Strojírenský zkušební ústav, s.p.
(Engineering Test Institute, Public Enterprise)
Hudcova 424/56b, 621 00 Brno, Czech Republic

TEST REPORT
39-11175/T1

Product:	Hot-water boilers for solid fuel (wood – A) with manual fuel supply
Type designation:	SOLARIS SLS
Versions:	SOLARIS SLS 18, SOLARIS SLS 25, SOLARIS SLS 50
Customer:	Boysis Serifali Mahallesi Husrev Sk. No:2 ERISKENLER Plaza Kat 3 34775 Umraniye Turkey
Manufacturer:	Boysis Serifali Mahallesi Husrev Sk. No:2 ERISKENLER Plaza Kat 3 34775 Umraniye Turkey
Responsible employee:	Ing. Stanislav Buchta
Report issue date:	2017-07-10
Distribution list:	1 copy to the Engineering Test Institute 1 copy to the Customer

The tests were conducted on the basis of Order X-59196 dated 2017-04-28 (received on 2017-04-28), Contract X-59196/39 and Amendment D1 to the Contract.

This the version is additional version of the report 39-10665.

I. Product description, intended use and mode of application

The steel hot-water boiler with manual fuel supply, type SOLARIS SLS, is designed for the burning of wood on the principle of upward burning with pyrolysis combustion. The boiler serves for the production of heating water.
The boiler body is made of welded steel components. The charging chamber is situated in the upper part of the boiler body, and the combustion chamber with ceramic lining is situated in the bottom part. The charging chamber is separated from the combustion chamber with a wall in which a ceramic nozzle is mounted with integrated holes for the secondary combustion air supply. The exhaust branch with a horizontal axis is situated in the rear side of the boiler. There is a control panel in the upper part of the boiler with an electronic regulation guaranteeing the control and safety functions, including the indication of the water temperature in the boiler.

SZU task: 39-10665 (INTEGRA ITG)

Basic technical specifications: SOLARIS SLS

Boiler type	Rated capacity Wood [kW]	Max. operating temperature [°C]	Max. operating pressure [bar]
SOLARIS SLS 18	18 kW	90	3
SOLARIS SLS 25	25 kW	90	3
SOLARIS SLS 50	48 kW	90	3

II. Sample tested

Boiler heat output version	Serial number	Place of testing
SOLARIS SLS 18	001	Caldera Heating Group Çali Sanayi Bölgesi Çinarlik Cd.No:18-20. Nilüfer-Bursa Turkey
SOLARIS SLS 25	002	
SOLARIS SLS 50	003	

Visual inspection, testing and evaluation were carried out by Ing. Michal Havlů, Test Engineer, at Boysis, Serifali Mahallesi Husrev Sk. No:2, ERISKENLER Plaza Kat 3, 34775 Umraniye, Turkey, in 08/2015. The tests were performed with the measurement and test equipment with valid calibration.

III. Measuring and testing equipment

No.	Description	Inventory number	Calibration valid until	Accuracy
1.	Combustion product analyser, Horiba, type 680 P	92-0004	Calibration prior to each measurement	see CRM 103000237769 see CRM 103000237770
2.	Weighing machine	02-2290	10/2015	see Calibration Sheet 6051-KL-H-0651-10
3.	Water meter, NW 20	02-1575	03/2017	see Calibration Sheet AKL-P/006/2009
4.	Data collection system	02-2241	12/2016	see Calibration Sheet 110002
5.	Moisture meter, thermometer	11-6258	11/2015	see Calibration Sheet 7630F/09
6.	Barometer	11-2541	11/2016	see Calibration Sheet 613-KL-K011-08
7.	Draught gauge	11-7275	01/2016	see Calibration Sheet 0144F/11
8.	Stop watch	99-0760	10/2015	see Calibration Sheet 2850E-07
9.	Calorimeter, IKA, type C 5000	02-2236	03/2017	± 0.12 MJ/kg
10.	Elemental analyser, Perkin Elmer, type 2400 CHNS	02-2107	03/2017	± 0.2 % rel.
11.	Gravimat, SHC 501	02-2328	12/2016	see Calibration Sheet 090177 (8,9), 090180
12.	Laboratory weighing machine	02-1458	06/2017	see Calibration Sheet 6051-KL-H376-09
13.	Weighing machine, Ohaus MB 45	02-2274	06/2017	see Calibration Sheet 6051-KL-H374-09
14.	Manometer	11-1985	02/2016	see Calibration Sheet 090162
15.	Prandtl tube, 0.3 m	ME 484	11/2015	see Calibration Sheet 5012-KL-RS090-09
16.	Psychrometer H 4220	92-0005	12/2016	see Calibration Sheet 090176

Note: * Calibrated prior to each measurement, with the use of certified reference material

IV. Results of tests and evaluation

No.	Requirement	Technical standard, regulation applied	Source materials	Evaluation	
				Test	Evaluation
1.	**Surface temperature test (1003*)**	ČSN EN 303-5:2013 Art. 5.12, 4.3.6	Pages 6 - 7	+	0
2.	**Test of heat output, input and efficiency(1004.1*)** **Test of combustion product temperature (1004.2*)**	ČSN EN 303-5:2013 Art. 4.4.2, 5.7, 5.8, 5.9, 5.10 ČSN EN 303-5:2013 Art. 4.4.3	Pages 8 - 14	+	0
3.	**Combustion efficiency test – emissions (1005.1*)**	ČSN EN 303-5:2013, Art. 4.4.7, 5.7.3, 5.7.4, 5.9, 5.10.4	Pages 15 – 16	+	0
4.	**Test of heat output, input and efficiency (1004.1*)** **Combustion efficiency test – emissions (1005.1*)**	ČSN EN 303-5:2013, Annex C, Deviations from Austria, C.2.2, C.2.3	Pages 17 – 19	+	0
		ČSN EN 303-5:2013, Annex C, C.3 Deviations from Croatia	-	0	0
		ČSN EN 303-5:2013, Annex C, Deviations from Denmark, C.4.1, C.4.2	Pages 20 – 22	+	0
		ČSN EN 303-5:2013, Annex C, Deviations from Germany, C.5.1, C.5.2	Pages 23 – 24	+	0
		ČSN EN 303-5:2013, Annex C, C.6 Deviations from Switzerland	Pages 25 - 26	+	0

