higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

# MARKING GUIDELINE

## NATIONAL CERTIFICATE (VOCATIONAL)

## INSTRUMENTATION TECHNOLOGY
**NQF LEVEL 3**

**XX February 2020**

**This marking guideline consists of 8 pages.**

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## QUESTION 1

1.1
- Misapplication
- Vibration and/or shock
- Overpressure and pressure spikes
- Temperature
- Water
- Electrical interference
- Chemical damage (Any 5 × 1) (5)

1.2
- Misapplication: Due to the variety of pressure transmitters available today, one of the most common reasons for electronic pressure-sensor failure is misapplication. Misapplication means using the wrong type of transmitter for an application. Some common misapplications include using a general industrial pressure transmitter in a bulldozer or agricultural combine or using a tank-level transmitter incompatible with the media stored in the tank.

- Vibration and/or shock: Vibration shakes equipment apart over time and impacts or shocks to a device only worsen the problem. WIKA's electronic pressure transmitters are designed to resist shock and vibration, and each of these rugged electronic pressure transmitters undergoes 20 mechanical tests in the factory before shipping.

- Overpressure and pressure spikes: Any device used in an environment above its recommended pressure range is under stress and may have a reduced lifetime. Pressure spikes are also common in some applications. Valves must be operated when running hydraulic equipment such as earth movers or dump trucks and this can produce pressure spikes capable of damaging pressure transmitters. Because of these applications all WIKA electronic pressure transmitters go through a complete battery of tests including impact resistance and housing stability.

- Temperature: Electronic devices are designed to operate within specified temperature ranges. Long-term use above or below the specifications is likely to lead to early failure. The repeated expansion and contraction involved in temperature cycling degrades gaskets and even the housing of the transmitter, leading to separation and leak paths. Any experienced process engineer or industrial vehicle mechanic can testify to the importance of using pressure transmitters designed to handle temperature extremes.

- Water: Everyone knows to avoid getting water in an electronic device, but incidental contact with water is almost unavoidable in many applications. All electronic pressure transmitters should be completely sealed. All WIKA pressure transmitters are thoroughly tested for water ingress as part of the more than 50 environmental tests performed as part of the quality-control process.

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- Electrical interference: Although electrical interference can be an issue for electronics given the proliferation of electrical interference sources, most electronic devices today are well shielded. But when that shielding degrades, electromagnetic or radiofrequency interference can cause pressure-transmitter problems such as signal instability or signal inaccuracy. WIKA electronic pressure transmitters are subjected to 10 separate electrical tests including overvoltage resistance and load dump.

- Chemical damage: Whether from caustic process media or fertilisers and pesticides sprayed from agricultural machines, pressure transmitters are almost inevitably exposed to corrosive chemicals which can ultimately shorten the lifetime of the device. The simple solution to this problem is to ensure that pressure sensors are constructed from materials compatible with the chemicals to which it may be exposed. (Any 5 × 2) (10)

1.3
- Check if the transmitter signal is used for controlling.
- Put the controller on manual.
- Connect a digital multimeter in the current range in series with the transmitter output.
- Isolate the process valve.
- Isolate the instrument isolation valve.
- Open the equalising valve.
- Open the bleed valve and depressurise the transmitter.
- Check for a 4 mA output signal and if not present adjust the zero screw. (8)

**[23]**

## QUESTION 2

2.1 2.1.1
- Bimetallic or spring-type thermometer
- Thermocouples
- RTDs
- Thermistors
- Liquid glass thermometers (5)

2.1.2 Every device used for process-critical measurement should be checked periodically✓ to ensure it continues to deliver the required accuracy.✓ In the case of temperature-measurement equipment, the properties of bimetals and thermocouple wires change with use and time resulting in measurement drift.✓ A thermocouple probe may be damaged in service, possibly mechanical or by corrosion, resulting in rapid deterioration of the wire.✓ RTDs and thermistors are also both fragile devices and easily damaged.✓ (5)

2.1.3 Quality standards✓ generally leave it to the user to decide how often a device should be calibrated.✓ However, an auditor will expect a sound justification for whatever frequency is given.✓ (3)

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2.1.4
- Environment where the device is used
- Risk of damage
- Rate of drift (3 × 2) (6)

2.1.5 The simpler way is to check how it reads the temperature of two physical constants,✓✓ for example the temperature at which ice melts and that of boiling water.✓ (3)

