**PUBLIC COMPANY ORLEN LIETUVA**

**POWER HOUSE**

**COOLING SYSTEM CIRCULATING WATER TREATMENT METHOD SELECTION STUDY**

**SCOPE OF WORK**

1. **General data of the system.**
   1. To cool Power House turbine condensers with circulating water two cooling towers with intake chambers of the same design and four circulating pumps are installed.
   2. Characteristics of cooling towers:
      1. Capacity 7000 - 9000 m3/h;
      2. Cooling surface area 1200 m 2;
      3. Water basin capacity 1800 m3;
      4. Intake chamber capacity 200 m3;
      5. Water tower height 50 m;
      6. Bottom diameter 40 m;
      7. Top diameter 26 m;
   3. Metals of cooling system apparatuses, pipes, fittings: steel (CT10,CT20), stainless steel (08X18H10T), brass (ЛОМШ), aluminum;
   4. Cooling system capacity ~ 6000 m3;
   5. Circulating water temperature upstream condenser tmin/taver./tmax 10/22/35 °C;
   6. Circulating water temperature downstream condenser tmin/taver./tmax 10/22/35 °C;
   7. Circulating pump capacity max. – 6300 m3/h, min. – 500 m3/h;
   8. Cooling system make-up 250–550 m3/h.
   9. For cooling tower basin and for process needs of the Power House make-up water is taken from Varduva river.
      1. Make-up (Varduva river) and circulating water test findings (mean values).

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| --- | --- | --- | --- | --- | --- |
|  |  | **Make-up water**  winter/summer (mean values) | | **Circulating water**  winter/summer (mean values) | |
|  |  | winter | summer | winter | summer |
| Hardness, K | mg-eqv/dm3 | 2.2 | 2.3 | 3.3 | 3.7 |
| Chlorides, (Cl) | mg/dm3 | 11 | 15 | 12 | 17 |
| Silicates, (SiO) | mg/dm3 | 7.7 | 2.5 |  |  |
| Alkalinity | mg-eqv/dm3 | 3.3 | 3.7 |  |  |

* 1. Circulating water is mainly used to cool steam turbine condensers. From intake chamber water is fed with circulating pumps to turbine condensers where utilized steam heat is routed to cooling towers. Depending on the operating mode of turbine (condensation, co-generation) and load, the quantity and temperature of circulating water changes. In condensation mode, the towers evaporate up to 220m3 of water.
  2. Part of cooled water is routed to cool the bearings, to heat exchangers to cool lube oil, to generator to cool cooling gas, to el. motors and boiler to cool their components. Heat exchangers normally have brass tubes however some plate heat exchangers have stainless steel tubes.
  3. Heated water downstream turbine condenser from the cooling water system is also fed to f Chemical Water Treatment Unit for demineralized water production. The quantity of water fed to Chemical Water Treatment Unit varies within the range of 150–350m3 depending on the season. In water treatment process, slaked lime (CaOH) and ferrous sulphate (FeSO4+7H2O) solution is used for water coagulation. Demineralization of water is based on ion exchange using ionic resins. For ionite regeneration, 2–4 % caustic soda (NaOH) and 1.5–6 % sulfuric acid (H2SO4) solutions are used.
  4. Main characteristics of demineralized water:

pH − 8.5-9.5

Hardness < 1 µg-eqv/dm3

Total alkalinity < 10 µg-eqv/dm3

SiO2 < 120  µg/dm3

Nacomp < 80  µg/dm3

Fe comp < 20  µg/dm3

Conductivity <2.0 µS/cm.

* 1. Characteristics of water after each ionite filter:

1H;(0H) filter outlet: acidity 0.8-1.2 mg-eqv/dm3;

Hardness 10−20 µg-eqv/dm3;

1A filter outlet: Chlorides, Cl < 3.0 mg/dm3;

Alkalinity < 100 µg-eqv/dm3;

DKB-1 (decarbonizer tank) outlet (2H inlet):

Carbonic acid in water, <6 mg/dm3;

2H filter outlet: Hardness < 1 µg-eqv/dm3

Acidity < 5−20 µg-eqv/dm3

2A filter outlet: Alkalinityphenolphthalein 0−5 µg-eqv/dm3

Alkalinitytotal < 30 µg-eqv/dm3

SiO2 <120  µg/dm3

Nacomp <80  µg/dm3

Fecomp <20  µg/dm3

pH 6.5−8.5

Conductivity <2.0 µS/cm.

1. **Description of an issue.**
   1. Make-up water for cooling system is taken from Varduva river. Coarse sieve installed upstream the pumps catches only coarse mechanical sediments. The system does not have any other water filtering, treatment or preparation facilities, the sediments are not tested for microbiological or chemical contamination.
   2. During water evaporation and condensation processes in cooling loops, water temperature, pressure, thermal, physical and chemical characteristics are changing. At the same time, the characteristics of impurities dissolved and suspending in water are changing. During technological process, the sediments of different types and compositions form on the internal surfaces of thermal equipment. Part of impurities dissolved in water precipitate and form sludge and further settle in places where the circulation of water is low, also attaches to cooling surfaces in heat exchangers.
   3. The film of different deposits consisting of bacteria, aquatic plants and other living organisms forms on the turbine condenser tubes, maim circulating cooling water lines, river water heaters. Very quickly, these deposits clog plate heat exchangers and 500 µk filters installed upstream (see Table 1). Deposits significantly reduce or completely stop the flow through the tubes of heat exchangers, impair heat transfer and significantly reduce the efficiency of heat exchangers.
   4. Turbine condenser cleanness and turbine condenser steam pressure increase (vacuum drop) are continuously observed. When condenser tubes get clogged, required quantity of steam is not cooled, vacuum is dropping and the efficiency of turbine is decreasing. Turbine condenser pressure increase by 0.01 bar means 450 kWh under-production of electricity. When pressure exceeds the normative pressure by 0.005 bar (0.5 kPa), the turbine has to be stopped and condenser has to be washed. Usually, the condensers of both turbines are washed before summer season.