No.	Requirement	Technical standard, regulation applied	Source materials	Evaluation	
				Test	Evaluation
5.	**Test of heat output, input and efficiency (1004.1*)** **Combustion efficiency test – emissions (1005.1*)**	ČSN EN 303-5:2013 Annex C, C.8 Deviations from Italy	Page 27	+	0

Note:
No.: 1 - 5
(**) Not a test

Evaluation:
+ Requirement fulfilled
- Requirement not fulfilled
x Not assessed
0 Not applicable

Accredited test number: **1003*** Test title: **Surface temperature test**

Test method: ČSN EN 303-5:2013 Art. 5.12, 4.3.6

Sample tested: SOLARIS SLS 18, SOLARIS SLS 25, SOLARIS SLS 50

Measuring equipment used: Chapter III - Measuring and test equipment

Test results:

Requirement	Requirement specification	Test evaluation	Note
Surface temperature The mean surface temperature shall be measured at nominal heat output. In order to do this, a minimum of 5 points on each boiler surface shall be measured. Under the same conditions, the critical temperatures (e.g. boiler doors, operating levers) shall be measured.	ČSN EN 303-5:2013 Art. 5.12	+	
The surface temperature on the outside of the boiler (including the bottom and doors but not including the flue gas outlet and maintenance openings of natural draft boilers) shall not exceed the room temperature by more than 60 K when tested in accordance with 5.12. The requirement for the bottom is not applicable for instances when the manufacturer declares that the boiler is to be installed on a non-combustible base. When tested in accordance with 5.12, the surface temperature of operating levers and all parts which shall be touched by hand during operation of the boiler shall not exceed the room temperature by more than the following values: - 35 K for metals and similar materials; - 45 K for porcelain and similar materials; - 60 K for plastics and similar materials.	ČSN EN 303-5:2013 Art. 4.3.6	+	

Measurement results: SOLARIS SLS 18, SOLARIS SLS 25, SOLARIS SLS 50

Average temperatures of boiler walls, doors and covers (^{0}C):			
Fuel type	Wood – A		
Boiler type	SOLARIS SLS 18	SOLARIS SLS 25	SOLARIS SLS 50
Front wall	54.3	52.2	51.2
Rear wall	38.9	38.8	42.1
Right wall	37.0	37.4	36.7
Left wall	36.8	37.2	36.0
Upper wall	41.0	41.0	42.3
Lower wall (a base was used, non-combustible material)	38.5	38.5	35.5
Temperatures of control elements (^{0}C):			
El. control panel – plastic	40.0	40.0	42.0
Handle of upper door - plastic	38.0	40.0	39.0
Handle of middle door - plastic	-	37.0	38.0
Handle of lower door - plastic	42.0	39.0	39.0

Measurement uncertainty: 2 ^{0}C for temperatures within the range of (0 ÷ 250)^{0}C

"The above-specified extended measurement uncertainties are calculated as a factor of the measurement uncertainty and the extension coefficient, k=2, corresponding to the coverage certainty of 95% as regards standard classification. The uncertainties do not reflect the impact of sample taking and lack of homogeneity. The standard uncertainty was determined in accordance with Document EA 4-02."

Test evaluation: The specified temperature rise values have not been exceeded.

Accredited test number:	**1004.1*** **1004.2***	Test title:	**Test of heat output, input and efficiency** **Test of combustion product temperature**

Test method:	ČSN EN 303-5:2013 Art. 4.4.2, 4.4.3, 5.7 to 5.10
Sample tested:	SOLARIS SLS 18, SOLARIS SLS 25, SOLARIS SLS 50
Measuring equipment used:	Chapter III - Measuring and test equipment

Test results:

Average measured and calculated values (solid fuels):

Test period:		I.	II.
Boiler type:		SOLARIS SLS 18	
Output tested:		Nominal	Nominal
Fuel type:		**Wood - A**	
Combustion period, (manual) stoking		Minimally 2 × 2 hours	
Nominal heat output (specified by manufacturer)	[kW]	18	18
Flue gas temperature	[°C]	105.4	104.9
Fuel mass added	[kg/hour]	4.62	4.67
Inlet water temperature	[°C]	58.4	56.5
Outlet water temperature	[°C]	81.5	79.7
Cooling water temperature	[°C]	27.3	25.3
Cooling water flow rate	[m3/hour]	0.3072	0.3070
Draught	[Pa]	11.0	11.0
Ambient temperature	[°C]	31.5	30.0
Relative air humidity	[%]	18.0	19.5
Barometric pressure	[kPa]	98.46	98.59

Analysis of combustion products:

Test (period of burning) :		I.	II.
Oxygen, O_2	[%]	8.17	8,00
Carbon dioxide, CO_2	[%]	12.10	12.10
Carbon monoxide, CO	[ppm]	102	207
Higher hydrocarbons, THC-OGC	[ppm]	9	9
Nitrogen oxides NOx	[ppm]	108	108