2.2 2.2.1



(3)

2.2.2 A glass thermometer consists of a glass tube filled with mercury or some other liquid, which act as the working fluid.✓ Temperature increase causes the fluid to expand,✓ so the temperature can be determined by measuring the volume of the fluid.✓ (3)

2.2.3 **Advantages**
- Small size
- Low cost
- Good sensitivity in NTC region
- Fast response over narrow temperature range
- Contact and lead resistance problem not occurring due to large resistance

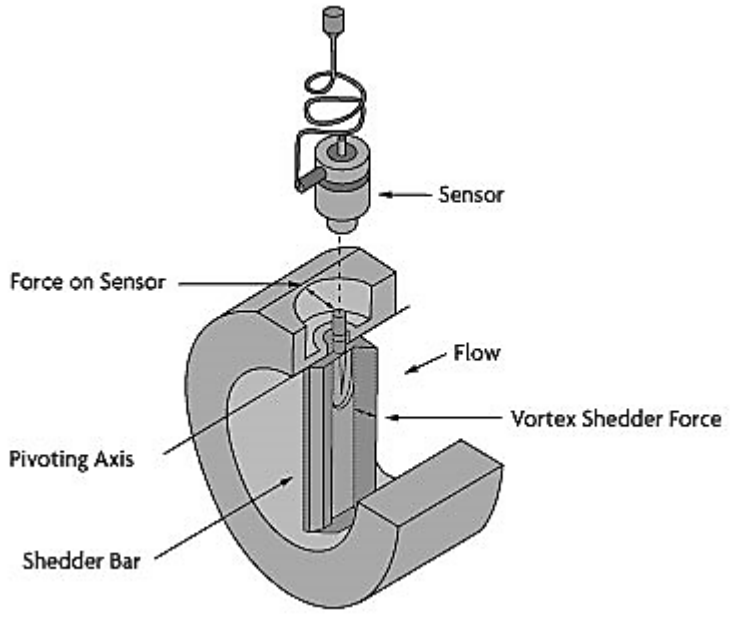
**Disadvantages**
- Not suitable for large temperature range
- Nonlinear resistant temperature characteristics
- Need shielded power lines
- Excitation current low to avoid self-heating (5 + 4) (9)

**[37]**

## QUESTION 3

3.1
- The approach channel should be straight and of uniform cross section for a distance of 15 to 20 times the maximum anticipated water depth (head) (Hmax) upstream of the weir.
- The approaching flow should be subcritical, tranquil and uniformly distributed across the width of the channel. The flow should not be turbulent, surging, unbalanced or have a poorly distributed velocity pattern.
- Centre the weir in the flow stream.
- Set the lowest point of the crest (the edge of the weir over which flow passes) at least two to three times (Hmax) above the channel floor.
- At full flow, the sidewalls on each side of the weir should extend two times (Hmax) on either side of the maximum width of the flow over the crest to the channel sidewalls.
- The lowest point of the crest should be at least 5 cm above the downstream water level.
- Weirs must be level from front-to-back and from side-to-side. No deviation is allowed.
- The point of measurement (Ha) is three to four times (Hmax) upstream of the weir. Any closer and the head reading is affected by drawdown as the flow approaches the weir.
- The zero elevation for Ha is the same elevation as the lowest point of the weir crest which is the same as the water surface being the weir once flow over the weir has ceased. (9 × 2) (18)

