higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE (VOCATIONAL)

RENEWABLE ENERGY TECHNOLOGIES
NQF LEVEL 3

21 November 2024

This marking guideline consists of 7 pages.

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QUESTION 1

1.1
- Conventional geysers use electric heating element to heat water, whereas SWH systems uses free of charge radiation✓
- Solar thermal systems have the ability to reduce the use of electrical energy, using SWH technologies as an alternative can help reduce GHG emissions associated with fossil fuel usage and reduce peak load demand.✓ (2)

1.2
- Solar energy is a renewable, free and abundant form of energy✓ and is considered to be the least expensive means of heating water for domestic use. ✓ (2)

1.3
- The reduction in residential power usage and peak usage and peak-hour demand will reduce costs and can improve electrical grid security. ✓
- Reduced municipal CO_2 emissions ✓ (2)

1.4 1.4.1 Total extra cost for SWH system:
R28, 600 – R8, 600 = R20, 000 ✓✓ (2)

1.4.2 Monthly kWh saving in Rand:
R3/kWh x 250 kW = R750 ✓✓ (2)

1.4.3 Payback period:
R20, 000 ÷ R750 = 26.6 months = about 2 years ✓✓ (2)

1.5
- A reduced electrical energy bill. ✓
- 50% to 90% of a normal household's hot water needs can be met dependent on the type of system and how hot water is used. ✓
- Solar hot water is a renewable technology and can greatly reduce CO_2 emissions associated with fossil fuel usage. ✓
- SWH systems usually have lower maintenance costs and higher durability compared to electric geysers. ✓
- SWH systems can be combined with electric geysers to ensure that hot water is always available. ✓
- SWH systems provide hot water during load shedding periods and shield the consumer from energy price increases.
- SWH systems can reduce peak load demand.
- Adding SWH systems to existing homes raises the resale value of the property.

ANY FIVE OR RELEVANT ALTERNATIVE RESPONSES (5)

1.6 1.6.1
- Water Services Act ✓ (1)

1.6.2
- Occupational Health and Safety Act✓ (1)

1.6.3
- National Building Regulations and Building Standards Act✓ (1)

[20]

QUESTION 2

2.1
2.1.1 False ✓
2.1.2 False ✓
2.1.3 True ✓
2.1.4 False ✓
2.1.5 True ✓
2.1.6 True ✓
2.1.7 False ✓
2.1.8 True ✓
2.1.9 True ✓
2.1.10 True ✓

(10 × 1) (10)

2.2

$\Delta T = T_f - T_i$
$\Delta T = 60℃ - 20℃$
$\Delta T = 40℃$✓

$Q = m \times C \times \Delta T$
$Q = 200 \times 4.18 \times 40$
$Q = 33440kJ/day$✓
$Q_T = \frac{Q}{\Omega}$
$Q_T = \frac{33440}{0.5}$
$Q_T = 66880\ kJ/day$✓

$Q = \frac{kJ}{3600} kWh$
$Q = \frac{66880}{3600} kWh$
$Q = 18.578kWh$✓

$Irradiation\ E = P \times t$
$Irradiation\ E = \frac{600}{1000} \times 8$✓
$Irradiation\ E = 4.8kWh/m^2$✓

Required Collector Surface Area = $\frac{Q_t}{Q_i}$
Required Collector Surface Area = $\frac{18.578}{4.8k}$
Required Collector Surface Area = $3.87m^2$✓

Required Collector Area = 3.9 m^2 can be achieved with 2 x 2m^2 solar collectors.✓ (8)

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2.3 2.3.1 System Sizing -
This means that the total collector area and the storage volume✓ must be able to meet at least 70% of the household's water demand during the summer period. ✓ To determine the storage capacity of the tank, the general rule is that a minimum of 50_litres of tank storage per person plus another 50_litres for the house should be sufficient. ✓ (3)

2.3.2 Proximity-
The SWH system should be installed as close as possible to the area of water usage in a building, ✓ for example close to the bathroom and/or the kitchen. ✓ This will reduce thermal 'losses' that may occur if the pipe work between the SWH system and the point of usage is too long. ✓ (3)

