

Date : 10.12.2018 0:54:10
 Company :
 Branch :
 Plant :
 Unit : GTE-160 (V 94.2) Siemens



Conclusion No. 05-O(N)
 on the technical condition of controlled equipment, registered during shutdown

Previous unit shutdowns:

15.05.2018	12.08.2018	14.09.2018	23.10.2018
00:26:00	08:06:00	03:55:00	15:00:00

1. Main events history

Event	Date	Time	Value	MU
Online	10.12.2018	0:00:00	112.9	MW
Start of unloading	10.12.2018	0:01:45	109.3	MW
Load before disconnecting the generator from mains	10.12.2018	0:54:08	1.6	MW
<i>Unloading rate before holding</i>		2.1		MW/min
Generator disconnection from the mains	10.12.2018	0:54:10	0.3	MW
MAX rotation speed during disconnection	10.12.2018	0:54:10	3,000.0	rpm
Closure of natural gas CST	10.12.2018	0:54:21	2,837.4	rpm
Jacking oil pump enabling	10.12.2018	0:57:25	497.1	rpm
Shaft-turning gear enabling	10.12.2018	1:03:23	177.3	rpm
Rotor shutdown		-	-	rpm

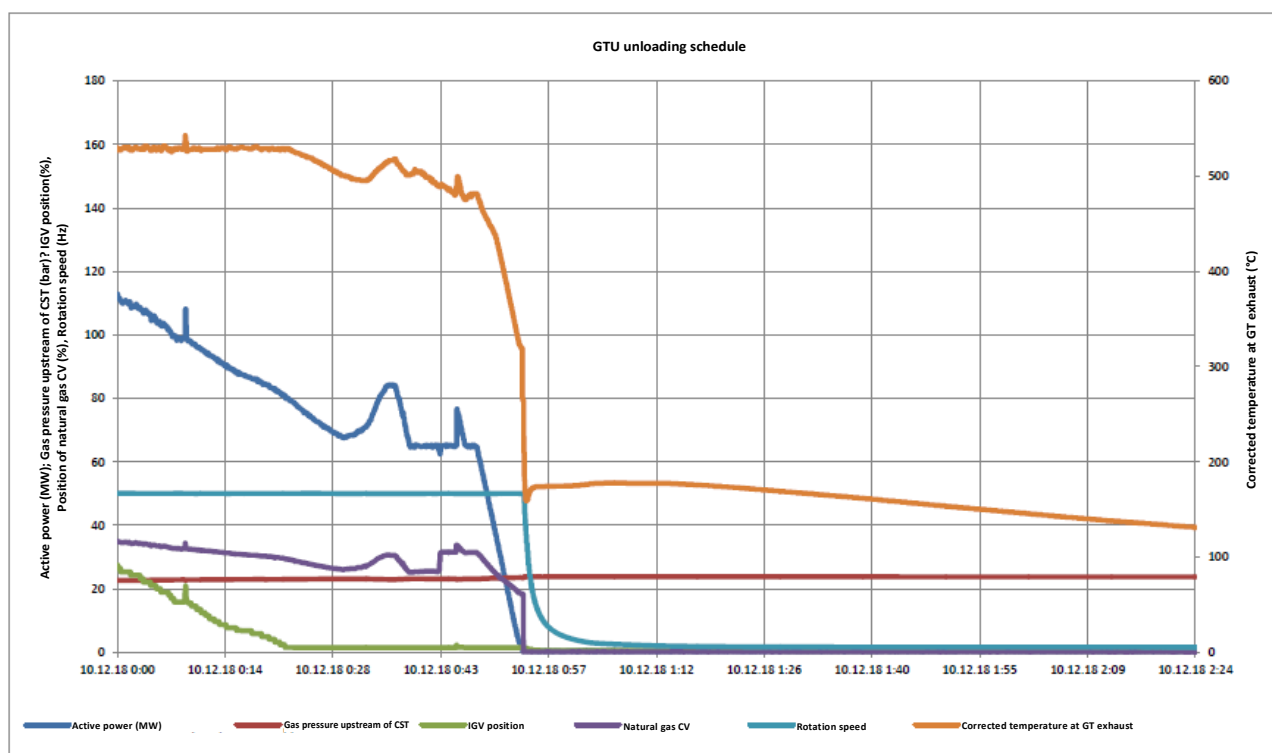


Fig. 1 Main parameters of GTU during unloading and shutdown.

