Capstone C-600-S SN 9269 History, Inspection, and Load Test Results.

History

C-600-S SN 9269 was manufactured by Capstone on 12-2-2016, it was purchased by Horizon, and commissioned on 3-9-2017 where it ran at a production facility supporting pump, compressor, controls, and heat trace loads. It ran for ~2300 hours prior to being shut down as utility power was made available. The turbine was moved from the field to Horizon's yard where it received storage maintenance consisting of battery charges, engine rotations, and sealing/desiccant placement into the engines. The storage maintenance has been kept current by Horizon.

Inspection, Load Testing

This system received electrical, and mechanical inspections, fuel system and combustion components checked. The wake batteries were replaced, along with the Controller UPS batteries. The main batteries were load tested and charged. The unit was then load tested, this consisted of a proper warm up and idle period, then load tested for the manufacturer recommended load test. Once complete and data recorded the load was reduced the turbine idled and shutdown. The main batteries were then charged and disconnected along with the wake batteries to prevent discharge prior to commissioning.

Bay B

ON Select All — MicroTurbine Data 1 — System: 9269 B

No	Parameter (Units)	Value	Record	No	Parameter (Units)	Value	Record	No	Parameter (Units)	Value	Record	No	Parameter (Units)	Value	Record
1	Control Date	4/19/202	ON	28	Power Demand (W)	112565	ON	55	Bat Avg Current (A)	2.4	ON	82	Inv Quadrature Curr (A)	3.2	ON
2	Control Time	14:15:40	ON	29	Power Supply Voltage (V)	25.4	ON	56	Bat Volts (Vdc)	298	ON	83	Output Frequency (Hz)	60.0	ON
3	Engine Speed (rpm)	55406	ON	30	Start Command (0/1)	1	ON	57	BC DC Bus (V)	775	ON	84	Output Phase A Mag (V)	390	ON
4	Main Gen Power (W)	123968	ON	31	RFC Command	0	ON	58	Bat Avg Power (W)	898	ON	85	Output Phase B Mag (V)	390	ON
5	TET#1 (°F)	1163.5	ON	32	RFC Control Mode	0	ON	59	Bat kWH (kWH)	1081	ON	86	Output Phase C Mag (V)	391	ON
6	TET#2 (°F)	1164.0	ON	33	Fuel Inlet P LP (psig)	0.0	ON	60	Battery State	4	ON	87	Output Current Phase A (A	134.0	ON
7	Turbine Exit Temp (°F)	1163.9	ON	34	Fuel Outlet P LP (psig)	0.0	ON	61	Charge Type	0	ON	88	Output Current Phase B (A	134.0	ON
