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IEA
SOLAR R&D

INTERNATIONAL ENERGY AGENCY

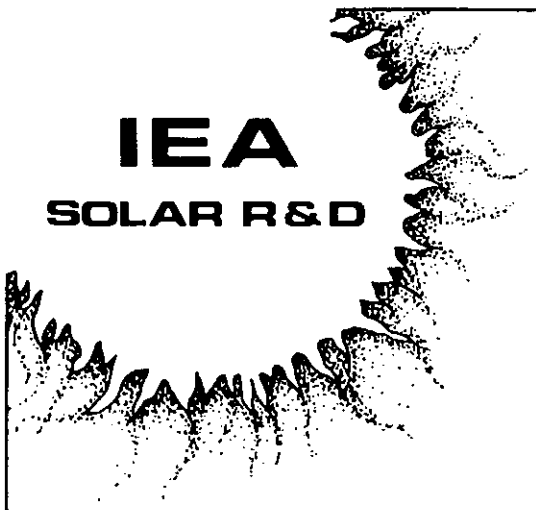
SOLAR HEATING AND
COOLING PROGRAMME

Task III

Performance Testing of Solar Collectors

# INSPECTION PROCEDURE FOR SOLAR DOMESTIC HOT WATER HEATING SYSTEMS

April 1990




INTERNATIONAL ENERGY AGENCY

SOLAR HEATING AND COOLING PROGRAMME

Task III

# INSPECTION PROCEDURE FOR SOLAR DOMESTIC HOT WATER HEATING SYSTEMS

# CHECK-LIST

Project / System :_____

Location :_____ Country :_____

Collector area :_____ m² / Storage volume :_____ l / Number of storage tanks :_____

System descriptors :

a) ❒ Solar only..... ❒ Solar pre-heat..... ❒ Solar plus supplementary

b) ❒ Direct..... ❒ Indirect

c) ❒ Open..... ❒ Vented ..... ❒ Closed

d) ❒ Filled..... ❒ Drain-back ..... ❒ Drain-down

e) ❒ Thermosyphon..... ❒ Forced

f) ❒ Circulating..... ❒ Series-connected

g) ❒ Remote storage.... ❒ Close-coupled collector storage.... ❒ Integral collector-storage

Completed by :_____ Date :_____

Address :_____

| IEA inspection procedure for SDHW heating systems | Project / System :_____ | 1 |
|---|---|---|

# CHECK-LIST

Group A : Assembly and installation

| Position | Check | O K ? | | Comments* / Action taken |
|---|---|---|---|---|
| A.1 | Position of collector(s) and storage tank, geometry of connecting pipework | Yes | No | |
| A.2 | Connection of collector(s) | Yes | No | |
| A.3 | Collector temperature sensor | Yes | No | |
| A.4 | Air ventilation valve(s) | Yes | No | |
| A.5 | Temperature / pressure-release valve(s) | Yes | No | |
| A.6 | Check valve(s) | Yes | No | |
| A.7 | Solenoid / gate valve(s) | Yes | No | |
| A.8 | Drain valve | Yes | No | |
| A.9 | Mixing / distribution valve(s) | Yes | No | |
| A.10 | Filter(s), screen(s) | Yes | No | |
| A.11 | Pump(s)<br>Direction of rotation | Yes<br>Yes | No<br>No | |
| A.12 | Expansion vessel | Yes | No | |
| A.13 | Thermal insulation of the piping | Yes | No | |

*Additional comments on the back of this sheet? Yes / No

| IEA inspection procedure for SDHW heating systems | Project / System :_____ | 2 |
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# CHECK-LIST

Group A : Assembly and installation

| Position | Check | OK ? | | Comments* / Action taken |
|---|---|---|---|---|
| A.14 | Pipe temperature sensor(s) | Yes | No | |
| A.15 | Storage tank : | | | |
| | - piping connections | Yes | No | |
| | - thermal insulation | Yes | No | |
| A.16 | Storage-tank temperature sensor(s) | Yes | No | |
| A.17 | External heat exchanger | Yes | No | |
| A.18 | Auxiliary electric heater | Yes | No | |
| A.19 | Thermostat for auxiliary electric heater | Yes | No | |
| A.20 | Clock for auxiliary electric heater | Yes | No | |
| A.21 | Controllers and control sensors | Yes | No | |

