



**higher education
& training**

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

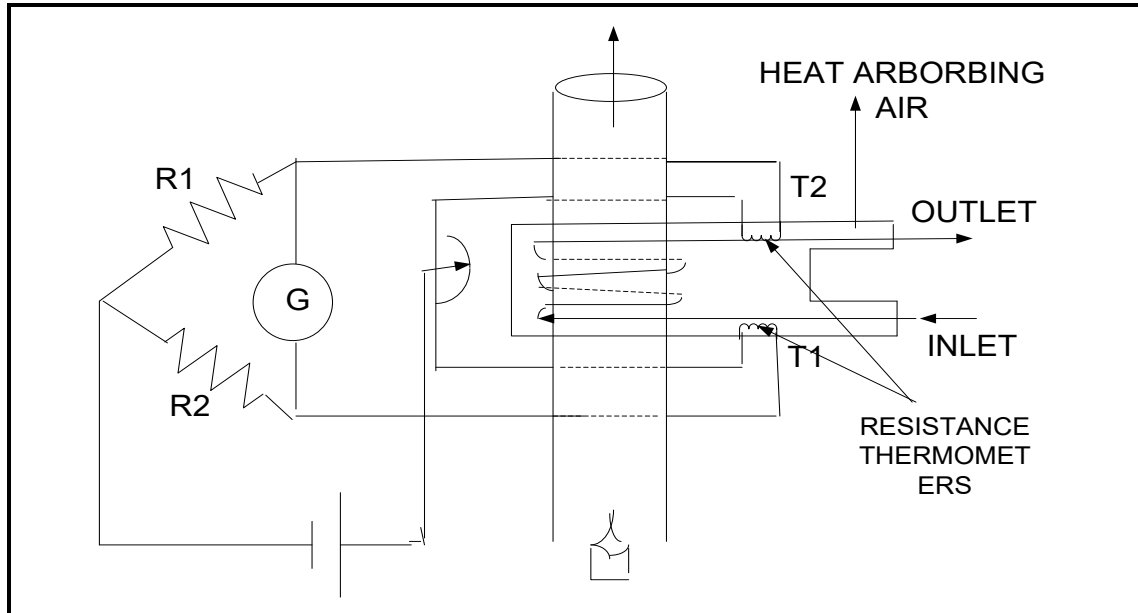
NATIONAL CERTIFICATE INDUSTRIAL INSTRUMENTS N6

27 MARCH 2018

This marking guideline consists of 8 pages.

SECTION A: ANALYSERS**QUESTION 1**

1.1



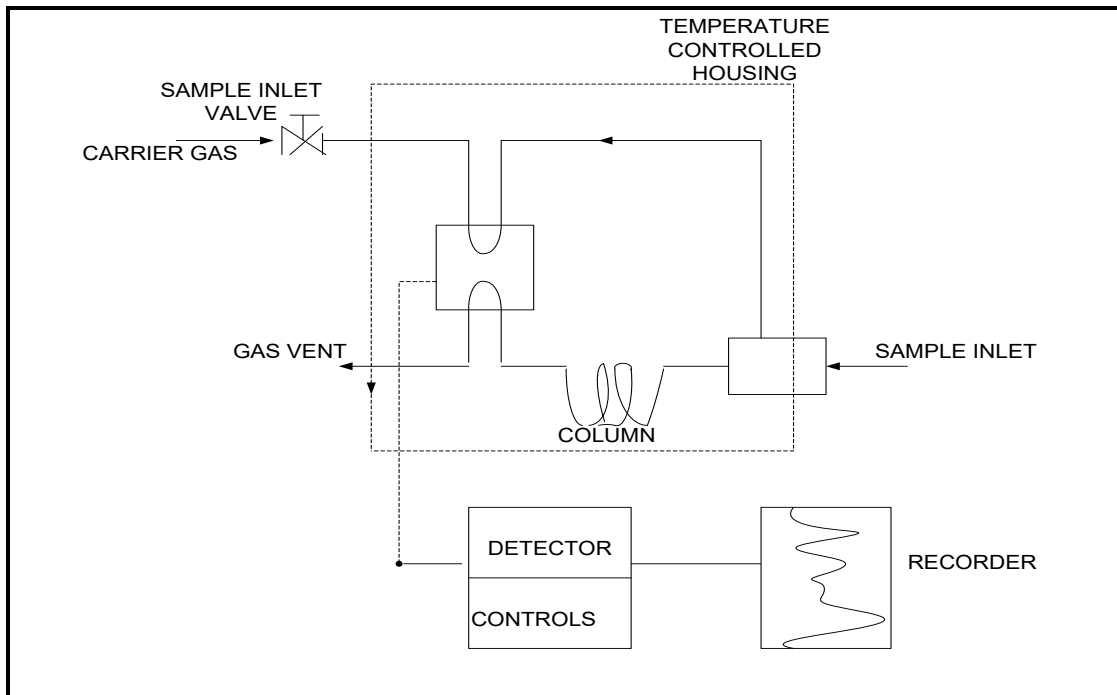
(5)

