Call for Tenders NGAPD-2048 for "South Field Mine Pumped Hydro Storage Plant: Early Technology Provider Involvement for Design, Supply, Erection and Commissioning of Pump, Turbine, Generator and Auxiliary Systems".

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1. Introduction

1.1 Call for Tenders

The Public Power Corporation S.A. (hereinafter PPC or the Company), 30 Chalkokondyli Street, GR 104 32, Athens, pursuant to the provisions of:

- the Regulations for Works, Supplies and Services of PPC (RWSS/PPC, Board Decision No 4/09.02.2022) published on the official website of PPC at https://eprocurement.dei.gr/images/kepy_dei_ae.pdf and https://eprocurement.dei.gr/images/kepy_dei_ae_en.pdf, and
- the present Call for Tenders

hereby invites interested Tenderers to submit a Proposal for the Call for Tenders NGAPD-2048 for the Scope "South Field Mine Pumped Hydro Storage: Early Technology Provider Involvement Tender for Design, Supply, Erection and Commissioning of Pump, Turbine, Generator and auxiliary systems".

This Tender Procedure does not constitute a binding commitment for PPC to award or enter into any contract with any Tenderer. PPC reserves the sole right to suspend, defer or modify this Tender Procedure, and to terminate any discussions or negotiations, at any phase of the proceedings, without being liable to any Tenderer or other party. PPC, its advisors, its staff and any of its affiliates bear no responsibility and assume no obligation for any existing errors or omissions of this Tender Procedure. The Tenderers acquire no right and may not claim for any compensation from PPC, its advisors, its staff or any of its affiliates as a result of their participation in this Tender Procedure any amendment or cancellation thereof, or PPC's decision not to award any contract.

1.2 Tender Scope and Objectives

PPC intends to execute the South Field Mine Pumped Hydro Storage Plant in two Lots, under two separate contracts as follows:

- **Lot 1:** Pump-Turbine, Generator and all directly related auxiliary systems and equipment that will be awarded in a two-stage process to the Successful Tenderer, under the present Tender Procedure
- **Lot 2:** Earthworks, civil and balance of plant electromechanical that will be assigned to a contractor (the Lot 2 Contractor) under a separate tender procedure

The present Tender Procedure refers to Lot 1 only.

Following the evaluation of the offers submitted by the Tenderers, the Company will nominate the Successful Tenderer. The subsequent contracting process will comprise two stages as follows:

- Stage 1: nomination as the Preferred Technology Provider, who will sign:
  - the Early Engineering Contract; and
  - the Collaboration Engagement Agreement including Exclusivity and Heads of Terms (HoTs) for LOT 1
- Stage 2: Contract for Lot 1 Project Execution, subject to the successful completion of the Early Engineering phase, agreement between the Parties on the final terms and conditions of the Lot 1 Contract, and the necessary approvals by PPC's competent bodies, in accordance with the Collaboration Engagement Agreement.

During the execution of the Early Engineering Contract, the design for the project will be progressed to such extent that:

- the Lot 1 concept design and specifications will be finalized with the contribution of the Preferred Technology Provider and will form an integral part of the Employer Requirements, allowing for the signature of the Lot 1 Contract

- the Lot 2 specifications, quantities, drawings and interfaces between Lot 1 and Lot 2 will be detailed enough to allow for the Lot 2 to be tendered as a Turnkey Design and Build contract

The value of the Early Engineering Contract will be 2.5 % of the Lot 1 Total Offered Price.
The duration of the Early Engineering Contract will be 9 months.

Optional Items
Each Tenderer shall include in its Offer the prices for all Optional Items.
During the performance of the Early Engineering Contract, the Services to be performed by the Early Engineering Contractor shall include the engineering services necessary for the Base Scope and for each and all of the Optional Items, irrespective of whether any such Optional Items are subsequently selected for implementation.
Prior to the signing of the Lot1 Contract, PPC may, at its sole discretion, choose to select any, all, or none of the Optional Items.

1.3 Validity of Offers

Without prejudice to any adjustment of any Offer pursuant to Article 3.12 (Clarifications During Evaluation Process), the Offer submitted by each Tenderer shall remain valid, binding and irrevocable during the evaluation process of the Tenders for a period of maximum six (6) months, starting the next day from the deadline for submission of the Proposals (the "Initial Validity Period"). By signing the Collaboration Engagement Agreement, the successful Tenderer commits to formulate its Offer for Lot 1 Project Execution in compliance with the provisions of said Collaboration Engagement Agreement.

The relevant declaration will be included in Folder A.

Offers setting a shorter period of validity are considered unacceptable and thus shall be rejected.

2. Glossary

Balance of Plant: all the electromechanical parts of the Plant that are not included in the Lot 1 scope.

Base Scope: means the main scope for Lot 1, without any Option.

Committee: PPC's competent Committee to open and evaluate the Tenders, issue decisions and evaluate any changes in the composition of a Tenderer.

Collaboration Engagement Agreement: means, the agreement between Employer and Successful Tenderer, intended to be signed simultaneously with the Early Engineering Contract, including exclusivity and Heads of Terms for Lot 1 Contract. Please refer to draft in Annex VI of this Call for Tenders.

Company or Client or Employer: means PPC

DoW: Division of Works between Lot 1 and Lot 2 (See Annex II "Technical Part")

Early Engineering Contract: means the contract between the Employer and the Successful Tenderer to advance the Project's design and contribute to the preparation of the Employer's Requirements towards finalization of the Lot 1 Contract under the FIDIC Yellow Book and tendering of the Lot 2 Contract.

Early Engineering Contractor or Preferred Technology Provider: means, the Successful Tenderer of this Tender Procedure after signing with the Company the Early Engineering Contract, who will work together with the Company and Tractebel for the finalisation of the Lot 1 Contract.

Early Engineering Scope of Services or Services: the services to be provided by the Early Engineering Contractor in accordance with the Early Engineering Contract, described in Clause 4.1 herein.

Eligibility Criteria: The minimum technical and financial criteria, specified in Clause 3.5, that Tenderers must fulfill in order to be eligible to proceed with the technical and financial evaluation of the present Tender Procedure

Employer's Requirements: means the documents entitled Employer's Requirements, that will be developed during the Early Engineering Contract and will be included in the Lot 1 Contract. Such documents specify the purpose, scope, and/or design and/or technical criteria for the Project and comprise among others the technical specifications, the Scope of Works, the Drawings and other supplementary information.

Evaluation criteria: the criteria specified in Clauses 3.10 and 3.11 based on which the proposals will be evaluated.

Letter of Final Tender: means the offer of the Lot 1 Contractor, comprising the parts of the original Tender submitted by the Tenderer in response to the Call for Tenders NGAPD-2048, as may have been adjusted by mutual agreement during the execution of the Early Engineering Contract.

Technical Part: Annex II to this Call for Tenders, that provides a comprehensive description of the Project's scope of supply and services, technical requirements, time schedule and other essential specifications. It serves as the basis for Tenderers to prepare their Proposals, ensuring alignment with the Project's technical and performance expectations.

HoTs: Heads of Terms regarding the Lot 1 Contract (Clause 5.2)

Lots: means Lot 1 and Lot 2.

Lot 1: Pump Turbine and Auxiliaries, as further detailed under the column Lot 1 of the DoW.

Lot 1 Scope: Engineering, Procurement/Fabrication, Erection and Commissioning and all other services and works relevant to Lot 1 (See Annex II "Technical Part")

Lot 1 Contract or Contract for Lot 1 Project Execution: The Turnkey Design and Build Contract for the Lot 1 Scope that will be signed between the Company and the Preferred Technology Provider, after the conclusion of the Early Engineering Contract.

Lot 2: Civil and electromechanical Balance of Plant as further detailed under the column Lot 2 of the DoW.

Lot 2 Scope: Ground works, civil works, architectural works, landscaping and electromechanical works BoP, that will be assigned to the Lot 2 Contractor under a separate tendering procedure.

Lot 2 Contract or Contract for Lot 2 Project Execution: The Contract that will be concluded for the Lot 2 Scope between the Company and the Lot 2 Contractor.

Lot 2 Contractor: means the contractor that will execute the Lot 2 Scope, which will be awarded under a separate tendering procedure.

Offer or Proposal or Tender: The Offer for the conclusion of the Early Engineering Contract and Contract for Lot 1 Project Execution with the Company under the terms specified herein, electronically submitted with the required declaration and all required documents.

Offered Price: The financial proposal for the Base Scope of Lot 1 Contract.

Total Offered Price: The financial proposal for the Base Scope and all the Options

Options List: is the list of the Optional items that must be offered by the Tenderers.

Optional Items or Options: are the contents of the Options List, as specified on the DoW. Each Tenderer must include in his Offer all Optional Items.

Options Price: the total price of the Options.

Plant: The South Field Pumped Hydro Storage plant.

Project: The South Field Pumped Hydro Storage project.

Scope: means Lot 1 Scope, unless otherwise specified.

Selected Options: are those Optional Items that have been selected / officially requested by the Company prior to the signing of the Lot1 Contract.

Selected Options Price: the total price of the Selected Options.

Successful Tenderer: The Tenderer with the highest Aggregate Evaluation Score.

Schedule of Guarantees: The formal document that outlines the various guarantees, as this is presented in Annex III of the present, to be duly filled in by Tenderers, as part of their Proposals.

System: the PPC Electronic Procurement System through the "tenderONE" platform of "cosmoONE" company.

Tractebel: The consultant that has been contracted by the Company for the *"Review & Evaluation of Conceptual/Pre-Feasibility study, Feasibility, study and Technical Specifications for EPC Tender – PHS Plant in depleted* South Field *Mine, Western Macedonia, Greece"*, that will work together with the Preferred Technology Provider and the Company to develop the design and specifications for Lot 1 and to prepare the necessary design, specifications, quantities and drawings that will allow the Tender for Lot 2 to be issued.

Tender Procedure: the present Call for Tenders.

Tenderer(s): economic operator(s) or associations of economic operator(s) that will participate in the present Tender Procedure.

Deviation of Mandatory Terms: means any deviation, reservation, exclusion, qualification, condition, assumption or proposed amendment that modifies, limits or otherwise affects the Mandatory Terms of the Tender or the allocation of risk established therein.

Mandatory Terms: means the terms specified in Clause 3.17 of the present Call for Tenders.

3. Instructions To Tenderers

3.1 Information for Tenderers

3.1.1 Participation in the Tender Procedure will be open to natural or legal persons or partnerships / associations thereof which fully meet the following requirements stated in Clauses 3.4 and 3.5 below.

3.1.2 Competent PPC Division for the Procedure – Place and time of submission of Tenders

a. The competent PPC division for the Tender Procedure is the New Generation Activities Procurement Department (NGAPD - ΔΠΝΔΠ), located at 25 Patission

Street, 104 45, Athens – Greece. For further information, you may contact Ms. Despina Veneri and Ms. G. Rossou via email at D.Veneri@ppcgroup.com and G.Rossou@ppcgroup.com respectively.

b. The Tender Procedure will be conducted electronically through the "tenderONE" platform of "cosmoONE" company of the PPC Electronic Procurement System, hereinafter referred to as the "**System**", through the www.cosmo-one.gr or www.marketsite.gr portals. The System ensures at a minimum, using technical means and appropriate procedures, that:

i. The time and date of accepting the tenders are precisely determined.
ii. Access to information transmitted, prior to the specified dates, is fully prohibited.
iii. Only authorized persons are entitled to designate or modify dates for opening the submitted applications.
iv. Throughout the Tender Procedure, including the opening of the quotations, all or part of the information submitted may be accessed only by authorized persons and only after the specified date and time.
v. In the unlikely event of violation or attempted violation of the restrictions and/or terms of access, as per ii., iii. and iv., such violations or attempted violations are clearly traceable.

A prerequisite for participation of the interested parties, is registration with the System. Upon successful registration, they will be provided with System Access Codes, required for system login and applications and/or Tender submissions. Registration does not incur any expenses for interested parties.

Interested parties can download User Instructions for Registration and System's User Manual free of charge from the Company's official website, specifically https://eprocurement.dei.gr «Electronic Submission».

Tenderers that are already registered in the System are not required to register again. Nevertheless, upon logging into the System, they are strongly advised to promptly update any personal information.

In order to submit a tender for the Tender Procedure, interested parties established in EU countries are required to have a qualified digital signature (qualified electronic signature according to EU regulation 910/2014) of themselves in the case of a natural person and of the legal representative(s) in the case of a legal person, issued by a qualified trust service provider.

Tenderers established outside EU with no access to qualified electronic signatures according to the above paragraph, can sign and certify / authenticate their signature with any other legal means. In such cases, the Proposal shall be accompanied by a declaration stating that the country of origin does not provide for the use of qualified digital signature.

Proposals shall be submitted electronically by interested parties through the "tenderONE" platform, commencing on the date of publication of the present Call for Tenders, with a closing date and time of submission on **16 February 2027 at 15:00** (Greece time). After the expiry of the above closing date and time, the submission of Offers is not possible.

c. The Tender Documents, setting out the tendering procedure and initial requirements for the execution of the "South Field Mine Pumped Hydro Storage: Early Technology Provider Involvement for Design, Supply, Erection and Commissioning of Pump, Turbine, Generator and auxiliary systems" (ETPI), comprising the following:

This "Call for Tenders NGAPD-2048", including the following annexes:

- Annex I: "Financial Offer Submission Forms", including:
  - I.a. Total Offered Price Form
  - I.b. Offered Price Breakdown Form
  - I.c. Options List Price Form
  - I.d. Early Engineering Pre-Agreed Rates Form
  - I.e. Price Allocation Table (in case of Associations of Economic Operators)
- Annex II "Technical Part"
- Annex III "Schedule of Guarantees"
- Annex IV "Declaration Forms"
- Annex V "Advance Payment Guarantee Sample"
- Annex VI "Collaboration Engagement Agreement"
- Annex VII "Interface Agreement Heads of Terms"

shall be available electronically through the "tenderOne" platform of "cosmoOne" (https://www.marketsite.gr/) and on PPC's e-procurement website (https://eprocurement.dei.gr/), where they will remain posted until up to one (1) day prior to the end of the period for the submission of Proposals.

3.2 Communication

Any communication between PPC and the Tender procedure applicants shall be made electronically via the System using the "Contact" functionality.

Communication, update and distribution of electronic documents will be carried out through the System, using the following procedures:

- Uploading or communicating relevant information via messages
- Uploading of relevant information by PPC
- Uploading of relevant information by Tenderers

All data sent, notified, submitted, or uploaded are displayed at the user interface screens. In particular, the relevant timestamp constitutes proof of communication and circulation of documents through the System. If the Company sets deadlines for replies, resubmissions, clarifications, or similar requests in its communications to the Tenderers, these deadlines shall be fair and reasonable and shall be clearly stated in the respective communication.

3.3 Clarifications on Tender Documents

Tenderers may request additional information and clarifications regarding electronic documents of the Tender Procedure no later than **26 January 2027**, through the "Contact" functionality of the System.

In case the deadline for submission of the Proposal is extended, the relevant deadline for request for additional information and clarifications may be extended accordingly at the sole discretion of PPC.

PPC will respond to requests submitted by the above closing date, not later than **9 February 2027.**

3.4 Admission of Tenderers

Participation in this Tender Procedure is open to economic operators or associations of economic operators established in:

1. A Member State of the European Union, or
2. A Member State of the European Economic Area (EEA), or
3. Third countries which have signed and ratified the Agreement on Government Procurement (GPA), to the extent that the contract to be awarded is covered by Annexes 1, 2, 4, 5 and the General Notes to the European Union's Appendix I to the GPA, or

4. Third countries not falling into the above cases that have concluded a bilateral or multilateral agreement with the European Union.

Third countries of cases 3 and 4 above must additionally uphold EU-equivalent cybersecurity, data protection, trade regulations, and intellectual property standards, including but not limited to GDPR, the NIS2 Directive, and EU strategic trade and security regulations.

Economic operators controlled by, affiliated with, or significantly influenced by entities originating from jurisdictions that do not meet the above criteria shall be excluded from participation. This includes, but is not limited to:

- Subsidiaries, branches, or joint ventures where a majority stake (direct or indirect) is held by an entity from a non-compliant jurisdiction.
- Entities with decision-making, operational, or technological dependencies on a parent company or controlling entity from a non-compliant jurisdiction.

The Company reserves the right to assess and exclude any Tenderer based on security, regulatory, or strategic interest considerations in accordance with EU and national procurement laws. Additionally, PPC shall exclude Tenderers based in or significantly dependent on entities from jurisdictions subject to trade restrictions, sanctions, or embargoes imposed by the European Union, the United Kingdom, or other relevant international bodies.

Each Tenderer, individually or as a member of an association of economic operators, may submit only one Proposal. In case more than one Proposal is submitted by an economic operator, all such Proposals shall be rejected. Noncompliance with the present provision shall lead to the exclusion of all involved Tenderers.

Where affiliated companies submit separate Proposals in the Tender Procedure, either independently or as members of different Associations of Economic Operators, such Proposals shall be rejected if it is established, at any stage before the completion of the Tender Procedure, that their participation has resulted in a distortion of competition.

A prerequisite for participation in the present Tender Procedure is the absence of exclusion grounds provided in para. 3.7 and the submittal of the relevant declaration in Annex IV [DECLARATION OF NON-EXISTENCE OF EXCLUSION GROUNDS OF THE TENDERER].

No Offer shall be accepted from economic operators who have been excluded from PPC contracts for the period of their exclusion.

Tenderers must meet the above admission criteria as of the date of publication of this Call of Tender (the latest).

3.5 Eligibility Criteria

The Tenderers shall meet the following qualifying criteria:

3.5.1 The Tenderer shall provide evidence demonstrating having successfully completed the **hydraulic and mechanical design, model testing, manufacturing, supply, installation and commissioning of reversible pump/turbine** for at least 1 project within the European Union of more than 60MW per unit and between 90 to 450 m water head commissioned in the last 10 years or at least 3 projects within Europe of more than 60MW per unit and between 90 to 450 m Water head commissioned in the last 20 years.

3.5.2 The Tenderer shall provide evidence demonstrating that they have successfully completed the **design, supply, installation and commissioning** of control system, governing system and excitation system for at least 1 hydro project within Europe of more than 60MW per unit commissioned in the last 10 years or at least 3 projects within European Union of more than 60MW per unit commissioned in the last 20 years.

3.5.3 Tenderers' Annual Turnover shall be higher than one hundred million Euros (€100,000,000) on average for the last three financial years.

3.5.4 The Tenderer shall provide evidence of certification ISO 9001, ISO 14001 and ISO 45001.

It is explicitly stated that Tenderers participating in this Tender Procedure are not allowed to rely on the financial, technical, or professional capacity of a third party. Consequently, the provision of third-party experience (borrowed experience) is not permitted.

3.6 Special Provisions for Associations of Economic Operators

Associations of Economic Operators (consortia, joint ventures etc.) are not required to adopt a specific legal form for their participation in the Tender Procedure, provided that a clear and binding reference to the formation of the Association by the members of the Tenderer is included. The requirement for the Association to adopt a specific legal form before signing any agreement with PPC will depend on its legal and commercial structure, as well as applicable law.

It is explicitly agreed that all members of an Association of Economic Operators shall bear sole, indivisible, joint, and several liability towards PPC for fulfilling all obligations arising from the Association's participation in the Tender Procedure and all respective agreements with PPC.

Associations of Economic Operators may participate in this Tender Procedure, provided that:

- All members thereof meet the requirements set out in Clauses 3.4, 3.7 and 3.5.4 regarding ISO certifications.
- The eligibility criteria set out in Clauses 3.5.1 and 3.5.2 are met by at least one member of the Association.
- The Annual Turnover requirement under Clause 3.5.3 is met:
  a) cumulatively by the members of the Association, and
  b) proportionately by each member of such an Association, according to its percentage of participation in the Association.

In the event that the tendering association constitutes an informal group of companies (i.e. a partnership/ association without separate tax and legal identity), the Proposal must be structured so as to ensure separate invoicing by the members of the group in case of contract award, in accordance with Greek tax legislation and practice.

Otherwise, if the above does not apply, and provided that the Association is selected as the Successful Tenderer, its members shall, prior to signing the relevant Agreement, establish an appropriate legal and tax structure, duly registered with the competent authorities, having its own tax identification number and duly authorised representative(s), which shall enter into the Agreement with PPC and issue the relevant invoices in its own name and on its own behalf. Certified supporting documentation evidencing compliance with these requirements shall be submitted to PPC prior to signing the Agreement.

3.7 Grounds for exclusion

Any economic operator or association of economic operators shall be excluded from participation in this Tender procedure, if one or more of the grounds for exclusion described in the relevant Declaration of Non-Existence of Exclusion Grounds of the Tenderer of Annex IV apply to them or to one of their members respectively.

The Tenderer, and in the case of an Association of economic operators, each member of the Association individually, must fill in and sign the above-mentioned Declaration.

3.8 Proposal Contents

3.8.1 Administrative Folder (Folder A)

The Administrative Folder (Folder A) shall include the following documents:

- Audited statements of accounts for the last three financial years. Where the audited financial statements for the most recently completed financial year are not yet available, and the statutory deadline for their preparation and audit under the applicable legislation has not yet expired, the Tenderer may submit unaudited financial statements or management accounts for that year, duly signed by its authorized representative(s), together with the audited financial statements for the preceding two (2) financial years. In such case, the Tenderer shall provide a declaration confirming that the statutory audit for the most recently completed financial year has not yet been finalized;
- List of eligibility reference projects, including documentary evidence demonstrating compliance with the technical eligibility criteria set out in Clause 3.5;
- Certificate of completion issued to the Tenderer by the respective client of each of the submitted eligibility reference projects;
- Certificate of Incorporation, issued by the competent registry of the Tenderer's country of registration, or equivalent document;
- Declaration of Legal Status and Authority to Represent and Bind the Tenderer, as per Annex IV;
- Declaration of Acceptance of Terms of the Tender Procedure and Validity of the Offer, in the form set out in Annex IV, confirming among other things that:
  - the Tenderer fully and unconditionally accepts and agrees to be bound by the Mandatory Terms set out in Clause 3.17 of the Call for Tenders NGAPD-2048, without any deviation, reservation, exclusion, qualification or condition;
  - the Tenderer accepts and agrees to be bound by the other terms and conditions and affirms compliance with all the specifications and requirements outlined in the Call for Tenders NGAPD-2048, subject to any deviations included and documented in its Proposal, as permitted by the Call for Tenders NGAPD-2048, and any clarifications provided during the pre-submission clarification process under Clause 3.3 (Clarifications on Tender Documents);
- Declaration of Non-Existence of Exclusion Grounds of the Tenderer, as per Annex IV;
- Joint Responsibility Declaration, in case the Tenderer is an Association of Economic Operators, as per Annex IV.

All Declarations shall be duly signed by the Tenderer's legal representative(s) or other duly authorized person(s). In the case of the Joint Responsibility Declaration, it shall be signed by the duly authorized representatives of all members of the Association of Economic Operators.

It is noted that, in the case of an Association of Economic Operators submitting a Proposal, each member thereof must also submit all Declarations required from Tenderers, as outlined above.

It is explicitly stated that **no Tender Participation Bond** is required in this Tender Procedure.

3.8.2 Technical Folder (Folder B)

I. General

1. Submission Letter
2. List of conditions deviations and exclusions

II. Performance
1. Schedule of Guarantees (filled in Annex III)

III. Programme
1. Lot 1 time schedule including Design, Model test, Manufacturing, Transportation, Erection, Commissioning

IV. Technical & Drawings
1. Technical Description
2. Powerhouse General Layout
3. Cross-Sectional views
4. Preliminary P&IDs
5. Electrical SLD
6. Completed list of Suggested Spare Parts for two years operation in line with the minimum requirements set forth in Annex II.

V. HSE
1. HSE Policy
2. HSE Statistics
3. Sub-contractors HSE Control and Management
4. Procedures for reporting Accidents

VI. Contract Management
1. Manufacturing Capacities and Capabilities
2. Lot 1 Contractor's Team CVs
3. Subcontractors' selection strategy
4. List of Key Subcontractors
5. Organogram of Project team
6. Quality Policy
7. Manpower Histograms
8. ISO Certificates
9. Training Programme
10. Lot 2 Contractor Interface strategy

VII. Value Engineering submittals
1. Proposal of alternative approaches to the scope, that will deliver added value to the Project, including technical description, estimation of cost impact on Lot 1 and on Lot 2 (if applicable), time and/or performance impact.

3.8.3 Financial Folder (Folder C)

The financial offer, for the requested Scope, will include:

1) The special electronic form(s) of the System, filled in by the Tenderer with the Offered Price.
2) The financial offer, in pdf file format or equivalent, as per I.a. "TOTAL OFFERED PRICE FORM" of Annex I of the present.
3) Analysis of the above Offered Price, in pdf file format or equivalent, according to the breakdown table in I.b. "OFFERED PRICE BREAKDOWN FORM" of Annex I of the present.
4) The financial offer for the Options List in pdf file format or equivalent, according to the breakdown table in I.c. "OPTIONS LIST PRICE FORM" of Annex I of the present.
5) The unitary rates of the Early Engineering Contract in pdf file format or equivalent, according to the breakdown table in I.d. "Early Engineering Pre-Agreed Rates" of Annex I of the present.
6) Only in the case a Tenderer is an Association of Economic Operators, a Price Allocation Table of the Offered Price, according to I.e. "PRICE ALLOCATION TABLE" of Annex I of the present.

All the above forms must be signed by the Tenderer's legal representative or another duly and legally authorized person and submitted electronically in accordance with the instructions of the System.

All financial offers described in this Tender Procedure shall be submitted in the form of a lump-sum fee, including all travel, accommodation and other related expenses.

All taxes, duties, levies etc. will be borne by the Tenderer, apart from VAT which, if applicable, will be borne by PPC.

Offers that are not submitted in the aforementioned form are considered unacceptable and thus shall be rejected.

3.9 Signature of submitted documents

All Proposals and accompanying documents shall be signed in accordance with the requirements of Sub-Clause 3.1.2(b) of the present Call for Tenders.

3.10 Electronic Opening and Evaluation of the Folders A and B (PHASE I)

All Proposals will be evaluated primarily to determine whether they meet the requirements set forth in this Tender Procedure. Proposals that fail to meet these requirements and/or contain incomplete submissions may be rejected.

With the exception of Mandatory Terms, the Tenderers may include in their Offer a list of conditions, deviations and exclusions. Before carrying out any technical or financial scoring, the Committee shall conduct a compliance review of each Offer on a pass/fail basis. Any deviations in any terms, other than the Mandatory Terms, shall be evaluated according to the procedure set out in the present Call for Tender NGAPD-2048. Any Deviation of Mandatory Terms shall fail the compliance review, and the Offer shall be rejected and shall not be technically or financially evaluated. Before rejecting the Offer on this ground, PPC may, at its discretion, request the Tenderer to withdraw the relevant Deviation of Mandatory Terms explicitly and unconditionally within a deadline set by PPC. Failure of the Tenderer to do so shall result in rejection of the Offer. A general declaration of acceptance shall not cure or override any contrary statement contained elsewhere in the Offer.

The Committee appointed by the Company shall proceed with the simultaneous opening of Folders A and B on a duly appointed date and time and shall verify the completeness of the submitted documents against the requirements of Sub-Clauses 3.8.1 and 3.8.2 of this document.

Taking also into account the provisions regarding the admission of Tenderers and the grounds for exclusion, as referenced above, the Committee will determine which Proposals comply with the terms of the Tender Procedure.

For accepted Proposals, the Committee will calculate the Technical Evaluation Score (TES) and rank the Technical Offers of all accepted Proposals accordingly.

The **Technical Score** of each offer shall be assigned taking into consideration the following evaluation criteria with respective weights:

- **30% Performance Score (PS).** The guaranteed values submitted by each Tenderer, included in the Schedule of Guarantees, compared to the minimum requirements
- **20% Compliance Score (CS).** The Tenderer's compliance with Tender requirements
- **20% Value Engineering Score (VES).** The Value Engineering proposal offered by each Tenderer and the anticipated added value to the Project
- **30% Time Score (TS).** The proposed Project delivery time of each Offer

The **Technical Evaluation Score** of each offer shall be calculated as follows:

TES(i) = 30% x PS (i) / PS(max) + 20% x CS(i) / CS(max) + 20% x VES(i) / VES(max) + 30% x TS(i) / TS(max)

Where:

TES (i) is the Technical Evaluation Score of the Offer (i)
PS (i) is the Performance Score of the Offer (i)
PS (max) is the maximum Performance Score among all acceptable Offers submitted
CS (i) is the Compliance Score of the Offer (i)
CS (max) is the maximum Compliance Score among all acceptable Offers submitted
VES (i) is the Value Engineering Score of the Offer (i)
VES (max) is the maximum Value Engineering Score among all acceptable Offers submitted
TS (i) is the Time Score of the Offer (i)
TS (max) is the maximum Time Score among all acceptable Offers submitted

Offers with a Compliance Score (CS(i)) below the threshold of 10% shall be rejected.

The Committee shall record the results of this process in the relevant Minutes, which will include:

- The list of Tenderers rejected due to non-compliance with the requirements outlined in Clauses 3.4 to 3.8
- The list of Tenderers accepted and technically evaluated according to the above, who will proceed to Phase II

The outcome of Phase I will be communicated to all Tenderers via the System as follows:

- Tenderers rejected due to non-compliance with provisions included in Clauses 3.4 to 3.8 will be notified of the rejection of their Proposal. The notification will specify only the part of the Proposal that was not accepted and led to the rejection, with the level of detail deemed appropriate by the Committee.
- Tenderers with accepted Proposals will be notified that they will proceed to Phase II, without receiving any information regarding their Technical Evaluation Score or ranking.

3.11 Opening of Folder C - Financial Evaluation and Award of the Contract (Phase II)

Evaluation of the Financial Offers (Phase II) shall be conducted in one or two stages:

- Opening of Folder C and initial evaluation of Financial Offers
- Submission of Improved Financial Offers (if requested)

3.11.1 Opening of Folder C – Financial Evaluation

The Financial Folder (Folder C) of the acceptable Proposals after evaluation of Folders A and B, shall be electronically unsealed by the competent Committee on a predetermined date and time set in the System by the Committee.

The Committee shall verify the compliance of qualified Tenderer's submitted Financial Offer (Folder C) with the requirements outlined in Sub-Clauses 3.8.3 of the present Tender Procedure.

The Financial Evaluation Score (FES) for each Offer shall be calculated using the following formula:

FES (i) = TOP (min) / TOP (i)

Where:

FES (i) is the Financial Evaluation Score of the Offer (i)
TOP (min) is the lowest Total Offered Price among all acceptable Offers submitted and not rejected during Phase I

TOP (i) is the Total Offered Price of the Offer under evaluation (i)

Optional Prices, will be taken into account for the Financial Evaluation.

The intermediate ranking of the accepted Tenderers is determined by the most techno-economically advantageous Proposal, i.e., the one achieving the highest Aggregate Evaluation Score (AES), which is the sum of the Technical Evaluation Score with a Weighting Factor of 30 % and the Financial Evaluation Score with a Weighting Factor of 70 %, according to the following formula:

AES (i) = TES (i) * 0.30 + FES (i) * 0.70

Where:
AES (i) is the Aggregate Evaluation Score of the Offer(i)
TES (i) is the Technical Evaluation Score of the Offer(i)
FES (i) is the Financial Evaluation Score of the Offer(i)

The Committee shall document the results of the financial evaluation and the respective intermediate ranking in the relevant Minutes. These Minutes shall include:

- Any Tenderers rejected in Phase II due to non-compliance with financial evaluation criteria.
- The ranking of admissible financial offers.

Each Tenderer shall be notified separately, through the System, whether its Offer has been accepted or rejected. Such notification shall not include any information regarding the Tenderer's ranking or disclose any information relating to any other Tenderer or its Offer.

3.11.2 Submission of Improved Financial Offers

Following the completion of the technical and financial evaluation of the initially submitted offers and the intermediate ranking of the accepted Tenderers who submitted acceptable offers, the Committee notifies each Tenderer individually through the System regarding the formal acceptance of their Offer, as outlined above.

If the Committee requests the submission of Improved Financial Offers, all Tenderers whose Proposals have not been rejected pursuant to Section 3.11.1 above shall be invited to submit an improved financial offer electronically through the System within a specified deadline upon the Committee's request. This process may be repeated more than once at the discretion of the Committee. The last submitted improved offer will be considered the best financial offer.

All other Tenderers are excluded from further participation in the process.

It is expressly clarified that each Improved Financial Offer submitted by a Tenderer invited to participate in this stage must:

- Strictly correspond to the initially declared technical specifications, as these were specified following evaluation of Folders A and B.
- Be equal to or lower than the initially submitted financial offer in the System or the most recently submitted improved offer (if lower). Any submission of an improved financial offer higher than the initial offer or the most recent improved offer (whichever is lower) is explicitly defined as a breach of the Tenderer's obligations in this process.

If, at any stage of the Improved Financial Offer process, a Tenderer does not submit an Improved Financial Offer, its most recently submitted valid Financial Offer shall remain in effect and shall be deemed its last valid Financial Offer.

It is clarified that during the Improved Financial Offer process, no information shall be disclosed regarding any Tenderer's ranking, score or evaluation outcome, whether in relation to that Tenderer itself or to any other Tenderer.

The Best and Final Offer, as determined through the above process, will be used for the final evaluation and the determination of the final ranking of the Tenderers, the Early Engineering Contract being awarded to the Tenderer achieving the highest final Aggregate Evaluation Score (AES), calculated as per above.

In the event of equal offers, the bidders with equivalent bids will be invited to submit their best and final financial offer electronically through the System within a specified deadline.

If VAT is applicable on the invoices issued by the Preferred Technology Provider to PPC, this will not be included in the Tender price and will not be considered in the comparison of offers.

Finally, the Committee will prepare and sign an Offer Evaluation Report detailing the entire process. Based on such Report, each Tenderer shall be notified separately, through the System, whether or not it has emerged as the Successful Tenderer. No further information shall be disclosed regarding any Tenderer's ranking, score or evaluation outcome, whether in relation to that Tenderer itself or to any other Tenderer.

If the Committee decides not to request any improved financial offers following the evaluation of all accepted proposals, the intermediate ranking defined in section 3.11.1 above will be considered the final ranking of this Tender Procedure.

3.12 Clarifications During the Evaluation Process

During the evaluation process of the Proposals (Phases I - II), the competent Committee may request clarifications from the Tenderers through the System, to which Tenderers shall be obliged to reply, within the time period specified in the request for clarification, which in any case shall not be less than five (5) working days from the date of PPC's relevant digital request. Clarifications shall be provided only when requested by the competent Committee and only those referred to in the points requested shall be taken into consideration. In that case, the provision of clarifications is mandatory for the Tenderer. PPC may, at its request, accept the submission of supplements and/or clarifications of the submitted documents. Condition for acceptance is that the clarifications fully comply with the relevant requirements of the Tender Procedure.

The clarifications may, indicatively, include the following topics:

i) Through the clarification process, PPC may require that a Tenderer provides supplementary, additional or revised information.

ii) Within this framework, PPC may request a Tenderer to:
   - withdraw a submitted deviation, either partially or entirely, or
   - accept alternative wording proposed by PPC, which shall replace the deviation originally submitted.

   In the above cases, PPC shall inform the Tenderers whether non-compliance with the above requests results in a reduced Compliance Score. In case PPC activates, at its discretion, the clarification process set out in this article, PPC shall address requests for clarifications to all Tenderers who have submitted deviations relating to the same subject-matter and/or conditions.

iii) As part of the clarification process, PPC may require participating Tenderers to add or modify parts of the Scope of Works, so that their Technical Proposals align with the outcome of that process and the requirements arising therefrom.

Rejected Tenderers reserve the right to raise objections in accordance with the provisions of Clause 3.13 of the present Tender Procedure. The list of qualified Tenderers on both Phases shall be finalized after any objections have been examined.

3.13 Tenderers' Objections

Each Tenderer is entitled to submit objections solely in the event of rejection of their Proposal within the framework of this Tender Procedure and only on the grounds of said rejection. Objections must be submitted electronically via the System, with the date of

registration in the System considered as the official submission date.

Objections shall be submitted within five (5) working days from the date on which the contested decision was communicated to the party submitting the objection.

Examination of Objections

- Objections shall be reviewed by a dedicated Committee established by PPC specifically for this purpose.
- The Committee shall examine the objections within fifteen (15) calendar days from the date of the objection.
- The Committee's decision shall be communicated electronically via the System, and an email notification shall be sent to the complainant.

The Committee's decision rejecting an objection is final and irrevocable and cannot be further contested before PPC bodies.

The submission of Objections does not automatically prevent the continuation of this procedure, and any acceptance of Objections does not affect the validity of the procedure, but may lead, at the sole discretion of the Company, to the amendment of the Committee's decision or to the repetition of the procedure.

3.14 Personal Data Protection - Information on the processing of personal data

PPC informs, in its capacity as data controller, the natural person signing the Proposal as a Tenderer or as a Legal Representative of a Tenderer, that its competent bodies and executives and/or third parties, on its instructions and on its behalf, will process the below data as follows:

I. The scope of processing extends to the personal data included in the Proposal files and the evidentiary means submitted to PPC, in the context of this Tender Procedure, by the natural person who is himself a Tenderer or Legal Representative of a Tenderer.

II. The purpose of the processing is the evaluation of the Proposal, the selection of the Counterparty for the respective agreement, the protection of PPC's rights, the fulfilment of PPC's statutory obligations and the overall safety and protection of transactions. Identity and contact data may also be used by PPC to inform Tenderers about the evaluation of Proposals.

III. The recipients of the abovementioned data are:
(a) Entities to which PPC assigns the execution of specific actions on its behalf, namely Advisors, executives, members of Evaluation Committees, Operators of the System and other agents thereof in general, subject to the condition of confidentiality in each case.
(b) The State, other public bodies or judicial authorities or other authorities or judicial bodies within the scope of their competences.

IV. The data of the Tenderers will be kept for a period of time equal to the Contractual duration, and after its expiration for a period of five (5) years, for future tax-fiscal audits or donor audits or other audits provided for by the applicable legislation, unless a different retention period is provided for by the legislation in force. In the event of pending litigation, the data shall be kept until the end of the pending litigation. After the expiry of the above periods, the personal data will be destroyed.

V. The natural person who is either a Tenderer or a Legal Representative of the Tenderer, may exercise any legal rights regarding the personal data appertaining thereto, by contacting the Data Protection Officer of PPC.

VI. PPC is obliged to take all reasonable measures to ensure the confidentiality and security of the data processing and to protect the data from accidental or unlawful destruction,

accidental loss, alteration, unauthorized disclosure or access by anyone and any other form of unlawful processing.

3.15 Cancellation of the Procedure

PPC reserves the right, by reasoned decision of its competent bodies, to cancel this Tender Procedure as a whole or in part, or to restate it under the same or different terms at any stage of this Procedure and at its sole discretion. PPC shall cancel (or restate) the Procedure, in particular if:

- no Proposals were submitted, or no admissible Proposals remain following the rejection of Proposals and/or the exclusion of Tenderers;
- it was conducted without observing the conditions set out in this Tender Procedure and in the relevant legislation, consequently affecting the result.
- competition has been insufficient
- the outcome of the Tender procedure is unsatisfactory to the Company.
- the Company's needs have changed.
- the Contract cannot be properly executed, due to force majeure

3.16 Reservation of Rights

Participation in the Tender Procedure shall be equivalent to a declaration by the Tenderer that they were fully aware of all the terms, information and documents of the Tender Procedure.

PPC reserves the right to postpone the date of submission of Proposals or make amendments to this Tender Procedure. These amendments will be included in relevant Supplements of this Tender Procedure, the issuance whereof will be published, as well as the Call.

PPC has no responsibility or obligation, in any event, to compensate the Tenderers for any expense or damage they might have suffered in preparing and submitting their Proposals, especially in the event that they are not accepted, or the Procedure is postponed or cancelled at any phase and time and for any reason or cause. Consequently, those who participate in the Tender Procedure and submit a Proposal, regardless of whether they were finally accepted or not, do not acquire any right whatsoever against PPC from this Tender Procedure and their general participation in the procedure.

With regards to the Options, the Company reserves the right to select any, all or none of the Optional Items offered by the Successful Tenderer.

Following the execution of the Early Engineering Contract or the Lot 1 Contract, as applicable, PPC reserves the right to request one or more adjustments to the respective Scope, including increases or reductions in the quantities, extent or volume of the services or works included therein, provided that such adjustments remain within the general nature and purpose of the relevant Contract.

In the case of the Early Engineering Contract, the cumulative value of any increases shall not exceed thirty percent (30%), and the cumulative value of any reductions shall not exceed thirty percent (30%), of the original Early Engineering Contract Price.

For the Lot 1 Contract, the cumulative value of any increases shall not exceed fifty percent (50%), and the cumulative value of any reductions shall not exceed thirty percent (30%), of the original Lot 1 Contract Price.

Any such adjustment shall result in a corresponding adjustment to the relevant contract price, calculated on the basis of the applicable contractual rates and prices. Where no applicable rate or price exists, the respective adjustment shall be determined on a reasonable and properly substantiated basis, in accordance with the relevant contract.

The contractor shall not be entitled to request any increase in the applicable contractual unit rates or unit prices, or to raise any other claim solely as a result of adjustments falling within the above limits.

Any adjustment to the scope shall, where applicable, be accompanied by a reasonable reassessment of the relevant Time for Completion and, where justified by the impact of such adjustment, an appropriate extension of time.

3.17 Mandatory Terms

The Mandatory Terms consist of the following:

1) The terms and conditions of the Collaboration Engagement Agreement as set out in Annex VI of this Call for Tender;

2) The terms and conditions of the Heads of Terms set out in sub-clause 5.2 which are marked with double asterisk (**), namely:
   a. General Conditions of Contract
   b. Joint and Several Liability
   c. Early Engineering Contract Deliverables design responsibility
   d. Accepted Contract Amount
   e. Overall Liability Cap
   f. Indirect or Consequential Damages, Loss of profit
   g. Definition of fitness for purpose
   h. Liquidated Damages Caps
   i. Delivery Incoterm
   j. Concurrent Delay
   k. Profit & Overheads
   l. Currencies of Payment
   m. Adjustment for Changes in Legislation (Change in Law)
   n. Adjustment for Changes in Cost – Main Principles
   o. Bank Guarantees
   p. Approvals
   q. Tests on Completion and Taking Over
   r. Tests After Completion
   s. Termination
   t. Force Majeure
   u. Claims
   v. Language for communications
   w. Governing Law
   x. Ruling Language
   y. Arbitration
   z. Interface Agreement
   aa. “not to exceed values” claims from Lot 2 Contractor

3) The number of pump-turbines shall be four (4). Any alternative offers with a different number of units are not accepted.

4) The Division of Works between Lot 1 and Lot 2 (DOW).

4. Early Engineering

4.1 Scope of Services

The aim of the Early Engineering Contract is for the Early Engineering Contractor to:

- support the Employer in the optimisation of the project
- complete the design, including all required studies and reporting, of the agreed scope and nature of the Works comprising the Lot 1 Contract to a level of detail sufficient for the Early Engineering Contractor to be able to:
    - agree to a lump sum Final Tender Price for the execution of those Works, and
    - provide sufficient information describing the Works under the Lot 2 Contract to be able to prepare the Tender Documents for that contract;
- support the Employer in the development and finalisation of the Employer's Requirements which describe and specify in detail the Works to be executed under the Lot 1 Contract, and which will form part of the Lot 1 Contract documentation for that contract;
- agree to all the terms and conditions of the Lot 1 Contract including all contractual and commercial parts of the Lot 1 Contract.

The basis of all activities and deliverables shall be the Initial Lot1 Scope included in Appendix 8 of the Early Engineering Contract, as adjusted to reflect the final Lot1 Scope, that will include any evolution in the design, specifications, division of works and battery limits that will have been agreed by both Parties during the course of this Agreement.

The Early Engineering Contractor's entire team for the execution of the Services under the Early Engineering Contract shall be based in the Early Engineering Contractor's offices in Europe.

4.1.1 Activities

Value Engineering

- Organise and participate in monthly value engineering workshops
- Identify the necessary redundancy and options that will allow the Plant to accommodate planned and unplanned outages without total loss of capacity
- Elaborate the design philosophy, with regard to ease of maintenance and availability of parts not kept in stock
- Evaluate alternative configurations
- Perform Design optimization
- Propose value engineering options

General

- Collaborate with Tractebel on the finalisation of the Feasibility Study and Tender Design
- Provide input to Tractebel as required
- Contribute to the preparation of Employer Requirements for Lot 1 Contract
- Contribute to the preparation of Employer Requirements for Lot 2 Contract
- Steady state and transient hydraulic design of waterways, outtake, intake and including tailrace.
- Ensure compatibility with the required number (4) of pump turbine units, their characteristics and operating considerations.
- Provide input for the Stability Study to confirm the line charging operation mode
- Efficiencies in generation and pump mode and round-trip efficiency
- Initiate and advance the design for the Hydraulic model Test of the runner (that will be performed as soon as reasonably practical after Lot 1 signature)
- Dimensioning of Lot 1 equipment
- Lot 1 Technical Specifications finalization
- Contribution to and coordination with grid modelling
- Elaborate a list of concerns/risks and suggest mitigation measures

- Establish the O&M approach including monitoring and maintenance as well as handover process to the Company
- Scope definition for Balance of Plant (Lot 2 electromechanical equipment)
- Establish (any) Minimum Requirements for Balance of Plant (Lot 2 electromechanical equipment)
- Pre-dimensioning for the parts of the Balance of Plant (Lot 2 electromechanical equipment) which depend on Lot 1 input
- Establish all interface points between Lot 1 and Lot 2 and define the required conditions at battery limits
- Review and comment on the powerhouse Civil Drawings issued by Tractebel and also propose optimization solutions. In addition, the Early Engineering Contractor shall provide the suggested placement of electromechanical equipment, weights, dimensions, foundation forces and access requirements for operation and maintenance of components under Lot 1.
- Review and comment on the overall layout of the powerhouse, contribute to relevant workshops and provide input regarding the positioning and general arrangement of M&E equipment.

4.1.2 Deliverables

- Hydraulic Design Report (steady state and transient)
- Process Flow Diagrams (PFDs)
- Piping and Instrumentation Diagrams (PIDs)
- Start-up and shut down conditions of the plant.
- Control Philosophy (First draft)
- O&M Philosophy (First draft)
- Commissioning Philosophy and Methodology (First Draft)
- General Arrangement Drawings
- Equipment List (Preliminary)
- Pump Turbine Datasheet
- Motor Generator Datasheet
- Technical Specification Pump Turbine
- Technical Specification for Mechanical Protection Equipment
- Technical Specification for Electrical Protection Equipment
- Technical Specification for Mechanical Equipment under Lot 1
- Single Line Diagram
- Consumer List
- Wiring Diagrams
- Technical Specification for all Electrical Equipment under Lot 1 (SFC, Phase Reversal, GCB, IPB, electrical protections)
- Technical Specification for all selected optional Electrical Equipment
- Control System Architecture
- Technical Specification for Plant Control System (DCS, SCADA)
- Technical Specification for Monitoring System
- Technical Specification for field Instruments
- Risk Analysis (Preliminary)
- Detailed Time schedule (including milestones for Lot 2 Contractor)
- Erection methodology (including specific requirements for Lot 2 Contractor)
- Detailed DoW between Lot 1 and Lot 2 including clear battery limits and conditions at battery limits as applicable
- Interface Matrix between Lot 1 and Lot 2, including:
  - all interfaces related to engineering, erection, construction and commissioning
  - necessary input data required from Lot 1 to Lot 2 and vice versa, including timing

4.2 General Conditions of Contract

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4.3 Particular Conditions of Contract

4.3.1 Part A. References from Clauses in the General Conditions

1.1 Definitions

1.1.4	Client's Representative	[Name of Representative]
1.1.5	Commencement Date	The Employer shall, no later than 28 days after the Effective Date, issue a Notice to the Early Engineering Contractor to commence the Services under this Agreement. The date on which the Notice is delivered to the Early Engineering Contractor in accordance with Sub-Clause 1.3 [Notices and Other Communications] shall constitute the Commencement Date.
1.1.8	Consultant's Representative	[Name of Representative]
1.1.9	Country	Greece
1.1.22	Project	Early Engineering for Pump, Turbine, Generator and Auxiliary Systems of South Field Mine Pumped Hydro Storage
1.1.24	Time for Completion	274 days

1.3 Notices and other Communications

1.3.1(c)	Communication	delivered by hand (against receipt), or sent by post, by courier, or by email
1.3.1(d)	Address for communications	
Client's address:		[Address]
Email:		[Email]
Consultant's address:		[Address]
Email:		[Email]

1.4 Law and Language

1.4.1	Law governing Agreement	Greek law
1.4.2	Ruling language of Agreement	English
1.4.3	Language for communications	The language for communications is English. However, Greek may be used solely to the extent necessary for (i) the review and analysis by the Early Engineering Contractor of Documents originally prepared in Greek and (ii) the preparation of any input, report or other documentation that the Early Engineering Contractor is required to prepare or provide for submission to the Greek authorities. The use of Greek for those purposes shall not affect English as the ruling language of the Agreement or as the language for all other communications and Deliverables under the Agreement.

1.8 Confidentiality

1.8.3	Period for expiry of confidentiality	Five years after the completion of the Services or the termination of this Agreement.

1.9 Publication

1.9.1	Publication restrictions	Two years after the completion of the Services or the termination of this Agreement, however the Employer, at its discretion, may, upon the issue of a Notice to the Early Engineering Contractor prior to the expiry of this initial restriction period, extend the restriction period for up to a further two years.

3.9 Construction Administration

Not included in Services

7.4 Third Party Charges on Consultant

Exemption Applies

8.2 Duration of Liability

8.2.1	Period of Liability	Four years after the completion of the Services or the termination of this Agreement

8.3 Limit of Liability

8.3.1	Limit of Liability	100% of the Contract Price stated in Appendix 3 to this Agreement

9 Insurance

9.1.1 Insurances to be taken out by Consultant

Professional Indemnity Insurance	Five million euros (5.000.000€)
Public Liability Insurance	One million euros (1.000.000€)

10 Disputes and Arbitration

10.4.1 Arbitration rules	Rules of Arbitration: International Chamber of Commerce (ICC Rules) Number of Arbitrators: three (3) arbitrators to be appointed in accordance with ICC Rules. Place of Arbitration: Athens, Greece.
10.4.1 Language of arbitration	English

4.3.2 Part B. Additional or Amended Clauses

1. **Delete the text of Sub-Clause 1.1.1 in its entirety and substitute with the following:**
"Agreement" means the Form of Agreement together with the Employer/ Early Engineering Contractor Model Services Agreement (General Conditions and Particular Conditions), Appendix 1 [Scope of Services], Appendix 2 [Personnel, Equipment, Facilities and Services of Others to be Provided by the Employer – not applicable], Appendix 3 [Remuneration and Payment], Appendix 4 [Programme], Appendix 5 [Rules for Adjudication – not applicable], Appendix 6 [Rely Upon Information], Appendix 7 [Form of Advance Payment Bond], Appendix 8 [Initial Lot1 Scope] and any letters of offer and acceptance attached to any of the above".

2. **Delete the text of Sub-Clause 1.1.3 in its entirety and substitute with the following:**
*"Wherever the term "**Client**" is used in the Conditions of Contract it is to be replaced by "**Employer**"."*

3. **The following text is added at the end of Sub-Clause 1.1.6:**
"For the avoidance of doubt, Confidential Information also includes any piece of Information as designated in Sub-Clause 1.1 and Clause 5 [Confidentiality Obligations] of the Collaboration Engagement Agreement".

4. **Delete the text of sub-clause 1.1.7 in its entirety and substitute with the following:**
*"Wherever the term "**Consultant**" is used in the Conditions of Contract it is to be replaced by "**Early Engineering Contractor**"."*

5. **Delete the text of sub-clause 1.1.27 in its entirety and substitute with the following:**
*""**Works Contract**" means the contract for the execution of the permanent works, the design of which is the subject of the Services under this Agreement, and associated temporary works (if any) under the Project and which is referred to as "**South Field Mine Pumped Storage Plant – Lot 1: Mechanical, Electrical and Control and Communication Works**"."*

6. **Add the following new sub-clause 1.1.29:**
"*"**Employer**" means the Party named in the Form of Agreement and legal successors to the Employer and permitted assignees."*

7. **Add the following new sub-clause 1.1.30:**
"*"**Early Engineering Contractor**" means the Party named in the Form of Agreement and legal successors to the Early Engineering Contractor and permitted assignees."*

8. **Add the following new sub-clause 1.1.31:**
"*"**Tender**" means the tender submitted by the Early Engineering Contractor in response to the Employer's Call for Tenders NGAPD-2048 for the execution of the Services entitled "South Field Mine Pumped Hydro Storage: Early Technology Provider Involvement for Design, Supply, Erection and Commissioning of Pump, Turbine, Generator and auxiliary systems".*

9. **New Sub-Clause 1.1.32**
Add the following new Sub-Clause 1.1.32:
"Overheads" means the Early Engineering Contractor's general, administrative, management and other indirect costs and expenses associated with the performance and administration of the Services, including facilities, head-office and administration management support, accounting, commercial, legal, human resources, and other general administrative expenses. Overheads amount to 10% (ten per cent) of the net costs accepted as payable under the Agreement."

10. **New Sub-Clause 1.1.33**
Add the following new Sub-Clause 1.1.33:

"Profit" means the Early Engineering Contractor's profit on the relevant costs. Profit amounts to 8% (eight per cent) of the net costs accepted as payable under the Agreement.

11. **New Sub-Clause 1.1.34**
"Pre-Agreed Rates" means the rates stated in Appendix 3 [Remuneration and Payment] which shall be used solely for the valuation of Variations and/or Exceptional Costs as expressly provided in the Agreement. The Pre-Agreed Rates are inclusive of all costs, Overheads and Profit relating to the work to which they apply. No additional Overheads or Profit shall be added to any Pre-Agreed Rates.

12. **Add the following at the end of Sub-Clause 1.6.3:**
"The Employer's consent, where required, shall not be unreasonably withheld or delayed".

13. **Sub-Clause 1.7.1 is amended as follows:**
"All Intellectual Property held in any medium, whether electronic or otherwise, created by the Early Engineering Contractor during the performance of the Services (Foreground Intellectual Property) shall be vested in the Early Engineering Contractor. The Early Engineering Contractor hereby shall grant to the Employer a royalty-free license to use and copy the Foreground Intellectual Property for any purpose in connection with the Project, subject to the License Conditions, which are defined herebelow.
License Conditions means that: (i) the Early Engineering Contractor has been awarded the Lot 1 Contract, unless the Employer has terminated the "Collaboration Engagement Agreement" as a result of the Early Engineering Contractor's failure to comply with its obligations under 4.2. or 4.3. of that Agreement; (ii) all undisputed amounts due to Early Engineering Contractor under this Agreement have been paid in full; (iii) any license or right granted to the Employer under this Agreement shall be solely for the execution, continuation, completion, operation and maintenance of the Project. The license shall not be generally transferable or sublicensable, except that the Employer may transfer/sublicense the license to any Affiliate, financing party, security agent, successor owner, purchaser, transferee or operator of the Project or the Plant, and may allow its Affiliates, Representatives, consultants, contractors, suppliers, lenders, advisers, operators and maintenance contractors to use, copy, reproduce and rely on the Foreground Intellectual Property, in each case on a need-to-know basis, solely for the purposes of the Project, including the execution, continuation, completion, financing, refinancing, ownership, insurance, operation, maintenance, repair, modification or disposal of the South Field Mine Pumped Hydro Storage Plant and its associated infrastructure and subject to appropriate confidentiality obligations. For the avoidance of doubt, no such use shall permit the Foreground Intellectual Property to be used for any project other than the Project.
The Early Engineering Contractor shall retain the right to use the Foreground Intellectual Property for its own purposes and for third parties".

14. **Sub-Clause 1.7.2 is amended as follows:**
"All Background Intellectual Property shall remain the property of the original owner. The Consultant hereby grants to the Client or agrees to procure the grant to the Client of an unrestricted royal-ty-free license to use and copy the Consultant's Background Intellectual Property to the extent reasonably required to enable the Client to make use of the Services or the Project, provided that the License Conditions (Sub-Clause 1.7.1) are satisfied. The Client hereby grants to the Consultant an unrestricted royalty-free license to use and copy the Client's Background Intellectual Proper-ty provided to the Consultant to the extent reasonably required to enable the Consultant to provide the Services".

15. After Sub-Clause 1.7.5 the following Sub-Clauses are added:

1.7.6 License Grant

Notwithstanding the provisions of Sub-Clauses 1.7.1 to 1.7.4, the Early Engineering Contractor agrees that all technical input, documentation, specifications, designs, reports, and the Services (but expressly excluding pricing, commercial terms contained in the Tender) submitted by the Early Engineering Contractor under this Agreement shall be licensed to the Employer on a royalty-free, irrevocable, non-exclusive basis, , provided the License Conditions (Sub-Clause 1.7.1.) are satisfied. The Employer shall have the unrestricted right to use, modify, reproduce, and share such input for the purposes of the Project, provided the License Conditions (Sub-Clause 1.7.1.) are satisfied.

1.7.7 Waiver of Restriction

The Early Engineering Contractor expressly waives any right to assert or enforce any intellectual property rights in a manner that would restrict, delay, or otherwise hinder the Employer's use of the provided input and deliverables of the present Agreement provided the License Conditions (Sub-Clause 1.7.1.) are satisfied. The Early Engineering Contractor shall not claim or enforce any intellectual property rights that would prevent the Employer from freely using, developing, or implementing the provided input and/or deliverables for the Project, solely for the execution of the Project, subject to the License Conditions (Sub-Clause 1.7.1.).

1.7.8 Use of Deliverables After Completion or Termination

In the event of termination of this Agreement, according to any of the Sub-Clauses 6.4.1. (a), (b) or (c), the Employer shall retain the right to use all deliverables of the present Agreement, including but not limited to drawings, designs, reports, calculations, and specifications, however expressly excluding the Early Engineering Contractor's commercial offer, vendor list, schedule of guarantees and contractual deviations, provided that the License Conditions (Sub-Clause 1.7.1) are satisfied. The Employer may provide them to any third party, such as another consultant, supplier, or contractor, however excluding any competitor of the Early Engineering Contractor, strictly for the continuation and completion of the Services, subject to those third parties agreeing to maintain confidentiality. Any use, modification, or reliance on the deliverables after completion or termination shall be at the Employer's sole risk. For the avoidance of doubt, in any other termination instance not covered by Sub-Clauses 6.4.1 (a), (b), or (c), the Employer shall have no right to use such deliverables for manufacturing, installation, commissioning, operation, repair, or maintenance of the Project or related components. However, in the event of completion of this Agreement, the Employer may use such deliverables as permitted under a final and binding Works Contract (i.e. the envisaged Lot 1 Contract) mutually agreed by the Parties.

1.7.9 Third-Party Rights and Indemnity

The Early Engineering Contractor warrants that all input, materials, and deliverables provided under this Agreement (''Deliverables") are either owned by the Early Engineering Contractor or appropriately licensed for use by the Employer for the purpose of the Project. The Early Engineering Contractor shall indemnify and hold harmless the Employer against any third-party claims, damages, or liabilities (excluding Employer's Affiliates) arising from an alleged infringement of third-party intellectual property rights related to the provided input and deliverables, provided that(i) the alleged infringement or misappropriation is not attributable to any act or omission of the Employer, its Affiliates, employees, subcontractors, or sub-suppliers, including but not limited to misuse, modification, or combination with non- Early Engineering Contractor products or services; (ii) the Employer notifies the Early Engineering Contractor in writing promptly upon becoming aware of the claim; (iii) the Employer provides the Early Engineering Contractor with all necessary information, reasonable assistance, and authority to defend or settle the claim; (iv) the Employer uses reasonable efforts to mitigate any damages. The Early Engineering Contractor shall have the right to control the defence and settlement of such claim, provided that the Employer remains indemnified and unharmed. If such a claim is upheld and the continued use of the Deliverables and Services is enjoined, the Contractor shall, at its own expense and discretion either (i) modify or replace the Deliverables or Services with a non-infringing equivalent that does not degrade performance or functionality; or (ii) obtain from the

third party the necessary rights (assignment, license, or sublicense) to allow continued and unhindered use by the Employer. The Early Engineering Contractor shall not be liable for any claims or damages resulting from the Employer's continued use of the Deliverables or Services after being notified to cease such use due to a third-party claim, unless the Early Engineering Contractor has failed to expeditiously perform any of its obligations under the immediately preceding sub-paragraph.

1.7.10 Exclusion of Innovation

The Early Engineering Contractor acknowledges that the purpose of this engagement is not the development of standalone new intellectual property or innovative solutions but rather the provision of early engineering and technological input necessary for the execution of the Project. Accordingly, all deliverables, technical input and related information provided under this Agreement shall be treated as technical information essential for the Project and shall be subject to the license and use rights set out in Sub-Clause 1.7.1. To the extent that any Foreground Intellectual Property is nevertheless created in the course of performing the Services, such Foreground Intellectual Property shall remain vested in the Early Engineering Contractor but shall be licensed to the Employer in accordance with Sub-Clause 1.7.6. For the avoidance of doubt, nothing in this Clause shall limit the Employer's rights under Sub-Clauses 1.7.6. to 1.7.8., nor affect the Early Engineering Contractor's ownership of its Background Intellectual Property or pre-existing know-how, except to the extent embodied in, or necessary for the permitted use of the deliverables.

16. **Sub-Clause 1.8.1**

Add at the end of Sub-Clause 1.8.1:

"..., except to insurers, auditors, or legal advisers who are bound by confidentiality obligations, or as required by law or regulation".

17. **Sub-Clause 1.8.2**

Add at the end of Sub-Clause 1.8.2:

"If disclosure is required by law, the receiving Party shall, where legally permitted, promptly notify the disclosing Party".

18. **Sub-Clause 1.8.3**

Delete the text of Sub-Clause 1.8.3 in its entirety and substitute with the following:

"The obligations set forth in Sub-Clause 1.8.1 shall expire five (5) years after completion of the Services or the termination of the Agreement (whichever is the earlier).

Upon written request, each Party shall return or destroy Confidential Information, except for copies required by law or for insurance/audit purposes".

19. **Sub-Clause 1.10.3**

Delete the text of Sub-Clause 1.10.3 in its entirety and substitute with the following:

"In conjunction with the requirements of this Clause 1.10 the Consultant shall at the Client's request demonstrate that it adheres to a documented code of conduct in respect to the prevention of corruption and bribery.

The Consultant shall, as a minimum, comply with the Consultant's Code of Conduct and with the PPC Suppliers/ Partners Code of Conduct, which set out binding principles and standards for integrity, anti-corruption and ethical business conduct.

The PPC Suppliers/ Partners Code of Conduct is available at:
https://www.ppcgroup.com/media/v5vlkzi3/ppc-suppliers-code-conduct_en0109205.pdf".

The Consultant's Code of Conduct is available at:

[•]

20. **A new Sub-Clause 2.1.4 is added as follows:**

"2.1.4 The Employer confirms that the information listed in Appendix 6 – Rely Upon Information (the "Rely-Upon Information") is provided for the purposes of the Services and the Early Engineering Contractor is entitled to rely upon such information in

performing the Services, not being required to review such documents for the purpose of this clause.
The Employer warrants that, to the best of its knowledge, the Rely Upon Information is accurate and complete in all material respects for the purposes for which it is stated to be provided.
If the Early Engineering Contractor suffers delay and/or incurs Exceptional Cost to the extent that such delay or cost is attributable to any Rely Upon Information being incorrect, incomplete, or being changed after it has been provided, the Early Engineering Contractor shall be entitled to an extension of time for any such delay and payment of any such Exceptional Cost".

21. **Sub-Clause 2.4**
Sub-Clause 2.4 is deleted and shall not apply.

22. **Sub-Clause 2.6.1**
Delete the text of Sub-Clause 2.6.1 in its entirety and substitute with the following:
"The Employer shall ensure that its representatives and staff engaged in the oversight of this Agreement possess the necessary skills and authority to perform timely reviews and fulfil the Employer obligations of this Agreement".

23. **Sub-Clause 2.6.2**
Sub-Clause 2.6.2 is deleted and shall not apply

24. **Sub-Clause 2.6.3**
Sub-Clause 2.6.3 is deleted and shall not apply

25. **A new Sub-Clause 2.7.2 is added as follows:**
"Only the Employer's Representative may issue binding instructions. Directions from others are not binding unless confirmed in writing by the Employer's Representative".

26. **Sub-Clause 3.3 (Standard of Care) is amended as follows**
Sub-Clause 3.3.1 is deleted and replaced with the following:
3.3.1 The Early Engineering Contractor shall exercise the reasonable skill, care and diligence to be expected from an experienced international consultant and technology provider regularly engaged in pumped hydro storage projects of similar size, nature, complexity and risk profile, and shall perform the Services in accordance with the Agreement, Good Industry Practices, applicable Law and the applicable codes and standards. This standard shall not qualify or reduce any obligation under the Agreement which is expressed as an absolute obligation.

Sub-Clause 3.3.2 is deleted and replaced with the following:
3.3.2 Without limiting Sub-Clause 3.3.1, the Early Engineering Contractor shall perform the Services with a view to satisfying any function and purpose that may be described in Appendix 1 (Scope of Services).

27. **A new Sub-clause 3.10 is added as follows:**
3.10.1 Advance Payment Guarantee
The Early Engineering Contractor shall obtain (at his cost) an Advance Payment Guarantee, in the amount of 10% of the Contract Price.
The Early Engineering Contractor shall deliver the Advance Payment Guarantee to the Employer within 14 days after the Effective Date.
The Advance Payment Guarantee shall be issued by a bank acceptable to the Employer, legally operating in Greece or, alternatively, in a Member State of the European Union or the European Economic Area. The Employer's approval of the issuing bank shall be based on reasonable grounds, including its financial standing, credit rating, regulatory status and overall reputation, and shall not be unreasonably withheld or delayed. Where the issuing bank is not established in Greece, it shall maintain a correspondent

systemic bank in Greece through which the Advance Payment Guarantee may be enforced without recourse to proceedings before foreign courts.
The Advance Payment Guarantee shall be irrevocable, unconditional, non-transferable and payable on first demand, shall be governed by the laws of Greece, and shall be subject to the exclusive jurisdiction of the courts of Athens, Greece. The Uniform Rules for Demand Guarantees, ICC Publication No. 758 ("URDG 758"), shall apply. The Advance Payment Guarantee shall be issued in the form set out in Annex V of the Call for Tenders. Any proposed modification thereto shall require the Employer's prior written approval. If the Employer does not approve a proposed modification, the Early Engineering Contractor shall provide a replacement guarantee fully complying with the prescribed form within the period specified by the Employer, which shall not be less than five (5) working days.
The Early Engineering Contractor shall maintain the Advance Payment Guarantee in accordance with Appendix 3. The Employer shall return the Advance Payment Guarantee within twenty-one (21) days after the release threshold specified in Appendix 3 has been reached, following the Early Engineering Contractor's written request.

28. **A new Sub-clause 3.12 is added as follows:**
"3.12 Progress Reports"
Monthly progress reports shall be prepared by the Early Engineering Contractor and submitted to the Employer. The first report shall cover the period up to the end of the first calendar month following the Commencement Date. Reports shall be submitted monthly thereafter, each within 7 days after the last day of the period to which it relates. Reporting shall continue until the Early Engineering Contractor has completed all work under the Agreement.
The monthly progress reports shall include as a minimum:
i) **Executive Summary**
Key achievements, major issues, and overall status.
ii) **Progress Status**
Overall engineering progress and progress by major discipline/work package.
Planned vs. actual progress, key milestones, delays, and forecast dates.
Status of drawings, calculations, reports, specifications, and other contractual deliverables.
Surveys, geological/geotechnical investigations, testing, and outstanding activities.
iii) **Risks & Outstanding Issues**
Key risks, technical issues, required decisions, and mitigation actions (e.g. Geotechnical, HSE, Quality).
iv) **Next Month Plan**
Main activities and deliverables planned for the following month.
v) **Appendices**
Progress S-curve, detailed deliverables register, updated schedule.

29. **After Sub-Clause 4.2.1 a new Sub-Clause 4.2.2 is inserted as follows**
"**4.2.2 Completion of the Services and Early Engineering Completion Certificate**
Following the proper and full completion of the Services in accordance with this Agreement, the Early Engineering Contractor may submit a written request to the Employer for the issuance of the Early Engineering Completion Certificate. Within thirty (30) days after receiving such request—and provided that the Employer is satisfied that all Services and Deliverables have been completed and submitted in the required final and editable formats and any issues raised in prior Notices of Non-Conformance have been resolved—the Employer shall issue the Early Engineering Completion Certificate confirming the satisfactory completion of the Services. The Employer shall not unreasonably withhold, delay or condition the issuance of the Early Engineering Completion Certificate.
If the Employer considers that the Services have not yet been completed in full, it shall notify the Early Engineering Contractor in writing, within thirty (30) days of the Early Engineering Contractor's request, identifying the outstanding items or deficiencies that

must be remedied before the Early Engineering Completion Certificate can be issued. Any such notice shall specify all outstanding items in reasonable detail.
The issuance of the Early Engineering Completion Certificate shall constitute formal completion of the Services, but shall not affect any rights of the Employer under the Agreement in respect of defects, liability, indemnities, confidentiality, or other post-completion obligations of the Early Engineering Contractor.
The Early Engineering Completion Certificate shall be backdated, if required, to indicate the actual completion date of the Services.".

30. **Sub-Clause 4.3.1**

The first paragraph of Sub-Clause 4.3.1 is deleted in its entirety and substituted with the following:
"Within twenty-eight (28) days of the Commencement Date the Early Engineering Contractor shall submit its Programme which shall include as a minimum:

a) the order and timing in which the Consultant intends to carry out the Services in order to complete the Services within the Time for Completion.
b) any key dates stipulated in Appendix 4 [Programme] or elsewhere in the Agreement for the delivery of any part of the Services to the Client.
c) the key dates when decisions, consents, approvals or information from the Client or third parties is required to be given to the Consultant.
d) any other requirements stated in Appendix 4 [Programme],
e) The Consultant shall keep the Programme under review and shall amend the same as and when necessary to comply with the Agreement".

31. **Sub-Clause 4.4.3**

Delete the text of Sub-Clause 4.4.3 in its entirety and substitute with the following:
"Where any circumstance referred to in Sub-Clauses 4.4.1(a), 4.4.1(b) and 4.4.1(d) causes the Consultant to incur Exceptional Costs, then the agreed remuneration shall be adjusted in accordance with Sub-Clause 7.1.2 [Payment to the Consultant]. As soon as reasonably practicable the Consultant shall inform the Client of the occurrence of the Exceptional Costs by issue of a Notice".

32. **The following new sub-clause 4.4.4 is added**

"In the event that the Early Engineering Contractor exceeds the Time for Completion as specified in Appendix 4 for any reason or cause other than those expressly provided in Sub-Clause 4.4.1 of the General Conditions, delay-related penalties ("Delay Penalties") shall be imposed.

The Delay Penalties shall amount to 1,00 % (one per cent) of the Contract Price, as defined in section 3.1 of Appendix 3, inclusive of any variations, subsequent supplement(s), amendment(s) or any other written agreement(s) executed between the Parties, in connection with this Agreement. This penalty shall apply for each and every full week of delay beyond the Time for Completion, as stated in Appendix 4. A grace period of two weeks shall apply, during which no Delay Penalties shall be imposed. However, once the penalty is triggered, it shall be calculated retroactively from the first day of delay.

Notwithstanding the provisions of Sub-Clause 7.2.3, the Employer shall impose the Delay Penalties by withholding corresponding amounts from any future payments due to the Early Engineering Contractor under the Agreement.

The cumulative amount of Delay Penalties shall in no event exceed ten percent (10%) of the total Contract Price of the Agreement, inclusive of any variations, subsequent supplement(s), amendment(s) or any other written agreement(s) executed between the Parties, in connection with this Agreement. For the avoidance of doubt, the Delay Penalties stipulated herein shall constitute the Early Engineering Contractor's sole and exclusive financial liability towards the Employer in respect of any delay in completion of the Services."

33. **After Sub-Clause 4.6 a new Sub-Clause 4.7 is inserted as follows**
"**4.7 Submission and Review of Deliverables**
The Early Engineering Contractor shall submit each deliverable or output of the Services in accordance with the Programme and the Scope of Services, in both editable and PDF formats, accompanied by a transmittal note referencing the relevant deliverable title and its submission status (draft or final).

Within fifteen (15) days from receipt of each deliverable/output, the Employer may issue a Notice of Non-Conformance if the Employer has (a) any remarks or comments on the content, clarity, or adequacy of the deliverable/output; or (b) identified any defects or deficiencies therein.
The Notice of Non-Conformance shall set out the Employer's observations and may request the Early Engineering Contractor to either:
(a) correct, revise, or supplement the deliverable within fifteen (15) calendar days of receipt of the Notice, or within such other period as may be agreed between the Parties; or
(b) address the Employer's comments as part of the submission of a subsequent and related deliverable, where the Employer deems such sequencing appropriate.

Failure by the Employer to issue a Notice of Non-Conformance within the above fifteen (15) days shall not be deemed acceptance of the deliverable and shall not relieve the Early Engineering Contractor of responsibility for the correctness, completeness, coordination or suitability of the Services.
However, the Early Engineering Contractor may proceed with the subsequent and related Services on the basis of the deliverable/output so submitted, and such continuation shall not be considered to be prevented or blocked solely by reason of the Employer's failure to issue a Notice of Non-Conformance within the review period.
Such continuation shall be without prejudice to the Employer's right to review the deliverable/output in the context of any subsequent deliverable, or any other rights or remedies of the Employer under the Agreement. If, following such continuation, the Employer identifies any non-conformity in the relevant deliverable/output, the Employer may require the Early Engineering Contractor to address it as part of the relevant subsequent deliverable or, where reasonably necessary, by way of correction, revision or supplementation. Such request of the Employer shall be treated as a Variation, only if and to the extent that: (i) it causes material rework of subsequent Services, which the Early Engineering Contractor had performed in accordance with the Agreement and the Programme, (ii) it would reasonably have been avoided if the Employer had been issued the comment within the fifteen (15) day review period and (iii) it is not attributable to any error, omission or breach by the Early Engineering Contractor. The latter shall give Notice in accordance with Sub-Clause 5.1 [Variations], identifying the relevant impact on time and cost, and any entitlement shall be limited to the necessary, reasonable and substantiated consequences of the Variation.
For the purposes of progress measurement and payment only, a deliverable, in respect of which no Notice of Non-Conformance has been issued within the applicable review period, may be taken into account under the Progress Measurement Mechanism, without constituting acceptance, approval or waiver by the Employer.

The timely and proper response by the Early Engineering Contractor to any Notice of Non-Conformance shall be a condition for the corresponding progress to be recognized under the Progress Measurement Mechanism. Failure to respond adequately or within the prescribed timeframe shall result in the relevant portion of the Services being marked as incomplete or non-compliant, and the corresponding payment shall be deferred or withheld until satisfactory resolution

Any review, comment, approval or failure to comment by the Employer shall not relieve the Early Engineering Contractor of any obligation or responsibility under the Agreement".

34. Sub-Clause 5.2.2

Delete the text of Sub-Clause 5.2.2 in its entirety and substitute with the following:
"The value of any Variation shall be determined in accordance with or based upon the rates and/or prices in Appendix 3 [Remuneration and Payment]. Where the rates and/or prices are not applicable to the Variation then the evaluation shall be in accordance with sub-clause 7.1.2 related to Exceptional Cost".

After Sub-Clause 5.2.2, a new Sub-Clause 5.2.3 is inserted as follows

5.2.3. Adjustments to the Scope of Services - Limit of Increase or Reduction

The Employer reserves the right to request one or more adjustments to the Scope of Services, including increases or reductions in the quantities, extent or volume of the Services included therein, provided that such adjustments remain within the general nature and purpose of the Agreement.

The aggregate value of all increases shall not exceed thirty percent (30%) of the original Contract Price, while the aggregate value of all reductions shall not exceed thirty percent (30%) of the original Contract Price.

Any such adjustment shall result in a corresponding adjustment to the Contract Price, calculated on the basis of the applicable contractual rates and prices. Where no applicable rate or price exists, the respective adjustment shall be determined on a reasonable and properly substantiated basis, in accordance with Sub-Clause 5.2.2.

The Early Engineering Contractor shall not be entitled to request any increase in the applicable contractual unit rates or unit prices, including the Pre-Agreed Rates set out in Appendix 3 [Remuneration and Payment], or to raise any other claim solely as a result of adjustments falling within the above limits.

Any adjustment to the Scope of Services shall, where applicable, be accompanied by a reasonable reassessment of the Time for Completion and, where justified by the impact of such adjustment, an appropriate extension of time.

35. Sub-Clause 6.1.2 c)

Sub-Clause 6.1.2 c) of the General Conditions shall not apply.

36. Sub-Clause 6.3.3

Delete the text of Sub-Clause 6.3.3 in its entirety and substitute with the following:
"If during the suspension and resumption of Services or part thereof the Early Engineering Contractor incurs Exceptional Costs, properly substantiated and documented by the Early Engineering Contractor, which for the avoidance of doubt may include either standby, or demobilization/ mobilization costs, depending on whether the Employer, at its sole discretion, instructs the Early Engineering Contractor to remain on standby or to demobilize and subsequently remobilize; however, until such instruction is issued, the Contractor shall maintain only such resources on standby as are reasonably necessary and shall use reasonable endeavours to mitigate and minimize any Exceptional Costs. Consequently, then:

a) the agreed remuneration shall be adjusted in accordance with Sub-Clause 7.1.2 [Payment to the Early Engineering Contractor] and subclause 4.4 [Delays];
b) the Time for Completion shall be amended in accordance with Clause 4.4 [Delays] to reflect the effect of the suspension on the Programme.
c) as soon as reasonably practicable the Early Engineering Contractor shall inform the Employer by issue of a Notice of the occurrence of these Exceptional Costs.

For the avoidance of doubt, where a suspension arises solely from a circumstance falling under Sub-Clause 4.4.1 (c), the Early Engineering Contractor shall not be entitled to Exceptional Costs solely by reason of that circumstance, except to the extent that the

Employer separately instructs a Variation or the relevant cost results from an act or omission for which the Employer is responsible under the Agreement.".

37. **Delete the text of Sub-Clause 6.4.1 in its entirety and substitute with the following: "Termination by the Client**
    a) If the Consultant without good reason is in breach of a material term or condition of the Agreement, the Client may give Notice to the Consultant outlining the breach and the remedy required under the Agreement. If the Consultant has not proceeded to remedy the breach within twenty-eight (28) days after the issue of the Notice, then the Client may terminate the Agreement upon giving fourteen (14) days' Notice to the Consultant.
    b) Notwithstanding the notice periods in Sub-Clause 6.4.1(a), if the Consultant becomes bankrupt or insolvent, goes into liquidation, has a receiving or administration order made against it, compounds with its creditors, or carries on business under a receiver, trustee or manager for the benefit of its creditors, or if any act is done or event occurs which (under applicable laws) has a similar effect to any of these acts or events, the Client may in so far as the applicable laws permit terminate the Agreement with immediate effect upon service of an appropriate Notice.
    c) Notwithstanding the notice periods in Sub-Clause 6.4.1(a), if the Early Engineering Contractor is in breach of Clause 1.10 [Anti-Corruption], the Employer may terminate the Agreement with immediate effect upon service of an appropriate Notice. The Early Engineering Contractor shall be entitled to make representations within fourteen (14) days of such notice, and termination shall be suspended pending the outcome of such representations.
    d) At its sole discretion upon giving the Early Engineering Contractor fifty-six (56) days' Notice
    e) Without prejudice to Sub-Clause 6.1.1 [Suspension of Services], where an Exceptional Event has led to a suspension of the Services for more than one hundred and sixty-eight (168) days the Client may terminate the Agreement upon giving fourteen (14) days' Notice to the Early Engineering Contractor.
    f) if the Delay Penalties have reached the cap stated in Sub-Clause 4.4.4 or if the Early Engineering Contractor's liability under the Agreement has reached the applicable Limit of Liability".

38. **Delete the text of Sub-Clause 6.4.2 in its entirety and substitute with the following: Termination by the Consultant**
    a) If the Services have been suspended under Sub-Clause 6.1.1 [Suspension of Services] for more than one hundred sixty eight (168) days in aggregate the Early Engineering Contractor may terminate the Agreement upon giving fourteen (14) days' Notice to the Employer.
    b) If the Services have been suspended under Sub-Clause 6.1.2(a) [Suspension of Services] for more than forty-two (42) days the Early Engineering Contractor may terminate the Agreement upon giving fourteen (14) days' Notice to the Employer.
    c) If the Client becomes bankrupt or insolvent, goes into liquidation, has a receiving or administration order made against it, compounds with its creditors, or carries on business under a receiver, trustee or manager for the benefit of its creditors, or if any act is done or event occurs which (under applicable laws) has a similar effect to any of these acts or events, the Consultant may in so far as the applicable laws permit terminate the Agreement with immediate effect upon service of an appropriate Notice.
    d) If the Client is in breach of Clause 1.10 [Anti-Corruption] the Consultant may terminate the Agreement with immediate effect upon service of an appropriate Notice. The Employer shall be entitled to make representations within fourteen (14) days of such notice, and termination shall be suspended pending the outcome of such representations".
    e) If the Services have been suspended under Sub-Clause 6.1.2(b) [Suspension of Services], for more than one hundred sixty-eight (168) days the Early Engineering

Contractor may terminate the Agreement upon giving fourteen (14) days' Notice to the Employer.

39. Sub-Clause 6.5.3

Delete the text of Sub-Clause 6.5.3 in its entirety and substitute with the following:
If the Agreement is terminated in accordance with Sub-Clause 6.4.1 (d) or Sub-Clause 6.4.2 (a), (b), (c), (d) or (e) [Termination of Agreement] and the Early Engineering Contractor incurs Exceptional Costs, then, without prejudice to any other rights the Early Engineering Contractor may have under the Agreement, the agreed remuneration shall be adjusted in accordance with Sub-Clause 7.1.2 [Payment to the Early Engineering Contractor]. In addition to the foregoing, in case of termination under Sub-Clause 6.4.1 (d) or Sub-Clause 6.4.2 (a) to (d), the Early Engineering Contractor shall be compensated a termination fee of eight percent (8%) of the remaining Contract Price related to the Services not performed by the Early Engineering Contractor. The Early Engineering Contractor shall inform the Employer as soon as reasonably practicable by issue of a Notice of the occurrence of the Exceptional Costs.

40. Sub-Clause 6.5.4

Sub-Clause 6.5.4 of the General Conditions shall not apply.

41. Delete the text of Sub-Clause 7.1.2 in its entirety and substitute with the following:

"Unless otherwise agreed in writing, the Client shall pay the Consultant in respect of Exceptional Costs:

a) The value of any resources required/incurred in accordance with or based upon the Pre-Agreed Rates stated in Appendix 3 [Remuneration and Payment], or where the Pre-Agreed Rates are not applicable then new rates and prices shall be provided by the Early Engineering Contractor under market standards, that for the avoidance of doubt shall include Overheads and Profit; and
b) the cost of all other expenses reasonably incurred and duly substantiated and documented by the Early Engineering Contractor, plus Overheads and Profit".

42. Sub-Clause 7.2.2

Add at the end of Sub-Clause 7.2.2:
"In case of delay on undisputed payment for more than 30 (thirty) days, an interest rate shall apply at the annual rate of 2% (two percent) above the 3 (three) month EURIBOR rate for Euro".

43. Delete the text of Clause 10 in its entirety and substitute with the following:

"10.1 Notice of Dispute

10.1.1 If any dispute, controversy or claim arises out of or in connection with the Agreement, including any question regarding its existence, validity, performance, breach, termination or any non-contractual obligations arising out of or in connection with it, either Party may give a Notice of Dispute to the other Party.

10.1.2 The Notice of Dispute shall briefly describe the nature of the dispute, the relief or remedy sought, and the main contractual and factual grounds on which the referring Party relies.

10.2 Steering Committee

10.2.1 Following the issue of a Notice of Dispute, the dispute shall be referred to the Steering Committee for amicable resolution.

10.2.2 The Steering Committee shall consist of two (2) representatives appointed by the Employer and two (2) representatives appointed by the Early Engineering Contractor. Each Party shall ensure that at least one of its representatives is a senior representative with sufficient authority to negotiate and recommend a settlement of the dispute. Each Party may replace its representatives by means of a Notice to the other Party.

10.2.3 The Steering Committee may invite the Parties' technical, legal, commercial or other advisers, including Tractebel or other Project advisers, to attend its meetings, provided that such persons shall act in an advisory capacity only and shall be bound by confidentiality obligations no less stringent than those applicable under the Agreement.

10.2.4 The Steering Committee shall meet within ten (10) Days after receipt of the Notice of Dispute, or within such other period as the Parties may agree in writing and shall use reasonable endeavours to resolve the dispute amicably.
10.2.5 The Steering Committee shall not act as an adjudicator, expert, arbitral tribunal or other decision-making body, and shall have no power to issue any binding determination or decision on either Party.
10.2.6 Any settlement or resolution reached through the Steering Committee shall be binding only if recorded in writing and signed by duly authorised representatives of both Parties. To the extent that such settlement or resolution requires any amendment, Variation or other contractual act under the Agreement, it shall be implemented in accordance with the relevant provisions of the Agreement.
10.2.7 If the dispute has not been resolved within thirty (30) Days after receipt of the Notice of Dispute, or within such longer period as the Parties may agree in writing, either Party may refer the dispute to arbitration in accordance with Sub-Clause 10.4 [Arbitration]. No further amicable settlement procedure, adjudication or reference to any other body shall be required as a condition precedent to arbitration.
10.2.8 Unless otherwise agreed by the Parties in writing, referral of a dispute to the Steering Committee shall not suspend the performance of the Services or the performance of the Parties' respective obligations under the Agreement.

10.3 No Adjudication

10.3.1 The Parties agree that adjudication shall not apply to this Agreement. Any reference in the Agreement to adjudication, an adjudicator, the Rules for Adjudication, an adjudicator's decision, a notice of dissatisfaction with an adjudicator's decision, or enforcement of an adjudicator's decision shall be deemed deleted and of no effect.
10.3.2 Appendix 5 [Rules for Adjudication] shall not apply.

10.4 Arbitration

10.4.1 Unless settled amicably in accordance with Sub-Clause 10.2 [Steering Committee], any dispute arising out of or in connection with the Agreement, including any dispute relating to any non-contractual obligations arising out of or in connection with the Agreement, shall be finally settled by arbitration under the Rules of Arbitration of the International Chamber of Commerce (ICC).
10.4.2 The dispute shall be settled by three (3) arbitrator(s) appointed in accordance with the ICC Rules.
10.4.3 The seat of arbitration shall be Athens, Greece. The language of the arbitration shall be English.
10.4.4 The arbitral tribunal shall have full power to determine all issues of fact and law arising in the dispute. Neither Party shall be limited in the arbitration to the evidence, arguments, submissions or positions presented before the Steering Committee.
10.4.5 Arbitration may be commenced before or after completion of the Services. The obligations of the Parties shall not be altered by reason of any arbitration being conducted during the progress of the Services.

10.5 Settlement Agreements

10.5.1 If a Party fails to comply with any settlement agreement signed in accordance with Sub-Clause 10.2.6, the other Party may refer such failure directly to arbitration under Sub-Clause 10.4 [Arbitration], without any further reference to the Steering Committee".

4.3.3 Appendix 1 Scope of Services

As per clause 4.1 of the present Call for Tenders NGAPD-2048.

4.3.4 Appendix 2 Personnel, Equipment, Facilities and Services of Others to be Provided by the Employer

Not applicable

4.3.5 Appendix 3 Remuneration and Payment

3.1 Contract Price

The Contract Price for the Services provided under the Scope of Services of this Agreement, as described above in Appendix 1 herein, shall be *[2.5 % of the Lot 1 Total Offered Price]*. During the performance of the Early Engineering Contract, the Services to be performed by the Early Engineering Contractor shall include the engineering services necessary for the Base Scope and for each and all of the Optional Items (Base Scope and Optional Items having the meaning defined in the Call for Tenders NGAPD-2048), irrespective of whether any such Optional Items are subsequently selected for implementation.

The Contract Price is a lump sum price and shall be fixed and not subject to escalation.

