

CALCULATION of BOILER WATER CIRCULATION

Project No. **SE2518**
Project **Samsung Electronics Incinerator Revamping Project**

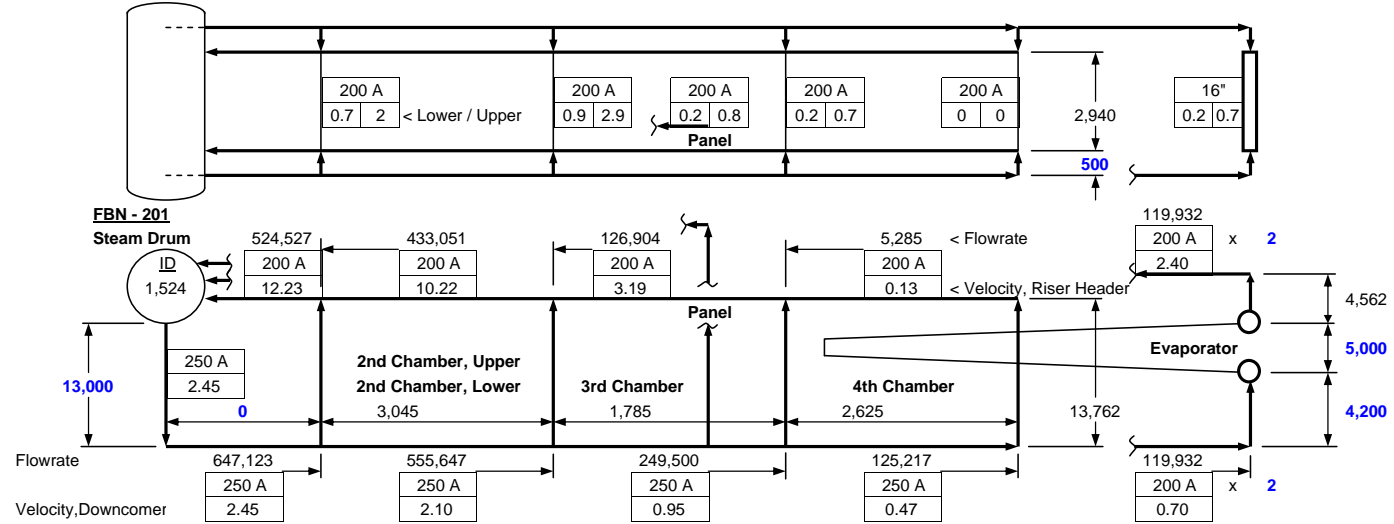
Itemno **BFN - 201**
Service **Boiler Package**

Doc. No. **CAL - BWC - 100**
Date **2014. 3. 12.**
Revision **0**
Sheet No. **1** of **4**

OPERATION DATA			
Load	100		%
Excess Air	70		%
Steam Flow, Drum Out	22,230		kg/h
Evaporation	23,402		kg/h
Steam Drum Oper. Press	26.5		kg/cm ² .g
Steam Drum Oper. Temp	228.1		°C
Fluid Properties	<u>Water</u>	<u>Steam</u>	
Density	829.7	13.50	kg/m ³
Enthalpy	234.4	669.4	kcal/kg
Viscosity	0.117	0.017	cP
	0.422	0.060	kg/m.h

