	**0 - 300 bar / 4,350 psi.**	Compressed air or Nitrogen gas
Seat tightness test system	according to API 527	

Range and application

VALVE SIZE		MAXIMUM TEST PRESSURE*			
Inch	**mm**				
½ - 4	15 - 100	400 bar / 5,800 psi			
6	150	150 bar / 2,175 psi			
8	200	90 bar / 1,300 psi			
10	250	70 bar / 1,015 psi			

Table: Test Bench Specification

Test bench safety system:

Maximum attention is paid to the security systems placed in the benches calibration. All components under pressure during the test are displayed and identified by special indicator lights and audible and alarm functions are controlled by a locking.

In case of emergency or a power outage, the test circuit's pressure will automatically be released. We paid particular attention to the pneumatic-hydraulic circuits that control the exchange between test gas/fluid environments.

For final adjustment, there are point-of-test checks and a hydraulic manual pump available. [3]

Pneumatic-hydraulic circuits for managing

the exchange between Gas/fluid test.

Clamping system:

Manual system:

The manual version consists of four hose clamps and allows the valve to be blocked under test with tie rods and locking nuts. This version is normally made for threaded and/or flanged valves up to 6"

The bench normally runs on gas and can be delivered with detachable parts (system clamping and control panel) so that it can be easily transported in a vehicle.

Figure3: Manual clamping device

Automatic system:

The automated version is offered with three clamps, with hydraulic thrust and adjustable torque, based on the nominal pressure of the valve under test. The test bench is designed for use with gases and liquids and is the ideal solution, within the wika range, to calibrate valves up to 14".

Characteristics of the automatic clamping system:

Automatic clamping system of heavy construction for clamping any type of safety valve. The valve can be tightened in seconds with clamping force maximum of 15 tonnes (15,000 g). (Table 1: Characteristic of the clamping system).

Description	Characteristics
clamping force	15 TONNE (15000 kg)
Operation	Hydraulic
Scale	1/2"-10" (DN15-205mm)
Clamping height	0-100mm (4")
Clamping diameter	Max18" 460mm
Dimension	

Table 01: Characteristics of the clamping system

- **Maximum achievable test pressure per valve size:**

The test bench is with a quick clamping unit. The valves mentioned in the table below indicate the dimensions of the valves and the maximum test pressure of the test bench. That table is printed on the laminated safety sheet, this sheet is clearly visible and it glued close to the machine as a safety measure for operators during testing.

Valve size		Valve size Maximum test pressure	
(Inch)	(mm)	Bar	PSI

1-4	25-100	500	7250
5	125	250	3625
6	150	250	3625
8	200	120	1740
10	250	120	1740

Table 02: Maximum achievable test pressure by valve size

	Input	25	50	75	100	150	200	250	300	400	500
		Test pressure									
	bar	25	50	75	100	150	200	250	300	400	500
	PSI	363	725	1088	1450	2175	2900	3625	4350	5800	7250
Valve size		Minimum required hydraulic pressure bar/PSI									
Inch	mm										
½" - 1	25	15	15	15	15	15	15	15	15	18	22
		218	218	218	218	218	218	218	218	257	321
1½" - 2"	50	15	15	15	15	20	27	34	41	54	68
		218	218	218	218	295	394	492	590	787	984
2½" - 3"	80	15	15	21	28	42	55	69	83	111	139
		218	218	301	402	602	803	1004	1205	1607	2008
4"	100	15	23	35	46	69	92	115	138	184	230
		218	334	501	668	1003	1337	1671	2005	2674	3342
5"	125	17	33	50	67	100	133	166	200		
		241	482	724	965	1447	1930	2412	2895		
6"	150	24	47	71	95	142	190				
		344	687	1031	1375	2062	2749				
8"	200	38	76	115	153						
		555	1109	1664	2218						
10"	250	51	102	154							
		743	1486	2229							
12"	300	78	155								
		1127	2254								

Table03: Minimum clamping pressure required for each valve size and pressure value test

Dead Weight Tester:

A dead weight tester is an instrument that calibrates pressure by determining the weight of force divided by the area the force is applied.

