PROTOCOL No. 1 / 2026

FOR TESTING THE VIBRATION CONDITION OF THE HYDROGENERATOR AT CHUREKOVSKA SHPP

1. **Date of Test: 30.05.2026**

The test was conducted in accordance with:

- BDS EN 60034-4:2008
- IEEE Std 43:2000
- BDS ISO 10816-5:2002

2. **Hydrogenerator type:** Vertical synchronous generator SGA 9C 06 T, manufactured by Hitzinger

- Rated apparent power: Sn = 1500 kVA
- Rated voltage: Un = 420 V
- Rated current: In = 2062 A
- Rated efficiency: η = 95.8%
- Rated power factor: cosφ = 0.9
- Rated speed: nn = 1000 min^{-1}
- Maximum runaway speed: nmax = 1850 min^{-1}
- Weight: G = 6200 kg
- Front bearing assembly: 6240 M/C3
- Rear bearing assembly: 7320 BECBP

3. Testing of the Electrical Parameters of the Hydrogenerator Stator Winding

3.1 Insulation Resistance Test of the Stator Winding to Ground – 1000 V Megohmmeter

$R_{из15}$	$R_{из60}$	$К_{абс.}$	$I_{утечка}$	t_{ok}
GΩ	**GΩ**	**-**	**μA**	**°C**
1.63	**3.05**	**1.87**	**0.233**	

3.2 Measurement of the DC Resistance of the Hydrogenerator Stator Winding at a Winding Temperature of 36°C

RU = 1.2400 mΩ

RV = 1.2418 mΩ

RW = 1.2560 mΩ

The resistance values of the three phases differ by less than 3%, indicating a completely symmetrical winding.

4. Measurement of the Vibration Condition of the Hydro Unit

The hydro unit consists of the hydrogenerator and the driving turbine.

They are rigidly coupled and their vibration condition is determined during joint operation under load.

The turbine has no independent bearings and is mounted directly on the hydrogenerator shaft.

4.1 Operating Conditions

The hydro unit had been operating continuously for 42 h 33 min.

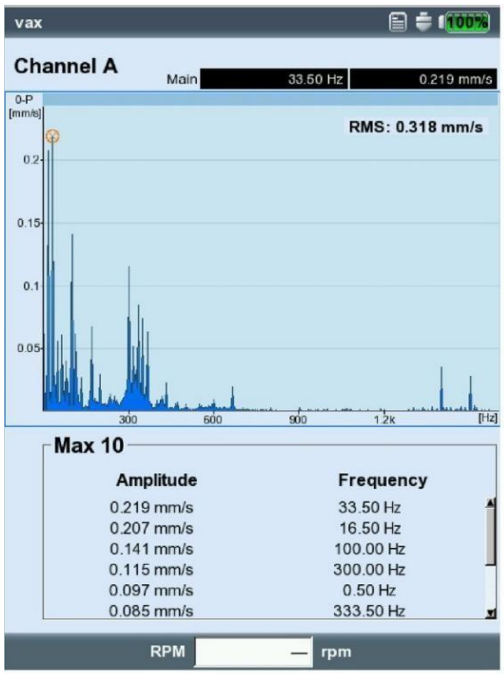
- Ambient temperature: tok = 15.1°C
- Apparent power: S = 1011 kVA
- Active power: P = 910 kW
- Stator current: I = 1280 A
- Stator voltage: U = 428 V
- Phase U temperature: tU = 35°C
- Phase V temperature: tV = 43.2°C
- Phase W temperature: tW = 37°C
- Front bearing temperature: 25.7°C
- Rear bearing temperature: 40.7°C

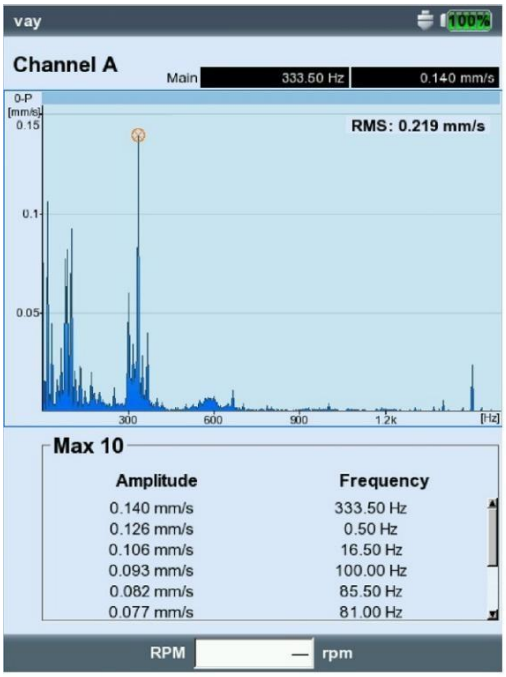
The measurements were carried out at 67.4% of the rated hydrogenerator output.

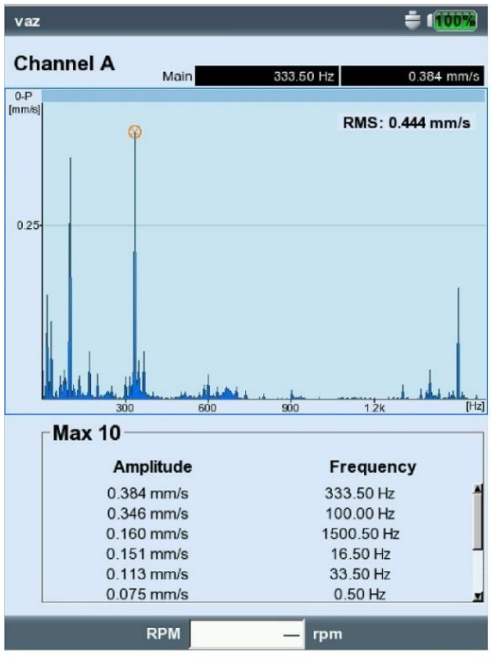
№	Axis	Front Bearing Velocity			Rear Bearing Velocity		
		Acceleration	Acceleration 0< f < 10000 Hz		Acceleration	Acceleration 0< f < 10000 Hz	
			max	rms		max	rms
		v, mm/s	m/s^2	m/s^2	v, mm/s	m/s^2	m/s^2
1	X	0,318	0.936	2.974	0,412	1.065	2.066
2	Y	0,219	0.988	2.342	1,149	0.526	1.296
3	Z	0,444	4.177	4.097	1,691	2.861	3.290

Vibration velocity and acceleration diagrams of the front bearing along the three axes X, Y, and Z.