*Additional comments on the back of this sheet? Yes / No

| IEA inspection procedure for SDHW heating systems | Project / System :_____ | 3 |
|---|---|---|

# CHECK-LIST

Group B : Component integrity and operating conditions

| Position | Check | | Results | | Comments* / Action taken |
|---|---|---|---|---|---|
| | **Collector(s)** | | | | |
| B.1 | Absorber plate : | leaky? | No | Yes | |
| | | corroded? | No | Yes | |
| | | deformed? | No | Yes | |
| | | degraded coating? | No | Yes | |
| | | deposits on coating? | No | Yes | |
| | Glazing : | broken? | No | Yes | |
| | | dirty? | No | Yes | |
| | | dusty? | No | Yes | |
| | | condensation / deposits? | No | Yes | |
| | | sagging? | No | Yes | |
| | | opaque? | No | Yes | |
| | Seals : | tight? | Yes | No | |
| | | deteriorated? | No | Yes | |
| | Frame : | corroded? | No | Yes | |
| | | blistering paint? | No | Yes | |
| | | rain leakage? | No | Yes | |
| | Brackets, fasteners, etc.: | loose screws? | No | Yes | |
| | | corrosion? | No | Yes | |
| B.2 | Ventilation holes : | blocked? | No | Yes | |
| | **Collector array** | | | | |
| B.3 | Collector joints : | leaky? | No | Yes | |

*Additional comments on the back of this sheet? Yes / No

| IEA inspection procedure for SDHW heating systems | Project / System :_____ _____ | 4 |
|---|---|---|

# CHECK-LIST

Group B : Component integrity and operating conditions

| Position | Check | Results | | Comments* / Action taken |
|---|---|---|---|---|
| | **Collector array (cont'd)** | | | |
| B.4 | Connecting tubes : leaky? | No | Yes | |
| | wet insulation? | No | Yes | |
| | damaged insulation? | No | Yes | |
| B.5 | Air ventilation valve(s) : leaky? | No | Yes | |
| | function OK? | Yes | No | |
| B.6 | Pressure-release valve(s) : leaky? | No | Yes | |
| | function OK? | Yes | No | |
| B.7 | Flow balance between subarrays: OK? | Yes | No | |
| | Outlet temperature: | | | |
| | sub-array 1:_____°C | | | |
| | sub-array 2:_____°C | | | |
| | sub-array 3:_____°C | | | |
| | ..... | | | |
| | **Heat transport system** | | | |
| B.8 | Joints : leaky? | No | Yes | |
| B.9 | Pipework : leaky? | No | Yes | |
| | wet insulation? | No | Yes | |
| | damaged insulation? | No | Yes | |
| B.10 | Solenoid / gate valve(s) : leaky? | No | Yes | |
| | function OK? | Yes | No | |
| B.11 | Drain valve(s) : leaky? | No | Yes | |

*Additional comments on the back of this sheet? Yes / No

| IEA inspection procedure for SDHW heating systems | Project / System :_____ _____ | 5 |
|---|---|---|

# CHECK-LIST

Group B : Component integrity and operating conditions

| Position | Check | Results | | Comments* / Action taken |
|---|---|---|---|---|
| | **Heat transport system (cont'd)** | | | |
| B.12 | Pump(s) : leaky? | No | Yes | |
| B.13 | Mixing / distribution valve(s) : leaky? | No | Yes | |
| B.14 | Liquid pressure gauge : leaky? | No | Yes | |
| | function OK? | Yes | No | |
| B.15 | System pressure<br>measured value :_____ OK?<br>nominal value :_____ | Yes | No | |
| B.16 | Expansion vessel : leaky? | No | Yes | |
| | damaged membrane? | No | Yes | |
| B.17 | Air/water expansion tank: levels OK? | Yes | No | |
| B.18 | Flow rate<br>measured value :_____l/min OK?<br>nominal value :_____l/min | Yes | No | |
| B.19 | **Storage tank** : any leakage? | No | Yes | |
| | wet insulation? | No | Yes | |
| | **Electric heater** | | | |
| B.20 | Thermostat set point :_____°C OK? | Yes | No | |
| B.21 | Heating element : OK? | Yes | No | |
| B.22 | Clock set points : OK? | Yes | No | |