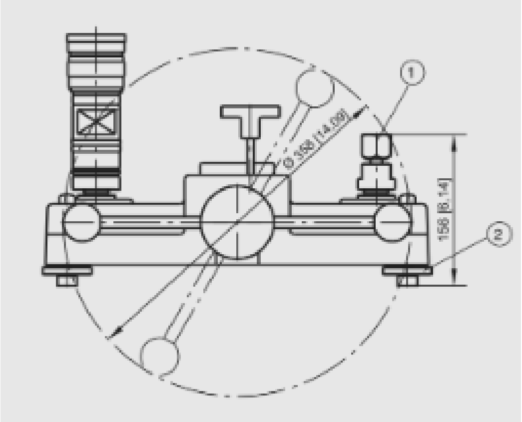
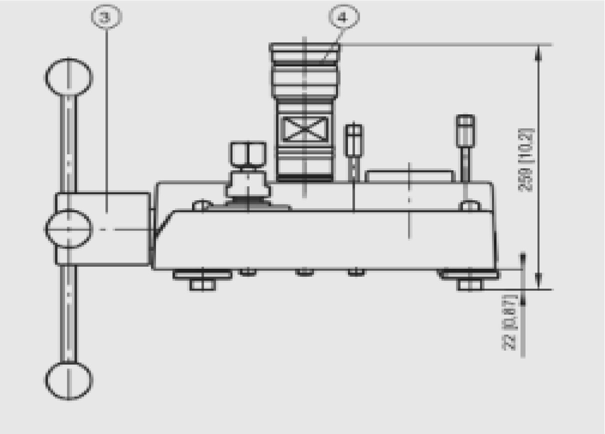
The formula for dead weight testers is pressure equals force divided by area of where force is applied.

Dead weights are usually used for pressure gauge calibration as they come with high accuracy, So they can be used as primary standard (as mentioned before).there are many types of them depending on the application and they are operated with oil (hydraulic) or with air (pneumatic).

