

**TECHNICAL SPECIFICATION**

For service

**SUBJECT:** Chaira PSHPP - Investigation and analysis of the technical condition of 400 kV oil-filled cable

1. **INTRODUCTION**

Chaira PSHPP is an underground power plant in the northeastern part of the highest mountain in Bulgaria - Rila. With generating capacity of 864 MW and pumping capacity of 788 MW, Chaira PSHPP is the largest pumped-storage plant in South-Eastern Europe. Four single-stage units, with pump-turbines Francis type, each with capacity of 216 MW in generator mode and 197 MW in pump mode, with generator voltage 19 kV, are installed in the underground part of the plant. The transformation of the generator voltage into a suitable voltage for transmission takes place with two block power transformers 19/19/400 kV, also installed in the underground part of the plant. With high-voltage cables running through an underground gallery, the plant is connected to 400 kV switchyard, and through it to the EES of the Republic of Bulgaria.

1. **SCOPE OF THE PUBLIC PROCUREMENT**
   1. Technical review, electrical and high-voltage measurements of:

* 400 kV high-voltage oil-filled cable, installed in cable gallery No.1 to 400/19/19 kV Power Transformer 1.
* 400 kV high-voltage oil-filled cable – 2 spare pcs., located in Belovo warehouse.
  1. Analysis of the condition of the cable oil by a set of tests.
  2. Evaluation of the operational condition and the remaining service life of the cable.
  3. Preparation of a comprehensive report about the conducted investigation.

1. **CURRENT SITUATION**

400 kV high-voltage oil-filled power cable provides the connection between main transformer No. 1 and 400 kV switchyard, Alabak line feeder. Each phase of the cable is made of oil-filled single-core cables equipped with one oil supply sections and two cable heads - one oil-immersed cable head on the main transformer side and one cable head for open installation in 400 kV switchyard. The power cables are laid on steel brackets anchored to the cable gallery walls. To accommodate the elongation of the cables during operation, they are laid on the "Vertical snake" principle. It is formed by placing brackets 200 mm higher than the others, at a distance of 3 m. On these brackets the cables are left lying freely on a leading clamp.

* 1. Technical data of SHOWA power cable, oil-filled, SHOWA CABLE CO:
* Rated linear voltage – 400 кV;
* Maximum operating voltage– 430 кV;
* Rated continuous current load per phase – 700 А;
* The current load of the cable is with guaranteed value of 700 A, provided that the maximum temperature of the conductor is ≤ +85ºС, and of the air +40 ºС.
* Conductor cross section /copper/ – 500 mm².
* Short circuit current - 1 s – 12 кА
* Мaximum level difference along the length of the cable route – 200 m with a 45º slope.
* Cable length per phase – approximately 535 m.
* Parameters of the system ensuring oil under pressure in the cable:
* Рshutoff=1 [kg/сm²] – shut-=off point-minimum admissible pressure;
* Ра=1,4 [kg/сm²] – lower alarm point;
* Рs=2,015 [kg/сm²] – rated pressure;
* Рmax. = 4,83 [kg/сm²] – upper alarm point.

The protection of the cables from atmospheric and switching surges on the side the 400 kV overhead line is ensured by a set of 400 kV surge arresters, installed immediately after the cable head in the switchyard, at the "cable-air" transition. The aluminum sheath of each 400 kV cable is directly earthed in one point by means of a grounding terminal, mounted on the cable head in 400 kV switchyard to the earthing installation of the 400 kV switchyard. At the oil-immersed cable head, the grounding terminal is connected to the earthing installation of the transformer room through a surge arrester.

In order to prevent air penetration in the cables in case of possible leakages in them, as well as to allow expansion of the oil when heated, without causing dangerous pressure, two oil-filled tanks are provided for each cable. They are connected to the cable at the outer /exposed/ cable head and to each other, which allows using the oil from the tanks of the other cables as well in case of larger leakages in one cable. The total number of tanks is 6. They are installed in the horizontal part of the cable gallery - at its exit in 400 kV switchyard. An oil sump is built in the switchyard to collect the oil from possible leakages.