Change in MTBF indicators during shutdown

Number of start-ups	Total EH, hours		Dynamic MTBF, hours		Operation with a frequency of <47.5 or >51.5 Hz, s	
	before	after	before	after	before	after
-	37,134.0	0.0	2,846.9	0.0	1.0	0.0

Normal shutdown with disconnection from the line with a load of 1.6 MW.

2. Air duct control

Parameter / Mode	Value		
	Premix	Diffusion	GTU shutdown
Time	10.12.2018 0:42:38	10.12.2018 0:43:10	10.12.2018 0:55:10
Outside air temperature, °C	-3.4	-3.4	-3.4
Outside air humidity, %	81.0	81.0	80.7
Pressure upstream of compressor, mbar	1,016.6	1,016.1	1,019.5
Pressure downstream of compressor, bar	7.4	7.4	1.5
Air temperature upstream of compressor, °C	5.3	5.3	5.3
Air temperature downstream of compressor, °C	270.3	270.3	184.7
IGV position, %	1.4	1.4	0.9
Pressure difference at heat exchanger, Pa	-	-	-
Pressure difference at mist separator, Pa	36.1	36.1	35.7
Pressure difference at pre-filter, Pa	108.2	108.2	64.3
Pressure difference at fine filter, Pa	110.0	109.8	61.2
Pressure difference at air intake system filter unit, Pa	239.6	236.7	98.5
Position of anti-surge valve ASV-1 downstream of the 5th stage	-	-	-
Position of ASV-2 downstream of the 5th stage	-	-	-
Position of ASV-3 downstream of the 10th stage	-	-	-

Values of air pressure difference on the mist separator section vary slightly (≈ 10 Pa) with the GTU load change from 0 to 100%.

3. Control of fuel valves, combustion modes, CC operation

Parameter / Mode	Value		
	Premix	Diffusion	GTU shutdown
Time	10.12.2018 0:42:38	10.12.2018 0:43:10	10.12.2018 0:55:10
GTU active power, MW	65.2	64.7	0.4
Corrected T downstream of GT, °C	491.9	490.3	170.0
Gas pressure upstream of CST, bar	23.1	23.1	23.8
Fuel gas flow rate, m ³ /hours	-	-	-
Natural gas CV position, %	25.5	31.3	0.1
Pilot gas CV position, %	56.9	10.1	0.4
CST state	open	open	closed
LCC pressure difference, mbar	150.6	150.8	22.4
RCC pressure difference, mbar	145.8	139.9	33.7
Pulsations in LCC, mbar	4.3	5.7	0.7
Pulsations in RCC, mbar	3.6	4.9	0.9

Normal transition of the combustion mode

No deviations from the WD were detected.

4. Control of lubrication system and HS AGS (hydraulic section of automatic governing system)

Parameter / Mode	Value		
	Online	Disconnection from the line	Shaft-turning gear
Time	10.12.2018 0:00:00	10.12.2018 0:54:10	10.12.2018 1:10:30
GTU rotation speed, rpm	3,001.9	3,001.0	129.8
Oil level in the oil tank, mm	394.1	394.3	387.5
Oil temperature in the oil tank, °C	58.2	57.4	50.7
Temperature upstream of bearings, °C	46.4	45.5	42.4
Pressure upstream of bearings, bar	2.4	1.6	1.6
MOP current consumption	32.3	31.9	36.6
AOP current consumption	-0.1	-0.1	40.0
EOP current consumption	0.0	0.0	0.0
Lift oil pump current consumption	32.3	31.9	36.6
Oil temperature at the discharge from the generator bearings (MAX), °C	64.6	63.9	50.5
Oil temperature in the AGS (automatic governing system), °C	52.5	55.2	53.3
Oil pressure in the AGS, bar	159.9	160.2	44.8
GSOP-A (governing system oil pump) current consumption, A	13.1	12.6	0.1
GSOP-B current consumption, A	0.0	0.0	0.0

During the shaft-turning device operation, the oil pressure upstream of bearings (10MBV26CP101) varies in the range of 1.2÷1.5 bar, which leads to switching ELOP (10MBV21AP003) on and prohibiting of its switching off