Dead weight testers are the basic primary standard for accurate measurement of pressure.

Dead weight testers are used to measure the pressure exerted by gas or liquid and can also generate a test pressure for the calibration of numerous pressure instruments.

Figure:WIKA Dead Wieght

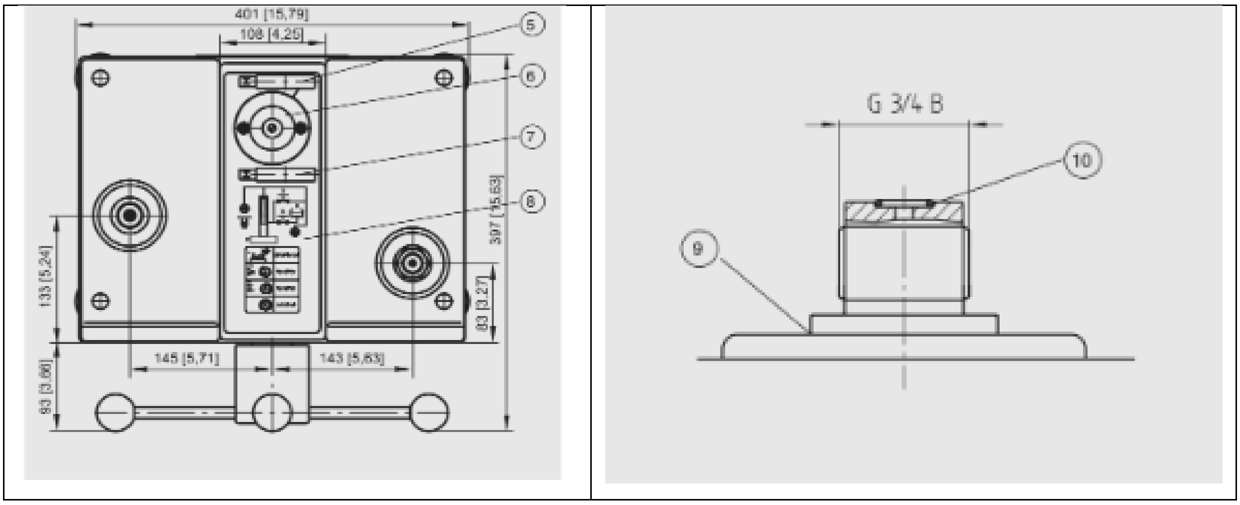
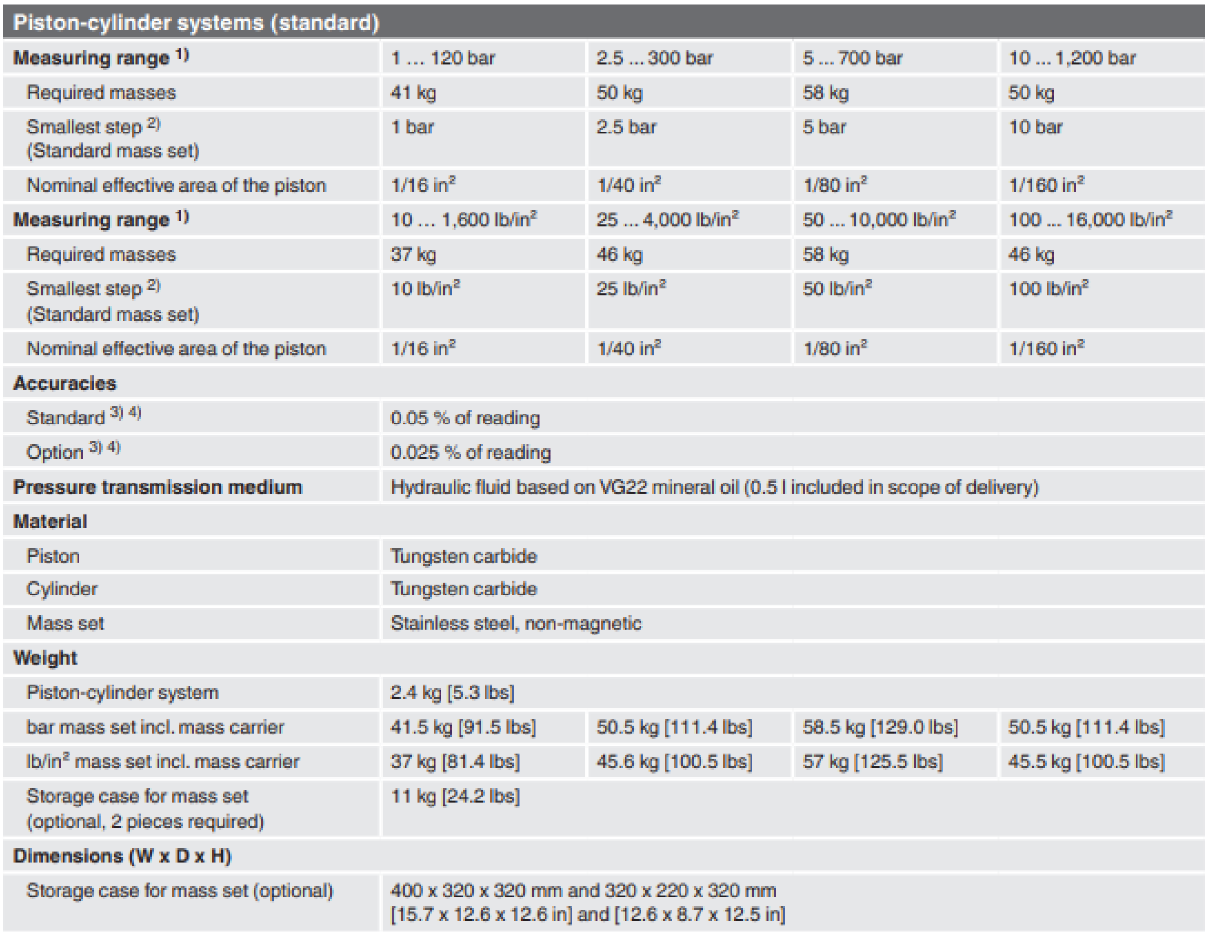


