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Thermal solar systems and components – Factory made systems – Part 1: General requirements

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Foreword

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(c) the National Enquiry Point on TBT/SPS Agreements of the World Trade Organisation (WTO).

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Draft Uganda Standards adopted by the Technical Committee are widely circulated to stakeholders and the general public for comments. The committee reviews the comments before recommending the draft standards for approval and declaration as Uganda Standards by the National Standards Council.

Committee membership

The following organisations were represented on Energy Management Subcommittee on Solar Energy, UNBS TC 13/SC 3, in the preparation of this standard:

- Renewable Energy Department, Ministry of Energy and Mineral Development
- Makerere University
- Incafex Solar Systems
- Battery Masters (U) Limited
- Equator-sun (U) Limited
- Ultratec (U) Limited
- Sonnerkraft Solar Systems
- Solar Masters
- Uganda National Plumbers Association
- Uganda Institute of Professional Engineers
- Uganda National Bureau of Standards

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Thermal solar systems and components – Factory made systems – Part 1: General requirements

1 Scope

This Uganda Standard specifies requirements on durability, reliability and safety for Factory Made thermal solar heating systems. The standard also includes provisions for evaluation of conformity to these requirements.

The requirements in this standard apply to Factory Made solar systems as products The installation of these systems itself is not considered, but requirements are given for the documentation for the installer and the user which is delivered with the system (see also 4.6)

2 Normative references

The followings referenced documents are indispensable for the application of the Uganda Standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 806-1, *Specifications for installations inside buildings conveying water for human consumption — Part 1: General*

ISO 6612, *Windows and door height windows — Wind resistance tests*

ISO 15783, *Seal-less rotodynamic pumps — Class II — Specification*

ISO 9906, *Rotodynamic pumps — Hydraulic performance acceptance tests — Grades 1 and 2*

ISO 4126-1, *Safety devices for protection against excessive pressure — Part 1: Safety valves*

ISO 4126-2, *Safety devices for protection against excessive pressure — Part 2: Bursting disc safety devices*

ISO 4126-3, *Safety devices for protection against excessive pressure — Part 3: Safety valves and bursting disc safety devices in combination*

ISO 4126-4, *Safety devices for protection against excessive pressure — Part 4: Pilot-operated safety valves*

ISO 4126-5, *Safety devices for protection against excessive pressure — Part 5: Controlled safety pressure relief systems (CSPRS)*

ISO 4126-6, *Safety devices for protection against excessive pressure — Part 6: Application, selection and installation of bursting disc safety devices*

ISO 4126-7, *Safety devices for protection against excessive pressure — Part 7: Common data*

ISO 4126-9, *Safety devices for protection against excessive pressure — Part 9: Application and installation of safety devices excluding stand-alone bursting disc safety devices*

ISO 9393-1, *Thermoplastics valves for industrial applications — Pressure test methods and requirements —*

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Part 1: General

ISO 9393-2, *Thermoplastics valves for industrial applications — Pressure test methods and requirements —Part 2: Test conditions and basic requirement*

DUS 854-1, *Thermal solar systems and components — Solar collectors — Part 1: General requirements*

ISO 10721-1, *Steel structures — Part 1: Materials and design*

ISO 10721-2, *Steel structures — Part 2: Fabrication and erection*

ISO/TR 11069, *Aluminum structures — Material and design — Ultimate limit state under static loading*

DUS 854-2, *Thermal solar systems and components — Solar collectors — Part 2: Test methods*

DUS 855-2, *Thermal solar systems and components — Factory made systems — Part 2: Test methods*

ISO 9488, *Solar energy — Vocabulary*

ISO/TR 10217, *Solar energy — Water heating systems — Guide to material selection with regard to internal Corrosion*

3 Terms and definitions

For the purposes of this Uganda Standard, the terms and definitions given in ISO 9488 and the following apply.

3.1

expansion line

for systems with closed expansion vessels, the connecting line between the collectors and the pressure expansion vessel

3.2

safety line

for systems with closed expansion vessels: the connecting line between the collector array and the safety valve

For systems with open expansion vessels: the connecting line between the collector array and the open expansion vessel

3.3

blow-off line

connecting line between the outlet of the safety valve and the environment

3.4

factory-made solar systems

packaged solar energy system for the purpose of hot water preparation only, either of the close-coupled or remote store type. The system consists of either one integral component or of a uniform set and configuration of components. It is produced under conditions, which are presumed uniform, and offered for sale under the same trade name.