*Additional comments on the back of this sheet? Yes / No

| IEA inspection procedure for SDHW heating systems | Project / System :_____ _____ | 6 |
|---|---|---|

# CHECK-LIST

Group C : Controllers and control sensors

## *WARNING*

*It is important to ensure that the control-system checks do not override the protection against freezing or overheating.*

- *Freezing may occur in the collectors if the pump is operated when the ambient air temperature is below about +4 °C (or even a higher value, e.g. +7 °C, in a dry climate).*
- *If the system is not able to withstand stagnation conditions at high irradiance levels, then the collector must be covered by an opaque material whenever the flow of heat transfer fluid through the collectors is interrupted.*
- *Even if the system is designed to withstand stagnation at high irradiance levels, dangerous overpressures and thermal stresses may occur when the pump is re-started under these conditions.*

| Position | Check / Measured values | O K ? | | Comments* / Action taken |
|---|---|---|---|---|
| | **Preliminary steps**<br>♦ set main power OFF<br>♦ label sensor cables<br>♦ replace temperature sensors by appropriate simulators | | | |
| C.1 | **Control unit:** Signal lamps test | Yes | No | |
| | **Control strategy**<br>***Mid-temperature range $T_L$ = 50 °C*** | | | |
| C.2 | Differential ON temperature<br>$\Delta T_{ON}$ = _____ °C<br>nominal value : _____ °C | Yes | No | |
| C.3 | Differential OFF temperature<br>$\Delta T_{OFF}$ = _____ °C<br>nominal value : _____ °C | Yes | No | |

*Additional comments on the back of this sheet? Yes / No

| IEA inspection procedure for SDHW heating systems | Project / System :_____ | 7 |
|---|---|---|

# CHECK-LIST

Group C : Controllers and control sensors

| Position | Check / Measured values | O K ? | | Comments* / Action taken |
|---|---|---|---|---|
| | **Control strategy (cont'd)** | | | |
| | ***Low-temperature range $T_L$ = 10 °C*** | | | |
| C.4 | Differential ON temperature<br>$\Delta T_{ON}$ = _____ °C<br>nominal value : _____ °C | Yes | No | |
| C.5 | Differential OFF temperature<br>$\Delta T_{OFF}$ = _____ °C<br>nominal value : _____ °C | Yes | No | |
| | ***High-temperature range $T_L$ = 90 °C*** | | | |
| C.6 | Differential ON temperature<br>$\Delta T_{ON}$ = _____ °C<br>nominal value : _____ °C | Yes | No | |
| C.7 | Differential OFF temperature<br>$\Delta T_{OFF}$ = _____ °C<br>nominal value : _____ °C | Yes | No | |
| | **Protection functions of the control unit** | | | |
| C.8 | Freeze-protection temperature<br>(temperature decreasing transition)<br>$T_{FP}$ = _____ °C<br>nominal value : _____ °C | Yes | No | |

*Additional comments on the back of this sheet? Yes / No

| IEA inspection procedure for SDHW heating systems | Project / System :_____ _____ | 8 |
|---|---|---|

# CHECK-LIST

Group C : Controllers and control sensors

| Position | Check / Measured values | O K ? | | Comments* / Action taken |
|---|---|---|---|---|
| | **Protection functions of the control unit (cont'd)** | | | |
| C.9 | Overheat-protection temperature (temperature increasing transition)<br>$T_{OP}$ = _____ °C<br>nominal value : _____ °C | Yes | No | |
| | **Sensors** | | | |
| C.10 | Collector temperature sensor :<br>- sensor output :_____ °C<br>- downstream fluid temperature :_____ °C | Yes | No | |
| C.11 | Storage temperature sensor :<br>- sensor output :_____ °C<br>- storage temperature:____ °C | Yes | No | |
| C.12 | Freeze-protection sensor :<br>- sensor output :_____ °C<br>- downstream fluid temperature :_____ °C | Yes | No | |
| C.13 | Overheat-protection sensor :<br>- sensor output :_____ °C<br>- measured reference temperature :_____ °C | Yes | No | |