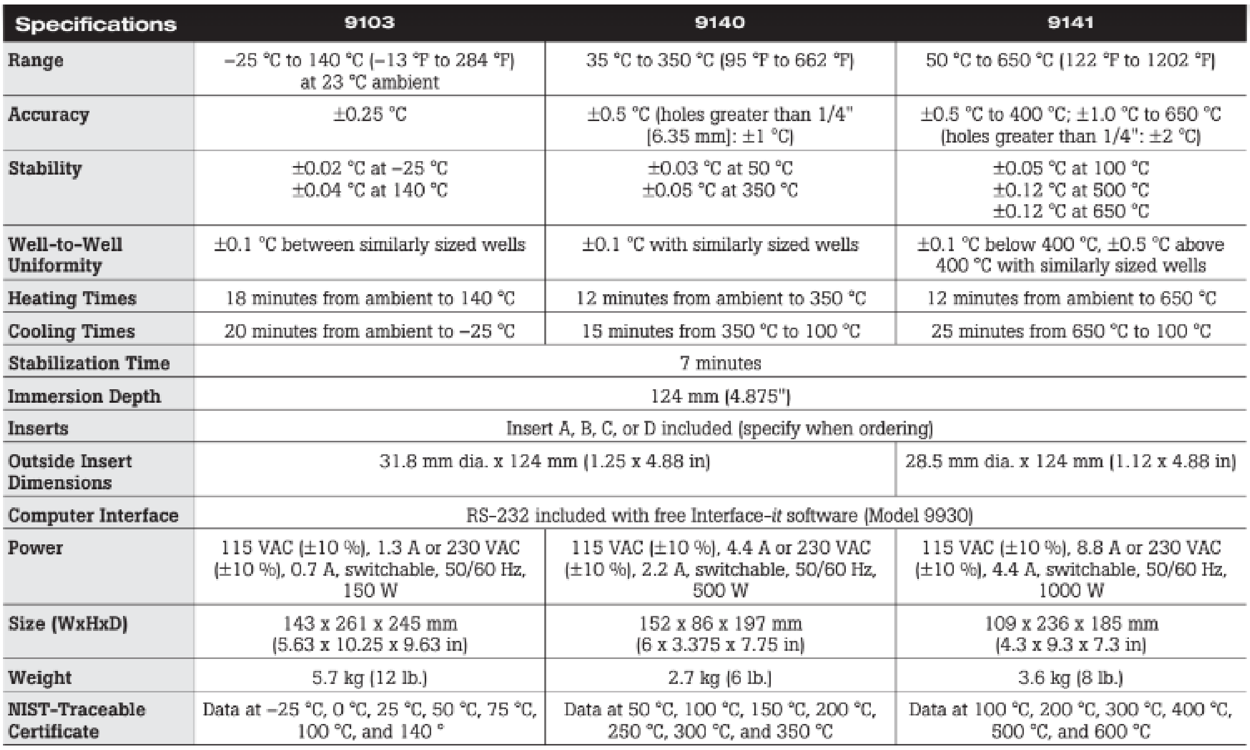
Figure DeadWieght Tester 2D Viwe



Piston-cylinder systems (standard)				
Measuring range 1)	1 … 120 bar	2.5 ... 300 bar	5 ... 700 bar	10 ... 1,200 bar
Required masses	41 kg	50 kg	58 kg	50 kg
Smallest step 2) (Standard mass set)	1 bar	2.5 bar	5 bar	10 bar
Nominal effective area of the piston	1/16 in²	1/40 in²	1/80 in²	1/160 in²
Measuring range 1)	10 … 1,600 lb/in²	25 ... 4,000 lb/in²	50 ... 10,000 lb/in²	100 ... 16,000 lb/in²
Required masses	37 kg	46 kg	58 kg	46 kg
Smallest step 2) (Standard mass set)	10 lb/in²	25 lb/in²	50 lb/in²	100 lb/in²
Nominal effective area of the piston	1/16 in²	1/40 in²	1/80 in²	1/160 in²
Accuracies				
Standard 3) 4)	0.05 % of reading			
Option 3) 4)	0.025 % of reading			
Pressure transmission medium	Hydraulic fluid based on VG22 mineral oil (0.5 l included in scope of delivery)			
Material				
Piston	Tungsten carbide			
Cylinder	Tungsten carbide			
Mass set	Stainless steel, non-magnetic			
Weight				
Piston-cylinder system	2.4 kg [5.3 lbs]			
bar mass set incl. mass carrier	41.5 kg [91.5 lbs]	50.5 kg [111.4 lbs]	58.5 kg [129.0 lbs]	50.5 kg [111.4 lbs]
lb/in² mass set incl. mass carrier	37 kg [81.4 lbs]	45.6 kg [100.5 lbs]	57 kg [125.5 lbs]	45.5 kg [100.5 lbs]
Storage case for mass set (optional, 2 pieces required)	11 kg [24.2 lbs]			
Dimensions (W x D x H)				
Storage case for mass set (optional)	400 x 320 x 320 mm and 320 x 220 x 320 mm [15.7 x 12.6 x 12.6 in] and [12.6 x 8.7 x 12.5 in]			

Table: manual deadweight specification

Field Dry-Wells(TemperatureCalibrator):

