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Guidance on Practice for Pressure Instruments

GP 30-05

BP GROUP
ENGINEERING TECHNICAL PRACTICES

Foreword

This is the second issue of Engineering Technical Practice (ETP) BP GP 30-05. The information has been developed over the years by the BP Group and heritage companies, and represents best practices for safe and successful operation of a wide range of petroleum and petrochemical facilities. It is based on parts of heritage documents of the merged BP companies: These source documents are listed below for historical reference only.

Amoco

A PC-PI-00-E	Process Control—Differential Pressure and Pressure Instruments—Engineering Specification (October 1997).
A PC-PI-00-G	Process Control—Differential Pressure and Pressure Instruments—Guide (October 1997).
A PC-PI-00-P	Process Control—Pressure Instruments—Supply Specification (October 1997).

Arco

ES 300	Instrumentation - General (December 1993).
ES 303	Pressure Instrument (December 1992).
ES 304	Pressure Gauges (September 1991).

BP (Pre-1999)

RP 30-1	Instrumentation and Control, Design and Practice (September 1993).
RP 30-2	Selection and Use of Measurement Instruments (September 1993).
RP 30-12	Field Instrumentation for Chemical Processing Plant (February 1997).



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1. Scope

- a. This BP Engineering Technical Practice (ETP) provides guidance on the selection and application of pressure indicators and gauges, differential-pressure instruments, pressure transmitters, pressure switches, and other pressure accessories.
- b. For guidance on practice for storage tank pressure instrumentation refer to **BP GP 58-XX Storage Tanks (??)**.

2. Normative references

The following normative documents contain requirements that, through reference in this text, constitute requirements of this technical practice. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this technical practice are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the referenced normative document applies.

American Petroleum Institute (API)

API RP 551 Process Measurement Instrumentation.

BP

GIS 30-051 Guidance on Industry Standards for Pressure Gauges.
 GP 12-60 Guidance on Practice for Hazardous Area Electrical Installations.
 GP 30-25 Guidance on Practice for Common Field Instrument Issues.
 GP 30-80 Guidance on Practice for Safety Instrumented Systems (SIS)-
 Implementation of the Process Requirements Specification.
 GP 30-90 Guidance on Practice for Commissioning of Instruments & Control
 Systems.

British Standards Institute (BSI)

BS 6739: 1986 British Standard Code of Practice for Instrumentation in Process Control
 Systems: Installation Design and Practice.

European Standard (EN)

EN 472: 1995 Pressure gauges - vocabulary (BS EN 472: 1995).
 EN 837-2: 1998 Pressure gauges Part 2: Selection and installation recommendations for
 pressure gauges (BS EN 837-2: 1998).

International Electrotechnical Commission (IEC)

IEC 60529 Degrees of protection provided by enclosures (IP Code).

National Association of Corrosion Engineers (NACE)

NACE MR0175 Sulfide Stress Cracking Resistant Metallic Material for Oilfield
 Equipment.

National Electrical Manufacturers Association (NEMA)

NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum).



Process Industry Practices (PIP)

PIP PCCPR001

Pressure Measurement Criteria.

3. Symbols and abbreviated terms

For the purpose of this GP, the following symbols and abbreviations apply:

DN	Nominal Diameter
DPDT	Double-Pole Double-Throw
MAWP	Maximum Allowable Working Pressure
NPS	Nominal Pipe Size
NPT	National (American) Standard Pipe Taper

4. General**4.1. Selection****4.1.1. Application**

- a. The type of pressure responsive element (Bourdon tube, diaphragm, or capsule) shall be selected in accordance with EN 837-2.
- b. Equipment selection, system design and installation of pressure instruments shall be specified in accordance with PIP PCCPR001.
- c. Terms used in this document should be as defined in EN 472 and as a secondary resource as defined in API RP 551, Section 4.
- d. Pressure instruments shall comply with GP 30-25 and GP 30-90.
- e. Instrument parts exposed to process fluids containing hydrogen sulphide shall be specified and installed to comply with NACE MR0175.
- f. For safety functions, separate sensor and transmitters shall be used. Refer to GP 30-80.
- g. A process line pressure instrument should be considered for applications if a pressure reduction station is not equipped with a process pressure indicator.