8	Compressor In Temp (°F)	68.0	ON	35	RFC Temp (°F)	0.0	ON	62	Bat Charg Phase No.	0	ON	89	Output Current Phase C (A	136.0	ON
9	Valve Position Feedback %	0	ON	36	RFC Speed (rpm)	0	ON	63	Bat Charg Cur Dmd (A)	0	ON	90	Output Current Neutral (A)	2.1	ON
10	AFR	0	ON	37	RFC Current FB (A)	0.0	ON	64	Bat Charging Volt Dmd (V)	339	ON	91	Output Voltage Phase A (V	275.7	ON
11	Wair (pph)	2935	ON	38	RFC Injector State	0	ON	65	Inv DC Bus Volts (Vdc)	776.1	ON	92	Output Voltage Phase B (V	276.0	ON
12	Ambient Pressure (psia)	12.3	ON	39	Fuel Valve Command (%)	58.9	ON	66	Inv Direct Curr (A)	190.1	ON	93	Output Voltage Phase C (V	276.3	ON
13	Wenergy (btu/sec)	448.6	ON	40	Fuel Inlet Pres (psig)	73.7	ON	67	LFC Pump PWM (%)	0.0	ON	94	Output Power Phase A (W)	37315	ON
14	Incident Record	0	ON	41	Fuel Valve Inj State	5.0	ON	68	AA Pressure (psig)	0.0	ON	95	Output Power Phase B (W)	37117	ON
15	Combustor Starts	148	ON	42	Fuel Valve Temp (°F)	80.6	ON	69	LFC Injector State	0.0	ON	96	Output Power Phase C (W)	37820	ON
16	Starts	104	ON	43	Fuel Valve Ex P (psig)	0.0	ON	70	LFC Pressure Command (ps	0	ON	97	Output Power (W)	112560	ON
17	TET Setpoint (°F)	1164.0	ON	44	Bat Therm.Temp (°F)	53.6	ON	71	LFC Pressure Feedback (ps	0	ON	98	Inv Heat Sink Temp (°F)	87.8	ON
18	Hours	2303:23:	ON	45	Bat PM Temp (°F)	32.0	ON	72	System Prime Status	0	ON	99	Output Current Limit (A)	438	ON
19	Combustor Time	2296:07:	ON	46	BC Heatsink T (°F)	78.8	ON	73	LFC Prime	0	ON	100	Gen Direct Current (A)	2.6	ON
20	System Severity Level	0	ON	47	BC Board T (°F)	75.2	ON	74	Boost Pump	0	ON	101	Gen Quad Current (A)	-214.7	ON
21	System State	0x2007	ON	48	Bat SOC (%)	82.9	ON	75	LFC Prime state	0	ON	102	Gen Direct Voltage (V)	65.3	ON
22	Sys Config/Eng State	0x0000	ON	49	Bat Base SOC (%)	90.6	ON	76	Boost Pump Status	0	ON	103	Gen Quadrature Voltage (V	367.1	ON
23	Power Enable	1	ON	50	Bat Ideal SOC (%)	93.6	ON	77	Drain Pump Status	0	ON	104	Gen Speed Cmnd (rpm)	55430.0	ON
24	RFC Power (W)	0.0	ON	51	Bat Last SOC (%)	3.0	ON	78	Prime Sol. Status	0	ON	105	Brake Voltage Cmnd (V)	784.9	ON
25	Discrete Outputs	0xec60	ON	52	Bat Leg A (A)	-0.0	ON	79	RFC DC Bus (V)	0	ON	106	Gen Current Feedback (A)	0.0	ON
26	Discrete Inputs	0x1b01	ON	53	Bat Leg B (A)	1.2	ON	80	LFC Pump Speed (%rpm)	0	ON	107	Gen Current Limit (A)	455.6	ON
27	Main Board Temp (°F)	63.9	ON	54	Bat Leg C (A)	1.2	ON	81	---	0	ON	108	Gen Heat Sink Temp (°F)	96.8	ON

