higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE (VOCATIONAL)

RENEWABLE ENERGY TECHNOLOGIES
NQF LEVEL 3

XX February 2020

This marking guideline consists of 7 pages.

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QUESTION 1

1.1
- Energy efficiency and energy demand management to lower energy demand in buildings
- Replacing inefficient traffic and street lights with energy efficient technologies
- Supporting installation of solar water heating systems (3)

1.2 To introduce solar water heating technologies as a clean and renewable alternative for domestic hot-water generation (2)

1.3
- Patterns of using hot water
- Lifespan of system
- System efficiency
- Subsidies
- Eskom/Municipal tariffs (Any 4 × 1) (4)

1.4
- Cistern lids must be designed to remain closed.
- Isolating valves must be fitted before and after the storage tank.
- A vent must be connected to the highest point of the water heater and be as short as possible.
- Pipes and components must be protected against freezing if relevant to the specific geographical area.
- The recommended temperature for water storage is at least between 55 °C and 60 °C, as bacteria such as Legionella can multiply in hot water systems with temperatures between 20 °C and 45 °C. Legionella bacteria can cause Legionnaires disease, which is a type of pneumonia or lung infection. Therefore, a hot water system must always be clean and maintained above 55 °C to prevent these bacteria from multiplying.
- The water temperature for taps must not be above 55 °C, but should be above 45 °C for taps at sinks to melt fat in the drain.
- The water velocity in any pipe shall not be more than 2.5_m/s.
- The ingress of moisture into insulation materials must be prevented.
- Water heater pipework must be connected with flush unions to make replacement easy.
- Pipes must be fixed to the building with properly spaced pipe supports.
- Every installation must be inspected for defects, faulty materials and compliance with drawings, specifications and requirements.
- Every installation must be pressure-tested with no loss of pressure.

(Any 3 × 1) (3)

1.5
1.5.1 B
1.5.2 A
1.5.3 C

(3 × 1) (3)

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1.6 1.6.1 Total extra cost: R32 500 – R9 000 = R23,500✓ (1)

1.6.2 Monthly kWh saving in Rand: R2,50 × 350 kW✓ = R875✓ (2)

1.6.3 Payback period (years): $\frac{23500}{875}$ = 26,86 months✓ = 2 years✓ (2)

[20]

QUESTION 2

2.1
- Risers
- Glazing
- Header
- Absorber plate
- Insulation
- Back plate (Any 5 × 1) (5)

2.2 2.2.1
- Shading decreases collector efficiency and should be avoided.
- Shading that falls over the collector early morning or late afternoon will have limited effects, and brief partial shading over the collector surface can in many cases be ignored. If possible it is best to avoid shading altogether.
- Looking at the installation from a collector facing true North, the area between North-East and North-West must be free of shade at an angle towards the horizon not exceeding 20°.
- It should be remembered that a quality solar water heating system will operate for more than 20 years and that during this period trees could grow substantially or other buildings be erected, causing shading. (Any 2 × 1) (2)

2.3 2.3.1 Rack mounting
2.3.2 Reflectance
2.3.3 Direct mounting
2.3.4 Hanger
2.3.5 Emmitance
2.3.6 Integral mounting
2.3.7 Standoff mounting
2.3.8 Conduction
(8 × 1) (8)

2.4 2.4.1 True
2.4.2 True
2.4.3 True
2.4.4 True
2.4.5 True
2.4.6 False
2.4.7 False
(7 × 1) (7)

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2.5 Situation in which radiation is converted into sensible heat within the material. (2)

2.6 ∆Tfinal – Tinitial
= 95 °C – 15 °C
= 80 °C✓
Q = C × m × ∆T
= 3,5 J/g/°C × 1 120 kg × 80 °C✓
= 313600 kJ✓

Q = 313600 ÷ 4,2 = 74,7 kWh✓ (4)

2.7
- Perform the installation in a safe manner.
- Take precautions to avoid any damage to the roof area.
- Position collectors for maximum performance but don't compromise acceptable mounting practices.
- Seal flash, hook, pipe and sensor penetrations in accordance with good roofing practices. Use permanent sealants like silicone, urethane or butyl rubber.
- Place collectors in such a way that they remain easily accessible for maintenance. (Any 2 × 1) (2)

[30]

QUESTION 3

3.1
- Chemical hazards are present when a worker is exposed to any chemicals (solid, liquid or gas) at the workplace.
- Some solar water heating systems use heat transfer fluids (HTF) such as polypropylene glycol, which is usually mixed with water.
- Albeit polypropylene glycol is not considered to be poisonous one should beware of dangerous health effects when accidentally ingesting large quantities of ethylene glycol.
- It can cause illness, skin irritation or breathing problems. (4)

3.2 3.2.1 Probability of being injured

3.2.2 Potential of work equipment or processes to cause harm to people or damage to property or the environment

(2 × 1) (2)

3.3
- Where there is no permanent access to roof areas, provide temporary access that is properly constructed.
- Scaffolding, constructed work platforms or mobile elevating work platforms are the preferred means of temporary access.
- Where this is not practicable, use portable industrial-grade ladders with a load rating of at least 120 kg secured against movement, pitched at about 75 degrees and extending at least one metre above the stepping-off point as a suitable means of temporary access.
- For major roofing work provide a scaffold stairway access tower.
- Never allow workers to use barrow hoists to gain access to the roof.