The Contract Price shall be the full remuneration and shall cover any expenditure required for the provision of the Services, including among others and indicatively, personnel salaries and wages, the cost of personnel travelling expenses for the visits included in the Scope of the Agreement, the value of all materials and supplies that will be used for the provision of the Services, insurance fees, FOREX currency risks, general expenses (including taxes, duties, etc. enforced in the Country of the Early Engineering Contractor), encumbrances of any kind relating to personnel of any rank and mainly including the Early Engineering Contractor's contributions to social security organizations, the Early Engineering Contractor's profit, and any other expenses required for the Early Engineering Contractor's compliance with the provisions of the Agreement.

The Contract Price shall also include all costs related to the requested site visits in Greece (travelling, accommodation, allowances, etc.), either on site or not.

Any value added tax (VAT), or any other tax currently applicable or that may be imposed in the future in Greece on the invoices issued by the Early Engineering Contractor to the Employer in respect of the Services, shall be borne and paid exclusively by the Employer. Such taxes are not included in the Contract Price.

3.2 Payment Schedule

Invoices and payments to the Early Engineering Contractor shall be made as follows:

1. Advance Payment of 10% of the Contract Price shall be paid after the Commencement Date, against an Advance Payment Bond which shall be issued in accordance with the Sample of Appendix 7 (Advance Payment Bond), and of a relevant supporting document, as agreed between the Parties, (advance payment invoice etc.). The payment shall be effected within 15 working days from receipt of the Advance Payment Bond and the respective supporting document.

   The Advance Payment Bond shall remain valid and enforceable until the cumulative value of Services certified and invoiced under the Agreement, including the Advance Payment, reaches fifty percent (50%) of the Contract Price. The Advance Payment Bond shall not be progressively reduced before that threshold is reached.
   If the Advance Payment Bond specifies an expiry date and the above threshold has not been reached by the date falling twenty-eight (28) days before that expiry date, the Early Engineering Contractor shall extend its validity until that threshold has been reached.

   In case that the Early Engineering Contractor forms a consortium, each member of the Early Engineering Contractor may issue its own Advance Payment Bond for its specific portion of the Contract Price as set out in Appendix 3, provided that any guarantees shall be issued on behalf of the consortium as a whole and shall explicitly provide for the joint and several liability of all consortium members in respect of the Advance Payment.

The remaining ninety percent (90%) of the Contract Price shall be paid to the Early Engineering Contractor on a monthly basis according to the Progress Measurement Mechanism of Sub-Clause 3.3 below.

2. Invoicing and Payments shall be made in EURO currency.

3. Payments shall be made within forty-five (45) days from the date of issuance of the relevant Invoice, provided that the following conditions are met:
   - the Invoice is accompanied by the corresponding Monthly Progress Certificate; and
   - in cases where the Early Engineering Contractor is established in a foreign country with which Greece has entered into a Double Taxation Convention, and where Greek tax authorities require proof that the Early Engineering Contractor is subject to taxation in its country of residence, the Early Engineering Contractor shall submit the appropriate certificate of tax residence ("Form"). This Form must be duly completed and also signed by the competent tax authority of the Early Engineering Contractor's country and be delivered to the Employer. The Form must be renewed annually. Failure to provide a valid Form, duly signed and submitted to the Employer, shall prevent the Invoice from being submitted to the competent Greek tax authorities, and consequently, shall preclude the full payment of the Invoice.

3.3 Progress Measurement

		Progress on First Submission (%)	Progress on Approval (%)
1	**Meetings workshops and activities**	**30,0**	
1.1	Kick Off Meeting	3,0	N/A
1.2	Optimisation and value Engineering Workshops (Month 1)	3,0	N/A
1.3	Site Visit	3,0	N/A
1.4	Monthly Engineering Workshops (Months 2-9)	16,0	N/A
1.5	Review and comment the powerhouse Civil Drawings. Provide the suggested placement of electromechanical equipment, weights, dimensions, foundation forces and access requirements for operation and maintenance of components under lot 1.	5,0	N/A
2	**Deliverables**	**70,0**	
2.1	Hydraulic Design Report (steady state and transient)	2,0	2,0
2.2	Process Flow Diagrams (PFDs)	2,0	2,0
2.3	Piping and Instrumentation Diagrams (PIDs)	2,0	2,0
2.4	Start-up and shut down conditions of the plant.	1,0	1,0
2.5	Control Philosophy (First draft)	1,0	1,0
2.6	O&M Philosophy (First draft)	1,0	1,0
2.7	Commissioning Philosophy and Methodology (First Draft)	1,0	1,0
2.8	General Arrangement Drawings	2,0	2,0
2.9	Equipment List (Preliminary)	1,0	1,0
2.10	Pump Turbine Datasheet	1,0	1,0
2.11	Motor Generator Datasheet	1,0	1,0
2.12	Technical Specification Pump Turbine	1,0	1,0

2.13	Technical Specification for Mechanical Protection Equipment	1,0	1,0
2.14	Technical Specification for Electrical Protection Equipment	1,0	1,0
2.15	Technical Specification for Mechanical Equipment under Lot 1	1,0	1,0
2.16	Single Line Diagram	1,0	1,0
2.17	Consumer List	1,0	1,0
2.18	Wiring Diagrams	1,0	1,0
2.19	Technical Specification for all Electrical Equipment under Lot 1	1,0	1,0
2.20	Technical Specification for all selected optional Electrical Equipment	1,0	1,0
2.21	Control System Architecture	1,0	1,0
2.22	Technical Specification for Plant Control System (DCS, SCADA)	1,0	1,0
2.23	Technical Specification for Monitoring System	1,0	1,0
2.24	Technical Specification for field Instruments	1,0	1,0
2.25	Risk Analysis (Preliminary)	1,0	1,0
2.26	Detailed Time schedule (including milestones for Lot 2 Contractor)	1,0	1,0
2.27	Erection methodology (including specific requirements for Lot 2 Contractor)	1,0	1,0
2.28	Detailed DoW between Lot 1 and Lot 2 including clear battery limits and conditions at battery limits as applicable	2,0	2,0
2.29	Interface Matrix between Lot 1 and Lot 2, including: · all interfaces related to engineering, erection, construction and commissioning · necessary input data required from Lot 1 to Lot 2 and vice versa, including timing	2,0	2,0

3.4 Pre-Agreed Rates

The Pre-Agreed Rates stated herebelow shall be deemed to include all costs, Overheads, Profit and other charges necessary for the performance of the Services to which such rates apply.

No additional amount for Overheads or Profit shall be added to any Pre-Agreed Rate.

The Pre-Agreed Rates shall remain fixed and valid until 15 months from the Commencement Date.

The Pre-Agreed Rates are as follows: [to be submitted by the Tenderer in Folder C]

4.3.6 Appendix 4 Programme

4.1 Commencement Date - Time for Completion

After the Effective Date, the Employer shall submit a formal notice to the Early Engineering Contractor for the commencement of Services under this Agreement. The date that the notice shall be delivered to the Early Engineering Contractor shall constitute the Commencement Date.
The Early Engineering Contractor shall complete the Services within the Time for Completion.

4.2 Project Programme

Following the provisions of Sub-Clause 4.3 of the General Conditions, the Early Engineering Contractor's first Programme submitted shall be evaluated by the Employer and rejected for resubmission or approved. The approved Programme shall constitute the Programme Baseline of the Project.

The Early Engineering Contractor shall submit, at the end of every month after the Commencement Date, a Tracking Programme that will depict the Baseline and a comparison between the Baseline and the actual condition, including completion progress per activity. The Tracking Programme shall be submitted both in "pdf" file format, as well as Time Schedule software used file format (MS Project).

Revision in the Programme Baseline may take place under a formal written request of any of the Parties and the consensus of both Parties to the new Programme.

4.3 Progress Measurement Mechanism

The Parties agree that, through the Progress Measurement Mechanism (PMM) of Sub-Clause 3.3 of Appendix 3, the Employer shall monitor the progress of the Services in accordance with the Project Programme and shall issue instructions to the Early Engineering Contractor in the event of delays. The results of the PMM shall be recorded each month in a Monthly Progress Certificate, which shall form the basis for determining the Employer's monthly payments to the Early Engineering Contractor, in accordance with the provisions of Section 3.2 of Appendix 3 [Remuneration and Payment].

4.3.7 Appendix 5 Rules for Adjudication

Not applicable.

4.3.8 Appendix 6 – Rely Upon Information

The information constituting Rely Upon Information is the following:

Geotechnical and topographic studies

4.3.9 Appendix 7 – Advance Payment Bond

As per Annex V of the present Call for Tenders No. NGAPD-2048.

4.3.10 Appendix 8 – Initial LOT1 Scope

Initial Lot 1 Scope means the engineering, procurement/fabrication, erection and commissioning and all other services and works relevant to the pump, turbine, generator and relevant auxiliaries of the South Field PHS, including all underlying assumptions, as further detailed herebelow, with the following order of precedence:

a) List of agreed deviations and clarifications,

b) The present Call for Tenders No. NGAPD-2048, including all Addenda

c) Early Engineering Contractor's Proposal.

5. Contract for Lot 1 Project Execution

5.1 General Information

Following the completion of the Early Engineering Contract, including optimisation of the project concept, agreements on technical issues and achievement of all technical deliverables, the technical contents of the Lot 1 Contract, including the following, will have been finalized:

- Employer's Requirements, including:
  - Scope of Works (including Division of Work Between Lot 1 and Lot 2)
  - General Requirements Specification
  - Mechanical Works General and Particular Specifications
  - Electrical Works General and Particular Specifications
  - Instrumentation and Control Works General and Particular Specifications
  - Drawings (including Diagrams and Civil Works Guide Drawings)

- Technical Schedules, including:
  - Detailed Construction Schedule (initial Sub-Clause 8.3 Programme)
  - Schedule of Milestones
  - Erection sequence and methodology
  - Mechanical Works Technical Data Sheets
  - Electrical Works Technical Data Sheets
  - Instrumentation and Control Works Technical Data Sheets
  - Schedule of Functional Performance Guarantees
  - Contractor's Design and Construction Organisation and Key Personnel
  - List of Subcontractors and Subcontracted Works
  - Work Activity (Manufacturing, Erection and Testing) Method Statements
  - Risk Matrix
  - Permits and Licenses
  - Health and Safety Management Plan
  - Environmental Management Plan
  - Quality Management Plan

- Interface Schedule, including:
  - Interface Matrix between Lot 1 and Lot 2
  - Conditions at battery limits between Lot 1 and Lot2
  - Definition of Interface Dependencies and Obligations
  - Interface Notification and Information Exchange Requirements
  - Insurance Requirements
  - Dispute Adjudication Agreement

Similarly, all the commercial and contractual contents of the Lot 1 Contract, including the following, will have been finalized:

- General Conditions of Contract (FIDIC 1999 Yellow Book)
- Particular Conditions of Contract together with their Annexes, including:
  - Accepted Contract Amount and Schedule of Payments
  - Schedule of Rates and Prices
  - Cooperation and Interface Management
  - Performance Damages (Rates and Cap)
  - Delay Damages (Rates and Cap)

- Insurance Requirements
- Dispute Adjudication Agreement

· Contractual Forms, including:

- Form of Contract Agreement
- Form of Performance Security
- Form of Advance Payment Security

5.2 Heads of Terms

General Conditions of Contract**	FIDIC Yellow, First Edition 1999
Joint and Several Liability**	As per FIDIC Yellow / First Edition 1999: If the Contractor constitutes (under applicable Laws) a joint venture, consortium or other unincorporated grouping of two or more persons: (a) these persons shall be deemed to be jointly and severally liable to the Employer for the performance of the Contract; (b) these persons shall notify the Employer of their leader who shall have authority to bind the Contractor and each of these persons; and (c) the Contractor shall not alter its composition or legal status without the prior consent of the Employer.
Early Engineering Contract Deliverables design responsibility**	The Early Engineering Deliverables prepared, developed and submitted by the Preferred Technology Provider under the Early Engineering Contract shall be incorporated into the Lot 1 Contract and shall form part of the Contract Documents, including the Employer's Requirements, the Contractor's Documents and/or the technical schedules, as applicable. The Lot 1 Contractor shall be deemed to have reviewed, verified, adopted and assumed full responsibility for such Early Engineering Deliverables, excepting for the Rely Upon Information contained on it, for the purposes of the Lot 1 Contract. Such deliverables shall be subject to the same design responsibility, warranties, guarantees, performance obligations, testing regime, defects obligations, indemnities, securities and remedies as apply to the corresponding deliverables, documents and obligations under the Lot 1 Contract.
Accepted Contract Amount**	The starting point for value of the Lot 1 Accepted Contract Amount will be the Base Price which will be equal to the Offered Price plus the Selected Options Price, minus 2.5% of the Base price, minus 2.5% Selected Options Price. The final value of the Lot 1 Accepted Contract Amount will be equal to the above starting point, reasonably adjusted to reflect: · Mutually agreed differences between the Initial Lot 1 Scope and the Lot 1 Scope · any mutually agreed differences between the Heads of Terms of Annex 1 of the Collaboration Agreement and the final terms and conditions of the Lot 1 contract, and · the indexation mechanism, according to a mutually agreed revision formula which will be based on the principles set out below. The Reference Date for the price adjustment indices will be the date of submission of the Offer.
Overall Liability Cap**	100% of the Accepted Contract Amount. For avoidance of doubt, limitation of liability shall apply also to any amounts payable under Sub-Clause 15.4(c). (including any costs of completion, losses or damages following termination). The Overall Liability Cap shall include any Liquidated Damages paid under the Contract. Carve-outs: fraud, deliberate default, willful or reckless misconduct, gross negligence, abandonment and third-party indemnities (limited to property damage, bodily injury and IP infringements).
Indirect or Consequential Damages, Loss of profit**	No party shall be liable to the other party for Indirect or Consequential Damages, Loss of profit

	Carve-outs: fraud, deliberate default, willful or reckless misconduct, gross negligence, abandonment and third-party indemnities (limited to property damage, bodily injury and IP infringements). For the avoidance of doubt, Delay Damages and Performance Damages payable under the Lot1 Contract shall not be treated as indirect or consequential loss.
Relied Upon Information and Employer's Requirements	The Rely Upon Information is as follows: 1. Topographic Survey including boundaries 2. Environmental Permit 3. Geotechnical studies 4. Grid Voltage Level. 5. Layout in terms of major changes in : • Overall internal dimensions • Depth, height width • Main compartments The Employer shall be responsible for the correctness of the data and information provided as "Rely Upon Information" (RUI). In case that the Contractor suffers delays and/or incurs costs as a result of any error, inaccuracy or defect in the RUI, the Contractor shall be entitled to an Extension of Time and Cost plus Profit. The Technical Specifications/Employer's Requirements shall not be part of Rely Upon Information. Employer shall not be responsible for the accuracy of the parts of the Employer's Requirements developed with the participation of the Contractor during the Early Engineering phase.
Definition of fitness for purpose**	At the end of first paragraph of Sub-Clause 4.1 after the word "Contract" the following shall be added: "(and each element of the Works shall be fit for its ordinary purpose)". Fitness for Purpose: Purpose of the Works is to provide the parameters as listed in the Schedule of Guarantees of the Contract.
Liquidated Damages Caps**	Liquidated Delay Damages Cap: 15% Liquidated Performance Damages Cap: 15% Aggregate Liquidated Damages Cap: 20% LDs shall be sole and exclusive remedy
Liquidated Damages	All liquidated Damages rates and method of their application shall be based on the "no double dip" principle, Performance Liquidated Damages rates shall be as per the Schedule of Guarantees. Delay Liquidated Damages: A. One milestone on Taking Over per Section. B. LD-bearing Interface Milestones The LD-bearing Interface Milestones for Lot 1 Contract shall include the following: 1) Design Milestones (a) Model Test Report non-objection (b) Interface Level 1 – Basic Design (c) Interface Level 2 – Intermediate Detailed Design (d) Interface Level 3 – Final Detailed Design 2) Embedded Parts Milestones (a) Draft Tube and Draft Tube Gate ready for concreting, with piping, per unit (b) Turbine Pit Liner and Spiral Case ready for concreting, with piping, per unit (c) Common embedded piping ready for concreting (d) Generator anchoring plates ready for concreting, per unit (e) MIV anchoring plates ready for concreting, per unit 3) Other Interface Milestones (a) MIV ready for connection with penstock, per unit

	(b) Transformer ready for energization, per transformer The payment or deduction of Interface Liquidated Damages in respect of a delayed Interface Milestone shall not, of itself, entitle the relevant Contractor to an extension of time or an adjustment of any subsequent Interface Milestone Date or any Taking-Over Milestone per Section. Any extension of time or adjustment to an Interface Milestone, or any Taking-Over Milestone per Section shall be determined exclusively in accordance with the express extension-of-time, milestone adjustment and interface coordination provisions of the relevant Lot Contract and the Interface Agreement. For the avoidance of doubt, any adjustment to an Interface Milestone Date shall not, of itself, constitute an extension of time for the Taking-Over Milestone per Section, and vice versa. The "no harm no foul" principle is not accepted. The Parties agree that the Delay Liquidated Damages constitute a proportionate contractual remedy, taking into account the loss likely to be suffered by the Employer and the Employer's legitimate interest in the Lot 1 Contractor's timely completion of the Works, the relevant Section and/or any Milestone Date expressly subject to Delay Liquidated Damages under the Contract. LDs shall be sole and exclusive monetary remedy.
Sections	The following Section of the Works will be defined: · Section 1 consists of Unit 1 and Unit 2 and all the Permanent Works necessary for the safe, proper and reliable operation of Unit 1 and Unit 2 in accordance with O&M operation manuals, and Section 2 consists of Unit 3 and Unit 4 and all remaining Permanent Works. · Additional Handovers will be defined to reflect the interdependencies between the Lot 1 and Lot 2 Contracts (not linked with Partial Taking Over).
Time for Completion of the Works	Partial Taking Over for completion of all Permanent Works save Units 3&4 = 4.5 years Overall Time for Completion = 5 years Note: Tenderers may propose alternative Times for Completion with their Offers, subject to evaluation. The Time for Completion for Partial Taking Over and the Overall Time for Completion shall be as per Successful Tenderer' proposal, or as otherwise agreed during the Early Engineering.
Programming (Cl. 8.3)	As per FIDIC 2017, with the following amendments: · Engineer's period of review for the revised programme will be increased from 14 days to 21 days. · The submission of the initial programme (Level 3) will be a prerequisite for the Commencement Date. The Contractor shall submit, 28 days after the commencement of the LOT1 Contract, an updated programme further detailing the activities of the initial programme. · The Contractor's programme shall be based on the milestones set forth in the Interface Matrix. Any failure by the Employer or the LOT 2 Contractor to meet the handover dates specified in the Interface Matrix shall be understood as a delay caused by the Employer, provided that Lot 1 Contractor is not in a concurrent delay. · The Lot 1 Contractor shall also submit an updated programme in any event every three months to reflect the actual progress on site. In addition: · the programme shall be drawn to a monthly time scale and shall show all Section Completion Dates and all other appropriate intermediate milestone dates for the detailed engineering and construction activities. Activity descriptions shall be discrete so that the actual and scheduled work progress can be determined. The Lot 1 Contractor shall identify the critical paths both in the activity listing and in the graphic display. · the Lot 1 Contractor shall submit and update on a monthly basis a 90-day Design Programme including submittal dates for all design

	deliverables on a daily time scale for the first 30-day period, and on a weekly time scale for the balance of the 90-day period. · the Lot 1 Contractor shall submit and update on a monthly basis a 90-day Construction and Installation Programme including all construction and installation activities, their descriptions, durations and dependencies on a daily time scale for the first 30-day period, and on a weekly time scale for the balance of the 90-day period.
Extension Of Time (EoT) (Cl. 8.4)	Contractor will be entitled to an Extension of Time and to any associated cost/profit only if provided under the FIDIC Yellow Book 1999 as amended in the Particular Conditions based on the principles set out in the paragraph below, and subject to the allocation of risks and responsibilities set out in the Interface Management Agreement. Any Extension of Time shall be regulated under Sub-Clause 8.4 [Extension of Time for Completion], while any entitlement to Cost and/or profit shall be determined under the applicable Sub-Clauses of the Contract. Sub-Clause 20.1 [Contractor's Claims] shall apply. The following amendments/additions shall apply to Sub-Clause 8.4 of the FIDIC Yellow Book 1999: a) **Access**: non-suitability or non-availability of an access route arises as a result of changes to that access route by a third party after the Base Date, b) **Adverse climatic conditions**: for the purposes of Sub-Clause 8.4(c), "exceptionally adverse climatic conditions" shall mean adverse climatic conditions at the Site which are Unforeseeable having regard to climatic data made available by the Employer and/or published in the Country for the geographical location of the Site, c) **LOT 2 Contractor**: Sub-Clause 8.4(e) shall be amended to include delay caused by the LOT 2 Contractor, including failure to meet agreed Interface Milestones or technical tolerances, provided that the LOT 1 Contractor is not in concurrent delay.
Delivery Incoterm**	The delivery term for all Plant, Materials and other goods incorporated into the Works shall be DDP Site at South Field, in accordance with Incoterms 2020.
Access routes	The Lot 1 Contractor's attention is directed towards the permissible condition and load-bearing capacities of the existing road bridges and other structures as well as the surfacing along the public road network. The Lot 1 Contractor shall be responsible for satisfying himself that any of his vehicles or equipment which he intends to pass over any of these and other existing bridges and structures in the area will not damage or endanger the integrity or safety of the bridges, other structures and roadways, other traffic and vehicles or the general public. The Tenderer shall undertake the permitting for access routing required for transportation. The Employer shall reasonably assist the Contractor where required.
Avoidance and mitigation of delays	The Contractor shall take all reasonable steps to avoid delay and to mitigate the effects of any delay that may occur in the execution of the Works, without prejudice to any other obligation under the Contract.
4.6 Cooperation	The following principle shall apply, subject to further provisions and undertakings under the interface agreement and documents: The Contractor shall be responsible for its construction activities on the Site, and Employer shall co-ordinate Contractor's activities with those of other contractors. The Contractor shall coordinate with other contractors in accordance with the Interface Matrix. However, the Employer shall remain responsible for the overall coordination of all contractors on Site.
Concurrent Delay**	Concurrent Delay shall be treated in accordance with Core Principles no. 10 and 14 of the Society of Construction Law Delay and Disruption Protocol and their analysis therein. However, in circumstances where both lot1 and lot2 contractors are concurrently in delay, no extension of the Project time schedule shall be granted, and the delayed parties shall remain liable for the consequences of their respective delays. On the contrary, where concurrent delays arise from

	causes not related to interface issues between the Lot1 and Lot2 Contractors (e.g. delays attributable to the Employer, governmental authorities, etc), the Project time schedule shall be extended, to the extent and in accordance with the provisions of the Contract.
Exceptionally Adverse Climatic Conditions (Cl. 8.4 (c))	It shall mean adverse climatic conditions at the Site which are Unforeseeable having regard to climatic data made available by the Employer and/or published in the Country for the geographical location of the Site.
Defects Notification Period	24 months from the Taking Over of each Section, with a refresh on defective parts up to a maximum aggregate of 4 years from Taking Over. Each Section shall have its own DNP. "No evergreen" warranty principle will be followed
11.1 Completion of Outstanding Work and Remedying Defects	Sub-clause 11.1 shall be amended as follows: In order that the Works and Contractor's Documents, and each Section, shall be in the condition required by the Contract (fair wear and tear excepted) by the expiry date of the relevant Defects Notification Period or as soon as practicable thereafter, the Contractor shall: (a) complete any work which is outstanding on the date stated in a Taking-Over Certificate, within such reasonable time as is instructed by the Engineer, and (b) execute all work required to remedy Defects, as may be notified by (or on behalf of) the Employer on or before the expiry date of the Defects Notification Period for the Works or Section (as the case may be). If a Defect appears, the Contractor shall be notified accordingly, by (or on behalf of) the Employer. "For the purposes of Clause 11, Defect means any error, deficiency, non-conformity with the Employer's Requirement or other defect in or to the Works or any part thereof, and which is notified to the Contractor by the Employer during the Defects Notification Period, provided that a Defect shall not include defects: (i) arising due to a failure to operate or maintain the Works in accordance with operation and maintenance manuals provided by the Contractor and in accordance with Good Operating Practice; (ii) arising due to operation of the Works outside of the specifications and tolerances provided for in the Contract (as may have been adjusted by Variation); (iii) arising due to modifications or repairs carried out by the Employer or third parties without the Contractor's prior written consent, which consent shall not be unreasonably delayed or withheld; (iv) arising due to fair wear and tear; For the avoidance of doubt, a Defect includes physical damage to any part of the Works resulting from a Defect. To the extent that the Contractor demonstrates that the work referred to in Sub-Clause 11.1 [Completion of Outstanding Work and Remedying Defects] is not a Defect, then the Employer shall give notice to the Contractor accordingly, and Sub-Clause 13.3 [Variation Procedure] shall apply".
Latent Defects	Contractor shall remain liable under applicable law in respect of latent defects, after the Performance Certificate has been issued. Acceptance of the Works shall have the meaning ascribed to it in Article 692 of the Greek Civil Code.
Payments	As per FIDIC Yellow / First Edition 1999 * with the following amendments: 14.2 Advance Payment Max 10% of the Contract Price This shall be made after the Employer receives (i) the Performance Security and (ii) an Advance Payment Guarantee (wording in accordance with corresponding Schedule for Early Engineering Phase), both from first-class European Banks. The amount of the Advance Payment Guarantee shall be progressively reduced per each invoice, which considers the corresponding

	percentage of the Advance Payment, and it shall be valid until the Advance Payment has been set off in full. 14.7 Payment - the advance payment shall be made within 21 days after receiving the documents in accordance with Sub-Clause 4.2 [Performance Security] and Sub-Clause 14.2 [Advance Payment], - Payment by "Payment Milestones" as properly defined in the Payment Schedule of the Contract, to be mutually agreed by the Parties during the Early Engineering phase, on a neutral cash flow basis. - 26 days for Statement acceptance - or rejection with particulars- by the Employer (Payment Certificate) and 30 days for payment after invoice. If after 26 days approval or rejection with particulars is not given by the Employer, then Contractor shall be entitled to invoice the amount of the Statement and Employer must pay such amount within the payment period.
Payment Milestones	To be mutually agreed based on Payment Milestones, aiming to achieve neutral cash flow, as close as reasonably practical. The Milestones proposed are presented hereunder. They will be finalized during the Early Engineering Contract. · Advance Payment · Various Basic and Detailed Engineering Milestones (always after employer approval) · Submission of unpriced POs for major components · Hydraulic model test completed · Mobilisation to site for starting erection · Successful FAT for major components · Delivery to site of major components · M-BOP Installation completed (per unit) · E-BOP Installation completed (per unit) · Erection completed (per unit) · Ready for wet testing per unit · Partial Taking Over per Section · Overall Taking Over
Profit & Overheads**	"Profit" means the Contractor's profit on the relevant costs. Profit amounts to 8% (eight per cent) of the net costs accepted as payable under the Contract. "Overheads" means the Contractor's general, administrative, management and other indirect costs and expenses associated with the performance and administration of the Services, including facilities, head-office and administration management support, accounting, commercial, legal, human resources, and other general administrative expenses. Overheads amount to 10% (ten per cent) of the net costs accepted as payable under the Contract.
Currencies of Payment**	EURO
Adjustment for Changes in Legislation (Change in Law)**	In Greece: Employer Risk, as per FIDIC Yellow / First Edition 1999 Outside Greece: Contractor risk, as per FIDIC Yellow / First Edition 1999
Adjustment for Changes in Cost – Main Principles**	With regard to sub-clause 13.8, the Particular Conditions shall include an indexation mechanism for certain parts of the Works, according to the following principles: · Base Date will be the date of submission of the Offer. · A price revision formula will apply that will include a fixed portion of 10%, and industry standard indexes for material, equipment and labour. · Generic Consumer Indexes shall not be used. · With regards to Equipment Indexation, indices representative of the specific mechanical and electrical equipment shall be used. · Equipment Indexation shall not apply until the relevant equipment are delivered or installed, or the material incorporated in the works, but on the date on which the Equipment or Material, should have

	been ordered as per the approved Time Schedule (except in case of delay attributable to the Employer). · Labour Indexation, shall apply on the date on which the services/works, should have been provided as per the approved Time Schedule (except in case of delay attributable to the Employer). · If at the time for the calculation, any index has not yet been published, then the calculation will be done provisionally using the latest available indices. When all indices have been published, the final calculation will be performed, and any differences compared to the provisional calculation will be settled.
Adjustment for Changes in Cost – Proposed Indices	Proposed indices: · G = Producer Price Index (Germany) – Machinery; Index: 61241, Product Group: GP19-28 (2digit) · H = Producer Price Index (Germany) – Electrical Equipment; Index: 61241, Product Group: GP19-27 (2digit) · L = Eurostat Labor cost index by NACE Rev. 2 - Index (2020 = 100) for European Union 27 Countries - ([B-E] Industry (except Construction)) - ([SCA] Seasonally and Calendar Adjusted data) – ([D11] Wages and Salaries (Total)) · E = Eurostat Labor cost index by NACE Rev. 2 - Index (2020 = 100) for Greece - ([F] Construction) - ([SCA] Seasonally and Calendar Adjusted data) – ([D11] Wages and Salaries (Total))
Bank Guarantees**	Advance Payment Bank Guarantee equal to the amount of the agreed Advance Payment. Performance Bond: 10% of the Contract Price and shall be reduced to 5% Contract Price of each Section with each Section Taking Over. The Performance Bank Guarantee of each Section shall be null and invalid after expiration of each Section's DNP. All Bank Guarantees shall be irrevocable, unconditional, non-transferable and "on first demand". Applicable Law for all Bank Guarantees shall be the Laws of Greece, and the courts of Athens shall have exclusive jurisdiction. URDG 758 shall be applicable for all Bank Guarantees. Bank Guarantees shall be issued by any first-class bank from Greece, or alternatively from within the European Union or the European Economic Area, on the condition that such institution maintains a correspondent systemic bank in Greece through which the enforcement of the Bank Guarantee may be effected without recourse to proceedings before foreign courts or authorities.
Insurances	PPC shall provide an Owner's Controlled Insurance Programme for CEAR. The LOT1 Contractor shall be additional insured. The LOT1 Contractor's insurances shall be primary. The LOT1 Contractor's insurances shall be as follows: 1) TPL. Minimum Amount of Third-Party Insurance, EUR 1,000,000 (one million Euros) per occurrence and EUR 2,000,000 in the yearly aggregate, with no limit on the number of occurrences. The deductibles shall be on reasonable commercial terms. 2) Professional Indemnity. the Lot 1 Contractor shall effect and maintain professional indemnity insurance against liability arising out of any act, error or omission by the Lot 1 Contractor in carrying out the Lot 1 Contractor's design obligations in an amount not less than EUR 5.000.000 (five million Euros) per occurrence and in the yearly aggregate. 3) Employer's Liability/ Worker's Compensation. Minimum Amount of Employer's Liability/ Worker's Compensation insurance, EUR 1,000,000 (one million Euros) per incident with no limit of number of occurrences. The deductibles shall be on reasonable commercial terms. 4) Transportation insurance.

	Contractor shall include insurance during shipment, for the total value of the equipment. Insurance shall cover until the Site and not only until port, import place etc. 5) Motor-CPE (Contractor's Equipment). Contractor shall include insurance for the total value of its machinery at Site. *Note: the HOTs include the main principles and the parties shall agree during the* Early Engineering *phase on further details and on any required adjustments of clause 18.*
Location of provision of services, project management, manufacturing and sourcing	Project Team: The complete Project Team of Lot 1 Contractor, including but not limited to the Project Management team, the Engineering team, and the Procurement team, will be based on Technology Provider's offices in Europe. The Contractor shall provide proof of compliance with the quality standards required for the project for all Suppliers/ Subcontractors, especially for non-European Suppliers/ Subcontractors. For that purpose, the Contractor shall provide for its Suppliers/ Subcontractors evidence of: 1) ISO 9001 certification. 2) One (1) reference of commissioned hydro project in Europe or executed in accordance with European standards, within the last 10 years. 3) Three (3) references of commissioned hydro projects in the last 15 years.
Approvals**	Any approval or consent or any review by the Employer or the Engineer shall not relieve the Contractor from any obligation or responsibility.
Variations	As per FIDIC Yellow / First Edition 1999 * under Clause 13, with following amendment: A prior agreement between the Parties shall not be required in case of instructions below the threshold amount of 1.5 million Euros per instruction. If the Contractor considers that the price adjustment proposed by the Employer/Engineer under the Instruction is inadequate, the Contractor shall remain bound to such Instruction but he shall reserve its rights to proceed under Contractor's Claims for further compensation (EoT/additional payment). Above 1.5 M EUR, the prior agreement between the Parties shall be required. The aggregate value of all increases shall not exceed fifty percent (50%) of the original Contract Price, while the aggregate value of all reductions shall not exceed thirty percent (30%) of the original Contract Price.
Tests on Completion and Taking Over**	The conditions precedent for the Taking Over are as follows: · The Works are completed according to the Contract, except for Punch List items, · Successful Tests on Completion, · Successful Trial Operation <u>Tests on Completion</u> · All applicable guaranteed values of the Schedule of Guarantees shall be measured during the Tests on Completion. · For the Tests on Completion to be considered successful, at least the rejection levels of each guaranteed parameter must be met. · In case of performance below rejection levels, the Contractor shall proceed with improvement works and retesting. <u>Trial Operation</u> Following Tests on Completion the plant will enter the Trial Operation phase. Uninterrupted operation of 15 days will be a condition precedent for Taking Over. Excuse events that will not trigger the restarting of the Uninterrupted operation will be defined during Early Engineering phase (i.e. minor outages/ trips, disturbances not attributable to the Contractor). <u>Punch List</u>

	Punch List: means a list of any minor outstanding work and defects which are not required by Law or under any consent and will not materially affect the use of the Works for their specified purpose. The Employer shall record any such punch items in the Taking Over Certificate and the Contractor shall complete such work within reasonable time taking into account the nature of the work after receipt of the Taking Over Certificate.
Tests After Completion**	Tests After Completion shall take place after 3000 hours of pumping or at the end of Defects Notification Period, whichever comes first, in order to prove the cavitation pitting guarantees.
Suspension	As per FIDIC Yellow / First Edition 1999 *
Termination**	As per FIDIC Yellow / First Edition 1999, and in addition: a) Employer shall be entitled to terminate when i) Lot 1 Contractor reaches the Liquidated Delay Damages cap, the Liquidated Performance Damages Cap, the Aggregate Liquidated Damages Cap or the Overall Liability Cap, ii) material breach, iii) failure to maintain required insurances b) the principle of FIDIC Yellow 2017, where initially a first 14 days' notice of Employer's/Contractor's intention to terminate the Contract is given, and then the Contract is terminated by a second notice to that effect, provided that the default has continued until the date of issue of the second notice. c) In case of termination for Employer's convenience pursuant to Sub-Clause 15.5, the Contractor shall be paid in accordance with Sub-Clause 19.6 with the addition of a termination fee of 8% of the remaining Contract Price to be executed as a result of any other losses and damages suffered by the Contractor as a result of this termination. d) In case of termination by Contractor pursuant to Sub-Clause 16.2, the sub-paragraph (c) of Sub-Clause 16.4 shall be replaced by a fixed termination fee of 8% of the remaining Contract Price to be executed as a result of any other losses and damages suffered by the Contractor as a result of this termination.
Force Majeure**	As per FIDIC Yellow / First Edition 1999 *, with the following additions 1) a new item is added in 19.1: 19.1 (vi) export restrictions, sanctions or embargoes (vii) outbreak and/or persistence of a disease, epidemic, pandemic 2) The following new sub-clause shall be added at the end of Clause 19: "19.8 Should an exceptional event arise that affects the execution of the Works and is not addressed elsewhere in the Contract, the Parties shall, in a spirit of cooperation, enter into discussions in good faith to reach an amicable agreement on appropriate measures to support the continued progress of the Project".
Claims**	As per FIDIC Yellow / First Edition 1999 * There shall be no time bar for Employer's claims.
Language for communications**	English
Governing Law**	Laws of Greece
Ruling Language**	English
Arbitration**	As per FIDIC Yellow / First Edition 1999 * relevant clause, and additionally: in Athens – Greece, ICC Rules, 3 arbitrators, Greek Law, English language.

** As per FIDIC Yellow / First Edition 1999 means that the original FIDIC Yellow / First Edition 1999 risk allocation between the Employer and the Contractor shall not be altered.*
*** the provision is Mandatory Term and not subject to any deviation by the Tenderers*

Dispute Adjudication Board Provisions	
Dispute Adjudication Board	As per FIDIC Yellow / First Edition 1999 relevant clause, and additionally: in Athens (or at Site) – Greece, 3 members, Greek Law, English language.
Appointment of DAB	At the end of Sub-Clause 20.3 the following is added: "Both Parties and each appointed member shall promptly sign or shall be deemed to have signed the Dispute Adjudication Agreement provided by the member, under which: (i) the monthly services fee and daily fee shall be as stated in the terms of the appointment; and (ii) the law governing the Dispute Adjudication Agreement shall be the governing law of the Contract defined in Sub-Clause 1.4 [Law and Language]".
Enforcement of DAB decisions:	In Sub-Clause 15.2 a new case (g) should be added as follows: (g) fails to give effect promptly to a decision of the DAB in accordance with Sub-Clause 20.4 [Obtaining the Dispute Adjudication Board's Decision]". In the first paragraph of Sub-Clause 16.1, after the phrase "or Sub-Clause 14.7 [Payment]" the following phrase is added: "…or fails to give effect promptly to a decision of the DAB in accordance with Sub-Clause 20.4 [Obtaining the Dispute Adjudication Board's Decision]…". Furthermore, in the same paragraph after the phrase "reasonable evidence or payment" add the phrase "…or the Employer has given effect to the decision of the DAB…". The same phrase should be added in the third paragraph of the same Sub-Clause again after the phrase "evidence or payment". In Sub-Clause 16.2 a new case (h) should be added as follows: "(h) the Employer fails to give effect promptly to a decision of the DAB in accordance with Sub-Clause 20.4 [Obtaining the Dispute Adjudication Board's Decision]". In the fourth paragraph of Sub-Clause 20.4 after the phrase "who shall promptly give effect to it" the following phrase should be added: "whether or not notice of dissatisfaction has been given under this Sub-Clause". Sub-Clause 20.7 should be replaced with the following: "In the event that a Party fails to comply with any decision of the DAB, whether binding or final and binding, then the other Party may, without prejudice to any other rights it may have, refer the failure itself directly to arbitration under Sub-Clause 20.6 [Arbitration] in which case Sub-Clause 20.4 [Obtaining DAB's Decision] and Sub-Clause 20.5 [Amicable Settlement] shall not apply to this reference. The arbitral tribunal shall have the power, by way of summary or other expedited procedure, to order, whether by an interim or provisional measure or an award (as may be appropriate under applicable law or otherwise), the enforcement of that decision".
Expiry of DAB (20.8)	Sub-Clause 20.8 should be replaced as follows: "If a dispute arises between the Parties in connection with, or arising out of, the Contract or the execution of the Works and there is no DAB in place by reason of the expiry of the DAB's appointment: (a) Sub-Clause 20.4 [Obtaining Dispute Adjudication Board's Decision] and Sub-Clause 20.5 [Amicable Settlement] shall not apply, and (b) the dispute may be referred directly to arbitration under Sub-Clause 20.6 [Arbitration]".

Interface Management	
Interface Agreement**	"Interface Agreement" means the tripartite agreement between the Employer, the Lot1 Contractor and the Lot 2 Contractor, setting out the contractual framework governing coordination, cooperation, interface obligations, Interface Programme, Interface Milestones, Interface Data, interface meetings, recovery actions and interface claims between the Employer, the Engineer and the Lotees. The Interface Agreement shall not create any contractual claims between LOT1 Contractor and LOT2 Contractor. Therefore, any design error, failure and/or delay of each Lot Contractor shall be regulated under the terms of its Lot Contract.
"not to exceed values" claims from Lot 2 Contractor **	If the Lot 1 Contractor revises "not to exceed values" as defined in the Interface Matrix at the Early Engineering phase, making it more onerous, it shall be liable for any reasonable and documented additional costs incurred by the Company as a result of claims or variations submitted by the Lot 2 Contractor arising from such revision. For the avoidance of doubt, such costs incurred by the LOT2 Contractor shall not constitute indirect or consequential loss or damage for the purposes of Sub-Clause 17.6 of the Contract. Furthermore, the procedures agreed by the Parties in the Interface Agreement shall apply. Such procedures shall not create any contractual claims between LOT1 Contractor and LOT2 Contractor.
Interface Matrix or Interface Schedule	"Interface Matrix or Interface Schedule" means the document specifically identified as such and attached to the Contract, which defines the interface milestones, technical requirements, tolerances and mandatory handover dates between Lot 1-Lot 2 (and any other contractors, if so) , included as Schedule [•] of the Contract. This document shall be developed during ECI-Phase.
Other Contractors	"Other contractors" or "Others" means any party or parties having a direct contract with the Employer for work on the Project outside the scope of this Contract and shall include any subcontractor of such other contractor or other.
Coordination and Interface Management	The Project involves other contracts, in particular the Lot 2 Contract (South Field Mine Pumped Storage Plant: Civil Works and certain Electromechanical Works), which will be awarded by the Employer to the Lot 2 Contractor, for the execution of various other works on the Project which will be performed concurrently with the Works under the Lot 1 Contract. A dedicated specification titled "Interfaces Between Contracts" (Interface Matrix) will include particular requirements for co-ordinated working with the Lot 2 Contractor and will form part of the Employer's Requirements. It shall include among others, interfaces within working areas for which the Lot 1 Contractor is responsible as well as at other structures and locations. The Lot 1 Contractor shall co-ordinate his general day to day activities with the Lot 2 Contractor to avoid hindrance and obstruction of the Lot 2 Contractor as far as is appropriate and reasonable. This will include co-ordination and co-operation with the Lot 2 Contractor at any interfaces between the work of this Contract and the work of the Lot 2 Contract and for reasonable joint use of infrastructure such as roads, temporary access, installation or storage areas and other general site services, at no additional cost to the Contractor. Such general and particular co-operation shall be foreseen and provided for in the Lot 1 Contractor's programming and is deemed to be included in the Accepted Contract Amount, in accordance with the Interface Matrix. The Employer shall have the overall coordination management. It is the responsibility of the Lot 1 Contractor to ensure co-ordination and co-operation with the Lot 2 Contractor in the initial agreement of the detailed schedule of interfaces between the contracts (the "Interface Schedule"), and subsequently working in accordance with that Interface Schedule, as stipulated in the above-mentioned specification Interfaces Between Contracts. The final form of the Interface Schedule as mutually agreed by the Employer, the Lot 1 Contractor and the Lot 2 Contractor, shall be binding upon both the Lot 1 Contractor and the Lot 2 Contractor, and shall be part of both Lot 1 Contract and Lot 2 Contract.

	For all these combined activities the Lot 1 Contractor will make prior planning, in co-operation with the Engineer and the Lot 2 Contractor, to prepare for and execute these combined activities and to make every reasonable effort to facilitate these activities within the performance of the Works. No claim for delay arising from interfaces between the Lot 1 Contract and the Lot 2 Contract shall be admissible unless the Lot 1 Contractor can demonstrate that it has attempted to provide all reasonable co-ordination efforts in accordance with the requirements of the Lot 1 Contract but that nevertheless unavoidable delays with respect to the progress of the Works have been incurred by the Lot 1 Contractor as a direct result of the actions or omissions of the Lot 2 Contractor. In the course of complying with the provisions of the Lot 1 Contract, various physical and performance interfaces of the Lot 1 Contractor's developed construction methods and procedures may depend on facilities, equipment or services of organisations not under its control, which may include but not be limited to: (i) design interfaces with the Lot 2 Contractor; (ii) site facilities and access; (iii) construction and installation access interfaces; (iv) time and programming interfaces; and (v) testing/commissioning interfaces. The Lot 1 Contractor shall identify all interfaces with organisations not under its control, but which may affect its construction or installation work, including but not limited to the interfaces defined in the Interface Schedule, and shall submit to the Engineer an Interface Report describing clearly all these external interfaces together with the nature of the potential interface consequences. The Interface Report shall be submitted within [*] days after the Commencement Date and shall be updated and resubmitted whenever the conditions affecting any interfaces change or new relevant information becomes available. The Interface Report shall contain sufficient appropriate information which the Engineer and the relevant Interface Committee, in accordance with the above-mentioned dedicated specification titled "Interfaces Between Contracts", can take fully into account in order to avoid any unnecessary detrimental consequences on the programme of Works. It is necessary that the Lot 1 Contractor identifies all interfaces to ensure that the design at the interface is understood by affected parties and changes to one side of the interface are accepted and accommodated by the other interface party. The Lot 1 Contractor shall include in the Interface Report the process by which interfaces are identified and controlled. Similar provisions will be included in the Lot 2 Contract for the Lot 2 Contractor.
Section Completion Certificate	The Project involves other contracts, in particular the Lot 2 Contract (South Field Mine Pumped Storage Plant: Civil Works and certain Electromechanical Works), which will be awarded by the Employer to the Lot 2 Contractor for the execution of various other works on the Project which will be performed concurrently with the Works under this Contract. For the purpose of the execution of the overall Project, portions of the Works under the Lot 1 Contract must be constructed to specific stages either to enable work by the Lot 2 Contractor to proceed or continue or to facilitate the commissioning of the Project. Key construction stages of the Works under the Lot 1 Contract shall be defined in the Lot 1 Contract by Sections, for each of which a separate Time for Hand Over shall be defined. Upon achieving each Hand Over by completing all related work specified in the Interface Matrix, to the reasonable satisfaction of the Engineer, the Engineer will issue a Handover Certificate for the related Interface works, which shall not be unreasonably withheld. The Handover Certificate for a certain Interface works as specified in the Interface Matrix is the written confirmation that, on the basis of the information available to the Engineer at the time of its issue, the respective Handover Interface Works as defined in the Contract has been satisfactorily completed and the risk of them is transferred to the Employer. The issue of a Handover Interface Works Certificate shall under no circumstances be considered to constitute the use or occupation of any part of the Works or

	grounds for the issue of a Taking-Over Certificate pursuant to Sub-Clause 10.2 [Taking Over of Parts of the Works]. The Lot 2 Contractor as well as the personnel of the Employer and Engineer will also require joint use of infrastructure such as roads, temporary access, installation or storage areas and other general site services, and the Lot 1 Contractor will make every reasonable effort to facilitate these activities within the performance of the Works at no additional cost nor additional risk of the Contractor. These activities by the Lot 2 Contractor, the related supervision activities by the Employer's and the Engineer's personnel shall under no circumstances be considered to constitute the use or occupation of any part of the Works pursuant to Sub-Clause 10.2 [Taking Over of Parts of the Works] and shall not be grounds for the issue of any Taking-Over Certificates.
Interface Agreement Heads of Term	The Heads of Terms of the Interface Agreement ("Interface HOTs") are set out in Annex VII "Interface Agreement Heads of Terms".

*** the provision is Mandatory Term and not subject to any deviation by the Tenderers.*

Call for Tenders **NGAPD-2048**

Scope: **«South Field Mine Pumped Hydro Storage: Early Technology Provider Involvement for Design, Supply, Erection and Commissioning of Pump, Turbine, Generator and Auxiliary Systems»**

ANNEX I

FINANCIAL OFFER SUBMISSION FORMS

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I.b. OFFERED PRICE BREAKDOWN FORM 4
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I.a. TOTAL OFFERED PRICE FORM

PUBLIC POWER CORPORATION
New Generation Activities Procurement Department

CALL FOR TENDERS
NGAPD-2048

ANNEX I.a: TOTAL OFFERED PRICE

Scope: South Field Mine Pumped Hydro Storage Plant: Early Technology Provider Involvement for Design, Supply, Erection and Commissioning of Pump, Turbine, Generator and Auxiliary Systems

S/N	Description	Unit	Numerical price (€)	Price in words (€)
1	Offered Price (Base Scope), as per Annex I.b	Lump Sum	-	
2	Options List Price, as per Annex I.c	Lump Sum	-	
TOTAL OFFERED PRICE (1 + 2)			**-**	

* The Total Offered Price includes all travelling, accommodation and other project-related expenses.

** The Total Offered Price includes the Early Engineering Services. The Early Engineering Contract Price is 2.5% of the Lot 1 Total Offered Price, as per the Call for Tenders.

NOTE: Amounts shall be stated in figures and words. In case of a discrepancy, the amount stated in words shall prevail.

FOR THE TENDERER

I.b. OFFERED PRICE BREAKDOWN FORM

PUBLIC POWER CORPORATION
New Generation Activities Procurement Department

CALL FOR TENDERS
No. NGAPD-2048

ANNEX I.b: OFFERED PRICE (BASE SCOPE) BREAKDOWN

Scope: South Field Mine Pumped Hydro Storage Plant: Early Technology Provider Involvement for Design, Supply, Erection and Commissioning of Pump, Turbine, Generator and Auxiliary Systems

S/N	Work / Service Description	Unit	Quantity	Unit Price (€)	Price (€)
BASE SCOPE					
1.1	Pump-Turbines – 4 units	Lump Sum	100,00%		
1.2	Governing system – 4 units	Lump Sum	100,00%		
1.3	Main Inlet Valves - 4 units	Lump Sum	100,00%		
1.4	Mechanical auxiliary equipment (e.g. unit cooling water system)	Lump Sum	100,00%		
1.5	Motor-generators – 4 units	Lump Sum	100,00%		
1.6	Excitation system – 4 units	Lump Sum	100,00%		
1.7	Static frequency converters (SFC) – 2 units (including Transformers)	Lump Sum	100,00%		
1.8	Spiral Cases – 4 units	Lump Sum	100,00%		
1.9	Draft tubes and draft tubes gates – 4 units	Lump Sum	100,00%		
1.10	Generator switchgear (Bus duct, GCB, etc.)	Lump Sum	100,00%		
1.11	IPBs	Lump Sum	100,00%		
1.12	Dynamic breaking and Phase reversal switches	Lump Sum	100,00%		
1.13	Cooling water system (including raw water pumps, primary and secondary circuits, etc.)	Lump Sum	100,00%		
1.14	Drainage system (including emergency drainage, OWS, oil filtartion, etc)	Lump Sum	100,00%		
1.15	Compressed air systems (Low pressure and high presure)	Lump Sum	100,00%		
1.16	Powerhouse / main crane(s)	Lump Sum	100,00%		
1.17	Control system, including control room equipment, condition monitoring and analysis system (with optimization & predictive maintenance tool)	Lump Sum	100,00%		
1.18	Electrical and Mechanical Plant Protection Systems	Lump Sum	100,00%		
1.19	General electrical and mechanical equipment (e.g. cabling, piping, and ducting (as required), in-air earthing and bonding system, Cathodic Protection, etc)	Lump Sum	100,00%		
1.20	Spare parts (for two years of operation)	Lump Sum	100,00%		
1.21	Special tools	Lump Sum	100,00%		
1.22	Accessories (any equipment furnished/offered in BASE SCOPE, **not** explicitly described by previous points)	Lump Sum	100,00%		
Sub Total 1.b					-
1.23	Engineering design, including Early Engineering Services	Lump Sum	100,00%		
1.24	Pump-Turbine hydraulic model test	Lump Sum	100,00%		
1.25	Transportation to Site (DDP)	Lump Sum	100,00%		
1.26	Erection	Lump Sum	100,00%		
1.27	Commissioning	Lump Sum	100,00%		
1.28	Tests on Completion	Lump Sum	100,00%		
1.29	Training	Lump Sum	100,00%		
Sub Total 1.c					-
OFFERED PRICE (BASE SCOPE) – NUMERICAL (€)				-	
OFFERED PRICE (BASE SCOPE) – IN WORDS (€)					

* Unit prices and the Offered Price include all travelling, accommodation and other project-related expenses.

** Where totals differ from the amounts derived from individual prices, the arithmetically derived totals shall prevail.

*** The Offered Price shall equal the corresponding figure of S/N 1 in Annex I.a.

**** Early Engineering Services are included in the Offered Price. The Early Engineering Contract Price is determined pursuant to Clause 1.2 of the Call for Tenders.

FOR THE TENDERER

I.c. OPTIONS LIST PRICE FORM

PUBLIC POWER CORPORATION
New Generation Activities Procurement Department

CALL FOR TENDERS
NGAPD-2048

ANNEX I.c OPTIONS LIST PRICE

Scope: South Field Mine Pumped Hydro Storage Plant: Early Technology Provider Involvement for Design, Supply, Erection and Commissioning of Pump, Turbine, Generator and Auxiliary Systems

S/N	Optional Item / Scope Description	Unit	Quantity	Unit Price (€)	Price (€)
Opt.01	Step-up transformer(s), including fire detection and protection	Lump Sum	100,00%		
Opt.02	Medium-voltage AC system (switchgear, busbar, etc.)	Lump Sum	100,00%		
Opt.03	Service / auxiliary transformers, including fire detection and protection	Lump Sum	100,00%		
Opt.04	Low-voltage AC system (essential and normal)	Lump Sum	100,00%		
Opt.05	DC system	Lump Sum	100,00%		
Opt.06	UPS system	Lump Sum	100,00%		
Opt.07	Backup diesel generator system for emergency and black start	Lump Sum	100,00%		
OPTIONS LIST PRICE (ALL OPTIONAL ITEMS) – NUMERICAL (€)				-	
OPTIONS LIST PRICE – IN WORDS (€)					

* All Optional Items shall be priced. PPC may select any, all, or none of them prior to signing the Lot 1 Contract.

** Unit prices include travelling, accommodation and other project-related expenses.

*** Options shall be activated only if officially requested by the Company.

**** The Options List Price shall equal the corresponding figure of S/N 2 in Annex I.a.

***** Where totals differ from the amounts derived from individual prices, the arithmetically derived totals shall prevail.

FOR THE TENDERER

I.d. EARLY ENGINEERING PRE-AGREED RATES FORM

PUBLIC POWER CORPORATION
New Generation Activities Procurement Department

CALL FOR TENDERS
NGAPD-2048

ANNEX I.d: EARLY ENGINEERING PRE-AGREED RATES

Scope: South Field Mine Pumped Hydro Storage Plant: Early Technology Provider Involvement for Design, Supply, Erection and Commissioning of Pump, Turbine, Generator and Auxiliary Systems

For use in valuation of Variations and/or Exceptional Costs under the Early Engineering Contract; not an additional component of the Total Offered Price.

S/N	Personnel Category / Discipline	Unit	Offered Rate (€)	Notes
1	Project Manager / Design Manager	Person-day		
2	Project Engineer / Engineering Coordinator	Person-day		
3	Senior Engineer / Lead Engineer (all disciplines)	Person-day		
4	Engineer (all disciplines)	Person-day		
5	Draftsperson / Designer	Person-day		

* All Pre-Agreed Rates shall be inclusive of all costs, Overheads, Profit and other charges relating to the applicable Services.

** No additional Overheads or Profit shall be applied to any Pre-Agreed Rate.

*** The Pre-Agreed Rates shall remain fixed and valid until 15 months from the Commencement Date, in accordance with Appendix 3 [Remuneration and Payment].

FOR THE TENDERER

PUBLIC POWER CORPORATION
New Generation Activities Procurement Department

CALL FOR TENDERS
NGAPD-2048

ANNEX I.e: PRICE ALLOCATION TABLE

Scope: South Field Mine Pumped Hydro Storage Plant: Early Technology Provider Involvement for Design, Supply, Erection and Commissioning of Pump, Turbine, Generator and Auxiliary Systems

To be completed ONLY by Tenderers participating as Associations of Economic Operators.

S/N	Member of the Association	Participation (%)	Total Offered Price (€)	Allocation per Member (€)
1	Leader: [Company name]		-	-
2	[Company name]			-
3	[Company name]			-
4	[Company name]			-
	TOTAL	**0,00%**		**-**

* Participation percentages shall total 100%. Complete additional member rows if needed, adjusting the total formulas accordingly.

** The allocated amounts are derived from the Total Offered Price as stated in Annex I.a.

*** The table may be amended, according to the proposed form of Association, upon agreement with the Company.

FOR THE TENDERER

Tender Procedure **NGAPD-2048**

Scope: **«South Field Mine Pumped Hydro Storage: Early Technology Provider Involvement for Design, Supply, Erection and Commissioning of Pump, Turbine, Generator and Auxiliary Systems»**

ANNEX II

TECHNICAL PART

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3. APPENDIX B – SOUTH FIELD POWERHOUSE PRELIMINARY LAYOUT DRAWINGS
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7. APPENDIX F – GEOTECHNICAL INTERPRETATIVE REPORT
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Early Technology Provider Involvement Tender

Technical Part

PPC

GREECE



RESTRICTED

September 29, 2026

REPORT

W004668 D4 v4

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REPORT

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Entity : Europe
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RESTRICTED

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Project : South Field Mine PHS
Country/State: Greece

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D	2026-09-29	Guarantees and standards update	Final	Multiple	T. de Colombel	S. Delmas
C	2026-09-23	Adding Appendices	Final	Multiple	T. de Colombel	S. Delmas
B	2026-07-22	Revision with comments	Final	Multiple	T. de Colombel	S. Delmas
A	2025-09-09	First submission	Draft	Multiple	T. de Colombel	S. Delmas

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SOUTH FIELD MINE PHS

Early Technology Provider Involvement Tender - Technical Part

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LIST OF ABBREVIATIONS AND ACRONYMS

CFSM	Converter-Fed Synchronous Machine
DEM	Digital Elevation Model
DFIM	Doubly-Fed Induction Machine
D/S	Downstream
EOT	Electric Overhead Travelling
EU	European Union
EUR	Euro
FAT	Factory Acceptance Tests
USD	United States Dollar
GCB	Generator Circuit Breaker
GDR	Geotechnical Data Report
GBR	Geotechnical Baseline Report
GRA	Geological Risk Assessment
GU	Geotechnical Unit
HSS	Hydraulic Steel Structure
IPB	Insulated Phase Busduct
MIV	Main Inlet Valve
MW	Mega Watt
MVA	Mega Volt Ampere
PFS	Pre-Feasibility Study
PHS	Pumped Hydroelectric Storage
PPC	Public Power Corporation
RfG	Requirements for Generators
rpm	Rotation Per Minute
U/S	Upstream

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1. INTRODUCTION

South Field mine Pumped Hydroelectric Storage (PHS) is a proposed hydroelectric scheme to be located in the prefecture of Kozani, Western Macedonia, northern Greece. The PHS is to be owned by **Public Power Corporation** (PPC), or “the Owner”.

The Project aims to allow energy from intermittent sources (such as solar, wind) and other renewables, or excess electricity from continuous base-load sources (such as gas) to be saved for periods of higher demand. It would store energy in the form of gravitational potential energy of water, pumped from a lower elevation reservoir to an upper reservoir.

South Field mine PHS would take the advantage of difference in elevation between South Field lignite mine pit (decommissioned after 2026), which would be used as the lower reservoir, and the surrounding plateau to the South-East of the mine, which would accommodate the upper reservoir.

The PHS facility is located within the boundaries of the Elispontos Municipal Unit of the Kozani Municipality, in the Regional Unit of Kozani, within the Region of Western Macedonia. More precisely, it is situated at the South Field Mine of the Western Macedonia Lignite Center, 5 km east of the Kardia Thermal Power Plant, 7 km northwest of the Agios Dimitrios Thermal Power Plant, 13 km northeast of the city of Kozani and 18 km southeast of the city of Ptolemaida.

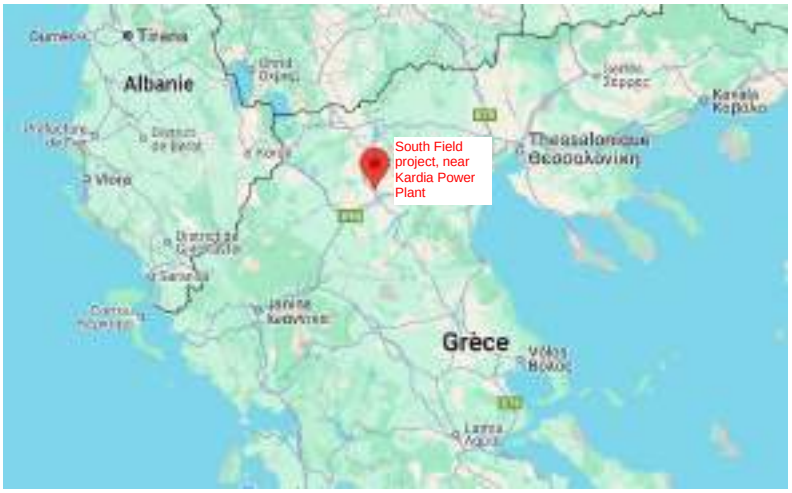


Figure 1-1: Location of the project

The project has undergone a conceptual / prefeasibility phase performed by PPC, which has been reviewed by Tractebel. During this prefeasibility review, no red flags were raised that could compromise the feasibility of the project. The site appears to be favourable for the construction of a PHS plant. A feasibility study is underway since the beginning of 2025.

Examples of possible changes, non-exhaustive, are:

- Upper and lower reservoirs min and max level (+/-3 meters)
- Length, diameter and number of penstocks,
- Setting of machines,
- Connection to the grid layout.

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2. PROJECT DESCRIPTION

2.1. MAIN PROJECT OUTLINE

The South Field PHS is a **240MW** pumped-storage plant, to be built as a capacity and energy provider for the Greek National Grid. It will operate between two man-made water reservoirs, connected by a 1 km (approx.) penstock pipeline, constituting of two open-air steel pipes. (Civil engineering, including the reservoirs and the penstock, are outside the scope of this RFQ.) Electric power will be supplied to the national grid through a switchyard located within the station perimeter.

At this stage of the project, the scheme comprises the following structures:

- An upper reservoir, located on the plateau on the South-East of the mine, utilizing the existing morphology and topography of the area, supplemented by embankments. Full Supply Level is expected to be at 659 m asl.
- A lower reservoir, formed by the large mine pit. The Full Supply Level of the lower reservoir is expected to be 535 m asl to create an active storage of approximately 9.3 hm^3. The bottom of lower reservoir reaches elevation down to 523 m asl.
- The foreseen waterway, would include the following sections, from upper to lower reservoir:
  - Upper intakes, with trash racks and safety gates;
  - 2 upper open-air penstocks, placed along the South-East slopes of the mine pit, with a constant diameter of 6 m and a length of about 1 km from the upper intake to the bifurcations, with concrete anchored elbows. The choice of a rigid penstock or expansion joints is to be determined at feasibility stage. Moreover, several sections of pipe of different thicknesses will be determined with varying maximum water pressure;
  - 2 bifurcations connecting the penstocks to the units, one for each penstock;
  - 4 main inlet valves of butterfly type, expected diameter of 2,6m;
  - 4 draft tubes equipped with 4 gates (bonneted gate type);
  - 4 tailrace structures connecting draft tubes with the lower intakes;
  - Lower intakes adjacent to the powerhouse structure, equipped with trash racks and stoplogs slots. A short channel is excavated between the lower intake and the reservoir.

  It should be noted that the waterway does not include an upper surge shaft or tank as the topography does not permit an easy construction of such a structure. This is a topographical constraint of the scheme. In that specific case, the overpressure and overspeed due to the transients can only be controlled by reducing the flow velocity in the waterway and therefore by increasing the diameter of the penstock.
- Powerhouse is open air type and made of reinforced concrete. It is founded at approximately El. 485 m asl and its top elevation is at ~El. 537.00 m asl – total height of ~52 m. This large excavation will be executed at the toe of the mine South-East slope and will be partially backfilled to form a platform where transformers will be installed.
- The Powerhouse is housing four (4) Francis reversible fixed speed pump-turbines and an average and maximum total power at generation mode of respectively **220 MW** and **240 MW**.

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- An outside gantry crane and an overhead bridge crane inside the Powerhouse are foreseen to handle heavy equipment. The transformers are located outside the powerhouse in a platform.
- A gantry crane is foreseen at the lower intake to handle trash racks or stoplogs and for maintenance of draft tube gate.

Following figures present the Project preliminary layouts. See APPENDIX B for preliminary drawings of the powerhouse.

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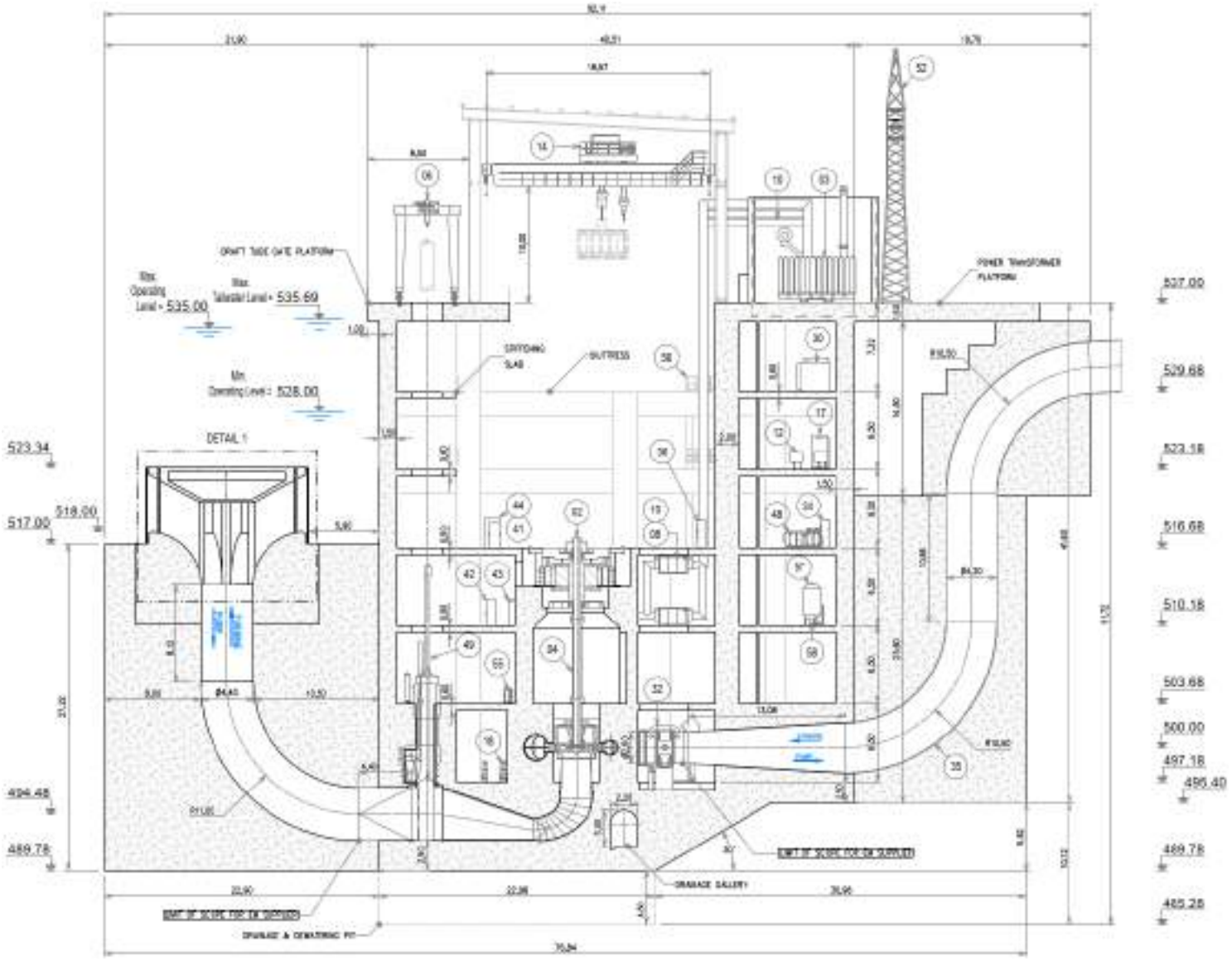


Figure 2-1: South Field PHS powerhouse preliminary longitudinal cross section

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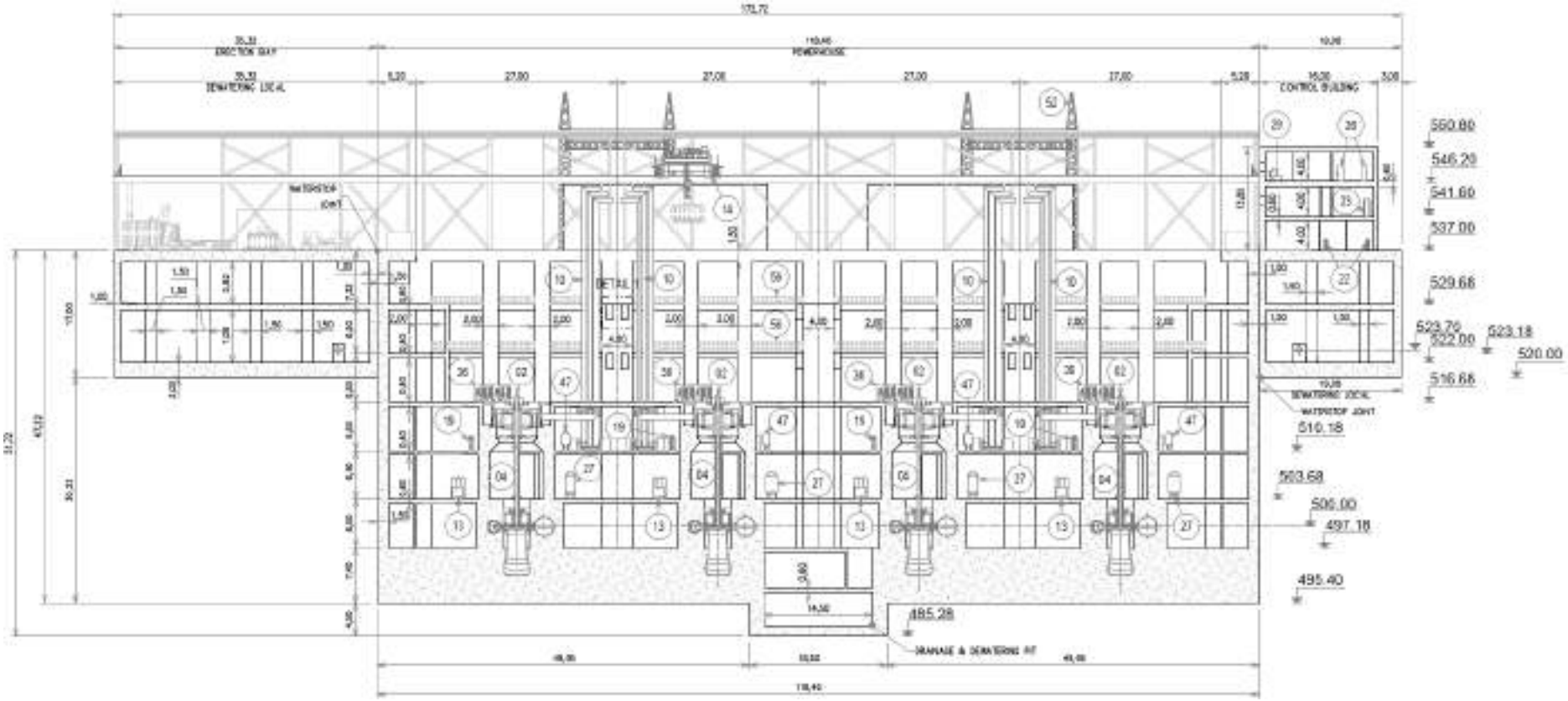


Figure 2-2: South Field PHS powerhouse preliminary transversal cross section

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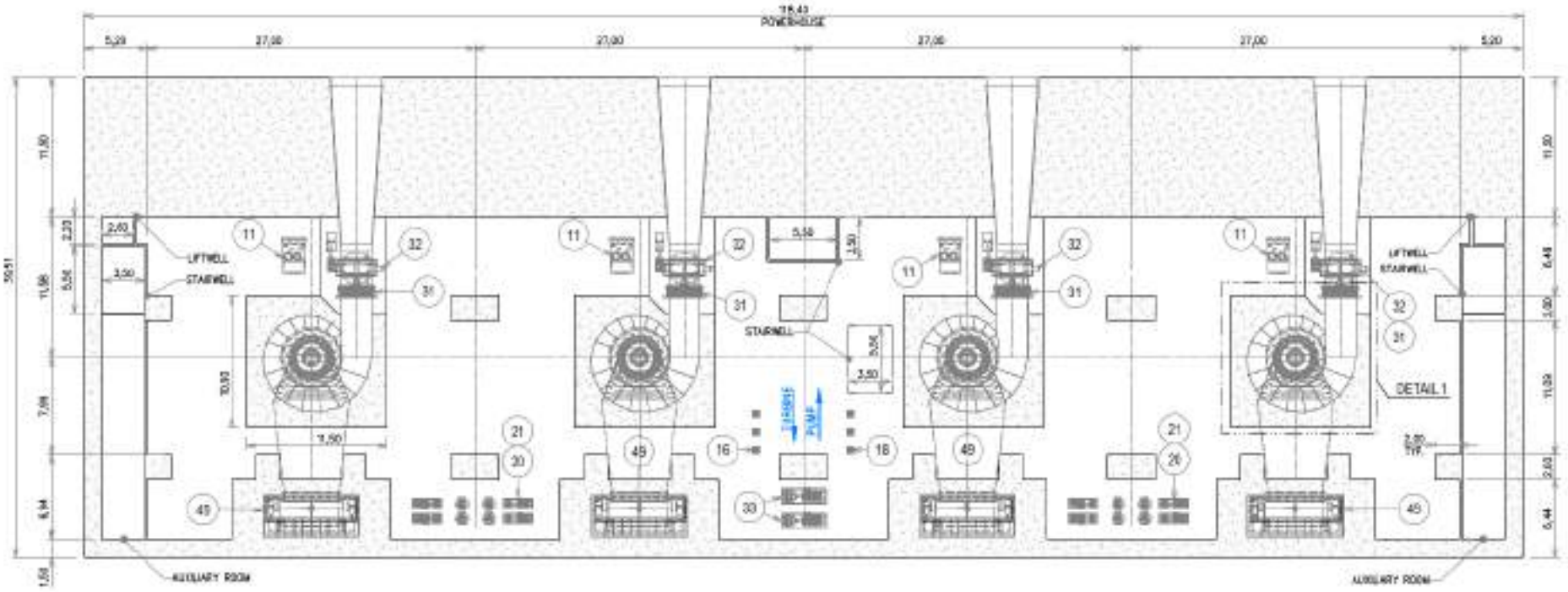


Figure 2-3: South Field PHS powerhouse preliminary plan view

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2.2. BATTERY LIMITS

2.2.1. MECHANICAL

This RFQ covers the mechanical equipment of the power plant from the penstock (not included) to the tailrace (not included), including the butterfly valves, pump-turbines (spiral cases, distributors, runners and shafts, cones, draft tubes), draft tube gates and all mechanical auxiliary equipment (including special tools, etc.) as further detailed in Chapter 2.3.

Some items will be quoted **optionally**, in line with the Division of Work presented in Chapter 2.3.

2.2.2. ELECTRICAL

This RFQ covers all the electrical and control equipment up and including the main power transformers terminals, including all the electrical and control equipment required for operation of the powerplant and for communication and control from outside the station as further described in Chapter 2.3.

See two Figures on next page showing the preliminary **Single Line Diagram**, and the preliminary **Control System** configuration.

Some items will be quoted **optionally**, in line with the Division of Work presented in Chapter 2.3.

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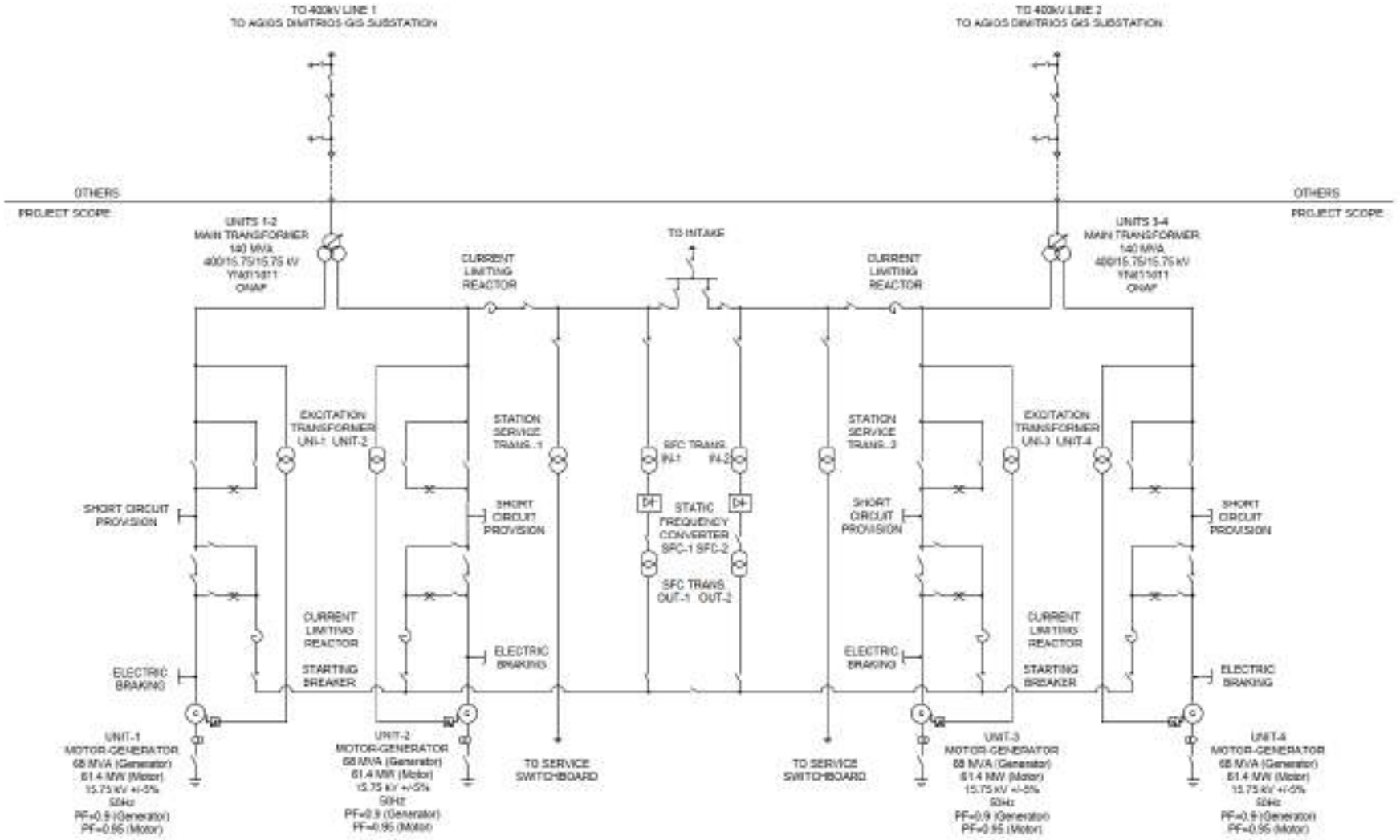


Figure 2-4: Preliminary Single Line Diagram describing electrical installation

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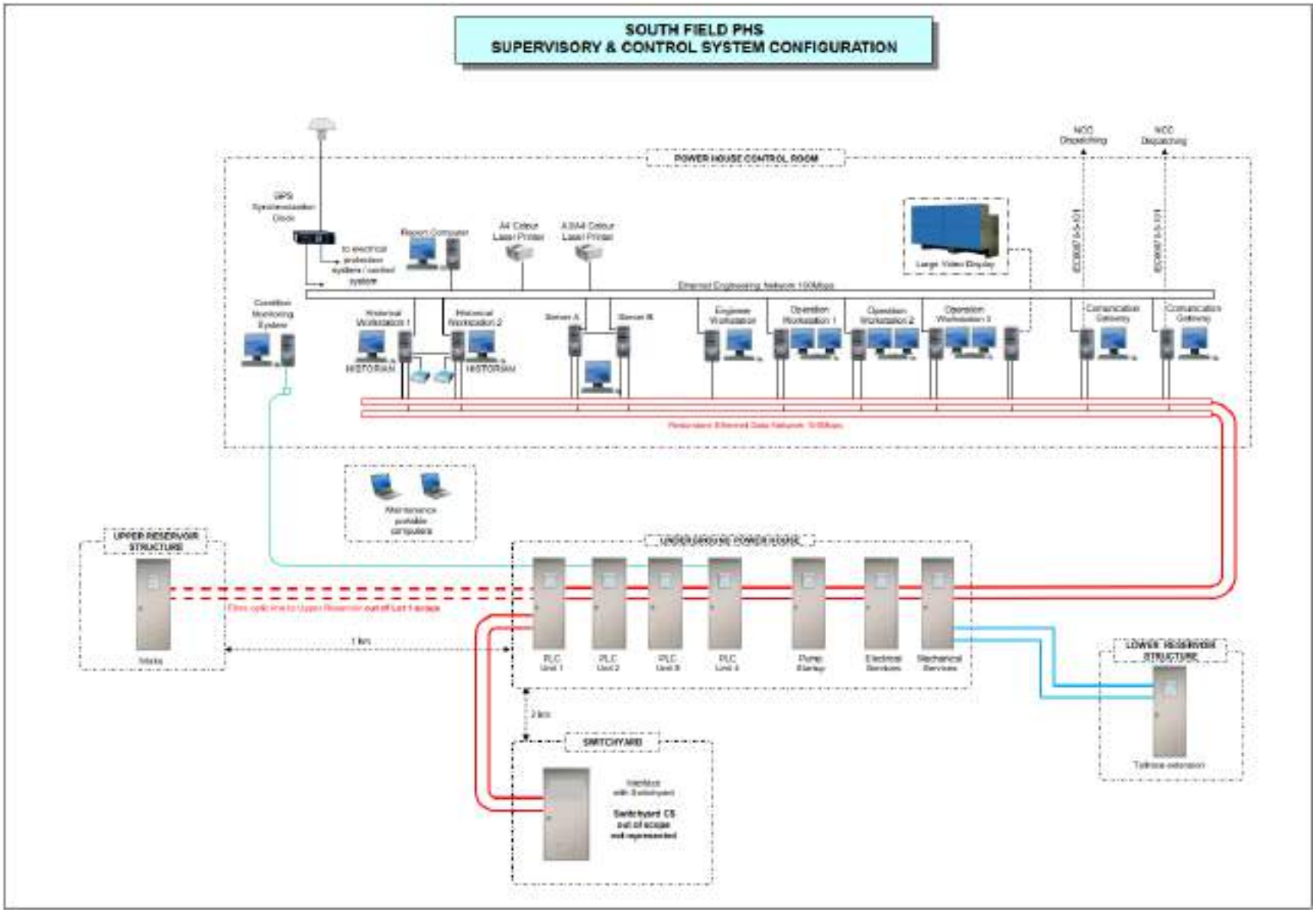


Figure 2-5: Preliminary Control System configuration

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2.3. SCOPE OF SUPPLY AND SERVICES

The scope of Supply and Services includes:

- Basic and Detailed Design Engineering (including erection engineering)
- Pump-Turbine Hydraulic Model Test
- Procurement
- Fabrication & Transportation to Site
- Erection
- Inspection and Testing, including FATs, iFATs and SATs
- Commissioning
- Trial Operation
- Performance field testing on one unit
- Training of Owner's personnel
- Rectification of Defects during Defects Notification Period

It is clearly understood that the quotation is to be for the work completed in every respect. The quotation must therefore include for temporary works all incidental and contingent expenses and risks of every kind necessary to design, manufacture, erection complete and maintain the whole of the works.

This division of works is based on the following split:

- **Lot 1 : Technology Provider (TP)** – Design and build contract based on the FIDIC yellow book – **scope of the present Request For Quotation.**
- Lot 2 : Infrastructures Contractor (IC) – Design and build contract based on the FIDIC yellow book.
- Interface and coordination of Lot 1 and Lot 2 done by a third party Owner's Engineer.

The following table details the division of work for Lot 1, Lot 2, and Owner's Engineer.