1.2

- Metered quantities of gas and air are introduced to a burner, and the tank is heated.
- When air is introduced to the air chamber, it absorbs the heat from the tank.
- The temperature rise of the air is measured by resistance thermometers to provide a measure of the heating value.
- Since both thermometers sense the same temperature, the bridge is in balance.
- When the cooling medium (air) is introduced through the capillary tubing, resistance thermometer T_1 will be cooled and resistance thermometer T_2 will be heated up as a result of heat exchange between the tank and the capillary tube.
- The bridge goes out of balance and this out-of-balance signal is proportional to the heat developed by the burning gas mixture.

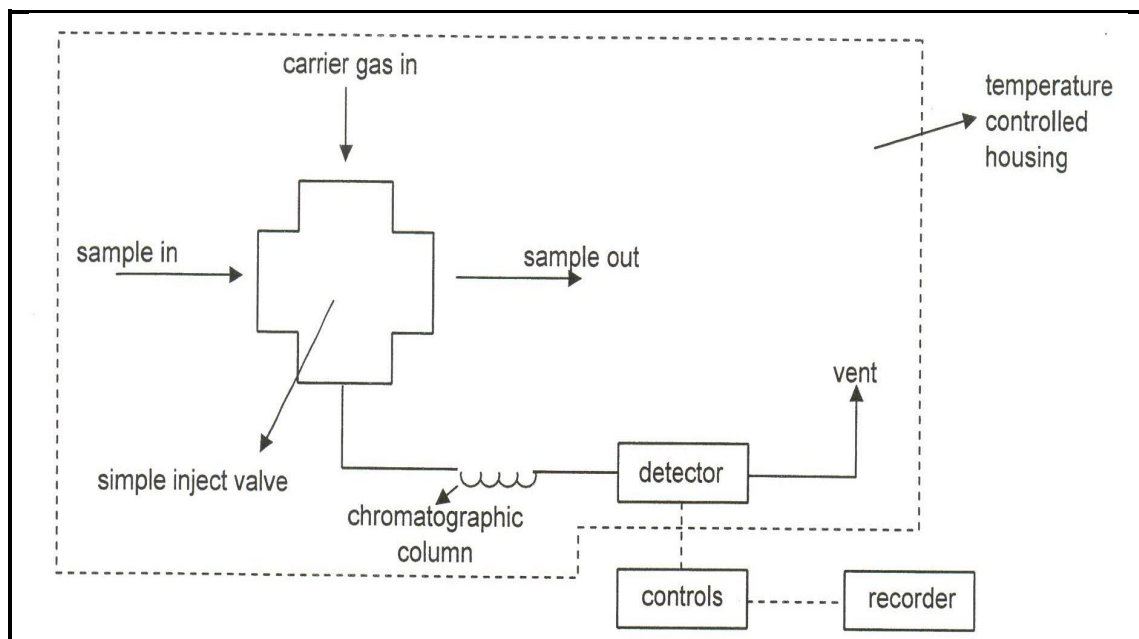
(8)

