



**REQUIRED DATA FOR  
TANKS CONTAINING  
INTERGRAL HEAT  
EXCHANGERS USED IN  
SRCC CERTIFIED  
SOLAR WATER HEATING  
SYSTEMS**

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### **Required data for tanks containing integral heat exchanger(s)**

(Valid for wrap-around, mantle, tank-in-tank, immersed heat exchangers)

The goal of these tests is to provide data for TRNSYS modeling of solar water heating systems. It is desired that the data be obtained by an independent, third-party entity. Additional details are available in SRCC's TM-1, "SDHW System and Component Test Protocols", available on the SRCC web site: <http://solar-rating.org/certification/ogdocuments/TM1.pdf>

A load-side heat exchange is defined to be one in which the load fluid (usually city water) is passed through the heat exchanger when hot water is being used. A supply-side heat exchanger is defined to be one in which the fluid from the solar collector (or a secondary) loop is passed when solar energy is being collected.

Note that OG-300 certification can be granted for systems using only the fluid(s) used in these tests and only over the range of flow rates and temperatures for which test data is submitted. In situations where the orientation of the tank and/or heat exchanger affects the performance, OG-300 certification can be granted for only those orientations.

### **Physical Description**

- a. Diameters and/or lengths and/or widths (internal and external).
- b. Lengths (internal and external) and spacing of tubes, baffles, and/or fins.
- c. Heights (internal and external), denote any minimum and maximum water levels.  
Including:
  - i. Height of bottom of heat exchanger above bottom of tank (millimeters)
  - ii. Height of heat exchanger (millimeters)
  - iii. Height above bottom of tank of port going out to the collector/heat exchanger (millimeters)
  - iv. Height above bottom of tank of port returning fluid from collector/heat exchanger (millimeters)
  - v. Height above bottom of tank of bottom of backup element/burner (millimeters)
  - vi. Height above bottom of tank of backup element/burner (millimeters)
  - vii. Height of backup thermostat above bottom of the tank (millimeters)
- d. Thicknesses (insulation, tank shell, tank vessel, fins, etc).
- e. Volumes (at  $T_{env}$ ) of the tank and any integral heat exchanger(s).
- f. Provide a diagram indicating geometry including vessel, shell, and any protrusions such as heat exchangers and plumbing connections.
- g. Indicate materials used for vessel, insulation, shell, tank liner, heat exchanger(s).  
Including:
  - i. Tank outer shell material (polymer, steel, stainless steel, aluminum)

- ii. Fluid container wall material (steel, stainless steel, polymer)
- iii. Fluid container wall liner (none, ceramic glass, stone)
- iv. Heat exchanger material (steel, aluminum, stainless steel, polymer, none)
- h. Indicate all piping lengths and orientations.
- i. Indicate slope of components.
- j. Photographs of the test article
- k. Manufacturer's specifications
  - i. Maximum Pressure rating (kPa)
  - ii. Maximum Temperature rating (C)
  - iii. UL listed? (yes or no)
  - iv. ASME boiler code listing (yes or no)

### **Pressure Tests**

Pressure tests shall be conducted as outlined in TM-1:

#### **Storage Tank Pressure Integrity Tests**

This test is only required if the tank has not undergone similar testing by an approved certification agency.

The test pressure shall be one and one half times the manufacturer's recommended operating pressure, up to a maximum of 1100 kPa Gauge (160 PSIG).

#### **Heat Exchanger Pressure Integrity Tests**

The test pressure shall be:

- for portions of the heat exchanger exposed to street (city/municipal) pressure: 1100 kPa gauge (160 PSIG).
- for heat exchangers not exposed to street pressure: the smaller of one and one half times the manufacturer's rated pressure or 1100 kPa gauge (160 PSIG).

#### **Pressure Integrity Test Procedure**

- a. A pressure gauge is attached to the exit port of the heat exchanger or tank and the outlet is sealed.
- b. The supply side is filled with unheated water.
- c. Hydraulic pressure is applied to the inlet port until the gauge indicates the test pressure has been reached.
- d. The inlet pressure port is then closed and the pressure is monitored for 15 minutes.
- e. The final pressure is recorded.

### **Pressure Drop Test**

The flow rates used for measuring the pressure drop across the heat exchanger should adequately represent the anticipated laminar, transition, and turbulent flow regimes experienced during

operation. The heat transfer fluids used in the heat exchanger should represent what is expected during use.

