

	A	B	C	D	E	F	G	H	I	J	K	L
1	THM 1304 Gas Turbine: Performance and Conversions					THM1304-12						
2												
3	<b>1.) Test Identification</b>	MAN TURBO Code Word:				VILLARPIPE		Unit #1		Unit #2		Unit #3
4	Date	dd.mm.yy						29.02.12		05.03.12		07.03.12
5	Time	hh:mm						18:25		14:45		12:25
6	Test Point #	MP\$\$				Punto A Garantia		MP02		MP03		MP01
7	Comment							unit loop		unit loop		unit loop
8												
9	<b>2.) Measurement Values</b>				Starts			xx		51		35
10	<b>2.1) Ambient Conditions</b>	g=9,8065			Run.-Hours GG			yy		188		109
11	Site elevation		h	m		440		440		440		440
12	Barometric pressure	add	p_0	bar-a		0,9615		0,9860		0,9930		0,9920
13	Temperature	add	T_0	°C		30		19		12		16
14	Relative humidity	add	φ	%		82		28		43		33
15	Weather conditions		-	-		bright		sunny		sunny		sunny
16	Saturation pressure	add	p_w_sat	bar-a		0,0424		0,0220		0,0140		0,0182
17	Specific humidity	add	x_w	-		0,0233		0,0039		0,0038		0,0038
18												
19	<b>2.2) Pipeline Compressor</b>											
20												
21	<b>2.3) Gas Turbine (general)</b>											
22	<b>2.3.1) Mechanical Values</b>											
23	Gas generator speed	SI-	N_GG	rpm				10743		10547		10610
24	Power turbine speed	SI-	N_PT	rpm		7541		7542		7540		7540
25	Power turbine speed	SI-	N_PT	%		83,51		83,61		83,59		83,59
26	Position IGW	ZI-	s_IGV	deg				-19,2		-18,7		-17,7
27												
28	<b>2.3.2) Fuel Gas</b>											
29	Temperature at orifice	TI-	T_f	°C				12,0		11,2		11,0
30	Pressure at orifice	PI-	p_f	bar-g				24,0		24,1		24,0
31	Pressure at orifice	add	p_f	bar-g				-		-		-
32	Differential pressure at orifice	PDT-	Δp_f	mbar-d				58		58		57
33	Differential pressure at orifice	add	Δp_f	mbar-d				-		-		-
34	Volume flow (Standard Cond.)	FI-	V_P_f_N	Nm3/h				2212		2212		2195
35												
36	<b>2.3.4) Exhaust Gas Emissions</b>											
37	Oxygen	add	x_O2	vol%				-		-		-
38	Carbon monoxide	add	x_CO	ppm				-		-		-
39	Nitrogen monoxide	add	x_NO	ppm				-		-		-
40	Nitrogen dioxide	add	x_NO2	ppm				-		-		-
41												
42	<b>2.4) Gas Turbine (thermodynamic)</b>											
43	Pressure loss suction		dp_1	[mbarg]		7,50		15,00		15,00		15,00
44	Temperature suction compr.	DCS	T_1	[°C]		30,0		18,1		8,9		10,0
45	Temperature suction compr.	add	T_1	[°C]		-		-		-		-
46	Pressure discharge compr.	DCS	p_2	[barg]				5,72		5,80		5,80
47	Temperature discharge compr.		T_2	[°C]								
48	Pressure inlet PT	DCS	p_4	[barg]								
49	Temperature inlet PT (max)	DCS	T_4_max	[°C]								
50	Temperature inlet PT (left)	DCS	T_4_1	[°C]				709		655		702
51	Temperature inlet PT (left)	DCS	T_4_12	[°C]				650		584		577
52	Temperature inlet PT (left)	DCS	T_4_10	[°C]				570		562		559
53	Temperature inlet PT (left)	DCS	T_4_9	[°C]				632		594		595
54	Temperature inlet PT (left,av)	DCS	T_4_l	[°C]				640		598		605
55	Temperature inlet PT(right)	DCS	T_4_3	[°C]				529		514		515
56	Temperature inlet PT(right)	DCS	T_4_4	[°C]				674		588		592
57	Temperature inlet PT(right)	DCS	T_4_6	[°C]				658		677		652
58	Temperature inlet PT(right)	DCS	T_4_7	[°C]				616		629		596
59	Temperature inlet PT(right,av)	DCS	T_4_r	[°C]				617		600		588
60												
61	Temperature inlet PT (left,av)	calc	T_4_l	[°C]				640		599		608
62	Temperature inlet PT(right,av)	calc	T_4_r	[°C]				619		602		589
63	Temperature inlet PT(av., T_i)	calc	T_4_m	[°C]								
64	Temperature inlet PT(av., GT)		T_4_m	[°C]								
65	Pressure loss exhaust	add	dp_5	[mbarg]		5,00		2,00		2,00		2,00
66	Temperature exhaust	add	T_5	[°C]				-		-		-
67												
68	<b>3.) Evaluation</b>											
69	<b>3.1) Pipeline Compressor</b>											