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Bay C

ON Select All — **MicroTurbine Data 1** — System: 9269 C

No	Parameter (Units)	Value	Record	No	Parameter (Units)	Value	Record	No	Parameter (Units)	Value	Record	No	Parameter (Units)	Value	Record
1	Control Date	4/19/202	ON	28	Power Demand (W)	112225	ON	55	Bat Avg Current (A)	-0.1	ON	82	Inv Quadrature Curr (A)	3.5	ON
2	Control Time	13:57:54	ON	29	Power Supply Voltage (V)	25.2	ON	56	Bat Volts (Vdc)	316	ON	83	Output Frequency (Hz)	60.0	ON
3	Engine Speed (rpm)	55260	ON	30	Start Command (0/1)	1	ON	57	BC DC Bus (V)	756	ON	84	Output Phase A Mag (V)	390	ON
4	Main Gen Power (W)	121200	ON	31	RFC Command	0	ON	58	Bat Avg Power (W)	-5	ON	85	Output Phase B Mag (V)	391	ON
5	TET#1 (°F)	1171.9	ON	32	RFC Control Mode	0	ON	59	Bat kWH (kWH)	1534	ON	86	Output Phase C Mag (V)	391	ON
6	TET#2 (°F)	1171.0	ON	33	Fuel Inlet P LP (psig)	0.0	ON	60	Battery State	4	ON	87	Output Current Phase A (A	135.0	ON
7	Turbine Exit Temp (°F)	1171.4	ON	34	Fuel Outlet P LP (psig)	0.0	ON	61	Charge Type	0	ON	88	Output Current Phase B (A	135.0	ON
8	Compressor In Temp (°F)	71.8	ON	35	RFC Temp (°F)	0.0	ON	62	Bat Charg Phase No.	0	ON	89	Output Current Phase C (A	137.0	ON
9	Valve Position Feedback %	0	ON	36	RFC Speed (rpm)	0	ON	63	Bat Charg Cur Dmd (A)	0	ON	90	Output Current Neutral (A)	2.1	ON
10	AFR	0	ON	37	RFC Current FB (A)	0.0	ON	64	Bat Charging Volt Dmd (V)	339	ON	91	Output Voltage Phase A (V	276.0	ON
11	Wair (pph)	2880	ON	38	RFC Injector State	0	ON	65	Inv DC Bus Volts (Vdc)	760.3	ON	92	Output Voltage Phase B (V	276.8	ON
12	Ambient Pressure (psia)	12.2	ON	39	Fuel Valve Command (%)	56.6	ON	66	Inv Direct Curr (A)	192.2	ON	93	Output Voltage Phase C (V	277.0	ON
13	Wenergy (btu/sec)	436.1	ON	40	Fuel Inlet Pres (psig)	78.7	ON	67	LFC Pump PWM (%)	0.0	ON	94	Output Power Phase A (W)	37458	ON
14	Incident Record	0	ON	41	Fuel Valve Inj State	5.0	ON	68	AA Pressure (psig)	0.0	ON	95	Output Power Phase B (W)	37540	ON
15	Combustor Starts	141	ON	42	Fuel Valve Temp (°F)	78.8	ON	69	LFC Injector State	0.0	ON	96	Output Power Phase C (W)	38002	ON
16	Starts	127	ON	43	Fuel Valve Ex P (psig)	0.0	ON	70	LFC Pressure Command (p	0	ON	97	Output Power (W)	113340	ON
17	TET Setpoint (°F)	1171.0	ON	44	Bat Therm.Temp (°F)	55.4	ON	71	LFC Pressure Feedback (p	0	ON	98	Inv Heat Sink Temp (°F)	96.8	ON
18	Hours	1991:09:	ON	45	Bat PM Temp (°F)	32.0	ON	72	System Prime Status	0	ON	99	Output Current Limit (A)	438	ON
19	Combustor Time	1983:43:	ON	46	BC Heatsink T (°F)	80.6	ON	73	LFC Prime	0	ON	100	Gen Direct Current (A)	3.5	ON
20	System Severity Level	0	ON	47	BC Board T (°F)	71.6	ON	74	Boost Pump	0	ON	101	Gen Quad Current (A)	-212.7	ON
21	System State	0x2007	ON	48	Bat SOC (%)	79.4	ON	75	LFC Prime state	0	ON	102	Gen Direct Voltage (V)	65.9	ON
22	Sys Config/Eng State	0x0000	ON	49	Bat Base SOC (%)	86.5	ON	76	Boost Pump Status	0	ON	103	Gen Quadrature Voltage (V	359.5	ON
23	Power Enable	1	ON	50	Bat Ideal SOC (%)	86.9	ON	77	Drain Pump Status	0	ON	104	Gen Speed Cmnd (rpm)	55284.0	ON
24	RFC Power (W)	0.0	ON	51	Bat Last SOC (%)	0.4	ON	78	Prime Sol. Status	0	ON	105	Brake Voltage Cmnd (V)	784.9	ON
25	Discrete Outputs	0xec60	ON	52	Bat Leg A (A)	0.0	ON	79	RFC DC Bus (V)	0	ON	106	Gen Current Feedback (A)	0.0	ON
26	Discrete Inputs	0x1b01	ON	53	Bat Leg B (A)	-0.1	ON	80	LFC Pump Speed (%rpm)	0	ON	107	Gen Current Limit (A)	455.6	ON
27	Main Board Temp (°F)	68.1	ON	54	Bat Leg C (A)	-0.1	ON	81	---	0	ON	108	Gen Heat Sink Temp (°F)	105.8	ON