Measure the pressure drop across the exchanger at a minimum of three different flow rates for each specified flow/fluid combination. If specific conditions are not specified, conduct these tests at 1, 4, 8, and 16 liters per minute.

## **Tank Heat Loss Tests**

### **1. Installed Capacitance and Draw Stratification Test (Q Initial)**

This test is to be performed indoors, preferably in an environment with nearly constant temperature. The tank is to be installed in a manner consistent with the intended system design.

- a. Charge tank:
  - i. Charge may occur at any rate up to manufacturer's recommended maximum flow rate.
  - ii. Heat and fully mix tank to 55°C (131°F).
  - iii. Charge the tank by filling it with conditioned fluid until  $|T_{in} - T_{out}| = 0.2^{\circ}C(0.4^{\circ}F)$  or

$$\frac{\partial |T_{in} - T_{out}|}{\partial t} = 0.05^{\circ}C(0.09^{\circ}F) \text{ for a 10-minute period. Tank shall be maintained at this temperature for}$$

a minimum of the tank dwell (fill) time.

- b. Measure ambient temperature during the entire test period.
- c. Purge the energy in the tank by circulating water through the tank with the inlet temperature equal to the ambient temperature at a flow rate of 0.125-  $|T_{in} - T_{out}| = 0.2^{\circ}C(0.4^{\circ}F)$  0.189 l/s (2-3 GPM) until or

$$\frac{\partial |T_{in} - T_{out}|}{\partial t} = 0.05^{\circ}C(0.09^{\circ}F) \text{ for a 10-minute period. Conduct real time measurement of } M_{\text{drawn}}, T_{in}, T_{out} \text{ and}$$

$T_{\text{amb}}$ .

Calculate the energy removed from the tank:

$$Q_{\text{initial}} = \int \text{Rho}(t) * C_p(t) * V_{\text{rate}} * [T_{\text{out}}(t) - T_{\text{in}}(t)] dt$$

### **2. Heat Loss Test [Standard Decay Method]**

This test is to be performed indoors, preferably in an environment with nearly constant temperature. Any source of heating including resistance heaters and or solar radiation are to be shut off or blocked. All pumps, etc. should be shut off for the duration of the test.

- a. Charge the tank as in the capacitance test above to  $T_{\text{tank avg start}}$ .
- b. Piping connections are to remain, but isolated via valves during the waiting period.
- c. Wait until:

$$\frac{T_{\text{tank avg start}} - T_{\text{amb ave}}}{3} \leq (T_{\text{tank ave final}} - T_{\text{amb ave}}) \leq \frac{2 * (T_{\text{tank ave start}} - T_{\text{amb ave}})}{3}$$

This is estimated before the test is run using the known tank volume and estimated environmental temperatures. Measure the environment temperature during the entire test period. At the end of the wait period:

- d. Open the supply and return valves
- e. Purge the remaining energy in the tank as in the capacitance test.
- f. Calculate the energy removed from the tank:

$$Q_{\text{del}} = \int \text{Rho}(t) * C_p(t) * V_{\text{rate}} * [T_{\text{out}}(t) - T_{\text{in}}(t)] dt$$

### 3. Tank Heat Loss Analysis

- a.  $Q_{\text{loss}} = Q_{\text{initial}} - Q_{\text{del}}$  (the delivered energy after the purge)

$$b. \quad M_{\text{tank}} * C_p (@T_{\text{max}}) = \frac{Q_{\text{initial}}}{T_{\text{tank ave start}} - T_{\text{tank ave final}}}$$

$$c. \quad T_{\text{tank ave final}} = T_{\text{tank ave start}} + \frac{Q_{\text{del}}}{M_{\text{tank}} * C_p}$$

$$d. \quad UA = \frac{M_{\text{tank}} * C_p}{\text{Time}_{\text{decay}}} * \ln \left[ \frac{(T_{\text{tank ave start}} - T_{\text{amb ave}})}{(T_{\text{tank ave final}} - T_{\text{amb ave}})} \right]$$

### Heat Exchanger Performance Test

These tests are to be performed with the heat transfer fluid(s) to be used in the actual installation. If multiple fluids are to be used, multiple tests are required.

#### Instrumentation

All measurements are to be made with laboratory quality instruments. Data is to be reported to a resolution consistent with the instrument's uncertainty.