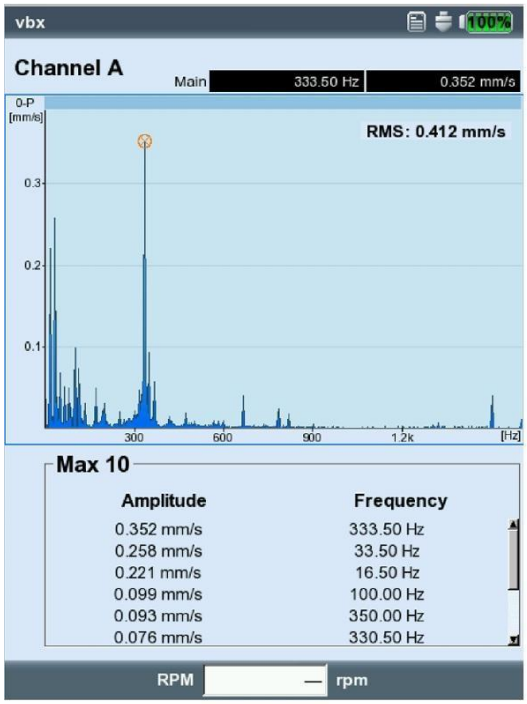
- **Vibration velocity diagrams of the front bearing**

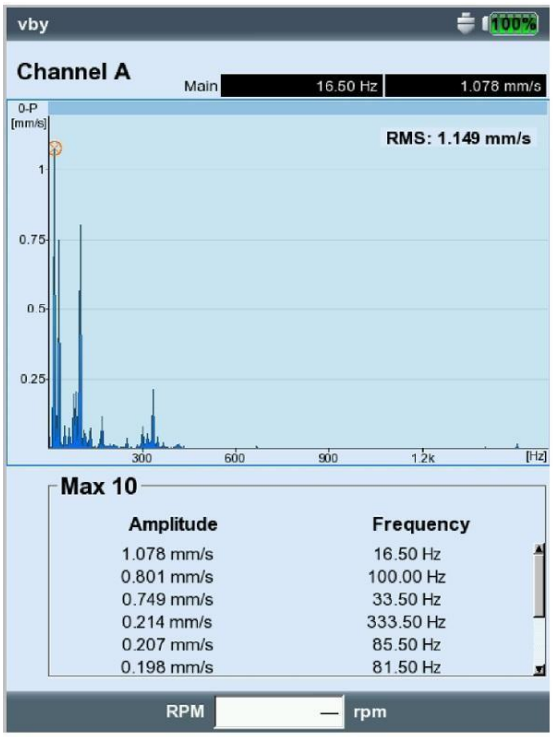


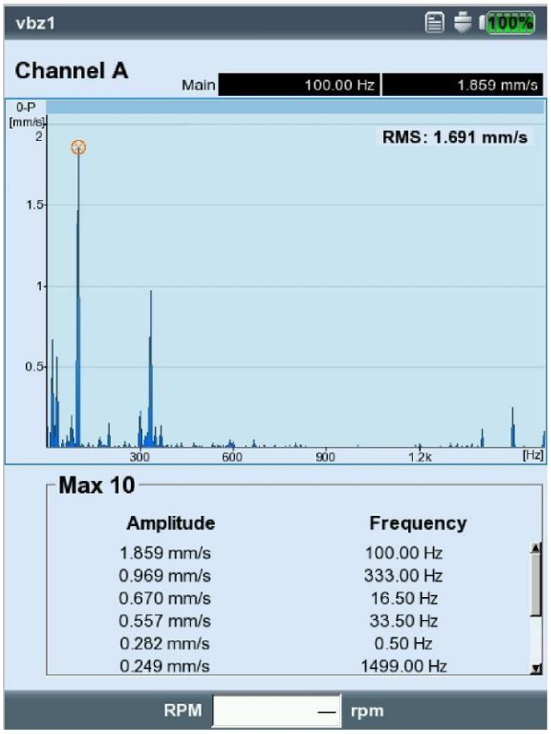




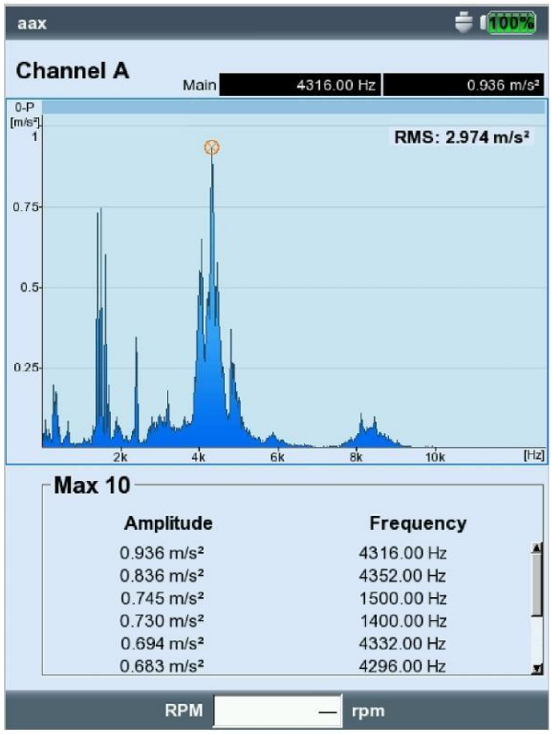
- **Vibration velocity diagrams of the rear bearing**