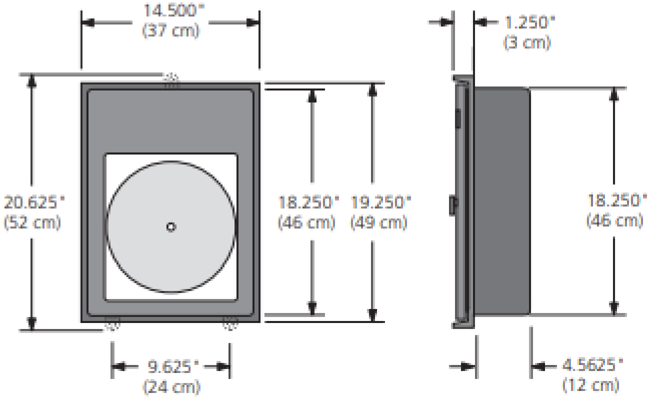


Specifications	9103	9140	9141
Range	−25 °C to 140 °C (−13 °F to 284 °F) at 23 °C ambient	35 °C to 350 °C (95 °F to 662 °F)	50 °C to 650 °C (122 °F to 1202 °F)
Accuracy	±0.25 °C	±0.5 °C (holes greater than 1/4" [6.35 mm]: ±1 °C)	±0.5 °C to 400 °C; ±1.0 °C to 650 °C (holes greater than 1/4": ±2 °C)
Stability	±0.02 °C at −25 °C ±0.04 °C at 140 °C	±0.03 °C at 50 °C ±0.05 °C at 350 °C	±0.05 °C at 100 °C ±0.12 °C at 500 °C ±0.12 °C at 650 °C
Well-to-Well Uniformity	±0.1 °C between similarly sized wells	±0.1 °C with similarly sized wells	±0.1 °C below 400 °C, ±0.5 °C above 400 °C with similarly sized wells
Heating Times	18 minutes from ambient to 140 °C	12 minutes from ambient to 350 °C	12 minutes from ambient to 650 °C
Cooling Times	20 minutes from ambient to −25 °C	15 minutes from 350 °C to 100 °C	25 minutes from 650 °C to 100 °C
Stabilization Time	7 minutes		
Immersion Depth	124 mm (4.875")		
Inserts	Insert A, B, C, or D included (specify when ordering)		
Outside Insert Dimensions	31.8 mm dia. x 124 mm (1.25 x 4.88 in)		28.5 mm dia. x 124 mm (1.12 x 4.88 in)
Computer Interface	RS-232 included with free Interface-*it* software (Model 9930)		
Power	115 VAC (±10 %), 1.3 A or 230 VAC (±10 %), 0.7 A, switchable, 50/60 Hz, 150 W	115 VAC (±10 %), 4.4 A or 230 VAC (±10 %), 2.2 A, switchable, 50/60 Hz, 500 W	115 VAC (±10 %), 8.8 A or 230 VAC (±10 %), 4.4 A, switchable, 50/60 Hz, 1000 W
Size (WxHxD)	143 x 261 x 245 mm (5.63 x 10.25 x 9.63 in)	152 x 86 x 197 mm (6 x 3.375 x 7.75 in)	109 x 236 x 185 mm (4.3 x 9.3 x 7.3 in)
Weight	5.7 kg (12 lb.)	2.7 kg (6 lb.)	3.6 kg (8 lb.)
NIST-Traceable Certificate	Data at −25 °C, 0 °C, 25 °C, 50 °C, 75 °C, 100 °C, and 140 °	Data at 50 °C, 100 °C, 150 °C, 200 °C, 250 °C, 300 °C, and 350 °C	Data at 100 °C, 200 °C, 300 °C, 400 °C, 500 °C, and 600 °C

Barton Recorder:

Field Dry-Wells(Temperature Calibrator):

Field Dry-Wells(Temperature Calibrator):



242E / J8A Chart Recorder Weights

Weight in lbs (kgs)	242E	J8A
	35 (16)	25 (11)