(Any 4 × 1) (4)

3.4
- A fall arrest system is designed to support and hold a person in the event of a fall.
- It can be used where work is to be carried out near an unprotected edge.
- 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.
- These systems require 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.
- It is not a work positioning system, as it is not designed to support a person while working.
- 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 5 × 1) (5)
[15]

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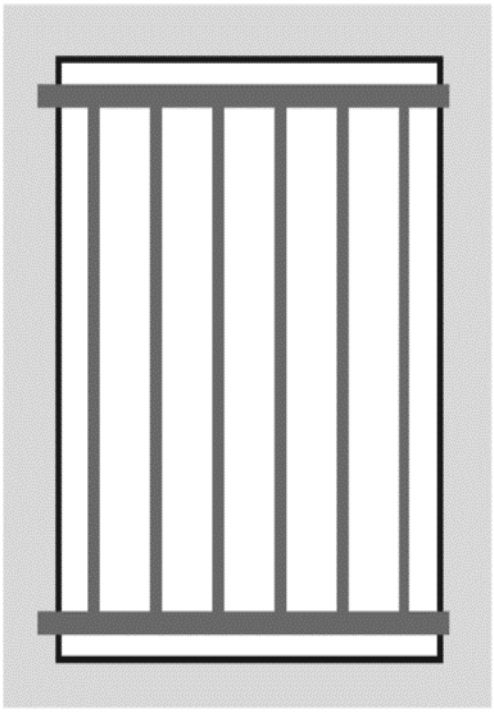
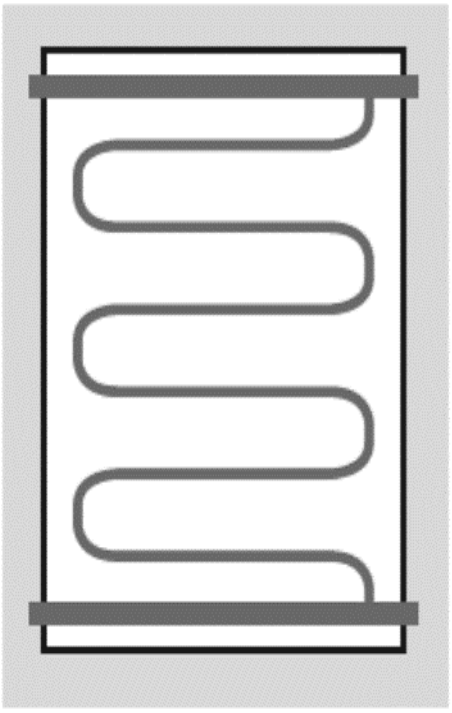
QUESTION 4

4.1



Harp-shaped absorber pipes



Meander absorbers (2 × 3) (6)

4.2
- In an evacuated tube collector a vacuum is created between two layers of glass.
- This insulates the inside of the tube from its environment, thus minimising heat loss.
- Two flat sheets of glass are usually not strong enough to withstand the vacuum. And this is instead created between two concentric tubes.
- The vacuum admits energy from the sun in the form of light that heats the thermal absorbent on the inner tube, but limits heat loss back to the environment.
- The concentric design has the added benefit that it is always perpendicular to the sun. (Any 3 × 1) (3)

4.3
- An air release valve is critical to an evacuated tube system. Due to the efficiency of the collector the manifold can become very hot;
- The stagnation temperature of the manifold can reach 295 °C.
- The water in the collector will be converted to steam and the system will be under severe pressure.
- The air release valve is a safety mechanism which releases this pressure. The valve must be opened after it has been installed. (Any 3 × 1) (3)

4.4
- Permanent connection: capillary soldering or brazing
- Nonpermanent connection: compression type (2 × 1) (2)

4.5
- Mixing valve
- Drain cock
- Ball to stop (3)

4.6
- Active closed-loop system filled with an anti-freeze mix is justified. The water-glycol HTF degrades over time and needs to be changed every few years.
- With direct systems you cannot simply rely on the collector and pipe work insulation to keep the components from freezing. The main purpose of the insulation is to reduce heat loss and increase performance. (2)

4.7
- Pencil/Pen and note pad
- Ladder
- Tape measure
- Pitch gauge
- Compass
- Camera/Cellphone
- Site assessment checklist, including the risk checklist (Any 3 × 1) (6)

4.8
- The low-pressure system is an air-vent system.✓ There is no pressure in the tank and water flows to the house by means of gravity feed.✓
- The tank of a high-pressure system is under municipal pressure which is transferred when the tap is opened.✓
- In a low-pressure system the water actually enters the tubes and is heated directly therein and through thermosiphoning the water in the tank is heated.✓ This is also referred to as a wet connection.✓
- There is no control mechanism in this process. The water will continue heating as long as the sun heats the water in the tubes.✓ This can be hazardous and a mixing valve at the hot water outlet to reduce the temperature of the water being drawn off may be required.✓ (Any 4 × 1) (4)

4.9
- Install all components including collector, tank, valves, fittings and pipe work according to the installation instructions provided in the manual.
- The collector should be installed in close proximity to the storage tank.
- The collector should be mounted with the correct orientation and tilt angle.
- Ideally, the collectors should be flush or rack mounted.
- The collector and pipe work must incline to allow complete drainage.
- Collector pairs should be mounted in parallel positioning.
- Collector mounting bolts should penetrate the roof rafters.
- All roof penetrations should be sealed.
- Vacuum breakers/air vents should be installed vertically on the highest point of the system. (Any 6 × 1) (6)

[35]

TOTAL: 100

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