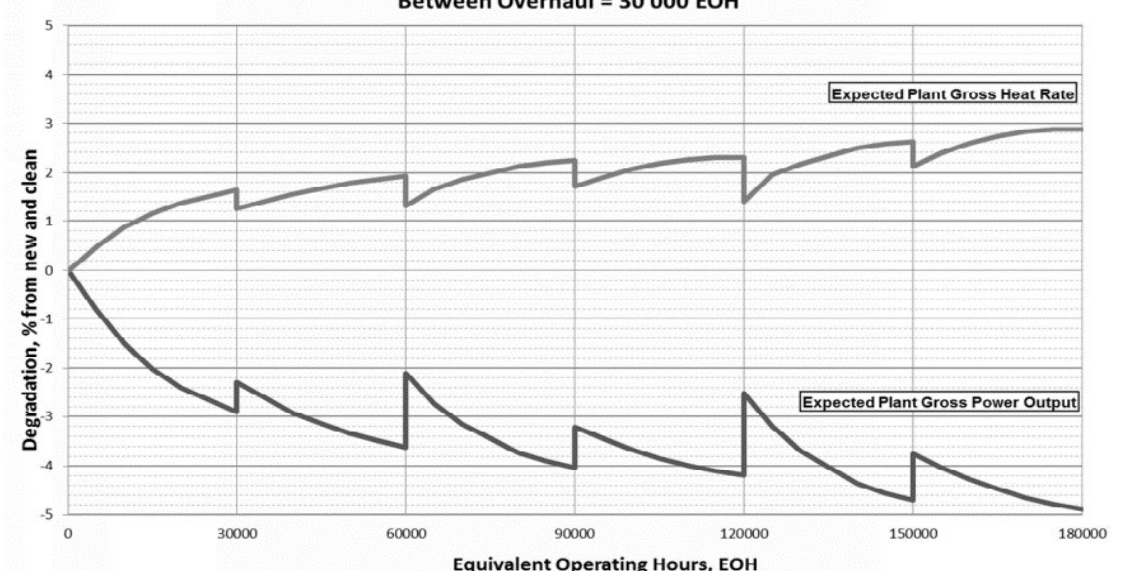





	CLIENT: Enter client name here	Enter Calculation Number Here													
	PROJECT: Performance Monitoring	REV	DATE	BY	CHK.	APP.									
	LOCATION: Delimara	0		GL											
<b>CALCULATION TITLE:</b> Performance degradation evaluation															
<b>DESCRIPTION:</b> Performance degradation evaluation															
1	<b>CALCULATION PURPOSE</b>														
2															
3															
4	Performance test run performed on the 04/06/2021 00:10 - 04/06/2021 01:10 All GTs running simultaneously during test.														
5															
6															
7															
8	<b>Test Summary</b>														
9															
10															
11	<table border="1"> <thead> <tr> <th></th> <th>Calculated</th> <th>Expected†</th> </tr> </thead> <tbody> <tr> <td>Gross Poutput degradation:</td> <td>0.76%</td> <td>2.30%</td> </tr> <tr> <td>HR degradation ΔHR (%)</td> <td>1.73%</td> <td>1.30%</td> </tr> </tbody> </table>							Calculated	Expected†	Gross Poutput degradation:	0.76%	2.30%	HR degradation ΔHR (%)	1.73%	1.30%
	Calculated	Expected†													
Gross Poutput degradation:	0.76%	2.30%													
HR degradation ΔHR (%)	1.73%	1.30%													
12															
13															
14															
15	†PPA degradation curve.														
16	<p><b>Delimara SCC-800 3x1 C Typical Power Output and Heat Rate degradation in case Time Between Overhaul = 30 000 EOH</b></p> 														
17															
18															
19															
20															
21															
22															
23															
24															
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26															
27															
28															
29															
30															
31															
32															
33															
34															
35															
36	<b>REFERENCES</b>														
37															
38															
39	1) SIEMENS Performace test report														
40	2) SIEMENS Performace test procedure														
41	3) SIEMENS LTSA 1CS107553 - Nominal degradation for extended service intervals SGT-800														
42															
43	<b>PLANT REFERENCE CONDITIONS</b>														
44															
45															