R	= Responsible of design and construction
E	= Evaluate and incorporate
In	= Input / contribution required
V	= Visa

		Owner/Owner's Engineer	Contractors		
Item No.	**Scope Description**	**PPC**	**Lot 1 (TP)**	**Lot 2 (IC)**	**Remarks/key interface**
1	**Project Wide / General**				
1.1	Project land, permits etc.	R	E	E	
1.2	Environmental Approvals	R	E	E	
1.3	Overall project layout	In	E	R	
1.4	BIM digital model	E	In	R	Participation of **Lot1 (TP)** in 3D model reviews for clash detection purposes will be required.
1.5	Document control system	R	E	E	
2	**Hydrology & Hydraulics**				
2.1	Head losses of water conveyance system	V	E	R	
2.2	Hydraulic transient studies	V	R	E	
2.3	Mode change timing	V	R	-	
2.4	Energy modelling, round trip efficiency	V	R	In	
2.5	Hydraulic design of intakes/outlets - upper & lower	V	E	R	
3	**Civil Works**				
3.1	Upper Reservoir, including lining, drainage, appurtenant structures etc. (e.g. LLO)	V	In	R	
3.2	Upper Intake/Outlet Structure	V	In	R	
3.3	Upper Reservoir Spillway	V	In	R	
3.4	Lower Reservoir, including appurtenant structures etc. (if any)	V	In	R	
3.5	Lower Intake/Outlet Structure	V	In	R	
3.6	Waterways including penstock steel liner and connecting steel liner from draft tube to lower Intake/Outlet Structure.	V	E	R	From Upper Intake/Outlet to Main Inlet Valve flange. From Draft Tube gate to Lower Intake/Outlet.
3.7	Powerhouse	V	E	R	
3.8	Provision of temporary Site Offices for Owner, Owner's Engineer and Meeting Rooms, including running costs	R	In	In	

Item No.	Scope Description	PPC	Lot 1 (TP)	Lot 2 (IC)	Remarks/key interface
3.9	Provision of temporary Site Offices for Contractor and subcontractors, workers welfare including changing rooms, canteen and toilets (including running costs)	V	R	R	Each lot responsible for his own supply
3.10	Main & local/site access roads, including connection to existing public roads, temporary roads and bridges	V	In	R	
3.11	Earthworks, all underground works, foundations, tunnels, galleries, culverts/duct banks	V	In	R	
3.12	Surface structures and building including offices, warehouse, workshop, utility buildings	E	In	R	-
3.13	All miscellaneous surface works including drainage, fencing, landscaping etc.	V	In	R	
4	**Primary Electromechanical Equipment**				
4.1	Main Inlet Valves including connecting sleeves with penstock and spiral cases, oleo hydraulic system, auxiliary systems and isolation valve	V	R	E	Pedestal is part of Lot 2. Interfaces with **Lot 2 (IC)** include civil loads and plant layout
4.2	Spiral Cases	V	R	E	Interfaces with **Lot 2 (IC)** include civil loads and plant layout
4.3	Pump-turbines and associated auxiliaries	V	R	E	
4.4	Draft tubes, including draft tube depression system	V	R	E	Interfaces with **Lot 2 (IC)** include civil loads and plant layout. Boundary between Lot 1 and Lot 2 is end of draft tube extension piece
4.5	Draft tube gates (bonneted type)	V	R	E	Interfaces with **Lot 2 (IC)** include civil loads and plant layout
4.6	Turbine governor system, including digital governor, HPU and all relevant sub-systems	V	R	E	Interfaces with **Lot 2 (IC)** include civil loads and plant layout
4.7	Unit cooling water system	V	R	E	Interfaces with **Lot 2 (IC)** include civil loads and plant layout
4.8	Motor-generator, including bearing oil system, excitation, excitation transformer and auxiliary equipment	V	R	E	Interfaces with **Lot 2 (IC)** include civil loads and plant layout
4.9	Static Frequency Converters (SFC), including SFC transformers	V	R	E	Interfaces with **Lot 2 (IC)** include civil loads and plant layout

Item No.	Scope Description	PPC	Lot 1 (TP)	Lot 2 (IC)	Remarks/key interface
4.10	Generator switchgear (Bus duct, GCB, etc.)	V	R	E	Interfaces with **Lot 2 (IC)** include civil loads and plant layout
4.11	IPBs	V	R	E	Interfaces with **Lot 2 (IC)** include civil loads and plant layout
4.12	Dynamic braking switch	V	R	E	Interfaces with **Lot 2 (IC)** include civil loads and plant layout
4.13	Phase reversal switches	V	R	E	Interfaces with **Lot 2 (IC)** include civil loads and plant layout
4.14	Step Up Transformer(s) (including fire detection and protection)	V	Optional	E	Interfaces with **Lot 2 (IC)** include civil loads and plant layout
5	**Electrical auxiliaries**				
5.1	Medium voltage AC system (switchgear, bus bar, etc.)	V	Optional	E	Interfaces with **Lot 2 (IC)** include electrical loads and plant layout
5.2	Cabling and piping	V	R	R	Each lot responsible for his own supply, interface to be detailed
5.3	Service/auxiliary transformers (including fire detection and protection)	V	Optional	E	Interfaces with **Lot 2 (IC)** include electrical loads and plant layout
5.4	Low voltage AC system (essential and normal)	V	Optional	E	Interfaces with **Lot 2 (IC)** include electrical loads and plant layout
5.5	DC System	V	Optional	E	Interfaces with **Lot 2 (IC)** include electrical loads and plant layout
5.6	UPS system	V	Optional	E	Interfaces with **Lot 2 (IC)** include electrical loads and plant layout
5.7	Backup diesel generators systems for emergency and black start	V	Optional	E	Interfaces with **Lot 2 (IC)** include electrical loads and plant layout
5.8	Electrical Plant Protection Systems	V	R	E	Interfaces with **Lot 2 (IC)** include electrical loads and plant layout
5.9	Plant control system (SCADA, DCS, plant controllers, etc.)	V	R	E	Several interfaces with building service systems, other control systems and the substation, as well as the National Grid Operator.
5.10	Condition monitoring and analysis system, including optimization and predictive maintenance tool.	V	R	E	
6	**Mechanical auxiliaries**				
6.1	Mechanical Plant Protection Systems	V	R	E	

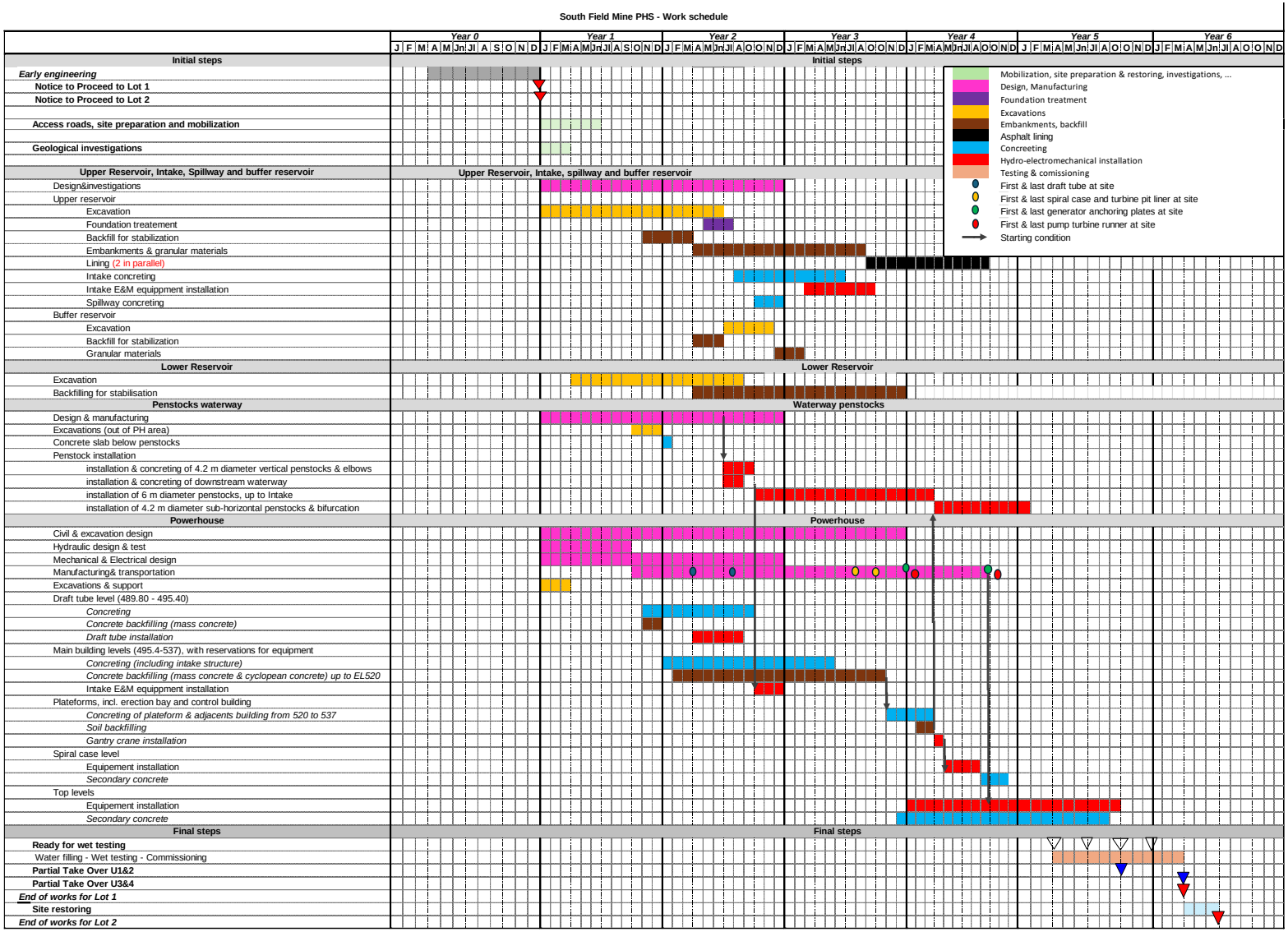
Item No.	Scope Description	PPC	Lot 1 (TP)	Lot 2 (IC)	Remarks/key interface
6.2	Common (station) cooling water system including raw water pumps, primary open loop and secondary closed loop circuits.	V	R	In	For dewatering compressors, IPBs, HVAC. Input from **Lot 2 (IC)** for HVAC loads.
6.3	Drainage system including emergency drainage and OWS	V	R	E	Includes headrace and tailrace dewatering
6.4	Turbine dewatering (blowdown) system	V	R	E	
6.5	Oil storage and filtration system	V	R	E	Assume mobile tanks and filtering plant
6.6	Compressed air system (service air and instrument air)	V	In	R	
6.7	Low pressure compressed air system for inflatable seal and generator braking.	V	R	E	
6.8	High pressure compressed air system	V	R	E	
6.9	Powerhouse / assembly bay crane(s), other cranes and hoists	V	R	E	
6.10	Mechanical Workshop equipment	V	In	R	**Lot 1 (TP)** will provide any specific needs for EM equipment
6.11	Electrical Workshop equipment	V	In	R	**Lot 1 (TP)** will provide any specific needs for EM equipment
6.12	Special tools	V	R	-	
6.13	Piping and ducting including supports	V	R	R	Each lot responsible for his own supply. Piping and ducting are included in each subsystem (cooling, drainage, dewatering, HVAC, etc.) General integration is the responsibility of **Lot 2 (IC)**.
6.14	Other crane and hoists	V	E	R	Input from **Lot 1 (TP)** as required, including locations and loads.
7	**Hydromechanical Equipment**				
7.1	Upper Intake trash racks, gates, stoplogs, hoists etc.	V	In	R	
7.2	Lower Intake trash racks, gates, stoplogs, hoists etc.	V	In	R	
7.3	All headwater, waterway and tailwater equipment	V	In	R	
8	**Building Services & other auxiliaries (including Master clock system / Time synchronization)**				
8.1	Overhead Medium Voltage line (or cable) from power house to upper reservoir, including fibre optic line for CS communication	V	E	R	**Lot 1 (TP)** shall supply characteristics for overhead line or cable / CS fibre optic line.

Item No.	Scope Description	PPC	Lot 1 (TP)	Lot 2 (IC)	Remarks/key interface
8.2	Earthing and lightning systems design	V	In	R	**Lot 2 (IC)** to provide its own equipment specifications. **Lot 1(TP)** shall be responsible for providing inputs for its equipment and checking the basic design
8.3	Embedded and buried earthing system installation, including interconnection to surface switchyard and at remote sites (e.g. intakes)	V	E	R	
8.4	In-air earthing and bonding system procurement and installation (EM equipment, building services, metallic fittings and structures)	V	R	R	Each lot responsible for his own supply. For each subsystem and metallic element.
8.5	Lightning protection system procurement and installation	V	E	R	Procurement and Installation by **Lot 2 (IC),** supervision by **Lot 1 (TP)**
8.6	Penstock Cathodic Protection design procurement and installation	V	In	R	If required, to be confirmed by **Lot 2 (IC)**
8.7	Powerhouse (EM equipment) Cathodic Protection design procurement and installation	V	R	In	If required, to be confirmed by **Lot 1 (TP)**
8.8	Small power and lighting	V	E	R	Interfaces with EPC include electrical loads and plant layout
8.9	Fire detection & alarm system	V	E	R	Inputs by **Lot 1 (TP)**
8.10	Information and Communication systems (ICS), including cybersecurity.	V	E	R	Implementation of cybersecurity measures including setup of the system under **Lot 1 (TP)** scope
8.11	Access control and intruder alarm systems	V	E	R	Internet, Wifi, telephones, etc.
8.12	CCTV and intruder detection systems	V	E	R	
8.13	Powerhouse vertical transport (lifts)	V	E	R	To be sized for plant maintainability according to relevant **Lot 1 (TP)** input
8.14	Domestic service and potable water system	V	E	R	
8.15	Sanitary drainage and wastewater system	V	E	R	
8.16	Ventilation & HVAC system	V	E	R	Cooling water from common system
8.17	Fire protection systems (wet and dry), including water supply and storage	V	E	R	Generator protection and transformer deluge included in **Lot 1 (TP)**. Integration by **Lot 2 (IC).**
8.18	First-fill (waterway priming) system, if needed	V	E	R	

Item No.	Scope Description	PPC	Lot 1 (TP)	Lot 2 (IC)	Remarks/key interface
8.19	Water supply system (from raw water supply pipe)	V	E	R	
9	**400kV Switchyard and Transmission Line (out of the project)**				
9.1	Switchyard and T/L land, permits etc.	R	-	E	
9.2	Switchyard civil works	V	-	E	Contractor licensed by the TSO
9.3	Switchyard electrical works	V	In	E	Contractor licensed by the TSO
9.4	Existing substation modifications / construction (if needed)	R	-	E	
9.5	Grid studies, connection application	R	In	-	
9.6	Transmission network interconnection	In	In	In	Responsibility is with TSO

Table 2-1: Division of work per lot

2.4. PRELIMINARY TIME SCHEDULE



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3. PROJECT INPUT DATA

The design of all components of the electromechanical equipment shall comply with current international Good Engineering Practices and be compatible with requirements of high reliability and durability.

The installations shall be designed to ensure reliable and easy operation and maintenance under all circumstances, requiring only minimal maintenance resources and without the interruption of the plant routine operation.

Equipment design shall fully consider the prevailing environment at the site of the works – climate, seismic conditions, water quality, etc. The Tenderers are required to fully ascertain these environmental conditions before submitting their Tenders.

3.1. PROJECT LIFETIME

The design life is the period for which the Works, when maintained in accordance with the maintenance plans, are fit to be used for their intended purpose without the loss of reliability or of structural, operational or aesthetic integrity.

The design life of individual Facilities and Components of the Works is given in the table below. A design life of 100 years shall be taken for the Permanent Works unless indicated otherwise in the tables or in the specific design requirements.

For all Components a manufacturer's certificated design life documentation shall be submitted for the Owner's approval. A test program shall be developed for Components for which the required design life is not adequately certified.

Certificates and test programs shall address all aspects that are relevant for the design life of the related Component, like frost/thaw resistance, fatigue strength, fire resistance, pressure wave resistance, resistance against de-icing salts, etc.

The test program shall be submitted for the Owner's approval.

Every Component of the Facility for which the design life is less than the design life of the related Facility shall be replaceable.

Ease of replacement of such Component shall be a primary design consideration.

Replacement of such Components shall be possible in a non-destructive manner to the surrounding structure and incur minimum disturbance to normal operating conditions.

The replacement procedures of such Components shall be described in the operation and maintenance manual.

The design life requirements for steel and concrete structures shall be met without taking into account any favourable effects from a cathodic protection system whether or not such a system will be installed.

For design calculations, the design life of all temporary structures that have to function for a period of 6 months or longer shall be at least 15 years unless otherwise stated.

The design lives of the main structural elements are as indicated below.

Element	Life duration
Structure/equipment	
Permanent civil components	100 years
Water intakes	100 years
Powerhouse structure	100 years
Watertightness system for reservoirs	30 years (1)
Permanent Mechanical components	
Runner, bearings	30 years (3)
Embedded parts (spiral case, draft tube, steel lining)	30 years (2)
Major Mechanical equipment (Cranes, Upper safety gate, Draft tube gate, Main Inlet Valve, Trash Racks, Penstocks)	50 years
Mechanical Auxiliaries (dewatering, cooling, ventilation, air conditioning, fire protection and firefighting, compressed air supply systems, etc.)	40 years
Permanent Electrical components	
Motor generator	40 years
Power transformers	40 years
SFC	30 years
HV Switchgear (outdoor equipment gantries, OHL, civil structures etc.)	50 years
MV IPB type busbars	40 years
GCB, Phase reversal switches	30 years
MV/LV electrical distribution equipment	30 years
SCADA, protection and control system	15 years
Embedded and buried earthing system	100 years
Water Supply Component	
Pipe	100 years
Pumps	30 years
Mechanical equipment (filter, valve, air valve…)	40 years

(1): Either membrane replacement, or bituminous concrete full-face check-up repair works + bituminous sacrificial layer to renew.

(2): Full painting works to be considered after 30 years to extend life during without limitation.

(3): lifespan expandable by changing contact surfaces or performing repairs

Table 3-1. Minimum design service lifetime for elements

3.2. WATER QUALITY DATA

The reservoirs will be filled by the local aquifer water and in addition with water conveyed from the Polyfytos reservoir through existing pipelines. Water quality data for both abovementioned sources are presented in Appendix A.

3.3. CLIMATIC DATA

3.3.1. TEMPERATURE

Data overview

Hourly temperature data was collected from the meteorological stations at Koilada and Pontokomi over an 11-year period, spanning from January 1, 2014, to December 31, 2024. Both stations are located near the South Field mine.

During this period, the average temperature recorded at both stations was 14.3°C. However, due to a higher number of outliers in the Pontokomi dataset, data from the Koilada station was primarily used for analysis. The evaluation was performed on both hourly and daily timescales.

Long-term temperature trend

Figure 3-1 below illustrates the monthly average temperatures recorded at the Koilada station from 2014 to 2024. The data shows a noticeable upward trend in average temperature - approximately a 1°C increase over the 11-year period - mainly driven by progressively warmer summer months.

Figure 3-2 displays the annual maximum and minimum temperatures based on daily data. Both trends show an increase over time.

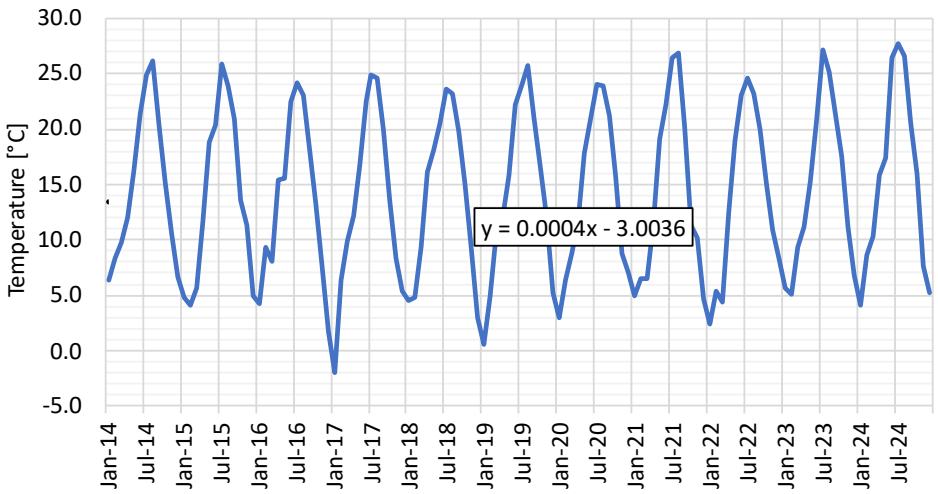


Figure 3-1: Monthly temperatures measured at Meteorological Station Koilada

Mean hourly and daily temperatures are shown in Figure 3-2 and Table 3-2, for each month of the year. For example, for July, the hottest month of the year, the average of all maximum hourly measurements amounts to 37.19°C; on a daily basis, this value reduces to 30.14°C. The lowest temperatures typically take place in January.

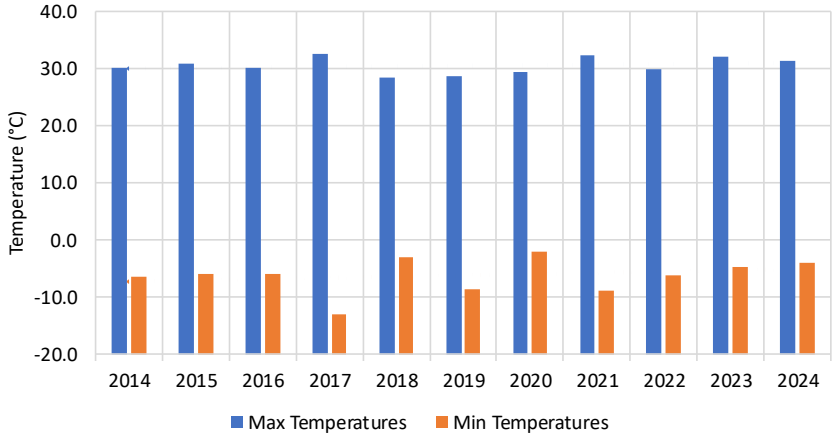


Figure 3-2: Maximum annual temperatures at meteorological Station Koilada

Monthly temperature statistics

Table 4-1 and Figure 3-3 provide a monthly breakdown of temperature data from Koilada. This includes maximum and minimum values on both hourly and daily scales, as well as monthly average temperatures.

For example, July - the hottest month of the year - had an average of 37.19°C for maximum hourly temperatures. On a daily basis, this figure decreased to 30.14°C. Conversely, the coldest temperatures typically occurred in January.

	Max Hourly Temperature [°C]	Min Hourly Temperature [°C]	Max Daily Temperature [°C]	Min Daily Temperature [°C]	Average Temperature [°C]
Jan	16.54	-8.96	10.96	-4.95	3.51
Feb	20.25	-5.69	12.83	-1.97	6.38
Mar	23.78	-2.48	15.40	1.78	8.43
Apr	27.41	1.07	19.70	5.78	12.90
May	30.83	6.85	23.00	11.38	17.29
Jun	35.45	10.92	28.37	15.64	22.07
Jul	37.19	13.50	30.14	18.74	25.23
Aug	36.42	14.19	28.67	19.71	24.76
Sep	34.32	8.18	26.14	13.21	20.28
Oct	27.52	4.17	20.62	8.63	14.78
Nov	22.80	-1.40	16.14	2.62	9.80
Dec	17.88	-5.57	11.33	-1.90	5.36

Table 3-2: Temperature measured at Meteorological Station Koilada

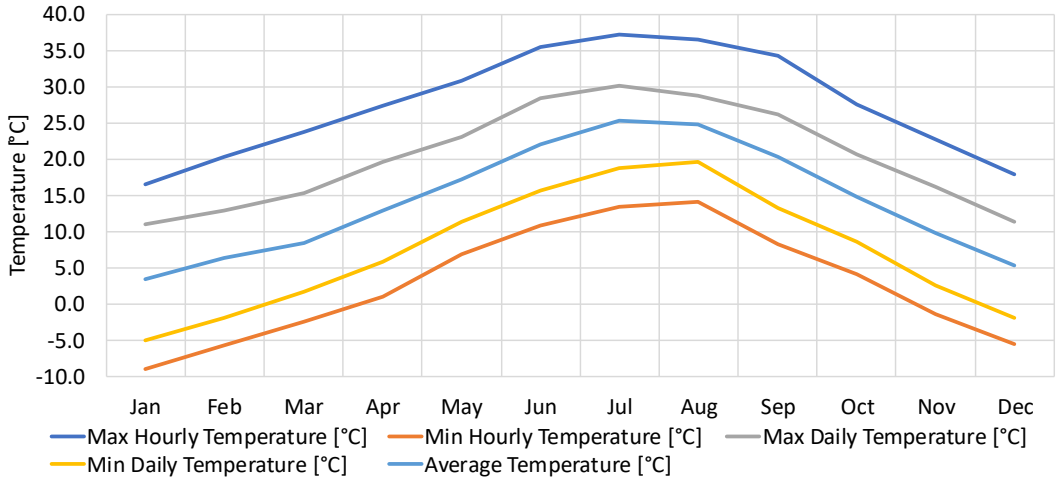


Figure 3-3: Temperature measured at Meteorological Station Koilada

3.3.2. RELATIVE HUMIDITY

Data overview

Similar to temperature, relative humidity (RH) data is available at hourly intervals from the Koilada and Pontokomi meteorological stations for the 11-year period from January 1, 2014, to December 31, 2024.

Due to numerous outliers in the Pontokomi dataset - including values exceeding 100% - only data from the Koilada station was used in the analysis. The assessment was conducted using both hourly and daily time steps.

Long-term humidity trend

Figure 3-4 presents the monthly averaged relative humidity values from 2014 to 2024. Although a slight downward trend is visible, it is primarily influenced by elevated RH values in 2014; excluding that year, no significant decline is observed.

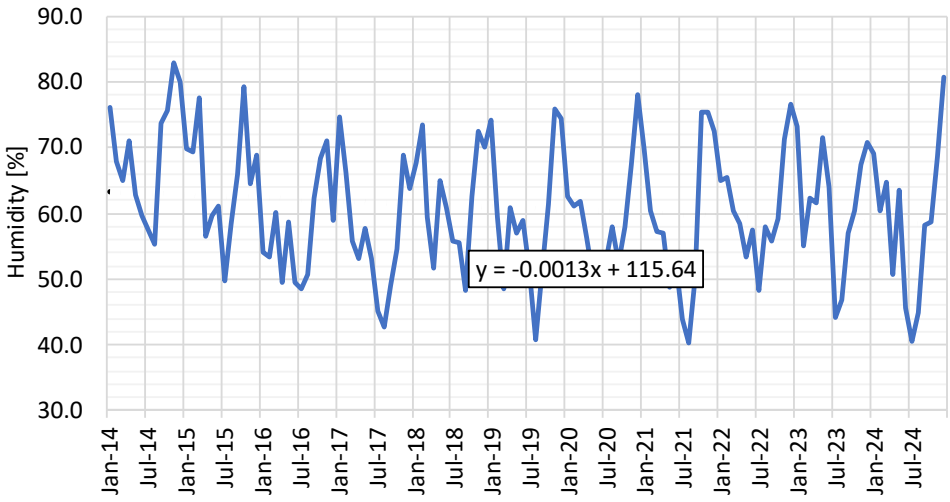


Figure 3-4: Monthly humidity measured at Meteorological Station Koilada

Monthly humidity statistics

Figure 4-5 and Table 3-3 show mean hourly and daily RH values for each month. The average maximum hourly RH ranges from 93.45% to 97.73%, while the minimum hourly RH varies between 16.82% and 32.27%. December typically exhibits the highest relative humidity, whereas August records the lowest.

	Max Hourly Relative Humidity [%]	Min Hourly Relative Humidity [%]	Max Daily Relative Humidity [%]	Min Daily Relative Humidity [%]	Average Relative Humidity [%]
Jan	96.27	30.64	92.03	48.89	68.77
Feb	94.73	21.73	83.83	40.72	62.93
Mar	97.00	17.55	89.60	36.48	61.22
Apr	95.45	17.82	84.74	36.30	57.01
May	96.91	21.09	82.17	39.94	58.95
Jun	94.73	19.82	80.63	35.95	55.86
Jul	95.45	17.09	78.82	31.93	48.89
Aug	93.45	16.82	76.14	34.48	50.14
Sep	95.27	20.82	82.73	37.48	56.79
Oct	94.73	24.09	84.85	45.97	64.88
Nov	97.73	29.64	92.56	50.64	71.51
Dec	96.91	32.27	92.58	50.67	72.28

Table 3-3: Relative humidity measured at Meteorological Station Koilada

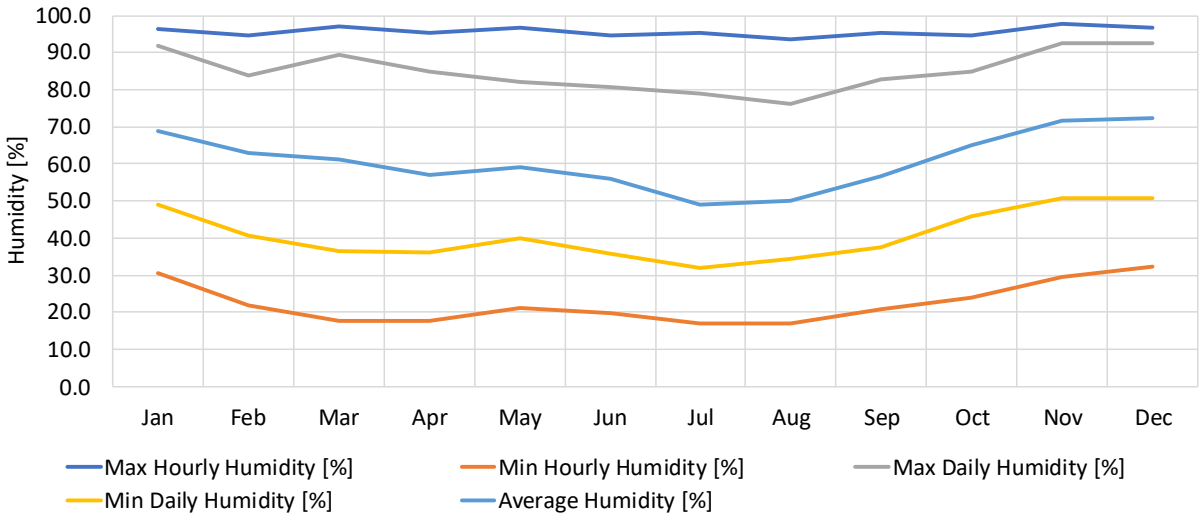


Figure 3-5: Relative humidity measured at Meteorological Station Koilada

3.4. SEISMIC HAZARD

Wherever relevant, the Tenderer shall take into account seismic-generated stresses by combining vertical and horizontal accelerations in their most unfavourable configuration. For each of these accelerations, the site maximum peak ground acceleration shall be considered.

South Field PHS area lies in the “Zone I” seismic classification as determined in the Greek Annex of Eurocode 8, which corresponds to the design seismic acceleration value (*a*) of 0.16g for a return period of 475 years. An importance factor 1,4 must be considered.

According to the revision of the Seismic Hazard Map (Government Gazette 1154/B/12-8-2003) of the current Anti-Seismic Regulation (NEAK 2000), the area is classified as Zone I, which corresponds to the design seismic acceleration value of 0.16g for a return period of 475 years.

Following the provisions of ICOLD bulletin 72, and the requirements of PPC, two types of earthquake shall be considered:

- Safety Evaluation Earthquake (SEE) which has a return period about 3 000 years;
- Operating Basis Earthquake (OBE) which has a return period about 475 years.

As no Probabilistic or Deterministic Hazard Seismic Assessment (PHSA or DHSA) has been carried out so far, PGA for OBE and SEE is assessed preliminary thanks to the following formula:

A dedicated Seismic Hazard Analysis is appended in Appendix D.

3.5. RESERVOIRS

The project includes two man-made reservoirs as described in Chapter 2.1.

Active storage of South Field PHS is defined by the volume between the Full Supply Level (FSL) and the Minimum Operating Level (MOL).

At this stage of the study, we propose considering the following water level ranges, outlined in the paragraphs below, for an active storage of approximately 6.9 hm^3.

The water levels for the upper reservoir are shown in the following table:

Water levels	Elevation
Minimum Operating Level (MOL)	644.5 m

Water levels	Elevation
Full Supply Level (FSL)	660.0 m

Table 3-4: Upper Reservoir Water Levels

The water levels for the lower reservoir are shown in the following table:

Water levels	Elevation
Minimum Operating Level (MOL)	528.0 m
Full Supply Level (FSL)	535.0 m

Table 3-5: Lower Reservoir Water Levels

3.6. PENSTOCK

The penstock consists of two exposed (mostly) and concreted steel pipes, laid in parallel. All penstock pipes will be designed in accordance with the recommendations in ASCE and CECT standards. The pre-sizing will consider the most severe situations, in particular absolute vacuum inside the penstock in case of emergency closure of the butterfly valve.

- Number of pipes: 2
- Number of Pump-turbines per pipe: 2
- Length of each pipe: 1 km approx.
- Diameter of each pipe: 6 m
- Generating discharge capacity per penstock: 2 x 59 $m^3.s^{-1}$
- Pumping discharge capacity per penstock: 2 x 52 $m^3.s^{-1}$

3.7. PUMP-TURBINE INPUT DATA

Parameter	Value	Comments
Main Inlet Valve technology	Butterfly valve	
Turbine technology	Vertical Reversible Francis	
Generator technology	Synchronous Motor-Generator	
Unit number	4	Offering four (4) pump-turbines is mandatory and alternative offers with a different number of units are not accepted.

Parameter	Value	Comments
Turbine output under max net head (132m)	62 MW	Mechanical power on turbine shaft
Unit rated output	61 MW	At Generator terminals
Turbine output under rated net head (122m)	62 MW	Mechanical power on turbine shaft
Turbine output under intermediate net head (115m)	56 MW	Mechanical power on turbine shaft
Lower limit in turbine output	≤ 50%	% of full output for each head
Power input at max head (133.4)	≥ 55.7 MW	Mechanical power on pump shaft
Power factor	0.90 0.95	In Generation mode In Consumption mode
Unit apparent power	68 MVA	
Generation time per day	11 to 14 hours	May vary during ETPI phase.
Pumping time per day	14 to 15 hours	May vary during ETPI phase.
Start&stop per day	4	
Lower reservoir MOL	528 masl	
Lower reservoir FSL	535 masl	
Upper reservoir MOL	644.5 masl	May vary during ETPI phase.
Upper reservoir FSL	660 masl	May vary during ETPI phase.
Gross head range	109.5 – 132 mWc	May vary during ETPI phase.
Unit setting (distributor centerline)	500 masl	May vary during ETPI phase.
Synchronous speed	333 rpm	Alternative offers are accepted
Waterways head loss	~2% of Gross head under max discharge conditions	Will be confirmed by Lot 2 Contractor.

Table 3-6: Pump-turbines input table

Pump-turbines should be designed in such a way that:

- **Operation in generating mode** (turbine) is to be optimized to cover full load to partial load operation down to 50% of max output, for a given net head. Priority is given to high load operation, flexibility being achieved by the number of units. See weighted average efficiency formula below, defined for turbine mechanical output on turbine shaft vs turbine net head. **Turbine efficiency shall include the butterfly MIV head losses**. The net head high pressure section measurement should be located on the high pressure side of the MIV.

  Turbine Weighted Average Efficiency (WAE) is to be obtained by the sum of products (efficiency x weighting factor) for all the operating points from Table 3-7.

Hn (m)	107.2	115	122	132
P (MW)	49.6*	56.0	62.0	62.0
100%	3%	12%	12%	3%
90%	3%	12%	12%	3%
80%	2%	8%	8%	2%
70%	1.5%	6%	6%	1.5%
60%	0.5%	2%	2%	0.5%
50%	0%	0%	0%	0%

Hn = Net head in turbine mode including MIV
P = Mechanical output on Turbine shaft
Load fractions are in % of max output under each given net head
(*) Max output under minimum head may vary, to be adjusted by the Tenderer according to max opening to achieve max output under other heads

Table 3-7: Weights for Turbine Operating points

On the next figure the expected operating range in output vs net head is shown, to be confirmed by the Tenderer in the deliverables. The minimum continuous output of 50% of max output per head shall be confirmed by the Tenderer. The area corresponds to a continuous and stable operation in turbine mode.

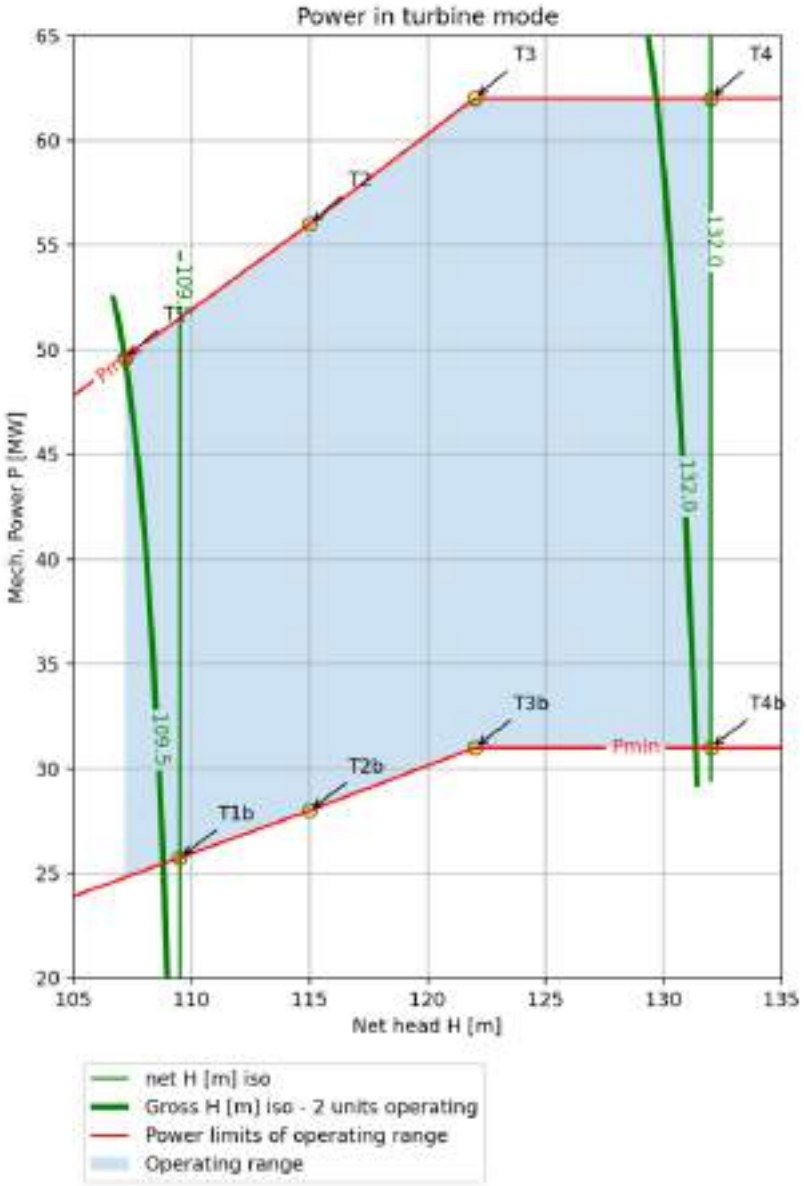


Figure 3-6: Turbine expected mechanical power output – continuous operating range

- **Operation in pumping mode** is to be optimized to cover the whole gross head range, with a priority given to intermediate heads. See weighted average efficiency formula below, defined for mechanical input on pump shaft vs pump net head. **Pump efficiency shall include the butterfly MIV head losses**. The net head high pressure section measurement should be located on the high pressure side of the MIV.

  Pump Weighted Average Efficiency (WAE) is to be obtained by the sum of products (efficiency x weighting factor) for all the operating points from Table 3-8.

Hn (m)	109.5	120	133.4
100%	25%	50%	25%
Hn = Net head in pump mode including MIV			

Table 3-8: Weights for Pump Operating points

On the next figure the expected operating range in pump mode with net head as a function of discharge is shown, to be confirmed by the Tenderer in the deliverables.

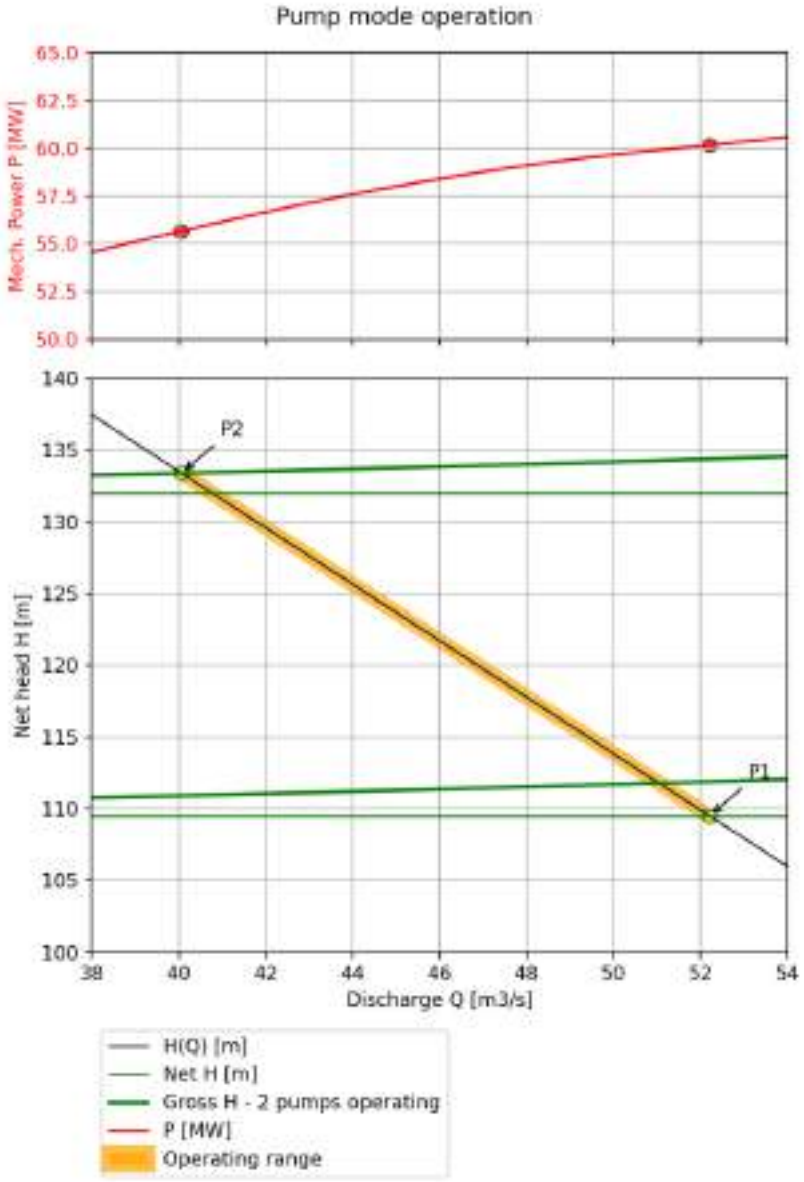


Figure 3-7: Pump expected head-flow curve - continuous operating range

- The pump-turbine should be designed in such a way to have a **cavitation free runner**. The maximum amount of cavitation pitting after one year or 3000 hours of operation in pumping mode shall be guaranteed. The guaranteed values (depth and volume) shall be those for a cavitation free runner, as set out in IEC 60609: amount of cavitation corresponding to IEC 60609 Fig. A.1 and A.2., with the following threshold values:
  - One fourth of minimum volume value from Fig. A.2: **$5*D^2$**
  - Approx. equivalent in dimension, that is the minimum depth value from Fig. A.1 divided by 1.6 (approx. cube root of 4): **$2.5*D^{0.4}$**

Guaranteed items will be the following:

- WAE Turbine
- WAE Pump
- Turbine mechanical max output under max and rated head
- Pump mechanical input under max head
- Cavitation pitting max depth per runner
- Cavitation pitting max volume per runner
- Motor and generator max efficiency
- Transformer max efficiency
- Noise and Vibration guarantees

3.8. ALLOWABLE MODE CHANGE TIMES

The different modes that are considered for the units are the following:

- **Stand still mode:**

The runner is stopped, filled with water. All auxiliaries are activated.

- **Generating Mode:**

Driven by the Pump-Turbine in turbine mode, the Generator provides active power to the grid, and can supply or absorb reactive electric power to/from the grid.

In this mode the unit can provide the following grid services:

- frequency control (within the unit load range);
- voltage control (within the unit PQ diagram).

- **Pumping Mode:**

The Motor, driving the Pump-Turbine in pump mode, uses the active power supplied by the grid to transfer water from the lower reservoir to the higher reservoir, thus storing potential energy. It can also supply or absorb reactive electric power to/from the grid.

In this mode the pump-turbines can provide the following grid services:

- voltage control (within the unit PQ diagram).

- **Synchronous condenser modes:**

The Unit is dewatered and spinning in air in the pump or turbine direction. It thus uses a limited amount of active power, but can supply or absorb reactive power, and contributes to the grid voltage control:

- Synchronous Condenser Mode in Generating rotation.
- Synchronous Condenser Mode in Pumping rotation.

- **Line Charging:**

The line charging mode of operation is used when the generator is to be connected to a transmission line which is not energized. The Manual regulator is selected and the exciter output is such as to cause the system voltage to be normal when the generator is placed on the transmission line.

This line charging mode capability shall be confirmed after the stability study, to be performed during the ETPI phase.

A typical Mode change diagram is presented on next figure.

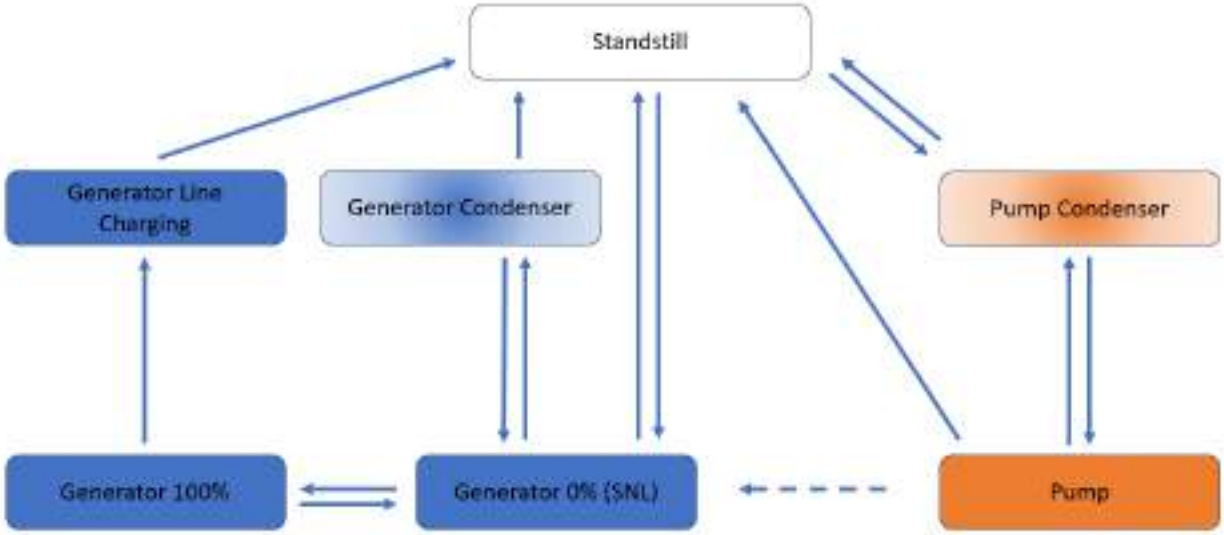


Figure 3-8: Mode change Diagram to be considered

Tenderer is to propose its own typical transition times. The sequence time for the main transition between modes shall be **guaranteed**, in particular the two following:

- Standstill to Generating (100%)
- Standstill to Pumping

4. CODES, GUIDELINES AND STANDARDS

4.1. HIERARCHY OF STANDARDS

In the event of any conflict in standards, the hierarchy of standards is as follows, with the standards occurring first in the list taking precedence over any standards later in the list:

1. Codes, Standards, Laws and Rules into force in Greece and Europe.
2. Particular Technical Specifications (**PTS**), see Chapter 5, and General Technical Specifications (**GTS**), see APPENDIX C
3. International standards.
4. National standards to which the manufacturer normally operates.

4.2. GENERAL STANDARDS

[1] International Commission on Large Dams (ICOLD)

[2] International Electrotechnical Commission (IEC)

[3] International Standards Organisation (ISO)

[4] European Committees for Standardisation (EN) including Eurocodes

[5] American National Standards Institute, (ANSI)

[6] American Society for Testing and Materials (ASTM)

[7] United States Army Corps of Engineers (USACE)

[8] United States Bureau of Reclamation (USBR)

[9] Japanese Industrial Standards (JIS)

[10] Deutsches Institut für Normung (DIN)

[11] British Standards Institutes (BSI)

[12] Verein Deutscher Ingenieure (VDI)

[13] Comité Français des Barrages et Réservoirs (CFBR-/ FRCOLD)

[14] Association Française de Normalisation (AFNOR)

4.3. SPECIFIC STANDARDS

[15] DIN 19704-1, Hydraulic steel structures – Part 1: Criteria for design and calculation, November 2014.

[16] DIN 19704-2, Hydraulic steel structures – Part 2: Design and manufacturing, November 2014.

[17] USACE EM 1110-2-2107, Design of Hydraulic Steel Structures, August 2022.

[18] USACE EM 1110-2-1602, Hydraulic Design of Reservoir Outlet Works, October 1980.

[19] Design Standards No.6, Hydraulic and Mechanical Equipment, Chapter 6: Bulkhead Gates and Stoplogs, USBR.

[20] Design Standards No.6, Hydraulic and Mechanical Equipment, Chapter 12: Trashracks and Trashrack Cleaning Devices.

[21] EN 15011:2020, Cranes – Bridge and gantry cranes.

[22] EN 13135:2026, Cranes – Safety – Design – Requirements for equipment

[23] ISO 4301-1:2016, Cranes – Classification – Part 1: General

[24] EN 13001-1, Cranes – General design – Part 1: General principles and requirements, April 2015.

[25] EN 60204-32:2025, Safety of machinery – Electrical equipment of machines – Part 32: Requirements for hoisting machines.

[26] FEM, European Materials Handling Federation

[27] CMAA Specification No.70-2020, Multiple girder cranes.

[28] CMAA Specification No.74-2020, Single girder cranes.

[29] NFPA 850-2026, Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations

[30] NFPA 851-2010, Recommended Practice for Fire Protection for Hydroelectric Generating Plants.

[31] Hydroelectric Power Plant Trashrack Design, Journal of the POWER DIVISION – Proceedings of the American Society of Civil Engineers, January 1971.

[32] Design of Hydraulic Gates, Paulo C.F. Erbisti, 2nd Edition, 2014.

[33] Fundamentals of vortex intake flow, in. J. Knauss Swirling Flow Problems at intakes, IAHR Hydraulic Structures Manual, 1987

[34] ASCE Manuals and Reports on Engineering Practice No. 79, “Steel Penstocks”

[35] CECT Comité Européen De La Chaudronnerie Et De La Tôlerie - Recommendations for study, construction and assembly of penstocks

[36] CODAP Code for Construction of Unfined Pressure Vessels

[37] ASME Section VIII Boiler and Pressure Vessel Code (BPVC) - Rules for Construction of Pressure Vessels

[38] IIW-1823-07 International Institute of Welding - Recommendations for design of welds under fatigue cycling loads.

[39] EN 1991 Eurocode 1 : Actions on structures

[40] EN 1993-4-3 Eurocode 3 - Design of steel structures - Section 4-3 : piping

[41] EN 13445 Unfired pressure vessel

[42] EN 13480 Metallic Industrial Piping Design Rules

[43] AWWA M11 Steel Pipe – A Guide for Design and Installation

[44] AWWA C200 Standard for Steel Water Pipe Six Inches and Larger

[45] AWWA C206 Standard for Field Welding of Steel Water Pipe

[46] AWWA C208 Dimensions for Fabricated Steel Water Pipe Fittings

[47] AWWA C210-2024 Liquid-Epoxy Coatings and Linings for Steel Water Pipe and Fittings

[48] USACE EM 1110-2-2901, Tunnels and Shafts in Rock, May 1997.

5. PRELIMINARY PARTICULAR TECHNICAL SPECIFICATIONS (PTS)

5.1. HYDRAULIC MACHINERY

5.1.1. PUMP-TURBINES

The four (4) Pump-Turbines shall be of the vertical shaft, single runner, with fixed speed, reversible Francis-type units, with movable wicket-gates, fixed stay vanes, steel-plate spiral cases and elbow-type suction draft tubes. Wicket gates shall be used to regulate power output and to control speed at starting, synchronization and shutting down during turbine operation.

- Nominal capacity: Each pump-turbine shall be specified to have a guaranteed turbine output of **62 MW** (mechanical output on turbine shaft) when operating under the nominal head at rated speed.
- Turning speed: **333 rpm**. (Tenderer may quote also for a different speed with the proper explanation).
- Distributor centerline is forecasted at **500 masl**. Tenderer may propose alternative values at a different elevation to minimize cavitation impact on pump-turbine.
- All four (4) Pump-Turbines should be capable of operating in **synchronous condenser mode**, both in turbine and pump rotation directions.
- The two Pump-Turbines on the same penstock should be able to operate in **hydraulic short-circuit mode**, one unit being in generating mode while the other in consumption mode, each one of them within its normal operating range (resp. turbine and pump modes).
- The pump-turbine should be designed in such a way to have a **cavitation free runner** in the continuous operating range, both in pump and in turbine modes.

The Pump-Turbine hydraulic design shall be tested and approved by the Owner through a **reduced scale model test** following IEC 60193:2019 standard. The hydraulic waterways to be included into the geometrical homology shall go from Main Inlet Valve (MIV) upper reservoir side to Draft Tube lower reservoir side. MIV obturator is to be included in fully opened position – its maneuverability on the reduced scale model is not needed. Draft tube gate slots are to be included in the geometrical homology.

5.1.2. GOVERNING SYSTEM

The governing system of each turbine-generator shall be of the electronic-hydraulic type, with digital computerized PID control, with acceleration sensing, speed regulation, and stabilizing and diagnostic functions.

The governing system shall be supplied complete, with electrical speed sensors, actuators, restoring connections, oil pumps set, sump tank, pressure tank, oil piping to the pump turbine servomotors, and all controls, instrumentation and accessories necessary for a complete governing system. The governing system shall be pressurized by nitrogen bottles.

The governing system shall have provisions for remote starting and automatic load control equipment.

5.1.3. INLET BUTTERFLY VALVE

Each pump-turbine shall be provided with a butterfly shut-off valve between the spiral case and the penstock. This valve shall be capable of the following:

- Isolation of the pump-turbine from the penstock, allowing for performing maintenance work on the pump-turbine, without emptying the headrace.
- Normal shut-off.
- Emergency shut-off in the event the wicket gates fail to close.
- Emergency shut-off in case of loss of power (load rejection)
- It shall be able to shut off the inflow into the powerhouse, in case of burst of pipe downstream of the valve.

The butterfly valves shall be equipped of a by-pass to balance the pressure before opening.

The butterfly valves shall be supplied complete with a dedicated oil pressure unit, all controls, actuators and filling and dismantling pipes. Closing should be done by the mean of one of two counterweights per butterfly valve. The connecting sleeves with penstock and the spiral case should be supplied together with the butterfly valves.

The oil pressure unit shall be pressurized by nitrogen bottles.

5.1.4. DRAFT TUBE GATE

On the low pressure side of each turbine, at the end of the diverging part, a draft tube bonneted gate shall be provided, as integral part of the turbine draft tube.

The draft tube bonneted gate shall isolate the related turbine from the low pressure water intake, for inspection and maintenance without any influence on the operation of the other units. In addition, it shall shut off the inflow into the cavern, in case of burst of any pipe or manhole between the main inlet valve and the draft tube gate. The draft tube gate shall close in two (2) minutes.

To prevent excessive pressure on the bonneted gate, hydraulic interlocking shall be implemented so that the bonneted gate can only be closed when the MIV is completely closed, and the MIV can only be opened when the bonneted gate is completely opened.

The draft tube gate shall be equipped of a by-pass to balance the pressure before opening. A safety valve shall be integrated to limit the pressure on the turbine side in case of leakage at MIV level.

The draft tube gates shall be supplied complete with a dedicated oil pressure unit, all controls, actuators and filling and dismantling pipes. Closing shall be capable by its own weight, closing speed shall be controlled by the oleo hydraulic system.

The oil pressure unit shall be pressurized by nitrogen bottles.

5.1.5. MECHANICAL AUXILIARY EQUIPMENT

The **mechanical auxiliary equipment as part of Lot 1 Technology Provider** should include:

- ✓ Cooling Water Systems
- ✓ Compressed Air Systems
- ✓ Station Drainage and Dewatering Systems
- ✓ Mechanical and Dielectric Oils handling and treatment Systems
- ✓ Fire Protection System of motors-generators and main power transformers
- ✓ Secondary lifting and handling capacities

5.1.5.1. Cooling Water Systems

Each unit will be equipped of a primary circuit of raw water (open loop) and a secondary circuit of treated water (closed loop), both circuits being connected to redundant heat exchangers (each exchanger being dimensioned to absorb the whole excessive heat production).

Each unit shall have its own water collection (input and output) on the low pressure side. The primary circuit should be designed with a complete redundancy, in particular with two pumps and two automatic filters, each one of them being capable of providing the total required discharge.

The maximum water temperature to be considered for the water input of the primary circuit shall be considered at 32°C. Any adjustment shall be made in accordance with IEC 60034-1.

A closed loop cooling system (secondary circuit), connected with the primary circuit through heat exchangers, shall be provided for removing excessive heat from the following systems:

- Pump-turbine and motor-generator;
- SFC cubicle and transformer (if necessary)
- High capacity compressors (if necessary)
- HVAC system. HVAC system is not part of Lot 1 supply. The following characteristics shall be considered for the cooling water system dimensioning of Lot 1:
  - Estimated water discharge for HVAC: 500 m3/h
  - Estimated electric load for HVAC: 1300 kW

The secondary circuit should be designed with a complete redundancy, in particular with two pumps, each one of them being capable of providing the total required discharge.

Cooling water systems shall be designed on a unit basis to provide for the normal operation of the pump-turbine and motor-generator for cooling requirements.

The system's closed loop shall circulate treated (potable) water as is necessary for equipment cooling. Equipment shall be separated from raw water running in the heat exchangers

The closed loop cooling system shall be supplied with two 100% capacity pumps (one duty and one stand-by), pressure controls, expansion tanks, and all piping, valves and controls necessary to circulate water through the heat exchanger and plant equipment coolers.

A dedicated system will provide fine-filtrated water for turbine shaft seal spraying.

Provisions shall also be made for supplying pressurized shaft seal water during unit outages or idle periods.

5.1.5.2. Compressed Air Systems

The compressed air systems will consist at least of the following:

- Blowdown (dewatering) compressed air system (MP/HP) – **Part of Lot 1**
- Generator braking compressed air system (LP) – **Part of Lot 1**
- Station's service and instrument compressed air system (LP) – **Part of Lot 2 – not to be quoted in this RFQ**

The blowdown compressed air system shall be designed to depress water level in the draft-tube to below the runner, in order to reduce pump start-up load and to allow the runner to spin in air while the unit operates as a synchronous condenser.

The blowdown air compressor's capacity shall be sufficient to recharge the air system and to depress the unit within approximately ten minutes. The system shall be designed to operate at one bar barometric pressure, and be compatible with the data supplied in paragraph 3.3 – Climatic data.

A separate compressed low pressure air system shall be forecasted to feed the generator braking and the maintenance inflatable shaft seal.

The service and instrument compressed air system shall be capable of supplying air to any individual consumer within the plant according to demand and specifications.

Each compressed air system shall be supplied with all required controls and accessories (filters, pressure reducers, driers, coolers, etc.), and two full-capacity compressors, one duty and one standby. The standby compressor shall start automatically, should the duty compressor fail.

5.1.5.3. Station Drainage and Dewatering System

Two separate sumps are installed to recover respectively the drainage water and the unit dewatering.

The drainage water sump has its own set of pumps: 3 x 100 m^3/h submersible pumps (preliminary value – two pumps shall be sufficient to cover the usual drainage volume, one pump in back-up). The pumps evacuate the drained waters (seepage water,

leakages, water discharged from automatic cleaning filters, water discharge from turbine shaft seals, etc.) through a collector pipe to the tailrace at lower water intake.

The dewatering sump has its own set of pumps: 2 x 300 m^3/h submersible pumps (preliminary value) used for the dewatering of the unit and final dewatering of the waterways. One pump (resp. two pumps) shall allow the final dewatering of the waterways (water level in penstock = lower reservoir FSL) in 20 hours (resp. 10 hours). The water is discharged through the collector pipe to the tailrace at lower water intake.

The 2 sumps are interconnected through an isolating gate/valve that permits to secure one set of pumps by the other, or to join the capacity of both pumping capacities in case of important dewatering service or flooding.

The drainage network comprises a water/oil separator and the oil collected will be pumped out for storage and recycling.

The power and control cubicles of dewatering and drainage pumping systems shall be installed at a top floor to be able to continue to operate even in case of flooding at lower floors.

5.1.5.4. Mechanical and Dielectric Oils handling and treatment system

Two oil treatment systems will be provided :

- One mobile oil treatment equipment and oil storage tanks (fixed and mobile) with associated piping network for mechanical oil (governing oil, bearings oil, MIV hydraulic oil);
- One mobile oil treatment equipment and mobile oil storage tanks with associated piping network for dielectric oil of transformers.

5.1.5.5. Fire Protection System

A fire protection system shall be provided for the motor-generators and transformers.

The firefighting system should be by default of water deluge type for the transformer and mist or inert gas for the generator. It should be in accordance with national regulations. Tenderer may propose types of firefighting system as an alternative.

General fire detection and protection system for the powerhouse, including offices, oil purification and storage room and other vital areas of the powerhouse that are exposed to fire hazards, and water intake and pumping facilities, is part of Lot 2 Infrastructures Contractor.

5.1.5.6. Heating, Ventilation and Air-conditioning Equipment (HVAC)

HVAC system is part of Lot 2 Infrastructures Contractor, not to be quoted with this RFQ. Lot 1 Technology Provider shall provide data to Lot 2 Infrastructures Contractor according to the project planning to be defined.

For information of the Lot 1 Technology Provider, the following basic criteria are adopted for the preliminary layout and sizing of the air conditioning and ventilation system:

- ✓ Ambient temperature in air-conditioned areas with permanent staff (control room, meeting rooms, offices, telecom rooms, rest rooms, etc.): between 21°C (winter) and 25°C (summer) with RH (relative humidity) 55% +/-5

- ✓ Ambient temperature in air-conditioned technical areas (sensitive equipment rooms, battery rooms, etc.) should be between 15°C and 30°C with RH (relative humidity) 55% +/-5

- ✓ In the other sections of the powerhouse, the HVAC system will be designed to compensate the heat dissipated by the equipment in the air of each room. Under no circumstances should the temperature inside the powerhouse exceed 35°C.

Design conditions are to be considered as follows (outdoor ambient conditions):

- Maximum dry-bulb temperature: +40°C outdoor, +45°C indoor
- Maximum wet-bulb temperature: +38°C
- Minimum dry-bulb temperature: -25°C outdoor, -15°C indoor

5.1.5.7. Lifting and handling capacities

Powerhouse / assembly bay travelling crane(s), other cranes and hoists are part of Lot 2 Infrastructures Contractor.

The lifting capacity of the main crane shall be fully adequate to tackle the heaviest assemblies of the Power Plant during erection (starting from above ground) and for plant maintenance.

Secondary handling equipment around specific elements of Lot 1 Technology Provider are to be quoted by the Tenderer, together with the special tools (Chapter 5.7.3), in particular the lifting beam for generator handling (stator and rotor) are part of Lot 1 Technology Provider scope.

5.2. ELECTRICAL EQUIPMENT

5.2.1. MOTOR-GENERATOR

Four identical indoors type vertical motor-generators are to be installed. Each shall be flange-connected and driven by a reversible hydraulic pump-turbine. Each shall have a minimum nominal output of **61 MW** when generating power under max water head and nominal speed of **333 RPM**.

5.2.1.1. Generator Rating Selection

Requirements for Generators (RfG) applying for Greek Transmission System Operator (TSO) should be respected, in particular for inertia and need of reactive power.

The criteria for sizing the output capacity of each generator shall be the maximum capacity, in turbine or pumping mode.

The generators shall be designed to carry this nominal capacity continuously at nominal voltage, frequency and power factor, without exceeding the temperature limit of Class B defined in the IEC 60085.

The equipment shall be mechanically designed to withstand continuously the maximum turbine output.

5.2.1.2. Motor-Generator Electrical Characteristics:

	Generator operation	Motor operation
Capacity at rated speed, frequency, voltage and power factor without exceeding maximum temperature rise, kVA	68 000	---
Motor max shaft output at rated speed, frequency, voltage and rated power factor without exceeding the maximum rated temperature rise, kW	---	60 470
Rated power factor	0.9	0.95
Rated frequency, Hz	50	
Rated voltage, volts	15 750	
Speed, rpm	333	
Nominal current, Amps	2493	2369
Unsaturated (rated current) direct axis transient reactance not greater than, percents	35%	
Short circuit ratio not less than:	0.9	
THD (Total harmonic Distortion) not greater than, percent	5% as per IEC 60034-1	
Deviation factor of wave form measured in percent for line-to-line on open circuit at rated voltage and frequency, not more than, percent	10% as per ANSI C50-12	
Efficiency at rated load, not less than, percent	98.40%	98.50%

Table 5-1: Motor-Generator Electrical Characteristics

5.2.1.3. Motor-Generator Mechanical Characteristics

	Generator operation	Motor operation
Moment of Inertia (GD^2) of rotating parts of the generator, ton-m2	1400	
Maximum runaway speed, rpm	585	---
Direction of rotation when viewed from excitation side:	Clockwise	Counter clockwise.
Means of starting	---	Static Frequency Converter

Table 5-2: Motor-Generator Mechanical Characteristics

5.2.1.4. Motor-Generator Cooling

The motor-generators shall be air-cooled, with a closed-loop cooling system and water-to-air coolers, located symmetrically around the periphery of the stator frame. The coolers shall be designed to withstand the high pressure of the cooling water system and N-1 redundancy operation. Cooling air will be circulated throughout the machine housing by the fan action of the rotor and/or the possible action of motor driven fans, supplied by frequency converter drives to optimize efficiency at partial load.

5.2.1.5. Temperature Rise

Temperature rise of the machine windings shall be rated to International Electro technical Commission (IEC) standards Class B insulation system as per IEC 60085 and 60034-1.

The motor-generators armature and field windings shall be rated for a maximum temperature rise of respectively 83K / 90K over a maximum ambient cooling temperature of 40^0C measured at the exit of the heat exchanger.

5.2.1.6. Other Pertinent Data

Stator windings shall be made with single-turn coils, with conductors transposed by the Roebel method and coils rigidly supported to prevent slippage. Windings shall be star-connected, for operation with high impedance grounded neutral.

A combined system of brakes and hydraulic lifting jacks shall be provided.

The upper thrust and guide bearing shall be insulated against shaft currents.

Electric heaters shall be mounted within the motor-generators air housing, to keep the insulation dry when not in operation.

A water-spray or inert gas fire protection system shall be provided inside each motor-generator housing.

5.2.1.7. Factory and Field Acceptance Tests

The motor-generator and excitation system capacity, factory and field test and other characteristics shall be specified in accordance with the latest International Electro technical Commission (IEC) Standards or any other international accepted standard.

5.2.2. EXCITATION SYSTEM

The excitation system shall be solid-state continuously acting rectifier-type, equipped with AC breaker located before the excitation system, and with DC field breaker located after the rectifier.

5.2.2.1. Ratings and Characteristics

The excitation systems shall be designed to provide negative excitation voltage and shall include provisions for initial excitation from the station battery and backup power from station service low voltage system. Accessories shall include non-linear field discharge resistors, an off-load polarity inverter feature and a solid-state voltage regulator. Excitation system shall be designed in a N-1 full redundancy.

- Excitation system voltage response time: not greater than 0.1 second.
- Excitation system voltage response ratio: not less than 2.5
- Excitation system minimum positive field forcing capability (ceiling voltage): 160 percents of rated field voltage at 130°C field winding temperature.

The excitation system shall be designed for automatic and manual control, and will be provided with a power system stabilizer, reactive current compensation and various limiter circuits.

The excitation system shall meet the requirements for line charging, from zero voltage to the rated voltage for the unit, transformer and transmission line, following the needs of local electrical grid as defined by TSO requirements.

5.2.3. STATIC FREQUENCY CONVERTER

5.2.3.1. Motor starting system

- The motor starting system shall be made of a soft starting method type using a **Static Frequency Converter** (SFC) – two (2) SFC to be provided for all four (4) units – as its primary starting method, and synchronous starting between units available as backup starting method (back-to-back operation: one unit in generating mode can be used to start any other unit in pumping mode – without SFC).
- Any of the two (2) SFC shall be able to start any one of the four (4) coupled motors/generators as a motor or as a synchronous condenser with its runner dewatered. The SFC shall accelerate the motor from zero to rated speed and shall automatically synchronize the motor to the power system.
- Any of the two (2) SFC shall be able to start two (2) units in sequence without delay between the motors, and without exceeding safe operating temperatures. The SFC should be able to restart this cycle within less than one hour.

- The two (2) SFC shall be capable of starting four (4) motors in sequence without delay between the motors, and without exceeding safe operating temperatures.
- The SFC shall be capable of providing automatic dynamic braking of any designated motor-generator from rated speed to zero both in generating and in motor mode. The SFC shall be able to stop the motor-generators in sequence without delay between the units and apply dynamic braking of the next motor-generator without exceeding safe operating temperatures.

In addition, the SFC will be able:

- To detect, when stopped, the position of the motor-generator rotor according to the measuring of the induced voltage of the stator without the need for a position encoder and producing a low-frequency torque in order to start the motor-generator in the pumping direction from zero speed, the runner being dewatered.
- To bring the speed of the motor-generator to a speed of 105% of the rated speed and to maintain this speed for a minimum duration of 30 minutes without exceeding safe operating temperatures.
- To precisely adjust the motor speed to a reference value between 95% and 105% of rated speed to enable fast synchronization. The oscillation of the speed around the reference value cannot exceed more than +-0.05% of the value of reference.
- To precisely adjust the motor-generator voltage to a reference voltage between 92.5% and 107.5% of rated voltage. Coordination with the excitation system will be made to ensure voltage stability.
- To provide dynamic regenerative braking in the directions of rotation of both generator and motor to produce a suitable braking torque in order to limit the braking times change of mode. Dynamic regenerative braking will be applied between 95% and 10% to 5% of rated speed.

5.2.3.2. Power supply

The SFC equipment shall be powered from a dedicated transformer supplied from the station medium voltage. If the SFC if operating at reduced voltage, it will require a step-up transformer and a by-bass switch at the SFC output on machine side.

5.2.3.3. Thyristors

The Thyristors used in the rectifier circuits shall be rated at a voltage to match the power supply voltage. Cooling of the Thyristors shall be by forced air or by water-to-air heat exchanger.

5.3. MAIN POWER TRANSFORMERS

Two (2) individual three-phase transformers shall be used for stepping up generator voltage from **15.75 kV** to the grid's **400 kV**, and for stepping down transmission system voltage for pumping operation from 400 kV to 15.75 kV. The transformers shall be oil-filled three windings with oil natural, air forced (ONAF) – OFAF to be quoted as an alternative. Each transformer shall be rated at **140 MVA** (indicative, to be confirmed by

Technology Provider) for 50 Hz. Operation, with expected minimum efficiency as per EU regulation (Tier-2). The transformers will be installed outdoors within the station perimeter, taking into account the ambient climatic conditions.

The transformer windings, including all specified taps, shall be capable of delivering the specified capacity without exceeding a 65°C winding average temperature rise or 80°C temperature rise over 30°C average ambient temperature. The transformers shall be able to deliver the specified capacities both in step-up and in step-down operation.

5.3.1. RATINGS

As a general rule, transformers ratings shall meet the TSO requirements. TSO needs shall overrule the following characteristics in case of conflict.

- Main Power Transformers:
  - Quantity, installed: 2
  - Capacity, MVA: 140/70/70 (indicative, to be confirmed)
  - Windings per phase: 3
  - Cooling: ONAF by default, and OFAF to be quoted as an alternative
  - Frequency, Hz.: 50
  - Phase angle displacement: High voltage, 30° ahead.

- High Voltage Windings:
  - Rated voltage, kV: 400/15.75/15.75
  - Switching impulse withstand voltage, kV: 1175 (*)
  - Lightning impulse withstand voltage, kV : 1425 (LI) / 1570 (LIC) (*)
  - Applied voltage or line terminal AC withstand, kV: 630 (*)
  - Connection: Star
  - OLTC (Number of taps to be confirmed by Technology Provider)
  - Uk $\geq$ 15%

(*) Values to be confirmed by TSO

- Low Voltage Windings:
  - Voltage, kV: 15.75
  - Short-time power-frequency withstand voltage, kV: 38
  - Lightning impulse withstand voltage, kV: 95
  - Connection: Delta

- Current Transformers
  - High voltage line-end, each Bushing:Star
  - Neutral end:Delta.

5.3.2. ACCESSORIES

5.3.2.1. Bushings

Bushings shall be of the condenser type with copper conductors. High voltage bushings shall be housed in individual oil-filled compartments separated from the main tank oil, adequate for terminations of the 400 kV cables.

5.3.2.2. Electrical Systems Cooling Equipment

For all air-forcing fans, required for operations at 46°C shall be supplied. The system shall be operated from a dual, redundant 400 Volt, 3-phase power source.

5.3.2.3. Oil Preservation System

System shall allow oil volume to expand and retract without contact with the atmosphere. The conservator tank shall be equipped with a rubber diaphragm, to isolate oil from the ambient air.

5.3.2.4. Secondary Windings Termination

Flanges shall be provided around the low-voltage bushings, which will allow for connection to the housings of isolated phase busses.

5.3.2.5. Fire Detection

Heat detectors shall be installed around the transformers, for fire detection. These detectors shall be fixed temperature devices, set to trip at 190°F (88°C).

5.3.2.6. Transportation and Placement

An approved carrier, specializing in handling this type of equipment, shall deliver transformers to the project site. A "low-loader" type of truck shall be used, to assure transformer stability and safety during transportation. During its transportation, the transformer shall be equipped with a shock recorder (including a long life battery) and shall be filled with nitrogen (including manometer and nitrogen bottle for filling in).

Transformer handling on site shall be done by the power crane, and by use of special rails provided for sliding them to their designated point. Anchor points suitable for pulling the transformers shall be provided.

A sump shall be installed around the transformers concrete foundations covered with steel grating, to allow for quick drain and collection of oil during spills.

A dedicated water/oil separator, connected to both transformers sumps, will be included in the Civil Work structure. Lot 1 Technology Provider shall provide the pumps and piping for the oil extraction. The oil collected will be pumped out for storage and recycling.

5.4. CONTROL SYSTEM

5.4.1. GENERAL

The power station shall be controlled by a Digital Control and monitoring System (DCS).

The DCS shall be microprocessor-based, distributed control and monitoring system consisting of the two following major levels, as described in the following chapters.

The complete architecture of DCS is described in Figure 2-5. Redundancy shall be included by default, especially for upper and lower reservoirs levels monitoring.

Note: the fibre optic communication line from power house to Upper Reservoir structure shall be included in **Lot 2 Infrastructures Contractor** scope, preferably installed together with the overhead line or cable. A redundant fibre optic line will be installed on one of the penstocks – also to be supplied by **Lot 2 Infrastructures Contractor**. Lot 1 Technology Provider shall supply characteristics for fibre optic lines.

5.4.2. LOCAL CONTROL LEVEL (LEVEL 1)

A set of Local Control Units (LCU) located at the powerhouse, to perform the primary interface and control functions between the plant operator and main station devices.

Each LCU shall be based on a redundant local PLC (redundancy of CPU, power supply, field network and communication cards) with one HMI and connected to the LAN for data exchange with the other LCU and the plant control system. The PLC will exchange signals with the redundant field by the mean of its own I/O modules or through remote I/O modules racks installed near the equipment in remote I/O rack cabinets or inside the cubicle of the different element. The remote I/O modules will interface the signal from the fields with the redundant field bus of the PLC.

The excitation system, the unit protection system, the turbine governor, the measuring system and other control and protecting devices which have independent control system shall preferably interface with the LCU directly via field bus for detailed data and hardwired connections for the main data (loss of the field-bus shall not interrupt operation)

In all cases, interfaces between Plant’s control system and Package control systems (supplied by mechanical system providers) shall be included in the scope of supply.

The interface between level 1 and upper levels (as level 2) is granted through a Dual high-speed real-time network consisting of fibre optic cable. It shall be used to interconnect between the operator consoles and each main station device, and between the main elements of the DCS.

5.4.3. CONTROL ROOM LEVEL (LEVEL 2)

The control room will be located inside the powerhouse, and contain the following major equipment:

- Two (2) redundant servers
- Multiple operator workstations (WS) for centralized operation and monitoring of the project. The WS's shall provide the following:
  - Operator interface to access and initiate control sequences;

- Access to controls, display status and alarms in a coherent logical manner;
- Access to the system's real-time data base;
- Operator configurable trending capability for all I/O points.

Each of the WS's shall also include:

- Processing and communication units to connect the human-machine interface to the DCS and all DPU real time data;
- Two (2) high resolution color video display terminals (VDT), one keyboard, one track-ball and audible alarm device;

- Two (2) hard copy printers – one for alarms and one for periodic logs, station and shift reports.
- One (1) large video display, showing major project status and alarm points.
- One (1) programmer/engineer workstation, consisting of a monitor, keyboard and printer, will be used to access the DCS system for analysis, diagnostics, and program changes. In addition, two laptops will be included for local maintenance of the Control System devices.
- One (1) Synchronization Clock system shall be provided to ensure a common time reference for all programmable control systems like DCS/PCS system equipment, all other PLCs of the plant, protection systems, station utilities, etc. to ensure a common time reference.
- Two (1) redundant data storage workstations (HISTORIAN) to perform historical data base recording, trending and performance calculations shall be provided.
- Two (2) gateways for powerplant external communication with the National Grid Operator shall be provided. The communication shall be realised through protocol IEC 60870-5-101. Signal interface (according to IPTO’s requirements) and the adequate equipment shall be provided for the 400kV Substation interconnection (the terminal point shall be an RTU installed in the substation communication room).

5.4.4. CONDITION MONITORING SYSTEM

At the local control level, closed and interfaced with the control system, a microcomputer system shall be provided for performance calculations (e.g. unit efficiency, reservoir management, etc.) and/or for data collection and interface with the plant information system.

Data processing system and tools will be supplied to execute performance calculations, condition monitoring and process optimization. Adequate equipment and software shall be provided for data acquisition of all process variables related to efficiency calculations, performance, process optimization and condition monitoring. A Computerized Maintenance Management System (CMMS) including a predictive maintenance tool shall be supplied as well, and the Lot 1 Contractor will update and fill all the data information and forms to the CMMS.

5.5. BUSES, SWITCHGEAR AND AUXILIARY BUSES

5.5.1. GENERATOR CIRCUIT BREAKER

Each motor-generating unit will be equipped with its own 15.75 kV circuit breaker with all related equipment (e.g. CTs, VTs, disconnector switches and earthing switches). Circuit breakers will be connected to the bus duct assemblies.

The generator circuit breaker will be of Vacuum or SF6 type and it has to fulfil the requirements according to IEEE (ANSI) C37.013 and IEC 62271 standards.

The disconnector and earthing switches will be provided.

The generator circuit breaker will be equipped with the short circuit provision for electrical testing purposes.

The proposed generator circuit breaker and its related system shall be the standard product of a competent manufacturer with proven high reliability and long-term operation records.

5.5.2. BUS DUCTS ASSEMBLIES

The 15.75 kV isolated-phase bus ducts (IPB) provides electrical connections to the motor-generators, circuit breakers, phase reversal switches, main transformer MV terminals, and current-limiting reactors.

Non-segregated phase bus will be used for the motor-generator starting circuit, for auxiliary busses used for metal-clad switchgear feeders and the excitation system AC and DC interconnections.

The busducts and switches to interconnect the units for back to back starting shall be also provided.

Note: The base scope of **Lot 1** includes only the IPB between the generator and the main transformer. The non-segregated phase auxiliary busses for the motor-generator starting circuit, the auxiliary busses for metal-clad switchgear feeders, the excitation system AC/DC interconnections, and the busducts and switches for back-to-back starting are not part of the IPB scope (Table 2-1, item 4.11), but are included under the Medium Voltage AC System (Table 2-1, item 5.1), as optional scope.

5.5.3. MAIN LEADS

The main leads of each motor-generator shall be an isolated-phase bus, rated at 15.75kV, 3,000 Amperes. An electrically continuous housing shall be used, to minimize magnetic flux resulting from the currents on each phase. Each bus shall consist of the following:

- Main isolated phase bus, to be connected to the low voltage bushings of the main power transformers.
- Isolated-phase taps from the main leads of each unit to the surge protection and potential transformer cubicle.
- Five-pole, motor-operated phase reversal switch for changing bus phasing when switching between generating and pumping modes.

- Disconnecting link and bus conductor test terminals installed in the main bus runs, between the motor-generator and the phase reversal switch.
- Three-pole, motor operated disconnecting switch for isolating the motor-generator and its excitation system during periods of inspection and maintenance.

5.5.4. STARTING BUS

The starting bus assemblies shall consist of isolated-phase bus sections, rated at 15.75 kV, running from the main leads of each unit to the starting circuit breaker, and non-segregated bus sections, also rated at 15.75 kV, connecting the SFC to each group of motor-generator starting circuit breakers. Each group shall consist of two units (e.g., units 1-2 and units 3-4). The schematic shall be designed so that either of the two SFC is capable of starting any unit (two (2) SFC for all four (4) units).

Similarly any unit shall be able to start any other unit in back to back mode.

5.5.5. NON-SEGREGATED PHASE AUXILIARY BUSSES

Non-segregated phase bus assemblies, rated at 15.75 kV, self-cooled, will connect the station service transformer 15.75 kV terminals to the SFC.

Non-segregated phase bus assemblies, rated, self-cooled, to connect the station service 15.75/0.4 kV transformer low voltage terminals to the main station switchboard.

5.6. GENERAL ELECTRICAL EQUIPMENT

5.6.1. VOLTAGE LEVELS

AC frequency is 50 Hz.

Voltage Level	Nominal Value
HV-AC: High voltage level	400 kV three phases
MV-AC: Medium voltage level (stator voltage)	15.75 kV three phases
MV-AC: Medium voltage level (inter sites links)	15.75 kV three phases
LV-AC: Low voltage level	400 V three phases
DC: voltage level (power and control)	220 V

Table 5-3: Voltage levels

For creepage distances, environment pollution level (according to IEC): Level IV (very heavy) corresponding to specific creepage distance of 31 mm/kV has to be considered.

5.6.2. EARTHING AND LIGHTNING PROTECTION

Lot 1 Technology Provider will be responsible for the design of the whole earthing system including lightning protection for the powerhouse building. Lot 1 Technology Provider will be responsible also of the delivery of the earthing connections for equipment.

Lot 1 Technology Provider shall evaluate design requirements, prepare detailed designs, and coordinate with civil works, providing Lot 2 Infrastructures Contractor with sizing, design details and installation guidelines. Lot 1 Technology Provider shall also supply materials, supervise installation, conduct testing, and oversee any necessary improvements.

- Earthing system shall be provided for all equipment supplied by Lot 1 Technology Provider, including the cable trays, piping networks, motors and transformers, etc. (to be included in current quotation for Lot 1).
- Lightning protection systems of civil structures and buildings are supplied by Lot 1 Technology Provider and installed by Lot 2 Infrastructures Contractor.
- Earthing and Lightning Protection Systems which is buried (in soil) or embedded (in concrete) is supplied by Lot 1 Technology Provider and installed by Lot 2 Infrastructures Contractor.

All metal works shall be earthed. All electrical equipment shall be connected through its own terminal to the earthing bus-bar in the switchboard by a continuous copper conductor within its appropriate cable or by copper conduit.

All metallic cases of instruments, control switches, relays, etc. shall be connected by means of bare copper conductors of not less than 2.5mm2, to the nearest earth bar.

The cables shielding shall be earthed in the same manner, to both ends of the cables.

Earth leakage circuit breaker (ELCB) shall be installed on the switchboards. The ELCB shall be connected by an insulated lead to a completely separate copper earthing rod.

The metal handrails and fences in front of transformers shall be electrically continuous and grounded at each corner. The metal gates shall be grounded by means of flexible copper conductors (Lot 2 Infrastructures Contractor).

The earthing system shall include the in-air above ground system (designed by Lot 1, procurement and installation by Lot 1 and Lot 2 – each lot responsible for his own supply), the underground and the in-structure earthing systems (designed and procurement by Lot 1, installed by Lot 2).

5.6.3. 15.75 KV MV SWITCHGEARS

The 15.75 kV switchgears will be provided to supply Station Service Transformers, SFCs and the intake. The switchgears will be equipped with current transformers (CT), voltage transformers (VT), protection modules, communication, earthing, as well as withdrawable vacuum or SF6 circuit breakers. The MV switchgears will be of modular type.

5.6.4. PHASE REVERSAL SWITCH

The 15.75 kV Phase Reversal Switch will be provided for each unit to reverse the motor phase sequence, enabling the pump motor to operate in both pumping (motor mode) and generating (turbine mode) configurations. The Phase Reversal Switch will ensure safe and reliable operation of the pump motors in both modes, with local and remote-control options, as well as visual status indicators for phase condition monitoring.

5.6.5. CURRENT LIMITING REACTORS

The Current Limiting Reactors will be provided for each unit group to limit inrush current during the startup of motors and to provide current limitation during fault conditions. These reactors will improve the stability of the electrical system and help protect equipment from overcurrent conditions.

5.6.6. LV AC/DC SWITCHGEAR

Under normal conditions the 400 V AC main distribution board of the PHS will be fed from one of the two (2) 1250 kVA (preliminary values), 15.75 / 0.4 kV station service transformers. The station service transformer 1 shall be fed from the group 1 (Unit-1-2) and the second station transformer shall be fed from the group 2 (Unit-3-4).

An Automatic Transfer Switch (ATS) shall be provided for the 400 V AC main distribution switchboard to ensure minimum interruption of the power supply during the failure of the any power sources/groups. ATS system will analyze and monitor both sources, ATS system shall have function to select primary and secondary source between two station service transformers and in case of failure of both of SS transformers emergency diesel generator shall be launched. ATS system shall normalize the condition after detecting, that one of the station service transformers is again energized.

Station service transformer circuit breakers located in the 400 V AC main distribution switchboard shall be electromechanically interlocked with each other in order to avoid parallel operation.

In case of a complete power failure the station service and unit auxiliary consumers will be supplied from the automatically starting 600 kVA (preliminary value), 0.4 kV emergency diesel generator set which will be connected to 400 V AC sub-distribution switchboard.

Emergency diesel generator circuit breakers will be electromechanically interlocked with the station service transformer circuit breakers in order to avoid the parallel operation of the DG with the SS transformers.

5.6.7. BATTERY SYSTEM

The 220 V DC system which shall provide power for the protection system, the control equipment, the switchgear control and for the emergency lighting within the power house, shall comprise of two twin rectifiers, two lead-acid batteries, a main distribution board with two bus sections and bus tie-breaker, one sub-distribution boards as required. The run time for the batteries shall be ten (10) hours.

If 48 V DC supply is required for the PLC-type control systems or the communication systems, including fibre-optic communication systems and telephone system, corresponding DC/DC converters will be connected to the 220 V DC supply.

5.6.8. UPS SYSTEM

The UPS system consisting of two static converters connected to the 400 V AC system, each with its own battery system, and a 230 VAC distribution board to serve essential consumers of the control system, such as PC’s, monitors and printers.

5.6.9. CABLES, CONDUITS, DUCTS, CABLE TRAYS

All the required medium voltage cables, AC/DC power cables, control cables, instrumentation cable, fibre-optic cables conduits ducts and cable trays required for all the PHS systems shall be provided.

5.6.10. EMERGENCY DIESEL GENERATORS

Powerhouse

An emergency diesel generating set with approximate capacity of 600 kVA, 0.4 kV shall provide emergency power to essential station services in the event of a loss of station service power and shall supply black start power to the 400 V AC system. The indoor-type diesel generator shall automatically start (battery starting) upon detection of a loss of voltage from the normal power supply to the switchgear assemblies, accelerate, and operate at the maximum anticipated emergency load, without exceeding a maximum transient voltage drop of 20%, as measured at the generator terminals.

The diesel-generator shall be sized based on the largest of the following load conditions:

- All normal station auxiliaries operating;
- All essential station auxiliaries operating, plus flood prevention loads;
- All essential station auxiliaries plus unit auxiliaries needed to start one main unit in generating mode.

The diesel electric generating unit shall be completely self-contained, designed for indoors service, with engine, generator, and all auxiliaries mounted on a common base, except for the main fuel tank, fuel oil day tank, exhaust silencer, control panel and remote mounted radiator. The main fuel tank shall have a capacity sufficient for 96 hours of continuous operation at full load. The tank shall be of the double wall construction, with an alarm for leakage occurring from the primary to the secondary containment.

Upper reservoir

Another emergency diesel-generating set with approximate capacity of 200 kVA, 0.4 kV shall provide emergency power to upper reservoir consumers in the event in case of failure of the supply from the medium voltage (MV) overhead line or cable. The indoors-type diesel generator shall start automatically upon a loss of voltage from the normal power supply to the switchgear assemblies, accelerate and operate at the maximum anticipated emergency load, without exceeding a maximum transient voltage drop of 20% as measured at the generator terminals.

The diesel-generator shall be sized based on the largest of the load condition. The diesel electric generating unit shall be completely self-contained, designed for indoors service, with engine, generator, and all auxiliaries mounted on a common base, except for the main fuel tank, fuel oil day tank, exhaust silencer, control panel and remote mounted radiator. The main fuel tank shall have a capacity sufficient for 24 hours of continuous operation at full load.

Both above mentioned diesel-generators will be included in the relevant optional price of the Lot 1.

5.6.11. INTAKE SUPPLY (UPPER RESERVOIR SIDE)

The power supply at the Upper Reservoir structure shall consist of a **step-down auxiliary transformer** with an initially estimated capacity of 200 kVA, connected to the powerhouse 15.75 kV medium voltage (MV) switchgear via an overhead line or cable (MV line part of Lot 2 Infrastructures Contractor scope). Power supply at the Upper Reservoir structure shall also include a 400 V AC sub-distribution switchboard, a 220 V DC system with charger and battery (the run time for the batteries shall be ten (10) hours), and a diesel generator set (as described above) for emergency power supply.

The equipment shall be located in the control and service building at the Upper Reservoir structure.

If 48 V DC supply is required, corresponding DC/DC converters will be connected to the 220 V DC supply.

The above mentioned transformer and other electrical components will be included in the relevant optional price of Lot 1 Technology Provider.

Lot 1 Contractor shall supply characteristics for overhead line or cable, and for Control System fibre optic lines.

Note: the fibre optic communication line shall be included in the **Lot 2 scope**, preferably installed together with the overhead line or cable, connecting intake with powerhouse. A redundant fibre optic line will be installed on one of the penstocks – also to be supplied by **Lot 2 Infrastructures Contractor**.

5.7. MISCELLANEOUS

5.7.1. MECHANICAL AND ELECTRICAL WORKSHOP EQUIPMENT

A fully equipped workshop shall be provided in order to enable to carry out on site maintenance and minor repair jobs on the mechanical, electromechanical, electrical, control and instrumentation equipment.

Mechanical and Electrical Workshop is part of Lot 2 Infrastructures Contractor. Lot 1 Technology Provider, will provide any specific requirements for his equipment.

5.7.2. SPARE PARTS

Scope of supply shall include the supply of mechanical and electrical systems spare parts required for a 2-years continuous operation. Lot 1 Technology Provider will supply all the spare parts he deems necessary to be able to achieve the availability guarantee. Any spare parts used during the Defects Notification Period will be replaced by Lot 1 Technology Provider.

Spare parts balance of quantities shall be shared with Lot 2 Contractor soon enough to integrate relevant storage areas in the overall power plant layout.

5.7.3. SPECIAL TOOLS

Special tools required for first assembly as well as for maintenance shall be provided.

Permanent special tools balance of quantities shall be shared with Lot 2 Contractor soon enough to integrate relevant storage areas in the overall power plant layout.

5.7.4. DOCUMENTATION

The cost shall include quotation for later supply of:

- A list of the applicable standards and their applications.

- A complete set of documentation for the plant, including (but not limited to) all equipment specifications and calculations, manuals of operation, maintenance manuals, list of recommended spare parts, safety instructions.
- A complete set of drawings, including process and mechanical flow charts, as-built drawings, parts drawings, foundations and load drawings. Permanent special tools drawings (linked to any short or long term maintenance) shall be included.

All documentation shall be provided in hard copies and electronic media.