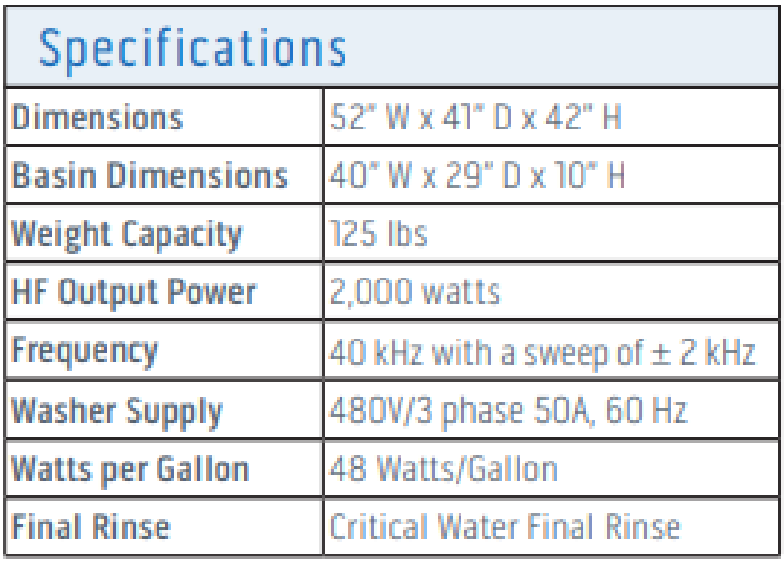
Figure: Barton Recorder 2D

Fifure: PORTABLE SHAKER TABLEMODEL 9100D

SPECIFICATIONS		
Performance		
FrequencyRange(operating)[1]	5Hz to 10kHz	300to600kCPM
MaximumAmplitude (50Hz,10-grampayload)	20gpk	196m/s^{2}pk
	20in/spk	500mm/spk
	150milspk-pk	3.8mmpk-pk
MaximumAmplitude (50Hz,500-grampayload)	2.5gpk	24.5m/s^{2}pk
	3.5in/spk	90mm/spk
MaximumPayload[2]	800grams	
TestOperation	Manual(ClosedLoop)orSemi-Automatic	
Auto-PayloadCalculation	Controlled via Reference Accelerometer,NoUserEntryRequired	
Memory	StoresSemi-AutomatedTestRoutine	
Non-VolatileMemory	StorageofCalibrationSettingsforAccuracy	
Programmability	Upto30TestPointsperRoutine	
AccuracyofReadout[3]		
Acceleration(10Hzto10kHz)	±3%[4]	
Acceleration(5Hzto10Hz)	±5%[4]	
Velocity (10Hzto1000Hz)	±3%	
Displacement(30Hzto150Hz)	±3%	
Amplitude Linearity(100Hz)[1]	<1%upto10gpk	
WaveformDistortion (30Hzto2kHz)[1]	<5%THD(typical)upto5gpk	
AccuracyVerificationTest	FieldDriftTestProcedureProvided[5]	
UnitsofReadout		
Acceleration(pkandRMS)	g	m/s^2
Velocity(pkandRMS)	in/s	mm/s
Displacement(pktopk)	mils	µm
Frequency	Hz	CPM
Physical		
InternalBattery (sealedsolidgelleadacid)	12VDC,4amphours	
ACPower(for rechargingbattery)	110–240VAC,50–60Hz	
InputPowerRatingfromcharger	18Volts DC, 1A	
OperatingBatteryLife[6]		
100Hz,1gpk[1]	18hours	
100Hz,10gpk[1]	1hour	
ExternalSourceIn(max)	1VACRMS	
MonitorReferenceOut	10mV/g(nominal)QuartzReferenceAccelerometer,BNCJackOutput	
USB Port	UsedforLoadingSemi-AutomatedTestRoutines(ModelCALROUTE)&providespowerforexternalpowersupplies	
Dimensions(HxWxD)	8.5x12x10in	22x30.5x28cm
Weight	18lb	8.2kg
OperatingTemperature	32˚F-122˚F	0 °C–50°C

Table:PORTABLE SHAKER TABLEMODEL 9100D Specification

Figure: Ultrasonic Industrial Cleaner



Specifications	
Dimensions	52" W x 41" D x 42" H
Basin Dimensions	40" W x 29" D x 10" H
Weight Capacity	125 lbs
HF Output Power	2,000 watts
Frequency	40 kHz with a sweep of ± 2 kHz
Washer Supply	480V/3 phase 50A, 60 Hz
Watts per Gallon	48 Watts/Gallon
Final Rinse	Critical Water Final Rinse

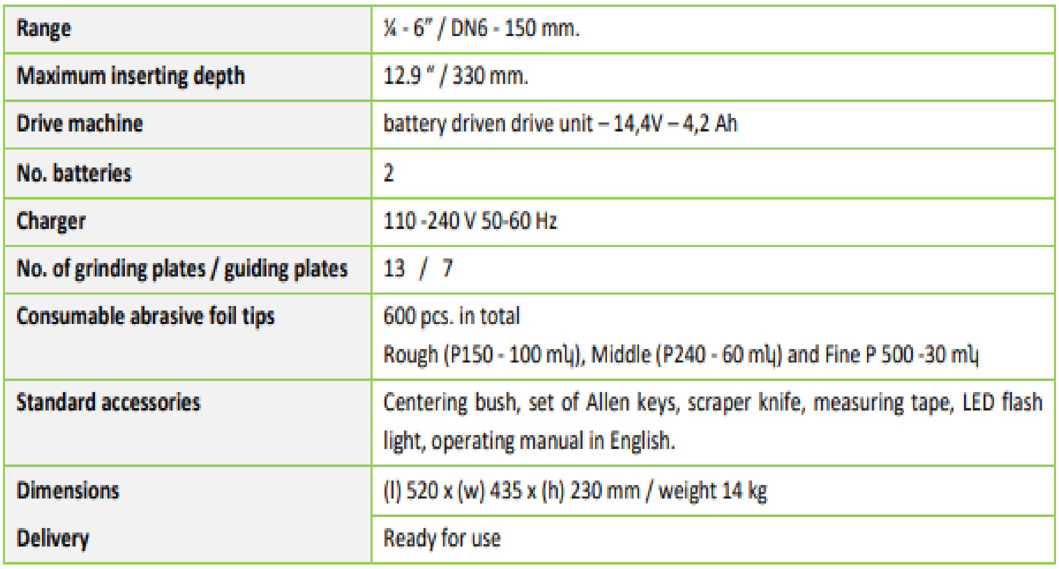
Table: Ultrasonic Industrial Cleaner Specification