Bay D

ON Select All — **MicroTurbine Data 1** — System: 9269 D

No	Parameter (Units)	Value	Record	No	Parameter (Units)	Value	Record	No	Parameter (Units)	Value	Record	No	Parameter (Units)	Value	Record
1	Control Date	4/19/202	ON	28	Power Demand (W)	113214	ON	55	Bat Avg Current (A)	1.2	ON	82	Inv Quadrature Curr (A)	2.6	ON
2	Control Time	13:25:03	ON	29	Power Supply Voltage (V)	25.0	ON	56	Bat Volts (Vdc)	349	ON	83	Output Frequency (Hz)	60.0	ON
3	Engine Speed (rpm)	55406	ON	30	Start Command (0/1)	1	ON	57	BC DC Bus (V)	758	ON	84	Output Phase A Mag (V)	391	ON
4	Main Gen Power (W)	122619	ON	31	RFC Command	0	ON	58	Bat Avg Power (W)	542	ON	85	Output Phase B Mag (V)	391	ON
5	TET#1 (°F)	1164.0	ON	32	RFC Control Mode	0	ON	59	Bat kWH (kWH)	1141	ON	86	Output Phase C Mag (V)	390	ON
6	TET#2 (°F)	1163.5	ON	33	Fuel Inlet P LP (psig)	0.0	ON	60	Battery State	6	ON	87	Output Current Phase A (A	136.0	ON
7	Turbine Exit Temp (°F)	1163.8	ON	34	Fuel Outlet P LP (psig)	0.0	ON	61	Charge Type	5	ON	88	Output Current Phase B (A	134.0	ON
8	Compressor In Temp (°F)	68.8	ON	35	RFC Temp (°F)	0.0	ON	62	Bat Charg Phase No.	2	ON	89	Output Current Phase C (A	136.0	ON
9	Valve Position Feedback %	0	ON	36	RFC Speed (rpm)	0	ON	63	Bat Charg Cur Dmd (A)	2	ON	90	Output Current Neutral (A)	1.8	ON
10	AFR	0	ON	37	RFC Current FB (A)	0.0	ON	64	Bat Charging Volt Dmd (V)	360	ON	91	Output Voltage Phase A (V	276.9	ON
11	Wair (pph)	2909	ON	38	RFC Injector State	0	ON	65	Inv DC Bus Volts (Vdc)	760.3	ON	92	Output Voltage Phase B (V	276.7	ON
12	Ambient Pressure (psia)	12.2	ON	39	Fuel Valve Command (%)	53.9	ON	66	Inv Direct Curr (A)	191.3	ON	93	Output Voltage Phase C (V	277.1	ON
13	Wenergy (btu/sec)	526.2	ON	40	Fuel Inlet Pres (psig)	84.2	ON	67	LFC Pump PWM (%)	0.0	ON	94	Output Power Phase A (W)	37639	ON
14	Incident Record	0	ON	41	Fuel Valve Inj State	5.0	ON	68	AA Pressure (psig)	0.0	ON	95	Output Power Phase B (W)	37282	ON
15	Combustor Starts	144	ON	42	Fuel Valve Temp (°F)	104.0	ON	69	LFC Injector State	0.0	ON	96	Output Power Phase C (W)	38029	ON
16	Starts	124	ON	43	Fuel Valve Ex P (psig)	0.0	ON	70	LFC Pressure Command (p	0	ON	97	Output Power (W)	113209	ON
17	TET Setpoint (°F)	1164.0	ON	44	Bat Therm.Temp (°F)	55.4	ON	71	LFC Pressure Feedback (p	0	ON	98	Inv Heat Sink Temp (°F)	96.8	ON
18	Hours	2089:14:	ON	45	Bat PM Temp (°F)	32.0	ON	72	System Prime Status	0	ON	99	Output Current Limit (A)	438	ON
19	Combustor Time	2082:20:	ON	46	BC Heatsink T (°F)	80.6	ON	73	LFC Prime	0	ON	100	Gen Direct Current (A)	-5.3	ON
20	System Severity Level	0	ON	47	BC Board T (°F)	71.6	ON	74	Boost Pump	0	ON	101	Gen Quad Current (A)	-215.3	ON
21	System State	0x2007	ON	48	Bat SOC (%)	75.1	ON	75	LFC Prime state	0	ON	102	Gen Direct Voltage (V)	68.6	ON
22	Sys Config/Eng State	0x0000	ON	49	Bat Base SOC (%)	82.2	ON	76	Boost Pump Status	0	ON	103	Gen Quadrature Voltage (V	357.7	ON
23	Power Enable	1	ON	50	Bat Ideal SOC (%)	82.2	ON	77	Drain Pump Status	0	ON	104	Gen Speed Cmnd (rpm)	55410.0	ON
24	RFC Power (W)	0.0	ON	51	Bat Last SOC (%)	0.0	ON	78	Prime Sol. Status	0	ON	105	Brake Voltage Cmnd (V)	784.9	ON
25	Discrete Outputs	0xec60	ON	52	Bat Leg A (A)	-0.0	ON	79	RFC DC Bus (V)	0	ON	106	Gen Current Feedback (A)	0.0	ON
26	Discrete Inputs	0x1b01	ON	53	Bat Leg B (A)	0.6	ON	80	LFC Pump Speed (%rpm)	0	ON	107	Gen Current Limit (A)	455.6	ON
27	Main Board Temp (°F)	70.5	ON	54	Bat Leg C (A)	0.6	ON	81	---	0	ON	108	Gen Heat Sink Temp (°F)	107.6	ON