NOTE 1 A single system can be tested as a whole in a test laboratory, leading to representative results for all systems with the same trade name, configuration, components and dimensions.

NOTE 2 External auxiliary water heating devices that are placed in series with the Factory Made system are not considered to be part of the system. Cold water piping from the cold water grid to the system as well as piping from the system to an external auxiliary heater or to tapping points is not considered to be part of the

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system. Piping between components of the Factory Made system is considered to be part of the system. Any integrated heat exchanger or piping for space heating option is not considered to be part of the system.

4 Requirements

4.1 General

The system shall fulfil general safety requirements e.g. care shall be taken to avoid protruding sharp edges on the outside of the system.

4.1.1 Suitability for drinking water

The system shall confirm to EN 806-1

4.1.2 Water contamination

The system has to be designed to avoid water contamination for backflow from all circuits to drinking main supplies.

4.1.3 Freeze resistance

4.1.3.1 General

The manufacturer shall state a minimal allowed temperature for the system. The parts of the system that are exposed to the outdoors shall be able to withstand freezing to this specified temperature without any permanent damage.

The manufacturer shall describe the method of freeze protection used for the system

Any indoor components that are to be installed in places where temperatures can drop below 0 ^{o}C, shall be protected against freezing.

The freezing mechanism shall be tested in accordance with 5.1 of DUS 855-2

4.1.3.2 Freeze protection by means of antifreeze fluid

The manufacturer shall define the composition of the heat transfer fluid, including additives, allowed for the system.

Precautions shall be taken to prevent the antifreeze fluid from deterioration as a result of high temperature conditions. These precautions shall be checked in accordance with 5.2 of DUS 855-2

NOTE In general the minimal allowed temperature of the system is equal to the freezing point of the antifreeze fluid. If the concentration of some antifreeze fluids – like glycols – exceeds a certain limit, they can freeze without damaging the system. In this case the minimal allowed temperature can be lower than the freezing point of the antifreeze fluid.

4.1.4 Over temperature protection

4.1.4.1 General

The system shall have been designed in such a away that prolonged high solar irradiation without heat consumption does not cause any situation in which special action by the user is required to bring the system back to normal operation.

When the system has a provision to drain an amount of drinking water as a protection against overheating, the hot water drain shall be constructed in such a away that no damage is done to the system or any other

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materials in the house by the drained hot water. The construction shall be such that there is no danger to inhabitants from steam or hot water from the drain (see 4.6.2)

When the overheating protection of the system is dependent on electricity supply and/or cold water supply, this shall be stated clearly in the instructions and on the system (see 4.6.3 and 4.7)

In case of drainback, system shall be checked in accordance with 5.1 of DUS 855-2

4.1.4.2 Scald protection

When the system is tested in accordance with 5.2 of DUS 855– 2, no steam shall escape from any tapping point. When this test has been performed with other than the highest irradiations this shall be mentioned in the documentation for the user (see 4.6.3)

For systems in which the temperature of the domestic hot water delivered to the user can exceed 60 ^{o}C, the assembly instructions shall mention that an automatic cold water mixing device or any other device to limit the tapping temperature to at most 60 ^{o}C ± 5 ^{o}C shall be installed on the solar heating system or elsewhere in the domestic hot water installation (see also 4.6.2).

This device shall be able to withstand the maximum possible domestic hot water temperature from the solar heating system.

4.1.4.3 Over temperature protection for materials

The system shall have been designed in such a way that the maximal allowed temperature of any material in the system is never exceeded.

4.1.5 Reverse flow protection

The system shall contain provisions in order to prevent increased heat loss resulting from reverse flow in any circuit. This shall be checked in accordance with 5.10 of DUS 855- 2

4.1.6 Pressure resistance

The storage tank and heat exchangers in this tank shall withstand 1.5 times the manufacturer's stated maximum individual working pressures.

When tested in accordance with 5.3 of DUS 855-2 to the above pressures, there shall be no visible permanent damage or leakage of the system components and interconnections. After the waiting period in the test, the hydraulic pressure shall not have dropped more than 10% from the value measured at the start of the waiting period.