Polir F6:

Product description:

The Ventil POLIR F6 is a portable, battery driven grinding and lapping machine for Globe and Safety valves in the range 3/8 – 6″. The handy machine is delivered ready for use, packed in a robust carrying case. The POLIR F6 is optionally available with a pneumatic drive motor (6 bar / 100 psi) or 220 VAC drive motor

Figure : Polir F6 Tool



Range	¼ - 6" / DN6 - 150 mm.
Maximum inserting depth	12.9 " / 330 mm.
Drive machine	battery driven drive unit – 14,4V – 4,2 Ah
No. batteries	2
Charger	110 -240 V 50-60 Hz
No. of grinding plates / guiding plates	13 / 7
Consumable abrasive foil tips	600 pcs. in total Rough (P150 - 100 mɥ), Middle (P240 - 60 mɥ) and Fine P 500 -30 mɥ
Standard accessories	Centering bush, set of Allen keys, scraper knife, measuring tape, LED flash light, operating manual in English.
Dimensions	(l) 520 x (w) 435 x (h) 230 mm / weight 14 kg
Delivery	Ready for use

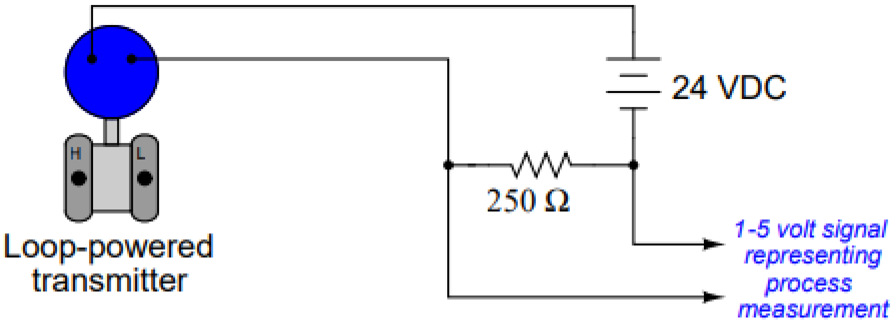
Table: Polir F6 Specification

Basic concept of HART

Looking at a standard loop-powered (2-wire) process transmitter circuit, we see the transmitter, a DC power supply (voltage source), and usually a 250 ohm resistor to create a 1 to 5 volt signal readable by any voltage-sensing indicator, controller, or recorder: H L 24 VDC 250 Ω Loop-powered transmitter 1-5 volt signal representing process measurement The transmitter's primary function in this circuit is to regulate current to a value representative of the measured process variable (e.g. pressure, temperature, flow, etc.) using a range of 4 to 20 mA, while the DC voltage source provides power for the transmitter to operate. Loop-powered instruments are very common in industrial instrumentation because they allow both power and (analog) data to be conveyed on the same pair of wires. With the advent of microprocessor-based process transmitters, it became possible for instrument technicians to digitally configure parameters inside the transmitter (e.g. range values, damping values) and also query the transmitter for self-diagnostic alarms. In order to make full use of this digital functionality, though, there must be some way to communicate digital data to and from the process transmitter over the same two wires used to convey the 4-20 mA analog signal. Otherwise, the only way to access this rich field of digital data inside the transmitter was to connect a communicator device to a special port located on the transmitter itself, which is inconvenient due to the nature of how these transmitters are used in industry (located in dirty places, often hard to access while holding on to a personal computer or other communication device). Thus the HART communication protocol was born to address this need. HART communicates digital data along the loop conductors in the form of AC signals (audio-frequency tones) superimposed on the 4-20 mA DC current signal. A modem built into the smart transmitter translates these AC signals into binary bits, and visa-versa. Now, instrument technicians could "talk" with the new microprocessor-based transmitters simply by connecting a HART communications device at any point along the two-wire cable, even at the far end where the cable terminates at the control system hardware (panel-mounted controller, PLC, DCS, etc.). Being able to communicate digital data over the same wire pair as the DC power and analog signal opens a whole new range of possibilities. Now, the field-mounted transmitter has the ability to communicate self-diagnostic information, status reports, alarms, and even multiple process variables to the control system in addition to the original analog signal representing the (main) process variable. With digital communication, the only data limitation is speed (data rate), not quantity. The control system may even communicate information to the transmitter using the same digital protocol, using this digital data channel to switch between different measurement range sets, activating special features (e.g. square-root characterization, damping, etc.), automatically and remotely.