6. Vibration and thermal control

7.1 Maximum values of babbit temperatures, vibrations

Parameter / Mode	Before GTU unloading			Before disconnection from the line		
	T babb, °C	RMS, mm/s	Shaft, μ	T babb, °C	RMS, mm/s	Shaft, μ
Time	10.12.2018 0:01:45			10.12.2018 0:54:08		
Bearing No.1	80.3	2.4	42.4	78.4	2.2	38.1
Bearing No.2	87.2	2.0	0.7	84.7	2.4	0.5
Bearing No.3	63.2	2.7	104.9	62.6	2.7	105.1
Bearing No.4	67.4	1.6	69.9	66.7	1.9	69.5
Bearing No.2 (st.T)	66.3			64.7		
Bearing No.2 (st.G)	68.7			64.2		

Lack of control in the parameter “bearing No. 2 shaft vibration (10MBD12CY940XQ01)” caused by the measuring channel failure.

7. Run-down parameters

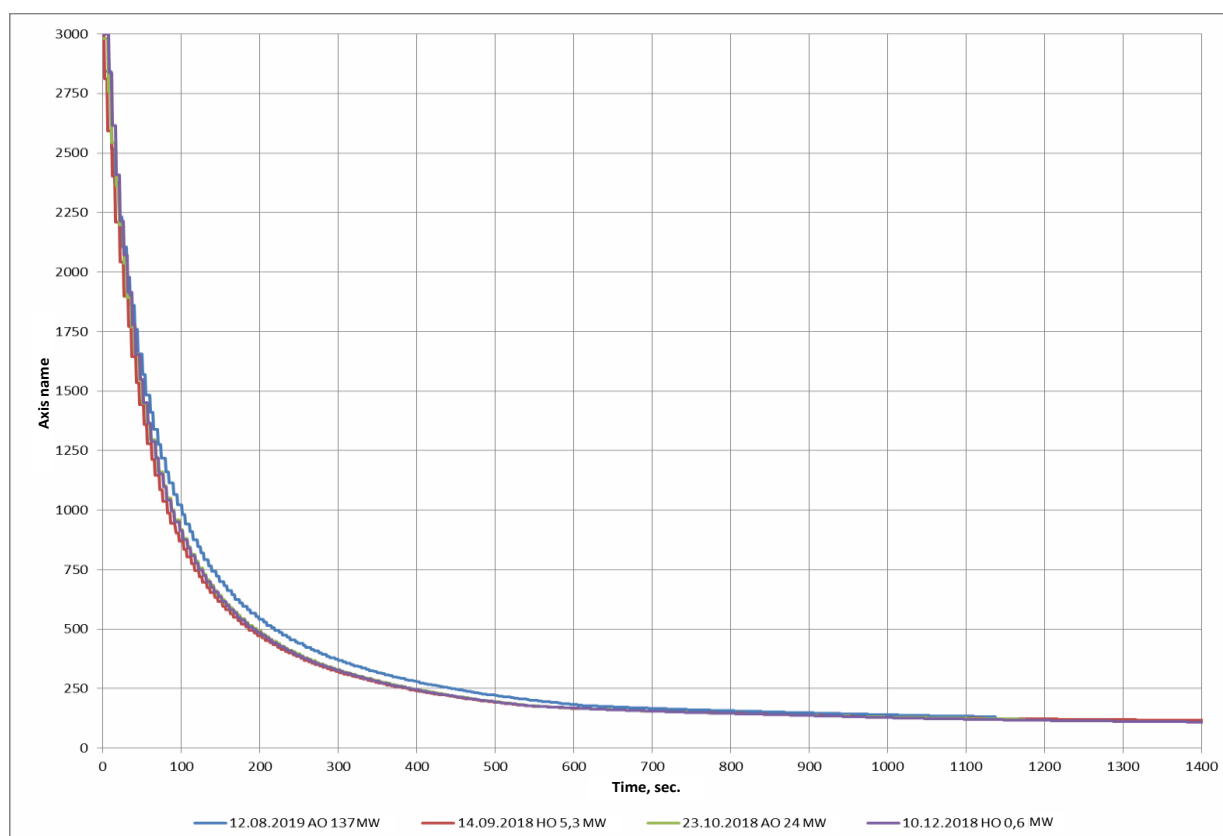


Fig.2 GTU run-downs.