Auxiliary combustion values (solid fuels):

Test (period of burning) :		I.	II.
Stoichiometric oxygen volume	[m3/kg]	0.898	0,898
Stoichiometric air volume	[m3/kg]	4.277	4.277
Stoichiometric volume of dry combustion products	[m3/kg]	4.200	4.200
Maximum content of CO_2	[%]	19.53	19.53
Stoichiometric air multiple	[-]	1.62	1.60
Volume of dry combustion products, actual	[m3/kg]	6.775	6.768
Content of H_2O in combustion air	[m3/kg]	0.059	0.058
Content of H_2O in combustion products	[m3/kg]	0.863	0.862

Calculated values - thermal overview

Test (period of burning) :		I.	II.
Loss of sensible heat of combustion products	[%]	4.8	4.8
Loss of gas underburning	[%]	0.1	0.1
Loss of mechanical underburning	[%]	0.3	0.3
Loss of heat transfer into environment	[%]	1.9	2.2
Total loss	[%]	7.0	7.4
Efficiency – indirect method	[%]	93.0	92.6
Fuel mass added - actual	[kg/h]	4.661	4.706
Heat input	[kW]	21.0	21.2
Heat output	**[kW]**	**19.3**	**19.3**
Uncertainty of determining heat output	[kW]	0.8	0.8
Efficiency – direct method	**[%]**	**91.8**	**91.3**
Output / nominal output	[%]	107.0	107.4

At nominal output, when burning **Wood – A,** the boiler efficiency meets the requirements applicable to **Class 5** as per ČSN EN 303-5:2013, Fig. 1.

Test evaluation:

The measured heat output is within the ± 8% tolerance;
Boiler Class 5;
At nominal output, combustion product temperature is less than 160 K above the ambient temperature;
When burning Wood – A, the period of burning is more than 2 hours;

Test results:

Average measured and calculated values (solid fuels):

Test period:		I.	II.
Boiler type:		SOLARIS SLS 25	
Output tested:		Nominal	Nominal
Fuel type:		**Wood - A**	
Combustion period, (manual) stoking		Minimally 2 × 2 hours	
Nominal heat output (specified by manufacturer)	[kW]	25	25
Flue gas temperature	[°C]	127.7	134.1
Fuel mass added	[kg/hour]	6.12	6.23
Inlet water temperature	[°C]	54.0	54.5
Outlet water temperature	[°C]	76.4	78.2
Cooling water temperature	[°C]	26.8	27.1
Cooling water flow rate	[m3/hour]	0.4402	0.4339
Draught	[Pa]	11.0	11.0
Ambient temperature	[°C]	30.0	31.0
Relative air humidity	[%]	14.5	13.5
Barometric pressure	[kPa]	97.93	97.66

Analysis of combustion products:

Test (period of burning) :		I.	II.
Oxygen, O_2	[%]	7.51	7.17
Carbon dioxide, CO_2	[%]	12.72	13.04
Carbon monoxide, CO	[ppm]	105	182
Higher hydrocarbons, THC-OGC	[ppm]	13	13
Nitrogen oxides NOx	[ppm]	112	117

Auxiliary combustion values (solid fuels):

Test (period of burning) :		I.	II.
Stoichiometric oxygen volume	[m3/kg]	0.899	0.899
Stoichiometric air volume	[m3/kg]	4.281	4.281
Stoichiometric volume of dry combustion products	[m3/kg]	4.204	4.204
Maximum content of CO_2	[%]	19.54	19.54
Stoichiometric air multiple	[-]	1.55	1.51
Volume of dry combustion products, actual	[m3/kg]	6.454	6.288
Content of H_2O in combustion air	[m3/kg]	0.042	0.040
Content of H_2O in combustion products	[m3/kg]	0.846	0.844

Calculated values - thermal overview

Test (period of burning) :		I.	II.
Loss of sensible heat of combustion products	[%]	6.1	6.3
Loss of gas underburning	[%]	0.1	0.1
Loss of mechanical underburning	[%]	0.2	0.2
Loss of heat transfer into environment	[%]	1.8	1.6
Total loss	[%]	8.2	8.2
Efficiency – indirect method	[%]	91.8	91.8
Fuel mass added - actual	[kg/h]	6.173	6.282
Heat input	[kW]	27.8	28.3
Heat output	**[kW]**	**25.2**	**25.7**
Uncertainty of determining heat output	[kW]	1.1	1.1
Efficiency – direct method	**[%]**	**90.9**	**90.8**
Output / nominal output	[%]	101.0	102.6

At nominal output, when burning **Wood – A,** the boiler efficiency meets the requirements applicable to **Class 5** as per ČSN EN 303-5:2013, Fig. 1.

Test evaluation:

The measured heat output is within the ± 8% tolerance;
Boiler Class 5;
At nominal output, combustion product temperature is less than 160 K above the ambient temperature;
When burning Wood – A, the period of burning is more than 2 hours;

Test results:

Average measured and calculated values (solid fuels):

Test period:		I.	II.
Boiler type:		SOLARIS SLS 50	
Output tested:		Nominal	Nominal
Fuel type:		**Wood - A**	
Combustion period, (manual) stoking		Minimally 2 × 2 hours	
Nominal heat output (specified by manufacturer)	[kW]	47	47
Flue gas temperature	[°C]	126.9	133.5
Fuel mass added	[kg/hour]	10.78	10.85
Inlet water temperature	[°C]	56.4	58.7
Outlet water temperature	[°C]	73.9	75.7
Cooling water temperature	[°C]	25.7	25.6
Cooling water flow rate	[m3/hour]	0.7850	0.7695
Draught	[Pa]	11.0	11.0
Ambient temperature	[°C]	30.0	32.0
Relative air humidity	[%]	16.0	15.0
Barometric pressure	[kPa]	98.39	98.26