Legend

NPS	NPS	Nominal Pipe Size	mm
Vel.	Vel.	Fluid Velocity	m/sec



Description	2nd Chamber, Lower		2nd Chamber, Upper		3rd Chamber		Panel		4th Chamber		Evaporator		Total	
Evaporation	10,774		1,641		3,238		2,665		287		4,797		23,402	
Circulation Ratio	30		30		25		25		25		25			
Flowrate, Total	323,220		49,218		80,951		66,620		7,183		119,932		647,123	
	Front Wall	1st Side Wall	1st Division Wall	2nd Side Wall	Panel	2nd Division Wall	3rd Side Wall	Rear Wall	Evaporator					
Flowrate, Total	91,476	189,486	116,661	30,581	66,620	27,082	3,388	1,897	119,932	647,123				
Flowrate / Tube	3,154	3,267	4,023	899	1,448	934	68	65	769					
Mass Velocity	916,439	949,169	1,168,747	261,319	1,107,735	271,317	51,830	50,043	588,029					
Steam Quality, 'x', Mean / Out	0.017	0.033	0.017	0.033	0.020	0.040	0.020	0.040	0.020	0.040	0.020	0.040	0.020	0.040
Density Mean / Outlet	413.3	275.2	413.3	275.2	375.6	242.7	375.6	242.7	375.6	242.7	375.6	242.7	375.6	242.7
Velocity through Tube	0.62	0.93	0.64	0.96	0.86	1.34	0.19	0.30	0.82	1.27	0.20	0.31	0.04	0.06
Downcomer from Drum	Downcomer	Riser	Downcomer	Riser	Downcomer	Riser	Downcomer	Riser	Downcomer	Riser	Downcomer	Riser	Downcomer	Riser
Static Head	10.786	10.502	5.688	10.502	5.688	10.502	5.169	10.502	5.169	10.502	5.169	10.502	5.169	10.502
Friction Loss Pipe	-0.13128	0.0000	0.0000	-0.0116	0.1094	-0.0231	0.2479	-0.0247	0.2553	-0.0247	0.0078	-0.0262	0.2628	-0.0268
Elbow / Reducer / Turn	-0.15253	-0.0344			-0.0560				-0.0046		-0.0030			0.0000
Header, In / Out	-0.0027	0.0080			-0.0247	0.0840			-0.0007	0.0023	-0.0047	0.0159		0.0000
Tube Entrance		0.0020		0.0021		0.0032		0.0002		0.0029		0.0002		0.0000
Tube Inside		0.0263		0.0280		0.0446		0.0031		0.0730		0.0033		0.0003
Acceleration Loss		0.0119		0.0128		0.0216		0.0011		0.0194		0.0012		0.0000
Tube Exit		0.0120		0.0129		0.0221		0.0011		0.0199		0.0012		0.0000
Force / Resistance	10.465	5.748	10.490	5.853	10.398	5.592	10.477	5.430	10.472	5.294	10.468	5.453	10.475	5.432
Force - Resistance	4.717	OK!	4.638	OK!	4.806	OK!	5.048	OK!	5.178	OK!	5.015	OK!	5.043	OK!
														3.901
														OK!

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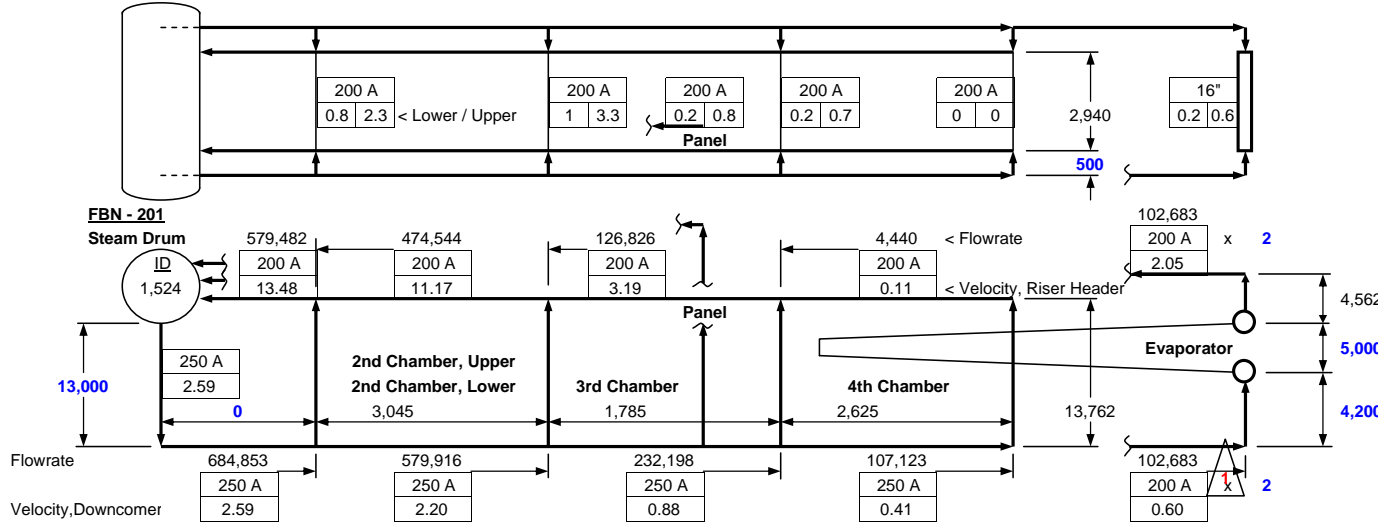
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Doc. No. **CAL - BWC - 100**
Date **2014. 3. 12.**
Revision **0**
Sheet No. **2** of **4**