	<b>CLIENT:</b> Enter client name here		<b>Enter Calculation Number Here</b>				
	<b>PROJECT:</b> Performance Monitoring		<b>REV</b>	<b>DATE</b>	<b>BY</b>	<b>CHK.</b>	<b>APP.</b>
	<b>LOCATION:</b> Delimara		0		GL		
<b>CALCULATION TITLE:</b> Performance degradation evaluation							
<b>DESCRIPTION:</b> Performance degradation evaluation							
46							
47	Ambient Temperature (degC):	24	*GT inlet T				
48	Barometric Pressure (kPa):	1013					
49	Ambient RH (%):	65					
50	Fuel Gas C/H:	3.12					
51	Fuel Gas CO2+N2 (vol%)	0.467					
52	Fuel Gas T (degC):	5	*GT NG inlet T				
53	Grid Frequency (Hz):	50					
54	Nominal Power Factor:	0.8					
55	Degradation (EOH):	0					
56	GT Gen nominal apparent P (MVA):	64.969	*From specs sheet SIE original proposal				
57							
58	Combined cycle corrections I->II:						
59	Kp_fl:	1.0166	*applied to ST				
60	Kp_XI->II:	1.0619	*applied to each GT				
61	KQI->II:	1.0408	*applied to each GT				
62	Kp_I->II:	1.0619	*applied to each GT				
63							
64							
65	<b>AVERAGE TEST DATA</b>						
66							
67							
68	Last compressor washing GT51:	19569	EOH				
69	Last compressor washing GT52:	21008	EOH				
70	Last compressor washing GT53:	20467	EOH				
71	<b>Process:</b>						
72	Test date from:	04/06/2021 00:10					
73	Test date to:	04/06/2021 01:10					
74	Ambient T (degC):	21.84					
75	Dew point T (degC):	18.76228614					
76	Barometric P (kPa):	1022.657545					
77	Fuel Gas C/H:	3.076577749					
78	HHV to LHV ratio:	1.111604882					
79	LHV (MJ/kg):	49.81132435					
80	GT51 Degradation (EOH):	32533.95399					
81	GT52 Degradation (EOH):	32317.2595					
82	GT53 Degradation (EOH):	31601.45532					
83	Avg Degradation (EOH):	32150.8896					
84	GT51 Comp inlet T (degC):	20.71057968					
85	GT52 Comp inlet T (degC):	21.05295116					
86	GT53 Comp inlet T (degC):	21.39225188					
87	GT51 inlet RH (%):	83.43244304					
88	GT52 inlet RH (%):	80.34059428					
89	GT53 inlet RH (%):	81.17044552					
90	GT51 ΔPin (mbar):	14.69183751					

	<b>CLIENT:</b> Enter client name here		<b>Enter Calculation Number Here</b>				
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	<b>LOCATION:</b> Delimara		0		GL		
<b>CALCULATION TITLE:</b> Performance degradation evaluation							
<b>DESCRIPTION:</b> Performance degradation evaluation							
91	GT52 ΔPin (mbar):	14.5716279					
92	GT53 ΔPin (mbar):	16.39034417					
93	GT51 ΔPout (mbar):	20.82485841					
94	GT52 ΔPout (mbar):	21.36404362					
95	GT53 ΔPout (mbar):	21.07409535					
96	GT51 CO2+N2 (vol%):	0					
97	GT52 CO2+N2 (vol%):	0					
98	GT53 CO2+N2 (vol%):	0					
99	GT51 NG Tin (degC):	79.21427512					
100	GT52 NG Tin (degC):	79.26530488					
101	GT53 NG Tin (degC):	79.30432199					
102	NG Tin BL (degC):	12.69953684					
103							
104							
105	<b>Electrical:</b>						
106	Total Aux power (MWe):	1.274	*Assumed same as per GTAll simple cycle test				
107	GT51 Frequency (Hz):	49.99044236					
108	GT52 Frequency (Hz):	50.01039654					
109	GT53 Frequency (Hz):	49.9925951					
110	ST Frequency(Hz):	50.00635744					
111	GT51 PF:	0.999990642					
112	GT52 PF:	0.999692343					
113	GT53 PF:	0.999322343					
114	ST PF:	67.07674813					
115	GT51 P (MW):	48.00728697					
116	GT52 P (MW):	47.51264564					
117	GT53 P (MW):	47.90361781					
118	GT51 App P (MVA):	47.90014498					
119	GT52 App P (MVA):	47.31065934					
120	GT53 App P (MVA):	48.00728697					
121	ST P (MW):	67.07674813					
122							
123							
124	<b>Stability criteria:</b>	PASSED					
125							
126	<b>GT51 CORRECTION</b>						
127							
128							
129							
130	Kp_TO	0.986015651	* Compressor inlet T				
131	Kp_Pamb	0.990556423	* Barometric pressure				
132	Kp_RH	0.998091658	* Relative humidity				
133	Kp_CH	1.000586615	* C/H gas fuel ratio				
134	Kp_N2&CO2	1.00000000	* N2+CO2 vol concentration				
135	Kp_freq	1.000251289	* Frequency				