5.7.5. TECHNICAL INTERFACES BETWEEN LOTS

The cost shall include quotation for later supply of all necessary information to cover the technical interfaces between lots, such as (not limited to):

- Design of the powerhouse including loads applied due to equipment's own weight and dynamic forces rising from operation and the different stages of concreting
- Layout guide drawings
- Civil works guide drawings
- Civil works Loads
- HVAC interface data
- Control system & protection interface data
- Electrical loads
- Reservations in CW for instrumentation on penstock (water levels and head losses for hydraulic measures)

5.7.6. ERECTION, COMMISSIONING AND TRAINING

The cost shall include quotation for the needed manpower for preparation (including general design), execution and supervision of:

- Equipment transportation and erection
- Commissioning and Trial run (15 days of uninterrupted Trial Operation)
- Continuous hands-on training during the trial operation
- Class and hands-on training as follows:
  - Training of Operators and Managers (2 weeks) that will include detailed explanation of the HMI interface, the main control system (DCS/PCS), the Condition Monitoring System as well as all measuring and control equipment (package units, measuring instruments, analysers, etc).
  - One (1) week training on the operation and maintenance of the reversible pump turbine, main inlet valve and auxiliary systems (SFC, turbine governor system, hydraulic power units)
  - One (1) week training on the operation and maintenance of the motor generator and auxiliary systems (bearing oil system, excitation …)
  - One (1) week training on the operation and maintenance of the remaining mechanical and electrical equipment

5.7.7. FIELD TESTING

The cost shall include the quotation for the needed manpower and equipment for preparation, execution and supervision of one (1) field performance testing on one unit.

This field testing shall take place after the last unit being commissioned, to have a better flexibility using all units to change head conditions. An indicative timeline for the field test is proposed as follows:

- Instrumentation at site: 5 days
- Testing of instrumentation and calibration: 1 day
- Performance measurement in generation mode: 1 day
- Performance measurement in pumping mode: 1 day

The above durations are the minimum requirement. The cost shall include sufficient field testing to fulfill all the obligations arising from the Contract.

Field testing shall evaluate all guaranteed performance values as per IEC 60041:1991 standard. Thermodynamic method is to be quoted by default, other methods can be quoted as alternatives. A report presenting measured values vs guarantees shall be delivered to the Owner.

5.7.8. GUARANTEES

The cost shall take into consideration that:

- Tenderer shall provide an unconditional guarantee (2-years Defects Notification Period - DNP) for the safe and efficient operation of the plant for a period of two years after commissioning.
- Tenderer shall provide written guarantees for the following on acceptance tests, with potential application of liquidated damages:
  - Efficiencies *(WAE Turbine, WAE Pump, Generator max efficiency, Motor max efficiency, Transformer efficiency)*;
- Tenderer shall provide written guarantees, with methods of measurements and required means for rectifying the situation, for the following on acceptance tests:
  - Power output in generation mode;
  - Cavitation pitting (allowed loss of mass and pitting depth);
  - Transition times for mode change;
  - Noise and vibrations;

Note: for the good comparison between Tenderers, the Pump-Turbine and Motor-Generator efficiencies are to be given considering the indications in Table 5-4 regarding distribution of mechanical losses. During execution, hydraulic efficiency will be checked during the reduced scale model testing, and a combined hydraulic / mechanical / electrical efficiency will be checked during the field testing. WAE formulae will then combine Pump-Turbine and Motor-Generator efficiencies.

No	Name	Guaranteed Value
1	Turbine Weighted Average Efficiency (on shaft[1])	Min 91.00%
2	Pump Weighted Average Efficiency (on shaft[1])	Min 92.50%
3	Turbine mechanical output under 122m net head (on shaft[1])	Min 62 MW
4	Turbine mechanical output under 115m net head (on shaft[1])	Min 56 MW
5	Pump mechanical input under max head (on shaft[1])	Min 55.7 MW
6	Turbine mode minimum stable operation output ratio	Min 50%
7	Motor efficiency, pump mode, under min head (mechanical losses included[2])	Min 98.50%
8	Generator efficiency, turbine mode at 100% max output (mechanical losses included[2])	Min 98.40%
9	Generator efficiency, turbine mode at 50% max output (mechanical losses included[2])	Min 97.5%
10	Main power transformer min efficiency	Tier-2
11	Cavitation Pitting depth per runner (function of runner low pressure diameter D)	Max $2.5*D^{0.4}$ mm
12	Cavitation Pitting volume per runner (function of runner low pressure diameter D)	Max $5*D^2$ cm^3
13	Standstill to Generating (100%) transition time	Max 100 sec
14	Standstill to Pumping transition time	Max 350 sec

(1) Pump-Turbine guide bearing losses included. Net head including the MIV losses.

(2) Motor-Generator guide and thrust bearings losses included (for thrust bearing, the whole shaft line weight and hydraulic thrust are to be considered in motor-generator efficiency)

Table 5-4: Items with guaranteed values

APPENDIX A. WATER QUALITY ANALYSIS

APPENDIX B. SOUTH FIELD POWERHOUSE PRELIMINARY LAYOUT DRAWINGS

APPENDIX C. GTS (GENERAL TECHNICAL SPECIFICATIONS)

APPENDIX D. SEISMIC HAZARD ANALYSIS

APPENDIX E. LOGISTIC STUDY

APPENDIX F. GEOTECHNICAL INTERPRETATIVE REPORT

At the helm of the Energy Transition, Tractebel provides a full range of engineering and consulting services throughout the life cycle of its clients' projects, including design and project management. As one of the world's largest engineering consultancy companies and with more than 150 years of experience, it's our mission to actively shape the world of tomorrow. With about 5,000 experts and offices in 33 countries, we are able to offer our customers multidisciplinary solutions in energy, water and urban.

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sampling water at the rejection point

PARAMETERS in 2024	UNITS	Neos Komvos				E7				E4				TS6			
		value				value				value				value			
		A quarter 2024	B quarter 2024	C quarter 2024	D quarter 2024	A quarter 2024	B quarter 2024	C quarter 2024	D quarter 2024	A quarter 2024	B quarter 2024	C quarter 2024	D quarter 2024	A quarter 2024	B quarter 2024	C quarter 2024	D quarter 2024
Temperature		14	26	23,8	10,4					13,5	23,7	20,4	10,6	15	25,9	23,9	11,5
pH		8,05	8,2	7,87	7,97					7,78	7,63	7,78	7,82	7,96	8	8,11	7,82
Conductivity	μs/cm	556	856	889	772					495	460	591	1141	1189	1181	1229	1207
Total Hardness of $CaCO_3$	ppm	1080	512	570	540					300	240	360	650	752	750	880	760
Chloride ions Cl^-	mg/l	7,184		7,45	5,99					14,019		24,08	19,50	8,083		7,32	6,38
Sulphate SO_4^{--}	mg/l	505,39		368,6	1099,3					262,12		104,15	1540,7	254,31		589	2087,8
Ammonium NH^+_4	mg/l	0,045		0,123	0,104					0,089		0,067	1,002	0,146		0,127	1,059
Nitrates **NO**$_3^-$	mg/l	14,6		6,92	0,15					6,6		1,86	0,20	18,9		9,76	0,25
Nitrites **NO**$_2^-$	mg/l	0,022		0,17	0,10					0,12		0,09	0,27	0,1351		0,25	0,18
Silicates SiO_2	mg/l	100,5		12,5	11,5					7,4		17,6	25,5	19,5		15,6	13,7
Phosphorus total (P)	mg/l	0,11		<0.0057	35,69					0,05		0,09	32,848	0,025		<0.0057	28,385
Calcium Ca^{++}	mg/l	370		134	111,51					80,1		80,22	165,67	124		228,47	207,30
Magnesium Mg^{++}	mg/l	38,85		93,02	70,41					44,2		60,94	53,56	97,9		95,06	95,60
Iron (Fe)	mg/l	0,017		<0.010	0,109					0,011		<0.010	0,055	0,011		<0.010	0,266
Total Dissolved Solids (TDS)	mg/l	333	556	577,9	463,2					297	276	354,6	798,7	832	827	860,3	844,9
Consumption $KMnO_4$	mg/l	1,86		1,72	1,66					0		0,23	1,53	1,52		1,49	1,67
Total suspended solids (TSS)	mg/l	2,8	1,8	3	12					1,2	2,7	2	2	5,1	1,3	3	30
Sodium Na^+	mg/l	5,6		11,10	6,42					10,2		11,82	10,26	7,1		11,84	6,72
Potassium K^+	mg/l	2,1		2,36	2,52					4,1		0,89	1,70	6,9		3,45	2,93
Manganese (Mn)	mg/l	0,008		0,06	0,09					0,013		0,13	0,11	0,03		0,12	0,17
Total Nitrogen		3,34		1,8	<0.5					1,6		0,4	<0.5	4,42		2,4	<0.5

sampling water at the rejection point

NEOS KOMVOS

		MONTH IN YEAR 2024											
PARAMETER	UNIT	1	2	3	4	5	6	7	8	9	10	11	12
Lead (Pb)	μg/l	0,405	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0.1	0,108	<0.1	<0.1
Nickel (Ni)	μg/l	2,67	2,94	3,64	11,9	3,04	11,9	10,1	7,14	13,6	17,3	20,1	10,4
Cadmium (Cd)	μg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0.1	<0.1	<0.1	<0.1
Mercury (Hg)	μg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,05	<0,05	<0,05	<0.05	<0.05	<0.05	<0.05
Zinc (Zn)	μg/l	5,26	7,55	<5	6,66	6,05	<5	<5	<5	<5	5,65	<5	5,05
Chromium (Cr)	μg/l	11,7	15,57	15,8	5,01	1,86	2,94	2,46	2,89	1,66	2,03	4,15	7,95
Vanadium (V)	μg/l	4,77	5,24	5,68	3,5	2,03	3,91	4,01	3,97	3,37	3,97	3,94	4,82
Copper (Cu)	μg/l	<5,5	<5,5	<5,5	<5,5	<5,5	1,03	<1	<1	<1	<1	<1	<1
Arsenicum (As)	μg/l	1,22	1,39	1,36	1,6	1,05	2,28	2,48	2,58	2,84	2,31	2,05	1,90
Argentum (Ag)	μg/l	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Barium (Ba)	μg/l			25,3			37,6			41,2			33,2
Boron (B)	μg/l			<50			69,7			86,8			54,1
Selenium (Se)	μg/l			1,1			3,07			1,52			11,3
pH	pH units	8,17	8,08	8,05	8,13	8,25	8,2	8,54	8,49	7,87	8,01	7,93	7,97
Conductivity	μs/cm	551	529	556	837	834	856	792	716	889	961	964	772
Total Hardness of $CaCO_3$	mg/l			1080	950	972	512	476	226	570	714	660	540
Total Dissolved Solids (TDS)	mg/l	331	317	333	544	542	556	475	430	577,9	625	627	463,2
Total suspended solids (TSS)	mg/l	7,1	2,1	2,8	2,1	1,7	1,8	11	4	3	2	7	12

E7

		MONTH IN YEAR 2024											
PARAMETER	UNIT	1	2	3	4	5	6	7	8	9	10	11	12
Lead (Pb)	μg/l	<0,1											
Nickel (Ni)	μg/l	14,9											
Cadmium (Cd)	μg/l	<0,1											
Mercury (Hg)	μg/l	<0,1	Εκτος	Εκτος	Εκτος								
Zinc (Zn)	μg/l	<5	λειτουργίας	λειτουργίας	λειτουργίας								
Chromium (Cr)	μg/l	4,5				Αναπέταση							
Vanadium (V)	μg/l	2,43											
Copper (Cu)	μg/l	<5,5											
Arsenicum (As)	μg/l	1,51											
Argentum (Ag)	μg/l	<20											
Barium (Ba)	μg/l												
Boron (B)	μg/l												
Selenium (Se)	μg/l												
pH	pH units	8,05											
Conductivity	μs/cm	751											
Total Hardness of $CaCO_3$	mg/l												
Total Dissolved Solids (TDS)	mg/l	451											
Total suspended solids (TSS)	mg/l	3,1											

E4

		MONTH IN YEAR 2024											
PARAMETER	UNIT	1	2	3	4	5	6	7	8	9	10	11	12
Lead (Pb)	μg/l	<0,1	<0,1	<0,1	<0,1	<0,1	0,103	<0,1	0,101	<0.1	0,138	0,142	0,171
Nickel (Ni)	μg/l	6,49	6,34	6,43	5,67	5,85	5,74	5,09	5,76	4,70	6,02	8,62	13,1
Cadmium (Cd)	μg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0.1	<0.1	<0.1	<0.1
Mercury (Hg)	μg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,05	<0,05	<0,05	<0.05	<0.05	<0.05	<0.05
Zinc (Zn)	μg/l	6,66	5,95	<5	<5	<5	<5	6,21	<5	<5	<5	<5	<5
Chromium (Cr)	μg/l	9,71	4,83	4,33	3,37	2,87	2,42	1,17	1,18	<1	3,87	4,74	9,85
Vanadium (V)	μg/l	3,37	2,54	3,36	3,56	3,77	3,23	3,06	3,04	1,86	2,86	2,32	3,74
Copper (Cu)	μg/l	<5,5	<5,5	<5,5	<5,5	<5,5	<1	<1	1,07	<1	<1	<1	1,07
Arsenicum (As)	μg/l	1,09	1,4	1,55	1,57	1,61	2,18	2,16	1,90	1,51	1,59	1,25	2,05
Argentum (Ag)	μg/l	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Barium (Ba)	μg/l			44,3			48,1			46,7			67,2
Boron (B)	μg/l			<50			<50			<50			<50
Selenium (Se)	μg/l			3,06			1,72			<1			10,7
pH	pH units	7,92	7,95	7,78	7,75	7,75	7,63	7,63	7,53	7,78	7,6	7,58	7,82
Conductivity	μs/cm	795	601	495	480	480	460	472	475	591	490	519	1141
Total Hardness of $CaCO_3$	mg/l			300	300	310	240	268	136	360	370	334	650
Total Dissolved Solids (TDS)	mg/l	477	361	297	287	287	276	283	285	354,6	294	311	798,7
Total suspended solids (TSS)	mg/l	8,4	2,3	1,2	1	0,4	2,7	13	2	2	<2	3	2

TS6

		MONTH IN YEAR 2024											
PARAMETER	UNIT	1	2	3	4	5	6	7	8	9	10	11	12
Lead (Pb)	μg/l	<0,1	<0,1	<0,1	<0,1	<0,1	0,132	<0,1	<0,1	<0.1	<0.1	0,149	0,186
Nickel (Ni)	μg/l	7,12	7,99	6,29	6,36	5,66	6,56	7,09	6,47	7,67	8,88	9,30	9,46
Cadmium (Cd)	μg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0.1	<0.1	<0.1	<0.1
Mercury (Hg)	μg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,05	<0,05	<0,05	<0.05	<0.05	<0.05	<0.05
Zinc (Zn)	μg/l	<5	7,82	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Chromium (Cr)	μg/l	2,06	2,71	2,92	2,8	2,7	2,59	1,91	1,73	1,47	1,33	1,65	4,65
Vanadium (V)	μg/l	3,23	3,05	3,43	2,46	3,69	4,17	4,21	5,53	4,09	4,04	3,64	5,22
Copper (Cu)	μg/l	<5,5	<5,5	<5,5	<5,5	<5,5	<1	<1	<1	<1	<1	<1	1,33
Arsenicum (As)	μg/l	1	1,05	1	0,828	1,11	1,22	1,31	1,52	1,40	1,38	1,26	2,35
Argentum (Ag)	μg/l	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Barium (Ba)	μg/l			34,1			40,7			40,8			54,4
Boron (B)	μg/l			198			189			206			334
Selenium (Se)	μg/l			4,82			3,21			1,19			11,8
pH	pH units	7,99	7,97	7,96	8,02	8,04	8	8,32	8,08	8,11	8,11	8,03	7,82
Conductivity	ms/cm	1360	1305	1189	1200	1173	1181	1191	1200	1229	1286	1237	1207
Total Hardness of $CaCO_3$	μg/l			752	732	725	750	790	420	880	840	780	760
Total Dissolved Solids (TDS)	mg/l	952	914	832	841	821	827	834	840	860,3	900	857	844,9
Total suspended solids (TSS)	mg/l	5,6	5,5	5,1	2,2	1,6	1,3	31	3	3	<2	21	30

sampling water at the rejection point

2024

NEOS KOMVOS

PARAMETER	UNIT	1	2	3	4	5	6	7	8	9	10	11	12
Iron (Fe)	μg/l	43,7	74,5	115	71	34,8	21,6	12,3	9,86	27,5	37,3	93,3	85,2
Manganese (Mn)	μg/l	6,9	7,98	10,9	30,6	23,5	6,01	2,51	3,45	10,8	25,4	81,6	21,1
Aluminium (Al)	μg/l	76,4	125	166	98,4	51	32,9	31,2	16,2	34,1	40,0	96,8	78,8
Barium (Ba)	μg/l	24,3	22,4		36,9	32,8		37,2	31,6		44,5	44,1	
Selenium (Se)	μg/l	1,01	1,06		3,05	2,9		2,52	1,48		1,64	1,64	
Strontium (Sr)	μg/l	208	200	215	309	322	340	347	322	388	419	413	346
Phosphorus total (P)	μg/l	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Molybdenum (Mo)	μg/l	2,63	2,3	3,18	5,79	6,73	7,72	7,96	6,59	6,87	6,67	5,54	8,44
Cobalt (Co)	μg/l	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Antimony (Sb)	μg/l	0,191	0,27	0,283	0,442	0,475	0,582	0,713	<0,1	<0.1	0,424	<1	<1
Tin (Sn)	μg/l	<0,6	<0,6	<0,6	<0,6	<0,6	<0,6	<0,6	<0,6	<0.6	<0.6	<0.6	<0.6
Thallium (Tl)	μg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<1	<1	<1	<1	<1	<1	<1
Bismuth (Bi)	μg/l	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Virillion (Be)	μg/l	<0,98	<0,98	<0,98	<0,98	<0,98	<1	<1	<1	<1	<1	<1	<1
Boron (B)	μg/l	<50	<50		57,7	64,8		70,2	<20		78,5	86,3	

E7

PARAMETER	UNIT	1	2	3	4	5	6	7	8	9	10	11	12
Iron (Fe)	μg/l	31,8											
Manganese (Mn)	μg/l	40,8											
Aluminium (Al)	μg/l	28,6											
Barium (Ba)	μg/l	31,1											
Selenium (Se)	μg/l	3,52											
Strontium (Sr)	μg/l	317											
Phosphorus total (P)	μg/l	<50											
Molybdenum (Mo)	μg/l	5,61											
Cobalt (Co)	μg/l	<1											
Antimony (Sb)	μg/l	0,434											
Tin (Sn)	μg/l	<0,6											
Thallium (Tl)	μg/l	<0,1											
Bismuth (Bi)	μg/l	<20											
Virillion (Be)	μg/l	<0,98											
Boron (B)	μg/l	<50											

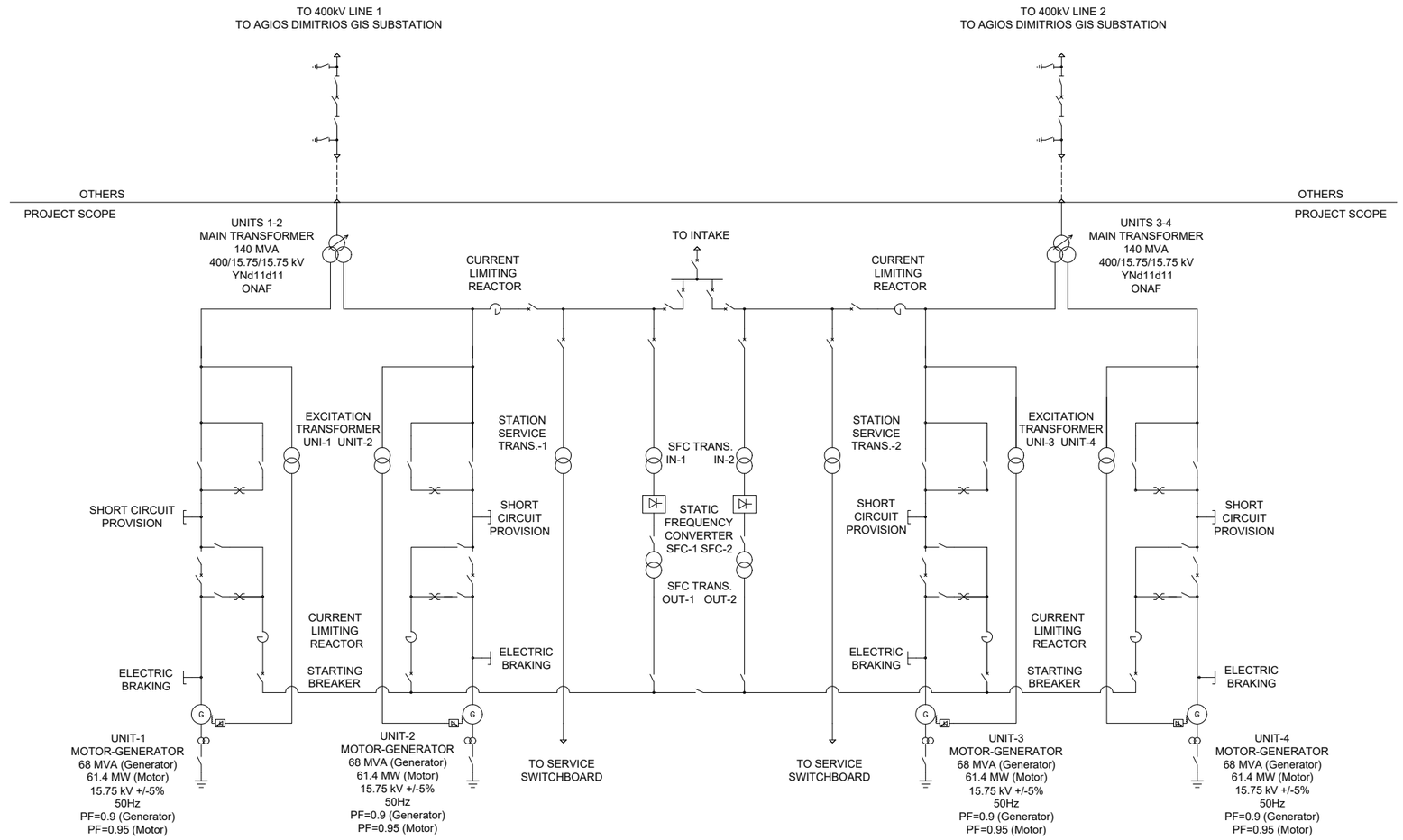
E4

PARAMETER	UNIT	1	2	3	4	5	6	7	8	9	10	11	12
Iron (Fe)	μg/l	139	74,9	117	122	58,7	43,0	31,6	24,8	86,7	54,7	121	105
Manganese (Mn)	μg/l	63,8	44,5	31,5	35,8	37	66,2	100	33,5	92,7	29,0	17,2	24,0
Aluminium (Al)	μg/l	150	82,4	78,9	179	58,8	48,0	15,5	13,7	13,7	34,8	93,2	97,9
Barium (Ba)	μg/l	40,8	40,1		40,9	41,4		42,6	43,8		48,0	43,2	
Selenium (Se)	μg/l	1,95	2,98		1,62	1,6		1,20	1,49		1,78	3,64	
Strontium (Sr)	μg/l	321	247	220	208	216	190	206	208	252	235	231	221
Phosphorus total (P)	μg/l	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Molybdenum (Mo)	μg/l	1,89	2,12	3,01	2,34	4,45	3,28	2,76	3,35	1,75	3,52	3,98	5,03
Cobalt (Co)	μg/l	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Antimony (Sb)	μg/l	0,169	0,414	0,404	0,293	0,443	0,557	0,659	<0,1	0,621	0,248	<1	<1
Tin (Sn)	μg/l	<0,6	<0,6	<0,6	<0,6	<0,6	<0,6	<0,6	<0,6	<0.6	<0.6	<0.6	<0.6
Thallium (Tl)	μg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<1	<1	<1	<1	<1	<1	<1
Bismuth (Bi)	μg/l	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Virillion (Be)	μg/l	<0,98	<0,98	<0,98	<0,98	<0,98	<1	<1	<1	<1	<1	<1	<1
Boron (B)	μg/l	<50	<50		<50	23,1		<50	<20		<20	<20	

TS6

PARAMETER	UNIT	1	2	3	4	5	6	7	8	9	10	11	12
Iron (Fe)	μg/l	32,7	24,9	43,5	17	41,6	35,2	12,4	9,47	19,3	22,1	113	102
Manganese (Mn)	μg/l	105	85,9	55,2	40	25,9	27,3	14,6	5,71	23,7	11,5	32,8	43,5
Aluminium (Al)	μg/l	27,8	26,3	29,9	21,3	40,2	43,9	21,9	11,7	12,4	21,9	90,2	116
Barium (Ba)	μg/l	37,5	36,2		32,9	38,2		41,6	42,8		44,0	42,9	
Selenium (Se)	μg/l	4,24	4,11		3,37	3,51		2,41	2,56		1,44	1,99	
Strontium (Sr)	μg/l	661	604	559	538	514	531	585	587	622	659	625	659
Phosphorus total (P)	μg/l	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Molybdenum (Mo)	μg/l	5,93	5,42	6,53	4,83	5,97	5,93	6,00	7,27	6,44	6,39	5,77	12,4
Cobalt (Co)	μg/l	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Antimony (Sb)	μg/l	0,198	0,215	0,250	0,288	0,208	0,615	0,308	<0,1	<0.1	0,250	<1	<1
Tin (Sn)	μg/l	<0,6	<0,6	<0,6	<0,6	<0,6	<0,6	<0,6	<0,6	<0.6	<0.6	<0.6	<0.6
Thallium (Tl)	μg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<1	<1	<1	<1	<1	<1	<1
Bismuth (Bi)	μg/l	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Virillion (Be)	μg/l	<0,98	<0,98	<0,98	<0,98	<0,98	<1	<1	<1	<1	<1	<1	<1
Boron (B)	μg/l	195	177		152	176		180	<20		185	188	

Polyphytos water quality @ Ag. Dimitrios Water tank 2023-2024					
PARAMETERS	UNITS	2023.02	2023.09	2024.01	2024.09
pH (22,1ºC)		8,2	8,3	8,4	8,2
Conductivity	mS/cm	0,43	0,40	0,41	0,41
Total Dissolved Solids (TDS)	mg/L	262	210	222	234
Total suspended solids (TSS)	mg/L	< 4,0	< 4,0	< 4,0	< 4,0
Chemical oxygen demand (C.O.D.)	mg O_2/L			< 15	< 15
Ammonium (NH_4^+)	mg/L			< 0,02	
Nitrites (**NO_2**-)	mg/L	< 0,01	< 0,05	1,1	< 0,05
Bromide (Br-)	mg/L	< 0,5	< 0,1	0,86	< 0,1
Nitrates (NO_3^-)	mg/L	0,7	1,2	< 0,5	0,9
Sulphates (SO_4^{2-})	mg/L	16,0	22,0	0,81	20,0
Sulphides (S^{2-})				< 0,1	< 0,1
Sulphites (SO_3^{2-})	mg/L	< 2,0	< 0,1	< 0,1	< 0,1
Residual chlorine	µg/L			0,02	< 0,06
Hexavalent Chromium (Cr^{+6})	µg/L			< 0,03	< 0,03
Arsenicum (As)	µg/L	< 20,9	0,757	0,795	< 1,0
Cadmium (Cd)	µg/L	< 0,9	< 0,1	< 0,1	< 0,5
Chromium (Cr)	µg/L	< 1,6	< 1,0	< 1,0	< 1,0
Copper (Cu)	µg/L	< 2,7	< 5,5	< 5,5	< 0,57
Mercury (Hg)	µg/L	< 0,7	< 0,1	< 0,1	< 0,1
Nickel (Ni)	µg/L	< 4,4	2,68	3,8	2,44
Lead (Pb)	µg/L	< 9,2	< 0,1	< 0,1	< 0,57
Zinc (Zn)	µg/L	< 1,9	< 5	< 5	< 9,15
Sodium (Na^+)	mg/L	6,2		6,37	12,4
Phosphorus (P)	µg/L	< 50	< 50	< 50	< 50
Total organic carbon (TOC)	mg/L	1,8	40,3	47,0	22,0
Dissolved oxygen	µg/L			8,3	7,3
Chloride ions (Cl-)	mg/L	3,8	6,8	1,0	6,3
Fluorides (F-)	mg/L	0,1	< 0,1	1,6	< 0,1
Total Nitrogen (**TN**)	mg/L	0,6	< 1,0	< 1,0	< 0,1
Aluminium (Al)	µg/L	< 20	< 10		
Barium (Ba)	µg/L	17,8	18,1		
Iron (Fe)	µg/L	< 5	< 5		4,28
Manganese (Mn)	µg/L	< 0,5	< 1		
Antimony (Sb)	µg/L	< 20	0,193		
Selenium (Se)	µg/L	< 19,2	< 1	< 1	< 0,55
Vanadium (V)	µg/L	< 5	1,38		
Molybdenum (Mo)	µg/L	< 10	< 1		
Cobalt (Co)	µg/L	< 5	< 1		
Tin (Sn)	µg/L	< 20	< 0,6		
Boron (B)	µg/L	< 50	< 50		
Virillion (Be)	µg/L		< 0,98		
Thallium (Tl)	µg/L		< 0,01		
Strontium (Sr)	µg/L	184	178		
Cyanide (CN-)	mg/L	< 0,01	< 0,01	< 0,01	< 0,01
Phenols (PhoH)	mg/L	<0,05	0,05	< 0,05	< 1,0
Total Petroleum Hydrocarbons (THC)	mg/L	1,2	0,4	0,2	< 1,0
Silicates (SiO_2)	ppm	3,4	3,1	4,8	4,0
HCO_3	ppm	235,0	208,3	224,3	214,1
Magnesium (Mg)	ppm	32,2	27,7	27,0	27,1
Copper (Cu)	ppm	0,0	0,0	0,0	0,0
Calcium (Ca)	ppm	36,2	30,5	38,2	34,1
Consumption $KMnO_4$	mg/L	8,3	7,2	9,6	9,7
turbidity	NTU	2,1	1,5	2,2	1,3
p-alkalinity (p-alk.)	ppm	4,3	7,9	5,6	6,0
Total alkalinity (m-alk.)	ppm	198,2	174,6	187,9	179,4
Total Hardness (TH)	ppm CaCO3	223,0	189,9	206,3	196,5
Carbonate Hardness (CH)	ppm CaCO3	144,0	127,8	137,6	131,3
Non-carbonate Hardness (NCH)	ppm CaCO3	79,0	62,2	68,7	65,2
Calcium hardness (CaH)	ppm CaCO3	90,4	76,0	95,3	85,2
Magnesium hardness (MgH)	ppm CaCO3	132,6	113,9	111,0	111,3
Carbonate Ions (CO_3^-)	ppm	0,9	1,1	1,2	1,1



LEGEND

REV	DATE	MODIFICATION	DRAWN	CHECKED	APPROVED
D					
C					
B					
A	16/07/2026	FIRST ISSUE	HEE	FTR	TDC

Customer

GREECE - WEST MACEDONIA

PUBLIC POWER CORPORATION S.A. (PPC SA)

Project

South Field PHS Plant

FEASIBILITY STUDY

Subject

ELECTRICAL SINGLE-LINE DIAGRAM

TRACTEBEL ENGINEERING S.A
Euroatrium - 7 rue Emmy Noether
93400 Saint-Ouen - FRANCE

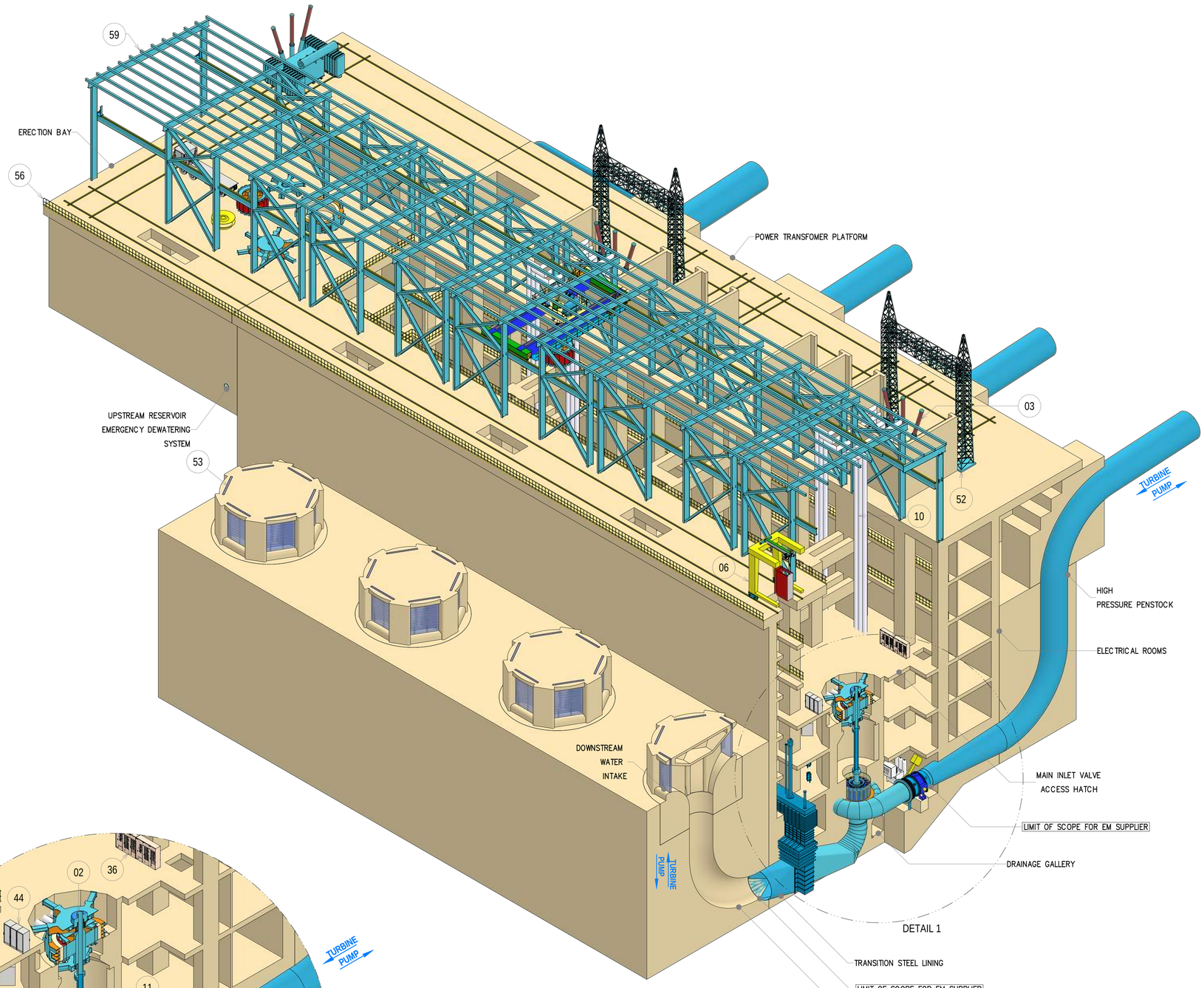
External Reference | Confidentiality Level

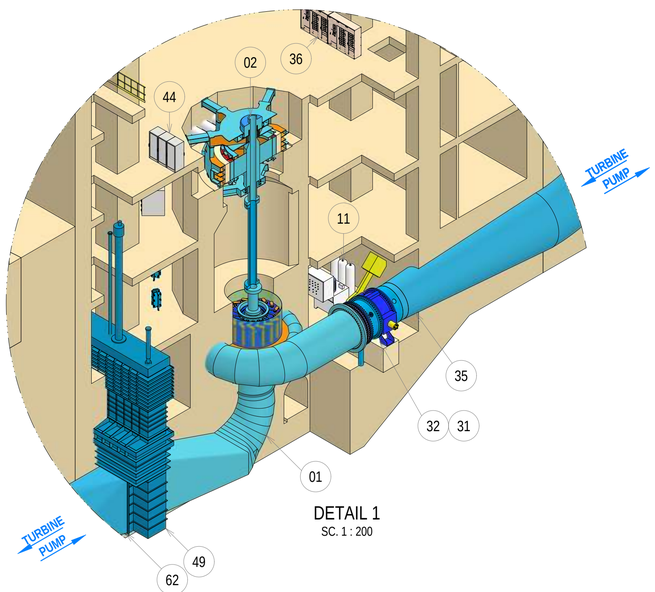
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Imputation	Technical Division	issuer	Nb Sheet	Size
W.004668.0001	ELECTRICAL		1	A1

Drawing Name: SF-PHS_FS_TE_ELE_PWR_DRG_0001 | Rev.: Rev.

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DETAIL 1
SC. 1 : 200

BILL OF MATERIALS			BILL OF MATERIALS		
ITEM	QTY	DESCRIPTION	ITEM	QTY	DESCRIPTION
01	4	TURBINE–PUMP (T/P)	34	4	COMMON AUX. DISTR. PANEL BOARD
02	4	GENERATOR–MOTOR	35	4	HIGH PRESSURE PENSTOCK
03	2	POWER TRANSFORMER	36	4	UNIT AUX. DISTR. PANEL BOARD
04	4	INTERMEDIATE SHAFT	37	2	DIESEL TANK
05	4	SFC TRANSFORMER	38	2	EMERGENCY DIESEL GENERATOR
06	1	DTG/LOWER INTAKE GRANTRY CRANE	39	28	STATION SERVICE TRANSFORMER
07	2	HP AIR TANK – COMMON	40	4	MV – 15,75kV SWITCHBOARD
08	8	PHASE REVERSAL SWITCH	41	4	MV – 15,75kV SWITCHBOARD
09	4	GENERATOR CIRCUIT BREAKER	42	4	COMMON AUX. CONTROLLER (PLC)
10	1	MV BUSDUCT SET	43	4	UNIT AUX. MV SWITCHBOARD
11	4	MIV HYDRAULIC PRESSURE UNIT	44	24	UNIT CONTROL CUBICLE
12	2	CURRENT LIMITING REACTOR – SFC	45	6	UNIT CONTROL CUBICLE
13	4	T/P HYDRAULIC PRESSURE UNIT	46	4	UNIT CONTROL CUBICLE
14	1	MAIN OVERHEAD BRIDGE CRANE	47	4	AIR TANK – UNIT BREAKING
15	4	DTG HYDRAULIC PRESSURE UNIT	48	6	AIR HANDLING UNIT (AHU) – MH
16	3	DEWATERING PUMP	49	4	DRAFT TUBE GATE (W/ MAINT. FLAP)
17	2	STATION SERVICE TRANSFORMER	50	6	WATER CHILLER – MH
18	3	DRAINAGE PUMP	51	4	EXCITATION TRANSFORMER
19	4	FIRE FIGHTING CO2 RACK	52	2	HV LINES GANTRY
20	8	UNIT COOLING WATER PUMP	53	24	LOWER INTAKE GRILLE – ELEMENT
21	8	COOLING WATER FILTER	54	1	TRANSFORMER RAILS
22	16	BATTERY RACK	55	8	HEAT EXCHANGER – TURBINE BEARING
23	2	BATTERY CHARGER	56	1	GUARDRAILS
24	8	DC DISTRIBUTION BOARD	57	4	LP AIR TANK – SERVICE
25	6	TELECOMMUNICATION BOARD	58	4	LP AIR COMPRESSOR – SERVICE
26	24	SERVER CUBICLE	59	1	ROOF STRUCTURE
27	4	HP AIR TANK – BLOWDOWN SYSTEM	60	4	HP AIR COMPRESSOR – UNIT
28	2	OFFICE DESK	61	1	EMERGENCY DEWATERING PENSTOCK
29	1	MAIN CONTROL DESK	62	4	WATERWAY TRANSITION LINER
30	2	STATIC FREQUENCY CONVERTER	63	2	EMERGENCY DEWATERING (ED) VALVE
31	4	MIV DISMANTLING JOINT	64	2	ED OUTLET VALVE
32	4	MAIN INLET VALVE	65	2	ED DISMANTLING JOINT
33	2	MAIN FIRE PUMP	66	2	ED INLET VALVE

LEGEND

- E01 → Item Number
- Concrete in section
- TURBINE → Flow in turbine mode
- PUMP → Flow in pump mode
- -50.00 Elevation level (m.a.s.l)

NOTES
1.- Overall dimensions will be confirmed at later design stage.
2.- The part list is purely indicative and non-exhaustive.

REV	DATE	MODIFICATION	DRAWN	CHECKED	APPROVED
D					
C	21/07/2026	PPC'S COMMENTS (2026-05-25)	RBC	FWI	SDM
B	13/04/2026	PPC'S COMMENTS (2026-03-09)	RBC	FWI	SDM
A	04/12/2025	FIRST EDITION	RBC	FWI	SDM

Customer
GREECE - WEST MACEDONIA
PUBLIC POWER CORPORATION S.A. (PPC SA)

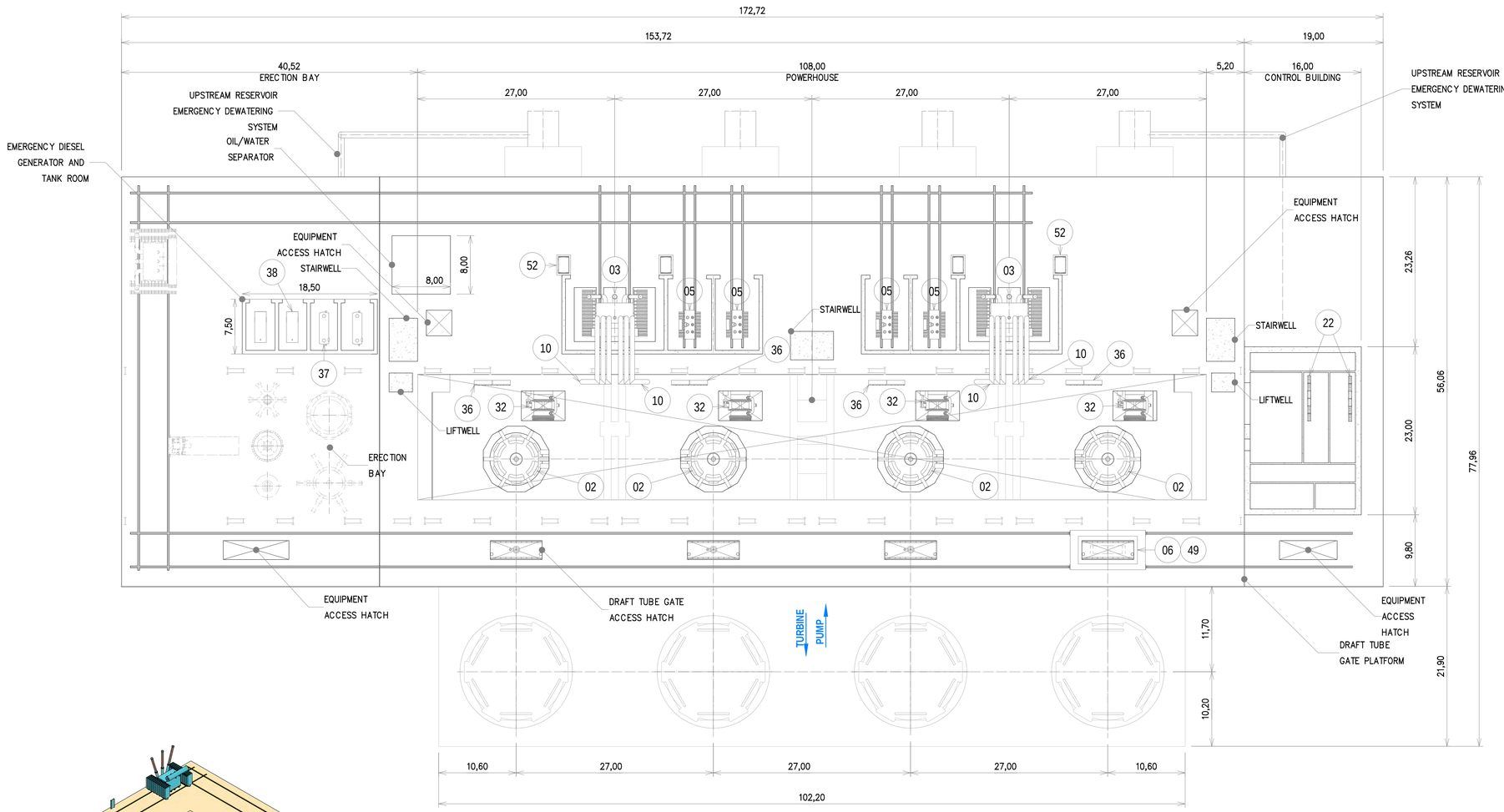
Project
South Field PHS Plant
FEASIBILITY STUDY

Subject
POWERHOUSE
ISOMETRIC VIEW

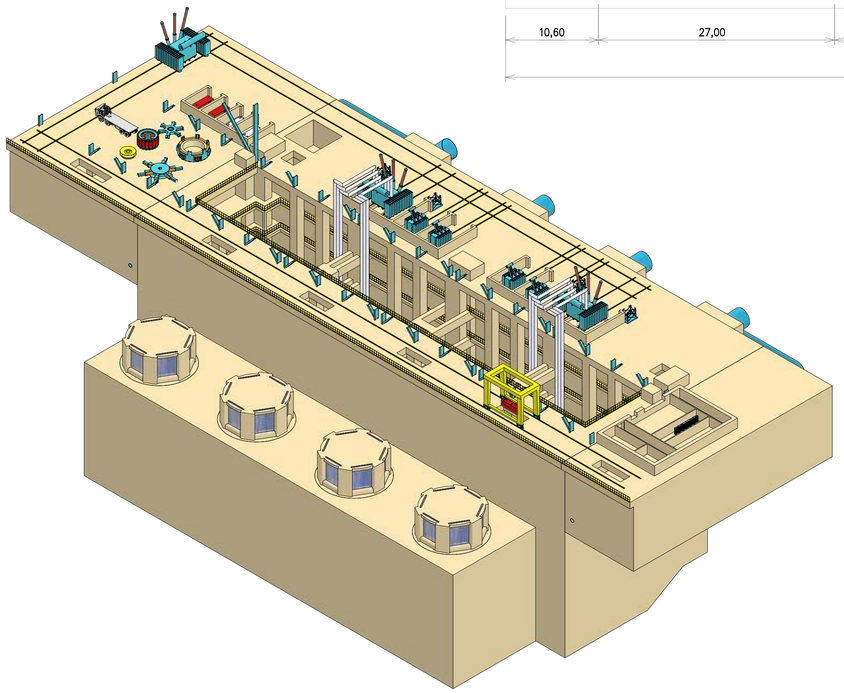
TRACTEBEL ENGINEERING S.A
Euroatrium - 7 rue Emmy Noether
93400 Saint-Ouen - FRANCE

External Reference: -
Confidentiality Level: RESTRICTED
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Rev.: C

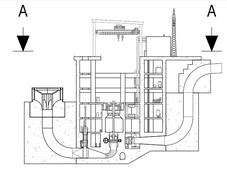
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SECTION A-A
SC. 1 :350



KEY PLAN



BILL OF MATERIALS			BILL OF MATERIALS		
ITEM	QTY	DESCRIPTION	ITEM	QTY	DESCRIPTION
01	4	TURBINE–PUMP (T/P)	34	4	COMMON AUX. DISTR. PANEL BOARD
02	4	GENERATOR–MOTOR	35	4	HIGH PRESSURE PENSTOCK
03	2	POWER TRANSFORMER	36	4	UNIT AUX. DISTR. PANEL BOARD
04	4	INTERMEDIATE SHAFT	37	2	DIESEL TANK
05	4	SFC TRANSFORMER	38	2	EMERGENCY DIESEL GENERATOR
06	1	DTG/LOWER INTAKE GRANTRY CRANE	39	28	MV – 15,75kV SWITCHBOARD
07	2	HP AIR TANK – COMMON	40	4	MV – 15,75kV SWITCHBOARD
08	8	PHASE REVERSAL SWITCH	41	4	MV – 15,75kV SWITCHBOARD
09	4	GENERATOR CIRCUIT BREAKER	42	4	COMMON AUX. CONTROLLER (PLC)
10	1	MV BUSDUCT SET	43	4	UNIT AUX. MV SWITCHBOARD
11	4	MIV HYDRAULIC PRESSURE UNIT	44	24	STATION SERVICE TRANSFORMER
12	2	CURRENT LIMITING REACTOR – SFC	45	6	UNIT CONTROL CUBICLE
13	4	T/P HYDRAULIC PRESSURE UNIT	46	4	UNIT CONTROL CUBICLE
14	1	MAIN OVERHEAD BRIDGE CRANE	47	4	AIR TANK – UNIT BREAKING
15	4	DTG HYDRAULIC PRESSURE UNIT	48	6	AIR HANDLING UNIT (AHU) – MH
16	3	DEWATERING PUMP	49	4	DRAFT TUBE GATE (W/ MAINT. FLAP)
17	2	STATION SERVICE TRANSFORMER	50	6	WATER CHILLER – MH
18	3	DRAINAGE PUMP	51	4	EXCITATION TRANSFORMER
19	4	FIRE FIGHTING CO2 RACK	52	2	HV LINES GANTRY
20	8	UNIT COOLING WATER PUMP	53	24	LOWER INTAKE GRILLE – ELEMENT
21	8	COOLING WATER FILTER	54	1	TRANSFORMER RAILS
22	16	BATTERY RACK	55	8	HEAT EXCHANGER – TURBINE BEARING
23	2	BATTERY CHARGER	56	1	GUARDRAILS
24	8	DC DISTRIBUTION BOARD	57	4	LP AIR TANK – SERVICE
25	6	TELECOMMUNICATION BOARD	58	4	LP AIR COMPRESSOR – SERVICE
26	24	SERVER CUBICLE	59	1	ROOF STRUCTURE
27	4	HP AIR TANK – BLOWDOWN SYSTEM	60	4	HP AIR COMPRESSOR – UNIT
28	2	OFFICE DESK	61	1	EMERGENCY DEWATERING PENSTOCK
29	1	MAIN CONTROL DESK	62	4	WATERWAY TRANSITION LINER
30	2	STATIC FREQUENCY CONVERTER	64	2	ED OUTLET VALVE
31	4	MIV DISMANTLING JOINT	63	2	EMERGENCY DEWATERING (ED) VALVE
32	4	MAIN INLET VALVE	65	2	ED DISMANTLING JOINT
33	2	MAIN FIRE PUMP	66	2	ED INLET VALVE

LEGEND

- E01 → Item Number
- Concrete in section
- Backfill in section
- -50.00 Elevation level (m.a.s.l)
- TURBINE Flow in turbine mode
- PUMP Flow in pump mode

NOTES
1.- Overall dimensions will be confirmed at later design stage.
2.- The part list is purely indicative and non-exhaustive.

REV	DATE	MODIFICATION	DRAWN	CHECKED	APPROVED
D					
C	21/07/2026	PPC'S COMMENTS (2026-05-25)	RBC	FWI	SDM
B	13/04/2026	PPC'S COMMENTS (2026-03-09)	RBC	FWI	SDM
A	04/12/2025	FIRST EDITION	RBC	FWI	SDM

Customer
GREECE - WEST MACEDONIA
PUBLIC POWER CORPORATION S.A. (PPC SA)

Project
South Field PHS Plant
FEASIBILITY STUDY

Subject
POWERHOUSE
ERECTION BAY LEVEL

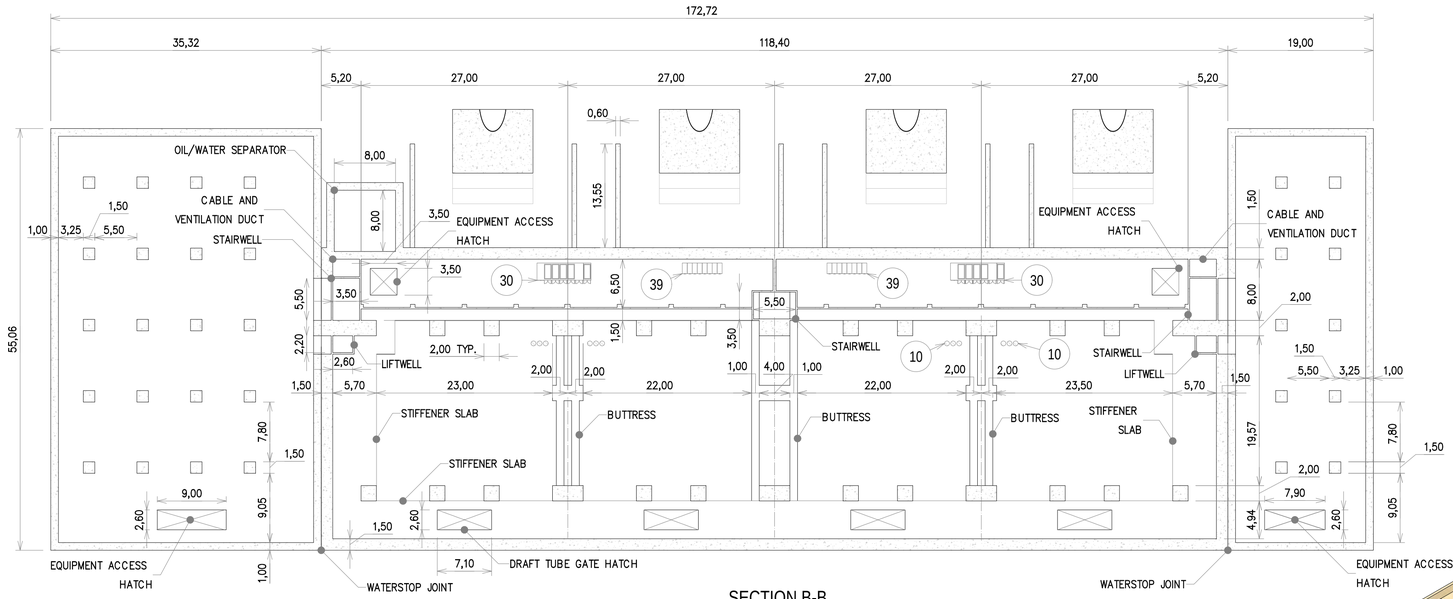
TRACTEBEL ENGINEERING S.A
Euroatrium - 7 rue Emmy Noether
93400 Saint-Ouen - FRANCE

External Reference	Confidentiality Level
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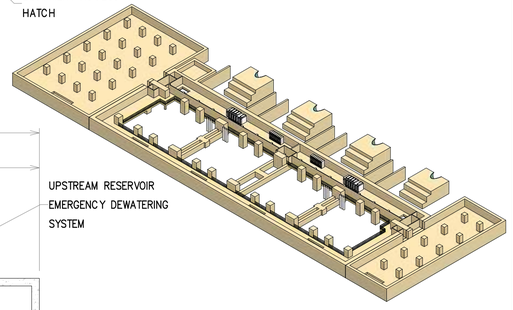
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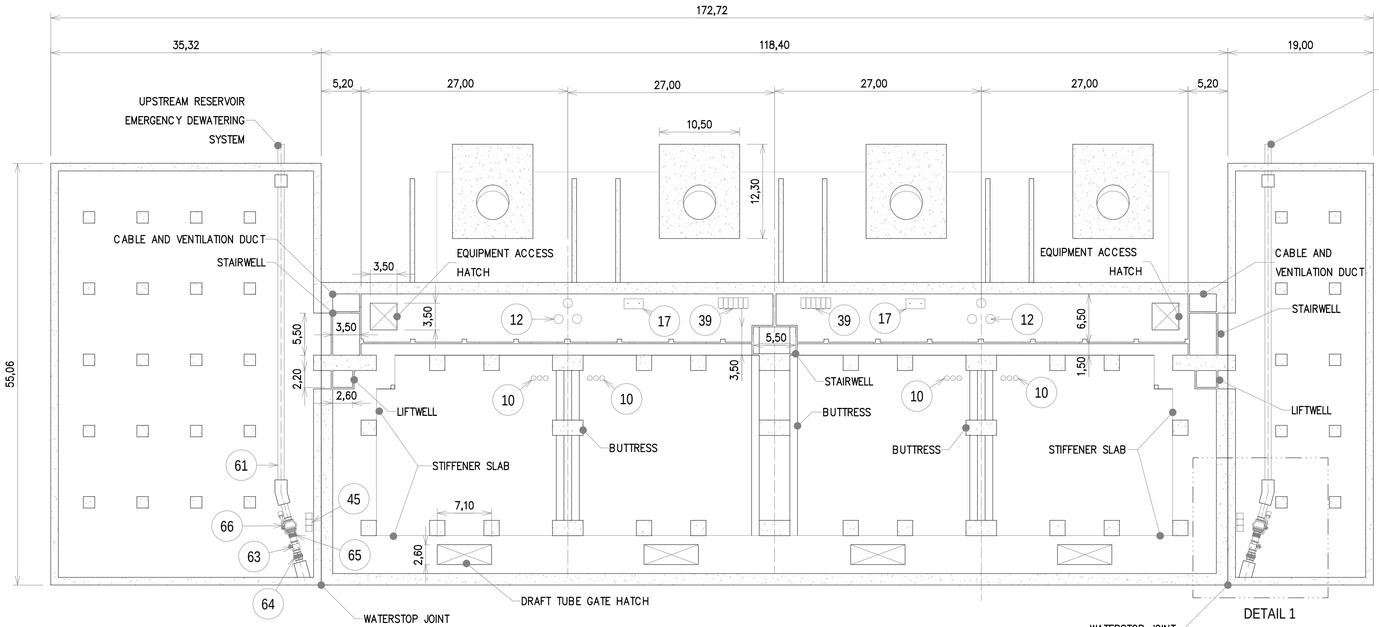
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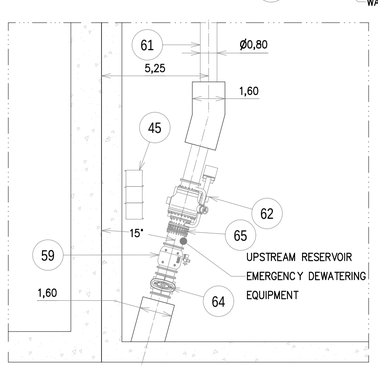


SECTION B-B
SC. 1 : 400

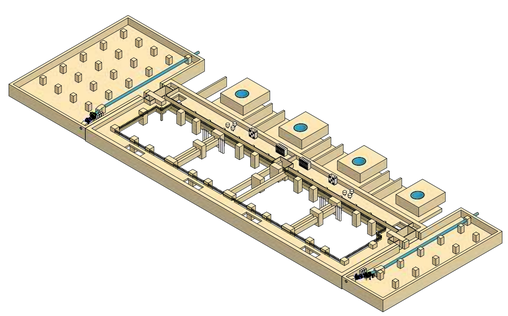




SECTION C-C
SC. 1 : 400

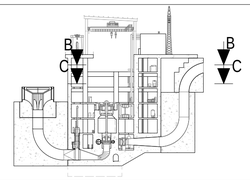


DETAIL 1
SC. 1 : 150



DETAIL 1

KEY PLAN



BILL OF MATERIALS			BILL OF MATERIALS		
ITEM	QTY	DESCRIPTION	ITEM	QTY	DESCRIPTION
01	4	TURBINE–PUMP (T/P)	34	4	COMMON AUX. DISTR. PANEL BOARD
02	4	GENERATOR–MOTOR	35	4	HIGH PRESSURE PENSTOCK
03	2	POWER TRANSFORMER	36	4	UNIT AUX. DISTR. PANEL BOARD
04	4	INTERMEDIATE SHAFT	37	2	DIESEL TANK
05	4	SFC TRANSFORMER	38	2	EMERGENCY DIESEL GENERATOR
06	1	DTG/LOWER INTAKE GRANTRY CRANE	39	28	MV – 15,75kV SWITCHBOARD
07	2	HP AIR TANK – COMMON	40	4	MV – 15,75kV SWITCHBOARD
08	8	PHASE REVERSAL SWITCH	41	4	MV – 15,75kV SWITCHBOARD
09	4	GENERATOR CIRCUIT BREAKER	42	4	COMMON AUX. CONTROLLER (PLC)
10	1	MV BUSDUCT SET	43	4	UNIT AUX. MV SWITCHBOARD
11	4	MIV HYDRAULIC PRESSURE UNIT	44	24	UNIT CONTROL CUBICLE
12	2	CURRENT LIMITING REACTOR – SFC	45	6	UNIT CONTROL CUBICLE
13	4	T/P HYDRAULIC PRESSURE UNIT	46	4	UNIT CONTROL CUBICLE
14	1	MAIN OVERHEAD BRIDGE CRANE	47	4	AIR TANK – UNIT BREAKING
15	4	DTG HYDRAULIC PRESSURE UNIT	48	6	AIR HANDLING UNIT (AHU) – MH
16	3	DEWATERING PUMP	49	4	DRAFT TUBE GATE (W/ MAINT. FLAP)
17	2	STATION SERVICE TRANSFORMER	50	6	WATER CHILLER – MH
18	3	DRAINAGE PUMP	51	4	EXCITATION TRANSFORMER
19	4	FIRE FIGHTING CO2 RACK	52	2	HV LINES GANTRY
20	8	UNIT COOLING WATER PUMP	53	24	LOWER INTAKE GRILLE – ELEMENT
21	8	COOLING WATER FILTER	54	1	TRANSFORMER RAILS
22	16	BATTERY RACK	55	8	HEAT EXCHANGER – TURBINE BEARING
23	2	BATTERY CHARGER	56	1	GUARDRAILS
24	8	DC DISTRIBUTION BOARD	57	4	LP AIR TANK – SERVICE
25	6	TELECOMMUNICATION BOARD	58	4	LP AIR COMPRESSOR – SERVICE
26	24	SERVER CUBICLE	59	1	ROOF STRUCTURE
27	4	HP AIR TANK – BLOWDOWN SYSTEM	60	4	HP AIR COMPRESSOR – UNIT
28	2	OFFICE DESK	61	1	EMERGENCY DEWATERING PENSTOCK
29	1	MAIN CONTROL DESK	62	4	WATERWAY TRANSITION LINER
30	2	STATIC FREQUENCY CONVERTER	64	2	ED OUTLET VALVE
31	4	MIV DISMANTLING JOINT	63	2	EMERGENCY DEWATERING (ED) VALVE
32	4	MAIN INLET VALVE	65	1	ED DISMANTLING JOINT
33	2	MAIN FIRE PUMP	66	2	ED INLET VALVE

LEGEND

E01 → Item Number

Concrete in section

Backfill in section

-50.00 Elevation level (m.a.s.l)

TURBINE → Flow in turbine mode

PUMP → Flow in pump mode

NOTES

1.- Overall dimensions will be confirmed at later design stage.
2.- The part list is purely indicative and non-exhaustive.

REV	DATE	MODIFICATION	DRAWN	CHECKED	APPROVED
D					
C	21/07/2026	PPC'S COMMENTS (2026-05-25)	RBC	FWI	SDM
B	13/04/2026	PPC'S COMMENTS (2026-03-09)	RBC	FWI	SDM
A	04/12/2025	FIRST EDITION	RBC	FWI	SDM

Customer

GREECE - WEST MACEDONIA

PUBLIC POWER CORPORATION S.A. (PPC SA)

Project

South Field PHS Plant

FEASIBILTY STUDY

Subject

POWERHOUSE

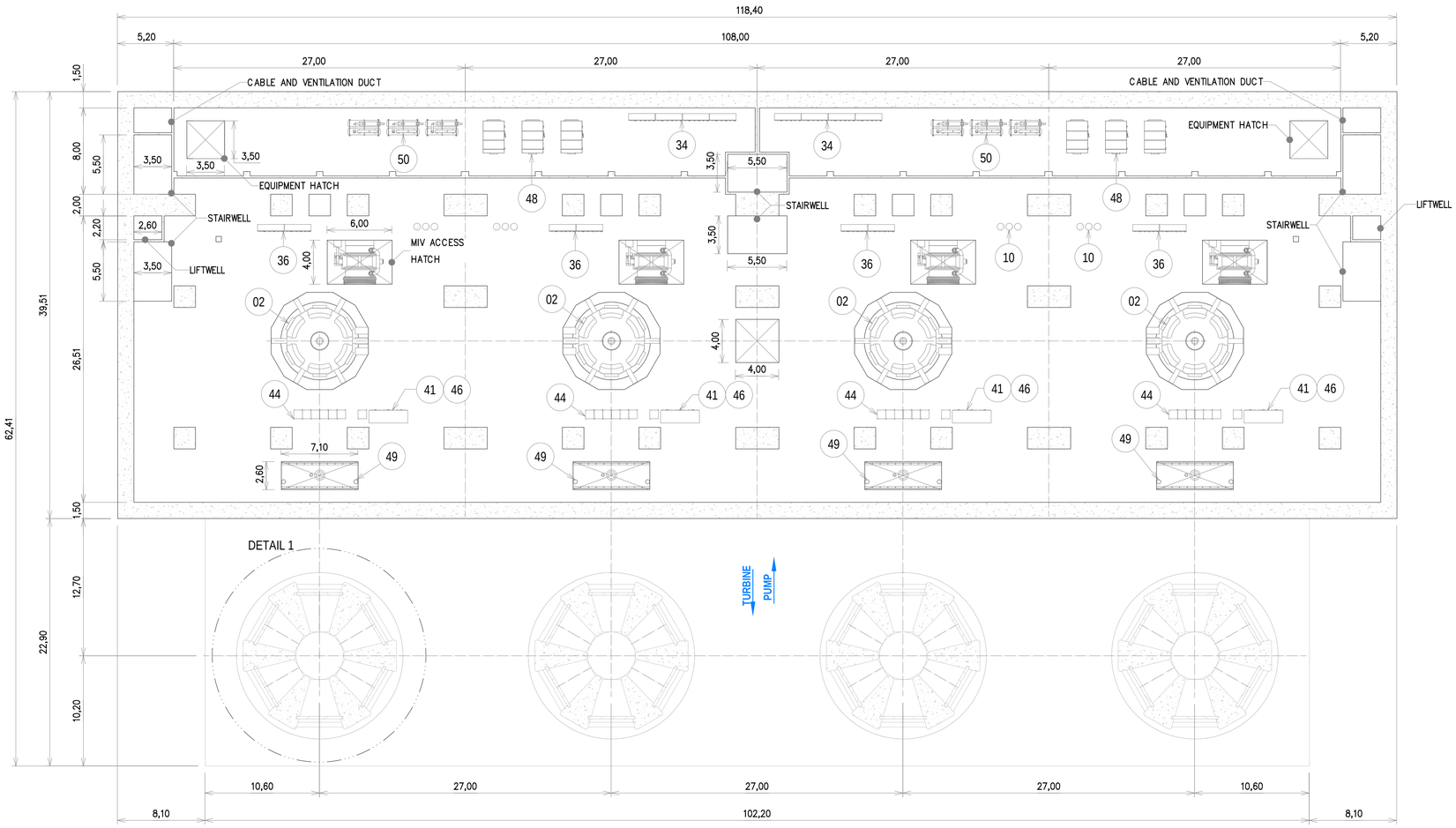
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TRACTEBEL ENGIE

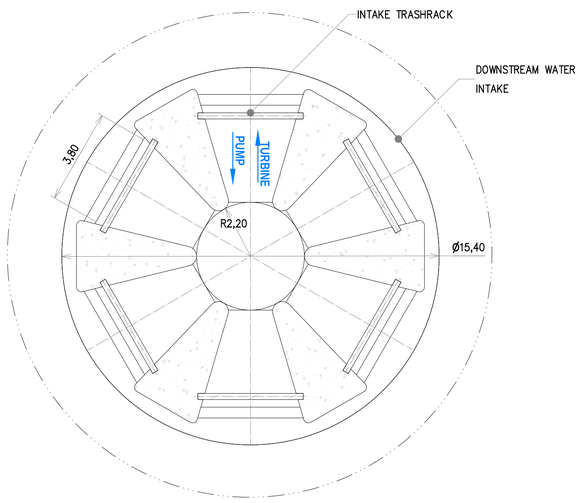
TRACTEBEL ENGINEERING S.A
Euroatrium - 7 rue Emmy Noether
93400 Saint-Ouen - FRANCE

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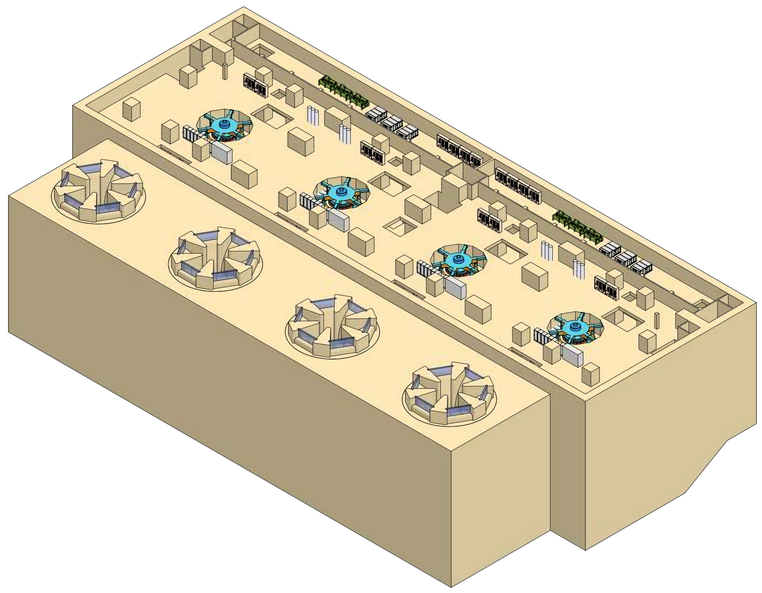
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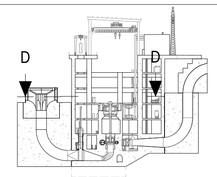
SECTION D-D
SC. 1 :250



DETAIL 1
SC. 1 : 125



KEY PLAN



BILL OF MATERIALS			BILL OF MATERIALS		
ITEM	QTY	DESCRIPTION	ITEM	QTY	DESCRIPTION
01	4	TURBINE–PUMP (T/P)	34	4	COMMON AUX. DISTR. PANEL BOARD
02	4	GENERATOR–MOTOR	35	4	HIGH PRESSURE PENSTOCK
03	2	POWER TRANSFORMER	36	4	UNIT AUX. DISTR. PANEL BOARD
04	4	INTERMEDIATE SHAFT	37	2	DIESEL TANK
05	4	SFC TRANSFORMER	38	2	EMERGENCY DIESEL GENERATOR
06	1	DTG/LOWER INTAKE GRANTRY CRANE	39	28	MV – 15,75kV SWITCHBOARD
07	2	HP AIR TANK – COMMON	40	4	MV – 15,75kV SWITCHBOARD
08	8	PHASE REVERSAL SWITCH	41	4	MV – 15,75kV SWITCHBOARD
09	4	GENERATOR CIRCUIT BREAKER	42	4	COMMON AUX. CONTROLLER (PLC)
10	1	MV BUSDUCT SET	43	4	UNIT AUX. MV SWITCHBOARD
11	4	MIV HYDRAULIC PRESSURE UNIT	44	24	UNIT CONTROL CUBICLE
12	2	CURRENT LIMITING REACTOR – SFC	45	6	UNIT CONTROL CUBICLE
13	4	T/P HYDRAULIC PRESSURE UNIT	46	4	UNIT CONTROL CUBICLE
14	1	MAIN OVERHEAD BRIDGE CRANE	47	4	AIR TANK – UNIT BREAKING
15	4	DTG HYDRAULIC PRESSURE UNIT	48	6	AIR HANDLING UNIT (AHU) – MH
16	3	DEWATERING PUMP	49	4	DRAFT TUBE GATE (W/ MAINT. FLAP)
17	2	STATION SERVICE TRANSFORMER	50	6	WATER CHILLER – MH
18	3	DRAINAGE PUMP	51	4	EXCITATION TRANSFORMER
19	4	FIRE FIGHTING CO2 RACK	52	2	HV LINES GANTRY
20	8	UNIT COOLING WATER PUMP	53	24	LOWER INTAKE GRILLE – ELEMENT
21	8	COOLING WATER FILTER	54	1	TRANSFORMER RAILS
22	16	BATTERY RACK	55	8	HEAT EXCHANGER – TURBINE BEARING
23	2	BATTERY CHARGER	56	1	GUARDRAILS
24	8	DC DISTRIBUTION BOARD	57	4	LP AIR TANK – SERVICE
25	6	TELECOMMUNICATION BOARD	58	4	LP AIR COMPRESSOR – SERVICE
26	24	SERVER CUBICLE	59	1	ROOF STRUCTURE
27	4	HP AIR TANK – BLOWDOWN SYSTEM	60	4	HP AIR COMPRESSOR – UNIT
28	2	OFFICE DESK	61	1	EMERGENCY DEWATERING PENSTOCK
29	1	MAIN CONTROL DESK	62	4	WATERWAY TRANSITION LINER
30	2	STATIC FREQUENCY CONVERTER	64	2	ED OUTLET VALVE
31	4	MIV DISMANTLING JOINT	63	2	EMERGENCY DEWATERING (ED) VALVE
32	4	MAIN INLET VALVE	65	2	ED DISMANTLING JOINT
33	2	MAIN FIRE PUMP	66	2	ED INLET VALVE

LEGEND

E01 – Item Number

Concrete in section

Backfill in section

-50.00 – Elevation level (m.a.s.l)

TURBINE – Flow in turbine mode

PUMP – Flow in pump mode

NOTES
1.- Overall dimensions will be confirmed at later design stage.
2.- The part list is purely indicative and non-exhaustive.

REV	DATE	MODIFICATION	DRAWN	CHECKED	APPROVED
D					
C	21/07/2026	PPC'S COMMENTS (2026-05-25)	RBC	FWI	SDM
B	13/04/2026	PPC'S COMMENTS (2026-03-09)	RBC	FWI	SDM
A	04/12/2025	FIRST EDITION	RBC	FWI	SDM

Customer
GREECE - WEST MACEDONIA
PUBLIC POWER CORPORATION S.A. (PPC SA)

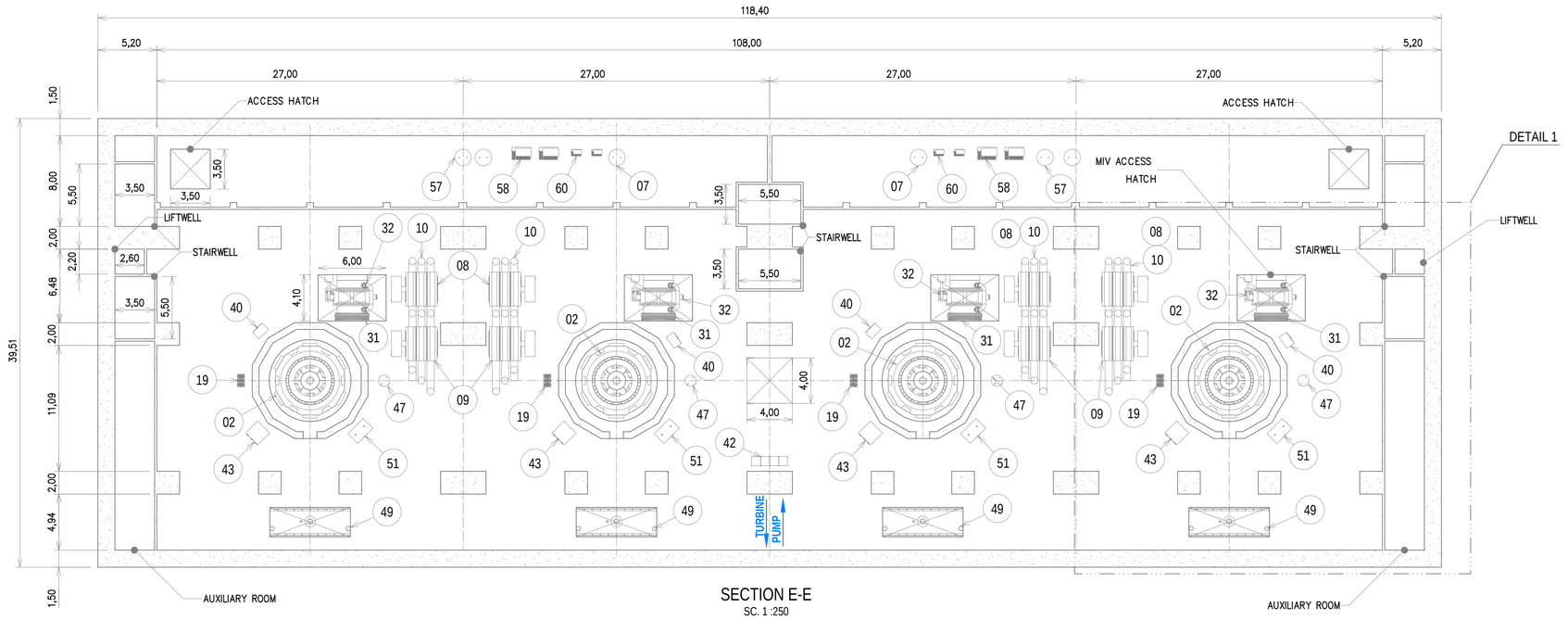
Project
South Field PHS Plant
FAISIBILITY STUDY

Subject
POWERHOUSE
UPPER LEVEL

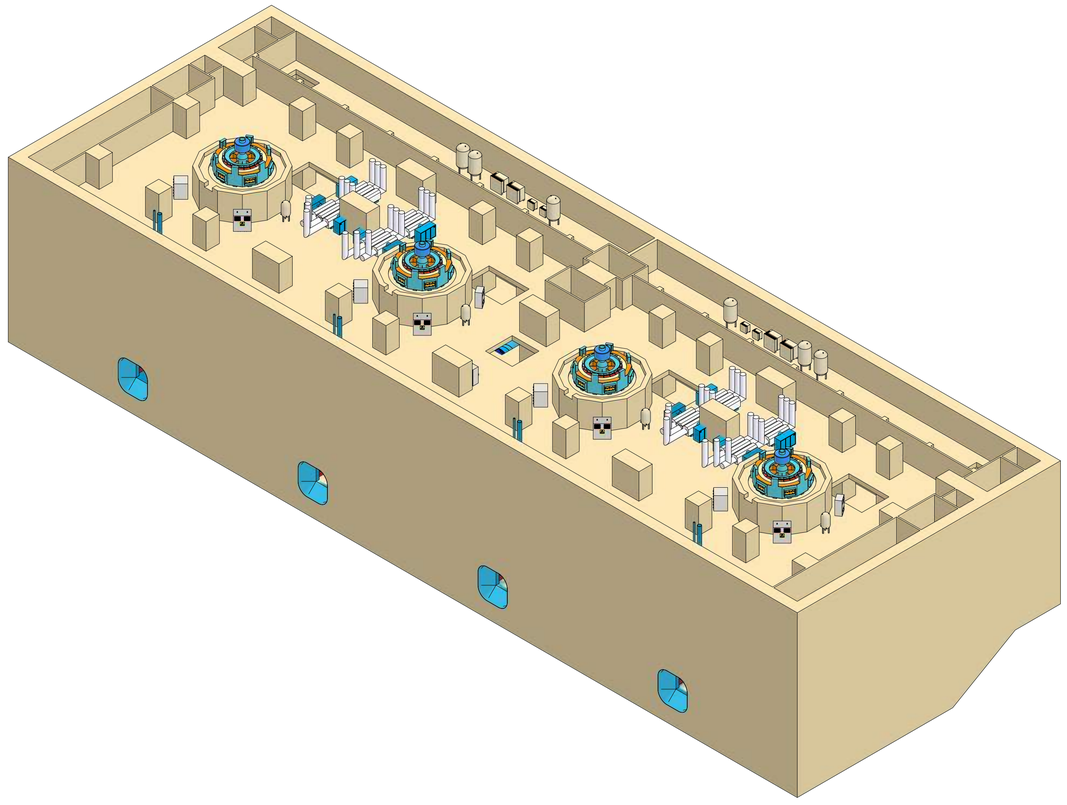
TRACTEBEL ENGINEERING S.A
Euroatrium - 7 rue Emmy Noether
93400 Saint-Ouen - FRANCE

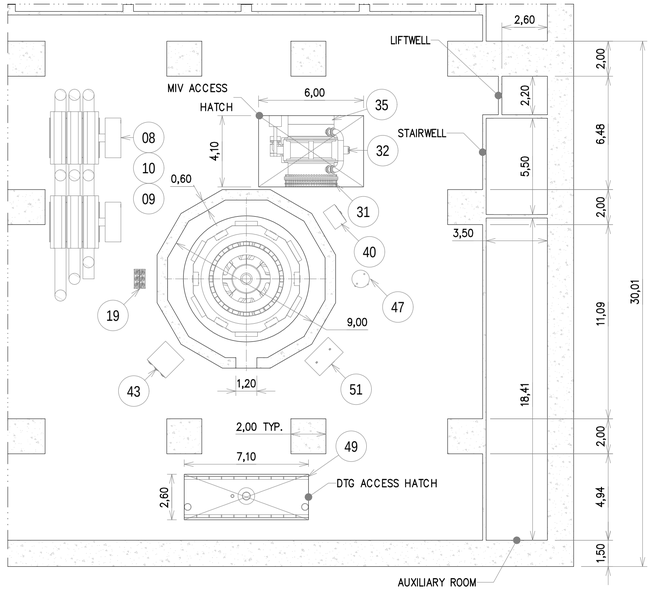
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Rev.: C

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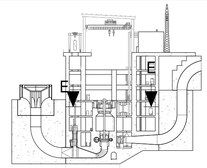
SECTION E-E
SC. 1 :250





DETAIL 1
SC. 1 : 175

KEY PLAN



BILL OF MATERIALS			BILL OF MATERIALS		
ITEM	QTY	DESCRIPTION	ITEM	QTY	DESCRIPTION
01	4	TURBINE–PUMP (T/P)	34	4	COMMON AUX. DISTR. PANEL BOARD
02	4	GENERATOR–MOTOR	35	4	HIGH PRESSURE PENSTOCK
03	2	POWER TRANSFORMER	36	4	UNIT AUX. DISTR. PANEL BOARD
04	4	INTERMEDIATE SHAFT	37	2	DIESEL TANK
05	4	SFC TRANSFORMER	38	2	EMERGENCY DIESEL GENERATOR
06	1	DTG/LOWER INTAKE GRANTRY CRANE	39	28	MV – 15,75kV SWITCHBOARD
07	2	HP AIR TANK – COMMON	40	4	MV – 15,75kV SWITCHBOARD
08	8	PHASE REVERSAL SWITCH	41	4	MV – 15,75kV SWITCHBOARD
09	4	GENERATOR CIRCUIT BREAKER	42	4	COMMON AUX. CONTROLLER (PLC)
10	1	MV BUSDUCT SET	43	4	UNIT AUX. MV SWITCHBOARD
11	4	MIV HYDRAULIC PRESSURE UNIT	44	24	UNIT CONTROL CUBICLE
12	2	CURRENT LIMITING REACTOR – SFC	45	6	UNIT CONTROL CUBICLE
13	4	T/P HYDRAULIC PRESSURE UNIT	46	4	UNIT CONTROL CUBICLE
14	1	MAIN OVERHEAD BRIDGE CRANE	47	4	AIR TANK – UNIT BREAKING
15	4	DTG HYDRAULIC PRESSURE UNIT	48	6	AIR HANDLING UNIT (AHU) – MH
16	3	DEWATERING PUMP	49	4	DRAFT TUBE GATE (W/ MAINT. FLAP)
17	2	STATION SERVICE TRANSFORMER	50	6	WATER CHILLER – MH
18	3	DRAINAGE PUMP	51	4	EXCITATION TRANSFORMER
19	4	FIRE FIGHTING CO2 RACK	52	2	HV LINES GANTRY
20	8	UNIT COOLING WATER PUMP	53	24	LOWER INTAKE GRILLE – ELEMENT
21	8	COOLING WATER FILTER	54	1	TRANSFORMER RAILS
22	16	BATTERY RACK	55	8	HEAT EXCHANGER – TURBINE BEARING
23	2	BATTERY CHARGER	56	1	GUARDRAILS
24	8	DC DISTRIBUTION BOARD	57	4	LP AIR TANK – SERVICE
25	6	TELECOMMUNICATION BOARD	58	4	LP AIR COMPRESSOR – SERVICE
26	24	SERVER CUBICLE	59	1	ROOF STRUCTURE
27	4	HP AIR TANK – BLOWDOWN SYSTEM	60	4	HP AIR COMPRESSOR – UNIT
28	2	OFFICE DESK	61	1	EMERGENCY DEWATERING PENSTOCK
29	1	MAIN CONTROL DESK	62	4	WATERWAY TRANSITION LINER
30	2	STATIC FREQUENCY CONVERTER	64	2	ED OUTLET VALVE
31	4	MIV DISMANTLING JOINT	63	2	EMERGENCY DEWATERING (ED) VALVE
32	4	MAIN INLET VALVE	65	2	ED DISMANTLING JOINT
33	2	MAIN FIRE PUMP	66	2	ED INLET VALVE

LEGEND

E01 → Item Number

Concrete in section

Backfill in section

-50.00 Elevation level (m.a.s.l)

TURBINE → Flow in turbine mode

PUMP → Flow in pump mode

NOTES
1.- Overall dimensions will be confirmed at later design stage.
2.- The part list is purely indicative and non-exhaustive.