Analysis of combustion products:

Test (period of burning) :		I.	II.
Oxygen, O_2	[%]	8.78	7.56
Carbon dioxide, CO_2	[%]	11.52	12.46
Carbon monoxide, CO	[ppm]	163	199
Higher hydrocarbons, THC-OGC	[ppm]	19	17
Nitrogen oxides NOx	[ppm]	107	109

Auxiliary combustion values (solid fuels):

Test (period of burning) :		I.	II.
Stoichiometric oxygen volume	[m3/kg]	0.898	0.898
Stoichiometric air volume	[m3/kg]	4.279	4.279
Stoichiometric volume of dry combustion products	[m3/kg]	4.202	4.202
Maximum content of CO_2	[%]	19.53	19.53
Stoichiometric air multiple	[-]	1.70	1.55
Volume of dry combustion products, actual	[m3/kg]	7.114	6.575
Content of H_2O in combustion air	[m3/kg]	0.051	0.048
Content of H_2O in combustion products	[m3/kg]	0.855	0.853

Calculated values - thermal overview

Test (period of burning) :		I.	II.
Loss of sensible heat of combustion products	[%]	6.5	6.4
Loss of gas underburning	[%]	0.1	0.1
Loss of mechanical underburning	[%]	0.3	0.3
Loss of heat transfer into environment	[%]	1.3	1.1
Total loss	[%]	8.2	7.9
Efficiency – indirect method	[%]	91.8	92.1
Fuel mass added - actual	[kg/h]	10.872	10.944
Heat input	[kW]	48.9	49.2
Heat output	**[kW]**	**44.0**	**44.9**
Uncertainty of determining heat output	[kW]	1.9	1.9
Efficiency – direct method	**[%]**	**90.0**	**91.2**
Output / nominal output	[%]	93.7	95.6

At nominal output, when burning **Wood – A,** the boiler efficiency meets the requirements applicable to **Class 5** as per ČSN EN 303-5:2013, Fig. 1.

Test evaluation:

The measured heat output is within the ± 8% tolerance;
Boiler Class 5;
At nominal output, combustion product temperature is less than 160 K above the ambient temperature;
When burning Wood – A, the period of burning is more than 2 hours;

Fuel analysis

Fuel type	Wood – A			
Analytical indicator	Symbol	Unit	Value	Uncertainty
Heat of combustion	Q_s	[MJ/kg]	17.79	0.14
Caloric value	Q_j	[MJ/kg]	16.20	0.14
All water in original condition	W^r_t	[% by weight]	10.87	0.03
Ash	A	[% by weight]	0.71	0.01
Carbon	C	[% by weight]	44.50	0.25
Hydrogen	H	[% by weight]	6.03	0.10
Nitrogen	N	[% by weight]	0.10	0.10
Sulphur	S	[% by weight]	0.007	0.002
Chlorine	Cl	[% by weight]	0.012	0.003
Oxygen – calculation for 100%	O	[% by weight]	37.78	
Conversion factor f_{emis} for emissions in [mg/m3] to [mg/MJ]	f_{emis}	[-]	0.26028	

Note: Sample in original condition

Measurement uncertainty: Specified in Measurement results

"The above-specified extended measurement uncertainties are calculated as a factor of the measurement uncertainty and the extension coefficient, k=2, corresponding to the coverage certainty of 95% for standard classification. The uncertainties do not reflect the impact of sample taking and lack of homogeneity. The standard uncertainty was determined in accordance with Document EA 4-02".

Accredited test number: **1005.1*** Test title: **Combustion efficiency test - emissions**

Test method: ČSN EN 303-5:2013
Art. 4.4.7, 5.7.3, 5.7.4, 5.9, 5.10.4

Sample tested: SOLARIS SLS 18, SOLARIS SLS 25, SOLARIS SLS 50

Measuring equipment used: Chapter III - Measuring and test equipment

Requirement	Requirement specification	Test evaluation	Note
Emission limits Combustion shall be of low-emission. This requirement shall be satisfied if the emission values shown in Table 6 are not exceeded when operating at nominal heat output or, in the case of boilers with heat output range, when operating at nominal heat output and minimum heat output, in accordance with 5.7, 5.9 and 5.10.	ČSN EN 303-5:2013 Art. 4.4.7	+	

Table 6

Stoking	Fuel	Nominal heat output	Emission limits								
			CO			OGC/THC			Dust		
			mg-m^3 at 10% O_2								
		kW	Class 3	Class 4	Class 5	Class 3	Class 4	Class 5	Class 3	Class 4	Class 5
Manual	Biogenic	≤ 50	5000	1200	700	150	50	30	150	75	60
		> 50 ≤ 150	2500			100					
		> 150 ≤ 500	1200			100					
	Fossil	≤ 50	5000			150			125		
		> 50 ≤ 150	2500			100					
		> 150 ≤ 500	**1200**			**100**					
Automatic	Biogenic	≤ 50	3000	1000	500	100	30	20	150	60	40
		> 50 ≤ 150	2500			80					
		> 150 ≤ 500	1200			80					
	Fossil	≤ 50	3000			100			125		
		> 50 ≤ 150	2500			80					
		> 150 ≤ 500	1200			80					

NOTE 1: The dust values in this Table are based on the experience of the gravimetric filter method. The method used needs to be referred to in the test report. The particulate matter emission measured according to this European Standard does not include condensable organic compounds which may form additional particulate matter when the flue gas is mixed with ambient air. The values are therefore not directly comparable with values measured by dilution tunnel methods. Neither can they be directly translated into ambient air particulate concentrations.