OPERATION DATA			
Load	100		%
Excess Air	50		%
Steam Flow, Drum Out	22,730		kg/h
Evaporation	24,546		kg/h
Steam Drum Oper. Press	26.5		kg/cm2.g
Steam Drum Oper. Temp	228.1		°C
Fluid Properties	<u>Water</u>	<u>Steam</u>	
Density	829.7	13.50	kg/m3
Enthalpy	234.4	669.4	kcal/kg
Viscosity	0.117	0.017	cP
	0.422	0.060	kg/m.h

Legend

NPS	NPS	Nominal Pipe Size	mm
Vel.	Vel.	Fluid Velocity	m/sec



Description	2nd Chamber, Lower	2nd Chamber, Upper	3rd Chamber	Panel	4th Chamber	Evaporator	Total			
Evaporation	12,481	1,761	3,267	2,689	241	4,107	24,546 kg/h			
Circulation Ratio	30	30	25	25	25	25				
Flowrate, Total	374,430	52,816	81,675	67,216	6,034	102,683	684,853 kg/h			
	Front Wall	1st Side Wall	1st Division Wall	2nd Side Wall	Panel	2nd Division Wall	3rd Side Wall	Rear Wall	Evaporator	
Flowrate, Total	104,938	217,371	130,348	30,855	67,216	27,004	2,846	1,594	102,683	684,853 kg/h
Flowrate / Tube	3,619	3,748	4,495	907	1,461	931	57	55	658	kg/h
Mass Velocity	1,051,301	1,088,847	1,305,867	263,658	1,117,648	270,533	43,537	42,036	503,458	kg/m2.h
Steam Quality, 'x', Mean / Out	0.017	0.033	0.017	0.033	0.020	0.040	0.020	0.040	0.020	0.040
Density Mean / Outlet	413.3	275.2	413.3	275.2	375.6	242.7	375.6	242.7	375.6	242.7
Velocity through Tube	0.71	1.06	0.73	1.10	0.97	1.49	0.19	0.30	0.83	1.28
	0.20	0.31	0.03	0.05	0.03	0.05	0.03	0.05	0.37	0.58
Downcomer from Drum	Downcomer	Riser	Downcomer	Riser	Downcomer	Riser	Downcomer	Riser	Downcomer	Riser
Static Head	10.786	10.469	5.688	10.469	5.688	10.469	5.169	10.469	5.169	10.469
Friction Loss Pipe	-0.14597	0.0000	0.0000	-0.0125	0.1298	-0.0251	0.2941	-0.0264	0.3016	-0.0264
Elbow / Reducer / Turn	-0.17084	-0.0453				-0.0699				-0.0046
Header, In / Out	-0.0034	0.0103			-0.0313	0.1065			-0.0007	0.0023
Tube Entrance		0.0026		0.0028		0.0040		0.0002		0.0030
Tube Inside		0.0336		0.0358		0.0545		0.0032		0.0741
Acceleration Loss		0.0157		0.0168		0.0270		0.0011		0.0198
Tube Exit		0.0158		0.0169		0.0276		0.0011		0.0202
Force / Resistance	10.420	5.766	10.456	5.890	10.343	5.683	10.443	5.476	10.437	5.296
Force - Resistance	4.655	OK!	4.567	OK!	4.660	OK!	4.967	OK!	5.141	OK!
									4.934	OK!
									4.962	OK!
									4.962	OK!
									3.893	OK!