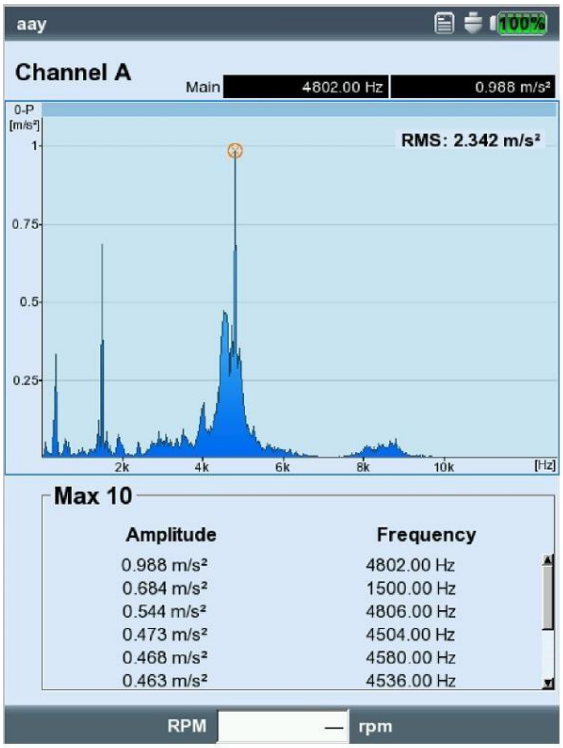


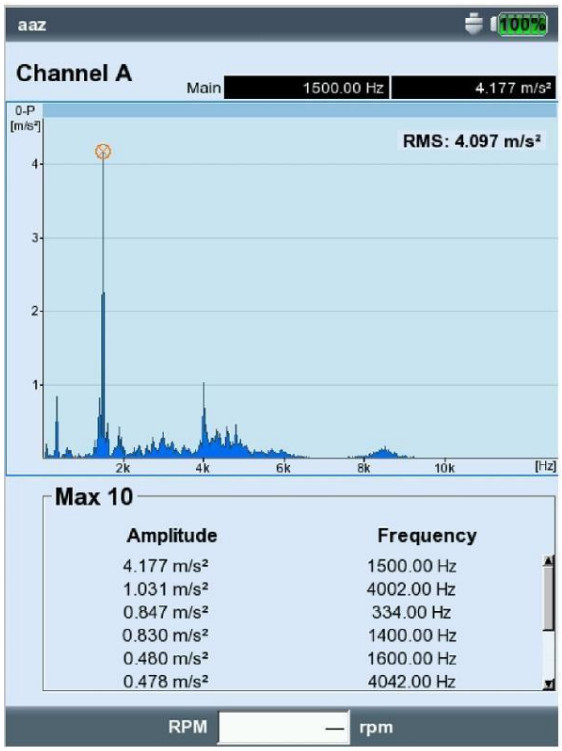




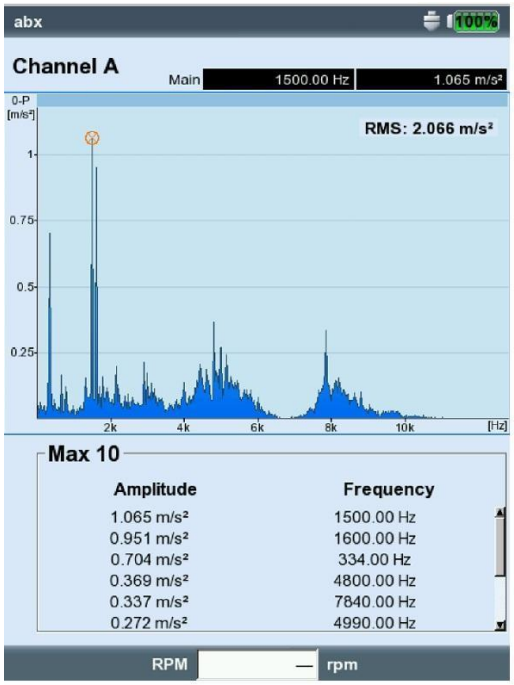
- **Acceleration of the front bearing**

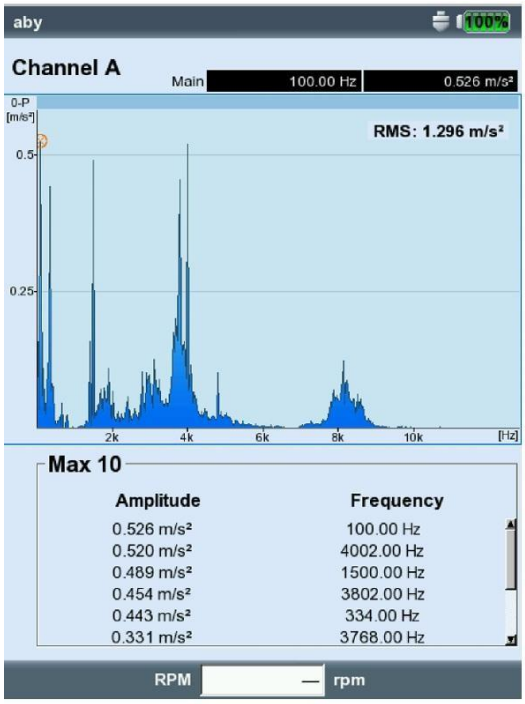


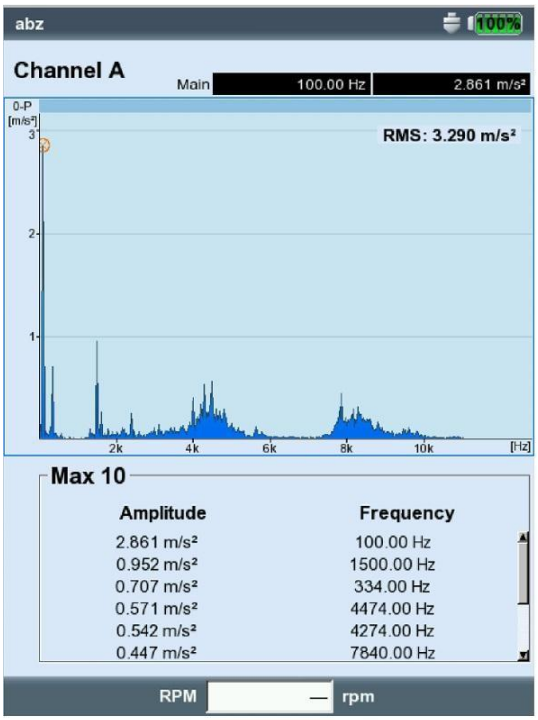




- **Acceleration of the rear bearing**







Result:

The test results indicate:

- Low vibration velocity values for both bearing assemblies (turbine side and opposite end), lower than or equal to the permissible limit of 1.6 mm/s for a new bearing assembly.
- Low vibration acceleration values for both bearing assemblies, lower than or equal to the permissible limit of 4.9 m/s^2 for a new bearing assembly.