70	Internal power		P_i,Co			4266		4155		4072		3994
71												
72	Mechanical loss compressor		P_me_Co			110		110		110		110
73	Power at coupling		P_C_Co	[kW]		4376		4265		4182		4104
74												
75	<b>3.2) Gear Box</b>											
76	Mechanical loss gear box		P_me_GB	[kW]		0		0		0		0
77	Power at gear box coupling		P_GB_co	[kW]		4376		4265		4182		4104
78												
79	<b>3.3) Gas Turbine</b>											
80	<b>3.3.1) Fuel Gas (composition acc. F-ATP/THM-Pipe-Att. 1)</b>											

	A	B	C	D	E	F	G	H	I	J	K	L
81	Real gas constant		R_f	J/kg/K		457,56		475,08		475,08		474,41
82	Real gas factor (Standard Cond.)		Z_f_N	-		-						
83	Fuel Density (Standard Cond.)		ρ_f_N	kg/Nm3		0,8107		0,7808		0,7808		0,7819
84	Lower Heating Value (Standard Cond.)		H_u_v	kWh/Nm3								
85	Lower Heating Value (Standard Cond.)		H_u_m	kJ/kg		48090		48623		48623		48564
86	Volume flow (Standard Cond.)		V_P_f_N	Nm3/h		1896,9		1939		1943		1931
87	Mass flow		m_P_f	kg/s		0,427		0,4207		0,4214		0,4194
88	Mass flow		m_P_f	kg/h		1538		1514		1517		1510
89												
90	<b>3.3.2) Exhaust Gas Emissions</b>											
91	Carbon monoxide (dry norm.cond., 15vol%O2)		x_CO	mg/Nm3								
92	Nitrogen oxides (dry norm.cond., 15vol%O2)		x_NOx	mg/Nm3								
93												
94	<b>3.3.3) Gas Turbine Overall Performance incl. Conversion to ISO-Cond.</b>											
95	Coupling power test		P_co_GT,t	kW		4376		4265		4182		4104
96	Heat input test		Q_in	kW		20543		20454		20489		20369
97	Thermal efficiency test		eta_th,t	-				0,2085		0,2041		0,2015
98	Thermal efficiency (corr P_test)			-				0,0028		0,0049		0,0068
99	Thermal efficiency (corr P_Compressor)			-				1,0201		1,0263		1,0232
100	Thermal efficiency (corr)		eta_th,corr	-		0,2130		0,2071		0,2036		0,2036
101	Gros specific heat rate			kJ/kW/h		16900		17380		17681		17684
102	Heat input corr		Q_in, corr	kW		20543		20591		20539		20162
104	ISO barometric pressure		p_ISO	[bar]		1,01325		1,01325		1,01325		1,01325
105	ISO inlet temperature		T_ISO	[K]		288,15		288,15		288,15		288,15
106	Temperature suction compr.		T_1	[K]		303,15		291,25		282,05		283,15
107	Speed gas generator		N_GG	[rpm]		0		10686		10660		10703
108	Speed power turbine		N_PT	[rpm]		7352		7502		7621		7606
109	Pressure discharge compr.		p_2	[bar]				7,00		7,04		7,04
110	Temperature discharge compr.		T_2	[°C]								
111	Pressure inlet PT		p_4	[bar]								
112	Temperature inlet PT	calc	T_4_1...8	[°C]								
113	Temperature inlet PT	calc	T_4_avg	[°C]								
114	Temperature exhaust		T_5	[°C]								
116	Pressure loss suction		dp_1	[kPa]		0,75		1,50		1,50		1,50
117	Pressure loss exhaust		dp_5	[kPa]		0,50		0,20		0,20		0,20
118	Corr fact dp_in on P_Co		eps_1P	[-]		0,9854		0,9708		0,9708		0,9708
119	Corr fact dp_out on P_Co		eps_2P	[-]		0,9953		0,9981		0,9981		0,9981
120	Corr fact dp_in on eta_th		eps_1eta	[-]		0,9930		0,9859		0,9859		0,9859
121	Corr fact dp_out on eta_th		eps_2eta	[-]		0,9953		0,9981		0,9981		0,9981
122	Degradation factor power			[-]		0,0000		0,0000		0,0000		0,0000
123	Degradation factor efficiency			[-]		0,0000		0,0000		0,0000		0,0000
125	Power at coupling		P_co_GT	[kW]		4584		4499		4451		4365
126	Fuel mass flow		m_P_f	[kg/s]								
127	Heat input		Q_P_in	[kW]		21272		21372		21508		21094
128	Thermal efficiency		eta_th	[-]		0,2155		0,2105		0,2070		0,2069
129	Gros specific heat rate (guar)			kJ/kW/h		16705		17100		17395		17398
130	Gros specific heat rate (guar + tol)			kJ/kW/h		17290		17100		17395		17398
131	Gros specific heat rate (diff)			kJ/kW/h				-190		105		108
132	Gros specific heat rate (diff)			%				-1,10		0,61		0,63