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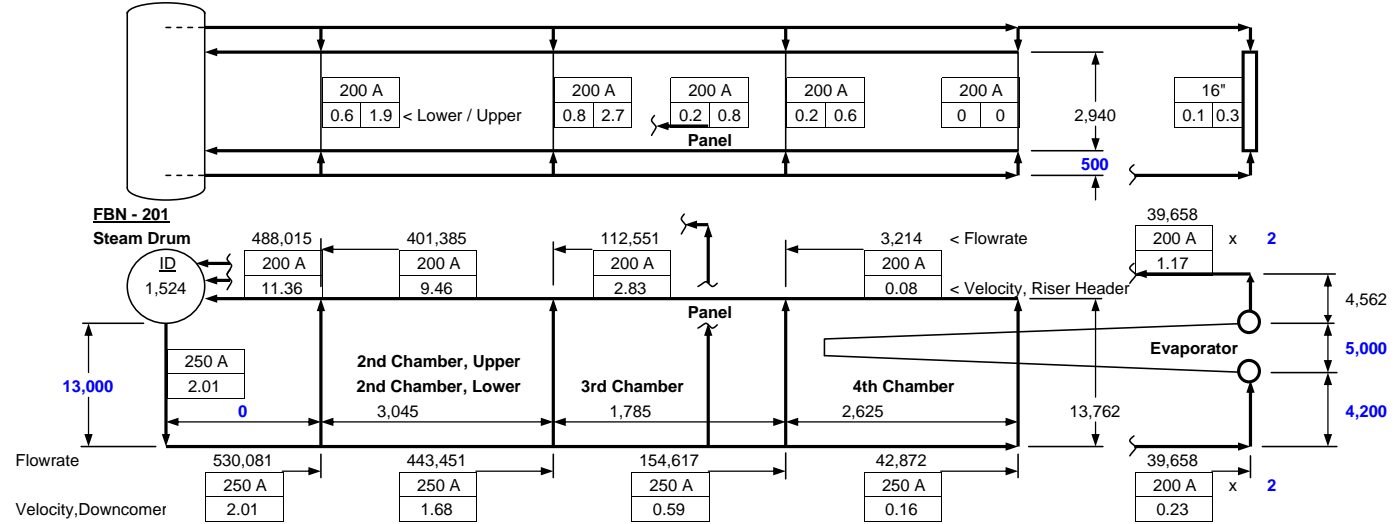
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Sheet No. **3** of **4**

OPERATION DATA			
Load	80	%	
Excess Air	70	%	
Steam Flow, Drum Out	18,120	kg/h	
Evaporation	19,909	kg/h	
Steam Drum Oper. Press	26.5	kg/cm ² g	
Steam Drum Oper. Temp	228.1	°C	
Fluid Properties	<u>Water</u>	<u>Steam</u>	
Density	829.7	13.50	kg/m ³
Enthalpy	234.4	669.4	kcal/kg
Viscosity	0.117	0.017	cP
	0.422	0.060	kg/m.h