To signal an emergency condition in the cable oil system, a cubicle is installed next to the exit of cable gallery No. 1 to the 400 kV switchyard. It is supplied with 220 VAC (normal) and 110 VDC (backup), with automatic switching. The normal or emergency state (imposition) of the oil system is signaled by green or red lamps, respectively, mounted on the front of the cubicle. The oil system emergency signal is received by electric contact pressure gauges on the tanks and is transmitted to the control system.

1. **TECHNICAL REQUIREMENTS TO THE PERFORMANCE OF THE SERVICE** 
   1. **Technical requirements to the service**
      1. In compliance with the requirements of standard IEC 60141-4:1980 ED1 and IEC 60141-4:1980 ED1 /AMD1:1990 ED1:

* Performing a technical review, minimum electrical and high-voltage measurements of the 400 kV oil-filled cable, as well as additional measurements, if necessary, in accordance with the parameters of the evaluation methodology.
* Conducting a minimum number of tests of the additional equipment and accessories (steel tubes, gaskets, distributing valves, oil tanks, pressure gauges, etc.), to prepare an analysis and assessment of their condition.
  + 1. Corrosion protection coating test
    2. Analysis of the operational cable oil filled in the cable, for each of the phases – R, S, T and the available spare cable oil in minimum scope:
* determining the type of cable oil depending on the chemical composition of the base, determined by infrared spectrometry;
* in case alkylbenzene base is established in the previous analysis, determining the type of oil (I, II or III), according to IEC 60867;
* physicochemical analysis by properties, as follows

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| Item | Property | Standard |
| 1 | Appearance (transparency, sediments, dispersed particles) | It is determined visually |
| 2 | Density at 20ºС, kg/dm³ | BDS EN ISO 3675 |
| 3 | Kinematic viscosity at 40˚С, mm²/s | BDS EN ISO 3104 |
| 4 | Pour point, ºС | BDS ISO 3016 |
| 5 | Neutralization number, mg KON/g | IEC 62021 |
| 6 | Halogens content (АОХ) mg/kg | BDS EN ISO 9562 or ASTM D4929 or Annex А of IEC 60867 |
| 7 | Water content, mg/kg | BDS EN 60814 |
| 8 | Corrosive sulfur | DIN 51353 |
| 9 | Potentially corrosive sulfur | BDS EN 62535 |
| 10 | Additives, % | BDS EN 60666 |
| 11 | Breakdown voltage, kV | BDS EN 60156 |
| 12 | Dielectric loss factor 90ºС (tgδ) | BDS EN 60247 |
| 13 | Specific volume resistivity |
| 14 | Relative dielectric permittivity |
| 15 | Gas absorption | BDS HD 488 S1 (IEC 60628) |
| 16 | Flash point, ºС | BDS EN ISO 2592 |
| 17 | Flash point, ºС | BDS EN ISO 2719 |

*Note: Wherever a specific standard, specification, technical evaluation, technical approval, technical reference, specific model, trademark, patent, source, specific process, type, specific origin or manufacture is specified in the requirements of the technical specification, it shall be considered that “or equivalent” is added.*

* determination of the sufficient minimum number of properties for current operational analysis of the oil and the limit values of each of the determined properties;
* on the basis of the analyses made, provision of information about a suitable product - cable oil for filling up.

*Note: The samples for analysis shall be provided by the Contracting Authority to the Contractor according to a pre-agreed procedure between the parties.*