When non-metallic materials are used in any circuit, this circuit shall withstand the above – mentioned pressures for at least one hour when tested at high temperature in accordance with DUS 854 -1

The drinking water /water mains circuit shall withstand the maximum pressure required by national drinking water regulations for open or closed drinking water installations.

The system shall have been designed in such a way that the maximal allowed pressure of any materials in the system is never exceeded.

Every closed circuit in the system shall contain a safety valve. This safety valve shall withstand the highest temperature that can be reached at its location. It shall conform to ISO 4126. If thermostatic valves are used, these shall conform to ISO 9393.

4.1.7 Electrical safety

If the system contains any electrical devices, these shall conform to IEC 60335-1 and IEC 60335- 2- 21.

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4.2 Materials

Any parts of the system to be mounted outdoors shall be resistant to UV radiation and other weather conditions over the prescribed maintenance interval. When any maintenance or replacement of system parts is required in order to maintain the system's working order over a period of 10 years, this shall be clearly stated in the documents for the user.

All materials used in the collector loop should conform to ISO/TR 10217 in order to avoid any internal corrosion.

4.3 Components and pipe work

4.3.1 Collector

For systems whose collector can be tested separately, the collector shall conform to DUS 854 -1, with the exception of:

- internal pressure tests for absorber (see 5.3.2 of DUS 854-1);
- freeze resistance test (see 5.3.10 of DUS 854-1);
- thermal performance measurement (see5.3.9 of DUS 854-1).

For systems whose collector cannot be tested separately (for instance integrated collector-store systems), the whole system shall conform to this standard, with the exception of:

- internal pressure tests for absorber (see 5.3.2 of DUS 854-1);
- exposure test (see 5.3.4 of DUS 854-1), on the condition that the installation manual for the system specifies that the empty system shall be protected against prolonged exposure to solar radiation;
- internal thermal shock test (see 5.3.6 of DUS 854-1);
- thermal performance measurement (see 5.3.9 of DUS 854-1);
- freeze resistance test (see 5.3.10 of DUS 854-1).

4.3.2 Supporting frame

Manufacturer shall state the maximum possible loads for their supporting frame, in accordance with ISO 10721 (steel) and ISO/TR 11069 (aluminium)

This shall be mentioned in the documents for the installer.

4.3.3 Piping

The materials of the collector loop shall conform to ISO/TR 10217.

The design and materials in the system shall be such that there is no possibility of deforming, clogging or lime deposit in its circuits that will drastically influence the system performance and safety.

Circulation pumps in the system shall conform to ISO 9906 and ISO 15783.

4.3.4 Heat Exchangers

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If the system is intended for use in areas with high water hardness and at temperatures above 60 ^{o}C, heat exchangers in contact with water mains/drinking water shall be designed such that scaling is prevented or there shall be a facility for cleaning.

NOTE High temperature difference between the metal surface of the heat exchanger and the surrounding drinking water mainly causes scaling. This can be avoided by increasing the heat exchanger area.

4.3.5 Control system

When present, the collector temperature sensor shall withstand stagnation conditions as specified in DUS 854-2 without drifting by more than 1 K.

When present, the store temperature sensor shall withstand 100 ^{o}C without altering by more than 1 K.

The location and installation of all temperature sensors shall ensure a good thermal contact with the part of which the temperature shall be measured. The temperature sensors shall be insulated against ambient.

4.4 Safety equipment

4.4.1 Safety valves

Each section of the collector array, which can be shut off, shall be fitted with at least one safety valve. ICS systems shall be fitted with at least one safety valve, which may be integrated with an inlet combination. The safety valve shall resist the temperature conditions which it is exposed to, especially the highest temperature that can occur. The safety valve shall resist the heat transfer medium. The safety valve shall be dimensioned such that it can release the highest flow of hot water or steam that can occur. The dimension of the safety valve(s) shall be proved by suitable means.

4.4.2 Safety lines and expansion lines

If the system is equipped with safety line, this safety line shall not be capable of being shut off.

If the system is equipped with a safety line and an expansion line, the safety line and expansion line shall be dimensioned such, that for highest flow of hot water or steam that can occur, at no place in the collector loop the maximum allowed pressure is exceeded due to the pressure drop in these lines. The dimension of the safety line and expansion line shall be proved by suitable means.

The expansion line and safety line shall be connected and laid in such a way that any accumulations of dirt, scale or similar impurities are avoided.