1.3

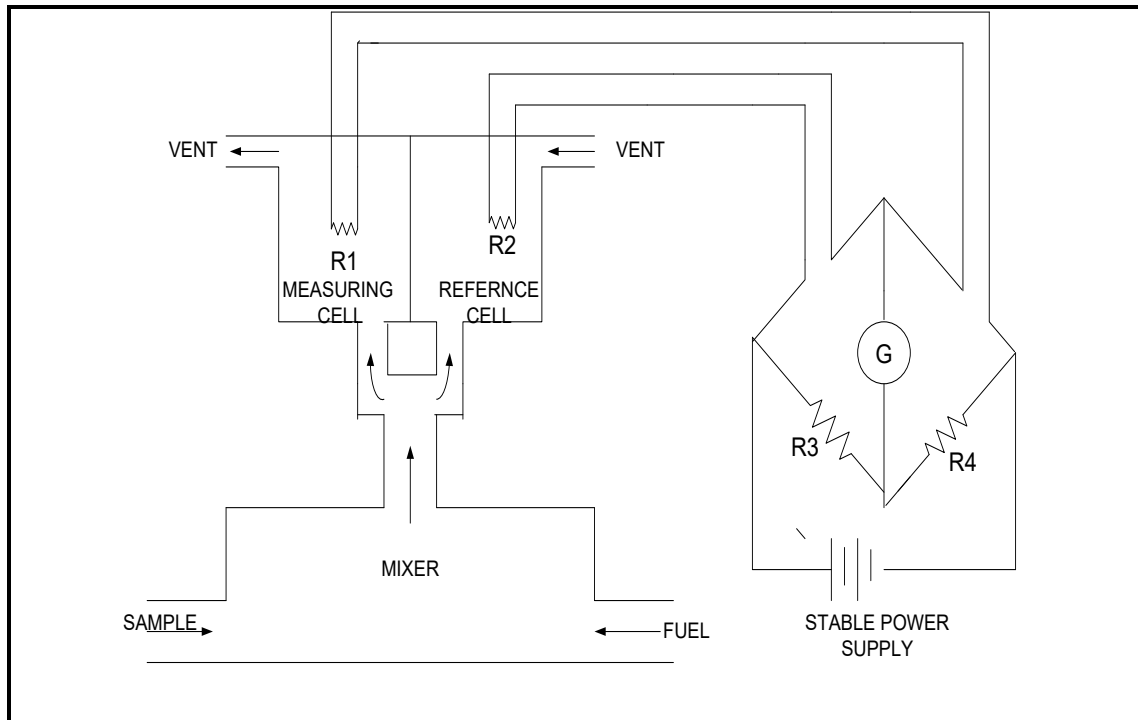


(5)

1.3 Alternative sketch for QUESTION 1.3



1.4



(6)

1.5

The measuring filament is provided with a catalytic surface to oxidise the fuel, while the reference filament serves only to compensate for sample temperatures and thermal conductivity variations. The analysis for oxygen content in the sample is accomplished by oxidising the fuel and measuring the heat generated. The reference arm of the bridge consists of platinum wire similar to the measuring arm. To be able to compensate for ambient temperature changes, all filaments are maintained at the same temperature. The arrangement does not compensate for variations in the thermal conductivity of the gas. The heat generated unbalances the bridge and the measured out-of-balance emf is proportional to the oxygen content of the sample.