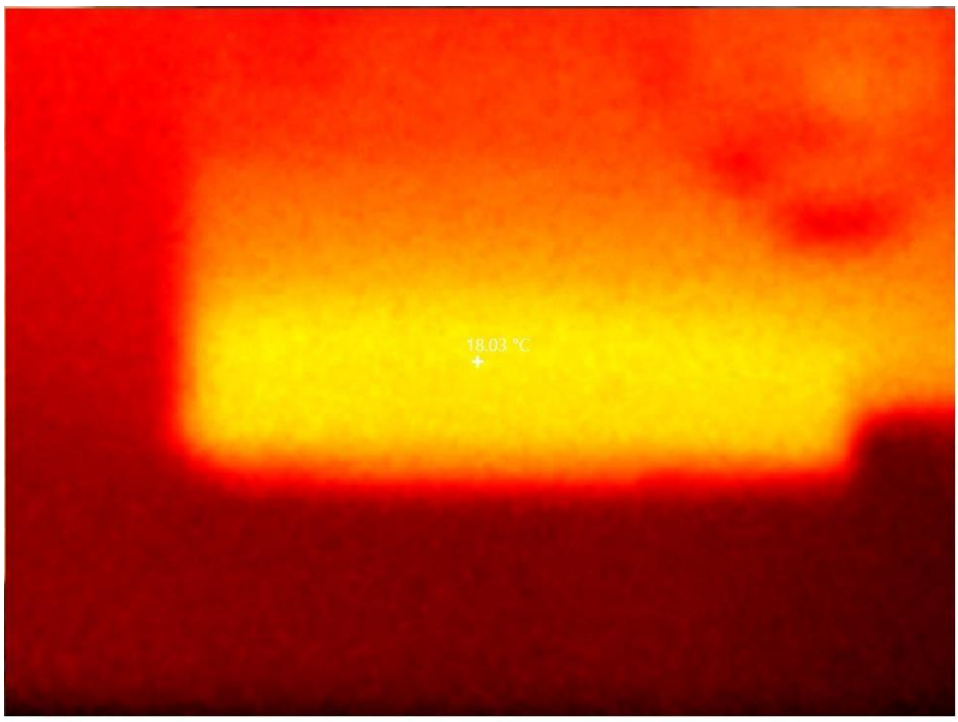
5. THERMOGRAPHIC INSPECTION OF THE HYDROGENERATOR

The hydrogenerator temperature distribution was measured using a thermal imaging camera during continuous operation at an ambient temperature of 15.1°C.

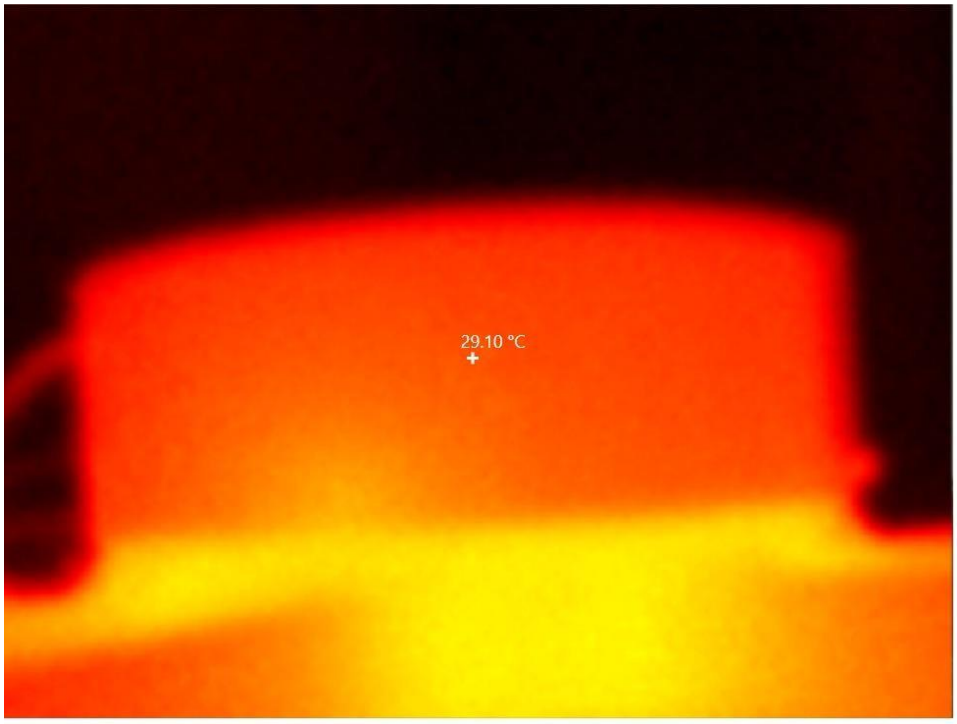
- Control Method: IEC 60034-14:2007
- Applicable Standards: BDS EN 60076-2:2011 / Ordinance No. 1 (State Gazette No. 46/2010, amended SG No. 95/2016)

Inspected Components:

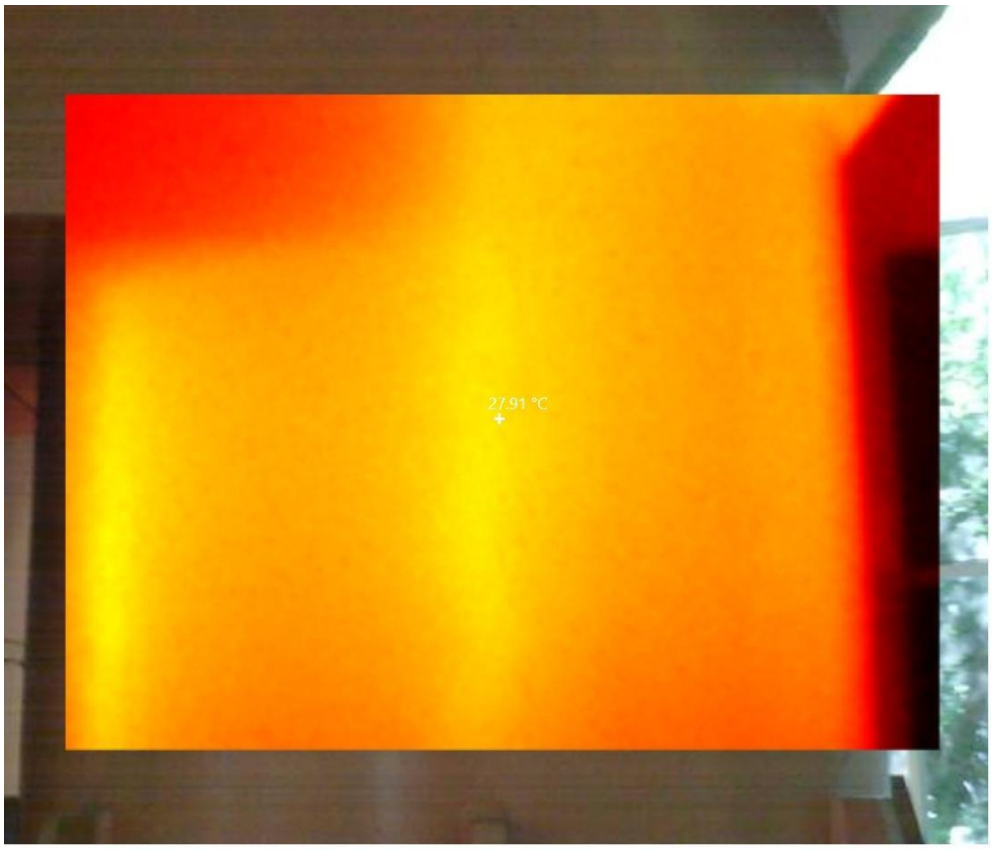
- Front bearing



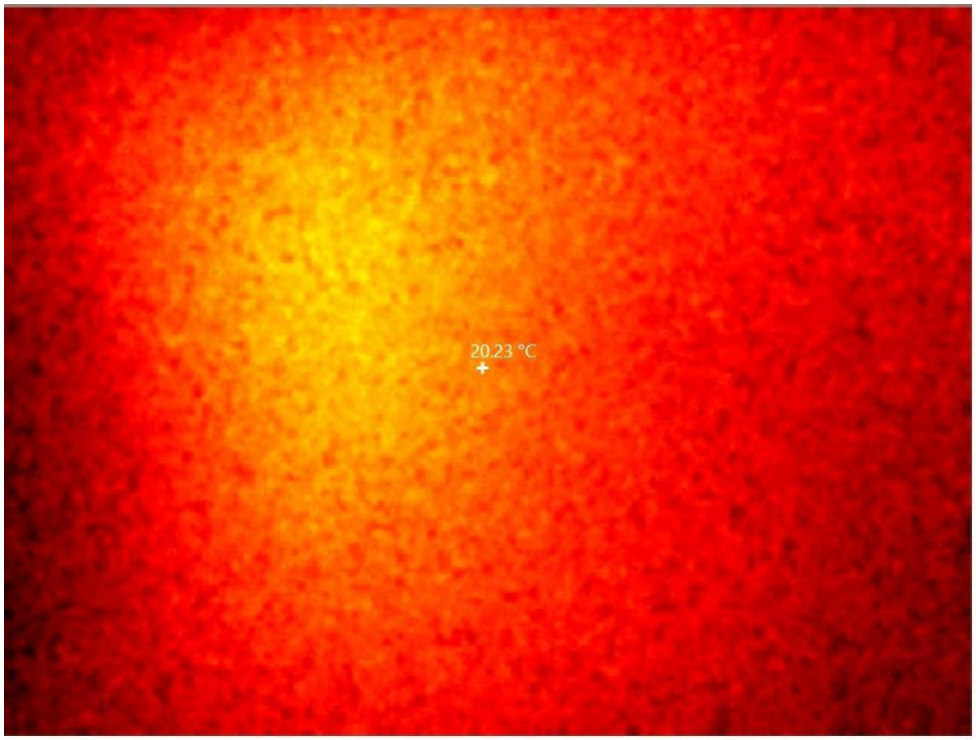
- Rear bearing



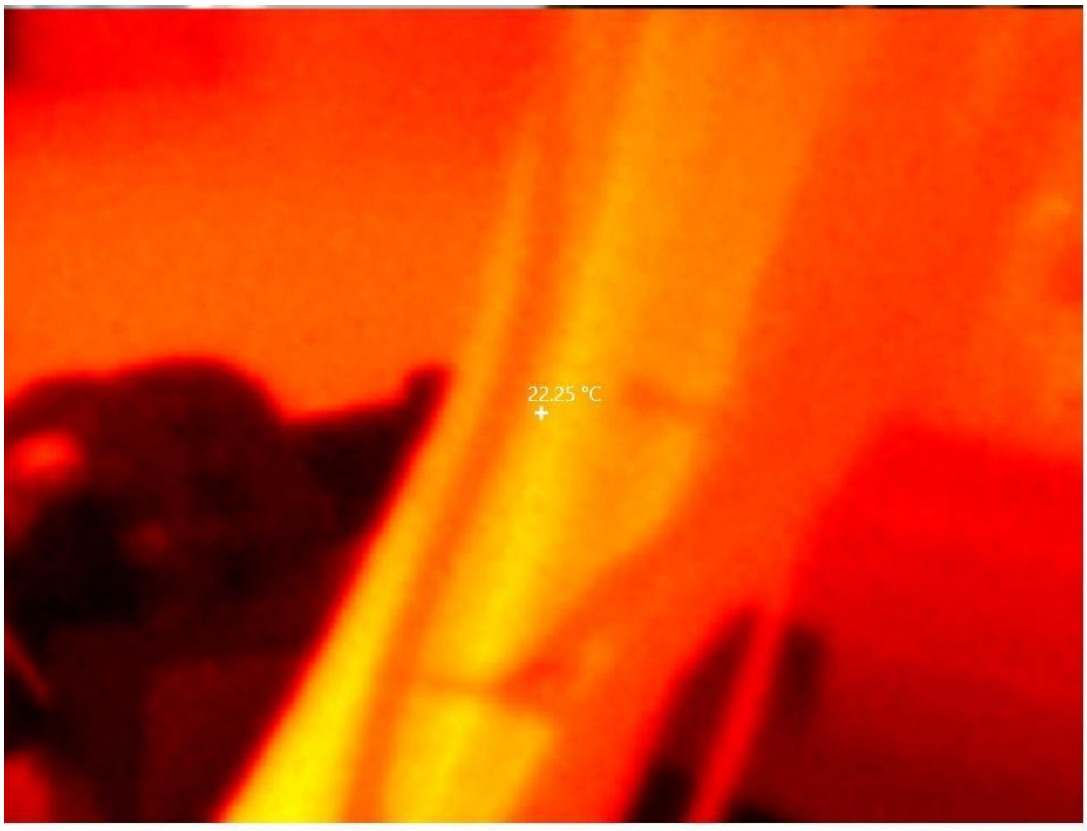
- Stator frame



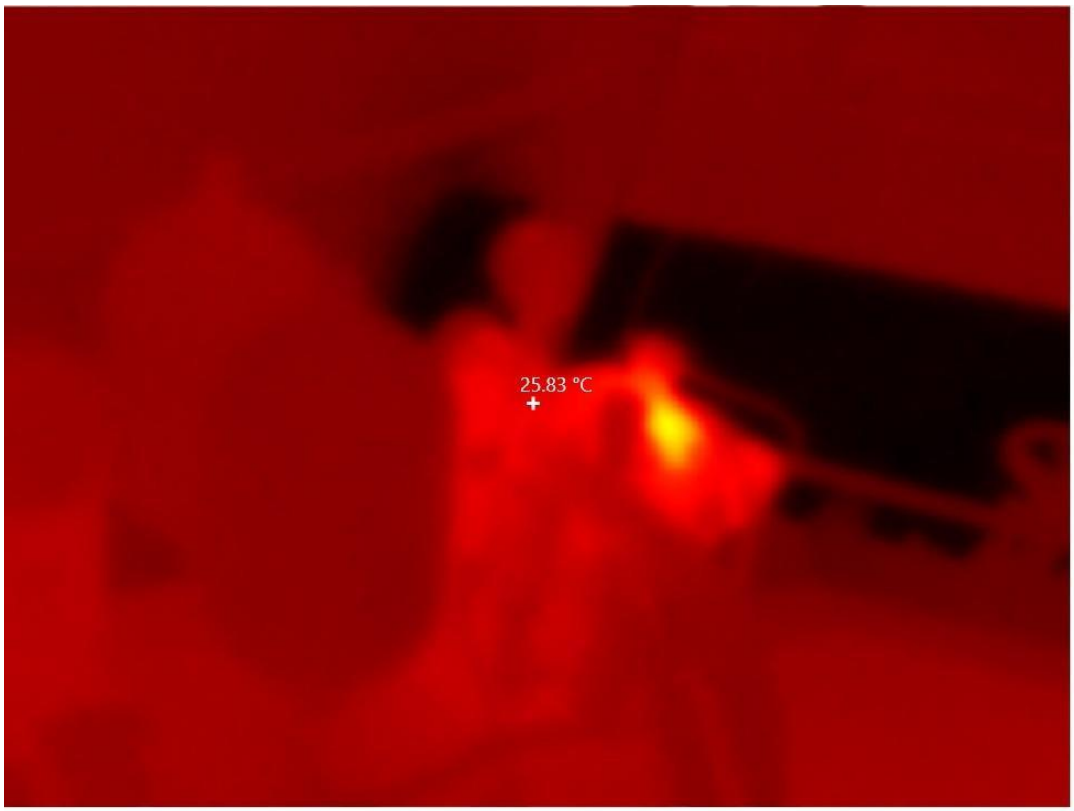
- Terminal box



- Generator output conductors



- Oil cooling unit



Maximum measured temperatures: Front bearing housing: 25.7°C, Rear bearing housing: 40.7°C, Generator frame: 27.91°C, Generator busbars: 20.23°C, Oil cooler: 25.83°C

	Max. Temperature	Ambient Temperature	Temperature Rise	Permissible Temperature