This provides confirmation that the pressure reduction station is functioning properly.

4.1.2. Range

- a. Pressure instrument ranges should be selected such that normal operating pressure is within the middle third of the range.

For most applications, standard ranges of pressure measuring devices can be used, as the standard ranges can meet the required accuracy of measurement.

Instruments with ranges starting from zero are easier to calibrate and check.

In some cases (for example, the measurement of extra high steam pressures), full range instruments do not give the required accuracy of pressure measurement. In these cases, reducing the span of the instrument around the working value to obtain the desired accuracy may be necessary.

- b. Pressure elements for use on applications subject to fluctuating pressures should be specified to operate below 60% of the maximum range. Manufacturers should be informed if sensor will be subject to regular cyclic operation. An acceptable fatigue life shall be guaranteed for sensors subject to regular cyclic operation.



- c. Pressure elements with static head correction should have a pressure range that ensures that the sum of the static head and the operating pressure satisfies the middle third conditions.
- d. Pressure instruments shall be capable of withstanding the MAWP or an over range protection system shall be specified (see also Section 6.2.a. The method of over range protection shall be subject to approval by BP.

In general, the use of over range protection devices should be avoided.

Normally, pressure control instruments have ranges that cover the normal operating pressure range. However, at least one pressure instrument input to the distributed control system or other main panel per system and all pressure gauges should cover the relief valve set pressure and accumulated relief pressure for the system being monitored.

4.2. Design considerations

- a. Calibration equipment shall be included in accordance with GP 30-90.
- b. Instrument's electronic housing as a minimum shall comply with IEC IP 66 in accordance with IEC 60529 (NEMA 4X in accordance with NEMA 250).

In aggressively corrosive environments, SS enclosures may be required.

- c. Instruments in hazardous (classified) areas shall comply with GP 12-60.
- d. Protection required for radio frequency interference (RFI) shall be discussed and agreed upon with Vendor.

The effect of RFI may need to be considered as part of the overall installation.

- e. Requirements for purge systems shall be specified in conjunction with GP 30-15.
- f. For process streams requiring special materials (for example, those containing chlorides or hydrofluoric acid) such as for Bourdon tubes in pressure gauges, K Monel with R Monel or other BP approved materials should be used.
- g. If materials are liable to separate, solidify, or deposit in impulse lines, the lines should be purged or trace heated, as appropriate. Alternatively, direct mounting diaphragms may be used.

Using diaphragm seal type connections prevents plugging of the instrument due to solidification of the viscous material, freezing, or settling of solids.

- h. Continuous purges should be controlled by a constant differential relay. Tubing downstream of the relay should be run in a continuous length.

Continuous tubing avoids leaks.

- i. Capillaries should have mechanical protection. The effect of blockages or capillary failure on the integrity of process control and safety systems shall be assessed.
- j. Pressure instruments installed in hazardous areas shall comply with GP 12-60.

4.3. Pulsation and vibration

- a. Higher grade gauges should be considered in the following applications:

Higher-grade gauges reduce pressure spikes and internal gauge failures.

1. Pulsating service, such as pump discharges.
2. Vibrating service.
3. Long lines subject to thermal expansion.
4. Lines subject to rapid valve closure.



The helical model and pulsation types are extremely prone to plugging in all but a clean service condition. This is also true for a liquid filled gauge.

- b. If pulsation dampers are used, they should be installed close to the measuring element. The use of partially closed isolating valves is not allowed.

Pulsation, vibration, or exposure to corrosive materials can damage internal pressure gauge components. There have been many Bourdon tube failures in pressure gauges. Pulsation dampeners or pressure snubbers should be considered at locations of known severe pressure pulsation, such as reciprocating pumps and compressors or where failures persist, to reduce damage to the gauge and take the bounce out of the gauge pointer.

If pulsation damping is used, such as on the discharge of positive displacement pumps, devices that are field adjustable should not be used. Proprietary items of an acceptable type include dampers, which can be supplied with a number of fixed orifices. Field adjustable orifices should not be used as they could be abused in service.