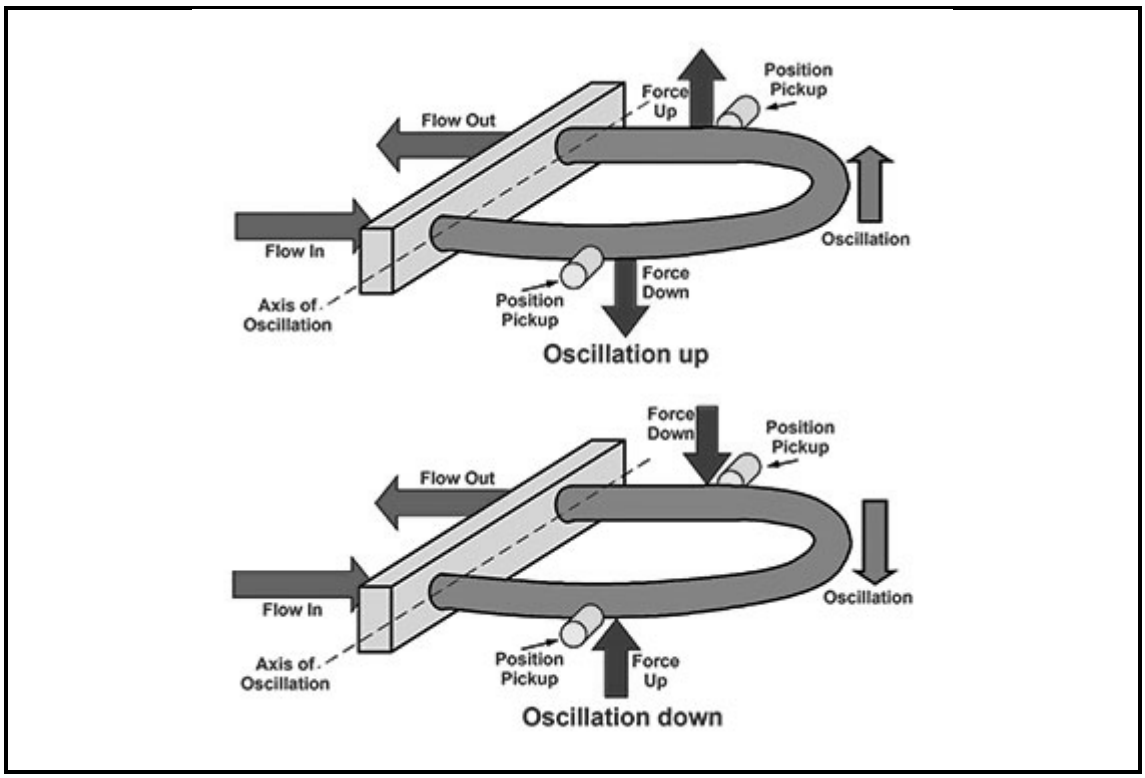
3.2 3.2.1



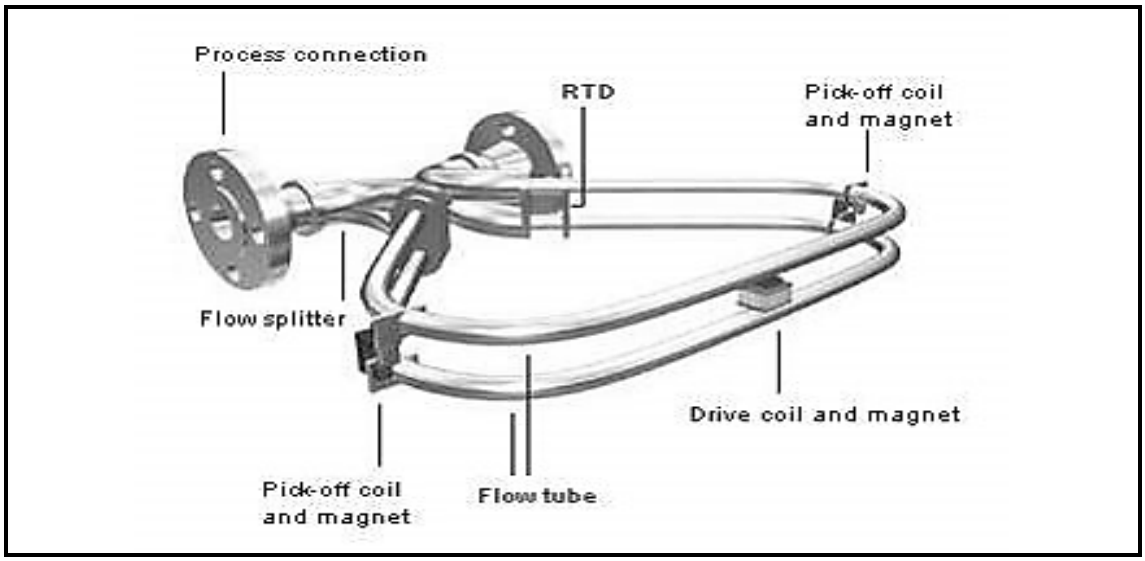

(7 for drawing + 3 for labelling) (10)

3.2.2 Vortex flowmeters operate under the vortex-shedding principle, where oscillating vortexes occur when a fluid such as water flow past a bluff (as opposed to streamlined) body.✓✓ The frequency that the vortexes are shed depends on the size✓ and shape of the body.✓✓ (5)