2.3.3 Water Quality -
The quality of the water can also affect the efficiency of a SWH system. ✓ So-called 'hard water' is water that contains large quantities of minerals such as calcium or magnesium. ✓ Hard water can form lime scale inside the pipes, collector and storage tank, which affects their performance. Unless scale buildup is controlled, system efficiency will decrease, thereby reducing the performance of the system. It is thus important to determine water quality before deciding on the type of system to be installed, as scaling can be reduced by installing an indirect SWH system. ✓ (3)

2.4
- Adding thicker timbers alongside the rafters✓
- Adding cross-bracing rafters ✓
- Adding additional supporting struts to the truss ✓ (3)

[30]

QUESTION 3

3.1
- Electrical Hazards ✓
- Falling Hazard✓
- Unguarded and moving machinery✓
- Ergonomic hazards – lifting heavy objects/ poor posture✓
- Chemical hazards – heat transfer fluids ✓ (Any 4 × 1) (4)

3.2
- Inspect ladder ✓
- Place ladder on firm even surface ✓
- Place ladder at safe angle - 75° - or ratio 1:4 ✓
- Ladder must extend at least 1m above spring-off point ✓
- Secure ladder at top and bottom ✓
- Use a barricade where the ladder obstructs a passage way or roadway ✓
- Ensure that ladder is long enough for the job ✓
- One person at a time on a ladder✓
- Shoe soles must have sufficient grip✓
- Never carry something on a ladder✓
- Never hang any items from the steps or rungs of the ladder✓
- Never overreach while you are on the ladder✓
- Never use a ladder horizontally ✓

(5)

3.3 Total Restraint Systems✓
- For working at heights. (The preferred harness system)
- Referred to as a travel restraint system.
- Systems protect the worker from approaching an unprotected edge, preventing a free fall from occurring.
- System consists of equipment rated for a fall, such as a full-body harness that is connected by a lanyard or safety line to a suitable anchorage point or horizontal lifeline. ✓ (Any 1 + 1)

(2)

Fall Arrest System✓
- To support and hold a person in the event of a fall.
- It is not a work positioning system, not designed to support a person while working.
- Only when total restraint is impractical should a fall arrest system be considered.
- Fall arrest is a minimisation measure as it does not prevent the fall from occurring.
- System requires a higher level of operator competency and supervision✓.
- A fall arrest system is an assembly of interconnected components consisting of a harness which is connected to an anchorage point by means of a lanyard incorporating an energy absorber.
- They can be used where workers are required to carry out their work near an unprotected edge.
- When fall arrest systems are used, an appropriate safety helmet must be worn to protect the worker from head injuries during an uncontrolled fall.✓

(Any 1 + 1)

(2)

Work Positioning Systems✓
- Enables a person to work while wearing a harness that prevents a fall altogether.
- By being under constant tension, the harness generally allows the worker to maintain a stable position and to work hands-free while completing a task. ✓ (Any 1 + 1)

(2)
[15]