Run-down start (< 3000 rpm)	Run-down time (< 250 rpm), (sec)	Av. time of previous 3 run-downs (sec)	Deviation of run-down time (sec)	Stable rotation speed at shaft-turning gear
10.12.2018 0:54:21	385	397	-12	98.8

8.1. Vibration characteristics

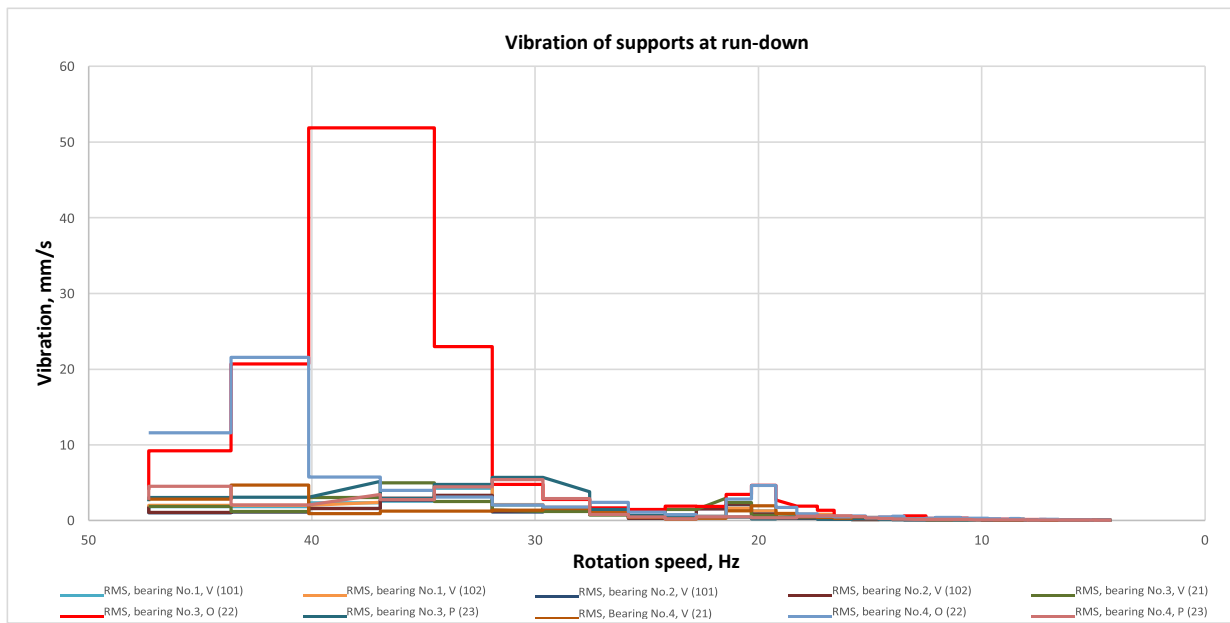


Fig.3 Amplitude-frequency characteristics of supports vibration.