REV	DATE	MODIFICATION	DRAWN	CHECKED	APPROVED
D					
C	21/07/2026	PPC'S COMMENTS (2026-05-25)	RBC	FWI	SDM
B	13/04/2026	PPC'S COMMENTS (2026-03-09)	RBC	FWI	SDM
A	04/12/2025	FIRST EDITION	RBC	FWI	SDM

Customer
GREECE - WEST MACEDONIA
PUBLIC POWER CORPORATION S.A. (PPC SA)

Project
South Field PHS Plant
FEASIBILITY STUDY

Subject
POWERHOUSE
GENERATOR LEVEL

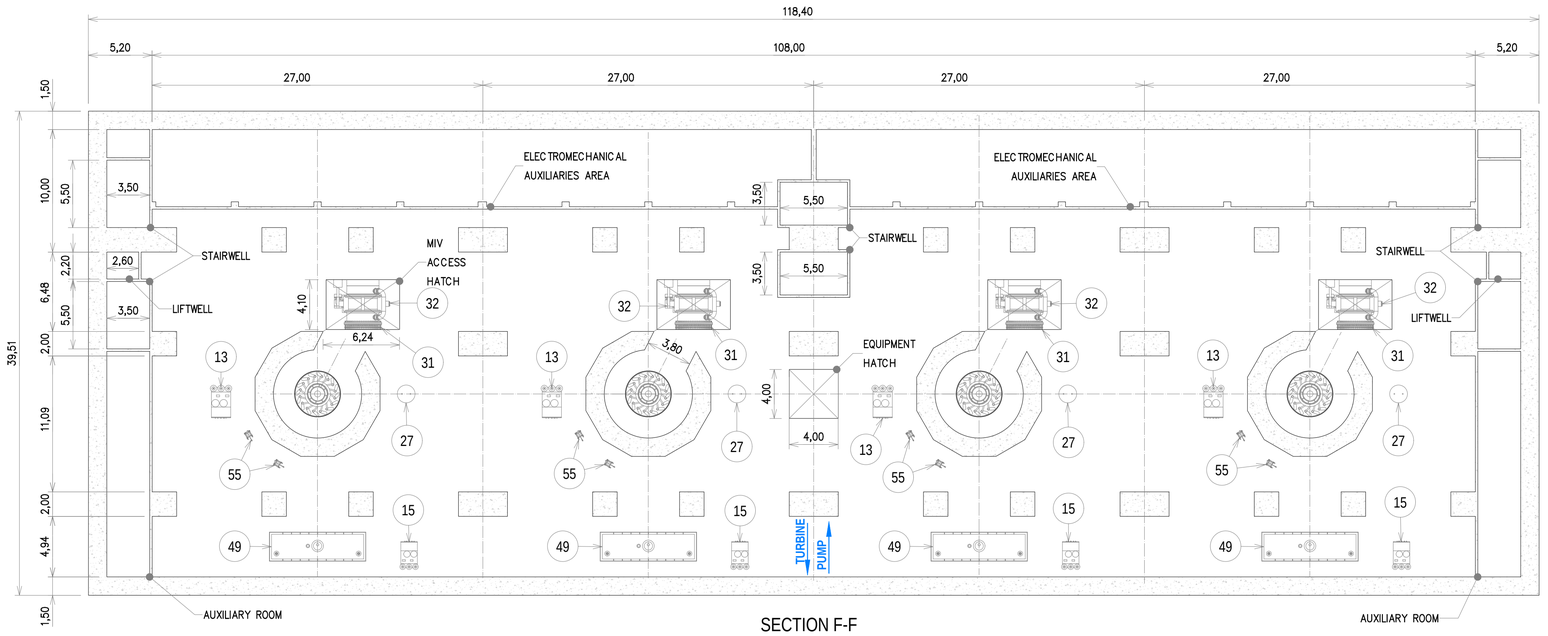
TRACTEBEL ENGINEERING S.A
Euroatrium - 7 rue Emmy Noether
93400 Saint-Ouen - FRANCE

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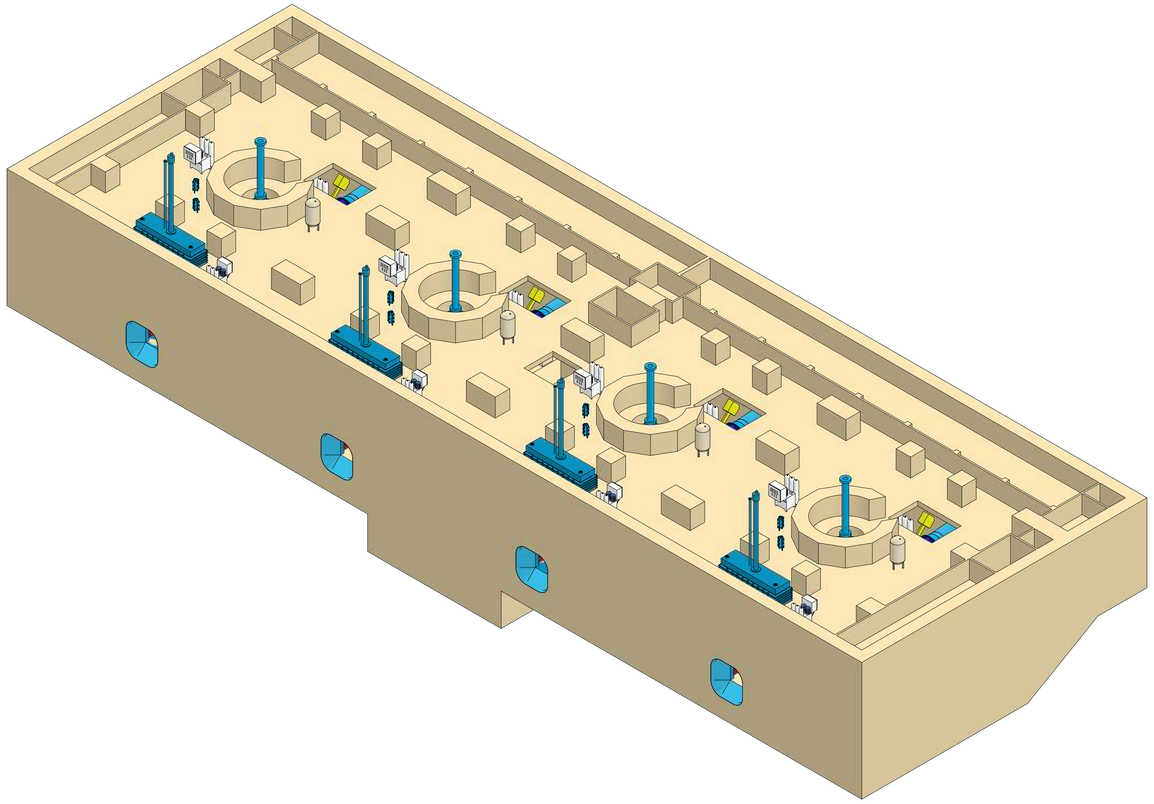
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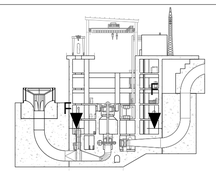
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SECTION F-F
SC. 1 :250



KEY PLAN



BILL OF MATERIALS			BILL OF MATERIALS		
ITEM	QTY	DESCRIPTION	ITEM	QTY	DESCRIPTION
01	4	TURBINE–PUMP (T/P)	34	4	COMMON AUX. DISTR. PANEL BOARD
02	4	GENERATOR–MOTOR	35	4	HIGH PRESSURE PENSTOCK
03	2	POWER TRANSFORMER	36	4	UNIT AUX. DISTR. PANEL BOARD
04	4	INTERMEDIATE SHAFT	37	2	DIESEL TANK
05	4	SFC TRANSFORMER	38	2	EMERGENCY DIESEL GENERATOR
06	1	DTG/LOWER INTAKE GRANTRY CRANE	39	28	MV – 15,75kV SWITCHBOARD
07	2	HP AIR TANK – COMMON	40	4	MV – 15,75kV SWITCHBOARD
08	8	PHASE REVERSAL SWITCH	41	4	MV – 15,75kV SWITCHBOARD
09	4	GENERATOR CIRCUIT BREAKER	42	4	COMMON AUX. CONTROLLER (PLC)
10	1	MV BUSDUCT SET	43	4	UNIT AUX. MV SWITCHBOARD
11	4	MIV HYDRAULIC PRESSURE UNIT	44	24	UNIT CONTROL CUBICLE
12	2	CURRENT LIMITING REACTOR – SFC	45	6	UNIT CONTROL CUBICLE
13	4	T/P HYDRAULIC PRESSURE UNIT	46	4	UNIT CONTROL CUBICLE
14	1	MAIN OVERHEAD BRIDGE CRANE	47	4	AIR TANK – UNIT BREAKING
15	4	DTG HYDRAULIC PRESSURE UNIT	48	6	AIR HANDLING UNIT (AHU) – MH
16	3	DEWATERING PUMP	49	4	DRAFT TUBE GATE (W/ MAINT. FLAP)
17	2	STATION SERVICE TRANSFORMER	50	6	WATER CHILLER – MH
18	3	DRAINAGE PUMP	51	4	EXCITATION TRANSFORMER
19	4	FIRE FIGHTING CO2 RACK	52	2	HV LINES GANTRY
20	8	UNIT COOLING WATER PUMP	53	24	LOWER INTAKE GRILLE – ELEMENT
21	8	COOLING WATER FILTER	54	1	TRANSFORMER RAILS
22	16	BATTERY RACK	55	8	HEAT EXCHANGER – TURBINE BEARING
23	2	BATTERY CHARGER	56	1	GUARDRAILS
24	8	DC DISTRIBUTION BOARD	57	4	LP AIR TANK – SERVICE
25	6	TELECOMMUNICATION BOARD	58	4	LP AIR COMPRESSOR – SERVICE
26	24	SERVER CUBICLE	59	1	ROOF STRUCTURE
27	4	HP AIR TANK – BLOWDOWN SYSTEM	60	4	HP AIR COMPRESSOR – UNIT
28	2	OFFICE DESK	61	1	EMERGENCY DEWATERING PENSTOCK
29	1	MAIN CONTROL DESK	62	4	WATERWAY TRANSITION LINER
30	2	STATIC FREQUENCY CONVERTER	64	2	ED OUTLET VALVE
31	4	MIV DISMANTLING JOINT	63	2	EMERGENCY DEWATERING (ED) VALVE
32	4	MAIN INLET VALVE	65	2	ED DISMANTLING JOINT
33	2	MAIN FIRE PUMP	66	2	ED INLET VALVE

LEGEND

E01 → Item Number

Concrete in section

Backfill in section

-50.00 Elevation level (m.a.s.l)

TURBINE Flow in turbine mode

PUMP Flow in pump mode

NOTES
1.- Overall dimensions will be confirmed at later design stage.
2.- The part list is purely indicative and non-exhaustive.

REV	DATE	MODIFICATION	DRAWN	CHECKED	APPROVED
D					
C	21/07/2026	PPC'S COMMENTS (2026-05-25)	RBC	FWI	SDM
B	13/04/2026	PPC'S COMMENTS (2026-03-09)	RBC	FWI	SDM
A	04/12/2025	FIRST EDITION	RBC	FWI	SDM

Customer
GREECE - WEST MACEDONIA
PUBLIC POWER CORPORATION S.A. (PPC SA)

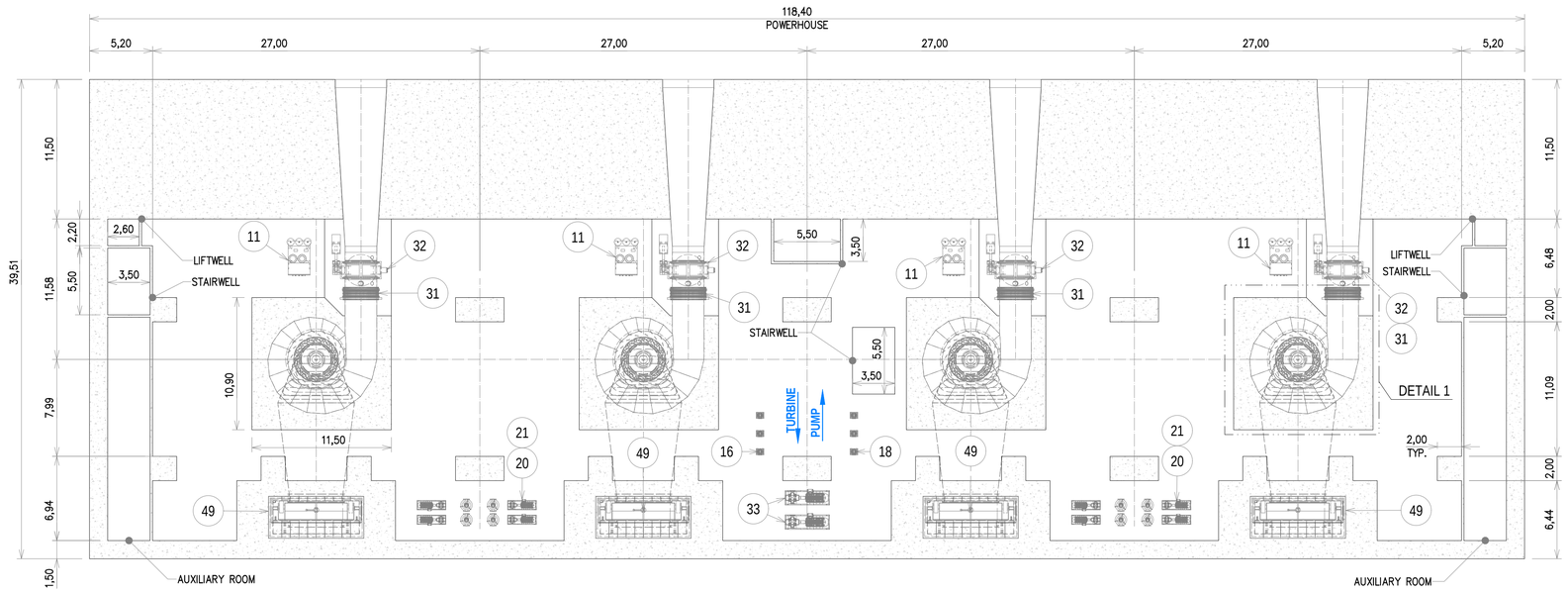
Project
South Field PHS Plant
FEASIBILITY STUDY

Subject
POWERHOUSE
TURBINE-PUMP LEVEL

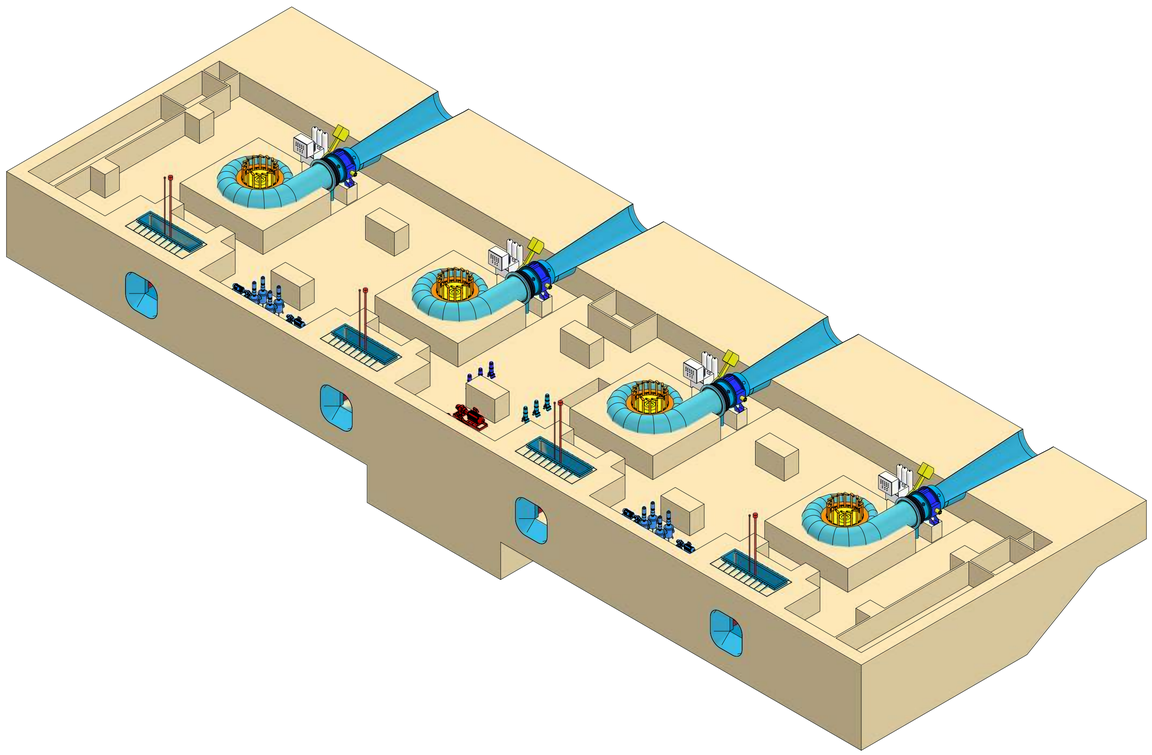
TRACTEBEL ENGINEERING S.A
Euroatrium - 7 rue Emmy Noether
93400 Saint-Ouen - FRANCE

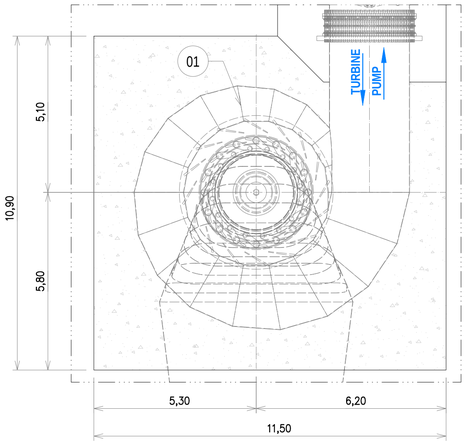
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Issuer: EFE
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Rev.: C

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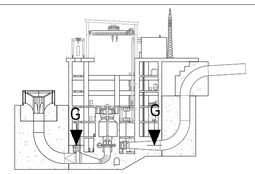
SECTION G-G
SC. 1 :250





DETAIL 1
SC. 1 : 100

KEY PLAN



BILL OF MATERIALS			BILL OF MATERIALS		
ITEM	QTY	DESCRIPTION	ITEM	QTY	DESCRIPTION
01	4	TURBINE–PUMP (T/P)	34	4	COMMON AUX. DISTR. PANEL BOARD
02	4	GENERATOR–MOTOR	35	4	HIGH PRESSURE PENSTOCK
03	2	POWER TRANSFORMER	36	4	UNIT AUX. DISTR. PANEL BOARD
04	4	INTERMEDIATE SHAFT	37	2	DIESEL TANK
05	4	SFC TRANSFORMER	38	2	EMERGENCY DIESEL GENERATOR
06	1	DTG/LOWER INTAKE GRANTRY CRANE	39	28	MV – 15,75kV SWITCHBOARD
07	2	HP AIR TANK – COMMON	40	4	MV – 15,75kV SWITCHBOARD
08	8	PHASE REVERSAL SWITCH	41	4	MV – 15,75kV SWITCHBOARD
09	4	GENERATOR CIRCUIT BREAKER	42	4	COMMON AUX. CONTROLLER (PLC)
10	1	MV BUSDUCT SET	43	4	UNIT AUX. MV SWITCHBOARD
11	4	MIV HYDRAULIC PRESSURE UNIT	44	24	UNIT CONTROL CUBICLE
12	2	CURRENT LIMITING REACTOR – SFC	45	6	UNIT CONTROL CUBICLE
13	4	T/P HYDRAULIC PRESSURE UNIT	46	4	UNIT CONTROL CUBICLE
14	1	MAIN OVERHEAD BRIDGE CRANE	47	4	AIR TANK – UNIT BREAKING
15	4	DTG HYDRAULIC PRESSURE UNIT	48	6	AIR HANDLING UNIT (AHU) – MH
16	3	DEWATERING PUMP	49	4	DRAFT TUBE GATE (W/ MAINT. FLAP)
17	2	STATION SERVICE TRANSFORMER	50	6	WATER CHILLER – MH
18	3	DRAINAGE PUMP	51	4	EXCITATION TRANSFORMER
19	4	FIRE FIGHTING CO2 RACK	52	2	HV LINES GANTRY
20	8	UNIT COOLING WATER PUMP	53	24	LOWER INTAKE GRILLE – ELEMENT
21	8	COOLING WATER FILTER	54	1	TRANSFORMER RAILS
22	16	BATTERY RACK	55	8	HEAT EXCHANGER – TURBINE BEARING
23	2	BATTERY CHARGER	56	1	GUARDRAILS
24	8	DC DISTRIBUTION BOARD	57	4	LP AIR TANK – SERVICE
25	6	TELECOMMUNICATION BOARD	58	4	LP AIR COMPRESSOR – SERVICE
26	24	SERVER CUBICLE	59	1	ROOF STRUCTURE
27	4	HP AIR TANK – BLOWDOWN SYSTEM	60	4	HP AIR COMPRESSOR – UNIT
28	2	OFFICE DESK	61	1	EMERGENCY DEWATERING PENSTOCK
29	1	MAIN CONTROL DESK	62	4	WATERWAY TRANSITION LINER
30	2	STATIC FREQUENCY CONVERTER	64	2	ED OUTLET VALVE
31	4	MIV DISMANTLING JOINT	63	2	EMERGENCY DEWATERING (ED) VALVE
32	4	MAIN INLET VALVE	65	2	ED DISMANTLING JOINT
33	2	MAIN FIRE PUMP	66	2	ED INLET VALVE

LEGEND

- E01 → Item Number
- Concrete in section
- Backfill in section
- -50.00 Elevation level (m.a.s.l)
- TURBINE → Flow in turbine mode
- PUMP → Flow in pump mode

NOTES
1.- Overall dimensions will be confirmed at later design stage.
2.- The part list is purely indicative and non-exhaustive.

REV	DATE	MODIFICATION	DRAWN	CHECKED	APPROVED
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C	21/07/2026	PPC'S COMMENTS (2026-05-25)	RBC	FWI	SDM
B	13/04/2026	PPC'S COMMENTS (2026-03-09)	RBC	FWI	SDM
A	04/12/2025	FIRST EDITION	RBC	FWI	SDM

Customer
GREECE - WEST MACEDONIA
PUBLIC POWER CORPORATION S.A. (PPC SA)

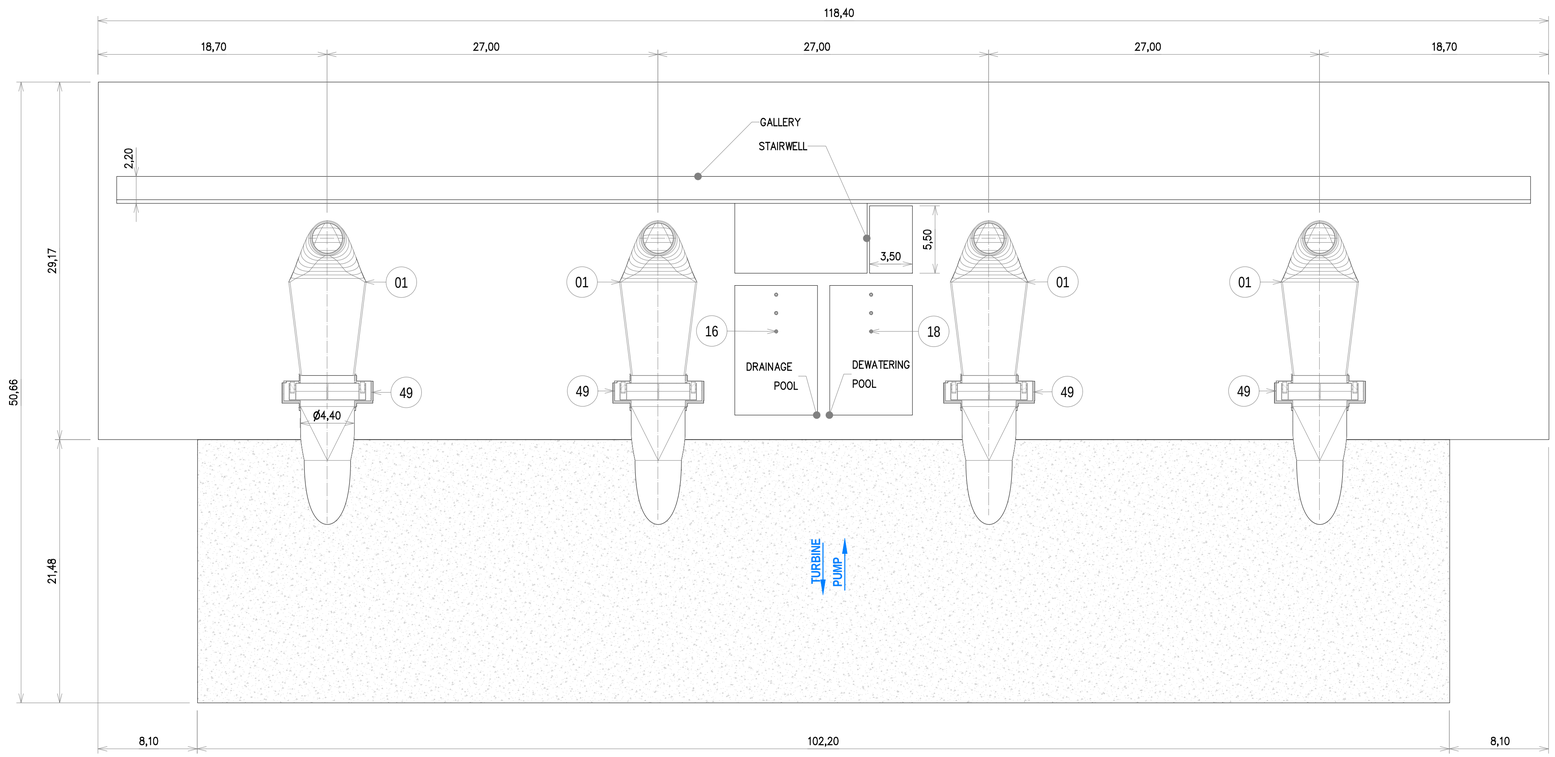
Project
South Field PHS Plant
FEASIBILITY STUDY

Subject
POWERHOUSE
SPIRAL CASE LEVEL

TRACTEBEL ENGINEERING S.A
Euroatrium - 7 rue Emmy Noether
93400 Saint-Ouen - FRANCE

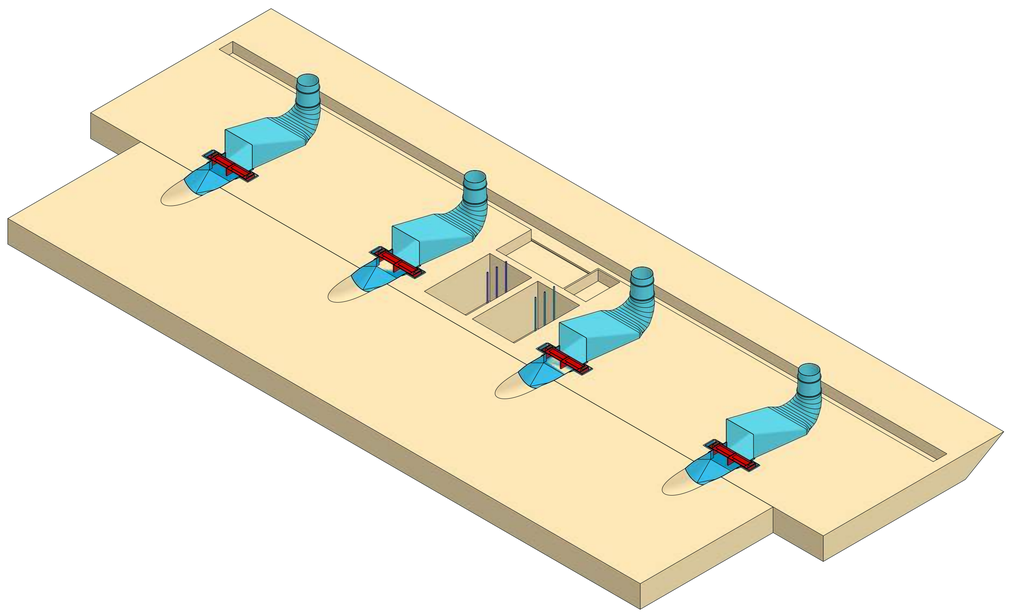
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issuer: EFE
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Rev.: C

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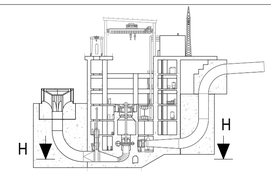


SECTION H-H

SC. 1 :250



KEY PLAN



BILL OF MATERIALS			BILL OF MATERIALS		
ITEM	QTY	DESCRIPTION	ITEM	QTY	DESCRIPTION
01	4	TURBINE–PUMP (T/P)	34	4	COMMON AUX. DISTR. PANEL BOARD
02	4	GENERATOR–MOTOR	35	4	HIGH PRESSURE PENSTOCK
03	2	POWER TRANSFORMER	36	4	UNIT AUX. DISTR. PANEL BOARD
04	4	INTERMEDIATE SHAFT	37	2	DIESEL TANK
05	4	SFC TRANSFORMER	38	2	EMERGENCY DIESEL GENERATOR
06	1	DTG/LOWER INTAKE GRANTRY CRANE	39	28	MV – 15,75kV SWITCHBOARD
07	2	HP AIR TANK – COMMON	40	4	MV – 15,75kV SWITCHBOARD
08	8	PHASE REVERSAL SWITCH	41	4	MV – 15,75kV SWITCHBOARD
09	4	GENERATOR CIRCUIT BREAKER	42	4	COMMON AUX. CONTROLLER (PLC)
10	1	MV BUSDUCT SET	43	4	UNIT AUX. MV SWITCHBOARD
11	4	MIV HYDRAULIC PRESSURE UNIT	44	24	UNIT CONTROL CUBICLE
12	2	CURRENT LIMITING REACTOR – SFC	45	6	UNIT CONTROL CUBICLE
13	4	T/P HYDRAULIC PRESSURE UNIT	46	4	UNIT CONTROL CUBICLE
14	1	MAIN OVERHEAD BRIDGE CRANE	47	4	AIR TANK – UNIT BREAKING
15	4	DTG HYDRAULIC PRESSURE UNIT	48	6	AIR HANDLING UNIT (AHU) – MH
16	3	DEWATERING PUMP	49	4	DRAFT TUBE GATE (W/ MAINT. FLAP)
17	2	STATION SERVICE TRANSFORMER	50	6	WATER CHILLER – MH
18	3	DRAINAGE PUMP	51	4	EXCITATION TRANSFORMER
19	4	FIRE FIGHTING CO2 RACK	52	2	HV LINES GANTRY
20	8	UNIT COOLING WATER PUMP	53	24	LOWER INTAKE GRILLE – ELEMENT
21	8	COOLING WATER FILTER	54	1	TRANSFORMER RAILS
22	16	BATTERY RACK	55	8	HEAT EXCHANGER – TURBINE BEARING
23	2	BATTERY CHARGER	56	1	GUARDRAILS
24	8	DC DISTRIBUTION BOARD	57	4	LP AIR TANK – SERVICE
25	6	TELECOMMUNICATION BOARD	58	4	LP AIR COMPRESSOR – SERVICE
26	24	SERVER CUBICLE	59	1	ROOF STRUCTURE
27	4	HP AIR TANK – BLOWDOWN SYSTEM	60	4	HP AIR COMPRESSOR – UNIT
28	2	OFFICE DESK	61	1	EMERGENCY DEWATERING PENSTOCK
29	1	MAIN CONTROL DESK	62	4	WATERWAY TRANSITION LINER
30	2	STATIC FREQUENCY CONVERTER	64	2	ED OUTLET VALVE
31	4	MIV DISMANTLING JOINT	63	2	EMERGENCY DEWATERING (ED) VALVE
32	4	MAIN INLET VALVE	65	2	ED DISMANTLING JOINT
33	2	MAIN FIRE PUMP	66	2	ED INLET VALVE

LEGEND

E01 Item Number

Concrete in section

Backfill in section

-50.00 Elevation level (m.a.s.l)

TURBINE Flow in turbine mode

PUMP Flow in pump mode

NOTES

1.- Overall dimensions will be confirmed at later design stage.

2.- The part list is purely indicative and non-exhaustive.

REV	DATE	MODIFICATION	DRAWN	CHECKED	APPROVED
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C	21/07/2026	PPC'S COMMENTS (2026-05-25)	RBC	FWI	SDM
B	13/04/2026	PPC'S COMMENTS (2026-03-09)	RBC	FWI	SDM
A	04/12/2025	FIRST EDITION	RBC	FWI	SDM

Customer

GREECE - WEST MACEDONIA

PUBLIC POWER CORPORATION S.A. (PPC SA)

Project

South Field PHS Plant

FEASIBILITY STUDY

Subject

POWERHOUSE

DRAFT TUBE LEVEL

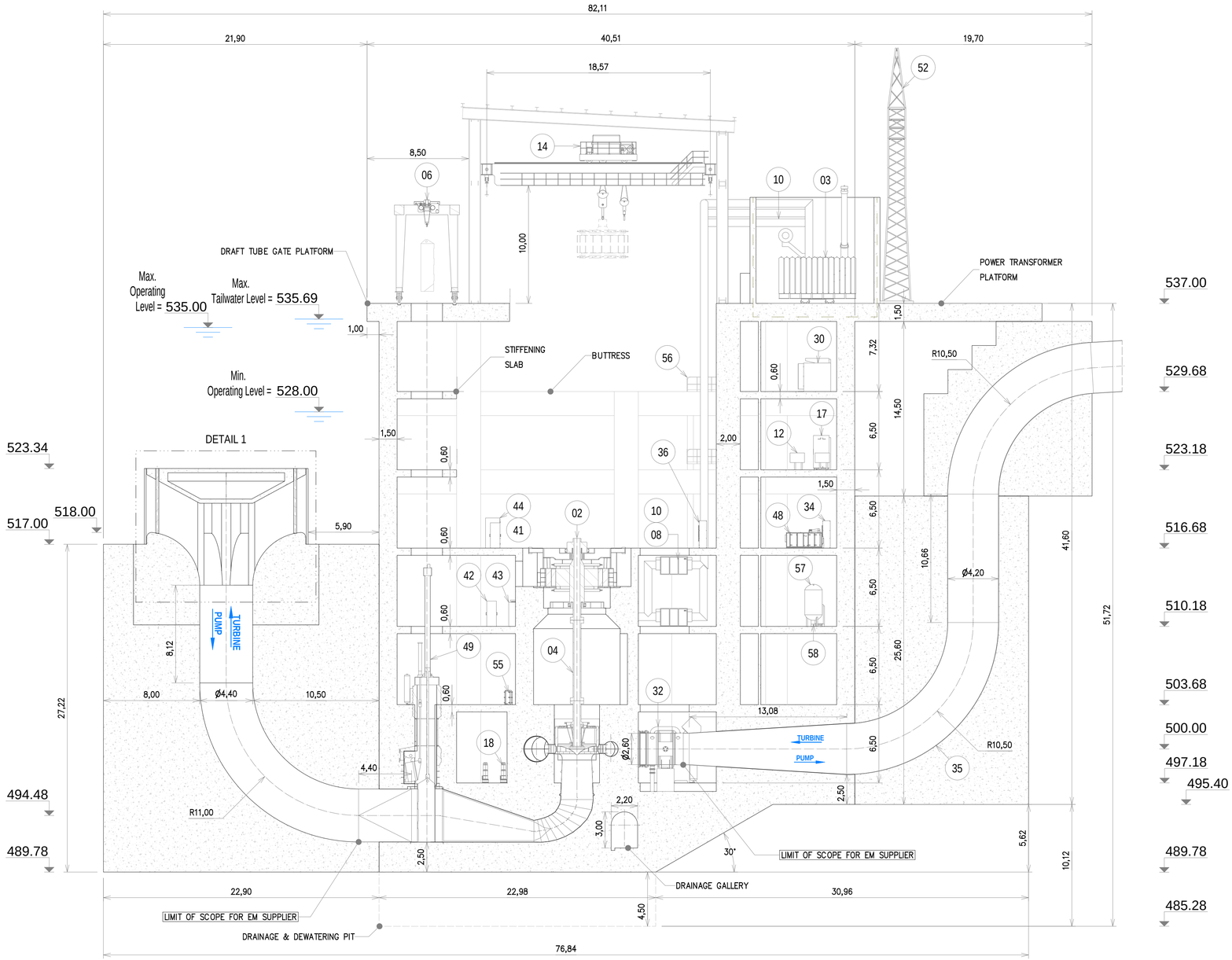
TRACTEBEL ENGINEERING S.A
Euroatrium - 7 rue Emmy Noether
93400 Saint-Ouen - FRANCE

External Reference	Confidentiality Level
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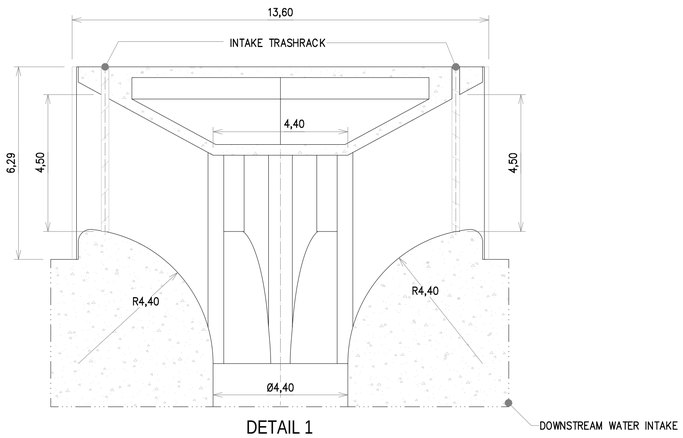
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Drawing Name	Rev.
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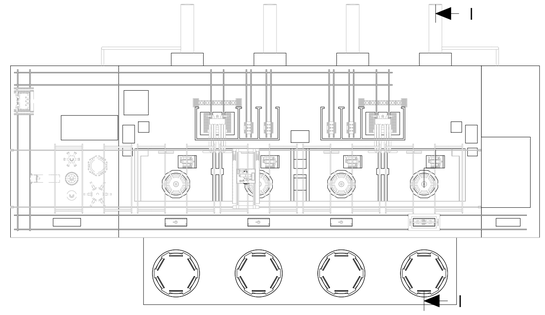
SECTION I-I
SC. 1 : 200



DETAIL 1
SC. 1 : 100

BILL OF MATERIALS			BILL OF MATERIALS			BILL OF MATERIALS		
ITEM	QTY	DESCRIPTION	ITEM	QTY	DESCRIPTION	ITEM	QTY	DESCRIPTION
01	4	TURBINE–PUMP (T/P)	23	2	BATTERY CHARGER	45	6	UNIT CONTROL CUBICLE
02	4	GENERATOR–MOTOR	24	8	DC DISTRIBUTION BOARD	46	4	UNIT CONTROL CUBICLE
03	2	POWER TRANSFORMER	25	6	TELECOMMUNICATION BOARD	47	4	AIR TANK – UNIT BREAKING
04	4	INTERMEDIATE SHAFT	26	24	SERVER CUBICLE	48	6	AIR HANDLING UNIT (AHU) – MH
05	4	SFC TRANSFORMER	27	4	HP AIR TANK – BLOWDOWN SYSTEM	49	4	DRAFT TUBE GATE (W/ MAINT. FLAP)
06	1	DTG/LOWER INTAKE GRANTRY CRANE	28	2	OFFICE DESK	50	6	WATER CHILLER – MH
07	2	HP AIR TANK – COMMON	29	1	MAIN CONTROL DESK	51	4	EXCITATION TRANSFORMER
08	8	PHASE REVERSAL SWITCH	30	2	STATIC FREQUENCY CONVERTER	52	2	HV LINES GANTRY
09	4	GENERATOR CIRCUIT BREAKER	31	4	MIV DISMANTLING JOINT	53	24	LOWER INTAKE GRILLE – ELEMENT
10	1	MV BUSDUCT SET	32	4	MAIN INLET VALVE	54	1	TRANSFORMER RAILS
11	4	MIV HYDRAULIC PRESSURE UNIT	33	2	MAIN FIRE PUMP	55	8	HEAT EXCHANGER – TURBINE BEARING
12	2	CURRENT LIMITING REACTOR – SFC	34	4	COMMON AUX. DISTR. PANEL BOARD	56	1	GUARDRAILS
13	4	T/P HYDRAULIC PRESSURE UNIT	35	4	HIGH PRESSURE PENSTOCK	57	4	LP AIR TANK – SERVICE
14	1	MAIN OVERHEAD BRIDGE CRANE	36	4	UNIT AUX. DISTR. PANEL BOARD	58	4	LP AIR COMPRESSOR – SERVICE
15	4	DTG HYDRAULIC PRESSURE UNIT	37	2	DIESEL TANK	59	1	ROOF STRUCTURE
16	3	DEWATERING PUMP	38	2	EMERGENCY DIESEL GENERATOR	60	4	HP AIR COMPRESSOR – UNIT
17	2	STATION SERVICE TRANSFORMER	39	28	MV – 15,75kV SWITCHBOARD	61	1	EMERGENCY DEWATERING PENSTOCK
18	3	DRAINAGE PUMP	40	4	MV – 15,75kV SWITCHBOARD	62	4	WATERWAY TRANSITION LINER
19	4	FIRE FIGHTING CO2 RACK	41	4	MV – 15,75kV SWITCHBOARD	64	2	ED OUTLET VALVE
20	8	UNIT COOLING WATER PUMP	42	4	COMMON AUX. CONTROLLER (PLC)	63	2	EMERGENCY DEWATERING (ED) VALVE
21	8	COOLING WATER FILTER	43	4	UNIT AUX. MV SWITCHBOARD	65	2	ED DISMANTLING JOINT
22	16	BATTERY RACK	44	24	UNIT CONTROL CUBICLE	66	2	ED INLET VALVE

KEY PLAN



LEGEND

- E01 → Item Number
- Concrete in section
- Backfill in section
- -50.00 Elevation level (m.a.s.l)
- TURBINE → Flow in turbine mode
- PUMP → Flow in pump mode

NOTES
1.- Overall dimensions will be confirmed at later design stage.
2.- The part list is purely indicative and non-exhaustive.

REV	DATE	MODIFICATION	DRAWN	CHECKED	APPROVED
D					
C	21/07/2026	PPC'S COMMENTS (2026-05-25)	RBC	FWI	SDM
B	13/04/2026	PPC'S COMMENTS (2026-03-09)	RBC	FWI	SDM
A	04/12/2025	FIRST EDITION	RBC	FWI	SDM

Customer
GREECE - WEST MACEDONIA
PUBLIC POWER CORPORATION S.A. (PPC SA)

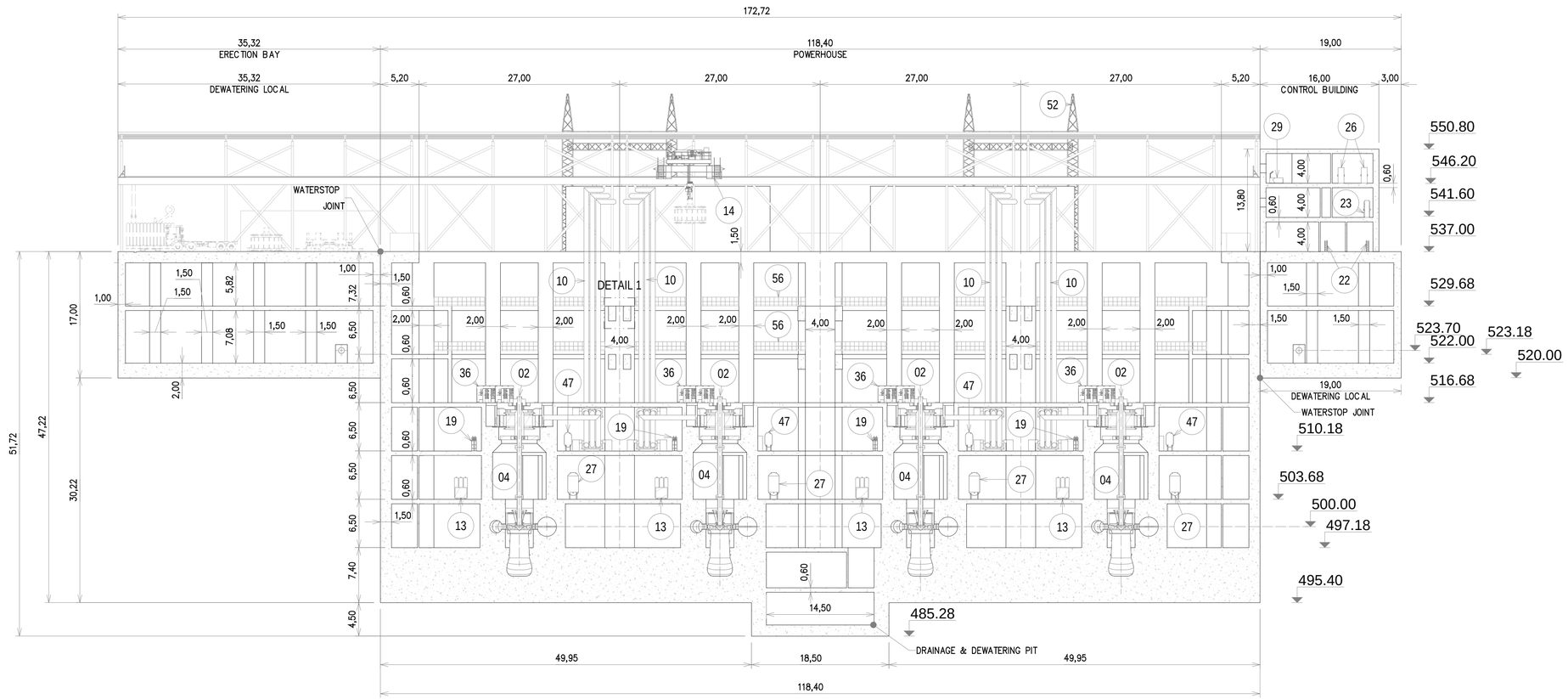
Project
South Field PHS Plant
FEASIBILITY STUDY

Subject
POWERHOUSE
CROSS SECTION

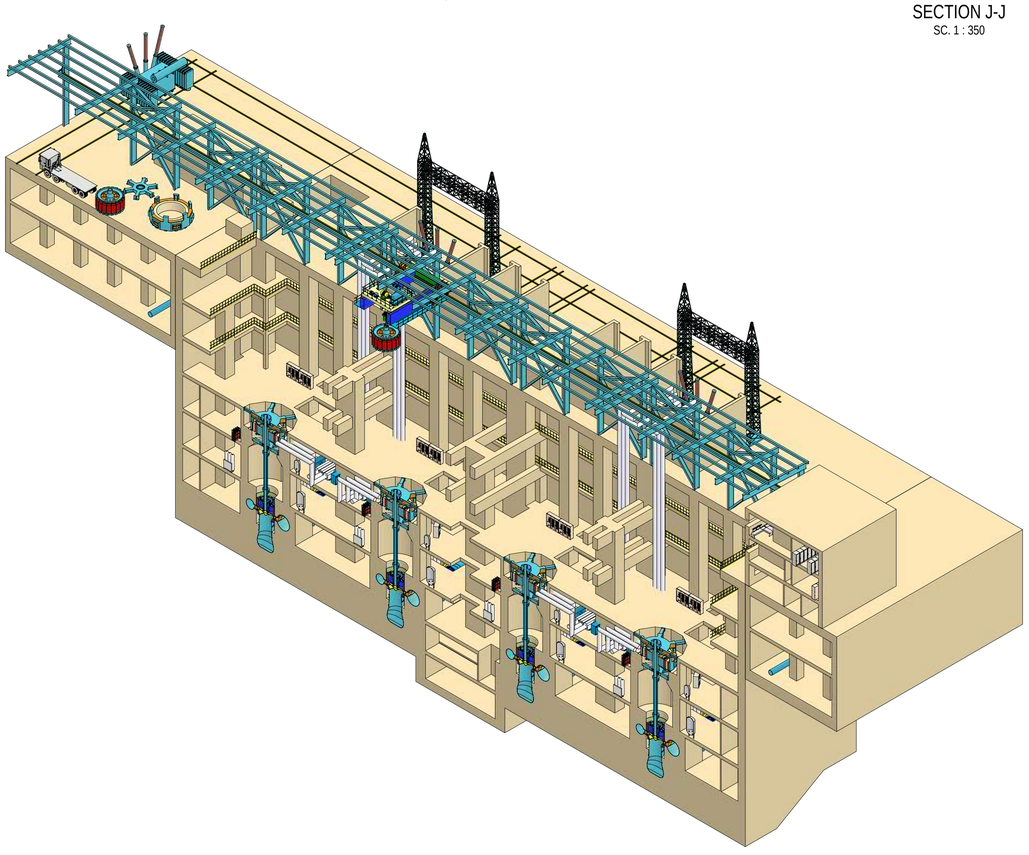
TRACTEBEL ENGINEERING S.A
Euroatrium - 7 rue Emmy Noether
93400 Saint-Ouen - FRANCE

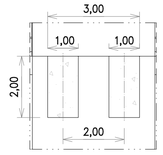
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Issuer: EFE
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Rev.: C

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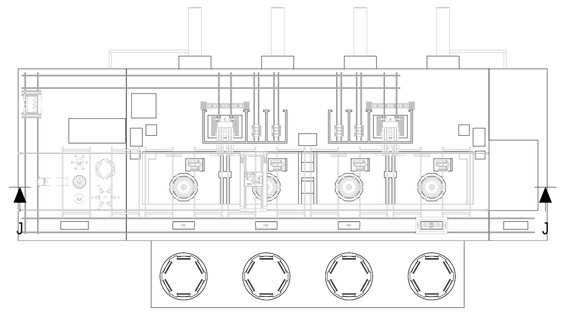
SECTION J-J
SC. 1 : 350





DETAIL 1
SC. 1 : 100

KEY PLAN



LEGEND

- E01 — Item Number
- Concrete in section
- Backfill in section
- TURBINE — Flow in turbine mode
- PUMP — Flow in pump mode
- -50.00 — Elevation level (m.a.s.l)

NOTES
1.- Overall dimensions will be confirmed at later design stage.
2.- The part list is purely indicative and non-exhaustive.

BILL OF MATERIALS			BILL OF MATERIALS		
ITEM	QTY	DESCRIPTION	ITEM	QTY	DESCRIPTION
01	4	TURBINE–PUMP (T/P)	34	4	COMMON AUX. DISTR. PANEL BOARD
02	4	GENERATOR–MOTOR	35	4	HIGH PRESSURE PENSTOCK
03	2	POWER TRANSFORMER	36	4	UNIT AUX. DISTR. PANEL BOARD
04	4	INTERMEDIATE SHAFT	37	2	DIESEL TANK
05	4	SFC TRANSFORMER	38	2	EMERGENCY DIESEL GENERATOR
06	1	DTG/LOWER INTAKE GRANTRY CRANE	39	28	MV – 15,75kV SWITCHBOARD
07	2	HP AIR TANK – COMMON	40	4	MV – 15,75kV SWITCHBOARD
08	8	PHASE REVERSAL SWITCH	41	4	MV – 15,75kV SWITCHBOARD
09	4	GENERATOR CIRCUIT BREAKER	42	4	COMMON AUX. CONTROLLER (PLC)
10	1	MV BUSDUCT SET	43	4	UNIT AUX. MV SWITCHBOARD
11	4	MIV HYDRAULIC PRESSURE UNIT	44	24	UNIT CONTROL CUBICLE
12	2	CURRENT LIMITING REACTOR – SFC	45	6	UNIT CONTROL CUBICLE
13	4	T/P HYDRAULIC PRESSURE UNIT	46	4	UNIT CONTROL CUBICLE
14	1	MAIN OVERHEAD BRIDGE CRANE	47	4	AIR TANK – UNIT BREAKING
15	4	DTG HYDRAULIC PRESSURE UNIT	48	6	AIR HANDLING UNIT (AHU) – MH
16	3	DEWATERING PUMP	49	4	DRAFT TUBE GATE (W/ MAINT. FLAP)
17	2	STATION SERVICE TRANSFORMER	50	6	WATER CHILLER – MH
18	3	DRAINAGE PUMP	51	4	EXCITATION TRANSFORMER
19	4	FIRE FIGHTING CO2 RACK	52	2	HV LINES GANTRY
20	8	UNIT COOLING WATER PUMP	53	24	LOWER INTAKE GRILLE – ELEMENT
21	8	COOLING WATER FILTER	54	1	TRANSFORMER RAILS
22	16	BATTERY RACK	55	8	HEAT EXCHANGER – TURBINE BEARING
23	2	BATTERY CHARGER	56	1	GUARDRAILS
24	8	DC DISTRIBUTION BOARD	57	4	LP AIR TANK – SERVICE
25	6	TELECOMMUNICATION BOARD	58	4	LP AIR COMPRESSOR – SERVICE
26	24	SERVER CUBICLE	59	1	ROOF STRUCTURE
27	4	HP AIR TANK – BLOWDOWN SYSTEM	60	4	HP AIR COMPRESSOR – UNIT
28	2	OFFICE DESK	61	1	EMERGENCY DEWATERING PENSTOCK
29	1	MAIN CONTROL DESK	62	4	WATERWAY TRANSITION LINER
30	2	STATIC FREQUENCY CONVERTER	64	2	ED OUTLET VALVE
31	4	MIV DISMANTLING JOINT	63	2	EMERGENCY DEWATERING (ED) VALVE
32	4	MAIN INLET VALVE	65	2	ED DISMANTLING JOINT
33	2	MAIN FIRE PUMP	66	2	ED INLET VALVE

REV	DATE	MODIFICATION	DRAWN	CHECKED	APPROVED
D					
C	21/07/2026	PPC'S COMMENTS (2026-05-25)	RBC	FWI	SDM
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A	04/12/2025	FIRST EDITION	RBC	FWI	SDM

Customer
GREECE - WEST MACEDONIA
PUBLIC POWER CORPORATION S.A. (PPC SA)

Project
South Field PHS Plant
FEASIBILITY STUDY

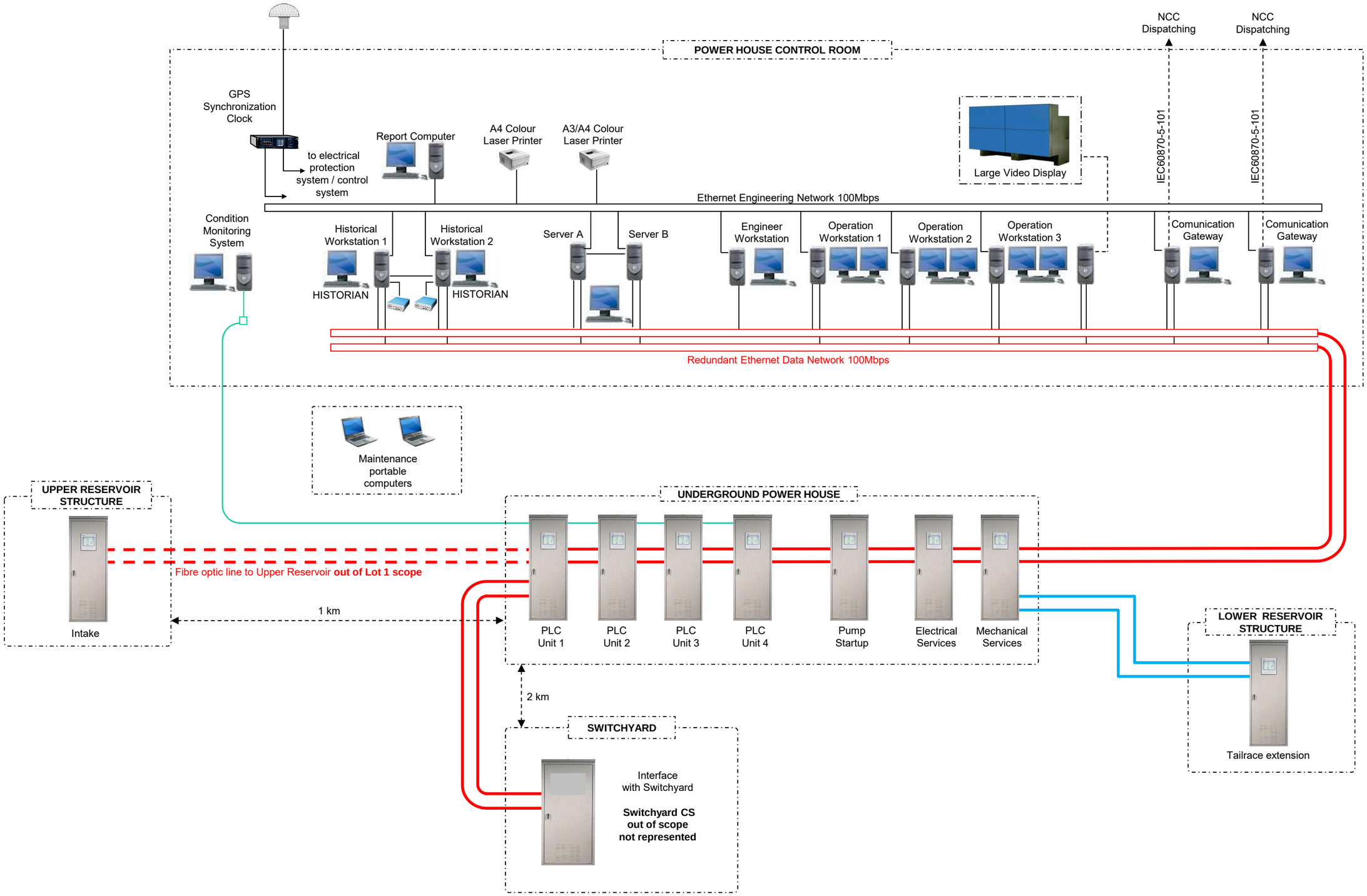
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LONGITUDINAL CROSS SECTION

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SOUTH FIELD PHS
SUPERVISORY & CONTROL SYSTEM CONFIGURATION



General Technical Specifications (GTS)

DRAFT

PPC

GREECE



RESTRICTED

September 23, 2026

REPORT

W.004668-APDXC-000005-B

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REPORT

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General Technical Specifications

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General Technical Specifications

LIST OF ABBREVIATIONS AND ACRONYMS

CFSM	Converter-Fed Synchronous Machine
DEM	Digital Elevation Model
DFIM	Doubly-Fed Induction Machine
D/S	Downstream
EOT	Electric Overhead Travelling
EU	European Union
EUR	Euro
USD	United States Dollar
GDR	Geotechnical Data Report
GBR	Geotechnical Baseline Report
GRA	Geological Risk Assessment
GU	Geotechnical Unit
HDPE	High Density PolyEthylene
HSS	Hydraulic Steel Structure
MW	Mega Watt
MVA	Mega Volt Ampere
PFS	Pre-Feasibility Study
PHS	Pumped Hydroelectric Storage
PPC	Public Power Corporation
RfG	Requirements for Generators
rpm	Rotation Per Minute
U/S	Upstream

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0 PREAMBLE

The present document defines the general requirements, rules and principles applying to the overall electromechanical (EM) and hydromechanical (HM) equipment that comprise the scope of work for the Contract.

These general rules and principles shall be read in conjunction with the requirements defined in the Particular Technical Specifications for the equipment and other Contract documents, in particular the General Requirements.

Should the Particular Technical Specifications for the equipment contradict these General Technical Specifications, the most constraining rule shall prevail.

The general rules and principles stated herein, as well as the requirements of the Particular Technical Specifications, are not restrictive.

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1 DESIGN OF THE EQUIPMENT

The design of all components of the electromechanical and hydromechanical equipment shall comply with current international Good Engineering Practices and be compatible with requirements of high reliability and durability.

The procurement and manufacturing of the components shall rely exclusively on materials, items and sub-components that are entirely new and of quality necessary for the intended purpose. No repairs by welding, patch or any other means of repair shall be permitted to remedy a defect in material or an error in construction without the prior written consent of the Owner, who may impose any controls he deems useful, at the expense of the Contractor. Below given thresholds to be proposed by the Contractor, component by component, the defects repair may be undertaken by the Contractor unilaterally in order not to interrupt the manufacturing processes in an extensive way. The thresholds shall be agreed by the Owner and are assumed to be in line with recognized standards (ex. CCH70-4 for casted components).

The Contractor agrees to perform all required studies and research necessary to justify the choices of technical and technological solutions proposed. These choices shall also be based, as far as possible, on experience acquired in the design and operation of comparable equipment.

In order to successfully complete his studies, the Contractor also agrees to undertake appropriate or necessary arrangements with other contractors concerning all topics involving areas of interface.

1.1 Design of the layout

The Installations shall be designed to ensure reliable and easy operation and maintenance under all circumstances, requiring only minimal maintenance resources and without the interruption of the plant routine operation.

Equipment design shall fully consider the prevailing environment at the site of the works – climate, seismic conditions, water quality, etc. The Contractor is required to fully ascertain these environmental conditions before submitting his Bid.

1.2 Design hypotheses and working stresses of materials

Ample factors of safety according to recognized design practices shall be used throughout the design of the equipment, especially in the design of parts and components subject to alternating stresses, vibration, impact or shock.

1.2.1 Hydraulic Steel Structure

Hydraulic steel structure comprise the structural steelwork subjected to loading due to water pressure: gate and stoplogs bodies, with seals and bearings, and the associated machinery and electrical equipment required for operating and supporting the gates, as well as dedicated handling equipment. It concerns both the fixed parts and the moving parts.

By extension, penstocks, steel liners as well as trash racks and their fittings shall also be considered as part of the hydraulic steel structures.

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The design of hydraulic steel structures shall mainly comply with the requirements of the latest edition of the DIN 19704 standard for gates, stoplogs and trash racks and with the requirements of the latest edition of the ASCE and CECT standards for penstocks and steel liners.

In particular, the following design aspects will be based on the provisions of the applicable standards:

- Material characteristics
- Determination of actions and their characteristic values, including friction effects
- Analysis of the effects of actions,
- Analysis of resistances (allowable stress levels)
- Analysis procedures
- Ultimate limit states verification (equilibrium, stability, and structural strength)
- Serviceability limit state verification (deformations compatibility, closing pressure)
- Constructive requirements

1.2.2Hydraulic Machinery

Hydraulic machinery comprises the turbines, pump-turbines, generator, generator-motor, main inlet valve and their fixed and moving parts.

1.2.2.1Loading conditions:

In general, the loading shall be divided into 3 different classes according to the following typical examples.

Normal Operating Loading	Exceptional Loading Cases	Extreme Loading Cases
Daily occurrences (depending on the project)	Happens 1 to 10 times per year	Happens 1 to 10 times per component lifetime
- Normal operation under the defined plant boundary condition within the limits defined, including normal flood conditions -Full load rejection -Start/Stops and transition as defined for the project.	- Failure of an emergency closing (valve, guide apparatus) - Activation of a safety element (shear pin, safety valve) - Runaway condition - Generator short circuit, bi and tri-phases - Earthquake (Operation Basis Earthquake) - Blocking of 1 servomotor for double servomotor operated servomotor - Operation against one locking device	- Failure of 2 emergency closing devices in series or parallel, if installed - Off-cam runaway condition for double regulated machines - Pressure test - Pipe or penstock rupture - Generator synchronization failure - Generator short circuit on 50% of the poles - Loading during installation and embedment - Earthquake (Maximum Credible Earthquake/Maximum Design Earthquake)

Such loading case definitions are linked to the stress levels described below.

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1.2.2.2Strength requirements

The design of the hydraulic machinery shall be verified, with sufficient safety margin, against plastic collapse, local failure, buckling, and cyclic loading. Serviceability shall also be checked: the compatibility of the deformation/deflection of the components with the available clearances.

Stress levels and deformations shall be examined by mean of reference strength of material analytical methods or by the way of numerical stress analysis (e.g. Finite Element Analysis).

A numerical stress analysis shall conform to the detailed design procedure described in **ASME Boiler and Pressure Vessel Code Section VIII division 2 Part 5**, applicable to the items submitted to a pressure test.

The allowable stresses *S* are determined as a fraction of the minimum yield strength.

The various loads for normal loading shall be combined if physically possible, and the most severe combination shall determine the design conditions. At unusual and extreme loading, each unusual or extreme load cases shall be combined with the most severe normal loading. Unusual or extreme load cases need not be combined.

1.2.3Bolting design criteria

1.2.3.1General consideration

Smaller diameters and long length screws shall always be preferred. Only rolled thread shall be used.

1.2.3.2Material characteristics:

Bolting material shall be carbon steel alloy-steel or stainless steels.

1.2.3.3Allowable equivalent stresses

	Normal Operating Condition	Exceptional & Extreme Condition
Carbon Steel and Alloy-steel	Min (S_Y/3 ;S_T/4)	S_Y/2
Stainless steel	S_T/4	S_T/3

SY : Yield Strength
ST : Tensile Strength

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1.2.3.4Bolt Pre-loading

Pre-load torque shall be sufficient to ensure permanent contact between elements or to provide a sufficient watertightness in assembled elements under pressure, however prestressing equivalent stress (combined tension and torsion) shall be less than 0.85SY. Bolts shall be higher material property classes (at least class 8.8 as per ISO831 for carbon steel) and tightened using a controlled tightening method.

1.2.4 Sizing Stresses exerted upon civil works

All equipment shall be properly anchored into the civil structural works.

- Anchoring system shall consist of :
- A Rigid fixture constituted by a metallic base plate,
- A set of embedded headed anchors.

Metal plates (both base plates and embedded head plates) supporting the equipment shall be properly dimensioned so that the most unfavorable loading situation shall not induce compressive stresses in the concrete exceeding 7 MPa.

Rotating machinery or equipment submitted to alternating loads shall be anchored by mean of pre-stressed embedded anchors or crossing pre-stressed anchors.

Shear forces on the anchoring system shall be resisted by the anchors, or by dedicated specific shear connectors in case of active (prestressed) anchor. Account for friction resistance at the concrete interface is not allowed.

The Contractor shall submit to the Owner all the necessary information related to the interface between the equipment and the civil work structure:

- The technical design of the anchor system (dimensions and materials, and pre-stressing forces whenever relevant)
- The total reaction forces and moments, distinguishing, for each load cases, the dead loads, the live loads and the service loads.
- The forces and moments reactions at each equipment supports, distinguishing, for each load cases, the dead loads, the live loads and the service loads
- All those information shall be consolidated in a dedicated foundation calculation report load report.

1.2.5 Sizing for seismic loads

Wherever relevant, the Contractor shall take into account seismic-generated stresses by combining vertical and horizontal accelerations in their most unfavourable configuration. For each of these accelerations, the site maximum peak ground acceleration shall be considered. The values to be considered shall not be less than 0.1g

1.3 Calculation notes

Calculation notes shall be submitted by the Contractor for review and comments by the Owner. However, the Owner may, at any time during the Contract period, request from the Contractor any additional calculation notes that he may consider useful; these calculation notes shall be

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submitted and within a reasonable time period reviewed and commented by the Owner as indicated in the Contract

1.4 Grouping by functional units

In order to increase the overall reliability of the equipment and guarantee the safety of operating personnel, the various power equipment items, as well as the various monitoring, control and automation systems, shall be grouped in separate functional units. The organization will be reflected in the way to number the drawing and documents as well as in the way to identify systems, sub-systems and components.

The natural partition of the scheme shall be as follows:

- **Dam equipment**, including:
  - Bottom outlet
  - Spillway

- **Waterways**, including:
  - Water intakes
  - Headrace tunnel
  - Upper surge shaft
  - Lined shaft and penstock
  - Manifold feeder of the turbine-pump units
  - Draft tubes
  - Lower surge tank
  - Tailrace tunnel

- **Generating unit**, including for each unit:
  - Main Inlet valve
  - Turbine
  - Generator
  - MV (medium-voltage) connections
  - Main transformer
  - VHV (very-high-voltage) connections
  - HV (high-voltage) circuit breaker bay
  - VHV busbar section isolators
  - Hydraulic, mechanical and electrical auxiliaries dedicated to the turbine-alternator unit

- **High and Very High Voltage line**, including, for each line:
  - All the bay equipment from the VHV circuit breakers to the conductor supports of the overhead power lines.

- **Transfer and VHV busbars**, including:
  - Voltage transformers
  - VHV earthing switches
  - All transfer bay equipment found between the two VHV isolating switches
  - Differential busbar protection

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- **Medium-voltage equipment**, including:
  - All incoming cubicles
  - Set of busbars
  - Voltage control
  - Outgoing cubicles of the underground and overhead types

- **General auxiliaries**, including:
  - All auxiliary systems shared by the Installation and not allocated to a turbine-alternator unit

- **Alternating current auxiliaries**, including low-voltage energy generation and distribution systems, as well as:
  - Transformers for the auxiliaries
  - Low-voltage switchboard
  - Emergency hydraulic unit
  - Emergency thermal unit / diesel generator
  - Automatic source-switching device

- **Direct current auxiliaries**, including the alternative sources, which include:
  - Electrochemical storage batteries
  - Charger-rectifiers
  - Direct-current general switchboards

1.5 Redundancy

Where the generation of electrical energy depends on the availability of essential and critical hydro-electromechanical auxiliaries, those auxiliaries shall be duplicated. Two complete sets or devices of redundant auxiliaries shall then be implemented.

In such a case, switching from the selected priority set or devices to the emergency one shall be performed by an automated mechanism, and the primary sensors initializing the emergency reactivation shall also be completely redundant.

1.6 Operation

The equipment shall be designed so as to facilitate operation, while taking particular care to ensure complete safety against the risks of operational errors, and to permanently allow convenient control of the equipment's satisfactory performance.

The Contractor shall take into account the fact that normal operation will be carried out by remote control and, during emergencies, operated locally in front of the equipment by the operating staff. Consequently, the equipment shall be designed to operate without local supervision, and shall include all necessary devices to remotely transmit the physical parameters of the process and any detection of faults, as well as anomalous operations.

The various components of the Project shall be laid out so as to be easily accessible for operation, maintenance, inspection and eventual repairs. Platforms, access ladders, manholes,

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inspection holes, handling hooks, guardrails, handrails, emergency lighting, covers and laggings etc., shall be integral parts of the finished Installations delivered by the Contractor. The scope of supply may vary according to the lots division of work of the project.

All equipment shall bear a nameplate displaying its main characteristics in English. The various components shall be located and painted according to conventions, in conformance with the lists of equipment, drawings and diagrams. Special care shall be taken to avoid painting of nameplates.

All spherical valves, safety valves, check valves and other various valves, as well as the equipment required for electrical switch-off and full isolation, shall be fitted with reliable position indicators that unambiguously display whether they are opened or closed, engaged or disengaged.

Lubrication systems, sensors and control components shall be easily accessible. Gauging or level measurement devices, manometers, flowmeters, thermometers and other indicators shall be of the direct-reading type, easy-to-read, graduated in legal units and suitably oriented.

Main components shall be equipped with elapsed time meters as well as operation counters that record the number of start-ups, engagements and disengagements, thereby allowing the possibility of programming maintenance operations and replacement of wearing parts.

1.7 Maintenance

The equipment shall be designed to facilitate assembly, disassembly, reassembly, maintenance and repair operations.

Aside from justified exceptions, explicitly agreed in writing by the Owner, the disassembly and reassembly of a unit shall not:

- Involve any interventions on any parts of civil works
- Involve the disassembly of another unit not directly concerned
- Require the intervention of specialists
- Necessitate the use of special tools and tool sets other than those explicitly provided by the Contractor

It shall be possible to carry out disassembly of any mechanical component, pump or valve, in complete safety, and requiring only minor draining of fluids from the circuit in which it is integrated. The procedures for draining circuits shall be provided by the Contractor. In order not to disturb operations, and thus the supply of electrical energy, all arrangements shall be made by the Contractor to allow, during ongoing operation, the replacement of sections of the Installation that require systematic interventions, such as:

- Replacement of a component part of a redundant arrangement
- Cleaning of filters
- Unclogging of water and oil circuits of heat exchangers
- Replacement of lamps, indicator lights, fuses, indicating instruments, cartridges, diaphragms, etc.

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In this regard, the design shall include the following:

- During full operation, test devices shall activate electrical protection relays.
- Wiring continuity control devices shall guarantee the main sequences of disengagement.

Parts prone to wear during normal operation shall be provided with removable linings in order to allow their replacement, or their rapid and economic repair. The technical sheets describing these parts shall include operation and maintenance instructions.

Equipment elements shall include permanent devices facilitating their handling – handles, rings, lifting eye bolts, service clips, etc. Loosening screws shall be provided with parts likely to be disconnected. Accessories, devices and special tools necessary for handling, removal and storage – shackles, hooks, slings, wedges, hoists, monorails, dismountable floors, chairs, bases and various supports, etc. – shall be integral parts of the finished Installations delivered by the Contractor.

The Contractor shall include in his design guideline drawings of all relevant details related to the permanent devices to be embedded in the civil works, either first and second stage concreting whose purpose is to facilitate disassembly and reassembly operations (pins, hooks, pegs, plates, etc., embedded in concrete). Supply of these devices is an integral part of the present Contract.

The various technical levels and floors of the hydroelectric power station buildings and of the associated HV substation shall be equipped with access grooves. The appropriate covering of these grooves is an integral part of the present Contract.

All of the hydraulic structures (intakes, bottom outlets, penstocks, drainage and dewatering systems, etc.) and all hydromechanical equipment, in general, shall be designed to sustain industrial-grade operation for a minimum period of five (5) years between dewatering for inspection and maintenance.

1.8 Safety of personnel and protection of equipment

The Installations shall be designed according to the safety codes and regulation applicable in Greece and in the EU to ensure full and total personnel safety, to protect materials and equipment, and to prevent any accidental contact with moving or electrically operated components.

Materials and components such as insulators, supports, protection envelopes, etc., shall:

- Be protected against degradation by rodents
- Be fireproof
- Be flame-retardant
- Emit no harmful substances under all conditions

All bolts, screws, etc., of rotating parts, or subject to vibration, shall be made "self-locking and shake-proof" by appropriate locking devices, after having been tightened using suitable tools (such as a torque wrench).

Accessible mobile components shall be protected with cowlings, screens, grids or caps. When necessary, the Contractor shall plan, from the very first assembly operations, the installation of footbridges and safe work areas, and shall set up all required guardrails, ladders and railings. These provisions are integral parts of the present Contract.

The planned circulation paths for the operators shall be clear of any obstacle, with clearance heights and widths adequate for the purpose.

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The various technical levels and floors of the hydroelectric power station buildings and the associated very-high-voltage substation shall be accessible, as follows:

- By means of staircases equipped with handrails
- With a stretcher for evacuation of casualties

All hazards or dangers shall be visibly indicated by the Contractor via pictograms or standardized representations and inscriptions written in English. Security instructions, locking procedures and building evacuation diagrams shall be legibly affixed to the Installations, in the necessary quantities. Exits and evacuation paths shall be indicated by escape way markers fitted with a self-contained independent lighting system.

All equipment shall be provided with all safety devices necessary for its use, maintenance and safeguarding. Mechanical and electrical locking devices, locks and padlocks, fixed and movable grounding devices, relief valves, double insulation with intermediate bleeding on pressure lines, etc., are integral parts of the present Contract.

In humid premises, lighting and required electrical outlets shall be supplied by a safe electrical power system protected according to good engineering practices.

In easily flooded locations, all required electrical material shall be guaranteed watertight.

Electrochemical secondary cell batteries shall be located within explosion-proof premises that are completely empty of other equipment. In addition, all equipment shall be of the explosion-proof type safely ventilated.

All locations prone to water and oil spills – mechanical workshops, assembly areas and rooms hosting mechanical and oil-hydraulic auxiliaries – shall be equipped with suitable drains and covered with non-skid compounds. In these locations, and in the associated staircases, tiled floors are prohibited.

Electrical insulation devices shall be of the visible switch-off type.

All metal parts or components, whatever their function, shall be equipped with grounding devices, according to the latest relevant standards and the Particular Technical Specifications. The Contractor shall submit all related assembly standards to the Owner for review and comments.

All rooms, premises, panels, cubicles, cabinets and enclosures shall be systematically locked. Keys shall follow a general hierarchical structure that the Contractor shall submit to the Owner for review and comments.

All doors leading HV and MV electrical equipment shall be equipped with one sided panic bars allowing for safe escape.

1.9 Standardization of the supplied material – interchangeability

Identical parts and systems shall be completely interchangeable.

Interchangeability shall be provided as follows:

- By homologous parts of identical equipment for bearings, thrust bearing pads, cooling agents, guide vanes, rods, labyrinth rings, wearing plates, servomotors, shaft seals, turbine and pump wheels, complete alternator rotors and stators, complete rotor poles, stator bars and

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connections, terminals, excitation devices, brake tracks and cylinders, electric pumps, various mechanical and electrical accessories, etc.

- By auxiliaries of the same nature and characteristics for components of various equipment items, such as electrical motors, pumps, valves and plumbing, stroke limiters, resistor probes, water circulation controllers, measurement indicating devices (pressure gauges, flowmeters, thermometers, etc.), regulation devices (pressure switches, flow controllers, thermostats, etc.), switchgears, electrical contact brushes and parts, fuses, circuit breakers, contactors, switches, pushbuttons, transducers, relays, lamps, medium-voltage cells, low-voltage valves, etc., and, naturally, for all replacement and wearing parts

The Contractor shall seek to standardize the construction, as much as possible, in order to reduce the amount of spare parts and facilitate maintenance, replacement and restocking operations.

At the very beginning of the design, the Contractor shall write a standardization brief concerning the various mechanical and electrical materials, which shall be reviewed and commented by the Owner. The Contractor shall abide by the standardization brief, and shall forward the standardization brief to his suppliers and subcontractors, in order to limit the number of brand names, types and references. The Contractor shall enforce the correct application of this requirement.

The actual measurements upon which the interchangeability demand shall be explicitly indicated on the Contractor's drawings and diagrams, as well as the execution tolerances.

1.10Lubrication

Special care shall be given by the Contractor to the lubrication efficiency of moving parts. Preference shall be given to self-lubricating or lifetime-lubricated devices. Otherwise, the lubrication points of the equipment shall be grouped in an easily accessible location that is clearly marked on the equipment and on the drawings.

The Contractor shall design the equipment to use the minimum number of different types of lubricant and submit to the Owner – according to a schedule agreed upon with the Owner– the brand names, types, detailed physicochemical characteristics and quantities necessary of each type of lubricant.

The proposed oils and greases must be marketed and available in Greece and the EU.

Oils shall be free of bacteria and shall contain suitable microbiocides to prevent any bacteriological growth when in service or during normal storage. The Owner will have the oil tested, and the Contractor shall replace the entire volume of any contaminated oil systems, followed by satisfactory cleaning of the affected systems.

Unless otherwise stated in the Particular Technical Specifications, the first oil or grease filling for bearings, pressure oil systems, transformers, etc., including the necessary quantity for flushing, shall be included in the Tender Price. The Tender Price shall also include an excess of at least 25% of the net amount required.

Bearings, and other components in which oil is circulating, shall be designed to avoid air being whipped into the oil causing froth or an increase in oil volume. Contamination of air, water and ground by lubricants and fuel shall be avoided by means of appropriate designs and equipment layout, in conformance with the latest recognized standards for modern engineering practice.

The filling points for lubricating oil systems shall be provided with fine wire gauze filters to prevent ingress of dust, etc. Filling points shall be easily accessible. Drip trays shall be provided beneath filling and drain points, as well as in any other locations subject to oil leakage or spillage.

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Self-lubricating bearings and bushings shall be preferred as far as the specific pressure on the bearing allows. Bearings and bushings subject to contamination from dirty water or air shall be further protected by suitable seals, and, if necessary, by additional grease lubrication. These bearings are required to operate in or out of water, without any lubrication. Inspection and replacement frequencies of bearings and bushings will have to be specified in the corresponding operation and maintenance manual.

Sliding surfaces shall be suitable for the pressure and velocity to be imposed, without any external lubrication. In general, the sliding material shall be either pure PTFE (polytetrafluoroethylene - Teflon), glass fibre reinforced PTFE, PTFE incorporated into sintered bronze, or certain designs of bronze impregnated with or having inert lubricating materials pressed in. The outer and inner races of the bearings shall be made of corrosion-resistant materials having sufficient strength, rigidity and thermal conductance.

Low-maintenance rolling bearings shall have stainless steel races and stainless steel balls or rollers.

1.11Noise

The equipment and its installation shall be designed for maximum reduction of noise of whatever nature – more specifically, noise caused by the main units, emergency units, transformers, pumps and compressors, and, more generally, by ventilation and fluid circulation.

Should the noise limits specified in the Particular Technical Specifications for the equipment concerned be exceeded, it is the obligation of the Contractor to undertake, at his own expense, and to diligently submit to the Owner as rapidly as possible, the remedial measures necessary to reduce noise strictly to the guaranteed level, such as the addition of soundproof cowlings and/or doors.

1.12Vibrations

The design of the equipment and its configuration shall not lead to the generation of vibrations or tremors that are harmful to the equipment or to the civil works and other materials in the vicinity of the equipment.

Measuring devices, security devices and sensors that must be installed in locations where unavoidable vibrations are generated by the Installations or the main equipment, shall be systematically sheltered from the effect of these vibrations (for example, by either mounting on adequate dampening devices – silent blocks or support plates provided with anti-vibration springs – or via mounting of measuring apparatus on independent supports).

1.13Industrial aesthetics

The layout of the equipment shall lead to harmonious appearance of the equipment.

The Contractor shall consider additional coverings and envelopes, when necessary, and also when these are requested by the Owner.

Dimensions of cubicles, panels, cabinets and wall-mounted enclosures shall be standardized.

At the start of the studies, the Contractor shall submit, for the Owner's review and comments, the general rules and guidelines for equipment installation, displaying the front view of cubicles and control panels, and the equipment components of panels, cabinets and enclosures.

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1.14Sealing and degree of protection of the enclosures

Pipework dedicated to lubrication, refrigeration, compressed gas and other service fluids shall be perfectly sealed. No abnormal leaks will be tolerated.

All normal leaks, bleedings and condensates shall be carefully collected by means of suitable devices, such as funnels, drip basins, tubes, gutters, etc.

Except for locations sheltering storage batteries, which have to be sealed to avoid the possible accidental acid spillage, humid locations shall be equipped with floor drains connected to the drain network.

All measures shall be undertaken to prevent escaping oil vapours – especially those coming from bearings and rotating parts – from settling in the surrounding environment and, in particular, on electrical components.

The minimum degree of protection from the enclosures shall be as follows:

- IP42 –for equipment installed in dry and clean premises
- IP54 –for equipment installed in humid locations and in areas where water splashing can occur
- IP54 –for all sensors, whatever their natures, such as pressure controllers, thermostats, limit switches, detectors, etc.
- IP65 –for external lighting, and cubicle or cabinet exposed to the rain or immersed in water or other fluids.

1.15Choice of auxiliary equipment

The choice of auxiliary equipment is subject to the approval of the Owner.

In order to ensure easy maintenance, auxiliary equipment shall be from a recognized brand name and of current production. Equipment characteristics and reliability shall meet the service requirements of the Installations.

1.16Choice of materials and components

In the choice and use of materials and components in his equipment, the Contractor shall take into account climatic and environmental conditions. In general, all electrical materials and components shall be tropicalized.

In air-conditioned premises (with design temperature of 25°C and design relative humidity of 55%), a long-term failure of the air-conditioning system should neither prevent normal equipment operation nor cause damages.

Materials shall be non-hygroscopic, fungus-resistant and not prone to mould.

All metal parts, fittings, supports, frames, cable trays, sealing accessories, guardrails, gratings, gutter covers, etc., shall be either rustproof, hot-dip galvanized, or painted.

The choice of surface protection for each material shall ensure long-lasting qualities.

With regard to insulation, Class B is the minimum class imposed, provided that, should the Contractor retain a higher class, the guaranteed temperature rises shall remain those of Class B.

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Consequently, all equipment proposed by the Contractor shall:

- Meet the Technical Specifications
- Be selected from among the best quality hardware currently produced by well-known manufacturers
- Hold credible references related to many years of operation testifying to their reliability, their robustness and their excellent performance under the same climatic conditions as the one prevailing at the site of the Installations
- Be perfectly adapted to the conditions of use

As far as possible, the principle of galvanic separation shall be used to protect against the dangerous propagation of voltage surges. This separation can be performed using transformers or, in circuits making use of electronics components, via optoelectronic couplers or relays.

1.17Electromagnetic compatibility (EMC)

The Contractor shall take all necessary measures to avoid electromagnetic disturbances in the control and command systems, the automated systems, the protection systems and the information transmission systems, and shall ensure the electromagnetic compatibility of the electronic systems.

Transitory electromagnetic and voltage surge disturbances, which could have fatal consequences, can originate in the following:

- Lightning shocks
- Electrostatic discharges
- Electric arcs due to defects in tools
- Electric arcs due to the switching or other operations of very-high-voltage equipment
- Electric currents of strong intensity at industrial frequency
- Ferro-resonance phenomena
- Corona effect on network elements at very-high-voltage
- Interfering resonances in electrical circuits, radio transmitters, radar beams, etc.

The electromagnetic disturbances shall not cause failures, defects, malfunctions or damage. At the request of the Owner, the Contractor shall provide all required explanations on the methods and devices implemented to protect the Installations against the effects of these disturbances.

1.18Lightning protection measures

One or more of the following systems shall be employed:

- Zinc-oxide lightning arresters on all high- and medium-voltage circuits
- Homopolar protection on all exposed low-voltage circuits
- Electronic grounding dedicated to low-current equipment
- Multiple ionic lightning conductors on the roofs of buildings

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1.19Quality Assurance Plan (QAP) and Health and Safety Plan (HSP)

Within the scope of his ISO 9000 certification, the Contractor shall submit to the Owner a Quality Assurance Plan (QAP), and a worksite Health and Safety Plan (HSP), according to a schedule agreed upon with the Owner.

The Quality Assurance Plan shall compel the Contractor to implement the organization models and procedures necessary for the execution of the activities linked to the various Project phases – studies, planning, procurement, manufacturing, factory testing, transportation, delivery, assembly, onsite testing, commissioning, semi-industrial operation, acceptance testing and warranty periods.

The Contractor shall maintain on site specialized personal to ensure the fulfilment of the agreed QAP and HSP.

1.20Environmental protection

The Contractor shall be responsible for restoring to their original state all storage, work and borrow areas, as well as roads, surroundings and access trails. Wastes of all types shall be evacuated to suitable dumps, Owner and according to procedures reviewed and commented by the Owner. The Contractor shall maintain on site specialized personal to ensure the fulfilment prevention of environmental damage of the coping of environmental instructions. The scope of work will be according to the lots division of work of the project.

1.21Marking and identification of equipment

Each equipment item shall be marked according to an identification code to be proposed by the Contractor at the beginning of the Project and agreed upon by the Owner. The identification code shall be based on the Power Station Classification System (KKS standard) and, for each component, shall indicate the following:

- Functional group,
- Function,
- Material type
- Code number

In the field, each component shall be labelled with a tag indicating the identification number. The tag dimensions and locations shall be selected to be easily readable. Text shall be black on a white/beige background. Tags shall be affixed to equipment by reliable means; glue will not be acceptable.

Tags and Codes shall be identical to those indicated on the drawings.

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2 STANDARDS AND TECHNICAL REGULATIONS

2.1 Standards and technical regulations

In their design and execution, the Works and equipment supplied shall be in accordance with the best and most recent state-of-the-art standards, the terms of the Contract and their consequences, as well as local laws and regulations

For the design, construction, transportation, installation and tests, the equipment items shall conform to the standards and technical rules indicated in these General Technical Specifications and in the Particular Technical Specifications and, failing this, to other standards and technical regulations, provided that:

- Those standards and technical regulations are established and published by an internationally recognized organization that is independent of the Contractor.
- Those standards and technical regulations shall be adapted to the material concerned.
- A copy of those standards and technical regulations, as well as their certified translation in English, shall be submitted by the Contractor to the Owner.
- Those standards and technical regulations, in the opinion of the Owner, are as demanding as, and shall lead to a supplied quality at least equal to that imposed by, the following standards and recommendations:

  - IEC International Electrotechnical Commission
  - UTE Union Technique de l'Electricité (Electricity Technical Union)
  - ISO International Organization for Standardization
  - EN Euronormes (European Standards)
  - DIN Deutche Industrie Normen (German Institute for Standardization)
  - VDE Verein Deutscher Elektriker (German Electrical Standards)
  - BS British Standards
  - ANSI American National Standard Institute
  - AISI American Iron and Steel Institute
  - IEEE Institute of Electrical and Electronic Engineers
  - ASME American Society of Mechanical Engineers
  - ASTM American Society for Testing of Materials
  - AWS American Welding Society
  - NEMA National Electrical Manufacturer Association
  - VSM Verein Schweizerischer Maschinen-Industrieller (Swiss standards concerning shafts and screw assembly)
  - FEM Fédération Européenne de la Manutention (European Federation of Handling Industries)
  - ASHRAE American Society of Heating, Refrigerating, and Air-Conditioning Engineers
  - NFPA National Fire Protection Association

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The valid edition of the documents is the last published edition as of the date of Contract signature.

During the execution of the Contract, upon a justified request from the Contractor, any substitution would remain possible, subject to the written consent of the Owner.

The equipment shall, however, in all cases, be in conformance with the laws, decrees and orders in force in Greece, in accordance with the stipulation in the Contract.

Should any documents of the Contract, or should the laws and regulations in force in the country of the Project, contain more severe or particular requirements, those requirements shall always prevail over the international standards and technical regulations quoted, or those standards and technical regulations proposed by the Contractor.

Should the specifications refer to several standards explicitly quoted, and in the event of differences between these standards, the most severe and complete standard shall always prevail.

All materials and testing methods shall be in conformance with the standard chosen, insofar as the standard is not in contradiction with the Requirements of the Contract. In all cases, the Requirements of the Contract shall prevail.

The Contractor may have to apply his own recommendations, based on his expertise, processes, procedures, technical regulations and/or internal standards. In such cases, and at the request of the Owner, the Contractor shall provide copies of those documents in English for review and comments, according to a schedule agreed upon with the Owner.

2.2 Material standards

For all equipment, the material quality and designation shall clearly appear on drawings and/or material lists.

Materials for general purposes shall be delivered according to the following standards, or their equivalent. The grades used shall depend on stress levels, environmental conditions, resulting material thicknesses, manufacturing procedures and inspection procedures.

Unless otherwise specified, material grades shall be proposed by the Contractor, subject to the Owner's review. All standards shall be the latest edition as of Contract signature or as stipulated in the Contract whichever is more stringent.

- Structural steel, general-purpose:
  - EN 10025
  - ISO 630
  - ASTM A36/A36M

- Structural steel, weldable, fine-grained:
  - EN 10028
  - ISO 4950-1, -2 and -3 (1995) and ISO 4951-1, -2 and -3

- Fine grained, normalized steel for penstock and steel lining:
  - EN 10113-2 (1993), ASTM A516/A516M

- Cast steel for general engineering purposes:
  - DIN 1681
  - ISO 3755
  - ASTM-A27/A27M

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- Iron castings, nodular:
  - DIN EN 1563
  - ISO 1083
  - ASTM A536

- Steel forgings for generator rotors:
  - ASTM A469

- Steel forging for shaft:
  - EN 10083
  - ISO 683-1
  - ASTM A668/A668M

- Stainless steel, general-purpose:
  - DIN 17740
  - ASTM A240, ASTM A269

- Stainless steel castings, general-purpose:
  - DIN EN 10213-1, DIN EN 10213-4 and DIN EN 10283
  - ASTM A487/A487M

- Bronze for bushings:
  - ASTM B584, ASTM B505/B505M

- Babbitt metal:
  - ISO 4381
  - ASTM B23

2.3 Standards for electrical equipment

Electrical equipment shall comply with the following codes, standards and regulations, or their equivalents. All standards shall be the latest edition as of Contract signature.