HART Tool:

Looking at a standard loop-powered (2-wire) process transmitter circuit, we see the transmitter, a DC power supply (voltage source), and usually a 250 ohm resistor to create a 1 to 5 volt signal readable by any voltage-sensing indicator, controller, or recorder:



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Concept vision

Accessibility and Ergonomics:

- Ensure that the instruments and equipment are arranged in a way that allows easy access for maintenance and repairs.
- Consider ergonomics to minimize strain or discomfort for technicians while performing maintenance tasks.

Modular Design:

- Create a modular design approach, where possible, for instruments and equipment, which allows much easier replacement or upgrade of components without the need for extensive disassembly or downtime.
- Built-in Diagnostics: Incorporate diagnostics features into the instrumentation design to enable self-testing and self-diagnosis capabilities. This can help identify potential issues or malfunctions, allowing for timely maintenance or repairs.

Serviceability:

- Design instruments and equipment with serviceability in mind. Use standardized connectors, accessible parts, and clear labeling to facilitate easier troubleshooting, repair, and replacement of components.

Robustness and Durability:

- Mobile workshops operate in diverse environments, so the instrumentation design should prioritize robustness and durability. Select materials and components that can withstand vibrations, temperature variations, dust, moisture, and other challenges commonly encountered in mobile settings.

Scalability and Flexibility:

- Design the maintenance plan to accommodate future growth and changes in the mobile workshop. Consider scalability and flexibility in terms of instrument capacity, storage, and maintenance procedures to adapt to evolving needs.

Integration with Monitoring Systems:

- Explore opportunities to integrate the instrumentation with remote monitoring systems or Internet of Things (IoT) platforms,which allows for real-time data collection, performance monitoring, and predictive maintenance, enabling proactive identification and resolution of potential issues.

User-Friendly Interfaces:

- Develop intuitive and user-friendly interfaces for instrument operation, maintenance, and diagnostics. Clear instructions, visual indicators, and user prompts can help technicians navigate maintenance tasks efficiently.

Feedback and Continuous Improvement:

- stablish a feedback loop with technicians and operators to gather insights and recommendations for improving the maintenance design. Regularly assess the effectiveness of the maintenance plan and make necessary adjustments based on feedback and lessons learned.

CONCLUSION

Conclusion

This instrumentation maintenance mobile workshop is a game-changing solution

with on-the-go accessibility and advanced capabilities, can transform maintenance operations.

Specially with its exceptional concept design that minimizes downtime, reduces costs and improves efficiency

along side with seamless functioning of critical instruments is ensured.

Exciting possibilities lie ahead as we implement this ground-breaking solution.

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Abstract

The Mobile Instrumentation Maintenance Workshop initiative offers quick and efficient maintenance solutions for sophisticated instrumentation equipment across a range of sectors. It lowers downtime and transportation expenses while increasing client satisfaction by providing on-site services. The project seeks to reach isolated regions in need of maintenance assistance and increase operational performance and device efficiency. In conclusion, this project presents a useful and effective strategy for handling maintenance issues in modern enterprises.

Key words:Instrumentation,Maintenance, Industrial instruments, Mobile Workshop

ملخص

تقدم ورشة صيانة الأجهزة المتنقلة حلول صيانة سريعة وفعالة لمعدات الأجهزة المتطورة عبر مجموعة من القطاعات.كما أنه يقلل من وقت التوقف عن العمل ونفقات النقل مع ارضاء العملاء من خلال توفير الخدمات في الموقع. يسعى المشروع إلى الوصول إلى المناطق المعزولة التي تحتاج إلى الصيانة وزيادة الأداء التشغيلي وكفاءة الأجهزة و في الختام جدير بالذكر أن استراتيجية هذا المشروع مفيدة وفعالة للتعامل مع قضايا الصيانة في المؤسسات الحديث

الكلمات الدالة: أداتية ، صيانة ، أدوات صناعية ، ورشة متنقلة

Résume

L'initiative Mobile Instrumentation Maintenance Workshop offre des solutions de maintenance rapides et efficaces pour les équipements d'instrumentation sophistiqués dans divers secteurs. Il réduit les temps d'arrêt et les frais de transport tout en augmentant la satisfaction des clients en fournissant des services sur site. Le projet vise à atteindre les régions isolées ayant besoin d'aide à la maintenance et à accroître les performances opérationnelles et l'efficacité des appareils. En conclusion, ce projet présente une stratégie utile et efficace pour traiter les problèmes de maintenance dans les entreprises modernes.

Mots clés :Instrumentation, Maintenance, Instruments industriels, Atelier mobile