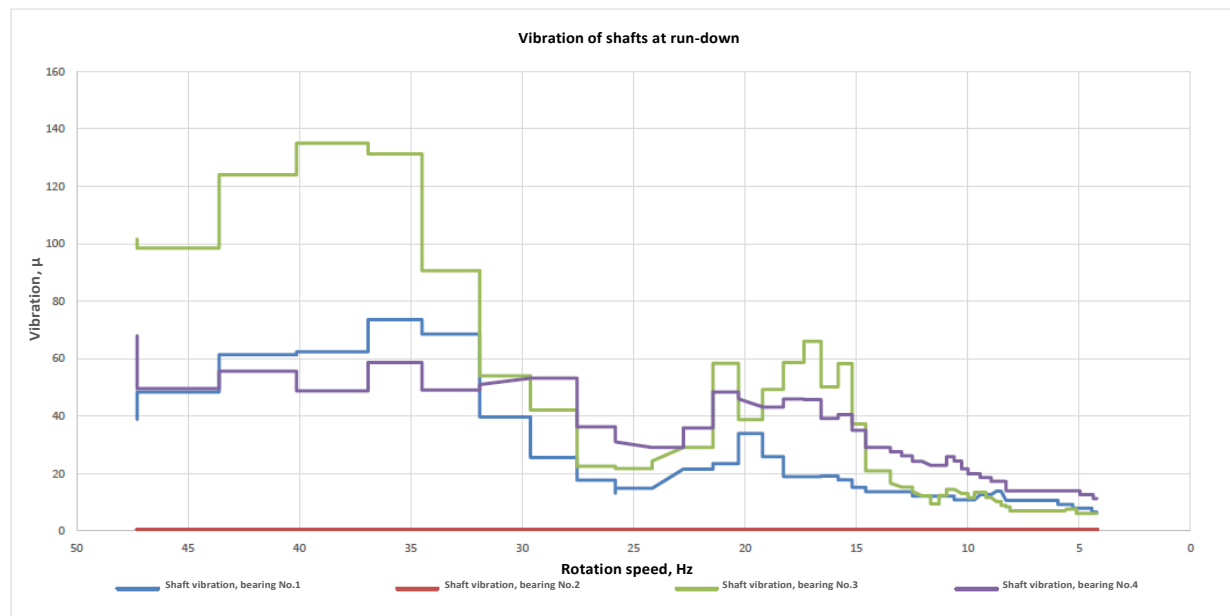


Fig.4 Amplitude-frequency characteristics of shaft train vibration.

Supports	A		B		C		Max. value of previous shutdown		Δ MAX present MAX prev.	
	mm/s	Hz	mm/s	Hz	mm/s	Hz	mm/s	Hz	mm/s	Hz
Bearing 1 (101)	4.24	34.50	2.01	31.91	1.49	21.44	6.1	34.2	-1.8	0.3
Bearing 1 (102)	4.54	34.50	2.08	31.91	1.62	21.44	6.4	34.2	-1.9	0.3
Bearing 2 (101)	3.23	34.50	2.08	21.44	1.81	50.00	3.7	34.2	-0.5	0.3
Bearing 2 (102)	3.30	34.50	2.16	21.44	1.80	50.00	3.9	34.2	-0.6	0.3
Bearing 3 (V)	4.96	36.92	2.95	22.77	2.35	21.44	4.5	39.9	0.5	-3.0
Bearing 3 (P)	5.70	31.91	5.16	40.13	1.44	27.55	5.9	31.8	-0.2	0.1
Bearing 3 (O)	51.86	40.13	4.77	31.91	4.63	20.29	52.8	39.9	-1.0	0.2
Bearing 4 (V)	4.67	43.61	1.93	20.29	1.56	29.63	3.4	47.2	1.2	-3.6
Bearing 4 (P)	5.38	31.91	4.48	47.29	3.40	40.13	5.3	31.8	0.0	0.1
Bearing 4 (O)	21.54	43.61	5.70	40.13	4.60	20.29	11.8	47.2	9.7	-3.6
Shafts	μ	Hz	μ	Hz	μ	Hz	μ	Hz	μ	Hz
Shaft in bearing No. 1	73.58	34.50	39.65	29.63	-	-	64.4	34.2	9.2	0.3
Shaft in bearing No. 2	-	-	-	-	-	-	-	-	-	-
Shaft in bearing No. 3	135.05	36.92	101.63	47.29	-	-	137.0	34.2	-1.9	2.8
Shaft in bearing No. 4	68.01	47.29	58.64	34.50	55.56	40.13	76.0	49.9	-8.0	-2.6