NOTE 2: Additional test methods and emission limits which apply in some countries are given in the A-Deviations in Annex C.

[a] Referred to dry exit flue gas, 0 °C, 1013 mbar.

[b] Boilers of class 3 for type E-fuels according to 1.2.1 or e-fuels according to 1.2.3 in this Table and marked with the classification E-fuels and e-fuels do not need to fulfil the requirements for the dust emissions. The actual value shall be stated in the technical documentation and shall not exceed 200 mg-m3 at 10 % O2.

Measurement results: SOLARIS SLS 18

Boiler output	Average values									
	Measured values						Converted values O_2=10%			
	O_2 [%]	CO_2 [%]	CO [ppm]	OGC/THC [ppm]	NO_x [ppm]	Dust [mg/m^3]	CO [mg/m^3]	OGC/THC [mg/m^3]	NO_x [mg/m^3]	Dust [mg/m^3]
Nominal (average values)	8.08	12.10	154	9	108	33	164	13	189	28

Test evaluation:
SOLARIS SLS 18 (Wood - A) meets at nominal output the emission requirements for **Class 5,** as per ČSN EN 303-5:2013 Table 6.

Measurement results: SOLARIS SLS 25

Boiler output	Average values									
	Measured values						Converted values O_2=10%			
	O_2 [%]	CO_2 [%]	CO [ppm]	OGC/THC [ppm]	NO_x [ppm]	Dust [mg/m^3]	CO [mg/m^3]	OGC/THC [mg/m^3]	NO_x [mg/m^3]	Dust [mg/m^3]
Nominal (average values)	7.34	12.88	143	13	114	34	144	17	189	28

Test evaluation:
SOLARIS SLS 25 (Wood - A) meets at nominal output the emission requirements for **Class 5,** as per ČSN EN 303-5:2013 Table 6.

Measurement results: SOLARIS SLS 50

Boiler output	Average values									
	Measured values						Converted values O_2=10%			
	O_2 [%]	CO_2 [%]	CO [ppm]	OGC/THC [ppm]	NO_x [ppm]	Dust [mg/m^3]	CO [mg/m^3]	OGC/THC [mg/m^3]	NO_x [mg/m^3]	Dust [mg/m^3]
Nominal (average values)	8.17	11.99	181	18	108	28	194	25	190	24

Test evaluation:
SOLARIS SLS 50 (Wood - A) meets at nominal output the emission requirements for **Class 5,** as per ČSN EN 303-5:2013 Table 6.

Accredited test number:	**1004.1*** **1005.1***	Test title:	**Test of heat output input and efficiency** **Combustion efficiency test - emissions**

Test method:	ČSN EN 303-5:2013 Annex C, Deviation from Austria, C.2.2, C.2.3
Sample tested:	SOLARIS SLS 18, SOLARIS SLS 25, SOLARIS SLS 50
Measuring equipment used:	Chapter III - Measuring and test equipment

Test results:

Requirement		**Requirement specification**	**Test evaluation**
Boiler efficiency for nominal heat output and minimum heat output		ČSN EN 303-5:2013 Annex C, Deviation from Austria, C.2.2	Wood - A
Boiler	**Minimum efficiency**		
Heating boilers for solid fuels	**75 %**		+
a) manually loaded			
up to 10 kW	79 %		
>10 to 200 kW	**(71.3 + 7.7 log Pn) %**		+
>200 kW	89 %		
a) automatically loaded			
up to 10 kW	80 %		
>10 to 200 kW	(72.3 + 7.7 log Pn) %		
>200 kW	90 %		
NOTE *Pn is the nominal heat output (Qn in this standard)*			

Requirement							**Requirement specification**	**Test evaluation**
Emission limits							ČSN EN 303-5:2013 Annex C, Deviation from Austria, C.2.3	Wood - A
Small burners used for solid fuels manually loaded								
Parameter	Emission limits mg-MJ							
	Wood		Other standardised biogenous fuels		Fossil fuels			
	Room heaters	Central heaters	< 50 kW nominal heat output	> 50 kW nominal heat output	< 50 kW nominal heat output	> 50 kW nominal heat output		
CO	1100	500	1100	500	1100	500		
NO_x	150	150/100[a]	300	300	100	100		+
OGC/THC	80/50[a]	50/30[a]	50	30	80	30		
Dust	60/35[a]	50/30[a]	60/35[a]	60/35[a]	50/35[a]	50/35[a]		
[a] Values applying as from 1.1. 2015.								

Measurement results: SOLARIS SLS 18

Boiler output	Minimum efficiency	Measured efficiency
I. period	81.0	91.8
II. period		91.3

Test evaluation:

The measured efficiency of SOLARIS SLS 18 (Wood - A) is **higher** than required.

Measurement results: SOLARIS SLS 25

Boiler output	Minimum efficiency	Measured efficiency
I. period	82.1	90.9
II. period		90.8

Test evaluation:

The measured efficiency of SOLARIS SLS 25 (Wood - A) is **higher** than required.

Measurement results: SOLARIS SLS 50

Boiler output	Minimum efficiency	Measured efficiency
I. period	84.2	90.0
II. period		91.2

Test evaluation:

The measured efficiency of SOLARIS SLS 50 (Wood - A) is **higher** than required.