4.4.3 Blow-off lines

If the system is equipped with blow-off lines, these blow-off lines shall be laid in such away that they cannot freeze up and that no water can accumulate within these lines. The orifices of the blow-off lines shall be arranged in such a way that any steam or heat transfer medium issuing from the safety valves does not cause any risk for people, materials or environment.

4.5 Resistance to external influences

The components, which are exposed to the effect of weather, shall resist weathering and shall be designed, constructed and fastened in such a way that they can withstand the weather.

In respect of lightening protection, the system should conform to IEC 61024-1.

NOTE In Annex E & F of DUS 855-2, a test method based on IEC 61024 -1 is given for solar water heating systems.

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4.6 Documentation

4.6.1 General

With each Factory Made solar heating system, the manufacturer or official supplier shall deliver documents for assembly and installation (for the installer) and documents for operation (for the user). These documents shall be written in the official language(s) of the country of sale. These documents shall include all instructions necessary for assembly and operation, including maintenance, and draw attention to further requirements and technical rules that are concerned.

4.6.2 Documents for the installer

The assembly instructions shall be appropriate to the system and include information concerning:

a) Technical data, at least those with respect to:

1) layout of the system;

2) location and nominal diameters of all external connections;

3) an overview with all components to be delivered (such as solar collector, storage tank, support structure, hydraulic circuit, back-up provisions, control system and accessories), with information on each component: type, electrical power, dimensions, weight, marks and mounting;

4) maximum operating pressure of all fluid circuits in the system, such as the collector circuit, the domestic hot water line and the auxiliary heating circuit (in Pa);

5) working limits; admissible temperatures, pressures etc throughout the system;

6) type of corrosion protection;

7) type of heat transfer fluid;

b) Packing and transport of the whole system and /or components and way of storage (outdoors, indoors, packed, not packed);

c) Installation guidelines with recommendations concerning:

1) mounting surfaces;

2) distances to walls and safety with regard to frost;

3) the way the entrance of piping into the building shall be finished (resistance against rain and moisture);

4) the procedure to be followed for thermal insulation of pipes;

5) the roof integration of the collector (if appropriate);

6) for drain-back or drain-down systems, the minimal pipe slope and any other instructions necessary to ensure proper draining of the collector circuit;

d) If a support frame that is normally mounted outdoors is part of the system, the maximum value of V_m (mean wind velocity) according to ISO 6612 and the statement that the system may only be installed in locations with lower values of V_m;

e) Method for pipe work connections;

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f) Types and sizes of the safety and security devices and their draining. The assembly instruction shall demand that any pressure relief valves from which steam can escape during normal or stagnation conditions shall be mounted, in such a way that no injuries, harm or damage can be caused by the escape of steam. When the system has a provision to drain an amount of drinking water as a protection against overheating, the hot water drain shall be constructed in such a way that no damage is done to the system or any other materials in the building by the drained hot water;

g) The necessary control and safety devices including the wiring diagram, including the need for a thermostatic mixing valve which limits the draw-off temperature to 60 ^{o}C, when this is required according to 4.1.2.2;

h) Reviewing, filling and starting up of the systems;

i) Commissioning of the system;

j) A checklist for the installer to check proper functioning of the system;

k) The lowest temperature at which the system can withstand freezing;

l) The required solar irradiation on the plane of the collector or the minimum solar lamp irradiance at the plane of the collector for which overheating protection of the system has been tested according to 5.2 of DUS 855-2, and the requirement that the system shall not be used in climate zones with higher irradiation valves than these values.

4.6.3 Documents for the user

The operation instructions shall include information concerning:

a) Existing safety and security components and their thermostat adjustment where applicable;

b) Implementation of the system drawing particular attention to the facts that ;

   1) prior to putting the system in operation it shall be checked that all valves are properly working and the system is filled with water and/or antifreeze fluid completely or according to the manufacturer's instructions;

   2) in the event of any failure condition a specialist shall be called in;

c) Regular operation of safety valves;

d) Precautions with regard to the risk of frost damage and/or overheating;

e) The manner of avoiding failure when starting under frost or possible frost conditions;

f) Decommissioning of the system;

g) Maintenance of the system by a specialist, including frequency of inspections and maintenance and a list of parts that need to be replaced during normal maintenance;

h) Performance data for the system (see also 4.8):