1. Temperature:

- a. Environment around the tank
  - b. Heat exchanger inlet
  - c. Heat exchanger outlet
  - d. Tank temperature
    - i. Inlet to the tank from the conditioning loop
    - ii. Outlet from the tank to the conditioning loop
    - iii. If a temperature tree is placed in the tank
      - 1. Enough sensors to obtain the average temperature of the water in the tank
      - 2. At least one sensor in the vicinity of the heat exchanger
2. Flow rate:
- a. Heat exchanger loop
  - b. Tank conditioning loop

### Test conditions

Conduct tests with all fluids at all flow rates and temperatures expected to be encountered in actual installations. The conditions listed in the data table below are the minimum values needed. Additional values may improve the modeling of this heat exchanger and/or allow its use under more operational conditions.

1. Flow rate:
  - 1.1 Supply Side heat exchanger: If this heat exchanger is to be used at different flow rates, conduct the tests at all flow rates to be specified in the application(s) for certification. If the collector loop flow is controlled to be variable, conduct tests at a minimum of three flow rates to obtain turbulent, transition, and laminar flow:
    - i) maximum design flow rate
    - ii) 50% of maximum design flow rate
    - iii) 10% of maximum design flow rate
  - 1.2 Load Side heat exchanger: If this heat exchanger is to be used at different flow rates, conduct the tests at all flow rates to be specified in the applications for certification. Conduct tests at a minimum of these three flow rates:
    - i) 0.5 gpm
    - ii) 1.5 gpm
    - iii) 3.0 gpm
2. Temperature:
  - 2.1 Tank: Condition the tank to the temperatures specified in the data table below.
  - 2.2 Heat exchanger: Set the temperature of the fluid entering the heat exchanger to the differential above (or absolute below) the tank temperature specified in the data table below.
3. Fluid: Conduct tests with all fluids to be used in certified systems.

Test Method (performed by the manufacturer or a test laboratory)

1. Charge the tank to the specified temperature ( $T_{\text{tank}}$ ) and then stop flow through the tank. If a temperature tree is not used, the whole tank must start at the specified temperature.
2. Stabilize heat exchanger flow rate ( $\text{FLOW}_{\text{HX}}$ ) to within  $\pm 0.006$  l/s (0.1 GPM) of the desired rate. Stabilize heat exchanger fluid inlet temperature ( $T_{\text{HX inlet}} - T_{\text{tank}}$ ) within  $\pm 0.1^\circ\text{C}$  ( $0.2^\circ\text{F}$ ).
3. Commence data collection at 15-second intervals. The rate of data collection and/or stabilization time must be increased for any flows at or below 0.0315 l/s (0.5 GPM). The data must include at least the parameters listed below.
4. Run each combination of temperature and flow rate for approximately 60 minutes, so that there is a significant change in tank temperature. Ideally, the time period shall be set so that the amount of input energy is the same for each test and enough energy (2000 kJ minimum) is input to avoid experimental error.
5. Purge the tank or measure internal tank temperatures to determine how much energy was added to or removed from the tank.
6. Repeat steps 1-5 with the desired flow rates, tank temperatures, and heat exchanger loop fluids. Note that certification can be granted for systems using only the fluid(s) used in these tests and only over the range of flow rates and temperatures for which test data is submitted.

Analysis Method (performed by SRCC):

1. The data from each of the data point sets in the test will be used to calibrate a TRNSYS rating model using the UA value and exponent in the tank coil heat exchanger model. A fitting routine will be used to fit the observed energy input to the observed data points (one per data point)
2. The UA parameter(s) will be used for modeling the heat exchanger in TRNSYS.

Test Report

The following information must be submitted with an application for OG-300 system certification.

1. Results of all measurements made to document the physical description of the test article (see list on page 1).
2. Documentation of the pressure tests
3. A table of pressure drop versus flow rate for each fluid.
4. The heat loss coefficient (UA) of the tank
5. A table of heat exchanger test data -
  - a. Supply Side Heat Exchanger:

Immersed Supply Side Heat Exchanger Test Results

Heat exchanger flow rate (kg/sec):			Heat exchanger fluid:	
$T_{\text{tank}} \text{ (C)} \rightarrow$	5	20	40	60

$T_{HX \text{ inlet}} - T_{\text{tank}} \text{ (K)}$				
5	---			
10				
20		----		
40			---	---

In each cell of the table provide the following:

- Environment temperature near tank ( $T_{\text{env}}$ )
- Supply Side Heat exchanger inlet ( $T_{HX \text{ inlet}}$ )
- Supply Side Heat exchanger outlet ( $T_{HX \text{ outlet}}$ )
- Supply Side Heat exchanger flow rate ( $FLOW_{HX}$ )
- Tank temperature near the heat exchanger ( $T_{\text{tank, near HX}}$ )
- Energy added to the tank ( $Q_{\text{added}}$ ),  $Q_{\text{added}} = \dot{m} * C_p (T_{(\text{Supply}) HX \text{ inlet}} - T_{\text{tank}})$

Example data tables for the Supply Side Heat Exchanger test are given on the following pages.

b. Load Side Heat Exchanger:

Immersed Load Side Heat Exchanger Test Results

Heat exchanger flow rate (kg/sec):			Heat exchanger fluid:	
$T_{\text{tank}} \text{ (C)} \rightarrow$ $T_{HX \text{ inlet}} \text{ (K)}$	5	20	40	60
5	---			
15				
30				

In each cell of the table provide the following:

- Environment temperature near tank ( $T_{\text{env}}$ )
- Load Side Heat exchanger inlet ( $T_{HX \text{ inlet}}$ )
- Load Side Heat exchanger outlet ( $T_{HX \text{ outlet}}$ )
- Load Side Heat exchanger flow rate ( $FLOW_{HX}$ ) (0.5, 1.5, 3.0 gal/min.)
- Tank temperature near the heat exchanger ( $T_{\text{tank, near HX}}$ )
- Energy added to the tank ( $Q_{\text{added}}$ ),  $Q_{\text{added}} = \dot{m} * C_p (T_{\text{tank}} - T_{(\text{Load}) HX \text{ inlet}})$

Example data tables for the Load Side Heat Exchanger test are given on the following pages.

Sample data submittal sheet:

Supply Side Heat-exchanger :

OG 300 ref#:

Company:

System:



Heat exchanger fluid

Concentration Vol. %



A		Heat Exchanger Flow Rate: ṁ [kg/s] _____										Date test recorded Start time _____					Date _____						
		1		2			3			4		notes											
T <sub>tank</sub> [C°]		5°		20°			40°			60°													
T <sub>HX inlet</sub> - T <sub>tank</sub> [K°]		T <sub>HX inlet</sub> [C°]	T <sub>HX outlet</sub> [C°]	T <sub>env.</sub> [C°]	T <sub>tank near HX.</sub> [C°]	Q <sub>added</sub> [KJ]	T <sub>HX inlet</sub> [C°]	T <sub>HX outlet</sub> [C°]	T <sub>env.</sub> [C°]	T <sub>tank near HX.</sub> [C°]	Q <sub>added</sub> [KJ]	T <sub>HX inlet</sub> [C°]	T <sub>HX outlet</sub> [C°]	T <sub>env.</sub> [C°]	T <sub>tank near HX.</sub> [C°]	Q <sub>added</sub> [KJ]	T <sub>HX inlet</sub> [C°]	T <sub>HX outlet</sub> [C°]	T <sub>env.</sub> [C°]	T <sub>tank near HX.</sub> [C°]	Q <sub>added</sub> [KJ]		
1	5°																						
2	10°																						
3	20°																						
4	40°																						
B		Heat Exchanger Flow Rate: ṁ [kg/s] _____										Date test recorded Start time _____					Date _____						
		1		2			3			4		notes											
T <sub>tank</sub> [C°]		5°		20°			40°			60°													
T <sub>HX inlet</sub> - T <sub>tank</sub> [K°]		T <sub>HX inlet</sub> [C°]	T <sub>HX outlet</sub> [C°]	T <sub>env.</sub> [C°]	T <sub>tank near HX.</sub> [C°]	Q <sub>added</sub> [KJ]	T <sub>HX inlet</sub> [C°]	T <sub>HX outlet</sub> [C°]	T <sub>env.</sub> [C°]	T <sub>tank near HX.</sub> [C°]	Q <sub>added</sub> [KJ]	T <sub>HX inlet</sub> [C°]	T <sub>HX outlet</sub> [C°]	T <sub>env.</sub> [C°]	T <sub>tank near HX.</sub> [C°]	Q <sub>added</sub> [KJ]	T <sub>HX inlet</sub> [C°]	T <sub>HX outlet</sub> [C°]	T <sub>env.</sub> [C°]	T <sub>tank near HX.</sub> [C°]	Q <sub>added</sub> [KJ]		
1	5°																						
2	10°																						
3	20°																						
4	40°																						
C		Heat Exchanger Flow Rate: ṁ [kg/s] _____										Date test recorded Start time _____					Date _____						
		1		2			3			4		notes											
T <sub>tank</sub> [C°]		5°		20°			40°			60°													
T <sub>HX inlet</sub> - T <sub>tank</sub> [K°]		T <sub>HX inlet</sub> [C°]	T <sub>HX outlet</sub> [C°]	T <sub>env.</sub> [C°]	T <sub>tank near HX.</sub> [C°]	Q <sub>added</sub> [KJ]	T <sub>HX inlet</sub> [C°]	T <sub>HX outlet</sub> [C°]	T <sub>env.</sub> [C°]	T <sub>tank near HX.</sub> [C°]	Q <sub>added</sub> [KJ]	T <sub>HX inlet</sub> [C°]	T <sub>HX outlet</sub> [C°]	T <sub>env.</sub> [C°]	T <sub>tank near HX.</sub> [C°]	Q <sub>added</sub> [KJ]	T <sub>HX inlet</sub> [C°]	T <sub>HX outlet</sub> [C°]	T <sub>env.</sub> [C°]	T <sub>tank near HX.</sub> [C°]	Q <sub>added</sub> [KJ]		
1	5°																						
2	10°																						
3	20°																						
4	40°																						
		End time										Submitted by											