- Electrical equipment, in general:
  - IEC 60038 – Standard voltages
  - IEC 60529 – Degrees of protection provided by enclosures (IP rating)
  - IEC 60664-series – Insulation coordination for equipment within low-voltage systems
  - IEC 61000-series – Electromagnetic compatibility

- Equipment installed in hazardous areas:
  - IEC 60079-series – Electrical apparatus for explosive gas atmospheres

- Instrument transformers:
  - IEC 61869-series – Instrument transformers

- LV cables:
  - IEC 60028 – International standard of resistance for copper
  - IEC 60287-series – Electric cables: calculation of the current rating
  - IEC 60724 – Guide to the short-circuit temperature limits of electric cables with a rated voltage not exceeding 0.6/1.0 kV

- Earthing system:
  - ANSI/IEEE 80 – Guide for safety in A.C. substation grounding

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  - IEC 61000-5-2 – Electromagnetic compatibility – installation and mitigation guidelines – earthing and cabling

- Auxiliary relays:
  - IEC 60255-series – Electrical relays
  - IEC 61810-1 – Electromechanical non-specified all-or-nothing relays – general requirements
  - IEC 62314 – Solid-state relays

- Control, relay and distribution panels, marshalling and boxes:
  - IEC 60269-series – Low-voltage fuses
  - IEC 60668 – Dimensions of panel areas and cut-outs for panel and rack-mounted industrial-process measurement and control instruments
  - IEC 60715 – Dimensions of low-voltage switchgear and controlgear. Standardised mounting on rails for mechanical support of electrical devices in switchgear and controlgear installations
  - IEC 60947-1 – Low-voltage switchgear and controlgear – general rules
  - IEC 60947-2 – Low-voltage switchgear and controlgear – circuit-breakers
  - IEC 60947-3 – Low-voltage switchgear and controlgear – switches, disconnectors, switch-disconnectors and fuse-combination units
  - IEC 60947-4 – Low-voltage switchgear and controlgear – contactors and motor-starters
  - IEC 61008-series – Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCBs)
  - IEC 61009-series – Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs)
  - IEC/TR 61818 – Application guide for low-voltage fuse

- Cableways:
  - IEC 61537 – Cable management – cable tray systems and cable ladder systems

2.4 Unit system

The international metric system (SI) shall be the only system used, for units as well as symbols and notations.

Texts of third-party origin, provided by the Contractor and based on other systems of units (including non-metric norms), shall be revised by converting all units to metric units and adding translated indications based on the international metric system.

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3 SPECIFICATIONS RELATED TO THE GENERAL DOCUMENTATION

This paragraph describes the specific requirements applicable to the documentation of Electromechanical and Hydromechanical Equipment and will be completed in the future by the Owner's General Requirements. In case of ambiguity between the documents the more stringent will prevail.

3.1 Documents to be submitted by the Contractor

Within the scope of the Contract, the Contractor shall provide drawings, diagrams, reports, instructions and calculation notes, as well as a compilation of documents provided by the Contractor's suppliers and subcontractors. The documentation provided shall include the following:

3.1.1 List of drawings and documents for all supplied works

To be completed in a later time according to the Owner's General Requirements.

3.1.2 General drawings for installation of supply components

These drawings shall provide the general Project installation layout of the hydro-electromechanical equipment, drawn to scale, and shall also specify their exact implementation method and the main dimensions. These drawings shall be submitted to the Owner for review and comments.

3.1.3 Design directive drawings to allow civil engineering studies

The design directive drawings shall indicate, inter alia, the following:

- The normal and exceptional loads and pressures generated by the hydro-electromechanical equipment upon the civil engineering structures – intensity; direction and orientation; and eventual coefficients of increase for static and dynamic stresses
- Suggested successive phases of concreting
- Bases
- Necessary structural openings either those that will remain open as well as those to be closed by concrete or another material.
- Conduits to be covered with concrete for anchoring or passing ducts
- Electrical conductors
- Pipework, gutters, drains, etc.
- Heavy and/or bulky equipment
- Access to various premises

For all parts to be covered with concrete, including those to be used for fastening of the equipment's positioning accessories during assembly, the foundation drawings shall specify the layout of the bearing plates and other erection bases to be supplied by the Contractor, which are to be sealed by the contractor of the civil works contract.

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With regard to heavy and/or bulky equipment – gates, shells, parts of scroll cases, parts of housings, bulkheads, draft tubes, test rings, parts of alternators, transformers, etc. – the Contractor shall provide detailed handling drawings.

All drawings shall be submitted to the Owner for review and comments.

3.1.4 Equipment manuals

The Contractor shall provide manuals for equipment operation and maintenance that provide a detailed description of the operation and maintenance of the mechanical and electrical systems, as well as their particular components.

All manuals shall be submitted to the Owner for review and comments. For manuals content see 3.1.12

3.1.5 Calculation notes

Calculation notes shall be provided for each major component or system. The calculation notes shall allow the Owner to judge the conformance of the studies to the General Technical Specifications and the various Particular Technical Specifications. These notes shall be prepared and submitted jointly with the preparation of the Detailed Drawings, and shall be subject to the review and comments of the Owner.

A list of the required calculation notes shall be drawn up at the beginning of the studies by mutual agreement with the Owner (as part of the documents and drawings list). However, the Owner reserves the right, during the course of the Project, to request from the Contractor any additional or complementary calculation notes that the Owner may consider useful. Each calculation note shall include, at a minimum, the following headings:

- Summary of the object and its Technical Specifications
- Hypotheses and design methods, including the standards used and bibliographical references
- All relevant data
- Loading cases
- Account of the results and of the ensuing technical and technological choices

Partial calculation notes may be submitted to the Owner according to the various stages of execution of the Works (for example: sealing , fixed parts, structures, handling components, etc.). A complete calculation note grouping, including all the partial calculation notes, shall then be submitted to the Owner.

The calculation notes shall be detailed as much as possible.

3.1.6 Mechanical detailed engineering drawings of the equipment

The mechanical detailed engineering drawings of the equipment shall include the following:

- Overall drawing of the sub-assemblies
- Detailed plans of component parts
- Equipment lists and quantities, etc.

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The equipment's detailed Drawings shall be prepared by the Contractor and/or his subcontractors and submitted to the Owner review and comments before any start of manufacturing. The drawings shall include all drawings, elevation and cross-sectional views necessary to show the equipment's design, functionalities, methods of assembly, and operation & maintenance.

These overall drawings, subsets and details, shall include, in addition to the manufacturing dimensions, the following:

- Indication of assemblies, sub-assemblies major components
- Tolerances
- Assembly and operation clearances, with the minimum and maximum acceptable variations
- Weld categories
- Types of non-destructive tests to be carried out on welds

The Owner can demand, and the Contractor shall provide, any required detailed drawings for better understanding of the equipment – e.g., equipment operation; equipment installation and sealing problems; equipment disassembly and maintenance, etc.

Generally, detailed drawings of assemblies, sub-assemblies and main components, as well as bills of material, shall be submitted to the Owner for review and comments, whereas the detailed drawings of component parts shall be submitted for information only.

3.1.7 Drawings of fluids networks

The fluids networks drawings shall include the following:

- Operation manuals
- Detailed functional diagrams (block diagrams and Process and Instrumentation Diagrams [P&IDs])
- Lists of apparatus
- Supplier's documentation for the components used
- Circuits layouts

The Contractor shall ensure proper consistency between:

- Identification code of the various devices on the diagrams of fluid networks
- Identification code of these same devices on the diagrams of the corresponding electrical and automated system connections
- Identification code marked on the tag physically attached to the devices (and on their package, in the case of spare or wearing parts)

For ease of reading, these diagrams shall include a list of symbols used, as taken from the standard. The physical representation conditions shall be specified.

For each equipment item, the list of apparatus shall indicate the following:

- Nature of the equipment item and its specific purpose
- Identification number
- Quantity
- Supplier

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- Manufacturer
- Catalogue number
- Degree of protection of its envelope
- Location in the Installation
- Range of the controlled parameters
- Electrical power capacity (if / relevant)
- Connection voltage (if / relevant)
- Number of conductors to connect (if / relevant)

All documentation related to fluid networks shall be submitted to the Owner for review and comments.

3.1.8 Drawings of the electrical circuits

The drawings of the electrical circuits shall be established in accordance with the IEC61082 and shall include the following:

- Single-line diagrams
- Standard and block diagrams
- Logic diagrams of the automated system and interlocking
- Internal wiring drawings of boards, cabinets, consoles, etc.
- Equipment connection drawings
- Cabling and Wiring layouts
- Cable classification lists
- Instrumentation diagrams
- Equipment layout drawings of boards, consoles, cabinets and enclosures
- Lists of apparatus
- Supplier's documentation for used components
- Lists of instructions and reproducible copies of programs (software) used in protection relays, programmable controllers and the supervisory control and data acquisition (SCADA) system

Single-line diagrams, standards and block diagrams, logic diagrams of the automated system and locking, as well as flow diagrams, are subject to the review and comments of the Owner.

To facilitate their reading, the diagrams shall include a list of symbols and identification markings used, as taken from the norms and standards. The physical representation conditions of the diagrams shall be specified – for example: control voltage, empty tanks, ambient temperature, etc.

All contacts of a relay or a primary detector shall be represented only once on the diagram, indicating the unused and available contacts. The representation method used shall be agreed by the Owner at the beginning of the Project.

For each cable, the cable classification lists shall indicate the following:

- Cable number
- Manufacturer
- Type
- Purpose
- Cross-section
- Voltage
- Composition

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- Ins and outs
- Numbers of corresponding connection diagrams
- Insulation type

The list of equipment for the various boards, consoles, cabinets and enclosures shall, for each apparatus, shall indicate the following:

- Nature and specific function
- Identification number
- Column number in the flow diagram where it appears
- Quantity
- Supplier
- Manufacturer
- Catalogue number
- Location in the equipment
- Main nominal characteristics

The cable layouts shall include, at intervals, the list of cable numbers passing the location.

3.1.9 Detailed schedule of studies, procurements, manufacturing, tests, deliveries, assemblies and commissioning

Based on the Project's general schedule, the Contractor shall prepare, not later than 2 months after submission of the Program (duration to be confirmed in the future by the Owner's General Requirements), a detailed schedule of studies, procurement, manufacturing in factories, equipment deliveries and the various phases of assembly and commissioning.

This schedule shall specify, inter alia, the following:

- Date of Contract signature and the contractual date of completion of the execution period
- Deadlines when information pertaining to the Installations, premises or equipment will be made available to the Contractor responsible for the civil works. This extends to other Contractors, if the case applies.
- Details of the dates on which the main orders for raw materials, sub-assemblies and equipment shall normally be placed, as well as the expected factory delivery dates
- Dates on which the Contractor shall submit to the Owner, and/or to the other contractors, information or documents required by the Contract
- Time required for manufacturing, processing and factory testing
- Estimated dates of packing and shipment for the various components supplied, taking into account the hazards of transport and the assembly schedule
- Various phases of assembly and commissioning tests for the main equipment
- Dates of performance test.

Once agreed by the Owner, the detailed schedule shall be periodically updated by the Contractor – as often as necessary, and, at a minimum, once per quarter – according to actual observed progress and any circumstances causing a delay in Contract execution. An updated schedule shall be included in each Quarterly Report prepared by the Contractor.

The Contractor shall immediately inform the Owner of difficulties that may be encountered in the execution of the Contract, their impact on the execution period and measures proposed to recover lost time and/or overcome these difficulties.

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3.1.10Procedures and control programs for inspections, factory (shop and laboratory) testing and onsite testing

The Contractor shall submit, for review and comments by the Owner all test procedures as well as an Inspection & Test Plan (ITP) that covers all supplied components.

All relevant documents shall be submitted not later than 6 month before the pertinent test shall be done as for the project's approved time schedule.

3.1.10.1TEST PROCEDURES

The detailed test procedures that the Contractor intends to follow shall be submitted for review and comments by the Owner, according to the dates indicated in the drawings and documents list

These procedures shall include, at a minimum, the following:

- Description of the methods of control, with reference to the relevant standards
- Personnel and resources implemented
- Outline of the future test report, including:
  - Choice and calibration of measuring devices
  - Experiment assembly diagram
  - Conditions of use
  - Precautions to be taken for personnel safety
  - Precautions to be taken for safeguarding of equipment
  - Error analyses, etc.

- Test datasheets
- Required results, and acceptance criteria

3.1.10.2PROGRAMS OF CONTROLS, INSPECTIONS AND FACTORY (SHOP AND LABORATORY) TESTING

Before initiating the procurement of raw materials for the production of each component supplied, the Contractor shall submit, for review and comments by the Owner, the control, inspection and test programs describing all controls, inspections and tests that must be carried out for each component during its manufacturing, including the following:

- Controls for the raw materials
- Controls during assembly and welding
- Controls during machining
- Final controls at the end of manufacturing

Furthermore, the Contractor is expressly responsible to immediately inform the Owner of any flaws, defects or malfunctions, detected during the course of manufacturing, in the raw materials, materials, parts, works, sub-assemblies and equipment, and to present the Owner with a detailed proposal for acceptance, repair or rejection of the defective elements.

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3.1.10.3PROGRAM AND PROCEDURE OF COMMISSIONING TESTS

The program and detailed procedure for preliminary tests and controls for commissioning shall be prepared by the Contractor and submitted to the Owner for review and comments. This program shall be submitted, at the latest, six (6) months before the beginning of the commissioning tests and shall follow the PPA stipulations and IEC Ltd requirements. Commissioning tests shall be carried out in conformance with the Contract and Particular Technical Specification requirement and relevant Standards, in particular:

- Turbine performance testing according to IEC 60041,
- Generator performance testing according to IEC 60034.
- Transformer testing according to IEC 60076,
- Functional tests on mechanical and electrical equipment.

3.1.10.4REPORTS CONCERNING INSPECTIONS AND TESTS

All agreed-upon controls, inspections and tests shall result in reports to be prepared and submitted by the Contractor. These reports shall indicate all test condition and results obtained, as well as all eventually inferred calculations and error analyses, in order to establish that the equipment characteristics meet Contract requirements and guaranteed values.

These reports will basically support:

- The acceptance of equipment shipments determined by the inspections, controls and tests during and at the end of manufacturing
- The completion of the equipment assembly determined by the controls during assembly.

3.1.11Assembly and disassembly instructions

The assembly and disassembly instructions shall include all information and sketches required for proper understanding of the assembly/disassembly processes. In particular, they shall describe the use of the assembly platforms with dimensional sketches, lifting and handling devices, special tools and corresponding instructions, detailed sequence of operations, machining allowances and tolerances, assembly allowances and tolerances, required controls, etc.

The assembly/disassembly instructions shall indicate, for each assembly/disassembly step of each main component, the dimensional and other checks to perform. These indications shall be provided in the form of explicit sketches and shall be presented in the form of individual control sheets. These control sheets shall include:

- Types of measuring instruments to be used
- Reference dimensions and tolerances
- Particular implementation conditions
- Places to record actual measurements

All control sheets filled out during assembly shall become part of the manufacturing and assembly document compilation to be submitted for use in operation of the Installations.

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3.1.12Start-up, operation and maintenance instructions

These instructions shall provide all relevant information regarding equipment start-up/shutdown, operation, adjustments, troubleshooting, repair and preventive maintenance.

The operation and maintenance manuals must be available at least 3 months before Taking Over and must be available during testing and training. The Manuals shall include drawings and diagrams, as well as photographs, aimed at facilitating understanding of the instructions. The Manuals shall include, at a minimum, the following volumes.

- **Volume 1 – General Description:**

  The General Description can include all or part of the operational instructions provided during the studies.

- **Volume 2 – Operation:**

  This volume shall describe:

  - Main characteristics of the equipment
  - Verifications prior to start-up
  - Sequence of start-up and shutdown operations
  - Locking system
  - Frequency of the tests to be carried out on little-used equipment
  - Dimensions/parameters whose periodic measurement is required for maintenance
  - Operational procedures
  - Tables listing possible operational mishaps, the most frequent damages, their causes and how to deal with them

  Volume 2 shall comprise the following:

  - **A. General Description:**
    - This description shall summarize the main characteristics of the equipment.
  - **B. Start-up Instructions:**
    - These instructions shall indicate, in the proper sequence, the operations required to start the equipment.
    - These instructions shall include precautions to be taken and shall emphasize critical points to observe.
    - These instructions shall be subdivided as follows: "Step-by-Step Manual Start-up", "Initial Start-up and Adjustments", "Sequenced Automatic Start-up", etc.
  - **C. Operation Instructions:**
    - These instructions shall include precautions to be taken and critical points to observe.
    - These instructions shall recommend a method for periodic reading of indications and recording in an operation log.
    - For each item, a table shall be included that indicates possible operational difficulties, their probable causes and how to deal with them.
  - **D. Shutdown Instructions:**
    - These instructions shall indicate, in the proper sequence, the operations required to stop the operation of the equipment.

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- These instructions shall include precautions to be taken and shall emphasize critical points to observe.
- These instructions shall be subdivided as follows: "Normal Shutdown", "Shutdown on Network Faults, either Mechanical or Electrical" and "Emergency Shutdowns", when relevant.

- **E. Graphs and Diagrams:**
  - This part of Volume 2 shall include characteristic operational graphs and diagrams; hill-type curves for the turbines; and characteristic curves of pumps and valves.

- **F. Equipment Consignment:**
  - The Contractor shall describe with precision the operations related to the consignment and the release from consignment of the equipment supplied.
  - Key operations shall be described in their proper sequence, with each equipment item mentioned in the description recorded according to its tracking number, which is the tracking number used in the drawings and diagrams on which the equipment is represented, and on the equipment itself.

- **Volume 3 – Maintenance:**

This volume shall describe:

- Instructions for preventive maintenance
- Verifications to be performed, adjustments, tolerances, lubrication frequencies, etc.
- Designation and potential sources of purchase, quantities, qualities, levels to follow, etc., for all fluids used, preferably in the form of tabular summaries
- Instructions for the replacement of wearing parts
- Reference tables and diagrams for the procurement of spare parts
- Minor and major periodic servicing
- Corresponding publications

Volume 3 shall comprise the following:

- **A. Disassembly Instructions:**
  - These instructions shall indicate the procedures to follow, operation-by-operation. Exceptional care and precautions to be taken shall be emphasized.

- **B. Maintenance Instructions:**
  - These shall include instructions for preventive maintenance and frequency of interventions, as well as lubrication information.
  - Programs that indicate the shutdowns and verifications to be performed after the various periods of operation shall be included.
  - A description summary and the identification of the special tools required shall also be included with these instructions.

- **C. Adjustments and Clearances:**
  - Information in tabular form concerning adjustments of the instruments, alarm and shutdown thresholds, operational clearances and necessary adjustments for a proper operation, shall be provided.
  - This section of Volume 3 shall also indicate, in tabular form, operating conditions, such as temperature, pressure, flow, current intensity, etc. The tables shall include recommended values alongside those measured during assembly and/or onsite testing.

- **Volume 4 List of Equipment**

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- Detailed list of all equipment supplied and installed
- List of manufacturers and catalogue numbers of each piece of equipment supplied and installed
- List of Spare Parts supplied with the corresponding catalogue numbers and names of manufacturers and as instructed in the Contract
- List of recommended spare parts as instructed in the Contract

3.1.13 Compilation of manufacturing and assembly documents intended for operation

This important compilation shall include the following:

- "As-built" drawings
- Suppliers' detailed documentation
- Tables indicating the various clearances and adjustments carried out during assembly and start-up
- Calculations that justify the adjustments of the protection relays
- Reports and certificates from factory controls, inspections and tests carried out on the equipment
- Collection of reports and certificates from controls, inspections and tests carried out during onsite assembly and start-up

This compilation shall comprise, at a minimum, the following documentation:

- **"As-built" documents** – These documents shall include the general Installation layouts; foundation and detailed mechanical engineering drawings; calculation notes; fluid, logic and flow diagrams; lists of equipment; fluid circuit and electrical wiring layouts; and operation handbooks, as listed in Subsections 3.1.1–3.1.8 above, duly corrected and supplemented in order to be in perfect conformance with the Installation as implemented, with regards to connection layouts, electrical and mechanical adjustments, etc.

- The complete collection of **reports concerning factory inspection and tests** – These documents shall include all reports and/or certificates of controls, inspections and tests carried out by the Contractor and/or his subcontractors in laboratories and in factories during the manufacturing process.

- The complete collection of **in situ test reports** – These documents shall include all reports and/or certificates of controls, inspections and tests carried out during assembly and during start-up of the Installations. This collection shall be supplemented with tables indicating the most recent adjustments of the various components of the supply carried out during the tuning phase.

All documents under this paragraph shall be submitted not later than 6 month before the plant commissioning date as for the project's approved time schedule.

3.1.14 Other Documents

- **Subcontract Documents** – Before ordering various materials and components, the Owner and the Contractor shall agree on a list of subcontract documents to be shared with the Owner for control, that shall include at least operation and maintenance manuals, drawings, and relevant calculation notes.

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- **Bills of Lading** – Before each shipment of equipment, the Contractor shall submit five (5) copies of the bills of lading to the Owner. The bills include details on the contents of each crate or package shipped in the form of detailed bills of materials, as well as various indications qualifying the particular shipment.

- **Quarterly Reports and Interim Reports** – To be completed in a later time according to the Owner's General Requirements.

- **Health and Safety Plan (HSP)** – To be completed in a later time according to the Owner's General Requirements.

- **Quality Assurance Plan (QAP)** – To be completed in a later time according to the Owner's General Requirements.

3.2 Formal provisions related to the documents

All documents shall be completed and published via an indelible process, entirely paginated, elaborated following a consistent method, perfectly legible and shall allow rapid and reliable identification of their subject.

All documents shall be provided in English and shall bear the standard uniform title block of the Project. Each document shall include a document number in conformance with the numbering rules of the Project, document Title, Author, Revision N and Date. A document without identification, therefore impossible to archive, shall not be regarded as a component part of the Project.

The numbered documents, including technical-commercial documentation from suppliers and subcontractors, shall include a flyleaf displaying the standard uniform Project title block.

3.2.1 Drawings

All drawings shall be exclusively provided in the standardized DIN A4, A3, A2, A1 or A0 formats, or folded A4 format, with insert band for structured presentation in ring binders. The apparent fold, after folding, shall show the standard uniform Project title block. Each transmittal of drawings shall be accompanied with a digital copy of same transmittal

3.2.2 Other documents

Instructions, reports, lists and nomenclatures shall be provided exclusively on numbered A4 (and A3 folded in two folds) format paper sheets. The first page shall include the standard uniform Project title block, which includes the complete title and document number, as well as the date and index pertaining to the last modifications made to the various sheets. Each transmittal of documents shall be accompanied with a digital copy of same transmittal

3.2.3 Diagrams

Fluid diagrams and single-line diagrams shall be drawn on A0 format, with A3 format copies provided. Logic and flow diagrams shall be drawn on A3 format in the form of stapled packages,

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excluding any other formats. A diagram shall be composed of several sheets, which shall be numbered, with the total number of sheets indicated on the title page. This page shall also carry the standard uniform Project title block, which includes the complete title and document number, as well as the date and index pertaining to the last modifications made to the various sheets. Columns or sections, numbered starting from "1" on each sheet, shall facilitate the location indication of a particular element on the sheet.

In the event of partial modifications to documents having several pages, the whole file shall be updated and resubmitted.

Diagrams, drawings and instructions shall be prepared using the notations, signs and symbols, as well as the requirements, stated in various IEC publications (in particular recommendations 27, 113 and 617), and in various ISO publications (in particular recommendation R 1219).

The identification of circuits, apparatuses, terminals and cables, the Contractor shall follow the recommendations of. IEC 61082 and IEC 60445,

Numerical references given by ANSI/IEEE C37.2-1979, "Electrical Power System – Device Function Numbers", shall be exclusively used in the electrical single-line and flow diagrams.

The flow diagrams shall represent the detailed and exhaustive development of each circuit. The polarities shall be represented by continuous bars – the positive polarities at the top of the sheet, and the negative polarities at the bottom of the sheet.

The flow diagrams shall be read from top to bottom and from left to right, with the relay and actuator coils being generally polarized to the negative pole. The representation of the relay's contacts shall be exhaustive under the coils outside the field of polarities. The cross-references (page and section) to the circuits in which the contacts are used shall be clearly stated.

All equipment terminals shall be illustrated, including intermediate input/output terminals. Electrical circuits shall be identified by equipotential numerical references. Sufficient space shall be allocated for possible modifications to the diagram.

3.2.4 Numbering of the documents

The magnitude of the Project is such that Owner and the Contractor need to implement a comprehensive and unique document numbering system, sufficiently general to cover the entire Project.

The details of this numbering system, based on KKS standard shall be prepared by the Contractor submitted to the Owner for its review and comments.

3.2.5 Distribution of the documents

To be completed in a later time according to the Owner’s General Requirements.

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3.2.6 Modified, corrected or updated documents

Documents that had to be revised, for whatever reason, during the studies or as documents intended for use during construction and operation, shall be redistributed according to the rules stated in the future by the Owner's General Requirements

The Contractor shall be held responsible for any delays or damages that may be caused by the absence of, or by delay in the submission of, the modified, corrected or updated documents.

3.2.7 Schedules for submission of drawings and documents

To be completed in a later time according to the Owner's General Requirements.

3.2.8 Conservation of the manufacturing drawings and documents

The Contractor shall maintain, for a minimum period of ten (10) years, without charge, all manufacturing drawings and including foundry patterns drawings, as well as all information from the studies that is likely to facilitate the performance of repair and maintenance in the Installations.

3.2.9 Review and comments of documents

To be completed in a later time according to the Owner's General Requirements.

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4 MATERIALS AND MECHANICAL EQUIPEMENT

4.1 Choice of materials

All materials incorporated in the equipment supplied shall be of the quality, grades and conditions specified in the standards defined in Section 2 above.

For all equipment, the material quality and designation to apply shall clearly appear on drawings and/or material lists.

Materials not specifically designated herein shall be subject to the Owner's review. Such materials shall be suitable for their purpose and shall comply with the latest issue or revision of the designated standards, or their approved equivalent.

Material lists shall be prepared and delivered to the Owner, to be included in the Contract. Any change of material will be submitted through a change order to be approved by the Owner.

The grades used shall depend on stress levels, environmental conditions, resulting material thicknesses, manufacturing procedures and inspection procedures. Unless otherwise specified, the material grades shall be proposed by the Contractor, and are subject to the Owner's review.

4.2 Cast parts

All castings shall be true to pattern and of uniform quality and condition, free from injurious blowholes, porosity hard spots, shrinkage defects, cracks and other defects, as determined by visual inspection, and shall be satisfactorily cleaned for their intended purpose. Casting surfaces that do not undergo machining, particularly those surfaces in contact with water, shall be dressed smooth, with all joints blended into adjacent surfaces, and shall be free from foundry irregularities – projections, ridges, hollows, honeycombing, pock marks, chip marks, etc. – so that they do not require surface smoothing operations prior to painting.

All steel castings shall be heat-treated in accordance with the relevant standard. All iron castings shall be mild annealed in a suitable annealing furnace to relieve casting strain before machining.

The processes of casting inspection and repair shall meet the requirements of CCH 70-4.

Defects in steel castings may be repaired to the extent and by methods reviewed by the Owner, including review and comments of welding procedure, pre- and post-weld heat treatment and non-destructive testing.

All defects shall be fully recorded and investigated. When major defects are found on the castings, according to a threshold to be agreed by the Owner, they shall not be repaired, plugged or welded without advance written authorization from the Owner. Such authorization will be given only when defects do not adversely affect the characteristics of the castings.

No repair welds in excess of 20 mm depth shall be permitted without stress relieving, unless otherwise agreed to by the Owner. Repair welding on steel castings, other than repair welding of minor defects, shall be done by the metallic arc process, followed by thermal stress relieving.

Repair of stainless steel castings shall be carried out with low-carbon electrodes of the same chemical composition as the casting material. Before repairs are made, repair procedures shall be submitted to the Owner for review and comments.

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No welding shall be carried out after the casting undergoes final heat treatment.

Test coupons, from which test specimens are prepared, shall be attached to all castings weighing 250 kg or more. The number, size and location of the test coupons shall be recorded, and the records made available to the Owner upon request.

For the main castings, the steel shall be made by the electric furnace process with separate refining process such as Vacuum Degasing (VD) and Vacuum Oxygen Decarburization (VOD) for stainless steel casting. Chemical analyses shall also be carried out and recorded at the time of pouring. The times and temperatures of pouring shall also be observed and recorded, as well as the times of removal of the casting from the mould. This information shall be submitted to the Owner at the time of inspection.

All steel castings that will be rotating parts during operation shall be given a double heat treatment (when relevant for material type and grade usual). In each heat treatment, the casting shall be held at the desired temperature for a sufficient amount of time to ensure proper grain refinement throughout the casting. Such castings shall be furnace-cooled after the final heat treatment. The grade, composition and ASTM specification number shall be subject to the Owner's review.

The castings shall be clearly stamped with the heat number and serial number in such locations as to be readily visible.

4.3 Forged parts

Forged shafts and all other forgings, unless otherwise specified, shall be in accordance with ASTM recommendations or better.

Ingots from which the forgings are made shall be cast in metal moulds. Sufficient discard shall be taken from each ingot to ensure freedom from piping and undue segregation. Flanges and other enlargements on the shaft need not be reduced in this proportion, but shall be reduced in a ratio of not less than 1.7 to 1.

Test coupons shall be provided in accordance with ASTM A668 recommendations or similar, unless otherwise specified.

All forgings shall be given such uniform heat treatment as may be required to produce materials conforming to the requirements of the specifications. All forgings, however, shall be annealed, or normalized and drawn, as final heat treatment. In the case of solid forged shafts, which are required to be bored, the final heat treatments, i.e., annealing, or normalizing and drawn, shall be performed after forgings have been bored. Upon request, a record of the heat treatments to which the forgings have been submitted shall be supplied to the Owner during the inspection.

All shafts 300 mm in diameter and over shall be bored axially throughout their full length, and shall have a finish of approximately 25 micrometers (Ra).

All hollow-bored shafts shall be finish-bored after the final heat treatment.

Forgings shall be clearly stamped with the heat number and serial number in such locations as to be readily visible.

No repair of forgings may be carried out without prior submission of the defect localization record and the proposed repair procedure – including welding procedure, pre- and post-weld heat treatment and non-destructive testing – to the Owner for his review.

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4.4 Piping systems, pipes and accessories

4.4.1 General

Piping systems shall be designed according to ASME B31.1 (2001), DIN EN 13480-3 (2002) or an equivalent recognized standard.

All piping shall be furnished complete with flanges, unions, expansion joints, gaskets, packings, valves, drains, vents, pipe hangers, clamps, supports, etc. In addition, the Contractor shall provide steel structures, walkways, platforms, stairs and ladders, all designed according to the safety requirements and equipped with handrails, over large diameter pipes lying more than 600 mm above the floor.

All pipes shall be carefully cleaned before installation; carbon steel pipe shall be cleaned by a chemical process. A detailed procedure shall be submitted for the Owner's review and comments.

All piping, valves and fittings, flanges and joints shall be designed for the highest pressure occurring in the actual system in service, including water hammer and other pressure transients where appropriate. Unless otherwise stated, all piping, valves and fittings shall, as a minimum, be classified as PN 10, at an ambient temperature of 40ºC, but not below the highest working pressure or the highest working temperature of the environment or as indicated in the Particular Technical Specifications (PTS).

All piping systems shall be pressure-tested at 1,5 times the maximum design pressure (design pressure shall be calculated for the max. water hammer case).

All pipes and fittings (flanges, elbows, valves, taps, etc.) of the piping systems shall be colour-coded painted, or banded and labelled according to a recognized standard. The colour coding and labelling scheme shall be submitted to the Owner for review and comments.

All piping systems shall be marked with arrows showing the direction of flow. Arrows shall be marked at every change of direction and at 20 m intervals in straight sections. The direction arrows will be located at completely visible points.

Fluid velocities in pipes shall be limited to 4 m/s in pressure pipe and 1 m/s in suction lines.

4.4.2 Pipes

Steel pipes shall be seamless pipes, with the exception of embedded pipes kept at atmospheric pressure.

All embedded steel pipes shall be made of steel, with 2 mm additional wall thickness for corrosion allowance – except for stainless-steel pipes, where a passivation process shall be applied.

The use of cast iron and nodular cast iron pipes for pressurized systems is completely forbidden.

Pipes in oil systems of nominal diameter of DN100mm or less shall be of stainless steel. Pipes of higher nominal diameter shall be of carbon steel.

Pipes in water systems of nominal diameter of DN100mm or less shall be of stainless steel. Pipes of higher nominal diameter shall be of hot galvanized carbon steel.

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The danger of galvanic corrosion and induced electric currents in the piping systems shall be considered, with the necessary isolating flanges provided and the ranking order of different materials taken into account.

Unless authorized by the Owner, the use of plastic pipes is forbidden.

Welding, as well as application of corrosion protection coating, shall be done in the Contactor's facilities as far as possible. Flanged connections and unions shall be provided, as necessary, for transport and installation, or in order to facilitate dismantling for repair purposes.

If the piping crosses expansion joints of civil structures, then, subject to review of the Owner, the piping shall be provided with flexible joints to allow for vertical, horizontal and angular deviations between the centrelines of connected pipes.

Pipes installation, whether aerial, underground or embedded, will allow full and easy drainage without undrained pockets.

4.4.3 Flanges and Gaskets

Metric flanges conforming to ISO 7005-1, ISO 7005-2 and ISO 7005-3 shall be used throughout. Flanges shall be of the weld neck or slip-on type. Sealing faces shall be machined.

Welded flanges for steel pipes shall be of material quality DIN-EN 10025 (1994) Grade Fe 360C, or better. Welded flanges for stainless steel pipes shall have a material quality corresponding to the pipe material.

Flat gaskets shall be of the rubber, metal mesh reinforced type, or better, and shall be guaranteed asbestos-free.

4.4.4 Fittings

In general, fittings shall be of the same or better material as the connecting pipes, with suitable corrosion protection. Threaded fittings shall not be used for dimensions larger than 50 mm (DN 50). For high-pressure oil systems, fittings with rubber seal sealing provisions shall be used.

4.4.5 Valves

In general, valves shall be delivered according to EN 12266-1:2012norms and related standards, and shall be leakproof – Rate 1 EN 12266-1– either in flow direction or in opposite direction.

As far as practicable, all valves for similar service shall be of the same make and type, and shall be interchangeable. Their type and material shall be adapted to the intended use, and the following rules shall apply:

- Small-sized valves, with nominal pressures less than 10 bar and nominal diameters less than DN 50 for water, may be made of cast iron or a suitable copper alloy, and shall conform to EN 12266-1.

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- Medium-sized valves, from DN 50 to DN 150, shall conform to EN 12266-1. Valves body shall be of nodular cast-iron (ductile iron) of quality not less than EN 1563 (2003) GGG-40 for nominal pressures up to PN 25.

- Small- and medium-sized valves shall be delivered with test reports conforming to EN 1024 (1995) 2.2 requirements.

- Larger valves, with diameter and pressure ratings exceeding the limits above, shall conform to EN 12266-1, with inspection certificate conforming to EN 10204 (1995) 3.1.B requirements, unless otherwise specified. Their valve bodies shall be made of nodular cast iron, cast steel or welded steel, as specified in EN 12266-1.

- Spindles, seals, seats and other wearing parts, where applicable, shall be made of suitable corrosion-proof material. The valves shall be designed so that vibrations will not occur when in service or when being set at nearly-closed or nearly-full-open positions. All valves shall be designed for opening and closing against the full pressure without undue cavitation or vibrations. If necessary, bypass valves of ample size shall be provided.

- Generally, all isolating valves, or valves on pipes leading directly from the headwater or the tailwater, shall be flanged.

- Gate valves of the free-flow rubber-lined-gate epoxy-lined-body type shall be preferred for nominal pressures less than 16 bar and dimensions less than DN 400.

- Other valves may be of the gate-type, ball-type (which is preferred for small dimensions and for high pressures) or butterfly-type (for larger dimensions and up to a maximum nominal pressure of 16 bar). Butterfly valves shall be of the flanged-type, epoxy- or rubber-lined, with rubber seals.

- Where flow regulation is required, butterfly valves are not allowed, as only open/close positions are allowed.

- Handwheels and handles shall be of ample size and, where necessary, shall have extended spindles and gearing so that any valve may be easily and conveniently operated by one man under service conditions. If extended spindles are used, a sufficient number of bearings shall be provided. Where passing through concrete, a sleeve shall be installed for protective purposes. The entire assembly shall be made of suitable corrosion-proof materials, subject to the Owner's review.

- Valves shall close with a clockwise rotation of the handwheel or handle and shall be provided with position indicators, rising-stem or equivalent.

- Valves actuators, whether electric, pneumatic or hydraulically operated, shall be constructed of materials suitable for the relevant operating media and the environmental conditions. The actuator shall have a local position indicator, adjustable limit switches for open and closed position and means for manual operation. Electric actuators shall be protected to an IP54 degree of protection, unless otherwise specified, with limit switches and additional torque limiters.

- Ball valves for automatic operation shall have two-sided bearings of the ball.

- Pilot valves, operated manually or via solenoids, shall be made of corrosion-resistant materials and shall have ample dimensions, with a minimum of head loss. Leaks shall not cause uncontrolled opening/ closure, but shall be drained through separate ports.

- Pressure-relief valves, safety valves and similar components shall work without vibrations and shall have a clearly defined pressure range within which the closing and opening will take place. They shall be workshop-tested and provided with a calibration certificate.

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- Orifices shall be made of stainless steel.
- Piping works shall be designed in order that valves can be easily dismountable, where ever required, dismounting sleeves or coupling shall be forecasted.

4.4.6 Supports, hangers, brackets and frames

Supporting of pipes shall be carefully considered to reduce vibrations and undue deflections, and to allow temperature expansion.

4.4.7 Grates and strainers

Strainer housings shall be made of corrosion-proof material or protected by means of hot-dip galvanizing or appropriate epoxy coating. Strainer elements shall be dismountable without interrupting the current operation of the system. They shall be designed for easy removal of the inner parts from above. Strainers shall be made of cleanable and completely corrosion-proof materials. Strainers will be designed to withstand maximum operation pressure when completely clogged.

Grates shall be dismountable and made of stainless steel or hot-dip galvanized carbon steel properly painted when size of more than 1 square meter. Grates shall, unless otherwise specified, be designed for one-sided pressure equal to the maximum static system pressure. Grates will be installed in a form that will avoid any vibration during maximum through flow.

Grates and strainers shall be provided with clogging indicators for local and remote indication.

4.4.8 Pumps

All pumps to be supplied for the Installations shall be from a reputable supplier and of a type best suitable for their purpose. They shall be furnished complete with electrically driven motors of ample capacity to provide safe and continuous service under all operating conditions of the respective system.

Pumps shall be delivered with complete test certificates covering verification of all pressure, flow and power characteristics. (See also following clauses concerning Tests).

For pumps rated 30 kW and above or of working pressure above 6 bar, the body shall be made of cast steel or nodular cast iron with quality not less than EN 1563 (2003). Pumps of operating pressure less than 6 bars, body may be made of cast iron of a quality not less than DIN EN 1561 (GG-25), or equivalent.

All wearing parts, sealing faces, shafts, etc., shall be made of corrosion-proof material and shall be easy to replace. Pumps shall be equipped with mechanical seal, seals shall be able to be replaced without extensive disassembly of the pump. Leak water shall be directed to suitable channels. Each pump shall have air and drain valves.

Water pump impellers and labyrinth rings shall be made of stainless steel suitable to water properties as specified in the “General information”.

Pump bearings shall be of the maintenance-free type.

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All pumps shall be fitted with isolating valves (suction and discharge), pressure gages (suction and discharge), switch valves and check valves, as required. The use of suction strainers shall be considered on a case-by-case basis.

Pumps for hydraulic systems shall be of the positive displacement type.

Each positive displacement pumping array, will be equipped on the discharge side with a pressure relief valve (PRV). The PRVs will be of sufficient capacity to bypass the full delivery of the pumps, already at a pressure raise of only 10% above the system working pressure.

All pumps shall have a pressure rating, guaranteed by the manufacturer, of a minimum of 20% above the normal system working pressure. The rated power of the pump's driving motor shall be sized at 110% of the maximum pump capacity at any theoretically possible pump operation condition according to the pump curve.

4.4.9 Threaded fasteners

All machine bolts, stud bolts, screws, nuts, and any other type of threaded fastener., shall have standard metric threading and conform to the relevant standards with regards to shapes and tolerances. They shall be marked by the manufacturer's symbol and class of strength.

All bolts, studs, nuts, washers, screws, etc., used in steel structures, of a size M 10, shall be made of stainless steel or other corrosion-resistant or hot-dip galvanized metal, except for bolts above Strength Class 8.8, for which corrosion-resistant or electrolytic zinc-coating materials shall be required.

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Bolts, nuts, studs and screws that require frequent tightening and unbolting during inspection or maintenance procedures shall be made of stainless steel.

In all cases, the material for bolts shall be chosen with attention to the surrounding material, as to avoid any possible formation of electrolytic couples.

All bolts, screws nuts and whatever threaded fastener shall be secured by an agreed method against loosening during operation.

The Contractor shall supply the net quantities plus 10% of spares of all permanent bolts, screws and other similar items and materials required for onsite installation of the works. All such bolts, screws, etc., that remain as surplus after installation of the equipment has been completed shall become spare parts and shall be wrapped (with lubricated wrappers), marked and handed over to the Owner.

4.4.10Lubricants

Oil of an agreed grade and quality shall be used for all purposes. In particular, bearings, governors and other lubricated systems shall use the same grade. For hydraulic circuits at pressures higher than 10 MPa, a high quality hydraulic oil shall be used.

Only oils and lubricants which are commercially available in Greece and in the EU shall be used. They should be in conformity with ISO 8068, ISO 6743-5 and ISO 4406 specifications. Oil classification shall take into account ISO 4406:2021and ISO VG definitions.

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Oils shall be free from bacteria and shall contain suitable microbiocides to prevent any bacteriological growth when in service or during normal storage.

Hydraulic systems oils will incorporate additive such as anti-foam and anti-freeze to insure their properly operation throughout any environment and operation conditions.

4.4.11Cranes and other lifting equipment

Generally, for the design, stress calculation, manufacturing and installation of cranes and other lifting equipment, the following Fédération Européenne de la Manutention (FEM – European Federation of Handling Industries) standards shall be applied:

- Section I: Heavy Lifting and Handling Equipment – Rules for the design of hoisting appliances (steel structures and mechanisms)
- Section IX: Series Lifting Equipment – Rules for the design of series lifting equipment (mechanisms)

In case of discrepancy between the standards the more stringent will prevail.

The Contractor shall propose the group classifications of cranes and auxiliary hoists, subject to the review and comments of the Owner.

All lifting equipment shall be subject to static and dynamic testing, with overloads as follows:

- 1.25 x nominal load for static testing
- 1.1 x nominal load for dynamic testing

The Contractor is responsible for supplying the test loads and dynamometers.

The average pressure exerted by the crane rails and their anchoring elements upon the concrete shall not exceed 10 N/mm^2.

All lifting equipment shall be subject to the rules and test required by Greek law and standards.

4.4.12Rubber seals for hydromechanical equipment

Rubber seals for hydraulic steelworks shall be of first-quality non-ageing chloroprene rubber material, which shall be unaffected by wetting/drying or temperature changes, and shall be protected against UV radiations

The Contractor shall furnish the name of the manufacturer and technical data of the gate seal material for the Owner's review.

All bolts, nuts and flat bars for fastening the seals shall be made of stainless steel.

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4.4.13Stairs, ladders and platforms

Stairs shall have a preferable inclination of approximately 35°. Ladders shall have a preferable inclination of approximately 75°. Stairs shall be provided with handrails of a minimum of 110 cm in vertical height on the inclined part. Platforms will be provided with handrails of a minimum of 110 cm in vertical height. Both stairs and platforms and handrails shall be designed according to EU standards provided with toe boards 10 cm in height.

Vertical ladders more than 3 m in height shall be caged.

Vertical ladders of more than 6m high shall be installed staggered with sections of maximum 6m long. At the end of each section a metallic hand railed platform will be provided.

Unless otherwise specified or stipulated in the applicable standards, the load assumptions for ordinary platforms shall be as follows:

- For platforms used by personnel and for support of light equipment with single weights of less than 500 N:3,000 N/m^2
- For all other platforms:5,000 N/m^2

Platforms and stairs shall be provided with slip-resistant gratings and/or checker plates.

Subject to the Owner's review, stairs, ladders, platforms, etc., may be manufactured in aluminium, if the rigidity of the structures is duly considered.

4.4.14Mechanical instrumentation

Mechanical instruments – manometers, pressure gauges, switches, transducers, thermometers, limit switches, etc. – shall generally be of the heavy-duty type and of the highest quality, with stainless steel piping and interior parts. Visual indicators shall be graded in bars, °C or any other SI unit. Instruments mounted outdoors or in humid environments shall have stainless steel or brass housings having a degree of protection of not less than IP54.

Mechanical instruments shall generally be supplied in 1% accuracy class and 100 mm minimum scale diameter.

Instruments, switches and transducers shall not be mounted on vibrating components, and all mechanical parts shall be suitably protected against shocks, vibrations, heat, humidity, splashing water, etc. At difficult locations, instruments may be filled with a damping liquid, e.g., glycerine, to reduce environmental effects or the effects of vibrations.

Switches shall have large-sized contacts, at least one normally-closed and one normally-open contact, and shall be easily adjustable.

Pressure, level and other transducers shall have 4–20 mA output with 2- or 3-wire connections. Temperatures to be remote-indicated and to be recorded shall be measured by means of duplex resistance thermometers of Pt100 platinum element type, with 100 ohm resistance at 0 °C.

All pressure gauges, switches and transducers shall have isolating and drainage 3 way valves and provisions to connect temporary instruments.

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To allow instrument withdrawal without draining the system, temperature gauges, switches and transducers shall have feeler pockets.

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5 MANUFACTURING

5.1 Manufacturing technical program

For each main component supplied, the Contractor shall prepare a technical manufacturing procedure to be submitted to the Owner. The procedure shall describe the various steps that the Contractor intends to follow in the manufacturing of the components.

Particular information shall be provided regarding the manufacturing process of forged and cast components, and the welding, heat treatment and non-destructive test procedures.

5.2 Welding

5.2.1 Preparation for welding

All welds shall be performed as shown in the detailed drawings and shall be made in such a manner that residual stresses are reduced to a minimum. Weld seams shall, as far as possible, be positioned outside zones of stress concentration.

Full information and specifications of all principal weld seams shall form part of the design drawings. The drawings shall indicate the type of weld and the choice of electrodes, wires and welding powders to be used. The number of welding passes shall be made in relation to the thickness of the plate. Each pass shall be thoroughly de-scaled before the next pass is applied.

Members and sections to be joined by welding shall be cut accurately to size, with their edges ground or machined to suit the required type of welding, and to allow full penetration and fusion of the weld with the base material.

The surface of members or sections to be welded shall be free from rust, grease, mill scale, and other foreign matter for a distance of at least 30 mm from the edge of the weld. All paint materials shall be removed well back of the heat-affected zones. Welding over zinc primers shall be avoided.

5.2.2 Welding procedure

All welding shall be performed by the electric-arc method, and according to relevant standards, unless otherwise agreed by the Owner.

The welding works for main structures and components shall be in accordance with the requirement of the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, and performed according to Welding Procedure Specifications (WPS) and Procedure Qualification Reports (PQR) established according to ASME Section IX and AWS code ("Standard Qualification Procedure").

Welding procedures and qualification records (WPS, PQR) according to EN ISO 15614-1 and ISO 15609-1 shall also be accepted.

WPSs and PQRs shall be submitted to the Owner for review and comments, and shall be issued with full information on all factors set forth in the respective welding forms according to the actual standard, e.g., QW-482 and QW-483 of ASME Section IX or equivalent.

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The welding procedures shall be selected in consistency with the composition and properties of the base material, type of weld and working stresses of the welded joint. Whenever required and in accordance with the requirement of the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, preheating and heat treatment of the welding seam shall be applied, unless otherwise agreed by the Owner.

The mechanical properties of the weld shall conform to the base material, as specified in the respective standards, and shall be confirmed by mechanical test on a sample during the qualification procedure phase.

All joining of plates in the principal stress direction shall be carried out using either single-welded or double-welded butt joints, unless otherwise agreed by the Owner. Adjacent plates, carrying high stresses, shall in general not differ more than 3 mm in thickness. If the difference is greater, the thicker plate shall be chamfered at a maximum of 1:4.

Principal welds shall be ground as specified in the welding procedure. In addition, all welds exposed to water having a velocity of 4 m/s or more shall be ground flush with the plates, unless otherwise agreed by the Owner.

In order to prevent the presence of residues in double-welded butt joints, the root shall be completely removed by grinding or back-gauging before proceeding with welding on the other side.

Welding of auxiliary structural members to components of the Plant for the purpose of assembly and installation works is completely prohibited, especially on high-grade material (e.g., the stay ring of the turbine). In extreme cases when it is allowed by the Owner, once the installation has been completed, auxiliary structural members shall be removed by burning them off, followed by grinding the affected areas flush with the plate, without introducing additional local thermal stresses. At a minimum, dye penetrant checks shall be performed on restored surfaces. Knocking-off of such members shall not be permitted.

The electrodes for arc welding shall be classified on the basis of mechanical properties of the as-welded deposited weld metal, type of covering, hydrogen absorption, welding position of the electrodes and type of current.

Electrodes shall be used only in the positions and under the conditions of intended use in accordance with instructions of each container. Electrodes for manual welding shall be suitable for welding in any position.

During welding operations, electrodes shall be stored and dried in electric heating furnaces prior to welding, according to manufacturer's instructions.

5.2.3 Welding repairs

In all welded assemblies, defects beyond the criteria of acceptance shall be eliminated. Depending on the size and number of defects to be eliminated, the Contractor retains responsibility for choosing between performing more or less numerous and important local repairs and that of a new assembly after cutting or entirely gouging the concerned weld. The Contractor's choice is subject to the agreement of the Owner.

If the extent of repairs of a weld performed by an automatic process is likely to extend beyond one-fifth of its length on at least its total thickness, the weld shall be redone and controlled once again.

For all welding repairs, the x-ray films or the results of the ultrasonic control revealing one or more defects of origin shall be submitted by the Contractor for Owner's review.

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All repairs shall be performed either according to the qualified welding procedure for the execution of the welds, or according to the qualified repair procedure. Welding repairs either in manufacturers' premises as well as on site shall be carried out by qualified welders as well as all current welding works.

However, if the defects, at the origin of one or more repairs, do not bring into question the qualified welding procedure followed during construction, and, if the Contractor decides to apply this procedure to perform the said repairs, no qualification test will be imposed. The repair shall performed by a qualified welder or operator.

All repair operations shall include the following:

- Verification of elimination of defects
- Non-destructive control of the zone repaired
- New heat treatment (local or global), unless justifications are brought by the Contractor and agreed by the Owner

At the same location, only two repairs by welding are allowed. The Contractor shall not continue beyond that before having submitted a report analysing the reasons for these successive repairs and receiving authorization from the Owner.

5.2.4 Heat treatment

The need and method for heat treatment shall be determined in accordance with the agreed design standard and ASME Boiler and Pressure Vessel Code, taking into account the stress levels, design temperatures, material properties (notch toughness, material thickness, etc.) and forming, welding and inspection procedures. Shop heat treatment of welded components shall be performed prior to final machining.

Procedures for heat treatment shall be submitted to the Owner for review and comments.

Site welding heat treatment shall be performed according to the specifications of welding procedures for the corresponding parts, which shall be submitted to the Owner for review and comments.

5.2.5 Welders qualifications

Welding shall be carried out only by experienced qualified welders. Welder qualification tests shall conform to ASME Code – Sections VIII and IX, or AWS B3.0. Conformity to EN ISO 9606-1 shall also be accepted.

All welders' and welding operators' test certificates shall be submitted to the Owner upon request. Welders for onsite work shall be tested no earlier than three (3) months prior to commencing onsite work operations.

5.3 Machining

Machining of all parts shall be accurate and to specific dimensions and tolerances, so that replacements made as per design drawings may be readily installed. Equivalent parts and spare parts shall be interchangeable.

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Unless otherwise specified or agreed upon, all work performed shall conform to the requirements of the latest editions of the agreed standards.

All machining shall be performed so as to secure proper matching of adjoining surfaces. Unfinished surfaces shall be true to the lines and dimensions shown on the drawings, and shall be ground to be free from projections and rough spots.

The surface finishes of all parts and components shall conform to the respective strength and service requirements, and shall be in conformance with the drawings. Surfaces to be finished by machining shall be indicated on the design drawings by corresponding standard symbols.

The following surface roughness [rms (µm)] or better shall be achieved:

- Runner:As required by IEC60193
  -

- Surfaces in contacts with water: As required by IEC60193 with at least
  - Wicket gates upper wearing ring 1.6
  - Wicket gates lower wearing ring 1.6
  - Runner Chamber 6.3
  - Head cover and bottom ring12.5
  - Wicket Gates 12.5
  - Wicket Gates – contact surface 3.2

- Machined surfaces:
  - Shaft at location of bearing 0.8
  - Bearing surface 0.8
  - Other shaft surface6.4
  - Servomotor rod and piston 0.8
  - Surface at location of self-lubricated Material and dynamic seals1.6

Corners and edges shall be eliminated, by grinding, lathing etc. to produce a noticed chamfer.

5.4 Surface treatment and painting

5.4.1 General

The Contractor shall provide complete and reliable surface treatment and protection against corrosion of the furnished equipment. Such works shall include workshop painting and coating and paint “touch-ups” and finishing at construction site. The protections shall be applied, as much as practicable, in the workshop.

Unless otherwise specified, coating and painting shall be carried out in accordance with these General Technical Specifications and ISO 12944, "Paints and varnishes — Corrosion protection of steel structures by protective paint systems", or other equivalent standard.

In all cases, the Contractor shall, however, fulfil the requirements imposed by the onsite conditions – water quality, climatic conditions, environmental conditions, etc. – that may, in many ways, affect the quality and suitability of the surface protection. The surface protection shall ensure lifelong protection of the equipment and minimize its maintenance.

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The Contractor shall submit, for the Owner's review and comments, anti-corrosion protection procedures with full details regarding the preparation, type of materials, methods and sequences of application the Contractor intends to use for the protection of structures, machinery and equipment during transport, site storage, building, concreting, erection and operation.

The Contractor shall ensure that his proposed materials, methods and sequences comply with relevant safety rules and health standards, and do not contaminate the environment.

Coating materials shall be standard products from reputable manufacturers with suitable experience in the field of corrosion protection for the type of equipment to be supplied. Coating materials shall be adapted to the quality of fluid in its most sever condition. The Contractor shall justify his use of the proposed product according to the proposed procedure.

In general, stainless steel components, as well as machined surfaces, shall not be painted or galvanized. Machined surfaces shall be protected against corrosion during transportation and storage by an easily removable varnish.

The painting materials of each individual painting system will be of the same manufacturer and will be compatible.

5.4.2 Steel structures and surface protection systems

The Contractor shall define structure and surface protection systems for the different cases:

- System No. 1 – Surfaces in contact with water
- System No. 2 – Ladders, stairs, railings, outdoor surfaces of auxiliary equipment
- System No. 3 – Surfaces in contact with air
- System No. 4 – Surfaces in contact with oil (internal oil tank)

5.4.3 Protection of auxiliary equipment

The protection system of the auxiliary equipment shall be in accordance with the protection scheme described above. However, the standard system from the component supplier can be proposed to the Owner for his review, as an alternative, with the submission of complete documentation.

5.4.4 Surface preparation and painting

Before any coat is applied, surfaces shall be properly prepared. For removing rust and mill scales, blasting shall be carried out down to clean bare metal, according to ISO 8501-1, Grade Sa 2.5. The average surface roughness after blasting shall not exceed 50 microns. Sandblasting or grit blasting shall be performed by dry compressed air or rotating wheel. If the blasting material is recuperated it shall be thoroughly cleaned before reuse.

Blasting and coating shall, as far as possible, be performed after the structures and components are welded and machined. Equipment that cannot be blast-cleaned after the last machining shall be blasted, primed and given one topcoat prior to machining.

Painting will be carried out as much as possible immediately after completion of surface preparation.

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Parts that cannot be blast-cleaned, such as pipes, shall be cleaned by power-tool and chemical agents.

All equipment parts shall be blasted in the manufacturer's shop unless otherwise specified or agreed by the Owner. The blasted surfaces shall receive a primer coat within a limited time after sandblasting. All work shall be executed under acceptable climatic conditions and with efficient ventilation for removing dust and thinner vapours.

5.4.5 Cleaning of welds

Erection welds and their heat-affected zones created during erection, which have already been blast-cleaned and painted, shall be re cleaned by sandblasting to Sa 2.5 on an area of at least 100 mm on each side of the weld and repainted.

5.4.6 Painting and marking

Paints shall preferably be applied by means of airless equipment. Areas difficult to reach may be brush-coated or coated using a glove. Other application methods require agreement by the Owner.

Coating of any surface shall not take place unless the temperature and humidity conditions are such that a perfect result may be expected. Steel temperatures shall always be at least 3 °C higher than the dew-point temperature of the ambient air. Painting works shall not be carried out on surface temperatures below +5 °C or above +35 °C, unless agreed by the Owner. During painting works, the ambient air temperature shall be kept within the limits recommended by the paint manufacturer. Application of paint shall never be undertaken under conditions where dust, sand, etc., can settle on the wet paint film.

Care shall be taken to maintain full paint thickness at all chamfers, corners and edges, and special attention shall be paid to the application of protective coatings over welds, mitre joints, etc.

Each coat shall be free from runs, drops, pinholes, waves, laps, sags and unnecessary brush marks, and shall be allowed to dry or cure before the succeeding coat is applied, the period of time not more and not less than instructed by the paint manufacturer.

Shop coats shall be checked for good quality and, where necessary, before proceeding with onsite painting or coating operations, the Contractor shall clean and repair all shop coats that are defective or damaged.

The Contractor shall consider that damage to paint work during shipment, storage and erection is unavoidable, and the application of all protective treatments shall be programmed accordingly. All parts subjected to mechanical machining such as guides, slides, tools etc. shall be protected by soluble, high intensity substances to ensure protection during sea transportation and lengthy storage.

Painting repair shall be done at site after installation.

All paints and primers shall be handled and delivered to the painting site according to manufacturer’s instructions and in sealed containers packed by the manufacturer. The manufacturer's instructions for preparation and application of all painting and protective coats shall be strictly followed.

Each paint shipment will be accompanied by the manufacturer’s certificate of date of manufacturing. Storage period of paints will be as short as possible. Paints whose storage period has passed the manufacturer’s recommendations will not be used and be withdrawn from the site.

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It is forbidden to store paint containers with the cover upside down.

Painting parameters – temperature, hygrometry, dew point, product batch number, coat thickness, etc. – shall be recorded in a painting record sheet to be established for each painting operation carried out in workshop and site and submitted during component inspection.

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6 ELECTRICAL COMPONENTS

6.1 General requirements

The Contractor shall submit to the Owner the manufacturer's name, type and full technical details for all electrical components that he proposes to use. An electrical device shall be defined as any device that has electrical connections.

Electrical components shall be labelled with the same name given in the design drawings and manuals.

Furthermore, the Contractor shall supply type test certificates for the main electrical equipment, such as high-voltage equipment (circuit breakers, disconnecting switches, insulators, etc.), CTs and VTs, motors and motor starters, power meters, transducers, protection relays and control equipment.

All electrical components shall be subject to the Owner's review.

6.2 Motors

6.2.1 General

All motors shall be in accordance with IEC 60034, Class F insulation, suitable for continuous operation and direct-on-line starting. The starting current at full voltage shall not exceed six times the full-load current.

All motors shall be capable, without injurious overheating, of continuous service operation at rated output, at any frequency between 47.5 Hz and 52.5 Hz, and at +/- 5 percent (5%) of nominal voltage, at nominal frequency.

All AC and DC motors shall have a degree of protection of IP54, with openings required for ventilation effectively screened. Submersible motors for drainage pumps shall have a degree of protection of IP68. Motors to be used outdoors or located in humid atmosphere shall be provided with heaters that maintain the motor temperatures at approximately 5 °C above ambient. The heaters shall operate continuously when the motor is not running.

Motors of 20 kW rating and above shall be fitted with embedded thermistors for thermal protection.

As far as found to be applicable, self-lubricating ball and roller bearings with solid races shall be provided for all motors. All vertical motors shall have thrust bearings. All motors with ratings of about 1 kW and above shall be equipped with lubricators that allow greasing while the motor is running and prevent over-lubrication. Additionally, the bearings shall be fitted with grease nipples that allow the use of a universal grease gun. The bearings shall further be protected and sealed against dust penetration and leakage.

Terminal boxes shall be weatherproof and vermin-proof IP54, fully enclosed and firmly attached to the motor frame. The arrangement of the terminal box shall be such so as to facilitate installation of cables and allow the fastening of weatherproof cable glands.

A permanently attached connection diagram shall be mounted inside the terminal box cover.

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For earthing purposes, each motor shall have adequately-sized bolts with washers at the lower part of the frame. In addition, each terminal box shall contain one earthing screw.

The insulation of all motors shall be Class F, but shall maintain during operation the temperature limits of Class B materials. The insulation shall be suitable for operation in damp locations, for occasional contact with corrosive gases and vapours, and for considerable fluctuations in temperature.

Noise levels of electric motors shall not exceed the overall level of 80 dB (A), measured at a distance of 1 m from the main surface of the machine and shall comply with pertinent EU regulation.

Motors shall always be of the three-phase type. If the power is lower than 0.75 kW, the motor may be single-phase and designed for a nominal voltage/frequency of 220 V / 50 Hz.

All motors shall be supplied with their data sheet completed.

6.2.2 Stator winding support

Stator windings shall be suitably braced to withstand the forces due to direct-on-line starting and transfer conditions, as mentioned above. Rotor windings shall be designed to give trouble-free continuous service including repeated direct-on-line start-up operations. Rotors shall be subjected to a 120% over-speed test for two minutes, without showing any winding dislocations.

6.2.3 Magnetic switches and motor starters

The rated voltage, current and duty of contactors and motor starters shall be suitable for service conditions. Starters and contactors shall comply with IEC 60947-4-1 and IEC 61095, and shall be suitable for direct-on-line starting and continuous electrical duty. The use category shall be not less than AC-3, in accordance with IEC 60947-4-1 and IEC 61095.

At a minimum, motor starters shall include the following:

- Lockable isolating switch, with padlock
- Magnetic protection by adjustable circuit breaker with manual resetting. Fuses shall not be used.
- Thermal protection by thermal overload relay fitted in each phase (<100 kW), or thermal relay supplied from secondary of CTs on each phase (>100 kW), with manual resetting
- Ammeter
- Control switches to operate the motor locally

Coordination between magnetic switch and magnetic and thermal protection of motor starters shall be at least Type 2.

6.3 Transformers

6.3.1 Current transformers

Unless otherwise specified, current transformers shall conform to IEC 61869.

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For all current transformers used for protective schemes, magnetization characteristics, turn ratios, secondary resistance values and secondary burden and accuracy classes shall be submitted for the review and comments of the Owner.

Primary polarity designation and secondary terminals shall be clearly marked via an agreed method on the appropriate faces of each current transformer. A local junction box shall be provided for each group of current transformers located near each other. Connections from the secondary terminals shall be taken via these junction boxes.

For all current transformers, the primary winding conductors shall have a short-circuit current and time rating not less than those of the associated switchgear.

Secondary windings of each current transformer shall be earthed at one point only.

6.3.2 Voltage transformers

Unless specified otherwise, voltage transformers shall conform to IEC 61869.

Terminal markings shall be permanent and shall be shown on the Contractor's drawings. A rating plate shall be provided on each voltage transformer. Where voltage transformers are installed in cubicles, a separate label shall be attached to the cubicle, identifying phasing and grouping.

A local junction box shall be provided for each group of voltage transformers.

The secondary terminals shall be connected to the junction boxes, which shall contain MCBs for secondary circuit protection.

Sub-circuits shall be individually protected and switched, and the MCBs shall have auxiliary contacts.

The Contractor shall determine the burdens and accuracy classes of the secondary windings, taking into consideration the most unfavourable conditions.

6.4 Solenoids

Solenoids shall withstand the specified voltage variation and shall be equipped with protection against voltage surges (RC filters).

Solenoids shall be equipped with an LED (light-emitting diode) lamp.

6.5 Heat relays

Heat relays shall be installed next to the contactors. They shall be built and tested in accordance with IEC 60947-4-1.

6.6 Electrical relays

Electric protection relays shall be the standard product of an experienced and reliable protection relay manufacturer. They shall be of the static type and they shall not be affected by external magnetic fields or any other influence (radio, computer, signals, impulses, etc.), consistent with the

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place or method of mounting. Electromagnetic relays shall have a transparent cover with appropriate seals and proper packing.

The relays shall comply with all IEC 60255 norms and have a maximum operating time of 40 ms. They shall be equipped with all necessary auxiliaries, such as tripping units, time relays, external resetting devices (hand reset flags with seal-in operation). The relays shall provide easy access for testing and setting purposes.

Protection relays shall, preferably, have serial communication to its applicable controller in the control system. Tripping of a protection system, as well as the sources of the protective action, shall be indicated and recorded as an alarm. Unless otherwise required for special purposes, protection relays shall remain in the tripped position until the operator resets the relay manually.

The control and auxiliary relays shall be grouped according to their sequence numbers and mounted on plug-in modules or stationary-mounted on swing frame with separate plugs and sockets to feature easy replacement and testing. The construction shall be sturdy and such that all parts are easily accessible for adjustment. Spare relay plug-ins shall be arranged in appropriate locations so as to further install more relays. Spare contacts shall be provided and connected to terminal blocks.

Relays installed in switchboards shall be arranged in compartments separated from the switchgear.

The coils shall be rated for continuous operation and shall have a finish adapted to tropical conditions. Coils shall be suitable for operation between 80% and 110% of their nominal voltage. Contacts shall be sized according to the voltage, current and type of load to be supplied and to withstand 1 million operations determined based on the supplier's curves.

Relay contacts connected to high impedance input of electronic equipment shall be silver-plated.

Time delay relays shall be of the solid-state type. It shall be possible to adjust the timing delays easily and the relays shall hold that adjustment.

In addition to the contacts required by the control scheme, at least one spare normally-open contact and one spare normally-closed contact shall be provided on each relay.

The manufacturer shall adapt the relay design to the special environment: vibrations caused by large rotary machines and dust.

The operation of each element of the relay shall also be identified by an LED.

Contact multiplying relays will not be acceptable.

6.7 Indicating instruments

Instruments shall conform to IEC 60051 (Particular Technical Specifications 1-9) and IEC 61554, and shall be of Class 1.5 or better. Instruments using electrical means for indication shall be capable of withstanding, or shall be adequately protected from, vibrations encountered during operation.

All electrical instruments shall be of flush-mounted design, dust-proof and moisture-proof. Instrument size shall be at least 96 mm x 96 mm.

All indicating instruments shall generally withstand, without damage, a continuous overload of 20% in reference to the rated output value of the corresponding instrument transformers. Ammeters shall not be damaged by fault-currents within the rating and fault duration time of the associated switchgear via the primaries of their corresponding instrument transformers.

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All instruments and apparatus shall be capable of carrying their full-load currents without undue heating. Means shall be provided for zero adjustment of instruments without dismantling.

Energy meters shall be of the electronic type with an accuracy class of 0.5 S, according to IEC 62052-11. They shall have transmission contacts.

All instrument scales shall be in accordance with IEC 60051, printed in black numbers and divisions on a white background. The unit measured shall be clearly marked on the instrument dial in black capital letters in an abbreviated form (e.g. A for amperes). Instruments shall have 90° or 240° circular scales calibrated 0–120%.

6.8 Electronic equipment assemblies

Modules and parts of all solid-state equipment shall be assembled from proven modules and components.

All components shall be conservatively rated. The surface temperature of any component shall be at least 5°C lower than the maximum test temperature of the equipment.

The printed circuit boards shall be of the plug-in withdrawable module types mounted on standard-width racks, which when mounted in racks or cubicles shall allow full unobstructed front and rear access to the boards and their connectors. About 10% of unused locations on the rack shall always be kept as spare locations to allow the Installation of additional boards.

Withdrawable boards, modules and cable plugs shall be key coded or otherwise identified to avoid the possibility of making replacements in the wrong position. Board frames shall be equipped with locking devices to prevent unplugging of boards due to vibrations or accidental disturbances.

Control systems or components using microprocessors shall have their programs and configuration date stored in a suitable non-volatile memory such as EPROM. The use of RAM memory with battery backup shall be avoided.

The Contractor shall include in his supply all the equipment, software and information necessary to enable the Owner to reprogram or reconfigure the control systems or the components. Following successful commissioning, the Contractor shall supply the Owner with a backup copy of all final software along with fully commented and indexed program listings. Spare parts shall be programmed and configured by the Contractor before their delivery.

Modules performing identical functions shall be interchangeable. The electronic components used in modules shall be of the highest quality having a designed in-service life of at least ten (10) years.

Replacement modules for all parts of the control system shall be easily available so that the Owner can carry out his own maintenance and repair work. It shall be guaranteed that spare components shall be available for a period of ten (10) years after product cancellation.

6.9 Cabinets and enclosures

6.9.1 General characteristics

The instructions below concern low-voltage electrical cabinets and enclosures. The cabinets and the enclosures shall be made of sheet metal steel of a minimum thickness of 1.5 mm, or 2 mm, if these

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metal sheets support equipment. All metallic parts shall be protected by zinc plating after a white metal blasting followed by an in-factory adapted anticorrosion protection coating.

The envelopes shall insure equipment protection against direct contacts with live parts, against the penetration of dusts, against splashing water and against mechanical damages. This equipment shall correspond to, at least, the following degrees of protection:

- IP41 –for cabinets and enclosures installed in dry and clean premises
- IP54 –for cabinets and enclosures installed in humid locations, and in places likely to be exposed to splashing water
- IP65 –for cabinets and enclosures installed outdoors

Depending on the thermal constraints, efficient natural or forced ventilation inside of the cabinets and enclosures may be necessary. In such a case, in the lower part, an air intake is provided with a wire mesh and a dust filter. For the cabinets and the enclosures installed in air-conditioned premises, it shall be verified that a breakdown of the air-conditioning for a few hours does not result in an increase of temperature that could damage the components installed in these cabinets and enclosures. Heat dissipation design and calculations shall be provided for Owner's review.

The enclosures and cabinets containing equipment shall include an anti-condensation heating device of adequate overall power and controlled by a hygrostat, as well as lighting controlled by a door contact.

The cabinets and enclosures shall be generously dimensioned and provide extra space for eventual additions (in the order of 20% extra space). Enough space is left between each component to allow connection, installation and convenient maintenance. Particular attention is given so that the extra space left for external cable connections is sufficient.

All components installed in cabinets and enclosures shall be tagged in conformance with the tags indicated on the drawings.

The cabinets and enclosures shall be provided with a front facing closing system (with square or triangular locks or key locks) which shall be standardized for all enclosures and cabinets on the installation. The hinges and locks shall be made of chrome-plated corrosion-resistant metal. The hatch or doors shall have the possibility to open at least a full 120°, and to be blocked in the open position. They necessarily include a grounding strand of 25 mm² cross-section.

The closing panel and doors include adapted sealing linings.

The cabinets shall be installed on a rigid metal base of 200 mm thickness; it is provided with a number of adapted lateral windows which can be closed by means of removable plates, allowing the installation and tightening of cable compression glands.

The wall mounting of enclosures, as well as cabinets, when specified, shall always be performed on the back face.

Cable entries shall always be from the bottom face of enclosures and cabinets. This face shall be provided with a removable bottom plate drilled on demand for fastening marine-type cable glands. This plate shall be fastened on the enclosure or cabinet by means of bolts with sealed joints. The plate and bolts shall be made of rustproof metal.

The connection devices for the cables coming from outside shall be sufficiently clear of the bottom part of the enclosure or cabinet in order to allow the spreading of the cables. Upon entry in the

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cabinets or enclosures, the cables shall be properly fastened on metal supports especially dedicated to this purpose.

A grounding busbar made of copper shall be provided near the bottom of each enclosure for electrical equipment. The frame of electrical devices shall be connected to the grounding busbar.

6.9.2 Terminal blocks

Terminal blocks shall be of an agreed brand and type.

Terminal blocks shall be with screw-type terminals, sized according to the wire to be connected. Double or more terminal blocks shall not be permitted. Terminal blocks include the possibility to insert test points. Terminal blocks for CT circuits shall have some safe and easy means of short-circuiting the CT circuit.

Terminal blocks for power, control, CTs and VTs circuit shall withstand 2.5 kV rms for one minute between adjacent terminals and between terminals and earth. For terminals used in alarm circuits, the withstand voltage shall be of 1,000 V rms for one minute.

When withdrawable terminal blocks are used on internal components, the terminal blocks shall be secured mechanically.

In each enclosure, the Contractor shall provide sufficient terminal blocks to terminate all incoming cable cores, excluding spare cores. In addition, twenty (20) percent spare terminal blocks shall be distributed amongst the functional groups of terminal blocks (as indicated by the wire number series).

6.9.3 Internal wiring

The internal connections in the cabinets shall be made of copper wires, with coloured insulation sheaths according to the nature of the circuit, flame retardant, flexible multi-strands, minimum specified voltage of 0.6/1 kV. The minimum cross-sections of the wires shall be as follows:

- 0.8 mm²:For control-and-command and measuring circuits other than current or voltage connected to electronic systems of the programmed automaton type
- 1.0 mm²:For control-and-command circuits of the internal relay
- 1.5 mm²:For command circuits connected to actuators
- 2.5 mm²:For voltage-measuring circuits
- 2.5 mm²:For power circuits
- 4.0 mm²:For current-measuring circuits

The measuring and counter circuits, as well as the circuits of each electrical protection relay, shall pass through testing devices allowing coupling without the connection/disconnection of the test device.

The wirings of internal circuits of different types shall be distinctly separated. All wires shall be tagged at both ends.

Generally, the wiring is laid within insulated ducts such as wiring ducts provided with a removable lid. These ducts shall be made of material which does not propagate flame. The actual filling of these wiring ducts, inspected when the equipment left the factory, shall not exceed 70% of the maximum

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capacity specified by the Manufacturer. The conductors laid in these ducts should have sufficient slack to allow eventual wiring modifications.

There shall be no more than two wires per terminal, with the exception of terminals for exterior couplings, for which only one wire is permitted on the exterior side.

The wiring threads and cable conductors, intended to be connected by screws, and cable supports shall be provided with a pre-insulated and crimped terminal end (sleeve), adapted to their cross-section. The crimping of this terminal end shall be performed with the help of a tool dedicated to this purpose.

6.10Cables

6.10.1General

The cable ends on a reel shall be hermetically sealed with a pressure cap.

The Manufacturer's identification, the rated voltage, size and number of conductors and the year of manufacturing shall be imprinted through the whole length of the cable. The space between two identification marks shall not be greater than 1000 mm.

Sequential metrical markers (every metre) shall be printed on the outside surface.

The external sheath of all of the electric cables shall be chemically treated, during manufacturing to obtain permanent protection from rodents.

All cables shall be flame-retardant. Type test certificates, according to IEC 60332, shall be submitted upon request.

6.10.2Medium-voltage power cables

Medium-voltage power cables shall comply with IEC 60502-2, with the main conductor in copper or aluminium, single-core or three-core, with individual metallic screen. The assigned voltage shall be selected according to the circuit for which they are intended to be used.

Cable accessories shall comply with IEC 60502-4.

6.10.3Low-voltage cables

- **Power cables:**
  - Low-voltage power cables shall comply with IEC 60502-1, with the main conductor in copper, semi-rigid and assigned voltage of 0.6kV/1kV. Cables outside buildings shall have an external metallic sheath.
  - Sizing of the conductors: The thermal behaviour in continuous operating conditions and short-circuit, as well as the overload capacities, shall take into account eventual downgrading due to the various methods of installation.
  - Acceptable current in continuous operating conditions: The power cables shall be selected to have the capacity to permanently transmit 120% of the current corresponding to the maximum load of the supplied equipment, taking into account the ambient temperature and

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heating due to the other cables, and all this without exceeding the maximum temperature stipulated in the IEC recommendations.

- **Control and measuring cables:**
  - Low-voltage control cables shall comply with IEC 60502-1, with main conductor in copper, semi rigid and assigned voltage of 0.6kV/1kV. Cables outside buildings shall have an external metallic sheath. The conductors shall have a minimum cross-section of 1.5 mm^2.
  - Low-voltage measuring cables connected to CTs and PTs shall comply with IEC 60502-1, with the main conductor in copper and assigned voltage of 0.6 kV/1kV. Cables outside buildings shall have an external metallic sheath. The conductors shall have a minimum cross-section of 4 mm^2 for voltage measurement circuits, and 6 mm^2 for current measurement circuits.
  - Instrumentation cables shall be twisted pair (or triple) each individually screened. The screens shall be 0.05 mm thick aluminium tape with overlapping edges. In contact with the screen, a continuous soft electrolytic copper wire shall be provided. Each cable shall have an overall aluminium screen covering the entire cable. Instrumentation cables shall have a rated voltage of Uo/U of 450/750 V.

6.11General rules for cabling material and works

6.11.1General

The Contractor shall prepare cable schedules and termination diagrams for all equipment included in the Contract, and to be submitted to the Owner's for review and comments in order to allow onsite cabling work operations and maintenance.

Termination diagrams shall show the following details for each cubicle, cabinet, device or other equipment to which the cabling defined in the Contract is to be connected:

- The designation of the cubicle
- A wire number (or blank space in the case of a spare terminal) next to each terminal
- For each cable: the cable identification number, the total number of cores and number of spare cores and the destination of the cable
- The wire number for each core in each cable

Termination diagrams shall refer to the associated circuit diagram and wiring diagram drawing numbers, including the revision number.

Cabling for protection, alarm, control and indication circuits shall be separated from the power supply or high-voltage cabling. Emergency control cabling shall be separated from all other cabling. Circuits with similar properties or functions shall be arranged in the same terminal block.

The Contractor shall provide the following minimum number of spare cores in each multi-core control cable:

- Up to 4 core cables:does not require spare cores
- Up to 12 core cables:shall have a minimum of 2 spare cores
- Up to 20 core cables:shall have a minimum of 4 spare cores
- Over 20 core cables:shall have a minimum of 6 spare cores

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6.11.2Cable installation materials

- **Cable terminations:**
  - Unless otherwise specified, the terminations on each end of each cable shall include the following:
    - Fastening the cable with an agreed gland (or clamp for bottom entry into floor-mounted indoor cubicles)
    - Sealed thermally shrinkable termination
    - Fitting an agreed lug to each core (except spare cores)
    - Fitting an agreed phase or polarity identification to each power cable core
    - Identification of each control and alarm cable core and cable identification tag

- **Cable identification tags:**
  - The Contractor shall provide and firmly attach stainless steel identification tags with appropriate dimensions to each cable, fastened longitudinally along the cable. Each identification tag shall be engraved with the appropriate cable number, in accordance with the cable schedules, the letters and numbers being not less than 5 mm high. PVC identification marks of the same characteristics can be acceptable subject to Owner's review and provided they are firmly fastened to the cables.

- **Cable glands:**
  - Cable glands shall be of the weatherproof compression type, and, for outdoor locations, shall be of non-ferrous metal. Cable glands for cables with an overall diameter over 20 mm shall be of metal, and as for single core, cable glands and locknuts shall be made of non-ferrous metal.

- **Conduits:**
  - Steel conduit shall be rigid screwed steel conduit with metric thread in ISO form. Fittings shall be of malleable cast iron. Conduit and fittings shall be hot-dipped zinc coated, both inside and outside.

- **Cable ladders, cable trays and supporting steelwork:**
  - All supporting steelwork shall generally be of adequate strength and made of stainless steel or hot-dipped galvanized steel after manufacturing
  - Cable ladder and tray systems shall be of an established design complete with horizontal bends, tees, inside and outside risers and all the necessary accessories including splices, support brackets, hangers, clamps, etc. Only known standard commercial types will be accepted.
  - Cable ladders and accessories shall be made of aluminium or stainless steel. Cable ladder rungs shall have slotted holes suitable for fastening cables with cable ties.
  - Perforated cable trays shall be made of aluminium or stainless steel of not less than 1.5 mm thick sheet steel.

- **Masonry anchors:**
  - Masonry anchors shall be corrosion-proof and of the expansion or resin adhesive type. The Contractor shall provide full details of the proposed masonry anchors, complete with typical pull-out values, for review.

6.11.3Cable installation

- **General:**
  - Cables shall be installed in accordance with IEC 60364. Wiring shall be neatly and securely fastened, enclosed in ducts or conduits, or supported on trays or ladders and run in the most

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efficient manner from point to point. Wiring shall be fastened using plastic strips at suitable intervals.
- In all locations within 1,800 mm from the floor and in any other locations where cables may be exposed to mechanical damages, the Contractor shall provide and install suitable sheet cover to protect the cables or, alternatively, shall enclose the cables in steel pipes or conduits. For the connections to sensors, flexible metallic conduit protected by a PVC sheet may be used.
- Cables shall not be installed in a common trench with pipework. Where cables on ladders pass under or be adjacent to pipes containing fluids, they shall be provided with covers to divert any leaking fluid. All cables and supports shall be kept clear of the plant's walkways and operating spaces.
- All wiring shall be left sufficiently long and neatly looped to allow a fresh termination to be made should the original termination break off. Cables shall be properly laid and fastened so that no stress is transmitted to the different devices in particular sensors and terminals.
- The Contractor shall provide all necessary terminals, cable glands, ties, cleats, cable boxes and terminating facilities, except for terminals in equipment provided by other contractors, to which cables are to be connected. The Contractor shall supply and install all facilities for the purpose of supporting cables.

- **Power cables:**
  - Single-core power cables shall be fastened at intervals not exceeding 2,500 mm and on either side of bends or risers and before terminations.
  - Single-core power cables forming part of a three-phase circuit shall, unless otherwise specified, be held in trefoil touching formation by cable ties installed every 600 mm for straight runs and every 300 mm in curves.

- **Bending radius:**
  - The bending radius of cables shall not be less than recommended by the manufacturer and in no case be less than eight (8) times the outside diameter of the cable.

- **Sealing of openings:**
  - Any cableway crossing through a concrete wall, floor or ceiling or entering into cubicles shall be sealed with a fireproof sealing mixture agreed by the Owner. At the point of entry, cable pipes, ducts and trenches entering buildings shall have the fireproof seal overlaid with plastic weatherproof compound.
  - The seals around cables shall be trimmed as required to give a neat appearance.

- **Cable trenches:**
  - Cable trenches shall be fitted with covers. Covers shall be made of reinforced concrete and shall be fitted on hot deep galvanized steel angle supports embedded in the trench.

- **Cables laid in the ground:**
  - Cables laid directly in the ground shall be at the following minimum depths:
    - Cables 0.6/1 kV:600 mm under roadways, 500 mm in other locations
    - Cables above l kV rating:700 mm at all locations
  - Before any bedding sand is placed in the trench, the excavation shall be inspected by the Owner. The lowest cables in a trench shall be laid on a 50 mm bed of sand. Sand shall then be added until the top of the uppermost cable is covered to a depth of 50 mm. Particular attention shall be paid to maintaining cable spacing appropriate to the design cable rating.
  - Concrete or clay brick protective cable covering shall be placed on top of the bedding and shall include either of the following:
    - Pre-cast concrete slabs of 38 mm minimum thickness and l5 MPa minimum compressive stress
    - Concrete slabs cast onsite of l00 mm minimum thickness
    - Clay bricks laid close together lengthwise for cables rated 1 kV or lower and crosswise for cables rated above 1 kV.

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- Before backfilling is started, the works shall be inspected by the Owner. Backfilling shall be carried out using the soil from the excavation. It shall be placed in layers not exceeding 300 mm loose depth. Each layer shall be compacted by hand or power ramming until dense firm compaction is achieved. Cable marker posts for direct-laid cables shall be supplied and placed at intervals of 30 m to indicate the position of the buried cables, and at every position where the cable changes direction.

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7 INSPECTION AND WORKSHOP TESTS

7.1 General

The various parts of the supply shall be subject, either in the workshops and laboratories of the Contractor or of his subcontractors as well as on site, to all inspections and tests in order to ensure:

- The quality of the raw materials and other materials
- The correct execution of machining operations
- The correct execution of pre-assemblies and assemblies
- The work progress status.

The main components and principal systems of the supply shall be subject to factory acceptance tests for which a forward programme is established by the Contractor and regularly updated. The list of main components shall be supplied in the Master Inspection and Test Plan by the Contractor, and shall be approved by the Owner. This programme shall include the tests methods to be used for each component. The Owner shall be informed of the planned calendar week of the tests and places where they will be carried out, at least four (4) weeks prior to the inspection. The exact inspection date shall be communicated fourteen (14) days in advance. This schedule shall be submitted to the Owner for review and comments.

No main equipment can be shipped without the factory acceptance tests having been made, and without all of the control documents and test report having been submitted for review and comment of the Owner. Factory tests, even if they are satisfactory, shall not replace, in any case, provisional acceptance of the materials, which can only be pronounced after assembly and the execution of conclusive onsite start-up tests.

All conveniences shall be given to the Owner to perform quality control activities in the various construction factories, including those of the Contractor's subcontractors. Generally, all inspections and tests are subject to the participation of the Owner.

The Contractor and his subcontractors are responsible for the following:

- To provide adequate advance notice to the Owner when inspections and/or tests are to be performed, as required by the Inspection and Test Plan (ITP) and/or as directed by the Owner
- To provide the Owner with all material resources and documents necessary to perform his inspections and/or tests

Prior to any inspections or tests, before or during the course of manufacturing, the Owner reserves the right to carry out evaluations of the means and methods of manufacturing, as well as inspections and tests, that the Contractor intends to implement for the completion of part of the supply.

Generally, inspection and tests shall be carried out in conformance with the following:

- Inspection & Test Plan (ITP), established during the detail design of the equipment and submitted for the review and comments of the Owner, which shall specify, for each major component, the inspections and tests to be carried out. The ITP shall also specify the reference documents for implementation of the inspections and tests.
- Inspection and test procedures submitted for the review and comments of the Owner, which define the procedures, acceptance criteria and required test equipment

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The list of inspections and tests described in Subsections 7.2–7.7 below is not restrictive. The Owner reserves the right to proceed, or to order to proceed, with any additional control that he would deem necessary, notably in the event of duly observed manufacturing defects; the exercise of this right would suspend the execution of the corresponding manufacturing.

7.1.1 Repairs

If any inspection and test on a components show any defect or non-conformity with the design documents or the technical specifications, the concerned component shall be repaired correspondingly. Such repair or modification shall in no way affect the quality, reliability of operation, interchangeability or lifespan of the component, and shall be performed only after obtaining authorization from the Owner.

If the repair or modification cannot be carried out in accordance with the terms mentioned above, the part or component concerned shall be rejected. Components presenting defects shall under no circumstances be delivered.

7.1.2 Tests of Spare parts

The spare parts shall be subject to the same inspection and test programs as those applicable for the main components with identical requirement in term of quality documentation.

Special care shall be taken by the Contractor concerning the reference number (for each component, part, sample, etc.) to enable appropriate monitoring of workshop tests.

7.2 Inspections and tests on mechanical components and sub-assemblies

An Inspection & Test Plan (ITP) shall be prepared and presented, indicating the all production quality controls, as well as all factory and onsite tests to be performed. All equipment shall be tested and inspected according to the ITP and the international standards or national standards accepted by the Owner.

7.2.1 General

All tests shall be done and certificates shall be issued by skilled and duly trained personnel or by a certified laboratory previously approved by the Owner

Non-destructive test procedures shall be established by a Level 2 qualified operator and verified by a Level 3 qualified operator according to the ASNT SNT-TC-1A or ISO 9712 – 2005. These procedures shall be submitted to the Owner review and comments.

Non-destructive tests shall be conducted by a Level 2 qualified operator, according to the SNT-TC-1A or ISO 9712 – 2005. Test reports will be sent to the Owner review and comments.