   1) the recommended load range for the system (in l/day) at specified temperature;

   2) the thermal performance and solar fraction of the system according to 5.9 of DUS 855-2, for loads in the specified recommended load range;

   3) the annual electricity consumption for pumps, control systems and electrical valves of the system for the same conditions as specified for the thermal performance, assuming a yearly pump operating time of the collector pump of 2000 h;

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4) if the system contains devices for freeze protection that cause electrical consumption, the electrical power of these devices (in W) and their characteristics (e.g. switch-on temperatures);

5) for a “solar-plus-supplementary system”, the maximum daily hot water load which can be met by the system without any contribution from solar energy, according to 5.10 of DUS 855-2;

i) The require solar irradiation on the plane of the collector or the minimum solar lamp irradiance at the plane of the collector for which overheating protection of the system has been tested according to 5.2 of DUS 855-2 and the requirement that the system shall not be used in climate zones with higher irradiation values than these values;

j) When the overheating protection of the system is dependent on electricity and/or cold water supply and/or the system being filled with drinking water, the requirement to never switch off the electricity supply and/or the mains water supply, or that the system is not drained when there is high solar irradiation;

k) The fact that drinking water may be drained from the system during high irradiation situations, if this method is used to prevent overheating;

l) The lowest temperature at which the system can withstand freezing;

m) Type of heat transfer fluid;

n) In case of solar heating systems with emergency auxiliary heaters, instructions shall be issued that this emergency heater shall only be used for emergency heater purposes.

4.7 Labelling

Every system shall have the following information durably marked on the plate or label to be visible at installation:

a) Name of manufacturer or responsible supplier of the system;

b) System type indication;

c) Manufacturing number or serial number;

d) Year of manufacture – this may be included in the production or serial number in coded or clear form;

e) Absorber and aperture area of the collector in m^2;

f) Nominal capacity of the storage vessel in L;

g) Design pressure of the drinking water line in kPa;

h) Collector heat transfer medium to be used;

i) Permissible operating pressure of the collector heat transfer medium in kPa or, in case the system has an open or vented collector circuit, a statement to this effect;

j) When the overheating protection f the system is depended on electricity or cold water supply and/or the system being filled with drinking water, a warning to this effect shall be marked on the system. In case of dependency on the electricity supply, the mains plug of the system shall also be clearly marked to this effect;

k) Electrical power of all electric components.

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4.8 System performance

The thermal performance of the system shall be tested according to one of the two test methods specified in 5.8 of DUS 855-2. The performance shall be reported to the user in the format as specified in Annex A of DUS 855-2 (see also 4.6.3).

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Annex A
(informative)

Conformity assessment

In Table A.1, guidelines are given to assess whether one or more tests should be repeated in order to assure that the changed product is still in conformity with the requirements.

Table A.1 – Guidelines for repetition of tests in case that, components have been changed

Component test	Anti-freeze fluid	Control unit	Collector [a]	Store [a]	Heat exchanger	Supporting frame	Collector piping or installation
Freeze resistance	x	x[b]	x[c]	x[d]			x[c]
Over temperature		x[b]	x	x			x
Pressure resistance			x	x	x		x
Collector			x				
Lightning protection			x	x[d]			x[e]
Mechanical strength						x	
Thermal performance [f]	x[g]	x	x	x	x		x[h]
Ability to cover load	x[g]	x	x	x	x		x[h]

[a] For ICS systems, a change on the ICS system implies a change on both collector and the store

[b] If the control unit is involved in frost or overheating protection

[c] Mainly for drain-back systems.

[d] If the tank is placed outdoors.

[e] If the material is changed (especially non-metal to metal)

[f] When, in the judgement of the second/third party, changes have a minor character or will improve the performance of the system, retesting of the performance and the ability to cover the load is generally not necessary and the old results can be used.

[g] Usually not affected, except when the viscosity of the fluid changes

[h] Mainly for thermosiphon systems

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Bibliography

[1] EN 1717, *Protection against pollution of potable water in water installations and general requirements of devices to prevent pollution by backflow*

[2] IEC 61024-1, *Protection of structures against fire, explosion and life hazards*

[3] IEC 60335-1, *Household and similar electrical appliances – Safety – Part 1: General requirements*

[4} IEC 60335-2-21, *Household and similar electrical appliances – Safety – Part 2-21: Particular requirements for storage water heaters*

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