(6)
[30]**TOTAL SECTION A: 30**

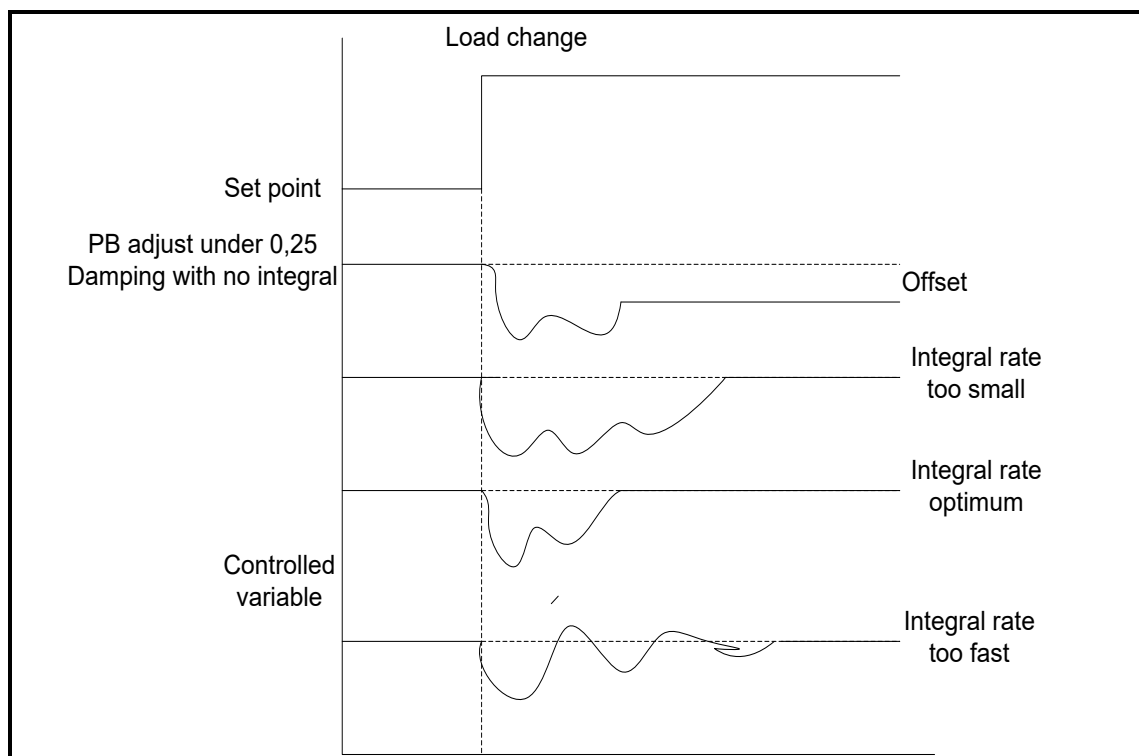
SECTION B: AUTOMATIC CONTROLLERS AND VALVES**QUESTION 2****2.1 Step 1**

- Set the integral rate at zero.✓
- Start with a wide proportional band and narrow it gradually step by step while observing the behaviour following set point changes until the desired stability is obtained. i.e. a damping ratio of 0,25.✓✓
- Now increase the bandwidth slightly to obtain a curve as for moderate band.✓

Step 2

- Allow the proportional band to remain at this setting.✓
- Begin with the slowest integral rate and increase in small steps while creating set point load changes, until cycling behaviour begins to increase.✓✓
- Decrease integral rate slightly.✓

(8)

2.2

(5)

2.3 2.3.1 A plant possessing inherent regulation will, after a sufficient time has lapsed, attain an equilibrium value called the potential value, provided all the conditions affecting the process are kept constant. (2)

2.3.2 Inherent regulation is when in the absence of a controller a plant reaches equilibrium conditions after a disturbance for any fixed set of conditions. (3)

2.3.3 This is the quantity of water that will pass through a specific valve size at maximum valve lift and one psi pressure drop. (2)