*Additional comments on the back of this sheet? Yes / No

| IEA inspection procedure for SDHW heating systems | Project / System :_____ _____ | 9 |
|---|---|---|

# CHECK-LIST

Group D : Freeze protection

**Any freeze protection provided?** Yes No

If yes : ---> D.1 / If no : ---> E.1

| Position | Check / Measured values | O K ? | | Comments* / Action taken |
|---|---|---|---|---|
| | ***NOTE***<br>*Also perform checks C.8 and C.12 if freeze-protection and control functions are combined.* | | | |
| | **Antifreeze fluid** | | | |
| D.1 | Glycol concentration :_____%<br>nominal value :_____% | Yes | No | |
| | **Drain-back** | | | |
| D.2 | Pipe slope of horizontal tubes :_____mm / m<br>nominal value :_____mm / m | Yes | No | |
| D.3 | Filling (observed from pressure gauge) | Yes | No | |
| D.4 | Drain-back (observed from pressure gauge) | Yes | No | |
| D.5 | Liquid level in drain-back tank | Yes | No | |

*Additional comments on the back of this sheet? Yes / No

| IEA inspection procedure for SDHW heating systems | Project / System :_____ _____ | 10 |
|---|---|---|

# CHECK-LIST

Group D : Freeze protection

| Position | Check / Measured values | O K ? | | Comments* / Action taken |
|---|---|---|---|---|
| | **Drain-down** | | | |
| D.6 | Vacuum relief valve : opens? | Yes | No | |
| | and closes? | Yes | No | |
| D.7 | Solenoid drain valve | | | |
| | opens at_____°C | Yes | No | |
| | nominal value :_____°C | | | |
| D.8 | Non-electrically operated freeze-protection valve | | | |
| | opens at_____°C | Yes | No | |
| | nominal value :_____°C | | | |
| | Sensing part properly placed? | Yes | No | |
| D.9 | Pipe slope of horizontal | | | |
| | tubes :_____mm / m | Yes | No | |
| | nominal value :_____mm / m | | | |
| D.10 | Drain-down valve opened manually : | | | |
| | drain rate :_____l / min | Yes | No | |
| | nominal value :_____l / min | | | |
| D.11 | Fail-safe condition | Yes | No | |
| | **Any other freeze protection?** | Yes | No | |
| | *If yes, indicate its working principle and check it according to the manufacturer's recommendations* | | | |

*Additional comments on the back of this sheet? Yes / No

| IEA inspection procedure for SDHW heating systems | Project / System :_____ | 11 |
|---|---|---|

# CHECK-LIST

Group E : Overheat protection (solar and auxiliary)

**Any overheat protection provided?** Yes No

If yes : ---> E.1 / If no :---> End

| Position | Check / Measured values | O K ? | | Comments* / Action taken |
|---|---|---|---|---|
| | ***NOTE***<br>*Also perform checks C.9 and C.13 if overheat-protection and control functions are combined.* | | | |
| | **Antifreeze fluid** | | | |
| E.1 | Boiling point :_____°C<br>at the pressure of_____ | Yes | No | |
| | **Draw-off** | | | |
| E.2 | Function of solenoid valve | Yes | No | |
| | **Reverse heat flow** | | | |
| | Check C.9 (switching on the overheat protection) | Yes | No | |
| E.3 | Switching off the overheat protection : | Yes | No | |
| | switching temperature :____°C | Yes | No | |
| | nominal value :_____°C | | | |
| | **Drain-back** | | | |
| E.4 | System drainage (function test) | Yes | No | |

*Additional comments on the back of this sheet? Yes / No

| IEA inspection procedure for SDHW heating systems | Project / System :_____ | 12 |
|---|---|---|

# CHECK-LIST

Group E : Overheat protection (solar and auxiliary)

| Position | Check / Measured values | O K ? | | Comments* / Action taken |
|---|---|---|---|---|
| | **Drain-down** | | | |
| E.5 | System drainage (function test) | Yes | No | |
| | **Auxiliary electric heater** | | | |
| E.6 | Function of thermostat at_____°C | Yes | No | |
| | **Any other overheat protection?** | Yes | No | |
| | *If yes, indicate its working principle and check it according to the manufacturer's recommendations* | | | |

*Additional comments on the back of this sheet? Yes / No