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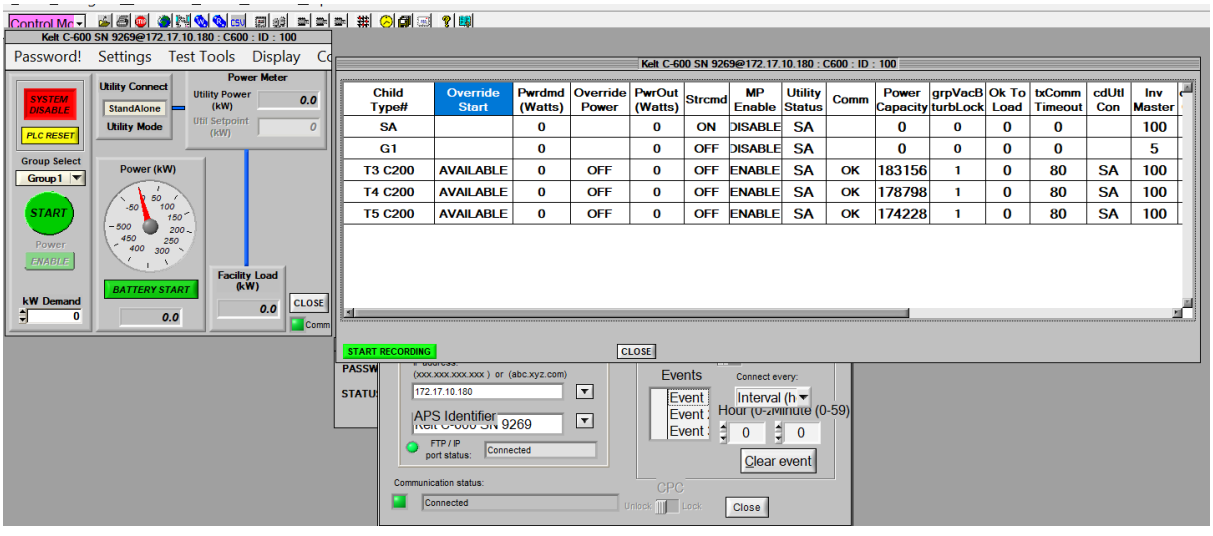
Controller



Child Type#	Override Start	Pwrdmd (Watts)	Override Power	PwrOut (Watts)	Strcmd	MP Enable	Utility Status	Comm	Power Capacity	grpVacB turbLock	Ok To Load	txComm Timeout	cdUtl Con	Inv Master
SA		0		0	ON	DISABLE	SA		0	0	0	0		100
G1		0		0	OFF	DISABLE	SA		0	0	0	0		5
T3 C200	AVAILABLE	0	OFF	0	OFF	ENABLE	SA	OK	183156	1	0	80	SA	100
T4 C200	AVAILABLE	0	OFF	0	OFF	ENABLE	SA	OK	178798	1	0	80	SA	100
T5 C200	AVAILABLE	0	OFF	0	OFF	ENABLE	SA	OK	174228	1	0	80	SA	100

Conclusion

All three bays, and the Controller passed the inspections and load tests with no immediate concerns regarding the long-term operation or reliability of the system. That said it is imperative that these systems receive the suggested maintenance at the suggested intervals to ensure proper operation and uptime.

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