* + 1. Submittal for review and acceptance of evaluation methodology/ies.
    2. Evaluation of the operational condition and remaining service life of the cable using the accepted methodology/ies.
    3. Preparation of a comprehensive investigation report with conclusions.
    4. In case of a positive result of the investigation, provision of technology for filling up oil in the cable.
    5. The necessary equipment to perform the activities shall be provided by the Contractor.
    6. The measurements and analyses shall be performed by independent accredited laboratories according to the requirements of BDS EN ISO/IEC 17025:2018 - "General requirements for the competence of testing and calibration laboratories (ISO/IEC 17025:2017)", or equivalent.
  1. **Requirements to the service in terms of environment and climate protection** 
     1. The adopted technology of work shall not allow the formation of harmful and toxic matters and substances, as well as noise and vibrations beyond the limits of the legally and regulatorily established norms.
     2. In the event of pollution, the Contractor undertakes to immediately take actions to limit the negative consequences regarding the components of the environment, and all costs shall be at his expense.
  2. **Requirements to the service in terms of ensuring healthy and safe working conditions**

The Contracting Authority shall ensure health and safety working conditions, according to the requirements of the regulatory documents on OHS and fire safety during execution of construction and installation works.

When carrying out the activities for performance of the procurement, the Contractor is obliged to comply with the provisions of the legal acts in force in the Republic of Bulgaria regarding health and safety working conditions and the resulting obligations for him:

- Law on Health and Safety at Work;

- ORDINANCE No. RD-07-2 dated 16.12.2009 on the terms and conditions for conducting periodic training and briefing of employees on the rules for ensuring healthy and safe working conditions;

- ORDINANCE No.2 dated 22.03.2004 on the minimum requirements for healthy and safe working conditions during execution of construction and installation works;

- ORDINANCE No. 9 dated 09.06.2004 on the technical operation of power plants and grids, issued by the Minister of energy and energy resources, as well as the Law on Health and Safety at Work;

- Regulations for safety when working in electrical systems of electrical and heating plants and on electrical networks.

- Regulations for safety when working in non-electrical systems of electrical and heating plants and on heat transfer networks and hydro-engineering facilities;

* 1. **Warranty period and other warranty conditions**

Not applicable to the subject of the procurement.

1. **CONDITIONS FOR PERFORMANCE OF THE PROCUREMENT**
   1. **Time and conditions to the time for implementation**

The time for performance of the service is not more than 8 months, as of the date of conclusion of the contract and the performance shall be in stages.

* + 1. **Stage 1:**

- within a period of not more than 60 (sixty) calendar days, as of the date of entry into force of the contract, presentation of a methodology for evaluation of the operational condition and the remaining service life of the cable.

- within 10 (ten) working days from the date of receipt of the methodology, the Contracting Authority shall appoint a Technical Council to review it. The Contracting Authority has the right:

* to approve and accept the methodology without remarks;
* to return the methodology to the Contractor with remarks and set a deadline for their rectification;
* not to accept the methodology.

- within 10 (ten) working days from the date of submission of the revised methodology to the registry office of HPP Enterprise, the Contracting Authority shall appoint a new Technical Council. The work on the acceptance of the methodology ends with minutes of the Technical Council, with which the Contracting Authority approves and accepts it, without remarks or does not accept it.

* + 1. **Stage 2** – performing the remaining activities within the scope of the procurement within the remaining time under the contract.
    2. **Stage 3**

- within 10 (ten) working days from the date of receipt of the investigation report, the Contracting Authority shall appoint a Technical Council to review it. The Contracting Authority has the right:

* to approve and accept the report without remarks;
* to return the report to the Contractor with remarks and set a deadline for their rectification;
* not to accept the report.

- within 10 (ten) working days from the date of submission of the revised report to the registry office of HPP Enterprise, the Contracting Authority shall appoint a new Technical Council. The work on the acceptance of the report ends with minutes of the Technical Council, with which the Contracting Authority approves and accepts it, without remarks or does not accept it.

**5.2. Place and conditions for execution**

- Chaira PSHPP.

- Warehouse – Repair Workshop in Belovo town.

**5.3. Control over the works by the Contracting Authority**

Not applicable to the subject of the procurement.

**6. OTHER CONDITIONS FOR PERFORMANCE OF THE PROCUREMENT**

**6.1. Technical requirements to the personnel performing the service.**

Not applicable to the subject of the procurement

**APPENDICES**

Not applicable to the subject of the procurement