2.4 $T = 86 + 273 = 359K$ ✓
 $P_1 = 10,85 + 1,0135 = 11,8635 \text{ Bars}$ ✓
 $P_2 = 2,3 + 1,0135 = 3,3135 \text{ Bars}$ ✓

$$C_v = \frac{Q}{295} \sqrt{\frac{G.T}{\Delta P(P_1 + P_2)}}$$

$$= \frac{386,5}{295} \sqrt{\frac{0,86 \times 359}{(11,8635 - 3,3135)(11,8635 + 3,3135)}}$$

$$= 2,0209 \checkmark \checkmark 2,018$$

(5)
[25]

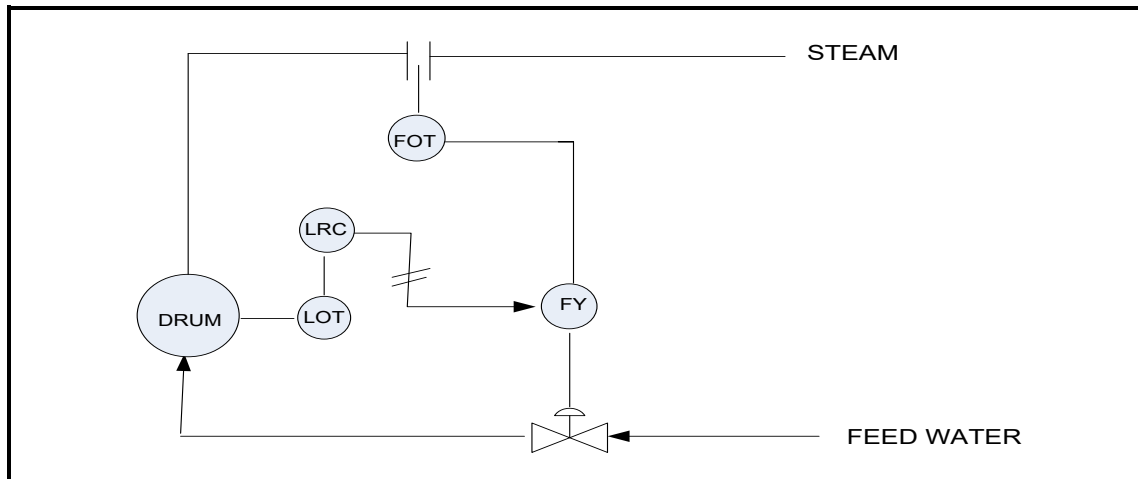
TOTAL SECTION B: 25

SECTION C: DISTILLATION COLUMN AND STEAM BOILERS

QUESTION 3

- 3.1 3.1.1
- This is a mechanical device consisting of a hopper on the front end of a boiler which has rotating paddles.
 - These paddles fling coal into the combustion chamber.
 - Here it initially begins to burn in suspension before dropping to the grate below.
 - Air is blown into the chamber beneath the grate to facilitate combustion.
- (4)
- 3.1.2
- A cyclone burner has three main parts, namely a burner area at the back end which ignites the coal,
 - a barrel area where the coal and air are mixed in a swirling action and ignite by a gas-fired burner, and
 - a re-entrant throat where the fire from the coal is forced into the furnace area of the burner.
- (3)

3.2



(5)

3.3 This system is called a two-element system because two detecting elements are used, namely a flow detector and a level detector. If the steam demand increases it causes the output of the combining relay to change as though the level has dropped in the boiler drum. More feed water is thus added. On the other hand, with constant steam demands, the level controller controls the feed water in the normal way via the combining relay. (5)

3.4

- Composition of overhead product
- Reflux rate
- Overhead product rate
- Tower pressure
- Temperature of condensed water

(5)

3.5

3.5.1 Prevents fuel from being admitted to an unfired furnace until the furnace has been thoroughly air-purged or cleaned.