If pulsation dampers are used, specific attention should be given to the process fluid. Mechanical dampers should not be used if they can be blocked by contamination in the process fluid.

Liquid filling of gauges and restriction orifice snubbers is not sufficient to damp severe pulsation, contrary to claims by many manufacturers. For gauges in non-rigid piping that have significant movement, pulsation protection using a pressure snubber should be considered. Identifying the cause of failure of replaced gauges assists in determining the common causes of failures and identifies areas that may need pressure snubbers.

Pulsation dampers may be fitted in the clean side of a chemical seal, but consideration should be given to the problem of damage to liquid filled systems and leakage of the filling fluid.

- c. On critical applications such as trips, consideration should be given to using:

- 1. Devices such as piezoelectric or strain gauge transmitters.

These transmitters can be electrically damped and are less susceptible to mechanical damage due to pulsation.

- 2. Short delay timers for processing of digital inputs.

A short delay timer eliminates spurious transient inputs.

5. Diaphragm seals

5.1. Applications

- a. If constructing pressure elements from process compatible materials is unduly expensive or impracticable, diaphragm seals should be used.
- b. In applications such as slurries; boiling or fouling services; or viscous (greater than 0.30 Pa s [300 centipoise] at 16°C [60°F]), corrosive, or dirty fluids, for which a Bourdon tube or bellows element is unsuitable, the preferred solution is a liquid filled diaphragm sealed element (refillable seals are suggested). Alternatively, purged taps may be used.

Diaphragm seals are typically a preferred alternative to heat tracing an impulse line.

Refillable diaphragm seals or purged taps are typically a maintenance problem and incur ongoing utility costs.



- c. If frequent need for rod-out is anticipated, seals or purges should be considered.

Rod-out taps can be dangerous.

The use of purges or fluid seal systems should be considered on potential blockage duties.

Purges should not constitute the only metallurgical protection on highly corrosive duties.

The use of a filter should be considered on powder measurements.

5.2. Design considerations

- a. If the pressure to be measured is below 2 bar(g) [30 psi(g)], the pressure loss effect of diaphragm seals should be considered.

Pressure loss across the diaphragm seal may lead to a sizeable error at these low pressures

- b. Seal materials should be chosen to meet the application, considering temperature and pressure ratings, resistance to corrosion, and the toxicity of the liquid fill.
- c. Remote diaphragm seals should be connected to the pressure instrument by armoured stainless steel capillary tubing. Tubing should be 300 series stainless steel 3 mm (1/8 in) OD, and protected by stainless steel spiral wound armour, 6 mm (1/4 in) OD.
- d. Physical arrangement of the installation of pressure instruments that have remote diaphragm seals should be reviewed to ensure the proper length of capillary tubing is specified for the application.

Keep the capillary length as short as possible to reduce temperature effects and response time and select larger ID capillaries to improve time response and/or select smaller ID capillaries to improve temperature response. Selection should consider also seal fluid selected. The vendor should be able to provide guidance about capillary length based on the specific application.

- e. Diaphragm seals for corrosive services should have a NPT 1/4 minimum flushing connection on the process side of seal.

5.3. Fill fluids

- a. Fill fluid should not freeze or become viscous at ambient temperatures.

For process temperatures -40 °C to 180 °C (-40 °F to 350 °F), Silicone Oil DC200 (manufactured by Dow Corning) can be used for diaphragm fill fluid. For process temperatures 0 °C to 300 °C (30 °F to 575 °F) Silicone Oil DC704 can be used.

Some facilities may use a locally produced fluid that has similar properties.

- b. Compatibility of these seal fluids with the process fluids should be verified.

If seal fluid is compatible with process fluid, damage in case of a rupture is reduced.

- c. A visible stainless steel tag should be attached to the differential pressure instrument indicating the type of fill fluid used and its specific gravity.
- d. Seal system should be filled by the pressure instrument supplier.
- e. Fill fluid for oxygen service shall be Fluorolube or equivalent.
- f. Glycol, silicon, or white oil may be used as seal liquids where the low-pressure leg of a differential pressure instrument is exposed to vapour service that is subject to condensation or liquid entrapment.

Capillary seals may be considered if seal liquids are difficult to maintain.