Measurement results: SOLARIS SLS 18

Boiler output	Average values								
	Measured values					Converted values O_2=0%			
	O_2 [%]	CO [ppm]	NO_x [ppm]	OGC/THC [ppm]	Dust [mg/m3]	CO [mg/MJ]	NO_x [mg/MJ]	OGC/THC [mg/MJ]	Dust [mg/MJ]
Nominal (average values)	8.08	154	108	9	33	81	93	6	14

Test evaluation:
The measured emission values for SOLARIS SLS 18 (Wood – A) **do not exceed** the specified values.

Measurement results: SOLARIS SLS 25

Boiler output	Average values								
	Measured values					Converted values O_2=0%			
	O_2 [%]	CO [ppm]	NO_x [ppm]	OGC/THC [ppm]	Dust [mg/m3]	CO [mg/MJ]	NO_x [mg/MJ]	OGC/THC [mg/MJ]	Dust [mg/MJ]
Nominal (average values)	7.34	143	114	13	34	71	94	8	14

Test evaluation:
The measured emission values for SOLARIS SLS 25 (Wood – A) **do not exceed** the specified values.

Measurement results: SOLARIS SLS 50

Boiler output	Average values								
	Measured values					Converted values O_2=0%			
	O_2 [%]	CO [ppm]	NO_x [ppm]	OGC/THC [ppm]	Dust [mg/m3]	CO [mg/MJ]	NO_x [mg/MJ]	OGC/THC [mg/MJ]	Dust [mg/MJ]
Nominal (average values)	8.17	181	108	18	28	96	94	13	12

Test evaluation:
The measured emission values for SOLARIS SLS 50 (Wood – A) **do not exceed** the specified values.

Accredited test number:	**1004.1*** **1005.1***	Test title:	**Test of heat output, input and efficiency** **Combustion efficiency test - emissions**

Test method:	ČSN EN 303-5:2013 Annex C, Deviation from Denmark, C.4.1, C.4.2
Sample tested:	SOLARIS SLS 18, SOLARIS SLS 25, SOLARIS SLS 50
Measuring equipment used:	Chapter III - Measuring and test equipment

Test results:

Requirement		**Requirement specification**	**Test evaluation**
Boiler Efficiency		ČSN EN 303-5:2013 Annex C, Deviation from Denmark , C.4.1	Wood - A
According to the Danish Construction Code BR08, Clause 8.5.1.4, Sub-clause 7, boilers for coal, coke, bio fuel or biomass shall have an efficiency equivalent to Class 3 in EN 303-5.			
Minimum efficiency	**(67 + 6 log Qn) %**		+
For boilers above 300 kW, the requirement corresponding to 300 kW shall be used.			

Requirement						**Requirement specification**	**Test evaluation**
Emission limits							
According to the Danish EPA Statutory Order no. 1432 of 11-12-2007, only Class 3 (or higher) is acceptable for Denmark.						ČSN EN 303-5:2013 Annex C, Deviation from Denmark , C.4.2	Wood – A
Stoking	**Fuel**	**Nominal heat output**	**Emission limit values** [a]				
			CO	**OGC/ THC**	**Dust**		
			mg/m³ at 10% O_2				
		kW	**Class**				
			3				
Manual	Biogenic	≤ 50	5000	150	150		+
		> 50 to 150	2500	100			
		> 150 to 300	1200				
	Fossil	≤ 50	5000	150	125		
		> 50 to 150	2500	100			
		> 150 to 300	1200				
Automatic	Biogenic	≤ 50	3000	80	150		
		> 50 to 150	2500				
		> 150 to 300	1200				
	Fossil	≤ 50	3000	100	125		
		> 50 to 150	2500	80			
		> 150 to 300	1200				

[a] Referring to dry exit flue gas, 0 °C, 1 013 mbar.

Measurement results: SOLARIS SLS 18

Boiler output	Minimum efficiency	Measured efficiency
I. period	74.5	91.8
II. period		91.3

Test evaluation:

Measured efficiency for SOLARIS SLS 18 (Wood - A) is **higher** than required.

Measurement results: SOLARIS SLS 25

Boiler output	Minimum efficiency	Measured efficiency
I. period	75.4	90.9
II. period		90.8

Test evaluation:

Measured efficiency for SOLARIS SLS 25 (Wood - A) is **higher** than required.

Measurement results: SOLARIS SLS 50

Boiler output	Minimum efficiency	Measured efficiency
I. period	77.0	90.0
II. period		91.2

Test evaluation:

Measured efficiency for SOLARIS SLS 50 (Wood - A) is **higher** than required.

Measurement results: SOLARIS SLS 18

Boiler output	Average emission values						
	Measured values				Converted values O_2=10%		
	O_2 [%]	CO [ppm]	OGC/THC [ppm]	Dust [mg/m3]	CO [mg/m3]	OGC/THC [mg/m3]	Dust [mg/m3]
Nominal (average values)	8.08	154	9	33	164	13	28

Test evaluation:
The measured emission values SOLARIS SLS 18 (Wood – A) **do not exceed** the specified values.

Measurement results: SOLARIS SLS 25

Boiler output	Average emission values						
	Measured values				Converted values O_2=10%		
	O_2 [%]	CO [ppm]	OGC/THC [ppm]	Dust [mg/m3]	CO [mg/m3]	OGC/THC [mg/m3]	Dust [mg/m3]
Nominal (average values)	7.34	143	13	34	144	17	28

Test evaluation:
The measured emission values SOLARIS SLS 25 (Wood – A) **do not exceed** the specified values.