	<b>CLIENT:</b> Enter client name here		<b>Enter Calculation Number Here</b>				
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	<b>LOCATION:</b> Delimara		0		GL		
<b>CALCULATION TITLE:</b> Performance degradation evaluation							
<b>DESCRIPTION:</b> Performance degradation evaluation							
136	Kpf	0.996432355	* Power Factor				
137	Kpdpin	1	* Inside control volume				
138	Kpdpout	1	* inside control volume				
139		0.969592184					
140							
141	Kh_TO	1.00400889					
142	Kh_CH	1.000499349					
143	Kh_N2&CO2	1.0000					
144	Khdpin	0.99783997					
145	Khdpout	0.998806313					
146	Kh_freq	1.000252734					
147	Khpf	0.996432355	Same as in power				
148	KhTfuel	1.000301983					
149		1.004868103					
150							
151							
152	Pgross_corrected (MW):	46.5474902					
153	Pgross_corrected new (MW):	46.756	*Simple cycle performance test report				
154							
155	<b>Gross power degradation (%):</b>		<b>0.45%</b>				
156							
157							
158							
159	<b>GT51 Corrected gross as-new HR (kJ/kWh):</b>	9573	* As per performance test report				
160	<b>LHV energy flow (MJ/s):</b>	126.7	* Coriolis flow meters				
161	<b>LHV energy flow USM (MJ/s):</b>	127.9	*Calculated energy flow from USM and Coriolis				
162	<b>Gross LHV Electrical efficiency (%):</b>	36.4%					
163	<b>Measured Gross LHV HR (kJ/kWh)</b>	9504.8					
164	<b>Corrected gross LHV HR (kJ/kWh):</b>	9551.0					
165	<b>HR degradation ΔHR (%)</b>		<b>-0.23%</b>				
166							
167							
168							
169	<b>GT52 CORRECTION</b>						
170							
171							
172							
173	Kp_TO	0.986015651	* Air inlet T				
174	Kp_Pamb	0.990556423	* Barometric pressure				
175	Kp_RH	0.998468186	* Compressor inlet T				
176	Kp_CH	1.000598645	* C/H gas fuel ratio				
177	Kp_N2&CO2	1.00000000	* N2+CO2 vol concentration				
178	Kp_freq	0.999936064	* Frequency				
179	Kpf	0.996454999	* Power Factor				
180	Kpdpin	1	* GT compressor air intake pressure drop				

	<b>CLIENT:</b> Enter client name here		<b>Enter Calculation Number Here</b>				
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	<b>LOCATION:</b> Delimara		0		GL		
<b>CALCULATION TITLE:</b> Performance degradation evaluation							
<b>DESCRIPTION:</b> Performance degradation evaluation							
181	Kdpout	1	* exhaust pressure drop				
182		0.96966266					
183							
184	Kh_TO	1.00400889					
185	Kh_CH	1.000499349					
186	Kh_N2&CO2	1.0000					
187	Khdpin	0.997902645					
188	Khdpout	0.998537206					
189	Kh_freq	1.000246072					
190	Khpf	0.996454999	Same as in power				
191	KhTfuel	1.000301983					
192		1.00463094					
193							
194							
195	Pgross_corrected (MW):	46.071					
196	Pgross_corrected new (MW):	46.558					
197							
198	<b>Gross power degradation (%):</b>	<b>1.045%</b>	*Simple cycle performance test report				
199							
200							
201							
202	<i>GT52 Corrected gross as-new HR (kJ/kWh):</i>	<i>9617</i>					
203	<i>LHV energy flow (MJ/s):</i>	<i>125.8308429</i>	*Coriolis flow meters				
204	<i>LHV energy flow USM (MJ/s):</i>	<i>126.9926418</i>					
205	<i>Gross LHV Electrical efficiency (%):</i>	<i>37.0%</i>					
206	<i>Measured Gross LHV HR (kJ/kWh)</i>	<i>9534.115144</i>					
207	<i>Corrected gross LHV HR (kJ/kWh):</i>	<i>9578.267059</i>					
208	<b>HR degradation ΔHR (%)</b>	<b>-0.40%</b>					
209							
210							
211	<b>GT53 CORRECTION</b>						
212							
213							
214							
215	Kp_TO	0.986015651	* Air inlet T				
216	Kp_Pamb	0.990556423	* Barometric pressure				
217	Kp_RH	0.998361082	* Compressor inlet T				
218	Kp_CH	1.000598645	* C/H gas fuel ratio				
219	Kp_N2&CO2	1.00000000	* N2+CO2 vol concentration				
220	Kp_freq	1.000217164	* Frequency				
221	Kpf	0.996445699	* Power Factor				
222	Kdpin	1	* GT compressor air intake pressure drop				
223	Kdpout	1	* exhaust pressure drop				
224		0.969822154					
225							