Sample data submittal sheet:

Load side Heat-exchanger :

OG 300 ref#:

Company:

System:



Heat exchanger fluid

Concentration Vol. %



A Flow HX load 0.5 gpm [1.8925 l/min.]		Heat Exchanger Flow Rate: $\dot{m}$ [kg/s] _____										Date test recorded Start time _____					Date _____					
		1			2			3			4			notes								
T <sub>tank</sub> [C°]		5°			20°			40°			60°											
T <sub>HX load inlet</sub> [K°]		T <sub>HX load inlet</sub> [C°]	T <sub>HX load outlet</sub> [C°]	T <sub>env.</sub> [C°]	T <sub>tank near HX.</sub> [C°]	Q <sub>added</sub>	T <sub>HX load inlet</sub> [C°]	T <sub>HX load outlet</sub> [C°]	T <sub>env.</sub> [C°]	T <sub>tank near HX.</sub> [C°]	Q <sub>added</sub>	T <sub>HX load inlet</sub> [C°]	T <sub>HX load outlet</sub> [C°]	T <sub>env.</sub> [C°]	T <sub>tank near HX.</sub> [C°]	Q <sub>added</sub>	T <sub>HX load inlet</sub> [C°]	T <sub>HX load outlet</sub> [C°]	T <sub>env.</sub> [C°]	T <sub>tank near HX.</sub> [C°]	Q <sub>added</sub>	
1	5°	na	na	na	na	na																
2	15°																					
3	30°																					
B Flow HX load 1.5 gpm [3.785 l/min.]		Heat Exchanger Flow Rate: $\dot{m}$ [kg/s] _____										Date test recorded Start time _____					Date _____					
		1			2			3			4			notes								
T <sub>tank</sub> [C°]		5°			20°			40°			60°											
T <sub>HX load inlet</sub> [K°]		T <sub>HX load inlet</sub> [C°]	T <sub>HX load outlet</sub> [C°]	T <sub>env.</sub> [C°]	T <sub>tank near HX.</sub> [C°]	Q <sub>added</sub>	T <sub>HX load inlet</sub> [C°]	T <sub>HX load outlet</sub> [C°]	T <sub>env.</sub> [C°]	T <sub>tank near HX.</sub> [C°]	Q <sub>added</sub>	T <sub>HX load inlet</sub> [C°]	T <sub>HX load outlet</sub> [C°]	T <sub>env.</sub> [C°]	T <sub>tank near HX.</sub> [C°]	Q <sub>added</sub>	T <sub>HX load inlet</sub> [C°]	T <sub>HX load outlet</sub> [C°]	T <sub>env.</sub> [C°]	T <sub>tank near HX.</sub> [C°]	Q <sub>added</sub>	
1	5°	na	na	na	na	na																
2	15°																					
3	30°																					
C Flow HX load 3.0 gpm [11.3550 l/min.]		Heat Exchanger Flow Rate: $\dot{m}$ [kg/s] _____										Date test recorded Start time _____					Date _____					
		1			2			3			4			notes								
T <sub>tank</sub> [C°]		5°			20°			40°			60°											
T <sub>HX load inlet</sub> [K°]		T <sub>HX load inlet</sub> [C°]	T <sub>HX load outlet</sub> [C°]	T <sub>env.</sub> [C°]	T <sub>tank near HX.</sub> [C°]	Q <sub>added</sub>	T <sub>HX load inlet</sub> [C°]	T <sub>HX load outlet</sub> [C°]	T <sub>env.</sub> [C°]	T <sub>tank near HX.</sub> [C°]	Q <sub>added</sub>	T <sub>HX load inlet</sub> [C°]	T <sub>HX load outlet</sub> [C°]	T <sub>env.</sub> [C°]	T <sub>tank near HX.</sub> [C°]	Q <sub>added</sub>	T <sub>HX load inlet</sub> [C°]	T <sub>HX load outlet</sub> [C°]	T <sub>env.</sub> [C°]	T <sub>tank near HX.</sub> [C°]	Q <sub>added</sub>	
1	5°	na	na	na	na	na																
2	15°																					
3	30°																					
		End time					Submitted by															