Component	ºC	ºC	ºC	ºC
Stator windings	27.2	15.1	12.1	105
Front bearing	18.03	15.1	2.93	90
Rear bearing	29.1	15.1	14	90
Terminal box busbars	20.23	15.1	5.13	90
Generator frame	27.91	15.1	12.81	90
Oil cooling unit	25.83	15.1	10.73	90

The measurements obtained from the installed sensors and thermal imaging camera indicate that no components or assemblies of the hydro unit exceed the permissible temperature limits.

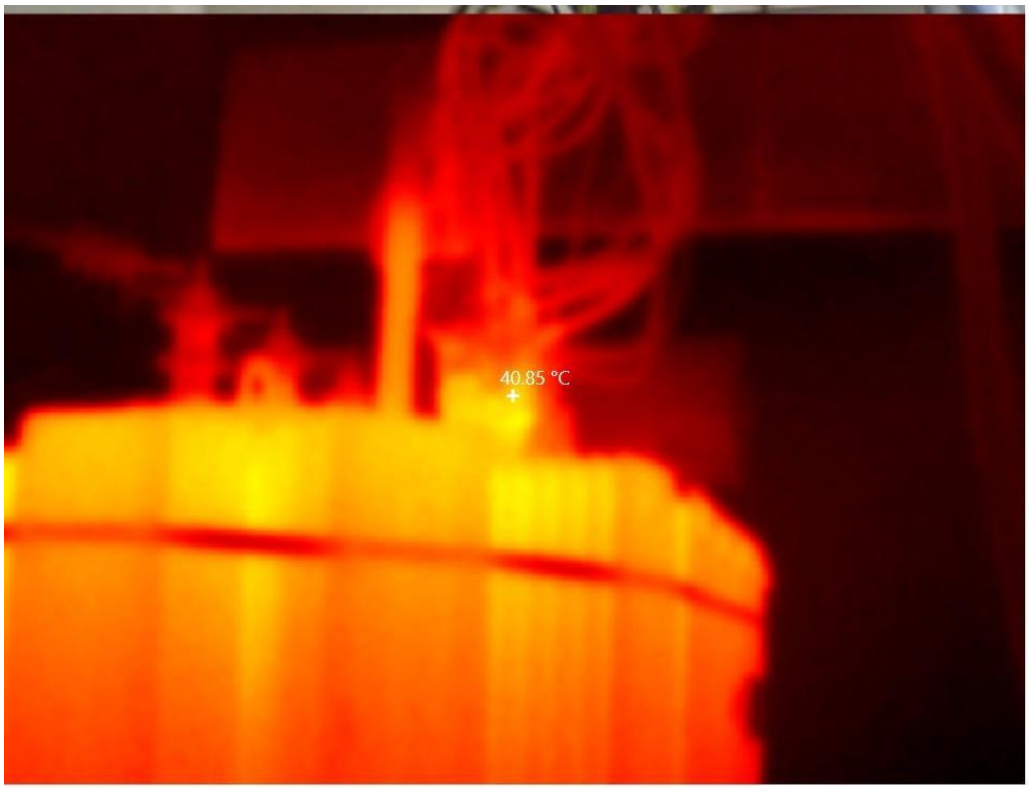
6. THERMOGRAPHIC INSPECTION OF THE 1600 kVA BLOCK TRANSFORMER