	<b>CLIENT:</b> Enter client name here		<b>Enter Calculation Number Here</b>				
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	<b>LOCATION:</b> Delimara		0		GL		
<b>CALCULATION TITLE:</b> Performance degradation evaluation							
<b>DESCRIPTION:</b> Performance degradation evaluation							
226	Kh_TO	1.00400889					
227	Kh_CH	1.000499349					
228	Kh_N2&CO2	1.0000					
229	Khdpin	1					
230	Khdpout	1					
231	Kh_freq	1.000252191					
232	Khpf	0.996445699	Same as in power				
233	KhTfuel	1.000301983					
234		1.008232829					
235							
236							
237	Pgross_corrected (MW):	46.458					
238	Pgross_corrected new (MW):	46.669	*as per Performance test report rev. D				
239							
240	Gross power degradation (%): 0.45%		*Simple cycle performance test report				
241							
242	GT53 Corrected gross as-new HR (kJ/kWh):	9594					
243	LHV energy flow (MJ/s):	125.8117253	*from coriollis				
244	LHV energy flow USM (MJ/s)	126.9733476					
245	Gross LHV Electrical efficiency (%):	36.6%					
246	Measured Gross LHV HR (kJ/kWh)	9454.9					
247	Corrected gross LHV HR (kJ/kWh):	9532.7					
248	HR degradation ΔHR (%): -0.64%						
249							
250	<b>OPEN CYCLE OVERALL PERFORMANCE</b>						
251							
252							
253	Simple cycle overall performance:						
254	Gross corrected Pout (MW):	139.08					
255	Net corrected Pout (MW):	137.80	* Assuming aux load same as in Perf test				
256	Net as new corrected Pout (MW):	138.700	* as simple cycle performance test report				
257	Poutput degradation: 0.651%						
258	Corrected gross as new HR (kJ/kWh):	9594	* as simple cycle performance test report				
259	Corrected net as new HR (kJ/kWh):	9682	* as simple cycle performance test report				
262	Corrected net LHV HR (kJ/kWh)	9642.3					
263	HR degradation ΔHR (%): -0.41%						
264							
265							
266	<b>Steam Turbine</b>						
267							
268							
269	*note that for ST some function calls a DELTA rather than absolute value						
270	Kp_TO	1.006462963	* Air inlet T				
271	Kp_Pamb	0.990693096	* Barometric pressure				
272	Kp_RH	1.002513161	* Relative Humidity				

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	<b>LOCATION:</b> Delimara		0		GL		
<b>CALCULATION TITLE:</b> Performance degradation evaluation							
<b>DESCRIPTION:</b> Performance degradation evaluation							
273	Kp_CH	0.999619164	* Gas fuel C/H ratio				
274	Kp_freq	0.99993194	* Frequency				
275	Kp_N2&CO2	0.99996603	* C/H gas fuel ratio				
276	Kpf	0.9999550020	* N2+CO2 vol concentration				
277	Kpstcwf	1.000000233	* CW flow variation				
278	Kpstcwt:	1.000148598	* CW T variation				
279		0.999591435					
280							
281	Corrected Gross ST Pout (MWe):	67.04934293					
282	Corrected Gross new ST Pout (MWe):	69.006					
283							
284	<b>COMBINED CYCLE OVERALL PERFORMANCE</b>						
285							
286							
287	<i>Combined cycle overall performance:</i>						
288	GT Gross corrected Pout (MW):	147.69	* IIB correction applied				
289	ST Gross Corrected Pout (MW):	67.05	* IIB flow degradation corrected				
290	Total Gross Corrected Pout(MW):	214.735					
291	Total Gross new corrected Pout(MW):	216.387	* as per combined cycle performance test report				
292	<b>Poutput degradation:</b>	<b>0.763%</b>	* Gross basis				
293	Aux. Load (kW):	3828.1	* see worksheet Elect.				
294	Regas Load (MW)	2.48	*52BAC Watt meter				
295	CW Load (MW):	1.13	*BBA Watt meter				
296							
297	<b>Total Net Corrected Pout(MW):</b>	<b>208.423</b>					
298							
299	<b>Poutput degradation:</b>	<b>0.462%</b>	*Net basis as in PPA				
300							
303	Gross Heat Flow (kJ/s)	391.9					
304	Corrected gross LHV HR (kJ/kWh):	6570.8					
305	Corrected net LHV HR (kJ/kWh)	6769.8					
306	Corrected net LHV HR (kJ/kWh)	6654.3	*REGAS load as net Poutput				
307	Corrected new net LHV HR (kJ/kWh)	6541.0					
	Corrected new gross LHV HR (kJ/kWh)	6460.0					
308	<b>Net HR degradation ΔHR (%)</b>	<b>3.50%</b>					
309							
	<b>Gross HR degradation ΔHR (%)</b>	<b>1.72%</b>					
310	<b>Net HR degradation ΔHR (%)</b>	<b>1.73%</b>	* REGAS load and CW load accounted as net Poutput				
311							
312							
313							