3.3




**OR**




(5 for drawing + 2 for labelling) (7)

3.4 3.4.1 False
3.4.2 False
3.4.3 True
3.4.4 True
3.4.5 True

(5 × 1) (5)
**[45]**

## QUESTION 4

4.1 4.1.1 B
4.1.2 C
4.1.3 A
4.1.4 I
4.1.5 H
4.1.6 J
4.1.7 G
4.1.8 D
4.1.9 F
4.1.10 E

(10 × 1) (10)

4.2 4.2.1 $\Delta P = pgh$✓

$$h = \frac{\Delta P}{pg}$$✓

$$h = \frac{200 \times 10^3}{13,6 \times 10^3 \times 9,8}$$✓

h = 1,5 m✓ (4)

4.2.2 $\Delta P = (p2 - p1)gh$✓

$$h = \frac{\Delta P}{(p2 - p1)g}$$✓

$$h = \frac{200 \times 10^3}{(13,6 \times 10^3 - 1\,000) \times 9,8}$$✓

h = 1,619 m✓ (4)

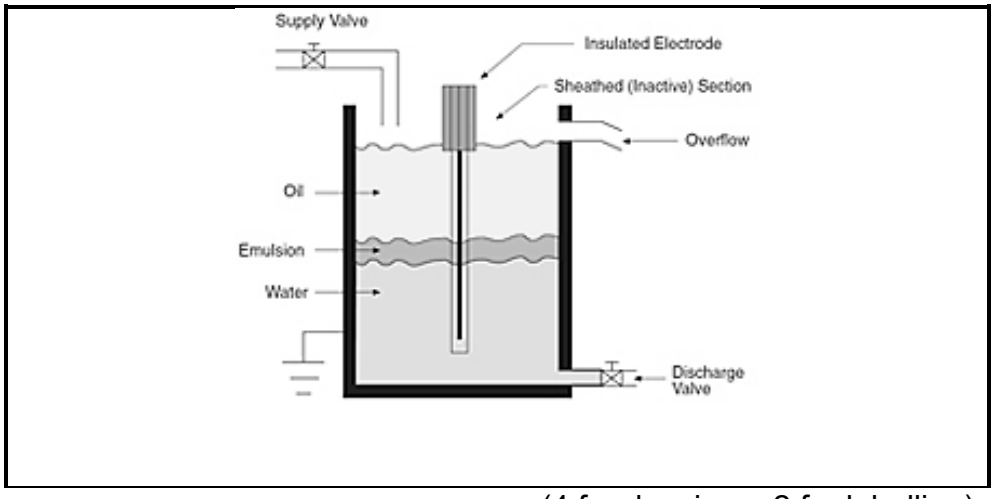
4.3 4.3.1 It operates on the principle of high-frequency sound signals.✓ A device called an ultrasonic transducer, which is basically a specialised loudspeaker/microphone, is suspended over the centre of the tank or container in which the level material is to be measured.✓ High-frequency pulses are emitted from the transducer. These pulses are directed at the surface of the liquid or solid which is to be measured.✓ The moment a pulse is emitted from the transducer, the electronic circuitry starts to time how long it takes for the ultrasonic sound waves to strike the measured material and bounce back in the form of an echo.✓ This period of time is inversely proportional to the level of material in the vessel.✓ If the time delay was long, it means that the level of the material was low.✓ (6)

4.3.2
- The ultrasonic transducer must be installed in such a way that the beam is not reflected back by the wall of the tank or any other obstruction, which may be present in the tank (beam-deflection angle).
- The transducer must be mounted perpendicular to the surface of the material to be measured.
- The height that the transducer is mounted above the tank must be such that the maximum level in the vessel falls within the operating range of the transducer. (3 × 2) (6)

4.3.3
- Severe agitation
- Dense steam
- Severe dusty conditions (Any 2 × 2) (4)

4.4 4.4.1 A metal probe is inserted and insulated from the silo or tank✓ and the tank or silo wall acts as the plates of a capacitor,✓ the capacitance of which depends on the medium between the probe and the wall.✓ When only air is present, the capacitance of the capacitor is low.✓ However, the capacitance will increase when part of the probe is in contact with the probe.✓ (5)

4.4.2




(4 for drawing + 2 for labelling) (6)

**[45]**

**TOTAL: 150**

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