3.5.2 Fuel is shut off upon a low-water signal in the boiler drum.

3.5.3 Shuts off fuel on highly combustible content in the boiler.

3.5.4 Fuel is shut off upon loss of airflow and/or combustion air, fan or blower.

(4 × 2) (8)
[30]

TOTAL SECTION C: 30

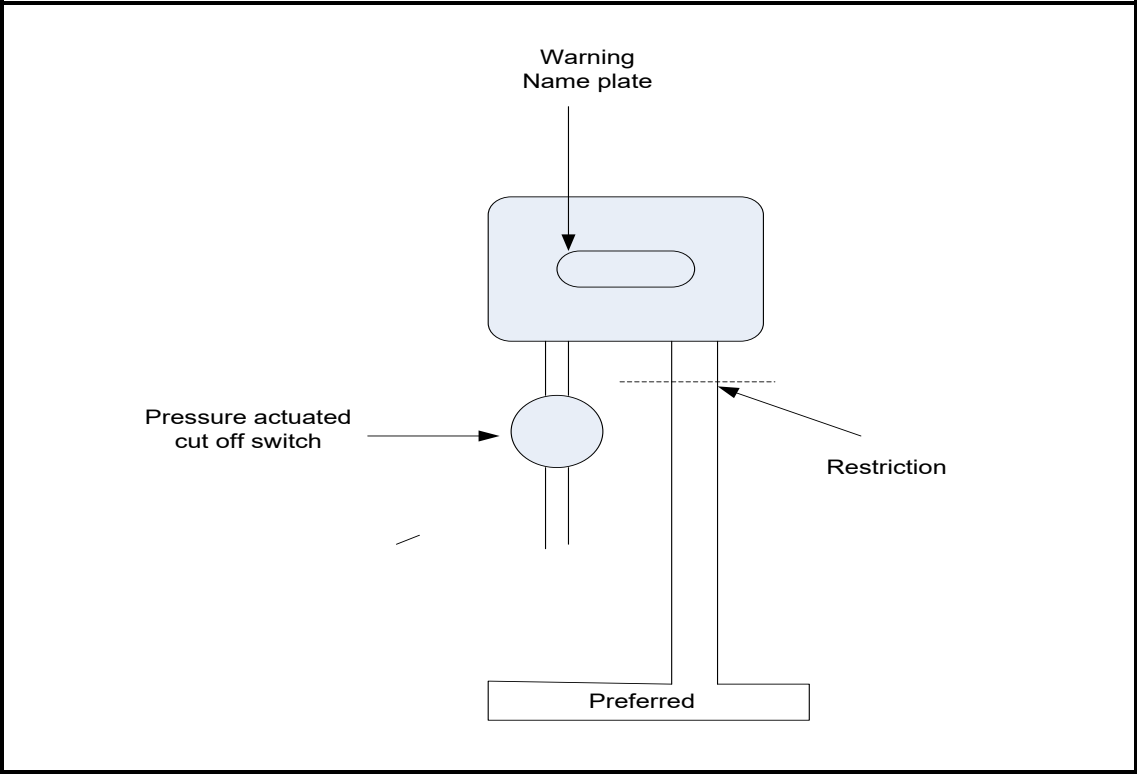
SECTION D: INTRINSIC SAFETY**QUESTION 4**

- 4.1
- What level of energy is incapable of igniting a hazardous atmosphere mixture?
 - What is a specific atmospheric mixture?
 - What are normal and abnormal conditions?
- (3)

- 4.2
- Type Z purging
 - Type Y purging
 - Type X purging
- (3)

- 4.3
- Non-incentive equipment are incapable, in their normal operating condition, of releasing sufficient energy to ignite a specific hazardous atmospheric mixture. If used in a Division 2 location, they may contain circuits of very high energy, potentially capable of ignition. However, two modes of failure are required to provide the necessary conditions for an explosion, namely:

- Failure in the equipment
 - Failure in the process
- (6)

- 4.4
- 
- (Any other suitable sketch is acceptable)
- (3)
[15]

TOTAL SECTION D: 15
GRAND TOTAL: 100