8.2. Babbit temperature

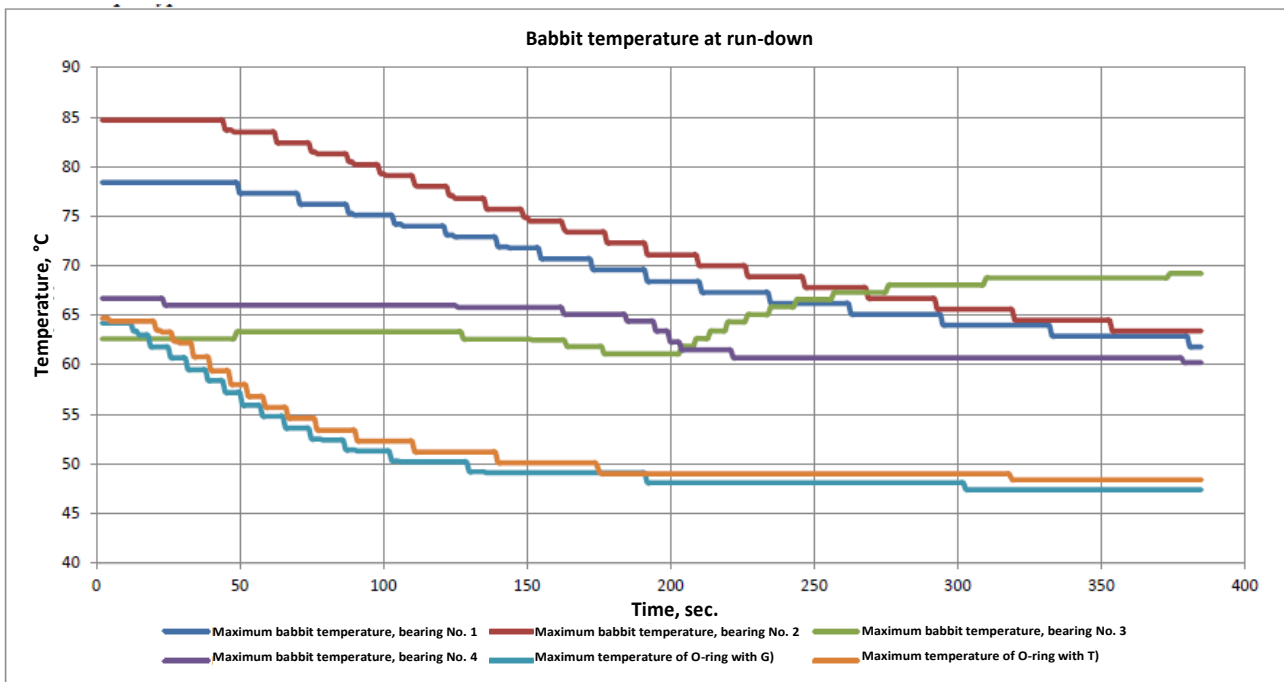


Fig.5 Bearings babbit temperature at run-down.

Rise in bearing No. 3 babbit temperature from 61 °C (at 522 rpm) to 69.2 °C (at 225 rpm).

Maximum temperature of babbit of supports at run-down

Time	Bearing No. 1, °C	Bearing No. 2, °C	Bearing No. 3, °C	Bearing No. 4, °C	Oil upstream of bearings, °C
Present	80.3	87.2	69.2	67.5	46.4
23.10.2018	79.0	84.8	62.0	65.7	47.6
14.09.2018	79.4	78.9	63.6	68.0	47.6

No deviations from the WD were detected.

CONCLUSION

1. *Normal shutdown. No restrictions for the next GT start-up.*

2. *Verify the measuring channel and the sensor measuring air pressure difference at mist separator section (10MBL10CP003), as well as its impulse lines. Compare the actual difference with the minimum difference value for this type of mist separator according to the passport.*

3. *To identify and eliminate the causes of oil pressure decrease during the operation of shaft-turning gear, follow the recommendations outlined in the information message IS/18-05 dated 26.10.2018, sent earlier.*

4. *Verify the measuring channel and the sensor measuring shaft vibration of the bearing No. 2 (10MBD12CY940XQ01).*

- High vibration levels (RMS of vibration velocity) were revealed at GT run-down in the axial plane of measurement. Maximum level is marked on the bearing No.3 - 51.8 mm/s. The causes for the high axial vibration can be the flexibility of supports, imbalance of the rotor of turbine-type generator. It is recommended to pull all threaded connections of generator supports No. 3, 4. Perform vibration survey of the unit when working in no-load mode and at run-down (measuring a frequency response from generator and the foundation supports). It is recommended to conduct measurements with a multichannel vibration analyzer with registration of synchronous signals.*
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Chief Dispatcher	<i>/Signature/</i> _____ signature	Full name
Expert on Turbine Equipment	<i>/Signature/</i> _____ signature	Full name
Vibration Expert	<i>/Signature/</i> _____ signature	Full name

Letter E - emergency, N - normal.