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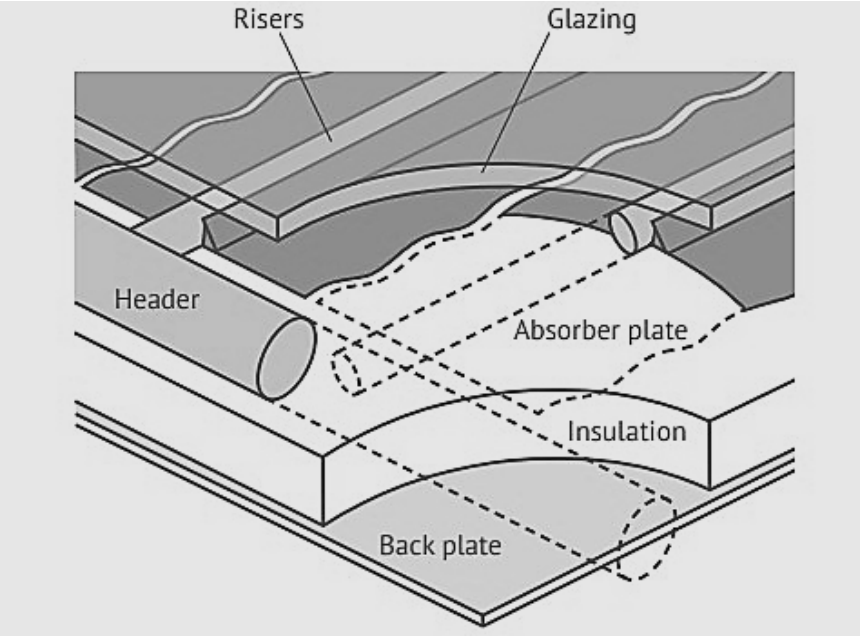
QUESTION 4

4.1



SOURCE: GIZ/ S4GJ – RET L3 Textbook

(6)

4.2 Passive systems rely solely on the thermosiphon effect for fluid movement, driven by natural density differences. ✓ In a thermosiphon system, the storage tank must be placed above the collector due to the natural cold-hot-fluid cycle.✓

OR ANY ALTERNATIVE RELATIVE ANSWER (2)

4.3 TP Valve (Temperature & Pressure Control Valve) ✓

Operating principle: The TP valve opens the outlet when reaching the preset settings for:
(i) Temperature ✓: The thermostat compound inside the temperature sensor which is submerged in the hot water storage heater expands as the temperature increases. ✓ The is expansion causes a thrust pin to move and act on the obturator opening the valve. Th e valve is set to open at temperatures of over 90°C. ✓

(ii) Pressure✓: The obturator, opposed by a set spring, rises on reaching the preset pressure setting and opens the outlet completely. ✓ The pressure setting is chosen according to the maximum permissible pressure in the system. As the temperature and pressure decrease, the opposite action occurs with the valve, subsequently reclosing within the preset tolerances. ✓ (7)

4.4 The term 'scale build-up' describes water ('hard water') that contains large mineral contents, usually dissolved calcium✓ or magnesium salts, ✓which can cause mineral deposits (lime scale or scaling) to form in the collector tubing and pipe work, ✓subsequently causing a decline in system performance or even dysfunctional system components ✓ (Any 3 × 2) (3)

4.5
- Cut tube end square to the required length, ream and remove bur on inside end. ✓
- Use cleaner and solder cup brush to ensure an efficient and clean preparation. ✓
- Apply paste flux to outside of tube and to inside of fitting so that the surfaces to be joined are completely covered. ✓
- Bend over solder wire about the length of the fitting. (15 mm for a 15 mm fitting, etc.) ✓
- Apply flame to tube and to cup of fitting until solder melts when placed at the joint. ✓
- Then pass flame to centre of fitting until solder is absorbed and joint completed. ✓
- Remove excess solder with small brush while plastic (soft), leaving a fillet around the end of the fitting whiles it cools. ✓
- Wet cloth to clean pipe work. ✓

(8)

4.6 a) Slip Joint Pliers✓
b) Tube Cutter ✓
c) Pipe Wrench✓

(3)

4.7
- The cold water is turned on so that the storage tank fills. ✓
- The hot water taps of the house are turned on until water free of air bubbles is delivered. ✓
- The whole system is checked for leaks. ✓
- The storage tank and collectors are checked to make sure that they are properly secured in place. ✓
- There is sufficient solar radiation - the hot pipe leading from the collectors to the storage tank could be checked by hand to indicate system functioning. ✓
- Once you have verified that the system is operating properly, you need to instruct the owner on the correct operation of the installation (demonstrate its function) and provide the client with the manual (installation/operation manual and/or owner's manual) which outlines the maintenance procedures and the guarantee/warranty conditions.
(Any suitable reference to the hand over procedure) ✓

(6)
[35]

TOTAL: 100

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