Legend

NPS	NPS	Nominal Pipe Size	inch
Vel.	Vel.	Fluid Velocity	m/sec



Description	2nd Chamber, Lower		2nd Chamber, Upper		3rd Chamber		Panel		4th Chamber		Evaporator		Total							
Evaporation	10,094	1,663			2,926		2,408		175		2,644	19,909	kg/h							
Circulation Ratio	30	30			25		25		25		15									
Flowrate, Total	302,829	49,877			73,149		60,200		4,367		39,658	530,081	kg/h							
	Front Wall	1st Side Wall	1st Division Wall	2nd Side Wall	Panel	2nd Division Wall	3rd Side Wall	Rear Wall	Evaporator											
Flowrate, Total	86,630	179,447	109,387	27,634	60,200	23,911	2,060	1,154	39,658	530,081				kg/h						
Flowrate / Tube	2,987	3,094	3,772	813	1,309	825	41	40	254					kg/h						
Mass Velocity	867,886	898,882	1,095,879	236,136	1,000,982	239,550	31,513	30,426	194,447					kg/m ² .h						
Steam Quality, 'x', Mean / Out	0.017	0.033	0.017	0.033	0.020	0.040	0.020	0.040	0.020	0.040	0.020	0.040	0.020	0.040	0.033	0.067				
Density Mean / Outlet	413.3	275.2	413.3	275.2	375.6	242.7	375.6	242.7	375.6	242.7	375.6	242.7	375.6	242.7	275.2	164.9	kg/m ³			
Velocity through Tube	0.58	0.88	0.60	0.91	0.81	1.25	0.17	0.27	0.74	1.15	0.18	0.27	0.02	0.04	0.02	0.33	m/sec			
Downcomer from Drum	Downcomer	Riser	Downcomer	Riser	Downcomer	Riser	Downcomer	Riser	Downcomer	Riser	Downcomer	Riser	Downcomer	Riser	Downcomer	Riser				
Static Head	10.786	10.593	5.688	10.593	5.688	10.593	5.169	10.593	5.169	10.593	5.169	10.593	5.169	10.593	5.169	10.593	5.613	m		
Friction Loss Pipe	-0.09044	0.0000	0.0000	-0.0076	0.0949	-0.0152	0.2151	-0.0158	0.2211	-0.0158	0.0065	-0.0165	0.2271	-0.0166	0.2271	-0.0166	0.2271	-0.0174	0.0102	m
Elbow / Reducer / Turn	-0.10235	-0.0309				-0.0492				-0.0037		-0.0024			0.0000		-0.0005	0.0011	m	
Header, In / Out	-0.0024	0.0072				-0.0222	0.0754			-0.0006	0.0019	-0.0038	0.0130		0.0000	0.0000	0.0000	0.0001	m	
Tube Entrance		0.0018		0.0019		0.0028		0.0001		0.0024		0.0001		0.0000		0.0000	0.0000	0.0001	m	
Tube Inside		0.0238		0.0254		0.0398		0.0026		0.0609		0.0027		0.0001		0.0001	0.0000	0.0037	m	
Acceleration Loss		0.0107		0.0115		0.0190		0.0009		0.0159		0.0009		0.0000		0.0000	0.0000	0.0008	m	
Tube Exit		0.0108		0.0116		0.0195		0.0009		0.0162		0.0009		0.0000		0.0000	0.0000	0.0009	m	
Force / Resistance	10.560	5.742	10.585	5.833	10.506	5.541	10.577	5.395	10.573	5.273	10.570	5.414	10.576	5.396	10.576	5.396	10.575	5.630	m	
Force - Resistance	4.818	OK!	4.752	OK!	4.966	OK!	5.183	OK!	5.300	OK!	5.157	OK!	5.180	OK!	5.180	OK!	4.945	OK!		m

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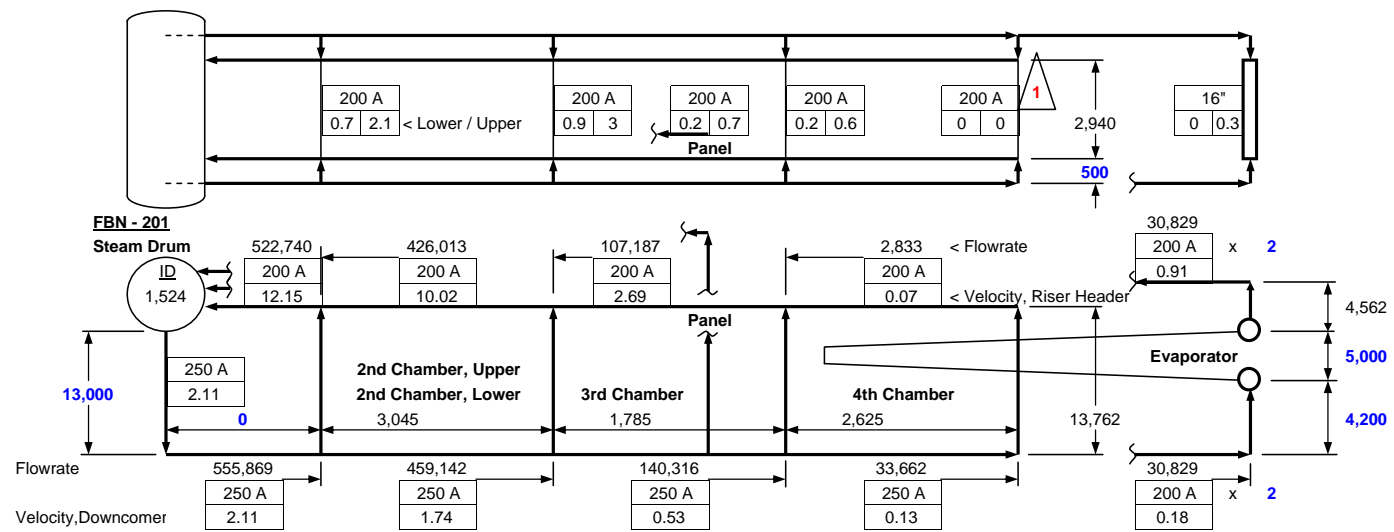
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OPERATION DATA			
Load	80	%	
Excess Air	50	%	
Steam Flow, Drum Out	18,280	kg/h	
Evaporation	20,431	kg/h	
Steam Drum Oper. Press	26.5	kg/cm ² g	
Steam Drum Oper. Temp	228.1	°C	
Fluid Properties	<u>Water</u>	<u>Steam</u>	
Density	829.7	13.50	kg/m ³
Enthalpy	234.4	669.4	kcal/kg
Viscosity	0.117	0.017	cP
	0.422	0.060	kg/m.h