The test reports shall include the following information as minimum:

- Test description

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- Procedures or items of the test standard, when applicable
- Test equipment and instrumentation including calibration certificates.
- Dimensions of samples (if necessary)
- Tabulation of data and test results
- Protocols
- Results of analyses

7.2.2 Inspections and tests to be carried out on main castings

Inspection	Appliance	Reference Standard
Chemical analysis	100% of the main castings (ladle analysis + attached coupon analysis)	ASTM A751:2021
Mechanical test	100% of the main castings – On attached coupon after final heat treatment. - Tensile test - Impact test - Bending test - Elongation (A% and Z%) - Nil ductility temperature test	ASTM A370:2023
Visual inspection	100% of the main castings	–
Ultrasonic test	100% of the main castings	EN 12680-1 CCH 70-4
Magnetic particle or dye penetrant test	100% of the main castings	EN 1369 CCH 70-4
Review of manufacturing process documents	100% of the main castings	–

7.2.3 Inspections and tests to be carried out on main forgings

Inspection	Appliance	Reference Standard
Chemical analysis	100% of the main forgings (ladle analysis + attached coupon analysis)	ASTM A751:2021
Mechanical test	100% of the main forgings – on attached coupon after final heat treatment - Tensile test - Impact test - Elongation (A% and Z%) - Nil ductility temperature test - Bending test - Hardness test	EN ISO 15461:2018 EN ISO 6892-1:2019 ASTM A370:2023
Visual inspection	100% of the main forgings	–
Ultrasonic test	100% of the main forgings after rough machining	EN 10228-3 ASME VIII-1
Magnetic particle or dye penetrant test	100% of the main forgings according to design after final machining	EN 10228-1,2 ASTM E165-02 ASTM A275-03

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Review of manufacturing process documents	100% of the main forgings	

7.2.4 Inspections and tests to be carried out on structural steel plates

Inspection	Appliance	Reference Standard
Chemical analysis	Mill certificate - Test on sample per batch of material	ASTM A751:2021
Mechanical test	Mill certificate - - Test on sample per batch of material - Test according to material specification	ASTM A370:2023
Ultrasonic test	100% for plates with more or equal to 30 mm thickness	EN 10160 EN 10307 ASTM A577 A

7.2.5 Inspections and tests to be carried out on welds

Inspection	Appliance	Reference Standard
Structural Butt Welds		
Ultrasonic test	100% before and after heat treatment, and before final machining	EN ISO 17640:2018 EN ISO 11666:2018 ASME VIII-1 UW51 and Appendix 12
Magnetic particle or dye penetrant test	100% after heat treatment, and after final machining	EN ISO 23278:2015 ASME VIII-1 Appendix 6 and 8
Visual inspection	100% before and after heat treatment, and after final machining	No visible defects can be accepted
Structural Fillet Welds		
Ultrasonic test	According to the requirement of the drawings	EN ISO 17640:2018 EN ISO 11666:2018 ASME VIII-1 UW51 and Appendix 12
Magnetic particle or dye penetrant test	100% after heat treatment, and after final machining	EN ISO 23278:2015 ASME VIII-1 Appendix 6 and 8
Visual inspection	100% before and after heat treatment, and after final machining	No visible defects can be accepted
Non-Structural Welds		
Magnetic particle or dye penetrant test	According to the requirements of the drawings	EN ISO 23278:2015 ASME VIII-1 Appendix 6 and 8

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Visual inspection	100% before and after heat treatment, and after final machining	No visible defects can be accepted

7.2.6 Dimensions and finish

Dimensional, tolerance and surface finish verifications shall be performed on all major parts, components and partial assemblies, to verify compliance of the manufactured part with the drawings' dimensions and insure their reliable operation and interchangeability.

In the same manner, profile, dimensional and surface finish verifications shall be performed on all the parts to confirm the scale-up between hydraulic model dimensions and prototype dimensions.

7.2.7 Inspections and tests to be carried out on painted surfaces

The Contractor shall keep constant supervision of the work and ensure that all specified conditions are met and keep a record at least twice every day and before applying any coats. The following items shall be recorded and signed:

- Date
- Name of painting company
- Working place
- Type of work (priming, painting, sandblasting)
- Air temperature
- Relative humidity
- Dew point temperature
- Steel temperature
- Paint type and production number
- Thickness of each coat (after drying)
- Comments on any irregularities

The records shall be filed by the Contractor, and will be reviewed during factory acceptance tests. At the site, copies shall be submitted to the Owner every day for review and comments and filed along with inspection and test reports.

The Owner may inspect the work after the pre-treatment is finished (blasting and cleaning) before beginning the paint application. The Contractor shall give notice well in advance.

Upon completion of each coat, the Contractor shall perform a detailed inspection of the painting finish and shall remove all spattering of paint material. He shall correct all damages that may be caused by such cleaning operations and after the drying period shall measure and record the film thickness of the coat.

The factory acceptance tests shall be done by certified laboratory previously approved by Owner and shall include at least the following tests:

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- **Dry film total thickness measurement:**

The specified DFT is to be understood as the mean value of ten measurements per 0.04 m2 (0.2 m x 0.2 m). No single measurement shall have a thickness less than 80% of the specified value. No single measurement shall show thickness greater than 250% of the specified value.

The mean DFT of the completed paint film shall not be less than 95% and not more than 200% of the guaranteed total dry film thickness, provided the number of coats is as specified.

The measurements shall be performed on completely cured paint, but not less than 24 hours after final application.

If the DFT per coat exceeds the specified value, the Owner can request a complete removal and a new application. If total dry film thickness of the fully-cured paint is less than specified, the Owner shall request additional coats until specified thickness is obtained.

- **Adhesion test:**

Unless otherwise agreed, the adhesion should be measured with an "Adhesion Tester", according to ISO 4624.

The adhesion of fully-cured paint must be more than 2.5 N/mm2 for epoxy systems or 2.0 N/mm2 for other paint systems. In cases the adhesion is less, the Owner may request complete removal of the paint film and new treatment.

After an adhesion test has been made, the Contractor shall ensure that the areas damaged during testing are touched up immediately to the specified coating thickness.

7.3 Workshop assembly

Whenever possible, the equipment shall be fully assembled in the workshop after manufacturing, as much as found practicable. All site welds shall then be temporarily fastened by tack welds. The equipment shall be checked and accepted with regard to dimensions, tolerances and alignment. Functional tests shall be made wherever possible.

The Contractor shall clearly state, in his Tender, the items for which the shop assembly has been planned.

After the assemblies have been inspected and accepted by the Owner, the components shall be match marked, with an indelible paint, disassembled and prepared for shipment.

7.4 Inspections and tests on fluid systems

Components which, during operation, will be submitted to pressure, for example the turbine governor pressure tank, air pressure tanks, etc., shall be inspected and tested according to the ASME Section VIII-1 design code and pertinent EU regulation. The pressure test is to be performed applying water at the prescribed test pressure in accordance with the relevant code.

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Those parts that may not or shall not be closed, and which are exposed during operation to only a low pressure of any liquid (e.g., bearing housings, oil containers, etc.), shall be subject to a tightness test with a suitable low-viscosity liquid. The testing period shall not be less than ten (10) hours, unless otherwise agreed.

All pipes and systems under pressure shall be pressure-tested at 1.5 times the design system pressure, for at least 30 minutes.

Additionally, a functional test of the entire system, as far as practicable, shall be carried out according to a test procedure to be submitted for the review and comments of the Owner.

7.5 Inspections and tests on babbitt surfaces

Tests and inspection of the babbitt surfaces of plain guide, thrust and counter thrust bearings shall include the following specific requirements:

- Ultrasonic test of 100% of the babbitt surface according to ISO 4386-1 Class 2 – Limit of acceptance: Group C, if not otherwise specified
- Dye penetrant test of 100% of the babbitt surface according to ISO 4386-3 – Limit of acceptance: Group C, if not otherwise specified
- Dye penetrant test of 100% of the perimeter of the babbitt layer. For each side, cumulative length of indications shall be not more than 5% of considered side.

7.6 Inspections and tests on nuts and bolts

Standard nuts and bolts for structural purposes shall be supplied with certificates of conformance.

Chemical composition and mechanical properties of special bolts and nuts shall be systematically verified by analyses and tests on specimens to be performed for each batch delivered.

7.7 Inspections and tests on standard components and procured items

7.7.1 Routine tests (individual tests)

Before shipment, all components shall be submitted to routine testing in factories as defined by IEC standards for the type of equipment considered. The purpose of these tests is to verify the satisfactory performance of the material and its compliance with specifications, performances and guarantees. Their main goal is to detect and eliminate any defects likely to later involve the refusal of certain components or sub-assemblies.

These tests shall mainly verify the operating characteristics. However, at the request of the Owner, a program of more specific test can be established by mutual agreement with the Contractor.

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7.7.2 Type tests

The Contractor shall submit to the Owner the type test certificates of the various equipment items supplied. If necessary, the Owner reserves the right to request the performance, without additional charges, of certain type tests for which the Contractor has not submitted certificates of conformance or could not justify compliance with the General and Particular Technical Specifications.

The tests shall be carried out in accordance with the standards quoted in the specifications.

7.7.3 Tests on electric motors

Tests on electric motors (with a motor minimum output to be agreed with the Owner) shall be carried out according to IEC 60034, including, as a minimum, the following:

- **Routine tests:**
  - Resistance of windings (cold)
  - Starting torque and current
  - No-load losses and current
  - Excitation current at rated speed and rated armature voltage (DC motors)
  - Open circuit secondary induced voltage at standstill (wound rotor)
  - Direction of rotation
  - Withstand voltage test
  - Vibration test
  - Temperature stabilization test (P >200 kW)

- **Type tests:**
  - Speed/torque characteristics
  - Overspeed test (if auxiliary system is fed from hydro-generator output)
  - Maximum safe operating speed (if auxiliary system is fed from hydro-generator output)
  - Noise
  - Electromagnetic compatibility (for emissions by DC motors)

7.7.4 Tests on power transformers

Tests on power transformers shall be conducted according to IEC 60076. Special tests shall be carried out according to the requirements of the Particular Technical Specifications.

7.7.5 Tests on instrument transformers

Tests on instrument transformers shall be conducted according to IEC 61869. Special tests shall be carried out according to the requirements of the Particular Technical Specifications.

7.7.6 Tests on pumps

The main pumps shall have to be fully inspected and tested at Manufacturer’s premises prior to delivery, in conformance with the stipulations of the relevant standards. Suitable inspection

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and test Certificates to this effect shall be required. The list of these main pumps shall previously be approved by the Owner.

The following tests shall be required:

(a) Hydraulic Test

The acceptance test shall be carried out as per the ANSI/HI 14.6 or ISO 9906 (or equivalent, subject to Owner's review)

Tolerances:Q tested= Q ordered +10%
H= +0
Pump efficiency= no minus tolerance

(b) Hydrostatic Test

(Shut-off head + max. inlet pressure) x 1.5 or (Condition point head + max. inlet pressure) x 2; whichever is greater (to be confirmed).

Operational/functional test of the pump driven by the project motor for verification of the basic parameters (pressure/flow/electric power/temperature/vibration)

7.7.7 Tests on air compressors

Routine tests on air compressors shall include, at a minimum, the following:

- Check of the air compressor's characteristics
- Operational test of the air compressor driven by the project motor for verification of the basic parameters (pressure/flow/electric power/temperature/vibration)
- Check of the associated instruments and actuators
- Functional test of the air compressor, verification of the protection

7.7.8 Inspection and tests on servomotors

Routine tests and inspection on the hydraulic cylinder shall include the following specific requirements:

- Inspection of raw material and welds, including 100% ultrasonic test (UT) and Dye-penetrant test (PT) or magnetic test (MT) test of the rod and the cylinder.
- Leak test of the piston and rod seal at the nominal pressure for six hours. No leakage will be accepted on the rod seals. Acceptable leakage on the piston seals will be evaluated on a case-by-case basis.
- Pressure test at 1.3 times the design pressure, for 30 minutes on each chamber.
- Strength test of the rod under pressure, at 1.3 times the design pressure, for 30 minutes. During this test, a tension strength, corresponding to 1,3 the design pressure of the servomotor, is applied to the rod which shall not be subject to permanent deformation.

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7.7.9 Inspection and tests on electronic equipment

Routine tests on the main electronic equipment – programmable logic controller (PLC), speed governor, automatic voltage regulator, protection relays, etc. – shall consist of functional tests specified in the Particular Technical Specifications.

Type tests on main electronic equipment – programmable logic controller (PLC), speed governor, automatic voltage regulator, protection relays, etc. – shall mainly cover the field of electromagnetic compatibility and environmental and power supply withstand conditions.

The tests described herein correspond to the tests to be performed on the single components before integration into cabinets and/or cubicles.

- **Electromagnetic compatibility – type test requirements:**
  - Industrial nominal frequency voltage endurance test according to IEC 60870-2-1. Electronic modules shall at least comply with Class VW1 (effective 500V test voltage) in the same standard. Specifically for protection relay systems, the equipment shall be compatible with IEC 60255-5, Series C.
  - Surge voltage endurance test according to IEC 60870-2-1. The equipment endurance to high surges of short duration shall be in Class VW3. Specifically for protection relay systems, the equipment shall be compatible with IEC 60255-5, with surge voltage at peak value of 5 kV.
  - Endurance to repetitive fast transients test. The equipment endurance to repetitive fast voltage transients shall be that provided in IEC 61000-4-4, Severity Level 2, for equipment installed in the control room, and Severity Level 4 for equipment installed in the other environments. Specifically for protection relay systems, the equipment shall be compatible with the IEC 60255-22-4, Class IV.
  - Oscillatory wave endurance test. Endurance of the equipment exposed to dampened oscillatory waves (such as those induced by atmospheric charges, or resulting from switching with arch reigniting in medium- and high-voltage) shall be compatible with that provided in IEC 61000-4-12, Severity Level 1, both for the ring wave test and dampened oscillatory wave test. The equipment installed in environments with small exposure shall be compatible with the Severity Level 4 and 3, of said standard respectively, for the ring wave and dampened oscillatory wave tests. Specifically for the protection relay systems, the equipment shall be compatible with IEC 60255-22-1, Class III.
  - Electrostatic discharge endurance test. The endurance of the equipment to electrostatic discharges shall be Class 3 defined in IEC 61000-4-2. Specifically for relay systems, the equipment shall be compatible with IEC 60255-22-2, Class III.
  - Electromagnetic radiation endurance test. The endurance of equipment under the influence of electromagnetic fields shall be that of Severity Level 3 defined in IEC 61000-4-3. Specifically for protection relay systems, the equipment shall be compatible with IEC 60255-22-3, Class III.
  - Magnetic field endurance. The endurance of equipment under effects of magnetic fields shall be Severity Level 2, in accordance with IEC 61000-4-8.

- **Environmental conditions – type test requirements:**
  - Dry and damp heat test according to IEC 60870-2-2. Equipment installed in air-conditioned room shall be of Class Cn, otherwise of Class Dn.
  - Damp heat test according to IEC 60870-2-2.
  - Barometric pressure withstand test according to IEC 60870-2-2. The test reports presented shall show that the material is suitable for the site where it is intended to be installed.
  - Vibration endurance test according to IEC 60870-2-2 for equipment installed in places where the occurrence of vibrations is expected, such as the powerhouse's structural blocks, intake, spillway and places close to the turbines, generator or high-capacity machinery. The equipment to be installed in these locations shall have the following vibration endurance:

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Aspect	Class
Low-frequency vibrations	VL3
High-frequency vibrations	VH1
Vibration severity	VS2
Time rating	VT1

- **Electrical power supply withstand – type test requirements:**
  - Digital equipment shall be set in the following classes, as stated in IEC 60870-2-1

Tolerances	Class	
	AC source	DC source
In relation to voltage value	AC3	DC3
In relation to frequency value	F3	–
In relation to harmonic presence	H4	–
In relation to ripple voltage	–	VR3
In relation to source interruption	VI3	VI3

7.7.10Miscellaneous components

Miscellaneous components – instruments, gages, safety valves, pressure reducers, transducers, etc. – shall be supplied with certificates of conformance and calibration certificates issued by the supplier.

They shall be subject to functional tests along with the system in which they will be integrated.

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8 SPARE PARTS, CONSUMABLE MATERIALS, REPLACEMENT PARTS, SPECIAL TOOLS

To be completed in a later time according to the Owner's Requirements.

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9 PACKING, LABELLING AND TRANSPORT

9.1 Cost of delivery

The materials stipulated in the Contract shall be delivered to the construction site, within the required time period and according to the specified conditions, under the care, risks and perils of the Contractor.

The delivery operations to the construction site include packing, transport and all associated inherent tasks thereto, such as: loading, stowage, sheeting, transhipments and eventual intermediate storages, unloading and unpacking of the supply at the sites of assembly, of pre-assembly or of storage that shall be under the sole responsibility of the Contractor.

All expenses related to these operations shall be paid by the Contractor.

9.2 Responsibility for transport operations

The Contractor is responsible for the transportation of all equipment and components supplied, as well as transportation of his own assembly equipment and tools, to the construction site.

The Contractor shall select an adequate route and means of transportation after having inquired on location regarding accesses, gauges, bearing capacity of infrastructure works, maximum permissible load per axle on trails and roads, available local lifting and handling facilities, available transportation facilities, etc. The Contractor shall obtain all administrative authorizations, contract for the required insurances, and complete required formalities with the relevant Authorities.

If certain special or exceptional transport is likely to cause stresses or damage to structures belonging to the public domain, the Contractor shall defray all protective or special measures requested by the Authorities concerned in order to protect and/or reinforce the aforementioned structures utilized.

No compensation can be granted to the Contractor to cover additional costs, of unspecified nature, which he would have disbursed for transportation and which he had not anticipated at the time of submission of the price of his Tender.

The Owner reserves the right to supervise the choice of carriers, to verify the weighing and packing operations, as well as to attend at all phases of shipment of the equipment from the manufacturing plants to destination.

9.3 Weighing of the supply

The Contractor shall determine and verify the dimensions and weight of the various components supplied, before and after packaging and shipment to the construction site.

The dimensions and bulk of the packages, which shall be indicated on the packing list, shall be compatible with the gauges and the admissible loads of the various transportation facilities and lifting gears that will be used during transportation.

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9.4 Packing of the supply

The Contractor shall make all the necessary arrangements to ensure complete preservation of the quality of the material shipped, during transport, as well as during storage in open-air storage areas, which could possibly be prolonged due to uncertainties of the construction site.

All components supplied shall be carefully packed by the Contractor, taking into consideration risks caused by repeated and brutal handlings, corrosion in a maritime environment, humidity, bad weather, duration of open-air storage at quay or on the construction site, etc.

Generally, components shall be packed in sturdy wooden crates, well-built and tightly closed. When found necessary, especially for fragile components such as electrical and auxiliary equipment, the items inside the crates shall be protected by sealed envelopes. These sealed envelopes, independent from the crates, shall be made of a thermosetting composite fabric, welded; moreover, a hygroscopic substance shall be placed inside the envelope.

Any machined steel parts not destined to be painted shall be protected with grease or a suitable removable coating. Other alterable steel parts shall be protected with paint. Parts that are to be painted onsite shall, at a minimum, be protected with a primary coat of paint. Machined surfaces shall be efficiently protected against shock that may happen during transportation.

Inside the crates, equipment shall be carefully wedged, and, when necessary, in particular for delicate equipment, the equipment shall be immersed in flexible chips to cushion any shocks.

For equipment having moving parts, the moving parts shall be anchored and maintained in position.

All fluid systems shall be emptied and properly cleaned. Certain components – such as pumps, compressors and servomotors – may be recommended to be transported filled with oil. The nature and type of the oil used for transport shall then be clearly indicated on a label affixed to the component. To avoid any risk of overpressure in the event of a temperature rise, these components shall never be filled to more than 75% of their volume.

All piping ends shall be firmly sealed (sleeves, plugs, caps), as well as both ends of electric cables (sealing caps made of cast synthetic material). Cable reels shall be firmly staved and ringed.

All packaging materials are to be regarded as lost; they shall be evacuated to waste dumps indicated by the Owner, and shall remain the property of the Owner.

Damage or loss due to inadequate packaging or protection may in no circumstances be invoked by the Contractor as a cause of an unforeseeable delay, and the Contractor shall bear full responsibility.

9.5 Package labelling

Each package supplied shall be clearly and indelibly identified by the Contractor in order to ensure delivery and facilitate storage and assembly. Spare parts shall be conditioned separately and individually labelled according to the KKS identification code valid for the project.

Methods of identification shall be captive and unable to be removed, and shall remain perfectly legible even after prolonged exposure to the elements.

Conventional ideograms and reference marks – indicating slinging points for handling, assembly orientation, degree of fragility, etc. – shall be affixed to all sides of the packages.

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A complete packing list summary of the shipped material shall be placed in two (2) copies inside each package, and one (1) copy shall be placed in a small transparent and sealed envelope accessible from the outside.

In all cases, the following minimum information shall be indicated on each package:

- Name of the Owner
- Name of the Contractor
- Contract number
- Name of the hydroelectric Installation
- Batch number (and/or sub-batch number and/or item number)
- Site or place of delivery
- Packing list number
- Number of packages in the packing list
- Dimension of the package
- Gross weight
- Net weight

The labelling details will be transmitted to the Contractor during the Project implementation stage.

All boxes shall be labelled with the appropriate international symbols for transportation.

9.6 Shipment

The Contractor shall request final authorization to carry out shipment of the packages at least fourteen (14) days before the planned shipment date, and shall concurrently transmit, before the departure of the factory material, five (5) copies of the bill of lading, in which the following information shall be included:

- Contract reference
- Estimated date of delivery
- The shipment's sequence number
- The number of packages and a copy of their labelling
- Designation of the material per package
- Type of packing
- Specific storage instructions
- Gross and net weight
- Identification of the transportation methods, as well as pro-forma invoice indicating the value of the packaged material

The five (5) copies of the bill of lading shall be addressed to the following recipients:

- To the Owner:One (1) copy
- To the Owner's Head Office:Two (2) copies
- To the onsite Owner office:Two (2) copies

The Owner reserves the right to refuse, at the sole expense of the Contractor, the onsite unloading of packages that have not been properly announced or authorized, or for which the required formalities, whether administrative as technical, were not completed by the Contractor or his carrier.

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Seismic Hazard Analysis

South Field PHS

PPC

GREECE



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November 12, 2025

NOTE

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SOUTH FIELD PHS
Seismic Hazard Analysis

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SOUTH FIELD PHS
Seismic Hazard Analysis

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1. INTRODUCTION

Public Power Corporation S.A (PPC) is considering the possibility to create a new production facility to operate as a closed-loop Pumped Hydroelectric Storage (PHS) at the South Field lignite mine at the prefecture of Kozani, Western Macedonia, North Greece.

The Project aims to allow energy from intermittent sources (such as solar, wind) and other renewables, or excess electricity from continuous base-load sources (such as gas) to be saved for periods of higher demand. It would store energy in the form of gravitational potential energy of water, pumped from a lower elevation reservoir to an upper reservoir.

South Field mine PHS would take the advantage of difference in elevation between South Field lignite mine pit (decommissioned after 2026), which would be used as the lower reservoir, and the surrounding plateau to the South-East of the mine, which would accommodate the upper reservoir.

Tractebel has been appointed by PPC to develop the design of the project through its various phases:

- Phase A: Site visit, Evaluation and Review of the conceptual study, Project Outline;
- Phase B: Feasibility Study and Tender Design;
- Phase C (optional): Preparation of EPC Tender Documents, Pre-Tender Clarifications support and Post-Tender evaluation support.

As part of Phase B, this report presents the seismic hazard analysis performed for the project location. The aim of the seismic hazard analysis is to obtain the peak ground acceleration (PGA) to be considered in the seismic safety evaluation of the dam and structures within the scope of design works.

The project area is located at the following approximate coordinates:

- 21,85 Longitude (deg.), 40,40 Latitude (deg.)

The location of the dam project area is shown in Figure 1-1.



Figure 1-1: Project Location

2. SEISMICITY AND EARTHQUAKE CATALOGUE

Greece is in an area with high seismic activity, with the occurrence of many earthquakes. Considering the relatively high occurrence rate of earthquakes in the region, the distance range of the earthquakes for the seismic catalogue has been taken with a radius of R=200 km. The ground motion levels are almost fully dominated by the earthquake sources in this range, and any seismic source beyond that length will not affect the ground motion levels. For the earthquakes, ISC (International Seismological Centre, www.isc.ac.uk) database was used. The minimum magnitude for the database has been selected as M_{min}=3.9, which is reasonable for areas with moderate to high seismicity. The epicentres of the earthquakes within a circular area with a radius of 200 km are shown in Figure 2-1.

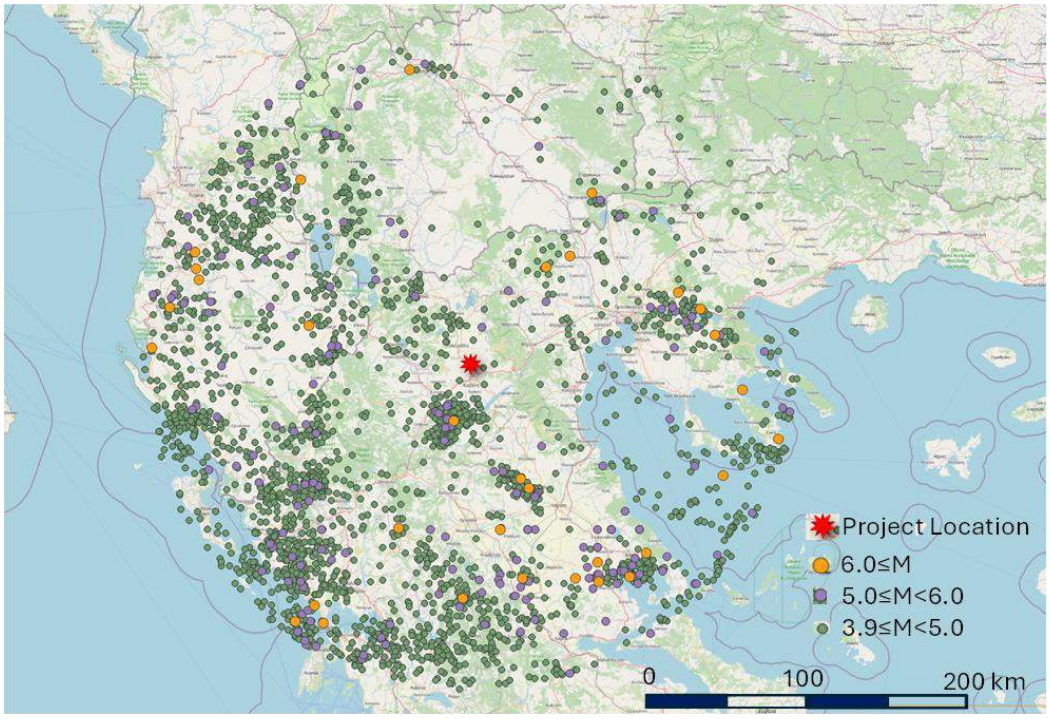


Figure 2-1: Epicentres of the Earthquakes within R=200 km Circular Area

It can be seen that the project is located in an area of moderate to high seismicity, with a significant number of earthquakes registered, especially within a range of 20-50 km to the south. The active faults at the project area have been obtained from the website “gaia.igme.gr” and shown in Figure 2-2 in larger scale and in Figure 2-3 in the vicinity of the project location. Figure 2-4 indicates the active faults and the epicentres of the earthquakes. It shows that the earthquakes with relatively lower magnitudes close to the project location may be associated with the local faults around the project location. It can also be observed that the identified active faults to the south and east of the project are a sensible match with the observed earthquakes. Moreover, many of the occurred earthquakes, especially to the west of the project, may not be associated with any identified faults. Nevertheless, the seismic source characterization has been performed mainly on the distribution of the epicentres of the earthquakes, also considering the active fault lines where applicable.

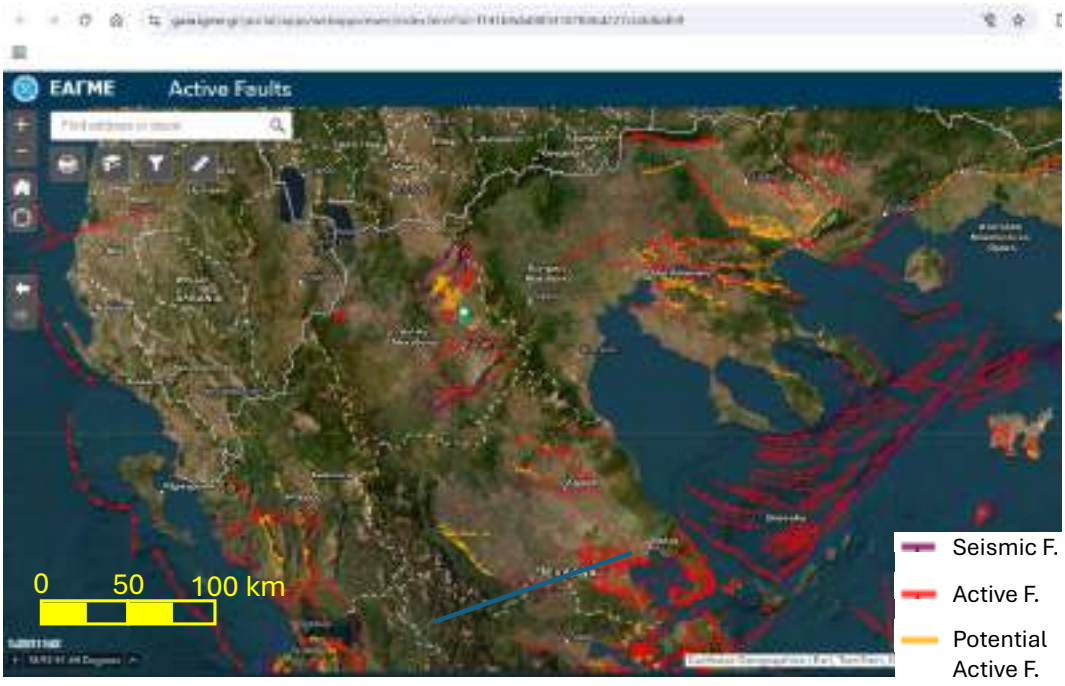


Figure 2-2: Active Faults around Project Area



Figure 2-3: Active Faults in Immediate Vicinity of the Project Area

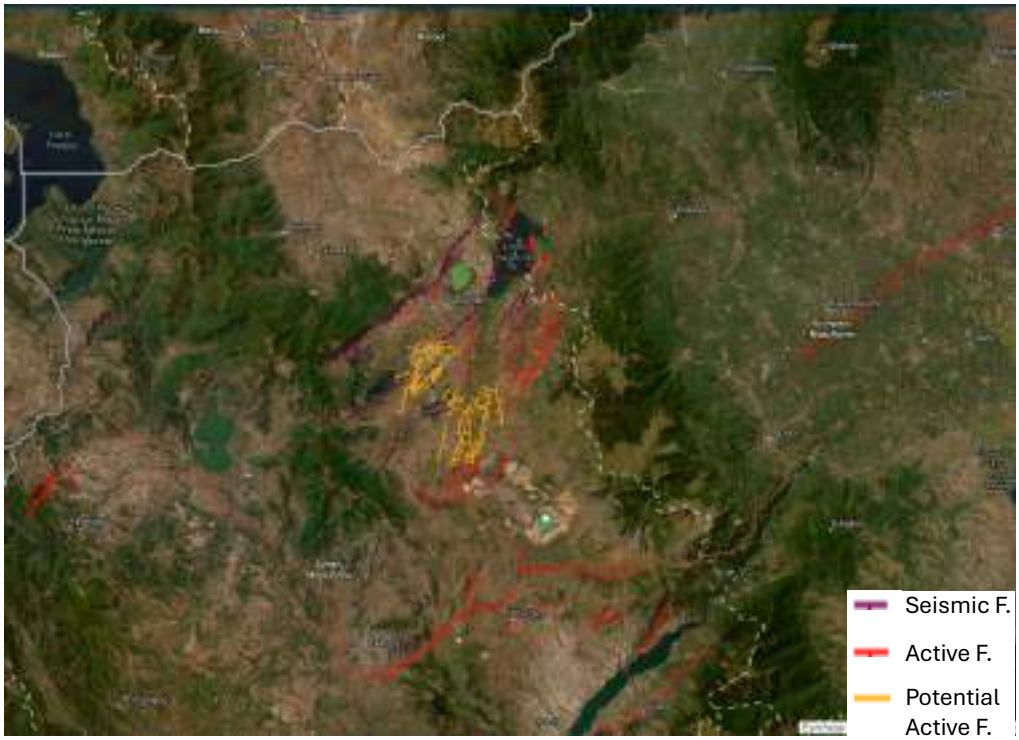


Figure 2-4: Active Faults and Epicentres in Immediate Vicinity of the Project Area

For the analysis of the earthquake data, the computer software “ZMAP” was utilized. The curve indicating the cumulative number of earthquakes vs time is shown in Figure 2-5. It can be seen that the rate of the earthquakes has a drastic change after 1962. Such a change in the earthquake rate cannot be interpreted as natural but it is obvious due to the poor or insufficient reporting in the earlier years. Evaluation of the activity rate parameters considering the whole range of time will lead to misleading results and lower activity rate than what is in real.

Figure 2-6 shows the cumulative number of earthquakes after 1962, only. It can be seen that the curve is almost linear indicating that the earthquake catalogue seems to be complete for the time from 1962 to present. In order to make a more accurate and reliable estimate on the activity rate of the earthquakes, the earthquakes occurred after 1962 have been considered in the analysis.

Foreshocks and aftershocks depend on the main shock both in terms of time and location. In the fundamental theory of probabilistic analysis, a statistically independent occurrence of the earthquakes is assumed. In this regard, it is common to remove the aftershocks and foreshocks from the catalogue. This process is called de-clustering. The earthquake catalogue has been de-clustered with the computer program “ZMAP” according to Reasenberg (1984) algorithm, which has resulted in an insignificant change in the database.

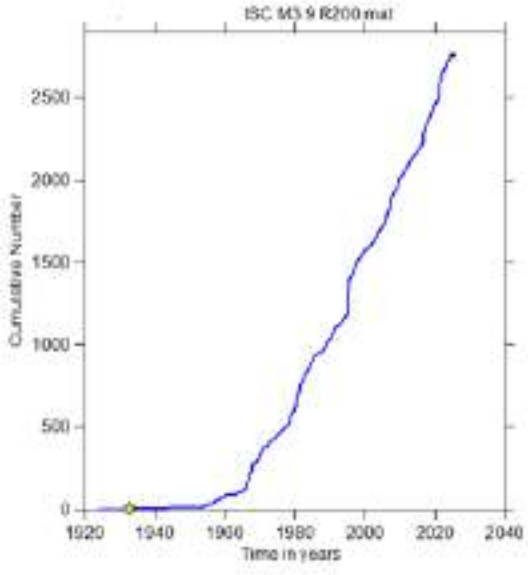


Figure 2-5: Cumulative Number of the Earthquakes

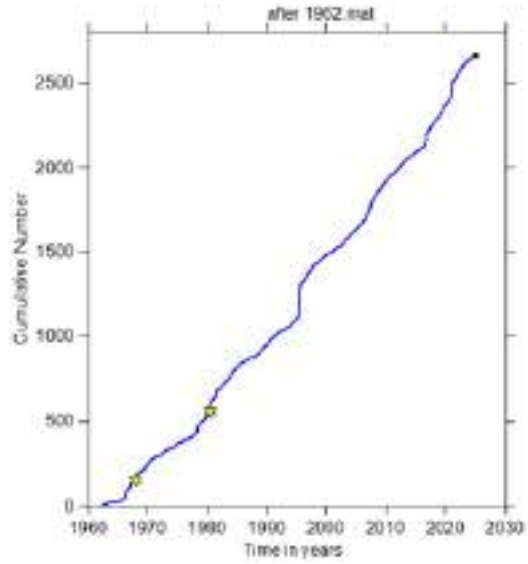


Figure 2-6: Cumulative Number of the Earthquakes after 1962

3. PROBABILISTIC ASSESSMENT

The probabilistic seismic hazard analysis involves the evaluation of the ground motion level and its probability at a site for a specified time interval. The seismic hazard at the site due to a single seismic source is obtained by addition of the three probability functions specified below:

The probability of an earthquake with a particular magnitude to occur on the source during a specified time interval.

The probability that the earthquake described in the previous item will occur at a specified distance from the site.

The probability that the ground motion with a magnitude and distance specified in the previous two items will exceed a specified level at the site.

By combining these three probability functions for each source, and adding the contributions from all sources, the specified level of ground motion for a specified period of time can be determined. In this way, parameters regarding the ground motion can be obtained for the design life of the dam and the desired risk level.

The seismic hazard at the dam locations is assessed by a probabilistic approach with the R-Crisis (Ver. 20.1.0) software, which is a well-known computer program for probabilistic seismic hazard calculations, developed at Instituto de Ingeniería, UNAM, Mexico. The input data required for the analyses are discussed in the following sections.

3.1. Seismic Sources Based on Earthquake Catalogue

Based on the distribution of the epicentres of the earthquakes and the locations of the identified active faults, seven area sources have been defined for the probabilistic seismic hazard evaluation. The defined areas are shown in **Figure 3-1** below. The earthquakes in the vicinity of the project location, including the earthquakes in the highly active area to the south have been considered in Area – 1. Six additional areas have been defined around Area-1 within the considered range of R=200 km.

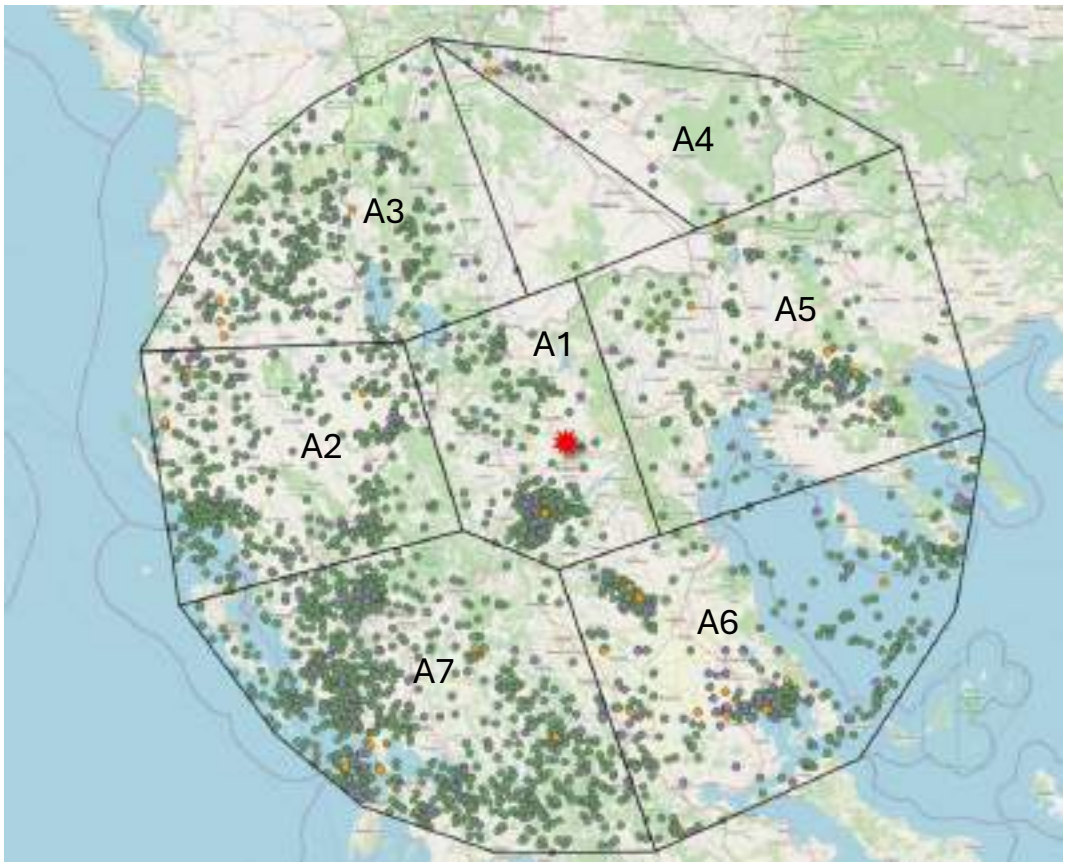


Figure 3-1: Seismic Area Sources

3.2. Frequency-Magnitude Relationship

The distribution of earthquake magnitude in time is defined by a magnitude-frequency relationship called as recurrence law. Gutenberg & Richter (1944), have examined the magnitude-time distribution of California earthquakes and recommended the following equation:

$\text{Log } \lambda M = a - bM$

were,

- λM = The rate of earthquakes with magnitudes greater than M
- M = Magnitude of the earthquake
- a, b = Regression coefficients

The equation assumes a linear relationship between the earthquake magnitude and logarithm of mean annual rate of exceedance. The frequency magnitude distribution curves and the obtained regression coefficients for the seismic area sources are presented in **Figure 3-2** below. For the curves and the determination of the regression coefficients, the software “ZMAP” has been used.

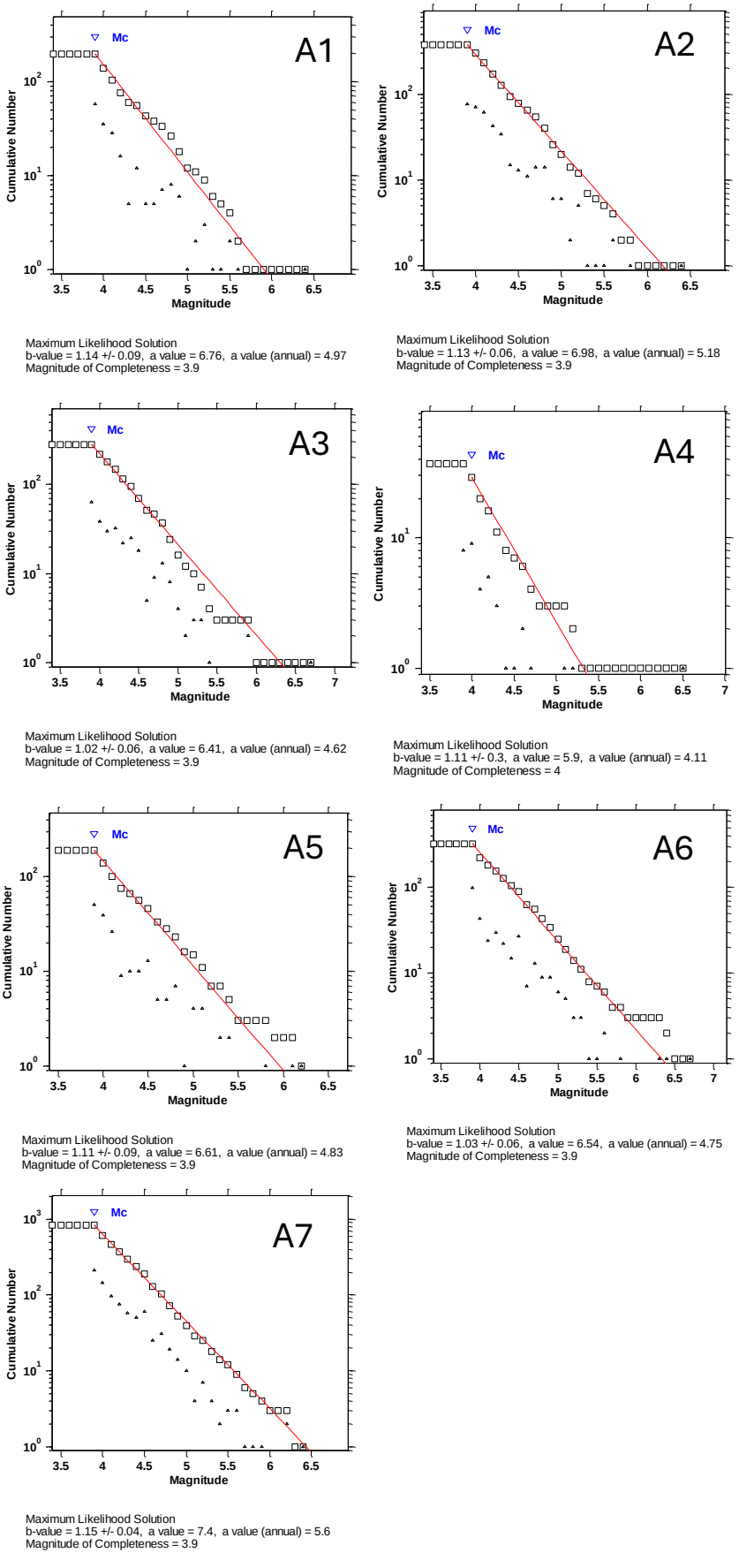


Figure 3-2: Frequency-Magnitude Relationship for Area Sources

In R-Crisis, the modified Gutenberg-Richter model is used where the earthquake magnitude exceedance rate is given by:

$$\lambda(M) = \lambda_0 \frac{\exp(-\beta M) - \exp(-\beta M_U)}{\exp(-\beta M_0) - \exp(-\beta M_U)}, M_0 \le M \le M_U$$

where λ_0 is the exceedance rate of magnitude M_0, b is a parameter equivalent to the "b-value" for the source (except that it is given in terms of the natural logarithm) and M_U is the maximum magnitude for the source.

The ultimate magnitude (M_u) was defined by staying rather on the conservative side, by adding a 0.5 magnitude to the maximum magnitude (M_{max}) of the defined seismic sources. The depths of the seismic sources have been taken as H=10 km. The parameters for seismicity in the seismic source areas are summarized in **Table 3-1**.

Table 3-1:Summary of the Parameters for Seismic Sources

Source	M_0	M_u	h	a	b	λ_0	β
A1	3.9	6.9	10	4.97	1.14	3.34	2.63
A2	3.9	7	10	5.18	1.13	5.93	2.60
A3	3.9	7.2	10	4.62	1.02	4.39	2.35
A4	3.9	7	10	4.11	1.11	0.60	2.56
A5	3.9	7.1	10	4.83	1.11	3.17	2.56
A6	3.9	7.5	10	4.75	1.03	5.41	2.37
A7	3.9	6.9	10	5.6	1.15	13.03	2.65

The magnitude frequency relationship with the above parameters, adopted in the probabilistic seismic hazard analysis is shown in **Figure 3-3** for the seven area sources.

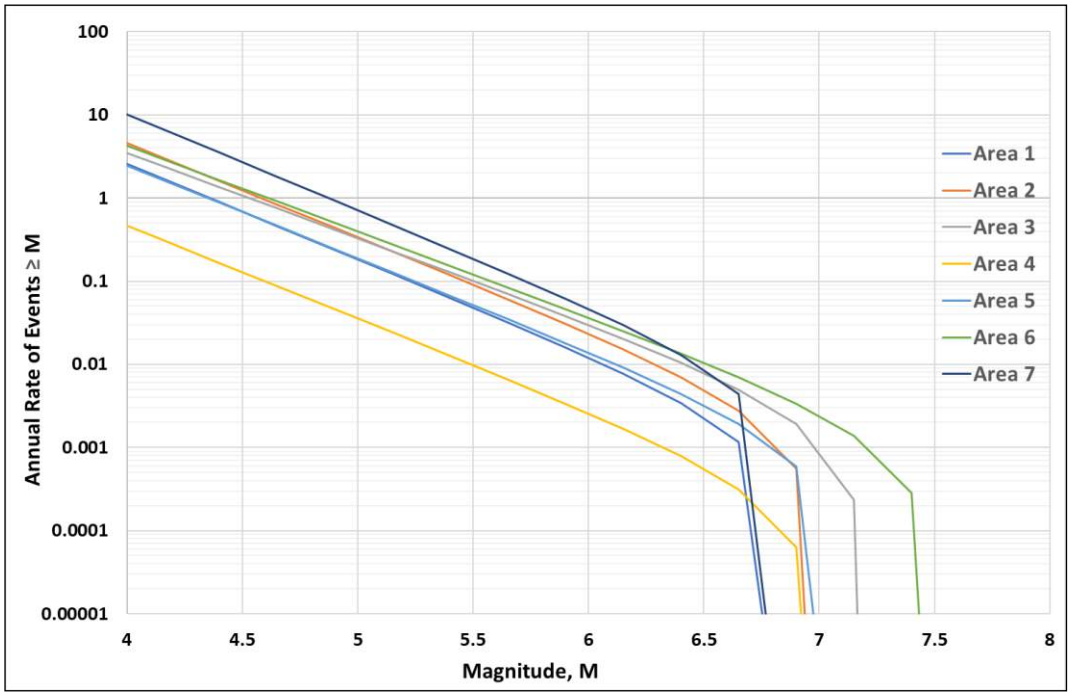


Figure 3-3: Magnitude Frequency Relationship for the seismic sources

3.3. Ground Motion Prediction Equations

The ground motion characteristics in a specified area are estimated by using attenuation relationships (also referred to as ground motion prediction equations) derived by statistical evaluation site records of earthquakes, considering the parameters such as magnitude, and distance to the seismic source. Most of the attenuation relationships are intended to estimate the peak ground acceleration, which plays a significant role in the seismic design of the structures.

Pacific Earthquake Engineering Research Center (PEER) coordinated a new project referred to as NGA-West2 by updating the NGA database. In the present study, the following four recent attenuation relationships for crustal earthquakes were used.

Abrahamson, Silva and Kamai (2014)

Boore, Stewart, Seyhan and Atkinson (2014)

Campbell and Bozorgina (2014)

Chiou and Youngs (2014)

The above ground motion prediction equations have been considered with equal weight (each with k=0.25) in the evaluation of the results.

In seismic hazard studies, truncation may be specified in the attenuation relationship by a method called "Sigma truncation". This means that the integration across the attenuation relation uncertainty implied in the calculations is not carried out up to infinity, but up to a certain value. In the performed seismic hazard analysis, uncertainty up to 2 sigma value has been considered in the probabilistic calculations.

3.4. Results of Probabilistic Analysis

The probabilistic analyses have been performed by the computer program R-Crisis, based on the input data and assumptions as explained in the previous sections of the report. The curves of PGA vs return period are shown in **Figure 3-4**.

For the dam design studies, the ground motion levels shall be selected by the Designer for each structure of concern, depending on the design requirements and conditions. The deterministic analyses results, submitted in the next chapter, need also to be considered for critical structures, based on the design criteria.

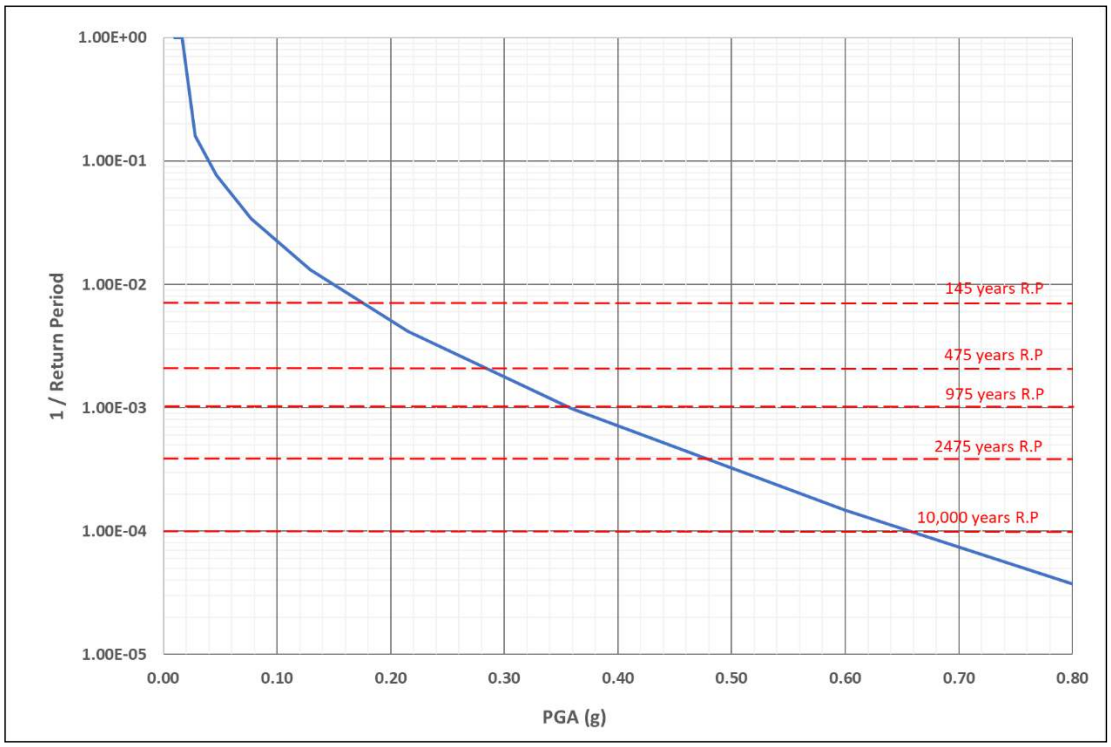


Figure 3-4: Obtained PGA Curve for the Southfield-Kardia project location by R-Crisis software

The uniform hazard spectra have also been determined for different return periods and given below as a table and figure in case it is required to be used in seismic design of the structures.

Table 3-2:Uniform Hazard Response Spectra for 5% Damping

Period (s)	Spectral Acceleration (g)			
	Return Period (years)			
	145	475	2475	10000
0.01	0.17	0.29	0.48	0.66
0.02	0.18	0.30	0.50	0.68
0.04	0.21	0.35	0.57	0.78
0.07	0.28	0.47	0.77	1.03
0.10	0.36	0.60	0.97	1.32
0.13	0.37	0.64	1.07	1.48
0.16	0.39	0.67	1.14	1.59
0.20	0.37	0.65	1.10	1.54
0.25	0.32	0.56	0.96	1.35
0.30	0.26	0.45	0.78	1.11
0.35	0.22	0.39	0.67	0.96
0.40	0.18	0.32	0.56	0.80
0.50	0.14	0.25	0.43	0.63
0.75	0.08	0.14	0.25	0.36
1.00	0.05	0.09	0.16	0.25
1.50	0.03	0.05	0.09	0.14
2.00	0.02	0.03	0.06	0.09
2.50	0.01	0.02	0.05	0.07
3.00	0.01	0.02	0.03	0.05
4.00	0.01	0.01	0.02	0.03
5.00	0.00	0.01	0.01	0.02

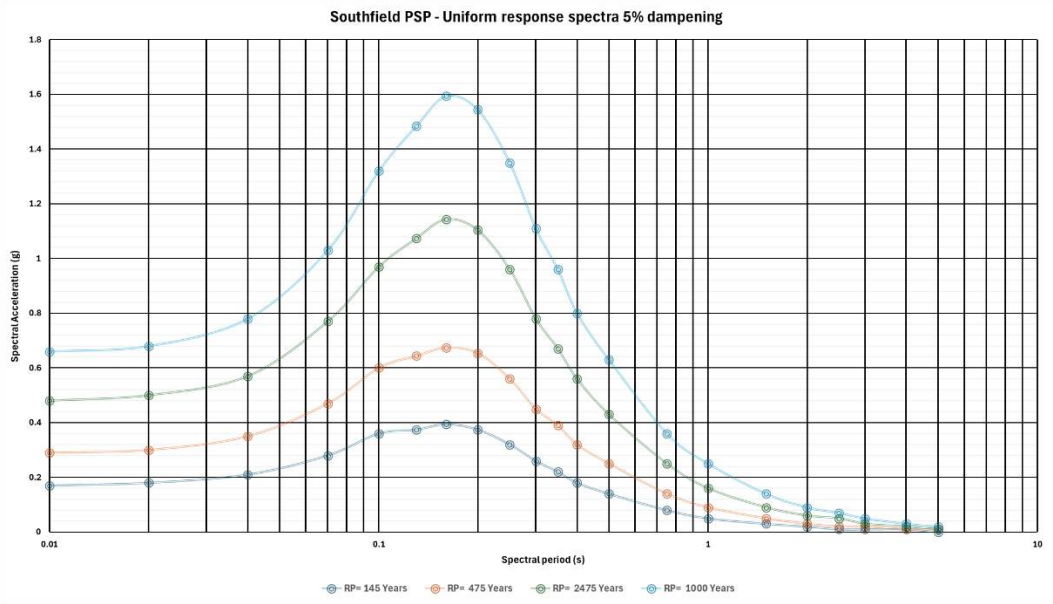


Figure 3-5: Obtained Spectral Acceleration Curve for the Southfield-Kardia project location by R-Crisis software for 5% damping ratio

In case of need in the seismic design of structures, the spectral accelerations are also given for 1% and 3% damping ratios. In order to obtain these spectral acceleration curves, the conversion suggested by “N. M. Newmark and W. J. Hall, Earthquake Spectra and Design, Earthquake Engineering Research Institute Monograph Series, 1982” was used. According to this, the conversion factors from 5% to 1% and 3% damping ratios are 1.3 and 1.16 respectively. The tables and the figures for 1% and 3% damping ratios are shown below.

Table 3-3:Uniform Hazard Response Spectra for 1% Damping

Period (s)	Spectral Acceleration (g)			
	Return Period (years)			
	145	475	2475	10000
0.01	0.22	0.38	0.62	0.86
0.02	0.23	0.39	0.65	0.88
0.04	0.27	0.46	0.74	1.01
0.07	0.36	0.61	1.00	1.34
0.10	0.47	0.78	1.26	1.72
0.13	0.48	0.83	1.39	1.92
0.16	0.51	0.87	1.48	2.07
0.20	0.48	0.85	1.43	2.00
0.25	0.42	0.73	1.25	1.76
0.30	0.34	0.59	1.01	1.44
0.35	0.29	0.51	0.87	1.25
0.40	0.23	0.42	0.73	1.04
0.50	0.18	0.33	0.56	0.82
0.75	0.10	0.18	0.33	0.47
1.00	0.07	0.12	0.21	0.33
1.50	0.04	0.07	0.12	0.18
2.00	0.03	0.04	0.08	0.12
2.50	0.01	0.03	0.07	0.09
3.00	0.01	0.03	0.04	0.07
4.00	0.01	0.01	0.03	0.04
5.00	0.00	0.01	0.01	0.03

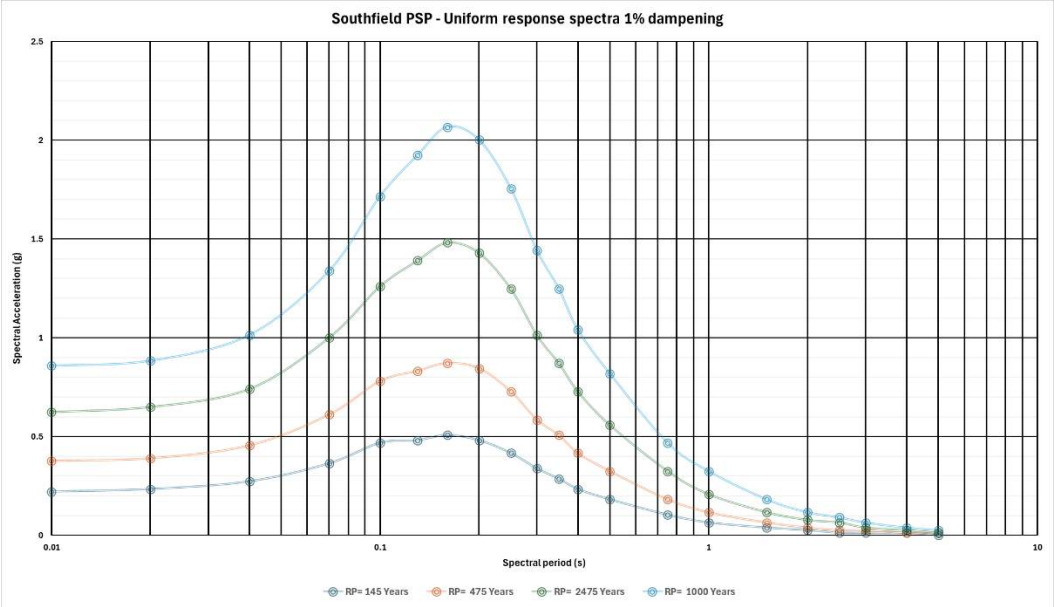


Figure 3-6: Obtained Spectral Acceleration Curve for the Southfield-Kardia project location by R-Crisis software for 1% damping ratio

Table 3-4:Uniform Hazard Response Spectra for 3% Damping

Period (s)	Spectral Acceleration (g)			
	Return Period (years)			
	145	475	2475	10000
0.01	0.20	0.34	0.56	0.77
0.02	0.21	0.35	0.58	0.79
0.04	0.24	0.41	0.66	0.90
0.07	0.32	0.55	0.89	1.19
0.10	0.42	0.70	1.13	1.53
0.13	0.43	0.74	1.24	1.72
0.16	0.45	0.78	1.32	1.84
0.20	0.43	0.75	1.28	1.79
0.25	0.37	0.65	1.11	1.57
0.30	0.30	0.52	0.90	1.29
0.35	0.26	0.45	0.78	1.11
0.40	0.21	0.37	0.65	0.93
0.50	0.16	0.29	0.50	0.73
0.75	0.09	0.16	0.29	0.42
1.00	0.06	0.10	0.19	0.29
1.50	0.03	0.06	0.10	0.16
2.00	0.02	0.03	0.07	0.10
2.50	0.01	0.02	0.06	0.08
3.00	0.01	0.02	0.03	0.06
4.00	0.01	0.01	0.02	0.03
5.00	0.00	0.01	0.01	0.02

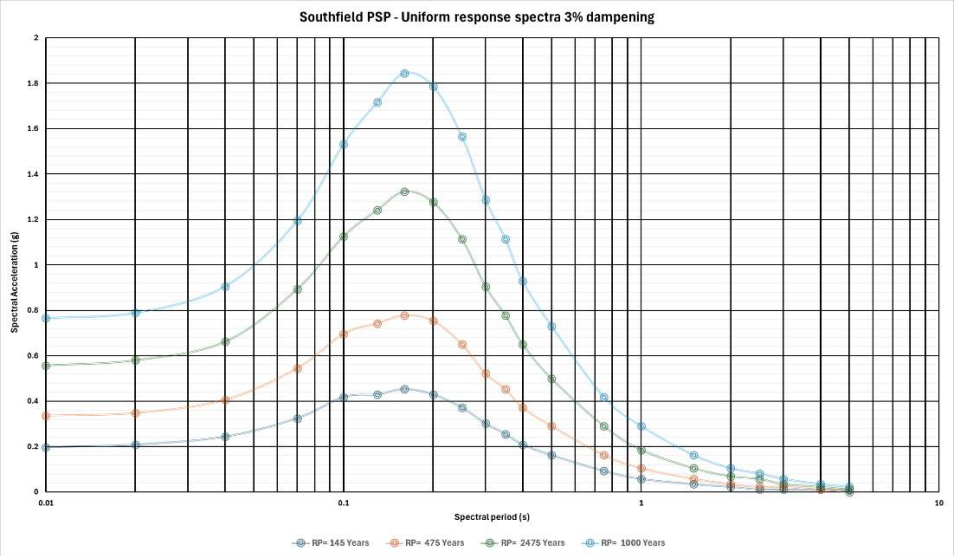


Figure 3-7: Obtained Spectral Acceleration Curve for the Southfield-Kardia project location by R-Crisis software for 3% damping ratio

3.5. Disaggregation of Seismic Hazard

In the hazard curve by probabilistic analysis, the combined effect of all magnitudes and distances on the probability of exceeding a specified ground motion level is considered. A process, called as disaggregation (also named after de-aggregation) is a common method to break the hazard back down into its contributions from various magnitude-distance pairs. In this way, the relative contribution of different events is computed and the most important events for the hazard can be determined. The results of disaggregation are different for different return periods. The disaggregation plot is shown at **Figure 3-8**, and indicates that the seismic hazard is predominantly dominated by the near earthquakes and the contribution from large-distance earthquakes are small even for high magnitudes.

A disaggregation analysis has been conducted for the site, using the same program, to determine the controlling magnitude-distance pairs on the seismic hazard. **Figure 3-8** shows the disaggregation plot 2475 years return period as an example, by using Abrahamson, Silva and Kamai (2014) relationship to provide insight to the contribution and importance of the specified seismic sources. It can be observed that most of the contribution is from the earthquakes with magnitude range between 5.0 – 6.0 and within close distance. It is noted that the distance used in this disaggregation is the Joyner-Boore distance, which is the closest distance to the surface projection of the rupture plane.

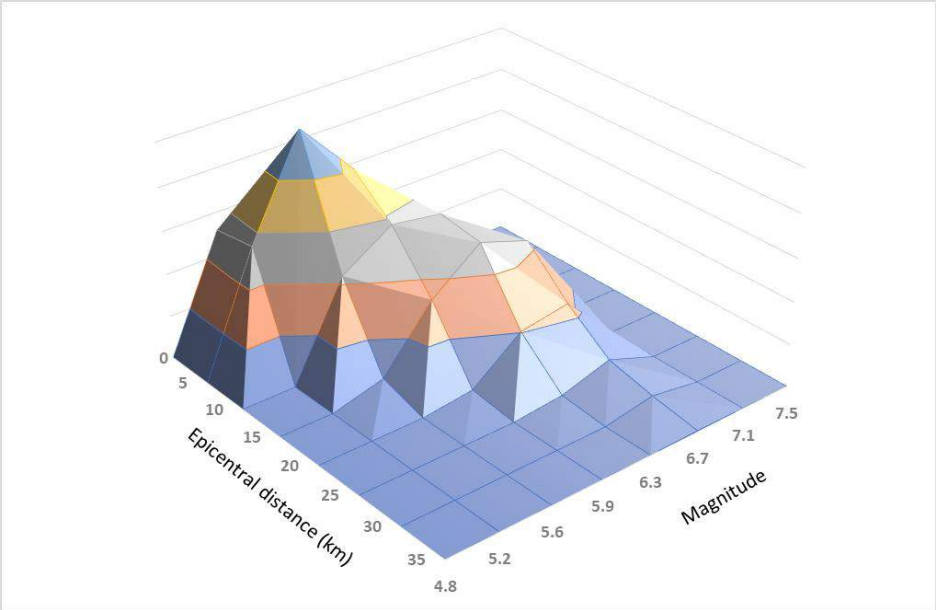


Figure 3-8: De-aggregation Plot for 2475 years return period by ASK(2014)

4. DETERMINISTIC ANALYSIS

In deterministic seismic hazard analysis, the maximum magnitudes (maximum credible earthquake, MCE) for the potential earthquake sources (point, line or area) related to the site are determined considering geological and seismotectonic characteristics. In order to determine the maximum level of ground motion, the MCE's are assumed to occur at the closest possible locations of the seismic sources to the site. The MCE for the seismic source that leads to the maximum level of the ground motion at the site is defined as the controlling maximum credible earthquake, CMCE, which shall be considered for the seismic design parameters. The return period of the deterministic ground motion is out of concern due to its definition with maximum magnitude and minimum distance. Each of the ground motion prediction equations (see Section 3.3) used for the analysis of the Peak ground acceleration prediction equations have been considered with equal weight (each with k=0.25). Here, the 84`th percentile (median + 1 standard error) ground motion level was considered in the ground motion prediction equations for SEE.

Based on the active fault map given in Figure 2-3, and the magnitude of the occurred earthquakes around the project area, whose epicentres are shown in Figure 2-1, it has been found reasonable to check two critical scenarios.

For the first scenario, an earthquake just at the project location has been considered with a magnitude of 5.5, at a depth of 10 km and Joyner-Boore distance of zero. The PGA has been obtained as 0.34 g for this scenario.

For the second scenario a larger magnitude earthquake has been considered. The earthquake magnitude has been assumed as M=6.9, which is 0.5 units larger than the maximum magnitude of the occurred earthquakes in seismic area 1. The depth has been similarly assumed as 10 km, and the Joyner-Boore distance has been considered as 10 km for this large magnitude earthquake. The obtained PGA for this scenario is 0.38 g.

Based on these results, the PGA by deterministic analysis has been obtained as 0.38 g.

The PGA which may be used for SEE has been obtained as about 0.5 g in the probabilistic analysis, which is higher. Actually, the difference between the results of deterministic and probabilistic analyses is normal, which arises due to the distinct methodologies, assumptions, and treatment of uncertainties in each approach.

PSHA estimates the likelihood that various levels of ground shaking will be exceeded at a site over a given time period. It integrates over all possible earthquake sources, magnitudes, distances, and ground motion models, accounting for both aleatory (random) and epistemic (knowledge-based) uncertainties. The result is a hazard curve, from which ground motions can be extracted for specific return periods (e.g., 3000 years for SEE). DSHA typically considers a worst-case scenario involving a selected earthquake (usually the maximum credible earthquake, MCE) on the most critical fault near the site. The ground motion is calculated for this single scenario, typically using conservative assumptions, but does not account for the full range of possible events or their probabilities.

PSHA considers contributions from all seismic sources that could affect the site, including: Near and far-field sources, Moderate and large magnitude events, A full range of recurrence intervals. Because it aggregates the cumulative probability from a wide range of events, it may yield higher PGA values than DSHA, especially for long return periods (e.g., 3000 years). In contrast, DSHA focuses only on the single most critical source—typically the closest or largest—and may exclude contributions from multiple simultaneous or interacting events.

PSHA explicitly incorporates uncertainty in: Magnitude-frequency relationships, ground motion prediction equations (GMPEs),Seismic source geometry and behavior. These uncertainties are typically handled using a logic tree structure, resulting in a broader and often higher estimate of ground motion, especially at long return periods.

DSHA often uses conservative but fixed input parameters, and although some uncertainty can be included (e.g., in GMPE selection), it does not account for the full range of aleatory uncertainty in the same systematic way as PSHA.

In this regard, the difference in SEE PGA values from PSHA versus from DSHA is a natural consequence of the different philosophies and computational frameworks behind the two methods.

Peak Ground Velocity:

For the deterministic scenario, the Peak Ground Velocity (PGV) values have also been determined in case if need for the seismic design of the structures. The same ground motion equations with equal weights have been used for PGV.

For the first scenario of M=5.5, H=10 km, Rjb=0; the PGV has been obtained as 14.5 cm/s. For the second of M=6.9, H=10 km, Rjb=10 km; the PGV has been obtained as 32.4 cm/s.

The above PGV values by deterministic analyses have been calculated for 84th percentile (mean + 1 standard error). In order to bring some conservatism and estimate a PGV which also corresponds to a level of ground motion of SEE as determined by probabilistic analysis, 93rd percentile value for the critical scenario (mean + 1.5 standard error) has also been determined as PGV = 44 cm/sec, which can be considered in the design in case of need.

5. GROUND MOTION TIME HISTORIES FOR DYNAMIC ANALYSES

This section of the report presents the ground motion time histories developed to be used in dynamic analyses (in case they are performed) as base motions. In order to develop ground motion records which will represent the earthquake loading, the following procedure has been adopted.

- A design spectrum has been established according to the obtained PGA of 0.50 g (corresponding to a 3000 years return period), according to Eurocode 8. It is worth noting that, for any other level of PGA, these submitted design spectrum and developed ground motions may be used by simple scaling using the ratio of PGA.
- 7 original ground motion records have been selected, based on the similarity to the adopted earthquake scenario adopted in the seismic hazard analysis, considering magnitude, distance, ground conditions and PGA, as much as possible, as summarized in the following table.
- In addition to the 7 ground motion records, 4 ground motion records for larger magnitude earthquakes at longer distances have also been prepared in case of need in the seismic design. The details are summarized in the table below.
- The original ground motion records have been processed in order to be compatible to the design spectrum. For the development of response spectra and processing of the original ground motions, the software “Seismomatch” has been used.

Table 5-1: Summary of the Selected Original Earthquake Records

Earthquake	Year	Magnitude	Joyner-Boore Dist. (km)	V_{s30} (m/s)	PGA(g)
Imperial Valley, Mexico	1979	6.53	0	242	0.47
Darnfield, New Zealand	2010	7.0	11.9	344	0.37
Laquila, Italy	2009	6.3	0	717	0.37
Chi-Chi, Taiwan-06	2005	6.3	0	489	0.48
Kobe, Japan	1995	6.9	0	312	0.43
San Fernando	1971	6.6	14	600	0.48
Northridge	1994	6.7	0	630	0.54

Table 5-2: Summary of the Selected Original Earthquake Records for Large Magnitude – Long Distance Earthquakes

Earthquake	Year	Magnitude	Joyner-Boore Dist. (km)	V_{s30} (m/s)	PGA(g)
Chi Chi, Taiwan	1999	7.6	99	430	0.15
El Mayor, Mexico	2010	7.2	150	630	0.06
Kocaeli, Turkey	1999	7.5	140	585	0.13
Tabas, Iran	1978	7.35	90	300	0.14

The design spectrum according to Eurocode, and the response spectra of the original ground motions are shown in Figure 5-1. The response spectra of the modified ground motions are shown in Figure 5-2, where it can be observed that the response spectra of the ground motions are well-matched with the target design spectrum.

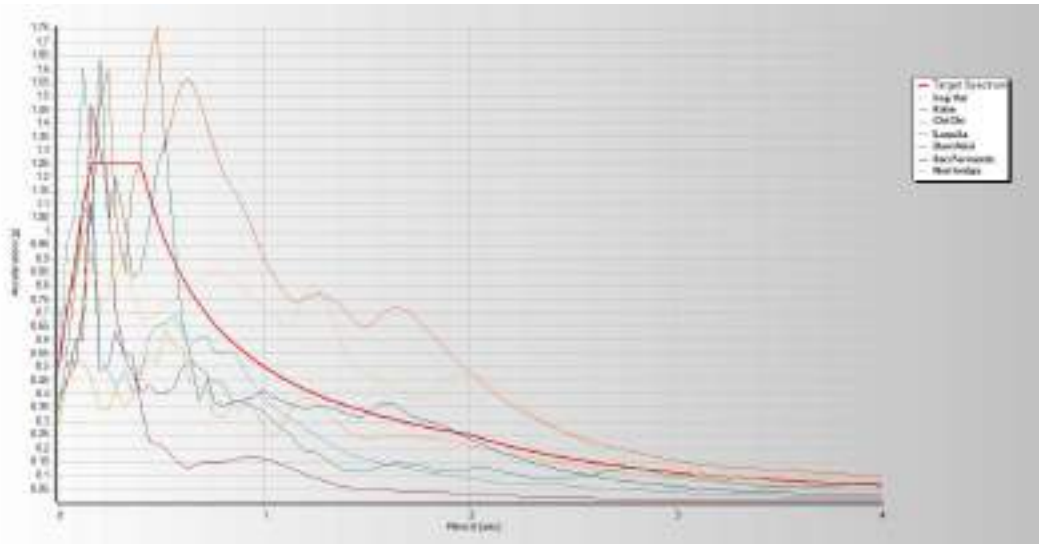


Figure 5-1: Design Spectrum according to Eurocode and Spectra of Original Ground Motions

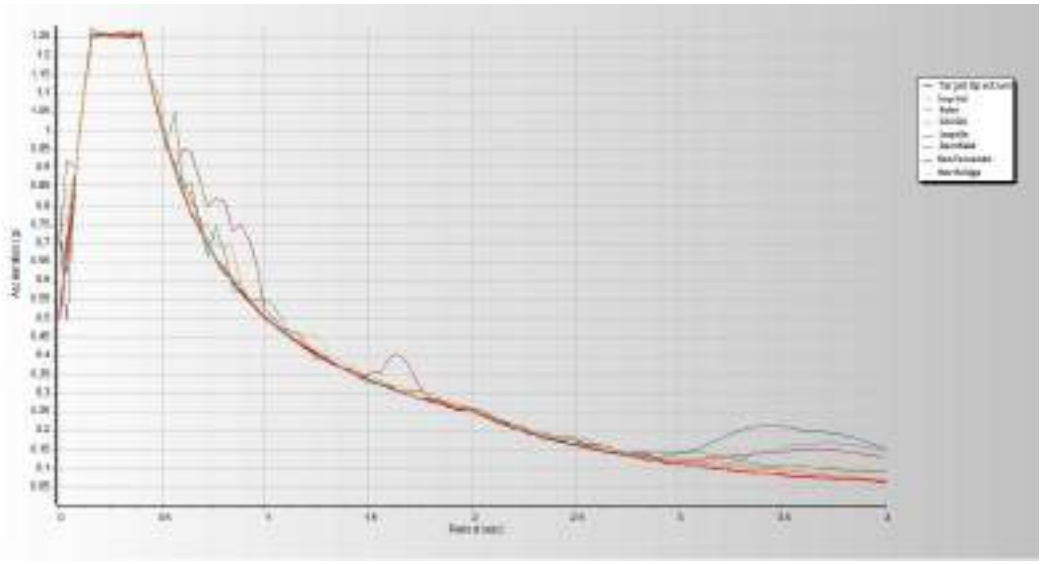


Figure 5-2: Design Spectrum according to Eurocode and Spectra of Matched Ground Motions

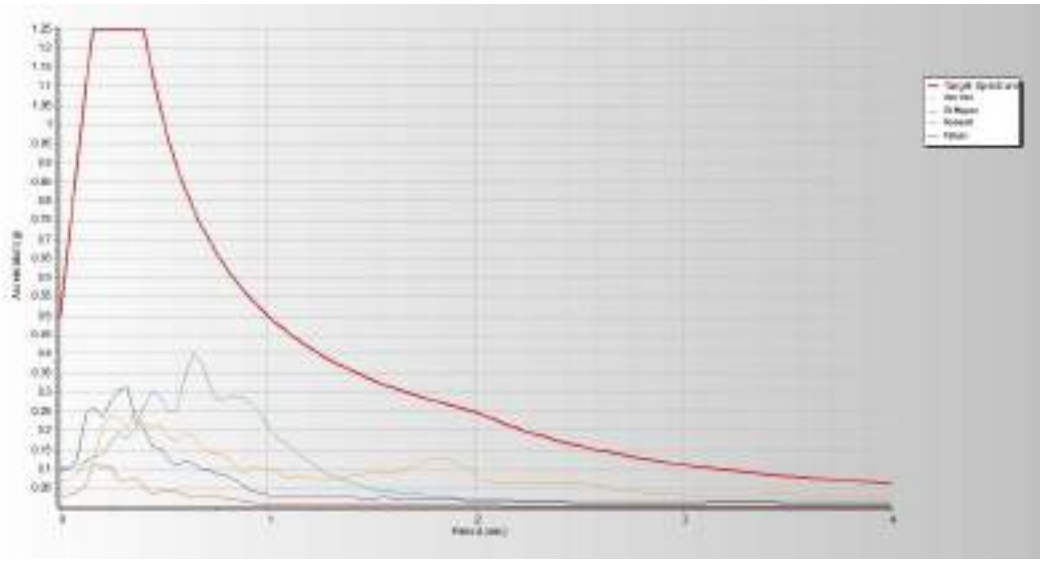


Figure 5-3: Design Spectrum according to Eurocode and Spectra of Original Ground Motions of Large Magnitude Earthquakes at Longer Distance

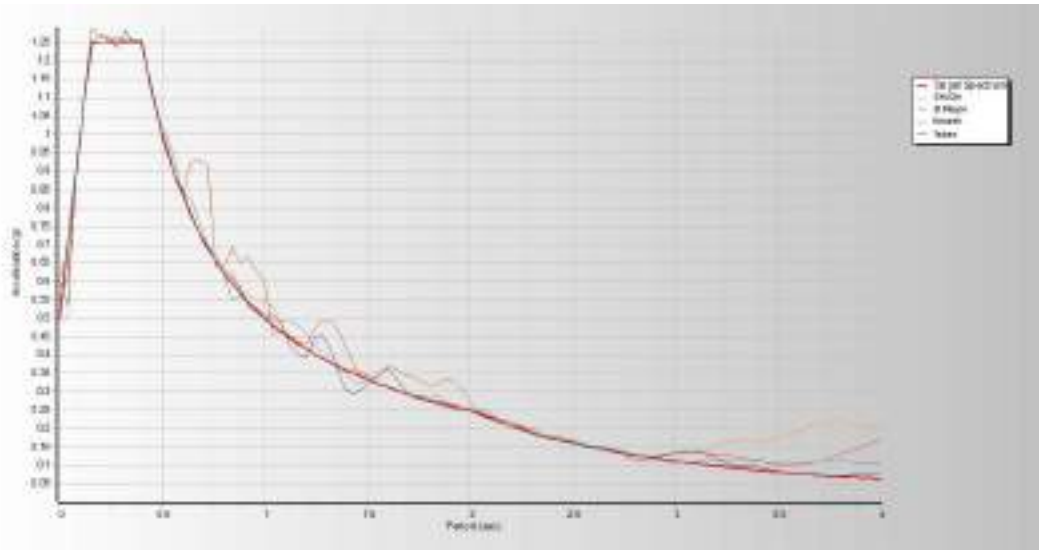


Figure 5-4: Design Spectrum according to Eurocode and Spectra of Matched Ground Motions of Large Magnitude Earthquakes at Longer Distance

The acceleration time-histories of the original and modified records are indicated in the figures below. The change in the acceleration levels and the frequency content can be observed from the graphs. The modified ground motion records are provided in digital format as an Appendix to this report. As mentioned above, these ground motion time histories may be used by simple scaling of the whole record to a desired level of PGA. Similarly, the desired damping ratio may be implemented by scaling the presented ground motion records.

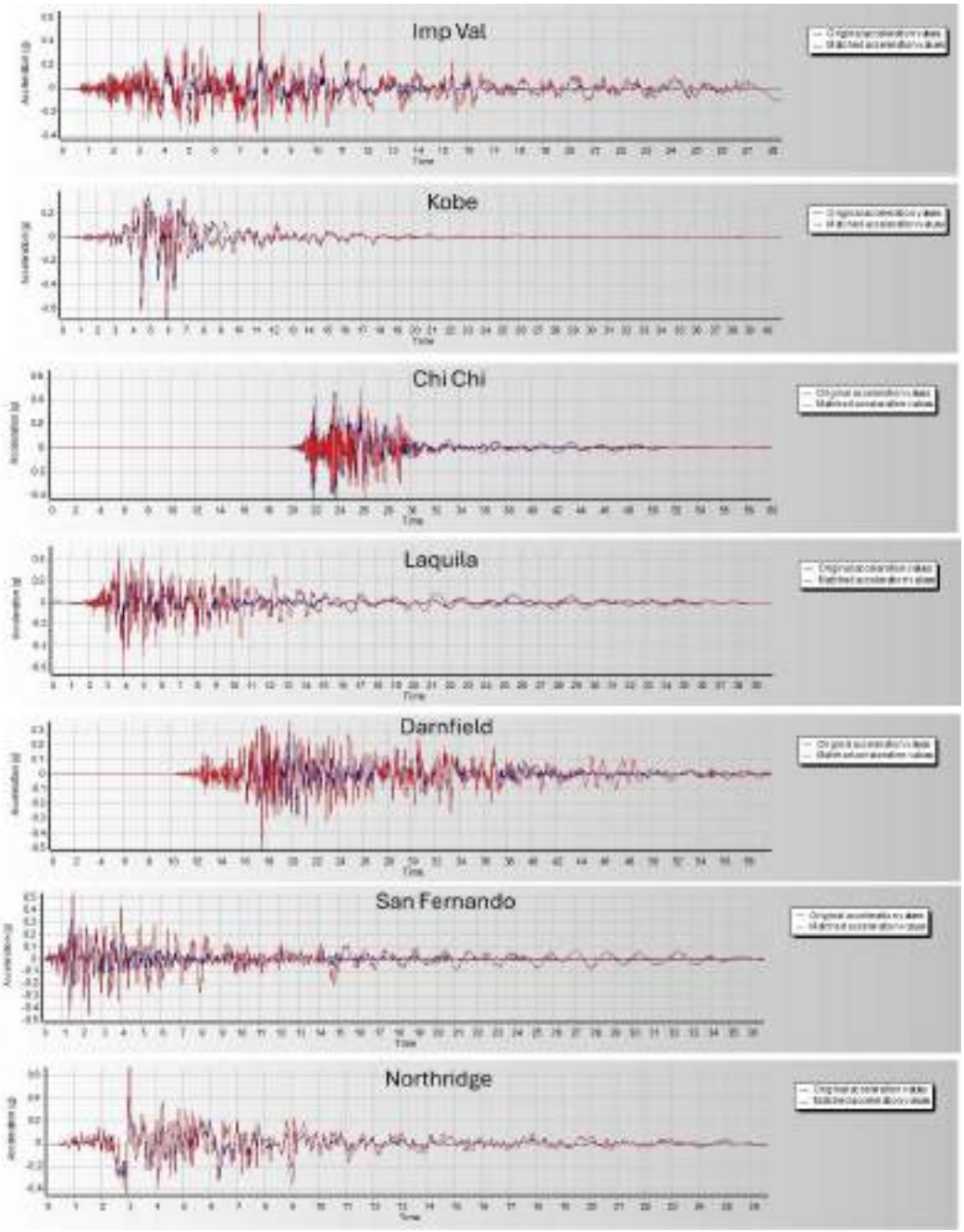


Figure 5-5: Time Histories of Original and Modified (Matched) Ground Motion Records

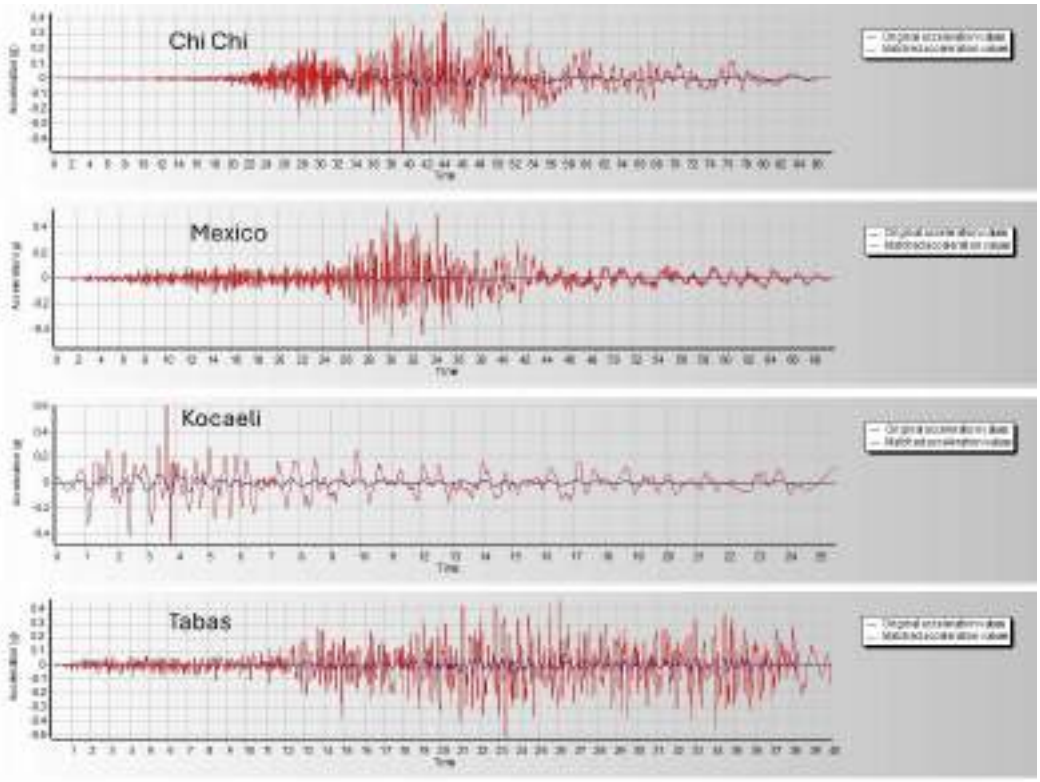


Figure 5-6: Time Histories of Original and Modified (Matched) Ground Motion Records of Large Magnitude Earthquakes at Longer Distance

6. CONCLUSIONS

A new seismic hazard study has been performed for the Southfield PSP Project, in order to provide a common basis related to the ground motion levels for the dam, reservoirs and the structures, required for the seismic design studies.

In the probabilistic analysis, the international earthquake catalogue by ISC has been considered for an area within a radius of 200 km. The PGA – return period curve has been obtained and submitted. In the seismic design, the selection of the PGA shall depend on the design requirements and conditions for each structure, to be determined by the Designer. Depending on the design criteria and needs, the PGA levels for different return periods (e.g. 475 years, 975 years, …) may be easily obtained from the PGA curve submitted in **Figure 3-4**.

For the deterministic analysis, the local faults in the vicinity of the project location have been considered by two scenarios. With the latter approach, a PGA of 0.38 g has been obtained for the MCE scenario.

In case of need, ground motion time histories for a PGA of 0.50 g (corresponding to a return period of 3000 years) have also been developed and provided in digital form to be used in transient (time-history) dynamic analyses. These time histories may be adopted to any desired level of PGA by using the ratio of PGA applied to the whole record. Similarly, the desired damping ratio may be taken into account by scaling the presented time histories, which are given for a 5% damping ratio.

APPENDIX A. ACCELERATION TIME HISTORIES OF THE MODIFIED GROUND MOTIONS DEVELOPED FOR DYNAMIC ANALYSIS

The time histories in digital format have been provided in an excel sheet along with this report.