Measurement results: SOLARIS SLS 50

Boiler output	Average emission values						
	Measured values				Converted values O_2=10%		
	O_2 [%]	CO [ppm]	OGC/THC [ppm]	Dust [mg/m3]	CO [mg/m3]	OGC/THC [mg/m3]	Dust [mg/m3]
Nominal (average values)	8.17	181	18	28	194	25	24

Test evaluation:
The measured emission values SOLARIS SLS 50 (Wood – A) **do not exceed** the specified values.

Accredited test number:	**1004.1*** **1005.1***	Test title: **Test of heat output, input and efficiency** **Combustion efficiency test - emissions**

Test method:	ČSN EN 303-5:2013 Annex C, Deviation from Germany, C.5.1, C.5.2
Sample tested:	SOLARIS SLS 18, SOLARIS SLS 25, SOLARIS SLS 50
Measuring equipment used:	Chapter III - Measuring and test equipment

Test results:

<table>
<tr><th colspan="5">Requirement</th><th>Requirement specification</th><th>Test evaluation</th></tr>
<tr><td colspan="5">Emission limits</td><td rowspan="2">ČSN EN 303-5:2013
Annex C,
Deviation from Germany, C.5.1</td><td rowspan="2">Wood Pellets – C1</td></tr>
<tr><td colspan="5">Table 7 – Emission limits
The emission limits are regulated in Chapter 2, paragraphs 4, 5 and Annex 2 of the German Immission Control Ordinance "Erste Verordnung zur Durchführung des Bundes-Immissionsschutzgesetzes (Verordnung über kleine und mittlere Feuerungsanlagen - 1. BImSchV)". Boilers operated with solid fuels shall only be installed, possess the quality and be put into operation if they fulfil the following specifications of the 1. BImSchV:</td></tr>
<tr><td></td><td>Fuel acc. to §3 (1)</td><td>Nominal output range kW</td><td>Dust g/m³</td><td>CO g/m³</td><td></td><td></td></tr>
<tr><td rowspan="4">Stage 2: Appliances, which will be installed after 31.12.2014</td><td>Numbers 1 to 5a</td><td>≥ 4</td><td>0.02</td><td>0.4</td><td rowspan="4"></td><td>+</td></tr>
<tr><td rowspan="2">Numbers 6 to 7</td><td>≥ 30 ≤ 500</td><td>0.02</td><td>0.4</td><td rowspan="3"></td></tr>
<tr><td>> 500</td><td>0.02</td><td>0.3</td></tr>
<tr><td>Numbers 8 to 13</td><td>≥ 4 < 100</td><td>0.02</td><td>0.4</td></tr>
<tr><td colspan="7">NOTE Differing from sentence 1 for firing systems (appliances) which will exclusively be fired by fuels according §3 article 1 Number 4 in the form of split logs, the limits according Stage 2 apply for firing systems (appliances) if they are installed after 31.12.2016.</td></tr>
</table>

Measurement results: SOLARIS SLS 18

Boiler output	Average emission values				
	Measured values			Converted values O_2=13%	
	O_2 [%]	CO [ppm]	Dust [mg/m3]	CO [g/m^3]	Dust [g/m^3]
Nominal (average values)	8.08	154	33	0.119	0.020

Test evaluation:
The measured emission values for SOLARIS SLS 18 (Wood – A) **do not exceed** the specified values.

Measurement results: SOLARIS SLS 25

Boiler output	Average emission values				
	Measured values			Converted values O_2=13%	
	O_2 [%]	CO [ppm]	Dust [mg/m3]	CO [g/m^3]	Dust [g/m^3]
Nominal (average values)	7.34	143	34	0.105	0.020

Test evaluation:
The measured emission values for SOLARIS SLS 25 (Wood – A) **do not exceed** the specified values.

Measurement results: SOLARIS SLS 50

Boiler output	Average emission values				
	Measured values			Converted values O_2=13%	
	O_2 [%]	CO [ppm]	Dust [mg/m3]	CO [g/m^3]	Dust [g/m^3]
Nominal (average values)	8.17	181	28	0.141	0.017

Test evaluation:
The measured emission values for SOLARIS SLS 50 (Wood – A) **do not exceed** the specified values.

Accredited test number:	**1004.1***	Test title:	**Test of heat output, input and efficiency**
	1005.1*		**Combustion efficiency test - emissions**

Test method:	ČSN EN 303-5:2013 Annex C C.6 Deviation from Switzerland
Sample tested:	SOLARIS SLS 18, SOLARIS SLS 25, SOLARIS SLS 50
Measuring equipment used:	Chapter III - Measuring and test equipment

Test results:

<table>
<tr><th>Requirement</th><th>Requirement specification</th><th>Test evaluation</th></tr>
<tr><td colspan="2"></td><td rowspan="2">Wood - A</td></tr>
<tr><td colspan="2">Clause 4.4.7, Table 7
The emission limits are regulated in Annex 4 of the Swiss Ordinance on Air Pollution Control ([OAPC] SR 814.318.142.1) of 1985-12-16 (as at 2010-07-15).
Boilers operated with woody biomass shall only be put on the market if they fulfil the following specifications of the OAPC:
– declarations of conformity (Figure 20 OAPC);
– Figures 1, 212, 23 Annex 4 OAPC;
– Figures 31, 32 Annex 5 OAPC.
Emissions for boilers operated with coal or wood fuels shall not exceed the following limits:</td></tr>
<tr><td rowspan="2">Type of installation</td><td colspan="2">Particular requirements (emission limits)[a] for carbon monoxide (CO) and particulate matter (dust)</td><td rowspan="5">ČSN EN 303-5:2013
Annex C
C.6 Deviation from Switzerland</td></tr>
<tr><td>CO (mg-m^3)</td><td>Dust (mg-m^3)</td></tr>
<tr><td>Boilers for log Wood - And boilers for coal, manual stoking</td><td>800</td><td>50</td><td>+</td></tr>
<tr><td>Boilers for chipped Wood - And boilers for coal, automatic stoking</td><td>400</td><td>60</td><td rowspan="2"></td></tr>
<tr><td>Boilers for Wood Pellets, automatic stoking</td><td>300</td><td>40</td></tr>
<tr><td colspan="4">[a] Referred to oxygen basis:
– for boilers for natural state wood 13 % volume;
– for boilers for coal 7 % volume.</td></tr>
<tr><td colspan="3">The sulphur content of coal, coal briquettes and coke shall not exceed 3 %. Boilers operated with non-woody biomass shall comply with the following specifications of the OAPC:
– Figures 741, 742, 743 Annex 2 OAPC;
– Figures 81, 82 Annex 3 OAPC.
According to Figure 743, Annex 2 OPAC, non-woody biomass, such as biogenic waste and products from agriculture, may only be burnt in boilers with a heat input of at least 70 kW. Such units need an approval and shall meet stronger emission limits according to Figure 742, Annex 2 OAPC.</td><td>0</td></tr>
</table>

Measurement results: SOLARIS SLS 18

Boiler output	Average emission values				
	Measured values			Converted values O_2=13%	
	O_2 [%]	CO [ppm]	Dust [mg/m3]	CO [mg/m3]	Dust [mg/m3]
Nominal (average values)	8.08	154	33	119	20

Test evaluation: The measured emission values for SOLARIS SLS 18 (Wood – A) **do not exceed** the specified values.

Measurement results: SOLARIS SLS 25

Boiler output	Average emission values				
	Measured values			Converted values O_2=13%	
	O_2 [%]	CO [ppm]	Dust [mg/m3]	CO [mg/m3]	Dust [mg/m3]
Nominal (average values)	7.34	143	34	105	20

Test evaluation: The measured emission values for SOLARIS SLS 25 (Wood – A) **do not exceed** the specified values.

Measurement results: SOLARIS SLS 50

Boiler output	Average emission values				
	Measured values			Converted values O_2=13%	
	O_2 [%]	CO [ppm]	Dust [mg/m3]	CO [mg/m3]	Dust [mg/m3]
Nominal (average values)	8.17	181	28	141	17

Test evaluation: The measured emission values for SOLARIS SLS 50 (Wood – A) **do not exceed** the specified values.

Accredited test number: **1004.1*** **1005.1***

Test title: **Test of heat output, input and efficiency**
Combustion efficiency test - emissions

Test method: ČSN EN 303-5:2013
Annex C,
C.8 Deviations from Italy

Sample tested: SOLARIS SLS 50

Measuring equipment used: Chapter III - Measuring and test equipment

Requirement	**Specification of requirement**		**Test evaluation**
Italian emission limits for heating plants fuelled with biomass solid fuels	Emissions refer to an 11% O_2		
Plant nominal thermal output (MW)	**>0,035 ÷ <0,15** (>35kW÷<150kW)	**>0,15 ÷ <1** (>150kW÷<1000kW)	
Total Particulate Matter	200mg/Nm^3	100mg/Nm^3	+
Total Organic Carbon (COT) Carbon Monoxide (CO)		- 350 mg/Nm^3	
Nitrogen Dioxide (expressed as NO_2)		500 mg/Nm^3	
Sulphur Dioxide (expressed as SO_2)		200mg/Nm^3	
Italian emission limits for heating plants fuelled with non-biomass solid fuels			
	Emissions refer to an 6% O_2		
Nominal Thermal output (MW)	>0.35 (350kW)		
Total Particulate Matter	50 mg/Nm3		0

Measurement results: SOLARIS SLS 50

Boiler output	**Average emission values**				
	Measured values			**Converted values O_2=11%**	
	O_2 [%]	**CO [ppm]**	**Dust [mg/m^3]**	**CO [mg/m^3]**	**Dust [mg/m^3]**
Nominal	8.17	181	28	176	22

Test evaluation: The measured emission values for SOLARIS SLS 50 (Wood – A) **do not exceed** the specified values.

Tested by: Mr. Michal Havlů Date: 08-09/2015 Signed:

Reviewed by: Mr. Stanislav Buchta Date: 08-09/2015 Signed:

The test methods in this Report were applied without deviations, additions or exceptions.

V. List of referenced source materials

The tests were performed based on

- Order X-59196 dated 2017-04-28 (received on 2017-04-28)
- Contract X-59196/39
- Amendment D1 to the Contract
- SZU task: 39-10665 (INTEGRA ITG)
- ČSN EN 303-5:2013 – Heating boilers - Part 5: Heating boilers for solid fuels, manually and automatically stoked, nominal heat output of up to 500 kW - Terminology, requirements, testing and marking
- SZU Methodology 0211 M 001 – Measurement of solid pollutants by manual methods
- SZU Methodology 0211 M 002 – Measurement of gaseous emissions
- Technical documentation to Task 32-0148, 39-10665
- Instructions for assembly, installation and operation of the boiler
- A set of required drawing documentation as per ČSN EN 303-5:2013; SOLARIS SLS 18, SOLARIS SLS 25, SOLARIS SLS 50

The persons named below are accountable for the accuracy of the above-specified data:

STROJÍRENSKÝ ZKUŠEBNÍ ÚSTAV, s.p. CZ 1

Mr. Stanislav Buchta
Head of Boilers and Industrial Heat Equipment Department

Mr. Milan Holomek
Head of Heat and Environment-Friendly Equipment Test Station