Sample data submittal sheet: Pressure drop heat exchanger

Supply Side Heat-exchanger:

FLUID type for intended \*)

OG 300 ref#:

Company:

System:

1			
2	HX port OD [mm]	HX port ID [mm]	HX pipe length [m]
3			
4			

A	Min 3 flow rates										Date test recorded					Date _____					
	FLUID types 1 _____ 2 _____ 3 _____ 4 _____										Start time _____ End time _____					notes					
T <sub>tank</sub> [C°]	37.78° C (100° F) +/- 5° K (9° R)					_____ ° C (_____ ° F) +/- 5° K (9° R)					_____ ° C (_____ ° F) +/- 5° K (9° R)					notes					
Heat Exchanger Flow Rate: ṁ [kg/s]	T <sub>HX</sub> inlet [C°]	T <sub>HX</sub> outlet [C°]	p <sub>HX</sub> inlet [mbar]	p <sub>HX</sub> outlet [mbar]	dp pressure drop [mbar]	T <sub>HX</sub> inlet [C°]	T <sub>HX</sub> outlet [C°]	p <sub>HX</sub> inlet [mbar]	p <sub>HX</sub> outlet [mbar]	dp pressure drop [mbar]	T <sub>HX</sub> inlet [C°]	T <sub>HX</sub> outlet [C°]	p <sub>HX</sub> inlet [mbar]	p <sub>HX</sub> outlet [mbar]	dp pressure drop [mbar]	T <sub>HX</sub> inlet [C°]	T <sub>HX</sub> outlet [C°]	p <sub>HX</sub> inlet [mbar]	p <sub>HX</sub> outlet [mbar]	dp pressure drop [mbar]	notes
1	<i>laminar</i>																				
2	<i>transition</i>																				
3	<i>turbulent</i>																				
4																					
B	Min 3 flow rates										Date test recorded					Date _____					
	FLUID types 1 _____ 2 _____ 3 _____ 4 _____										Start time _____ End time _____					notes					
T <sub>tank</sub> [C°]	37.78° C (100° F) +/- 5° K (9° R)					_____ ° C (_____ ° F) +/- 5° K (9° R)					_____ ° C (_____ ° F) +/- 5° K (9° R)					notes					
Flow rate [L/m] Absence of specifics **)	T <sub>HX</sub> inlet [C°]	T <sub>HX</sub> outlet [C°]	p <sub>HX</sub> inlet [mbar]	p <sub>HX</sub> outlet [mbar]	dp pressure drop [mbar]	T <sub>HX</sub> inlet [C°]	T <sub>HX</sub> outlet [C°]	p <sub>HX</sub> inlet [mbar]	p <sub>HX</sub> outlet [mbar]	dp pressure drop [mbar]	T <sub>HX</sub> inlet [C°]	T <sub>HX</sub> outlet [C°]	p <sub>HX</sub> inlet [mbar]	p <sub>HX</sub> outlet [mbar]	dp pressure drop [mbar]	T <sub>HX</sub> inlet [C°]	T <sub>HX</sub> outlet [C°]	p <sub>HX</sub> inlet [mbar]	p <sub>HX</sub> outlet [mbar]	dp pressure drop [mbar]	notes
1	1																				
2	4																				
3	8																				
4	16																				
	Test completed date					Submitted by															

Notes: \*) Conduct all flow test (min three flow rates laminar, transit and turbulent) for each fluid intended to be used in heat exchanger.  
 \*\*) If specific flow conditions are not specified by manufacturer conduct test with 1, 4, 8, 16 liter per minute flow rates.