The transformer temperature distribution was measured using a thermal imaging camera after 5 minutes of operation at an ambient temperature of 16.2°C.

- Measurement method: IEC 60034-14:2007.
- Applicable standards and regulatory requirements: BDS ISO 10816-5:2008, BDS EN 60076-2:2011, Ordinance No. 1 (Official Gazette No. 46/2010, as amended by Official Gazette No. 95/2016).

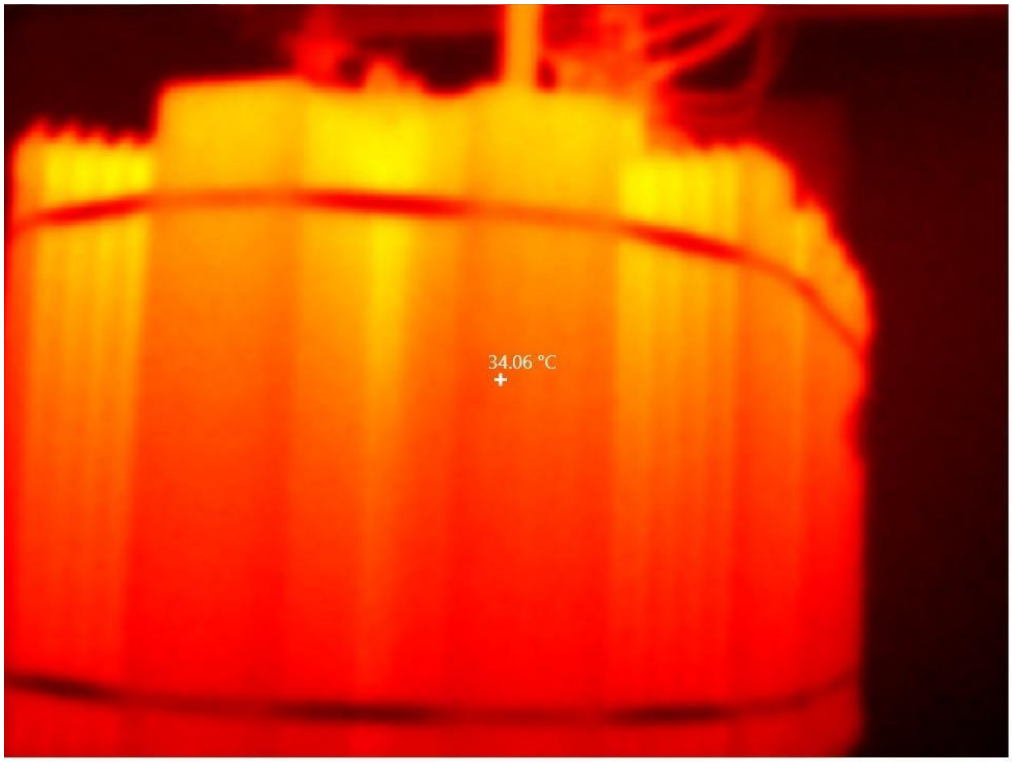
Inspected Components:

- LV terminals



- HV terminals

- Transformer cooler



Maximum measured temperatures:

LV terminals: 29.58°C, HV terminals: 29.26°C, Transformer cover: 38.07°C, Cooler: 36.97°C

	Max. Temperature	Ambient Temperature	Temperature Rise	Permissible Temperature
Component	°C	°C	°C	°C
LV terminals	40.85	15.1	25.75	90
HV terminals	29.12	15.1	14.02	90
LV cables	23.33	15.1	8.23	90
HV cables	23.31	15.1	8.21	90
Transformer cover	36.01	15.1	20.91	90
Cooler	34.06	15.1	18.96	90

The thermographic inspection confirms that no transformer components exceed the permissible temperature limits.