Legend

NPS	NPS	Nominal Pipe Size	inch
Vel.	Vel.	Fluid Velocity	m/sec



Description	2nd Chamber, Lower	2nd Chamber, Upper		3rd Chamber		Panel		4th Chamber		Evaporator	Total								
Evaporation	11,443	1,684		2,795		2,300		154		2,055	20,431								
Circulation Ratio	30	30		25		25		25		15									
Flowrate, Total	343,297	50,517		69,872		57,503		3,850		30,829	555,869								
	Front Wall	1st Side Wall	1st Division Wall	2nd Side Wall	Panel	2nd Division Wall	3rd Side Wall	Rear Wall	Evaporator										
Flowrate, Total	96,726	200,362	118,464	26,396	57,503	22,755	1,816	1,017	30,829	555,869	kg/h								
Flowrate / Tube	3,335	3,455	4,085	776	1,250	785	36	35	198		kg/h								
Mass Velocity	969,038	1,003,647	1,186,818	225,558	956,141	227,968	27,781	26,823	151,154		kg/m ² .h								
Steam Quality, 'x', Mean / Out	0.017	0.033	0.017	0.033	0.020	0.040	0.020	0.040	0.020	0.040	0.020	0.040	0.020	0.040	0.033	0.067			
Density Mean / Outlet	413.3	275.2	413.3	275.2	375.6	242.7	375.6	242.7	375.6	242.7	375.6	242.7	375.6	242.7	275.2	164.9			
Velocity through Tube	0.65	0.98	0.67	1.01	0.88	1.36	0.17	0.26	0.71	1.09	0.17	0.26	0.02	0.03	0.02	0.03	0.15	0.25	
Downcomer from Drum	Downcomer	Riser	Downcomer	Riser	Downcomer	Riser	Downcomer	Riser	Downcomer	Riser	Downcomer	Riser	Downcomer	Riser	Downcomer	Riser	Downcomer	Riser	
Static Head	10.786	10.574	5.688	10.574	5.688	10.574	5.169	10.574	5.169	10.574	5.169	10.574	5.169	10.574	5.169	10.574	5.169	10.574	5.613
Friction Loss Pipe	-0.09883	0.0000	0.0000	-0.0081	0.1061	-0.0162	0.2404	-0.0167	0.2459	-0.0167	0.0060	-0.0173	0.2513	-0.0173	0.2514	-0.0174	0.2514	-0.0178	0.0065
Elbow / Reducer / Turn	-0.11255	-0.0385				-0.0577				-0.0034		-0.0021				0.0000		-0.0003	0.0007
Header, In / Out	-0.0029	0.0088			-0.0266	0.0906			-0.0005	0.0018	-0.0035	0.0120			0.0000	0.0000	0.0000	0.0000	0.0000
Tube Entrance		0.0022		0.0024		0.0033		0.0001		0.0022		0.0001		0.0000		0.0000		0.0000	0.0001
Tube Inside		0.0290		0.0309		0.0459		0.0024		0.0562		0.0025		0.0001		0.0001		0.0001	0.0024
Acceleration Loss		0.0133		0.0143		0.0223		0.0008		0.0145		0.0008		0.0000		0.0000		0.0000	0.0005
Tube Exit		0.0134		0.0144		0.0228		0.0008		0.0148		0.0008		0.0000		0.0000		0.0000	0.0005
Force / Resistance	10.533	5.755	10.566	5.856	10.474	5.594	10.558	5.419	10.554	5.264	10.552	5.437	10.557	5.420	10.557	5.420	10.556	5.624	
Force - Resistance	4.778	OK!	4.710	OK!	4.880	OK!	5.139	OK!	5.289	OK!	5.115	OK!	5.137	OK!	5.137	OK!	4.933	OK!	