Table 1

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| --- |
| 500 k filters |
| cid:image011.png@01D9E7D8.EAFB24E0 |
| Plate heat exchanger. 500 k filters upstream heat exchanger. |
| cid:image012.png@01D9E7D8.EAFB24E0 |

1. **Attachments.**
   1. Yearly expenditure for cleaning of heat exchangers, filters and other elements.
   2. Losses resulting from the contamination of turbine condenser.
2. **Description and specifics of work.**
   1. CONTRACTOR has to perform all required circulating and make-up water tests.
   2. CONTRACTOR has to familiarize itself with data and description of issue provided herein.
   3. CONTRACTOR has to familiarize itself with existing cooling and river water diagrams, expenditure incurred for cleaning of heat exchangers, filters and other elements and losses resulting from the contamination of turbine condenser.
   4. CONTRACTOR has to present proposal concerning continuous circulating water monitoring and water quality control.
   5. CONTRACTOR has to present a plan of means and actions to prevent the formation of algae, scaling and other fouling.
   6. CONTRACTOR has to present economic justification, calculations of the pay-off for the implementation of plan of means and actions proposed by it.
      1. Calculations have to presented for two modes:
         1. When turbine is operating in co-generation mode and cooling towers evaporate 15 t/h of circulating water;
         2. When turbine is operating in condensing mode and 220 t/h of circulating water are evaporated.
         3. Under both modes, in addition 350 t/h of demi water are prepared.
      2. Expenditure for recommended cooling and river water treatment preparations must be calculated.
      3. Calculations must take into account additional costs required to heat river water from river water temperature to required temperature upstream clarifiers, including existing river water pre-heater reconstruction or new pre-heater construction and connection to existing diagram should the preparations recommended for cooling and river water treatment be unsuitable for demineralized water preparation;
      4. Potential additional costs which may arise though not described herein must be estimated as well.
   7. In addition, the CONTRACTORS may propose water treatment method not described herein which would solve the OWNER’S issues with cooling and river water.
   8. The CONTRACTOR may present a table with comparison of different options (current diagram utilized by the Power House, diagram with the use of chemical preparations, other proposed options) specifying CAPEX and OPEX in EUR/1000m3.
   9. Requirements for work execution and documentation.
      1. Presentation of study report:
         1. 6.1.1. Once draft study report is ready, the CONTRACTOR shall present it in two stages - first draft shall be presented to engineering staff of the OWNER and further the final revision shall be presented to the management of the OWNER.
         2. After presentation, the CONTRACTOR shall submit the final revision of report to the OWNER. Final revision shall be present in soft copy (.doc and .pdf) and one hard copy in Lithuanian and English.
   10. Qualification requirements for CONTRACTOR.
       1. CONTRACTOR and SUBCONTRACTORS must have experience in work with power plants, must know the process diagram of power plant and understand the processes of cooling water systems.
       2. CONTRACTOR must provide the lists of similar scope works performed during the last five years. The list must contain the following details: names of companies where works have been performed, description of works, year when works were performed, contact persons. Attach documents proving experience. At least two studies of this type for power plants must be completed within last 5 years.
       3. Present information on qualification, academic degrees of key staff.
       4. Present certificates entitling to perform such activities, provide such services.
   11. Specific requirements.
       1. CONTRACTOR shall visit the site for full evaluation of the existing infrastructure and the scope of work. Any costs related to preparation of the proposal shall be exclusively at the CONTRACTOR'S expense.
       2. Before submitting a proposal, the CONTRACTOR shall analyze this SOW and include in the proposal all works described in this document and its attachments. Any minor works not included in this SOW though required for ensuring the completeness of the works shall be considered included in the proposal.
       3. All information required for study shall be collected by the Contractor itself. The Owner shall present only available main information (types of equipment,diagrams, normative characteristics).
       4. Contractor shall provide contact details of Contractor and Subcontractors (address, telephone numbers, contact persons).
       5. CONTRACTOR shall present proposals of the vendors of proposed equipment and materials/substances planned to be used and warranties concerning fit for declared purpose.
3. **Materials, equipment, and services to be provided by the OWNER.**
   1. The OWNER shall present information specified in Par. 3 (Attachments) only to the winner of tender.
   2. Other information (circulating, process and river water process diagrams, capacities of process equipment, normative characteristics, etc.) shall be presented to all potential CONTRACTORS that visit the site.
4. **Materials, equipment, and services to be provided by the CONTRACTOR.**
   1. CONTRACTOR shall perform all works specified in the Scope of Work, shall provide equipment and means required for this purpose.
5. **Requirements for Work Completion**
   1. Work shall be deemed fully completed once the OWNER receives hard copy report (in Lithuanian and English) agreed with the OWNER and signs work handover and acceptance statement in the form established by it. The CONTRACTOR shall also present a soft copy report on electronic media in doc. and pdf. formats.
6. **Requirements for work schedule.**
   1. CONTRACTOR shall present proposal for development of study which should be effective through to 31 March 2025.
   2. CONTRACTOR shall submit its work execution schedule.
   3. Initial study report should be presented within 3 months after the conclusion of contract.
   4. Final study report should be presented within 6 months after the conclusion of contract.