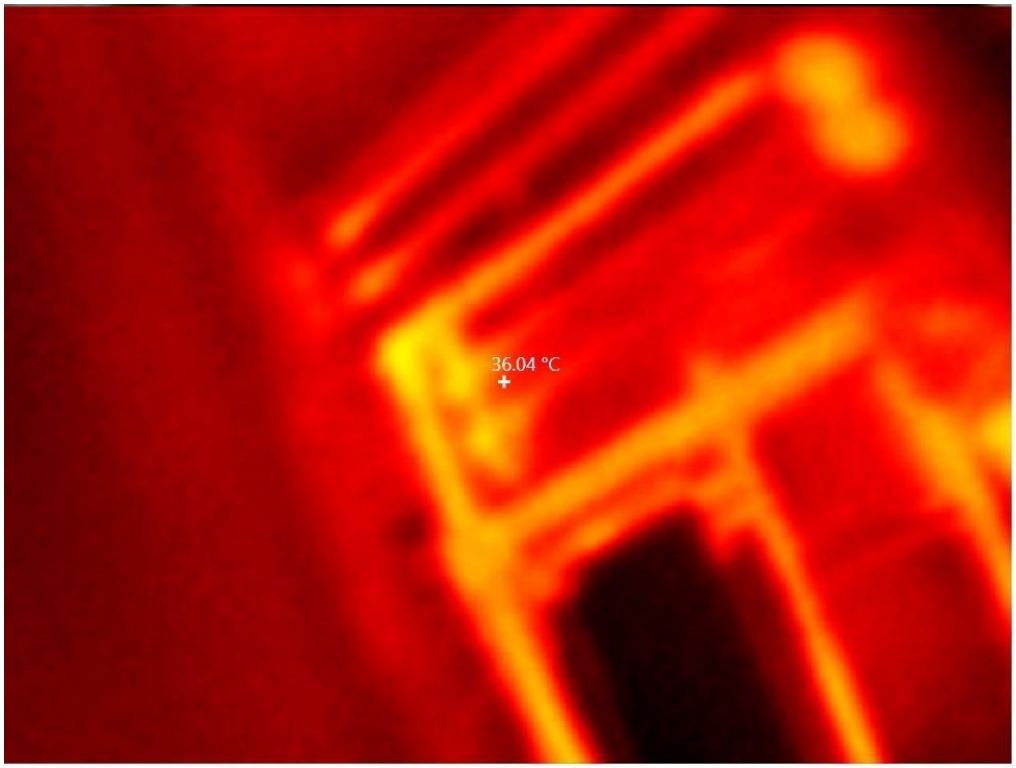
7. THERMOGRAPHIC INSPECTION OF THE CIRCUIT BREAKER AND DISCONNECTOR

The circuit breaker and disconnector temperatures were measured using a thermal imaging camera after 15 minutes of operation at an ambient temperature of 16.2°C.

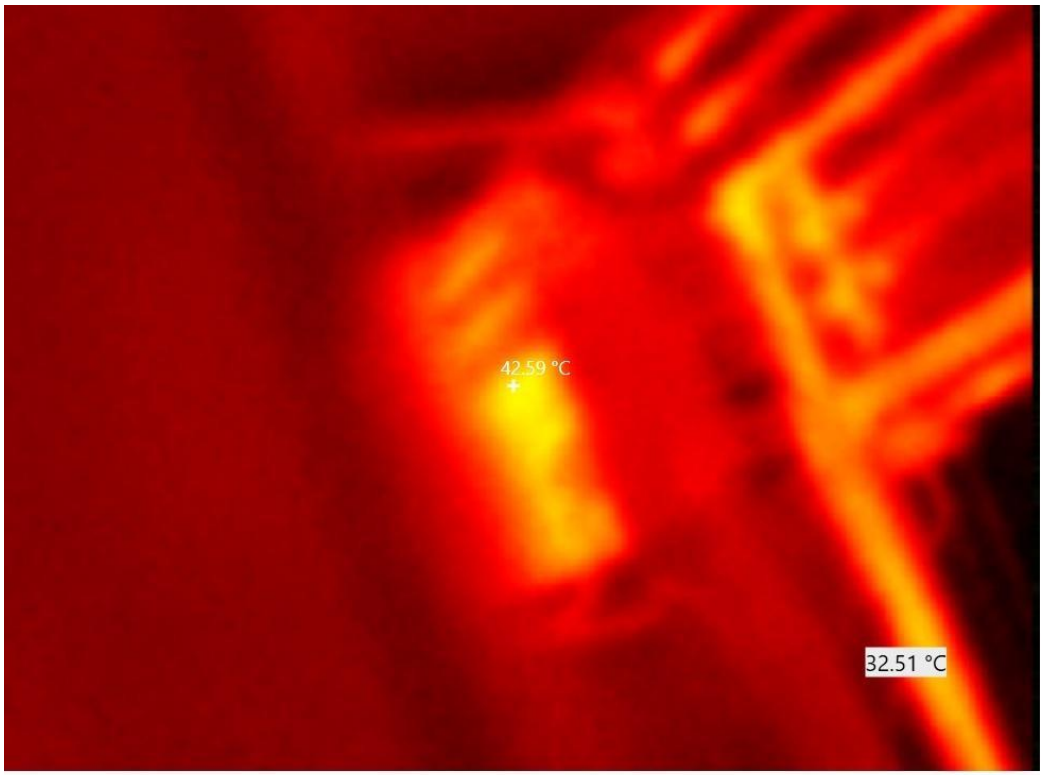
- Measurement method: IEC 60034-14:2007.
- Applicable standards and regulatory requirements: BDS ISO 10816-5:2008, BDS EN 60076-2:2011, Ordinance No. 1 (State Gazette No. 46/2010, as amended and supplemented by State Gazette No. 95/2016).

Inspected Components:

- Circuit breaker



- Disconnector



	Max. Temperature	Ambient Temperature	Temperature Rise	Permissible Temperature
Component	ºC	ºC	ºC	ºC
Circuit breaker	36.04	15.1	20.94	90
Disconnector	42.59	15.1	27.49	90

The thermographic inspection confirms that no components exceed the permissible temperature limits.

8. WORKPLACE MICROCLIMATE

The temperature of the working areas complies with the requirements of Ordinance RD-07-3 of 18.07.2014 concerning the minimum workplace temperature requirements of 20°C. As the power plant is remotely operated, there is no permanently assigned operating personnel on site. Personnel are present only during maintenance activities and equipment adjustments.

9. EQUIPMENT USED

- Smart Balancer type VIB 5.310 SR Schenck

- Metrel 10 kV Megohmmeter
- Hioki RM3548 Micro-ohmmeter
- Fluke TiS45 Thermal Imaging Camera

10. ANALYSIS AND FINDINGS

The electrical tests of the hydrogenerator indicate very good technical condition and confirm that the hydro unit can remain in operation for an unlimited period of time.

The vibration measurements demonstrate normal vibration levels corresponding to excellent bearing condition. The hydro unit can remain in operation without restrictions.

The thermographic inspection of the hydro unit, power transformer, disconnector and circuit breaker confirms excellent overall condition with no overheating of components or assemblies.

11. CONCLUSION

The electrical, vibration and thermal measurements performed indicate that the components, assemblies and equipment of CHUREKOVSKA SHPP are in good technical condition.

The power plant can continue operating reliably and without limitations for an unlimited period of time.

Date: 01.06.2026

Pazardzhik

Conducted by: Eng. A. Bikov