Microsoft Excel
97-2003 Worksheet

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Logistics study report

South Field PHS

PPC
GREECE



RESTRICTED

September 9, 2025

REPORT

W.004668 D5 v1

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SOUTH FIELD MINE PHS
Logistics study report

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SOUTH FIELD MINE PHS
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1. INTRODUCTION

Public Power Corporation S.A (PPC) is considering the possibility to create a new production facility to operate as a closed-loop Pumped Hydroelectric Storage (PHS) at the South Field lignite mine at the prefecture of Kozani, Western Macedonia, North Greece.

The Project aims to allow energy from intermittent sources (such as solar, wind) and other renewables, or excess electricity from continuous base-load sources (such as gas) to be saved for periods of higher demand. It would store energy in the form of gravitational potential energy of water, pumped from a lower elevation reservoir to an upper reservoir.

South Field mine PHS would take the advantage of difference in elevation between South Field lignite mine pit (decommissioned after 2026), which would be used as the lower reservoir, and the surrounding plateau to the South-East of the mine, which would accommodate the upper reservoir.

Tractebel has been appointed by PPC to develop the design of the project through its various phases:

- Phase A: Site visit, Evaluation and Review of the conceptual study, Project Outline;
- Phase B: Feasibility Study and Tender Design;
- Phase C (optional): Preparation of EPC Tender Documents, Pre-Tender Clarifications support and Post-Tender evaluation support.

The study presented in this report falls in the scope of phase B and aims to provide a desktop preliminary logistics study related to the transportation of major components for the South Field pumped hydro power plant project.

The transportation route analysed covers the journey from the entry point of Thessaloniki Port up to the arrival of the area owned by PPC, identified in the study as the entrance of the Kardia Power Plant. The section of the route extending beyond this point—within PPC-owned land leading to the South Field—was not included in the scope of this assessment. Given that this area lies entirely within PPC's property and is already well known and managed internally, it was assumed that no further analysis was required as part of this external logistics review.

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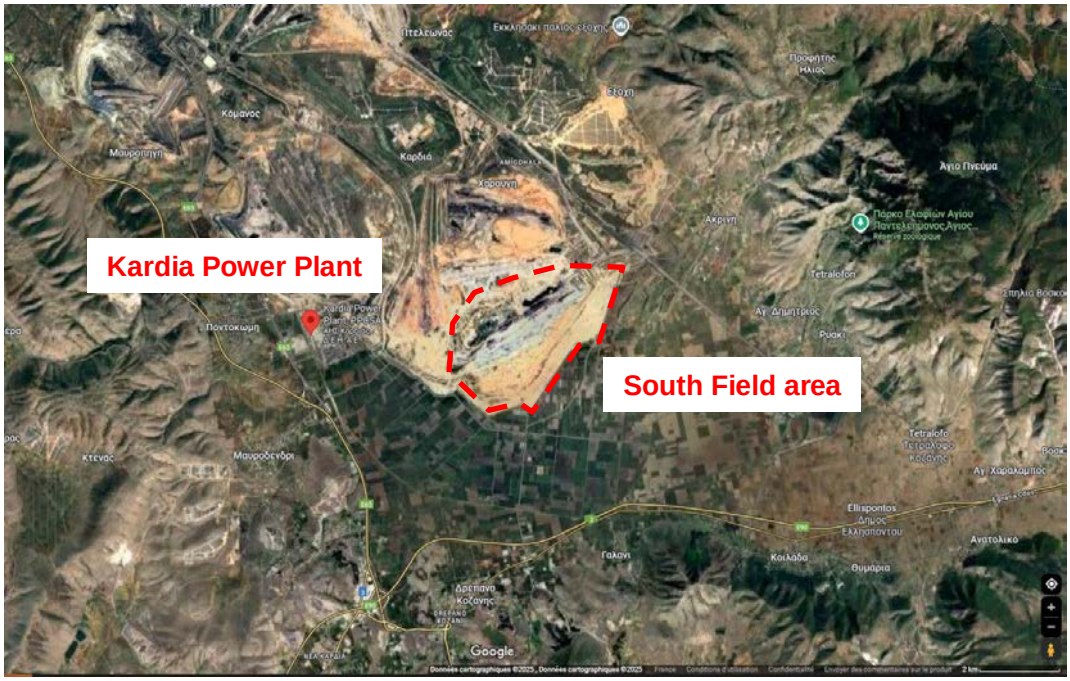


Figure 1-1 : South Field Mine location

The desktop study was performed by the Greek Branch of Lahmeyer based on a list of major components which represents the dimensioning components, in terms of size and weight, to be transported to the Project. In the sequel, the desktop study defines several routes that can be utilized for the transportation of components. Moreover, in addition to the Greek Consultant's own experience on the area, information and feedback was searched and analysed out of major components' transportation using the same or similar transportation routes, summarizing the problems, bottlenecks and lessons learned.

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2. ASSUMPTIONS OF PREFEASIBILITY STUDY

For the current logistics study, the following dimensions of major critical components were taken into account as per a preliminary estimation based on the main characteristics of the scheme :

- Transformer without bushing :
  - Length : 6,25m ;
  - Width : 2,3m ;
  - Height: 3,7m;
  - Weight: 90t.
- Pump-turbine spiral case:
  - Length: 8,8m;
  - Width : 7,8m;
  - Height : 2,5m;
  - Weight : not relevant as very low compared to other elements.

  It is to be noted that the component can be provided in parts of 80% size, i.e. Length:7,04m ; width : 6,24m, Height =2,5m.
- Half of the stator :
  - Dimensions : 3,4 m x 7,8 m x 2,2 m ;
  - Weight : 50t.
- Rotor of generator:
  - Diameter : 4,7m ;
  - Height 1,4m;
  - Weight (without poles) : 75t.

  It is to be noted that the component can be provided in parts and assembled on site if necessary, making the first heaviest part the transformer.

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3. RESULTS OF EVALUATION

The present report represents a first approach for the transportation of the oversized parts from Thessaloniki port to the South Field pumped hydro power plant.

It is to be noted that the details of the dimensions of the cargo are not the final ones but should not significantly differ in the future. Given this fact, the current report presents the possible routes and critical points on each route. This document must not be considered as a route survey. For a proper route survey a complete packing list is required supplemented by the transport drawings of the critical components and is meant to be done in a next phase when the design is finalized.

There can also be the case that for different components the convoy must follow a different route. Also, the document is based on the experience and status of the roads as of today. The status / condition of the roads might be different in the future.

As per the Consultant's experience, wind turbine components are currently delivered nowadays to Akrini which is very close to the South Field area (parts of wind turbines with a weight of 80 tons and also with a width of around 4.50m). These cargos are delivered through the Edessa/Agras route (intitled here after route 2). Blades are 77m long and 4.60m wide. The blades are delivered through Veroia route (Egnatia highway) (intitled here after route 1).

Moreover, 200t transformers were also transported recently to Aminteo city following the Gianitsa/Edessa /Agras route. On top of that 128 t transformers will be further deliver to Akrini again through the Gianitsa/Edessa/Agras route. According to information provided by PPC, the most recent transportation to Kardia TTP is related with a transformer of 225t shipping weight and 10.28x3.515x4.3(LxWxL in m) dimensioned. This was transported from Thessaloniki Port to Kardia TPP in 2015 through Egnatia highway.

It should be mentioned that another existing alternative route passing through the old national road connecting the city of Veroia with Kozani was not assessed by the Consultant as: i) by the time of drafting of the present report, it shares the same limitation with route 1 (45t weight limitation, at the Axios river bridge, located close to Malgara toll station) related to the transportation of the transformer and ii) the rest large components (i.e. pump - turbine spiral case, rotor of generator) can be transported via route 1 – Egnatia highway. Thus, the alternative which is an old provincial road with increased level of difficulty (i.e. narrow road – one line per direction without barriers in the middle, with a lot of turns and changes in the inclination), has no advantage for these components. If the weight limitations at Axios bridge change in the future, this route could be followed for the transportation of the transformer, but this should be assessed at a later stage (close to the transportation date when equipment and conditions of road are finalized)."

3.1. Port of Entry

The Port of Entry for the equipment is considered to be Thessaloniki Port which has the needed depth for ocean vessels, plenty of storage area, and machinery for the discharge of the equipment from the vessel(s).

In order to exit Thessaloniki from the West, the transportation convoy has to cross 3 rivers which are Galikos, Axios and Loudias. This is valid for either ROUTE 1 (including alternative through Gianitsa) or ROUTE 2 through Gianitsa/Edessa/Agras.

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3.2. Route 1: Thessaloniki – Veroia – Egnatia highway

The route is as per the image below:

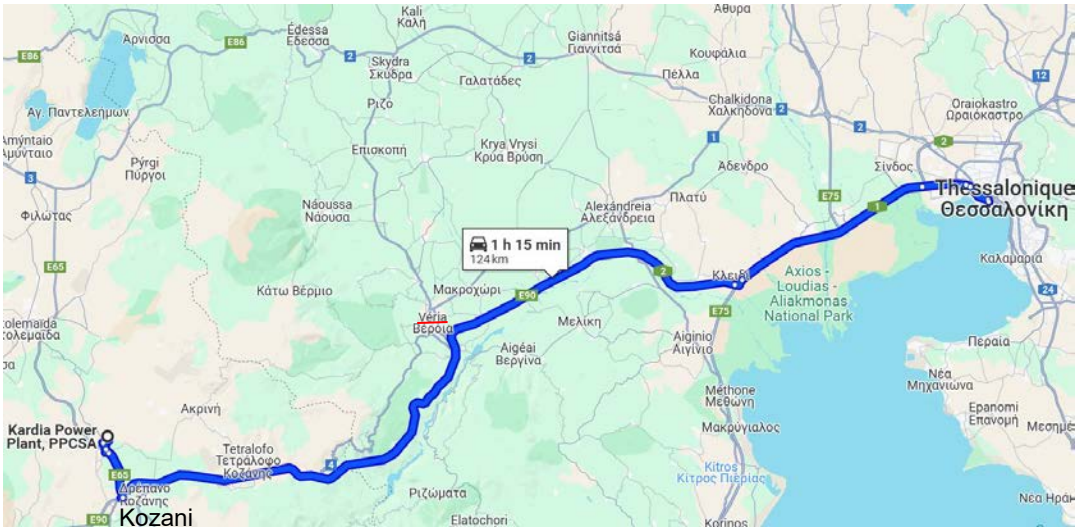


Figure 3-1 : Route 1 layout

Almost the entire route lies on E75 and E90 which is Egnatia Odos. Egnatia Odos is currently a public company and is in the privatization process to be part of TERNA. There are parts at the beginning belonging to Thessaloniki municipality and parts after Kozani belonging to the West Macedonia Region.

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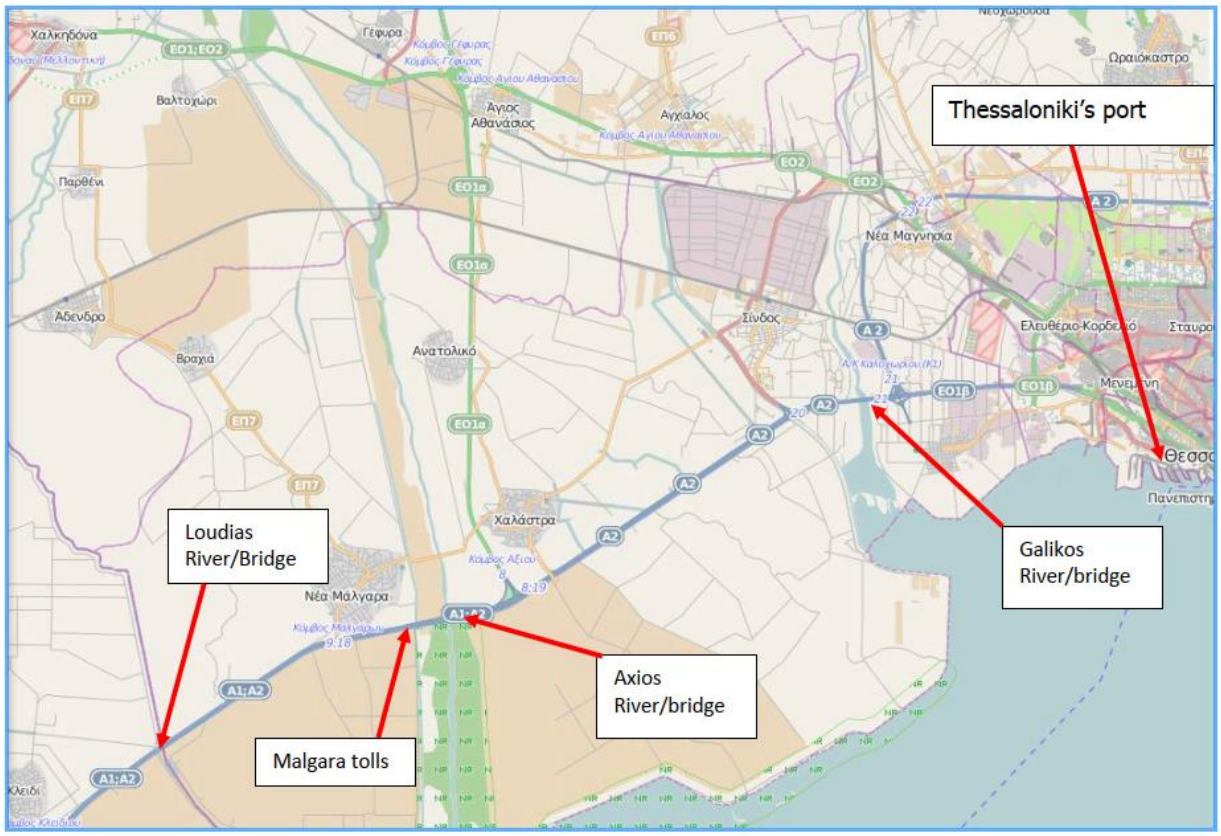


Figure 3-2 : Route 1 – map of main points part A



Figure 3-3 : Route 1 – map of main points part B

Maximum weight allowed: Gross weight is limited to approx. 45 tons but depending on the axle distance and number of axles, especially for very long cargo, permits for heavier gross weight might also be awarded. Drawings need to be sent to Egnatia Odos to pass the permitting process and the bridge checks.

There are weight restrictions on the route mainly over the Axios River at Margara. The bridge is under heavy maintenance and may be OK in a later stage.

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Location of Axios bridge: https://maps.app.goo.gl/V9v24FvMEsxNkPpY8



Figure 3-4 : View of Axios bridge

Height: Height is limited to 4.75m in total height due to the tunnels.

Length: Length is not an issue up to 45m but with some modifications to be made to transportation equipment (trucks) by the transportation companies.

Width: Width is OK up to 3.75m with only special traffic permits and up to 6.5m or even a bit more with some modifications and special procedures (removal of signs, barriers, etc.…). For more than 3.75m and due to several tunnels on the part after Veroia, police and road authorities might ask for closing of the highway. This was a common practice with the previous police commander of Veroia. For the needs of transportation of wind turbine components to a wind farm close to the South Field area , the same route was used from the port of Thessaloniki and the new commander accepted night driving with traffic restraints especially if the cargo is not very heavy and can move fast on the uphill.

As for the width, the most critical part is at the kiosk at Malgara tolls (https://maps.app.goo.gl/D2eJdamDVaynTohj9), just after Axios River. The max width there is limited to approx. 4.50m but is easy to extend it. Technically it is OK to drive even at 6.5 m width



Figure 3-5 : Malgara tolls

Tolls at Polimilos (https://maps.app.goo.gl/gNLpsowqisASsU8P8) are much wider on the right side.

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Figure 3-6 : Polimilos tolls

- **Alternative for Route 1**

An alternative to bypass Axios bridge is to follow the National Road 2 Thessalonikis - Edessas up to Giannitsa (this section is common with Route 2 described further down) and then drive south through local roads and meet Egnatia at the Niselli interchange. This route was followed up recently as per the Consultant's experience but Giannitsa municipality raised restrictions on the bridge over Loudias to 60t gross weight.

The route is as per the next image.

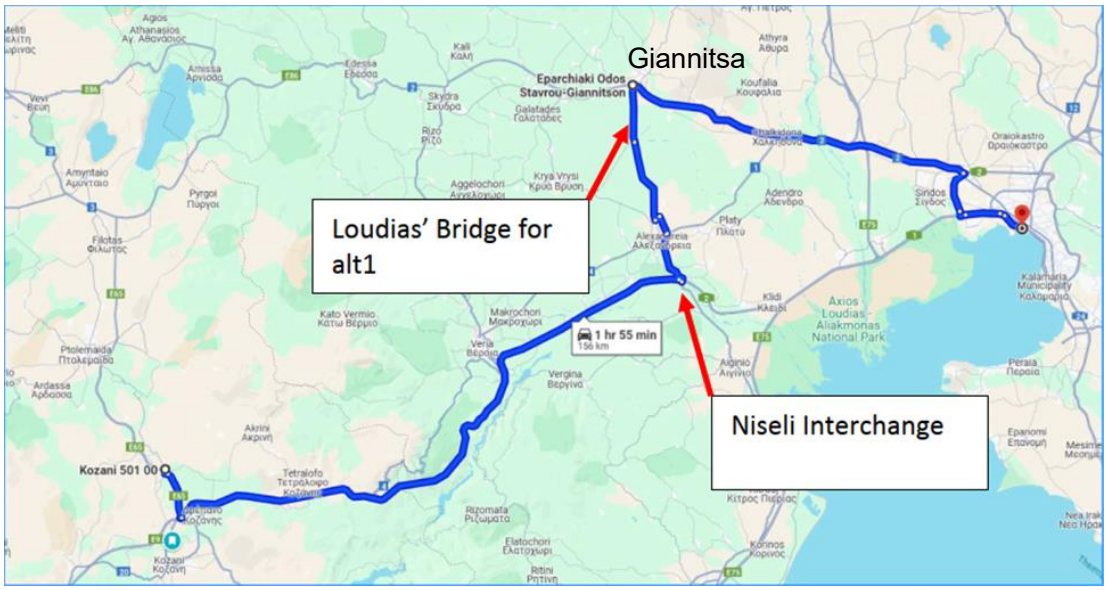


Figure 3-7 : Alternative of Route 1 layout

The location of Loudias Bridge is shown below:

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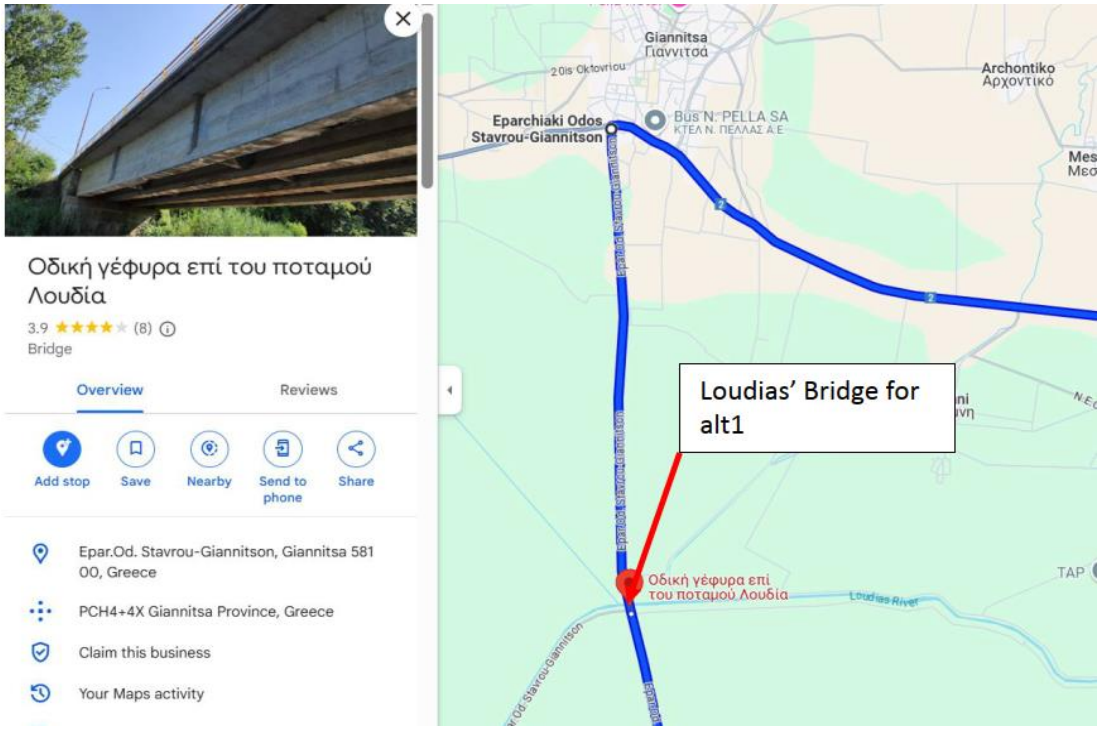


Figure 3-8 : Loudias bridge

The bridges on the road up to Giannitsa (alternative route 1 and route 2) also depicted in the following figure:

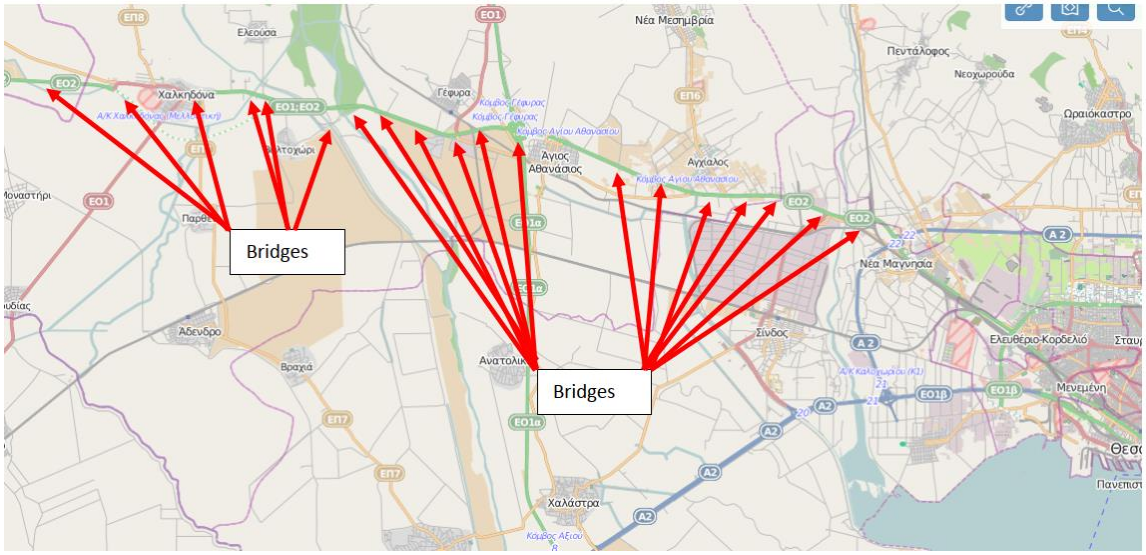


Figure 3-9 : Bridges up to Giannitsa

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3.3. Route 2: Thessaloniki – Giannitsa – Edessa – Agras - Ptolemaida

As per the Consultant's experience, this route was recently used for the transportation of the parts of a wind farm in the vicinity of South Field to Anatoliko and Akrini (same route for South Field project). The transported components were nacelles, drive trains and hubs. Also soon according to our information 128t transformers are going to be delivered to Pontokomi Substation very close to the South Field area. At the moment, the communication with West Macedonia region for the permits and the studies for the bearing capacity of 9 bridges is ongoing. Up to Faraggi village, where the borders of the West Macedonia region are, permits for transportation of transformers of 200t for Aminteo (Rodonas and Loakomata substations) were issued.

Weight: up to 200t load or 295t gross weight until West Macedonia limits (Faraggi) and 70t load or 109 gross weight up to Akrini. Maybe by the end of next month, permits for a 128t load and approx. 201t gross will be available.

Width: up to 6.0m and maybe more with special permits if police and road authorities will accept (closing of the Edessa -Agras section is necessary). It can be up to 7.0m in case the height of the load will be up to 3.5m to be able to load it on a trailer of 1.5m and the over width will pass over some safety barriers.

Length: Total length is limited, for a load wide up to 3.5m to 35.0m

Height: is limited to a total height of 5.10m.

The route is as per the below image:

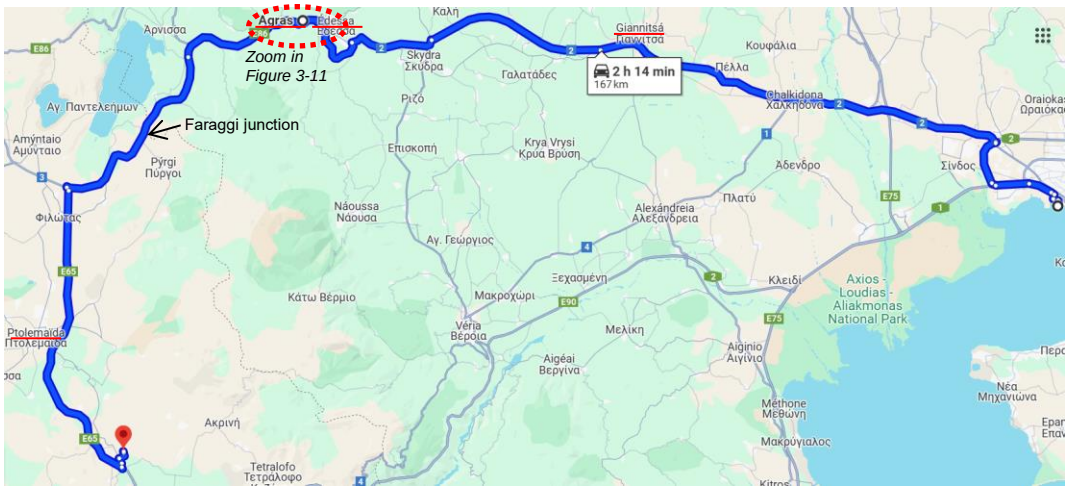


Figure 3-10 : Route 2 layout

The road from Edessa interchange to a point after Agras village is narrow with plenty of turns (red circle in figures) the most critical of them being the left turn over Agras Hydro plant. This part of the road must be closed to traffic and at the moment police are accepting to block the traffic without asking for special permits. This might change in the future.

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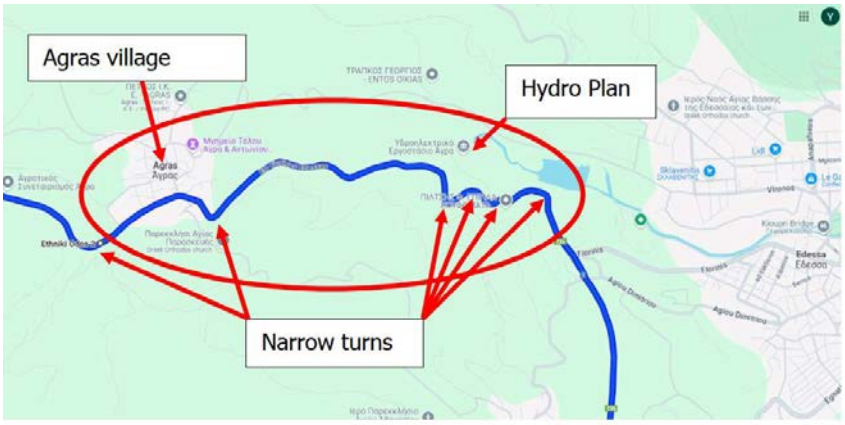


Figure 3-11 : Route 2 detail before Agras village

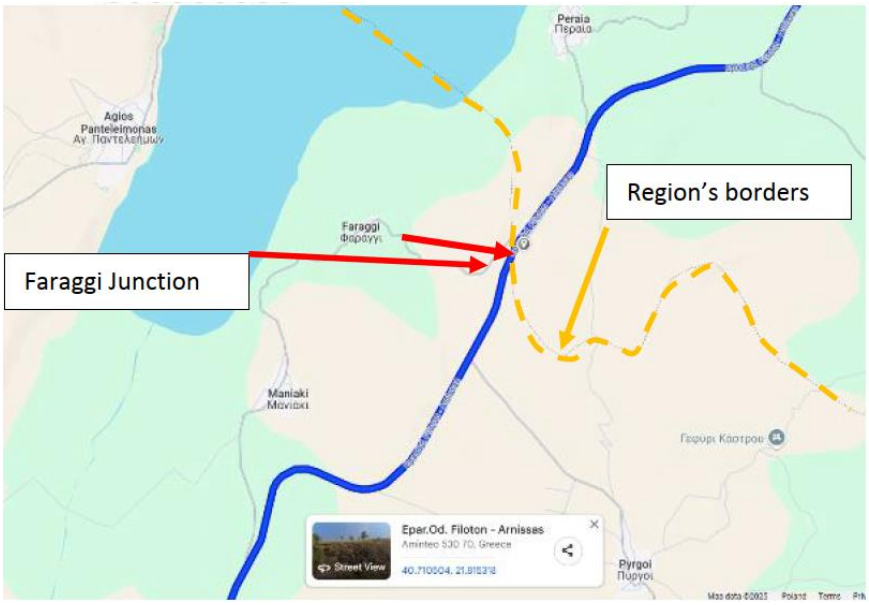


Figure 3-12 : 200t transformer at the road before Agras



Figure 3-13 : The critical turn at Agras Hydro Plant

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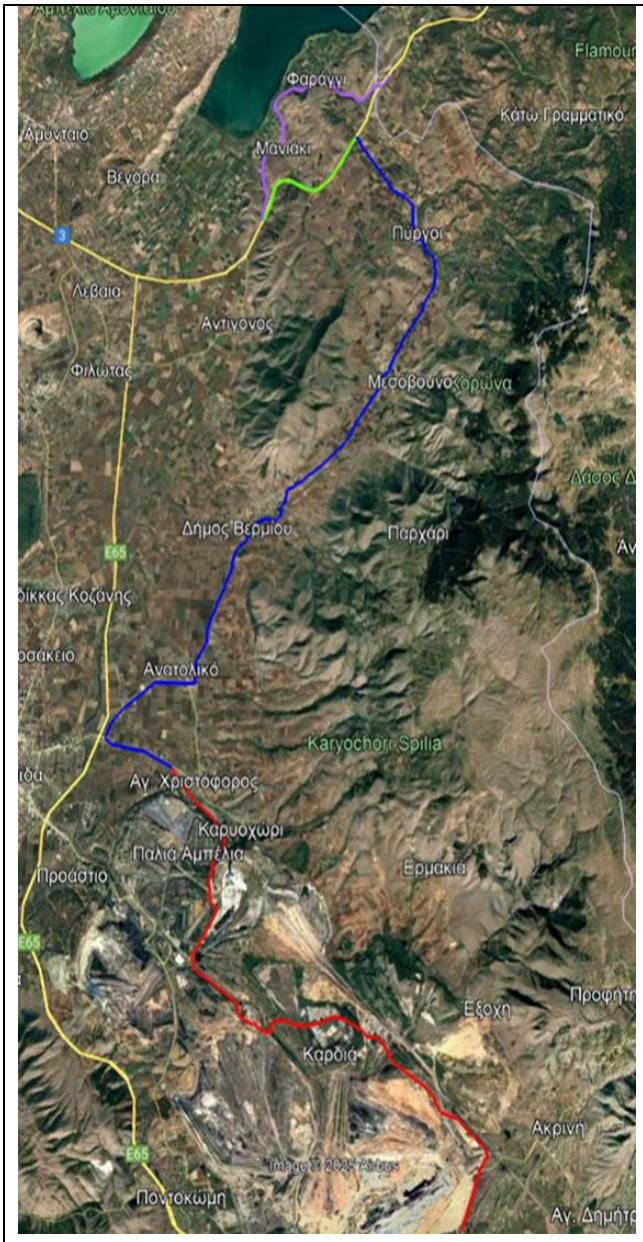


(https://maps.app.goo.gl/XzYXgRLXSEtxqJr39)

Figure 3-14 : West Macedonia region borders

An alternative to avoid the main road belonging to the West Macedonia region (in order to avoid difficulties for permit issuances) for the heavy loads, is to follow the below route.

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Magenta: Through Faraggi and Maniaki. The road belongs to Florina prefecture.

Green: Driving from west to east. Belongs to West Macedonia but there are no bridges.

Blue: Is under investigation and most probably to Eordaias Municipality and Kozani prefecture.

Red: Belongs most probably to PPC.

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4. CONCLUSION

The aim of the present report is to assess the feasibility of transportation of the equipment from the Thessaloniki port up to the Project's site. Given the early stage of the project, the report assesses any transportation alternatives at current status. These conditions may change in the future. A proper route survey should be performed upon finalization of the design when a complete packing list and also transport drawings of the critical components shall be available.

The report provides the possible routes and indicates the critical points of each route. These are also summarized in the following figure and table. **It is highlighted that, if possible, given the route's limitations, Route 1 is considered as more favourable since all licenses are issued by Egnatia Motorway S.A., while in case of Route 2, interface between several Authorities of different Regional Units is necessary. The desk study shows that, excluding the transformer, all components should be able to go through Route 1 given a few adaptations of equipment. For the transformer, at the time of this report, route 2 is considered as the only available solution due to weight (Axios bridge) restrictions, and even so studies should be carried out to check the weight restrictions of some bridges.**

It should be mentioned that the other existing alternative route (for the avoidance of tunnels) passing through the old national road connecting the city of Veroia with Kozani was not assessed by the Consultant due to the fact that it faces the same issue as the route 1, in terms of weight limitation (45t gross weight) at the Axios river bridge (located close to Malgara toll station), and therefore has no added value for the transformer transportation. Moreover, since the transportation of spiral case and rotor is feasible despite the tunnels, we consider route 1 (Egnatia odos – highway road) as the best option for these components, as the alternative is an old provincial road with increased level of difficulty (i.e. narrow – one line per direction without barriers in the middle , with a lot of turns and changes in the inclination).

The aforementioned weight restrictions are valid at the time of drafting of the present report due to the improvement works that are currently taking place at the Axios bridge (the known transportation of heavy equipment mentioned at the start of the report was possibly done before the works and therefore when weight limitations were higher). The weight limitation will most probably increase after the completion of the works and authorize much heavier loads. If its weight is authorized, the transformer could go through the Egnatia highway and deviate on the old national road at Veroia to avoid the tunnels, however, due to the difficulties of this road, the recommendation of borrowing route 2 remains.

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Component	Route 1	Alternative for Route 1	Route 2
Transformer without bushing: Length: 6,25m Width: 2,3m Height: 3,7m weight: 90t	Not possible due to height limitation to 4.75m due weight limitations to 45t (Axios river bridge).	Not possible as Giannitsa municipality usually raises restrictions on the bridge over Loudias to 60t gross weight.	Could be possible, however Authorities may require studies for some of the bridges up to South field project site for weight limitation purposes.
Pump-turbine spiral case: Length: 8,8m width: 7,8m Height: 2,5m (however, can be provided in parts of 80% size, i.e. Length:7,04m ; width : 6,24m, Height =2,5m)	Possible if provided in parts for a width up to 6.50m and with some modification and special procedures	-	Possible if provided in parts: - with width up to 6.0m - with bigger dimensions, with special permits if police and road authorities provide the required approval. - with width up to 7.0m in case the height of the load will be up to 3.5m to be able to load it on a trailer of 1.5m and the over-width will pass over some safety barriers.
Rotor of generator: Rotor diameter: 4,7m Rotor height 1,4m Rotor weight (without poles): 75t (can be provided in parts)	Possible if provided in parts of weight under the limitation of 45t and assembled on site.	-	Possible if provided in parts of weight under the weight limitation of : - 200t load or 295t gross weight until West Macedonia limits (Faraggi) - 70t load or 109 gross weight up to Akrini

Figure 4-1 : Synthethis map and table of roads for transportation per equipment

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Geotechnical Interpretation Report

South Field PHS

PPC

GREECE

RESTRICTED

April 29, 2026

REPORT

W004668 N6 v1

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SOUTH FIELD PHS
Geotechnical Interpretation Report

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SOUTH FIELD PHS
Geotechnical Interpretation Report

LIST OF ABBREVIATIONS AND ACRONYMS

GIR	Geotechnical Interpretation Report
GDR	Geotechnical Data Report
GBR	Geotechnical Baseline Report
GRA	Geological Risk Assessment
GU	Geotechnical Unit
PFS	Pre-Feasibility Study
ΔΕΗ	Δημόσια Επιχείρηση Ηλεκτρισμού
PPC	Power Public Corporation
ERT	Electrical Resistivity Tomography
MASW	Multichannel Analysis of Surface Waves
SR	Seismic Refraction
XRD	X-ray diffraction method

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0. EXECUTIVE SUMMARY

The South Field Pumped Hydroelectric Storage (PHS) is a 240MW pumped-storage plant, to be built as a capacity and energy provider for the Greek National Grid. The site is located in the prefecture of Kozani, Western Macedonia in the South field lignite mine pit which will be decommissioned in 2026.

The proposed scheme takes the advantage of difference in elevation between the mine pit and the surrounding plateau located around the mine. It will operate between two man-made water reservoirs, connected by a 1 km (approx.) penstock pipeline, constituting of two open-air steel pipes. The scheme comprises the following structures:

- An upper reservoir, located on the plateau on the South-East of the mine, utilizing the existing morphology and topography of the area, supplemented by embankments.
- An additional basin (buffer reservoir) is adjacent to the upper reservoir and allow management of excess water into the scheme, while also preventing overflow caused by over-pumping or other unexpected situations.
- A lower reservoir, formed by the large mine pit.
- The waterway includes the following sections, from upper to lower reservoir:
  - Upper intakes, with trash racks and safety gates;
  - 2 upper open-air penstocks, placed along the South-East slopes of the mine pit,
  - 2 bifurcations connecting the penstocks to the units, one for each penstock;
  - 4 main inlet valves;
  - 4 draft tubes equipped with 4 gates;
  - 4 lower intakes adjacent to the powerhouse structure, discharging directly into the lower reservoir.
- Powerhouse is open air type and made of reinforced concrete. A large excavation will be executed at the toe of the mine South-East slope and will be partially backfilled to form a platform where transformers will be installed.
- The Powerhouse is housing four (4) Francis reversible fixed speed pump-turbines and an average and maximum total power at generation mode of respectively 220 MW and 240 MW.

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Figure 0-1: South Field Mine PHS project layout

South Field Mine is still in operation, with operation planned to continue until 2026. The mine personnel indicated during the site visit carried out in April 2025 that a total of 15 million cubic meters is forecasted to be excavated by the end of 2025. Therefore, the final geometry of the bottom of the mine and the excavation front will not be known before the end of the operation.

The excavation workfront of the mine is located in the southeastern part of the pit. The northern and western part of the mine pit are surrounded by man-made deposits. The planned upper reservoir is located on the northeastern side, on a surrounding plateau. The elevation in this area ranges between ~ 637.00 to ~ 665.00 m.a.s.l. and features several berms. The southeastern boundary of this area is marked by a solar panel farm.

Soulou river is located on the western side of the mine. It is an artificial conduit constructed for accommodating the inflows to the sump pits of the mines. Its final discharge is lake Vegoritida.

Several specific environmental conditions constrain the project infrastructure characteristics such as

- The southeastern boundary of the upper reservoir adjoins a solar panel farm. The upper reservoir footprint and slope steepness will be constraint on the southeast.
- The stability of the mine's slopes, especially in the north-western part of the lower reservoir, where mine disposal material had been deposited over an extended period, which resulted in reduced slope stability and an increased potential for landslides. The western boundary of the mine was particularly affected, experiencing a significant landslide in 2024.

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- To mitigate this geotechnical risk and ensure long-term stability, the geometry of the lower reservoir has been intentionally shaped to allow for controlled backfilling of the critical zone, and in the southwestern part of the lower reservoir, marked with red on the following figure, excavation was defined to define the shape of the lower reservoir which improves the stability of the lower reservoir, see Figure 2-2.

The interpretation report is based on a series of documents handed down by the client (PPC), the site reconnaissance defined by Tractebel and the results of surface and sub-surface investigation and laboratory tests.

The main geological entities which were observed during the field work can be solely considered as soil ground to hard soil ground. The samples from retrieved cores were tested in the laboratory (i.e. physical & mechanical characteristics; ring shear test; direct shear; UCS; residual shear strength; CU-pp & UU triaxial).

After interpreting the available data, there is no proof of significant neo tectonic features that may entail geological risk. Additionally, the available instrumentation data do not indicate any slope movement that may relate to those features.

Seasonal groundwater flow is observed through the features, which mainly constitutes the discharge of precipitation and runoff activity. The groundwater level beneath the Upper reservoir area lies deeper (more than 40-50 m deep) and is considered moderately shallow (10 to 18 m deep) at the surrounding the Lower reservoir, and relatively shallow (4 to 8 metres deep) over the Lower reservoir.

Regarding the identified geotechnical and lithological units, the Project area comprises of six (6) geotechnical units (GU), each with a particular composition and its associated geomechanically properties.

- **GU-F** that corresponds to human induced, polygenetic, uncompacted to partially self-compacted waste deposits (fill material), characterised by distinct heterogeneity. Located overlaying the **GU-Gcs** and **GU-Mb** at the N-NW-S as well as in the SW mid area of the reservoir invert.
- **GU-Pcg** that corresponds to the Quaternary Proasteion fluvial and lake formation that encompasses all the over Upper reservoir area, including buffer reservoir.
- **GU-Gcs** corresponds to the Upper Pleistocene deposits of the "*green*" series, located on underlying the **GU-F** and **GU-Pcg** and outcropping the NE and E of the lower reservoir. It is also found in the western and SW area of the Upper and buffer reservoir.
- **GU-L** corresponds to thick Lignite-bearing layers; either these are represented by thick uniform Lignite layers or Lignite-dominant series. Can be found underlying the **GU-Gcs** in the upper reservoir and **GU-F** in the lower reservoir
- **GU-Mb** that corresponds to the base Marl, which mainly consist of silty Marl of variable strength, and few alternations of clay, sand and conglomerates.

The upper reservoir area rests on thick Upper Pleistocene "green" series/**GU-Gsc**, and the Quaternary deposits of Proasteion/ **GU-Pcg** which overly the Lignite-bearing strata (being visible along the SE mine slopes). The **GU-Pcg** and the **GU-Gsc** strata seem to be suitable enough as foundation material for the ring dam embankment.

Due to the poor conditions of the ground and to avoid hazardous behaviour, and high dynamics loads envisioned, an underground penstock is not recommended, and the foundation material for the backfilled penstocks should be competent enough or be removed.

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The waterways and penstock alignment is planned to transfer water resources from SE towards NW. Subsequently, the alignment in its approximately 35 - 40% extends over the Proasteion alternate conglomerate and fine deposits series, for the 30-35% extends over the “green” series, and for the remainder 25-30%, it reaches the Powerhouse structure through Lignite-bearing strata.

Based on the available information, the South and West part of the Lower Reservoir area is covered by the partially self-compacted waste deposits (fill material) **GU-F**. The central are dominated by the autochthonous lower Lignite-bearing **GU-L** strata and the underlying base Marl. On the other hand, the Eastern parts are characterised by thin “green” series (**GU-Gcs**) overlaying a Lignite-bearing layer (**GU-L**) and/or the base Marl (**GU-Mb**). The underlying base Marl that can be found at 520 to 525 m.a.s.l.

The powerhouse upper layer comprises of Lignite-bearing series (**GU-L**) with Marly impurities which overlie a Marl base (**GU-Mb**). Given the uncertainties and associated risks in the powerhouse area and the foundations stringent requirements (see subchapter 6.4.1), a multi-analysis is carried out. An investigation program principle for the powerhouse is also highly recommended, (see sub-chapter 6.5).

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1. INTRODUCTION

The site is located in the prefecture of Kozani, Western Macedonia in the South field lignite mine pit which will be decommissioned in 2026.



Figure 1-1 : Location of the project



Figure 1-2 : Location of the project within Kardia & South field mines

The Project aims to allow energy from intermittent sources (such as solar, wind) and other renewables, or excess electricity from continuous base-load sources (such as gas) to be saved for periods of higher demand. It would store energy in the form of gravitational potential energy of water, pumped from a lower elevation reservoir to a higher elevation. South field PHS would take advantage of the elevation difference between the South field still operational lignite mine pit - to be used as lower reservoir - and the surrounding plateau located around the mine to create an upper reservoir located on the North-East of the mine. Tractebel has been appointed by PPC to develop the design of the project through different phases:

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- Phase A: Site visit, Evaluation and Review of the conceptual study, Project Outline;
- Phase B: Feasibility Study and Tender Design;
- Phase C (optional): Preparation of EPC Tender Documents, Pre-Tender Clarifications support and Post-Tender evaluation support.

This Geotechnical Interpretation Report falls in the scope of phase B and is structured as follows:

Chapter 0: Executive summary

This section provides an overview of the Geotechnical Interpretation Report, the interpretation of the results for the ground conditions and its suitability and risks for the project.

Chapter 1: The present introduction.

Chapter 2: Project definition and general layout

This section recalls and describes the general layout, structures features and constraints for the project.

Chapter 3: Geological setting and history

The chapter presents the geological setting and history based on the appraisal of the available desk studies and the executed field investigation works.

Chapter 4 Investigation and laboratory data results

This section gathers the data of all subsurface and surface investigation programs, including in-situ tests, groundwater regime and installed site instrumentation, as well as the results of the conducted laboratory results.

Chapter 5 Interpretive ground model

This section describes and discriminates by structure and zone of the project the interpretative geological structures and features, geotechnical units, ground water condition and hydrogeology, geotechnical zoning and derived geotechnical parameters for the area the project.

Chapter 6 Geotechnical risks, uncertainties and recommendations.

This section establishes the key geotechnical risks, uncertainties, potential impacts, and suggested mitigation measures identified from the interpretation of the available investigation, instrumentation and laboratory tests results data.

Chapter 8 Conclusions, recommendations and overall suitability of site

This section presents the conclusions regarding the project structures, layout, and ground model.

Chapter 9 Annex and references

In this section the different References and Annex with further information are located.

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2. PROJECT DEFINITION AND GENERAL LAYOUT

2.1. Topography

South Field Mine is still in operation, with operation planned to continue until 2026. The mine personnel indicated during the site visit carried out in April 2025 that a total of 15 million cubic meters is forecasted to be excavated by the end of 2025. Therefore, the final geometry of the bottom of the mine and the excavation front will not be known before the end of the operation.

The proposed location for the lower reservoir is within the existing mine pit area. The current elevation of the mine ranges between 499 and 655 m. It extends approximately 3 km in length and up to 900 m in width.

The excavation workfront of the mine is located in the southeastern part of the pit. The northern and western part of the mine pit are surrounded by man-made deposits.

The planned upper reservoir is located on the northeastern side, on a surrounding plateau. The elevation in this area ranges between ~ 637.00 to ~ 665.00 m.a.s.l. and features several berms. The southeastern boundary of this area is marked by a solar panel farm.

In the South Field Mine, slope heights typically range from 10–15 m, locally reaching up to 20 m. Bench widths vary between 50 m and 180 m, while in the upper bench zone—where the Upper Reservoir is planned—the bench width exceeds 350 m.

Soulou river is located on the western side of mine. It is an artificial conduit constructed for accommodating the inflows to the sump pits of the mines. Its final discharge is lake Vegoritida.

Soulou River will have to accommodate flows from both the South Field PHS Project and the Kardia PHS Project.

It is important to highlight that a Digital Elevation Model[1] of the forecasted natural ground at the end of the mine operation has been provided by PPC and was used as input data for the design of the PHS. The resulting design - particularly related to the lower reservoir, powerhouse and waterway - will have to be carefully reviewed and adjusted during the execution phase in case the final mine topography at the end of the mine operation differs from the forecasted natural ground.

The Greek Grid GGRS87 coordinates system is the planimetric and altitude reference considered for the South Field PHS Project.

[1] File entitled “29.5.2025 as built with MINE CONTOURS with forecasted natural ground.dwg”

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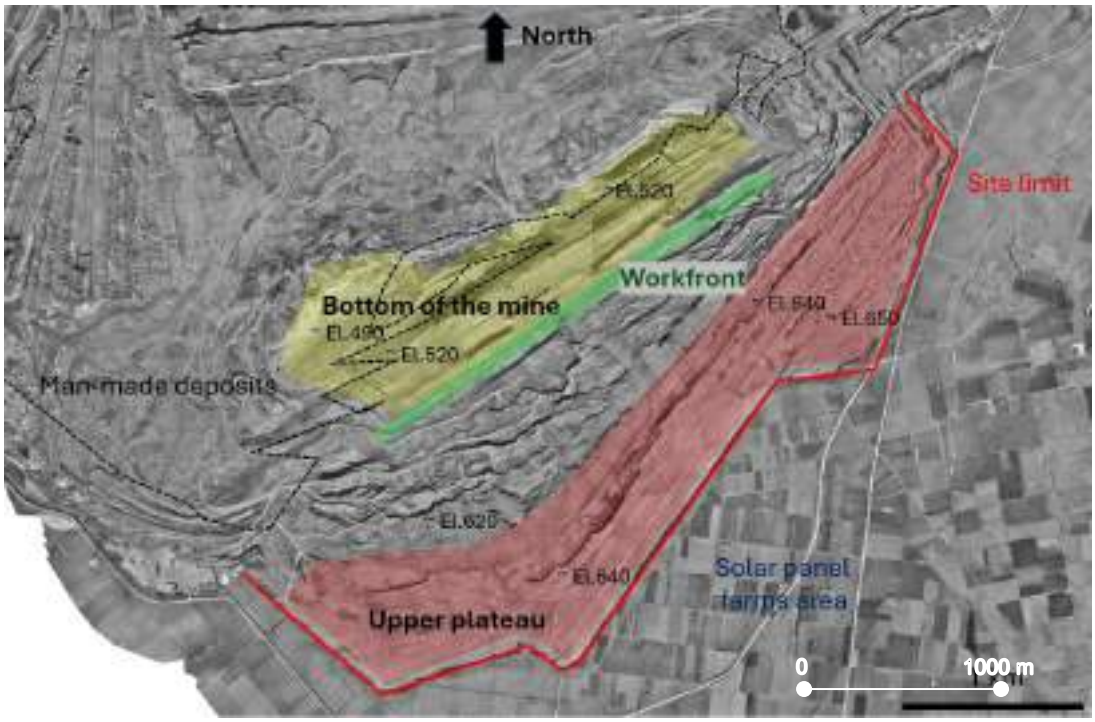


Figure 2-1: Satellite view of the South Field mine

2.2. Basic criteria and constraints

2.2.1. Client's requirements

The requirements from PPC are recalled here after:

- Average power at Switchyard: ≥ 220 MW
- Total storage capacity: ≥ 2 700 MWh
- Minimum generation duration at full power: 12 hours
- Minimum Pumping duration at full power: 16 hours

The design should take into consideration the constraint relative to the waterhead variation ratio ($\Delta H_{max} / \Delta H_{min} < 1.2$) for fixed speed units.

2.2.2. Site constraints

2.2.2.1. UPPER AREA

The southeastern boundary of the upper reservoir adjoins a solar panel farm. The upper reservoir footprint and slope steepness will be constraint on the southeast. A buffer reservoir was introduced as an additional requirement by PPC as safety measure to prevent overflow due to over pumping or another unexpected situation and also manage excess water into the scheme.

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2.2.2.2. LOWER AREA

In the north-western part of the lower reservoir, mine disposal material had been deposited over an extended period, which resulted in reduced slope stability and an increased potential for landslides. The western boundary of the mine was particularly affected, experiencing a significant landslide in 2024. In 2025, geotechnical investigations and a topographical survey were carried out under PPC's supervision to provide input data for a slope-stability analysis conducted in parallel by a local engineering company. A stabilizing berm was subsequently constructed in the affected area. For the design of the reservoir shoreline along the western side, it was required that the shoreline be positioned at a safe distance from both the landslide toe and the stabilizing berm.

To mitigate this geotechnical risk and ensure long-term stability, the geometry of the lower reservoir has been intentionally shaped to allow for controlled backfilling of the critical zone, indicated in blue in the following figure. This backfill configuration improves the stability of the weakened area, reduces the likelihood of future slope movements, and enhances the overall safety of reservoir operation.

In the south western part of the lower reservoir, marked with red on the following figure, excavation was defined to define the shape of the lower reservoir which improves the stability of the lower reservoir, providing an access ring road around the lower reservoir and at the same time to provide a backfilling material which will be used for the backfilling of the above-mentioned area of the lower reservoir.

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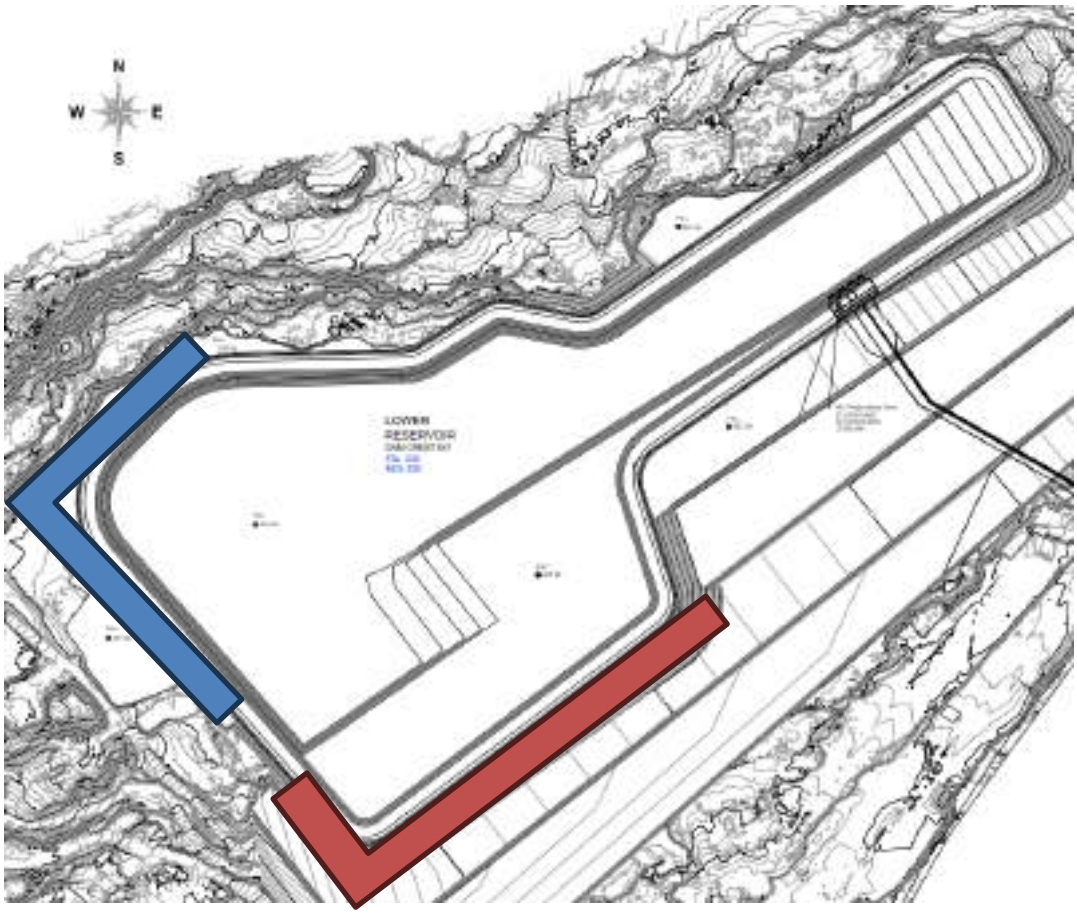


Figure 2-2: Backfilled and Excavated Areas of the Lower Reservoir

2.2.3. Environment

Several specific environmental conditions exist on the project and are listed and explained here after:

- Excess water management, considering none of the existing mine drainage facilities will remain operational after the mine closure;
- Mine slopes stability is to be ensured (see 2.2.2.2).

2.2.3.1. EXCESS WATER MANAGEMENT

In order to control the water table of the mine pit and to ensure the stability of the Upper and lower reservoir slopes and the safe and reliable operation of the PHS scheme, strict monitoring and control of the water level will be mandatory.

Available data from the existing drainage facilities indicates that, in 2022, a total of 12.5 hm^3 was pumped out of the mine pit, with a maximum monthly value of 1.2 hm^3. The current drainage capacity is 1,530 m^3/h, provided by various pumps installed in the mine pit sumps.

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PPC has indicated that, following mine closure, none of the existing mine drainage facilities will remain operational. Consequently, provisions must be made to ensure proper evacuation of excess water entering the PHS closed loop, especially in the lower reservoir area.

PPC estimates a total annual inflow of 11.5 hm^3 entering into the future lower reservoir, which represents 1.2 times the useful volume of the PHS scheme.

Additionally, flood risk assessment indicates that a 10,000-year flood event could generate up to 1.0 hm^3 of excess water into the lower reservoir (run-off 850,000 m^3 & direct rainfall 178,000 m^3), causing the water level to rise by 0.69 m.

pit sump	Discharge (m^3/h)	Manometric head (m)	Power (kW)	Pump location altitude (m)	Exit altitude (m)	Difference (m)
Submerged Sector 7 * (T7 floating)	400	240	400	470	654	184
Submerged Sector 6 * (T86 floating)	250 / 400 (average value 330)	230	250	540	653	113
Section 4 * (T4)	400	160	160	573	654	81
Nea Kavasa	400	160	160	629	693	64
* There are 2 electric pumps at the pit sumps						

Table 2-1: Characteristics and capacities of the pit sumps of South Field mine (Source : PPC)

2.3. General layout of the project

The South Field PHS is a pumped-storage plant, to be built as a capacity and energy provider for the Greek National Grid. It will operate between two man-made water reservoirs, connected by a 1 km (approx.) penstock pipeline, constituting of two open-air steel pipes. Electric power will be supplied to the national grid. The power evacuation will be at Agios Dimitrios TPP existing 150 kV switchyard.

The scheme is described here after, and the main characteristics are given in

Upper reservoir		
Dam crest elevation	m	660.50
Maximum Water Level (MWL)	m	660.23
Full supply level (FSL)	m	659.00 *Normal operating conditions* 660.00 *as a temporary level for excess-water management*
Minimum operating level (MOL)	m	644.50
Bottom elevation	m	638.00
Reservoir volume between FSL and MOL	hm^3	9.3
Total storage capacity (between bottom to crest level)	hm^3	12.5
Dam crest width	m	8

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Inside slope	(h:v)	2.5:1
Outside slope	(h:v)	2.5:1
Buffer reservoir		
Dam crest elevation	m	640.00
Maximum Water Level (MWL)	m	639.00
Bottom elevation	m	627.65
Total storage capacity (between bottom to crest level)	hm^3	2.29
Dam crest width	m	4
Inside slope	(h:v)	2.5:1
Outside slope	(h:v)	2.5:1
Lower reservoir		
Powerhouse and access crest elevation	m	537.00
Maximum Water Level (MWL)	m	535.69
Full supply level (FSL)	m	535.00
Minimum operating level (MOL)	m	528.00
Bottom level	m	523.00
Reservoir volume between FSL and MOL	hm^3	9.3
Total storage capacity (between bottom to powerhouse crest level)	hm^3	16.4

Table 2-2. The general layout of the project is illustrated on Figure 0-1. The tentative project layout described below was defined following a techno-economic optimization study as described at the feasibility study [8].

At this stage of the project, the scheme comprises the following structures:

2.3.1. Upper reservoir, upper intake, spillway and outlet

The upper reservoir is located on the plateau south-east of the mine pit. The boundaries of the potential area which may be occupied by the upper reservoir were given by the Client at the outset of the study. A final buffer reservoir, introduced as an additional requirement from PPC, is also considered.

- The upper reservoir is set on a plateau that is lower than the natural ground. The bottom elevation is proposed at 638 m.a.s.l. and crest elevation at 660 m.a.s.l., with a full supply level equal to 659 m.a.s.l., 1 meter beneath the crest level.

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- A buffer reservoir is introduced as a safety measure that shall be used as a temporary storage in the case of a need such as overpumping of flood and management of water excesses in the are of the project . The water shall be discharged into the Soulou river by pumping station (not part of the scope), since the buffer reservoir is more than 20 m below the natural surrounding ground. An additional benefit of this concept is the ability to control the discharge into the Soulou river, allowing a time delay between the releases from Kardia and South Field PHSs and thereby reducing the required river conveyance capacity.
- The principal location of the upper intake structure on the northern side of the upper reservoir is prescribed by the location of the powerhouse.

  To comply with the Greek legislation, a spillway and a bottom outlet will be implemented on the upper reservoir. The location of spillway and bottom outlet has to be arranged under consideration of safe discharge possibilities for all releases. The spillway structure is located at the southern end of the reservoir, while for the bottom outlet structure, a shared civil structure with the PHS intake was selected, with a bypass DN800 connected at the downstream end of the penstock bifurcations, upstream of the powerhouse.
- The upper dam - creating the upper reservoir – is built with materials excavated from the dam and reservoir foundation and has a ring shape.
- The Drainage Gallery is running below the bottom of the upper reservoir and connects the Intake structure with the aeration shaft on the northern part of the reservoir as shown in the general layout. Easy access to the gallery is via the Intake structure or penstock gallery, collecting pipes, which collect possible drainage water below the bottom sealing of the reservoir.

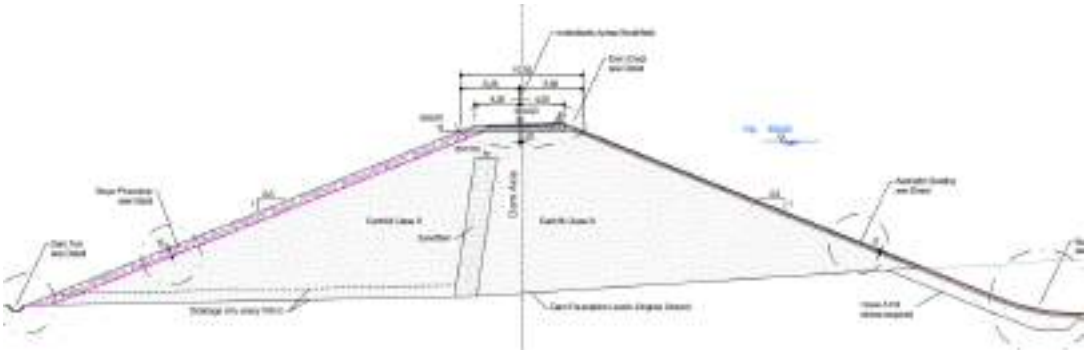


Figure 2-3: Typical Section of Upper Reservoir Embankment

2.3.2. Penstock, waterways

Therefore, the upper intake is located at the North border of the upper reservoir the closest to the mine pits slopes and lower intake within the powerhouse is located in the mine pit directly underneath the intake.

- The waterways include the following sections, from upper to lower reservoir:
  - Upper intakes, with trash racks and safety gates;
  - 2 upper open-air penstocks, placed along the South-East slopes of the mine pit,
  - 2 bifurcations connecting the penstocks to the units, one for each penstock;
  - 4 main inlet valves;
  - 4 draft tubes equipped with 4 gates;

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- 4 lower intakes adjacent to the powerhouse structure, discharging directly into the lower reservoir.

The overpressure and overspeed due to the transients are controlled by capped flow velocities in the waterway (which depend on the penstock diameter).

2.3.3. Lower reservoir

- The lower reservoir is formed by the large mine pit and shall be created in the lowest part of the open mine, where it performs as a drainage sump for the entire mining pit. At this stage the bottom of lower reservoir reaches elevations down to 523 m.a.s.l.
- The Full Supply Level of the lower reservoir is set at 535 m.a.s.l. and the minimum operating level is set at 528 m.a.s.l.
- The Client has to comply with obligations imposed by the authorities to ensure the stability of the slopes in the mine, in particular in the elevation range between FSL of 535 m.a.s.l. and MOL of 528 m.a.s.l.

2.3.4. Powerhouse and lower intake

The powerhouse is located at the toe of the Southeastern slope of the mine -forming the excavation workfront - and positioned toward its northern section to align with the location of the upper reservoir on the northern part of the upper plateau. Powerhouse is open air type and made of reinforced concrete. A large excavation will be executed at the toe of the mine South-East slope and will be partially backfilled to form a platform where transformers will be installed. The Powerhouse is housing four (4) Francis reversible fixed speed pump-turbines and an average and maximum total power at generation mode of respectively **220 MW** and **240 MW**.

2.3.5. Access road

Access to the reservoirs is provided primarily via the existing road located between the two solar farms, which serves as the main approach to the site. This road is used up to the southern side of the upper reservoir, where it connects to a permanent embankment crest road constructed along the top of the upper reservoir embankment.

A toe road will provide access around the Buffer Reservoir. This road gradually descends along the southern side of the buffer basin, allowing convenient access to the planned location of the future pumping station. From this point, the road reconnects with the existing access road, thereby forming a complete route around both the upper and the buffer reservoirs. This access road arrangement ensures efficient construction logistics, operational accessibility, and long-term maintainability of all key reservoir and pumping facilities.

Access to the lower reservoir is provided by a continuous ring road constructed around the reservoir perimeter. This road forms the primary access route for construction, operation, and maintenance activities associated with the Lower Reservoir facilities.

The ring road will be directly connected to the powerhouse plateau ensuring efficient access between the reservoir and the powerhouse area. From the powerhouse plateau, connectivity to structures located outside the mine area is provided via the existing mine road network, which is retained and utilized with minimal modifications. This access arrangement ensures robust and reliable access to the lower reservoir and associated

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infrastructure while maximizing the use of existing roads and minimizing the need for new road construction.

2.3.6. Structure summary

Upper reservoir		
Dam crest elevation	m	660.50
Maximum Water Level (MWL)	m	660.23
Full supply level (FSL)	m	659.00 *Normal operating conditions* 660.00 *as a temporary level for excess-water management*
Minimum operating level (MOL)	m	644.50
Bottom elevation	m	638.00
Reservoir volume between FSL and MOL	hm^3	9.3
Total storage capacity (between bottom to crest level)	hm^3	12.5
Dam crest width	m	8
Inside slope	(h:v)	2.5:1
Outside slope	(h:v)	2.5:1
Buffer reservoir		
Dam crest elevation	m	640.00
Maximum Water Level (MWL)	m	639.00
Bottom elevation	m	627.65
Total storage capacity (between bottom to crest level)	hm^3	2.29
Dam crest width	m	4
Inside slope	(h:v)	2.5:1
Outside slope	(h:v)	2.5:1
Lower reservoir		
Powerhouse and access crest elevation	m	537.00
Maximum Water Level (MWL)	m	535.69
Full supply level (FSL)	m	535.00
Minimum operating level (MOL)	m	528.00
Bottom level	m	523.00
Reservoir volume between FSL and MOL	hm^3	9.3

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Total storage capacity (between bottom to powerhouse crest level)	hm^3	16.4

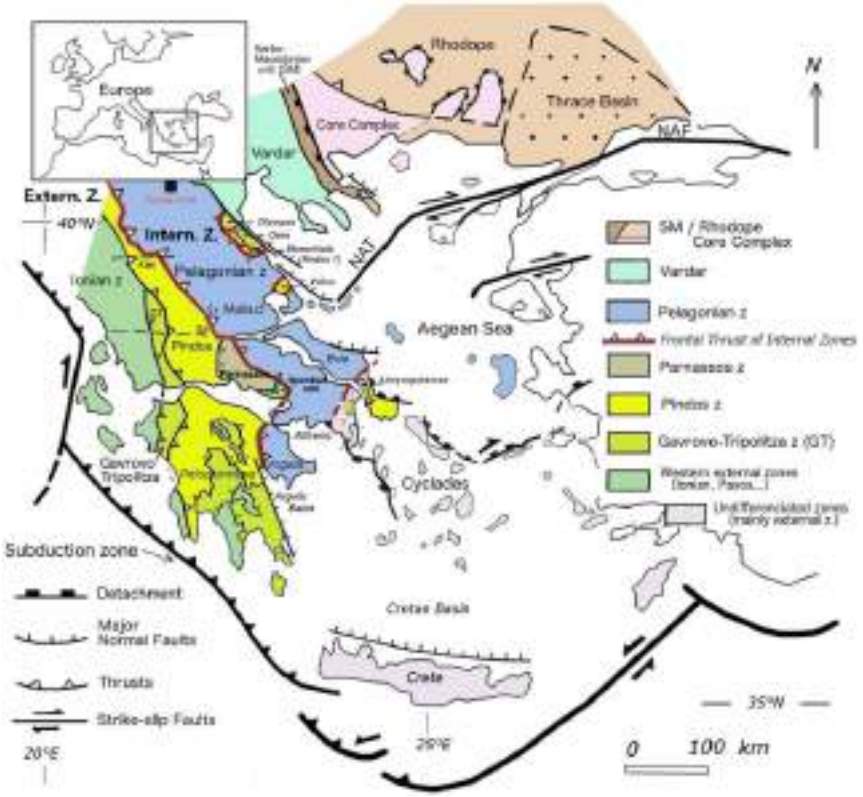
Table 2-2: Project main characteristics

3. GEOLOGICAL SETTING AND HISTORY

3.1. Regional geology

The South Filed mine deposits constitute part of Sarigöl sub-basin, and part of an extensive NNW-SSE graben which was formed during the Middle-Upper Miocene. Lignite depositions and the associated interlayers have undergone a series of Pleistocene tectonic partitioning that comprised simultaneous heaving and plunging episodes. Sarigöl sub-basin as outcome of this tectonic process is bounded towards the north by the Comano uplift block unit, and to the east, south, and west is demarcated by vertical faults.

The lignite deposits are developed over the loose sediments of Ptolemaida basin, a part of an extensive graben which identifies within the Pelagonian unit; the upper unit of the Internal Hellenides. The Hellenides mountain belt constitute the outcome of the alpine Tethyan orogen. During the Tertiary age, a final continental collision occurred, accompanied by three folding-tectonic phases. The latest (Middle-Upper Miocene) resulted in large NW-SE faults and the subsequent formation of the basin. Figure 3-1 illustrates a simplified geological map of Greece.



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Figure 3-1: Simplified geological map of Greece

The climatological conditions (precipitation, air and water temperature) alongside the geological composition of the surrounding slope margins over the entire geological course have played a key-role for the control of deposition and suspension phases. Transitions, swift changes and/or alternations of the aforesaid conditions led to this characteristic lithostratigraphic variability of lignite-bearing series and barren layers of marls, clays, sands and conglomerates. Prior to mining activities over the extended basin of Ptolemais, the Pliocene ligniferous layers were partially overlain (disconformity) by Lower Pleistocene (Villafranchian) riverbed conglomerates (also known as Proasteion series “Green” series) and mainly covered by Holocene alluvium deposits.

3.2. Structural regime (geotectonics)

With respect to the broader geotectonic context, West Macedonia constitutes an NNW-SSE trending basin which comprises of five sub-basins, namely: Kozani, Ptolemaida, Amyntaio, Florina, and Monastiri. As illustrated in Figure 3-2 below, its geometry (i.e. NNW to SSE) aligns with the overall development axes of the surrounding massif. The basin corresponds to the tectonic activity of the Middle and Upper Miocene which resulted in the formation of an extensive graben which belongs to the Pelagonian geotectonic zone.

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Figure 3-2: Geomorphological map of the West Macedonia graben (Kantiranis, et. Al, 2016)

Two major tensile episodes signify the formation of the existing individual structural blocks within the broader basin. The onset of the first tensile stress event is identified in the Upper Miocene (where deposition starts in a lake environment and subsequently Lignite series start to form over the Marl base), resulting in the fracturing of the deposited series. Deposition and Lignite formation continues up to the Upper Pliocene. The second tensile stress episode lasts between Upper Pliocene and Lower Quaternary and reactivated the existing ENE-WSW trending faults. This second event shapes the structural character of the broader area resulting to the distinct heaving or plunging (new uplifts or sub-grabens) of particular tectonic blocks.

In line with the basin evolution, the broader mine field identifies within the Ptolemais sub-basin. With respect to the sedimentation activity, individual basins reflect separate evolution during the Quaternary period. The main influence factors for the development of particular sub-basin characteristics are the ongoing tectonic activity, the surrounding geomorphology, the hydrological and hydrogeological regime, and certainly, the climate over the course of Quaternary period. The activity over the existing faults continues until

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Upper Pleistocene to Holocene, whilst erosion of the surrounding mountain slopes (e.g. formation of debris cones), terrestrial deposits, and the alluvial activity cover a part of the graben sub-basin and finally shape the area's current morphology.

3.3. Main geological units

South Field mine deposit is part of Sarigöl sub-basin, and part of an extensive NNW-SSE graben which was formed during the Middle-Upper Miocene. Lignite depositions and the associated interlayers have undergone a series of Pleistocene tectonic partitioning that comprised simultaneous heaving and plunging episodes. Sarigöl sub-basin as outcome of this tectonic process is bounded towards the north by the Comano uplift block unit, and to the east, south, and west is demarcated by vertical faults.

The climatological conditions (precipitation, air, and water temperature) alongside the geological composition of the surrounding slope margins over the entire geological course have played a key-role for the control of deposition and suspension phases.

Transitions, swift changes, and/or alternations of the aforesaid conditions led to this characteristic lithostratigraphic variability of lignite-bearing series and barren layers of marls, clays, sands, and conglomerates.

As explained, sequential flooding and deposition activity were the major subsequent events which led to the sedimentation and formation of alternating lignite series and barren layers. The general conceptual stratigraphy of the area (from bottom to top) comprises of:

- a sedimentary base which mainly consists of clays, marls, sands, and conglomerates (Base Marl of Upper Pliocene);
- overlain by Pliocene lignite-bearing strata (Lower and Upper ligniferous series of Upper Pliocene);
- followed by alternations of strong sandy clays, clayey marls, and sands, also named after "greenish grey clay-marl deposits";
- overlain by a disconformity fluvial phase which consists of sands, clays, sandy marls, and few sandstones; and;
- Quaternary red clays and conglomerates. Holocene and Pleistocene series rest in disconformity over the aforementioned Neogene series and consist of fluvial conglomerates in the lower parts (Pleistocene) overlain by a recent alluvium and eluvium mantle (gravels, sands, clays).

The excerpt of the regional geological map allocates the broader Project area within the geological context of Kozani prefecture (Figure 3-3). A more detailed map can be seen in A0 [Regional geological map].

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Figure 3-3: Excerpt of Kozani geological map including Sarigöl basin (ΙΓΜΕ 1:5000)

Parts of the described stratigraphy exist and have been encountered during the core mining activities in the South Field mine and during the recent geotechnical investigation programme. Figure 3-4 presents the complete regional stratigraphy, and the sections identified in the South Field mine area.

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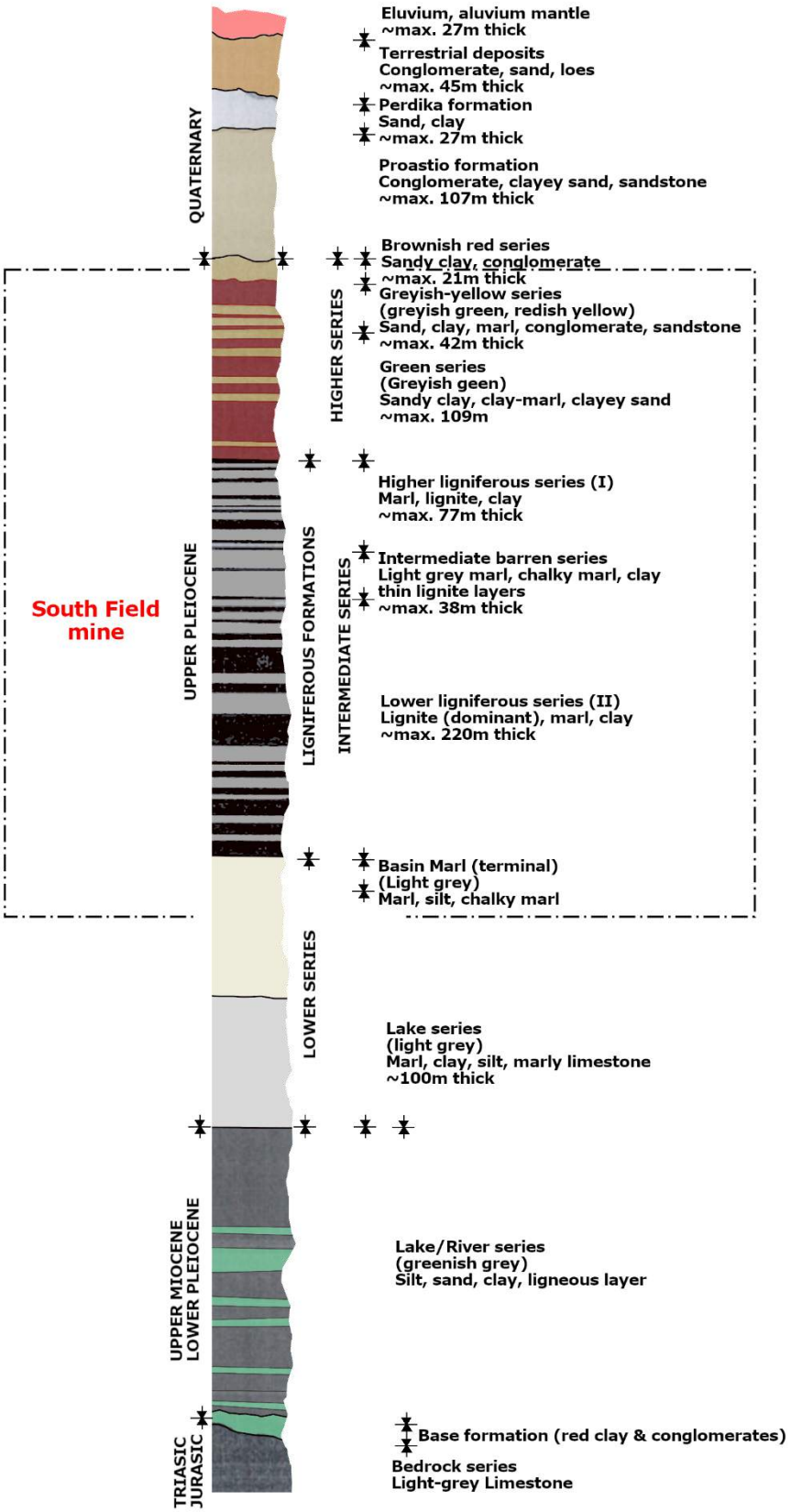


Figure 3-4: Stratigraphy of South Field mine (ΙΓΜΕ, 2009; edit 2024)

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3.4. Geological survey

3.4.1. Previous investigation campaigns

The Client (PPC) has handed over a series of documents pertaining to the regional geology, the geological regime of the Project's area, the broader hydrogeological conditions, and the geotechnical regime. This documentation provides factual information of the previous investigation campaigns and the periodical hydrological studies.

Document	Author	Date	Description
Πορεία Αποστράγγισης Ορυχείων Πτολεμαΐδας & Εκτίμηση Περιβαλλοντικών Επιπτώσεων στο Υδατικό Σύστημα	Louloudis – Mertiri – Kasfikis	11/2009	Groundwater management and control plan of Ptolemaida lignite mine deposit (basin) and environmental impact assessment with respect to the groundwater and runoff regime of the area. Analytical report of the recorded and monitored aquifers and aquicludes.
Hydraulic Protection Measures of the Ptolemais Mines from the Surface Run-off	Louloudis – Mertiri – Liakoura – Kasfikis	06/2020	Detailed presentation of the existing control measures for the protection of the South Field, Kardia and Mavropigi mines from surface water and the design of the new hydraulic protection measures.
Study of the Dewatering Measures of the Ptolemais Mines & Environmental Impacts Assessment on the Water System for the Year 2022	Louloudis – Mertiri – Liakoura – Kasfikis	10/2023	Hydrological (primarily) and hydrogeological study with respect to the protection works in the South Field, Kardia and Mavropigi Mines from underground and surface water, in the year 2022.
Υδρογεωλογική Μελέτη για την Περιβαλλοντική Παρακολούθηση και Διαχείριση του Υδατικού Δυναμικού των Ορυχείων Πτολεμαΐδας κατά το Έτος 2023	Louloudis – Mertiri – Kasfikis	11/2024	Similar to document HYD-202310 [ENG], the study comprises the hydrological (primarily) and hydrogeological details with respect to the protection works in the South Field, Kardia and Mavropigi Mines from underground and surface water, in the year 2023.
Υδρογεωλογική Μελέτη για την Περιβαλλοντική Παρακολούθηση και Διαχείριση του Υδατικού Δυναμικού των Ορυχείων Πτολεμαΐδας κατά το Έτος 2024	Mertiri – Kasfikis	09/2025	Similar to document of the previous year (2024), the study comprises the hydrological (primarily) and hydrogeological details with respect to the protection works in the South Field, Kardia and Mavropigi Mines from underground and surface water, in the year 2023
Geotechnical Investigation of Long-term stability of the slopes of the South Field Mine, in the frame of the implementation study of a pumped storage project. Stage A Submission – Geotechnical Interpretation Report	Steiakakis - Kavvadas	11/2025	Interpretation of the executed geotechnical investigations and the available monitoring data of the peripheral slopes of South Field Mine. The assessment focuses on the project's feasibility with respect to the stability of the slopes surrounding the lower reservoir, taking into account the conditions of the upper reservoir and the powerhouse station slopes.

Table 3-1 summarises the available technical information and provides a brief description of their content.

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Document	Author	Date	Description
Πορεία Αποστράγγισης Ορυχείων Πτολεμαΐδας & Εκτίμηση Περιβαλλοντικών Επιπτώσεων στο Υδατικό Σύστημα	Louloudis – Mertiri – Kasfikis	11/2009	Groundwater management and control plan of Ptolemaida lignite mine deposit (basin) and environmental impact assessment with respect to the groundwater and runoff regime of the area. Analytical report of the recorded and monitored aquifers and aquicludes.
Hydraulic Protection Measures of the Ptolemais Mines from the Surface Run-off	Louloudis – Mertiri – Liakoura – Kasfikis	06/2020	Detailed presentation of the existing control measures for the protection of the South Field, Kardia and Mavropigi mines from surface water and the design of the new hydraulic protection measures.
Study of the Dewatering Measures of the Ptolemais Mines & Environmental Impacts Assessment on the Water System for the Year 2022	Louloudis – Mertiri – Liakoura – Kasfikis	10/2023	Hydrological (primarily) and hydrogeological study with respect to the protection works in the South Field, Kardia and Mavropigi Mines from underground and surface water, in the year 2022.
Υδρογεωλογική Μελέτη για την Περιβαλλοντική Παρακολούθηση και Διαχείριση του Υδατικού Δυναμικού των Ορυχείων Πτολεμαΐδας κατά το Έτος 2023	Louloudis – Mertiri – Kasfikis	11/2024	Similar to document HYD-202310 [ENG], the study comprises the hydrological (primarily) and hydrogeological details with respect to the protection works in the South Field, Kardia and Mavropigi Mines from underground and surface water, in the year 2023.
Υδρογεωλογική Μελέτη για την Περιβαλλοντική Παρακολούθηση και Διαχείριση του Υδατικού Δυναμικού των Ορυχείων Πτολεμαΐδας κατά το Έτος 2024	Mertiri – Kasfikis	09/2025	Similar to document of the previous year (2024), the study comprises the hydrological (primarily) and hydrogeological details with respect to the protection works in the South Field, Kardia and Mavropigi Mines from underground and surface water, in the year 2023
Geotechnical Investigation of Long-term stability of the slopes of the South Field Mine, in the frame of the implementation study of a pumped storage project. Stage A Submission – Geotechnical Interpretation Report	Steiakakis - Kavvadas	11/2025	Interpretation of the executed geotechnical investigations and the available monitoring data of the peripheral slopes of South Field Mine. The assessment focuses on the project's feasibility with respect to the stability of the slopes surrounding the lower reservoir, taking into account the conditions of the upper reservoir and the powerhouse station slopes.

Table 3-1: Geological & Geotechnical Reference Data

3.4.2. Site reconnaissance

Site reconnaissance covered the extended Project area. The main geological entities which were observed during the field work can be solely considered as soil ground to hard soil ground. The Marl base (M_b) can be marginally considered as soft rock. In brief, the North – NW - West outskirts of the Project (the area that surrounds the Lower Reservoir) are covered by self-compacted manmade induced contemporary deposits (Figure 3-5), a byproduct of the recent mining activity.

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Figure 3-5: NNW manmade mining waste deposits

Outcrops observed at the SE - South - SSW slopes along the excavated (active) workfronts of the mine constitute the autochthonous series of the basin, as those represented by horizontally to sub-horizontally bedded layers that dip SW-WSW (Figure 3-6). Parts or even the entire lithological column of the area are visible at these southern slopes and consist of conglomerates/mudstones and clay intervals (Proasteion series); Silts, silty Marl interbeds, Clays, and sandy Silts ("green" series"); Lignite-bearing layers; and silty Marls and Marl beds (i.e. base Marl) (Figure 3-7).

A general view of the entire South Field mine area and the extent of the autochthonous lithological entities, as well as the recent Holocene deposit of the mining waste byproducts is illustrated in Figure 3-8, below.



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Figure 3-6: SE-S slopes consisting of Lignite-bearing strata overlain by *Green* and Proasteion series (view from NW)



Figure 3-7: Lignite outcrops overlying Marl at the SE mine slope (below the Upper Reservoir)

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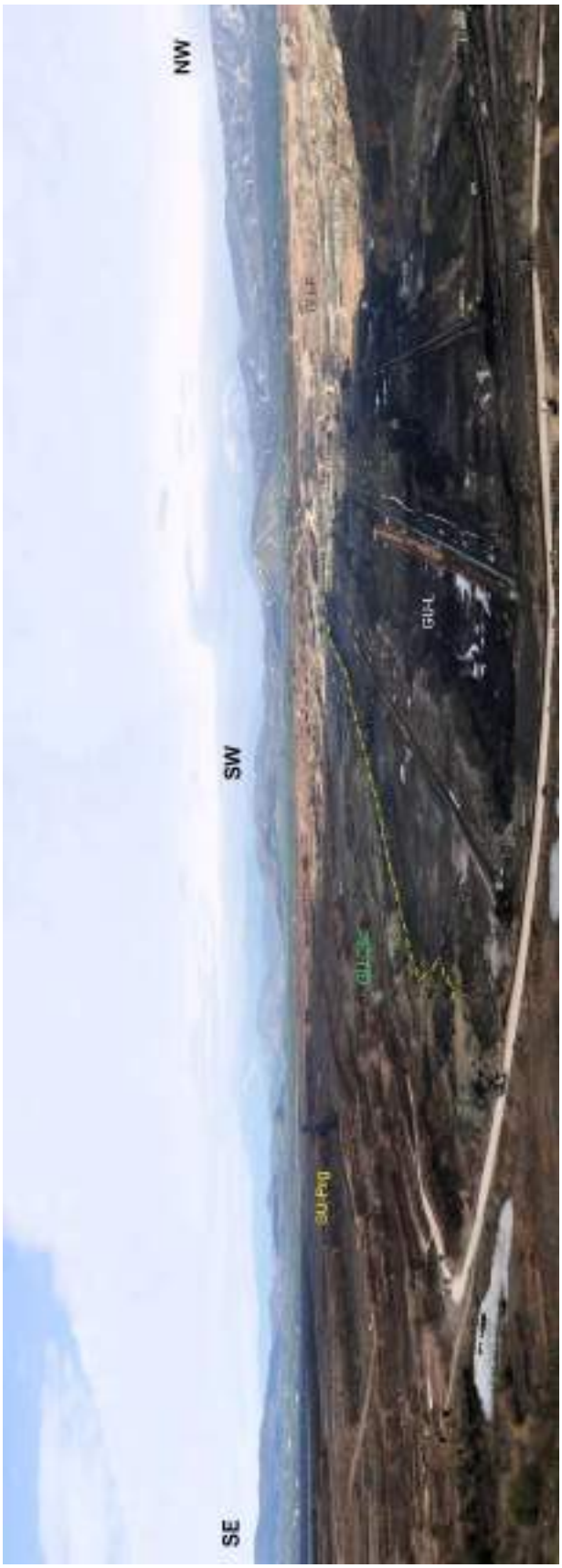


Figure 3-8: General view of the South Field mine and the identified lithological entities

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3.4.3. Geological and geotechnical investigations+

To this date, a series of subsurface investigations with respect to the Project area has been executed between January and August 2025.

The primary objectives of the investigation campaign focus on the assessment of the prevailing geological-geostructural regime and the hydrogeological behaviour of the existing lithologies and provide clarity with respect to geo-mechanical properties of the area. The execution of the aforementioned investigation campaign provides valuable information regarding:

- the analysis and stability of mine slopes (performance of temporary and permanent slopes with respect to the construction and operation of the reservoirs),
- a preliminary geological model,
- the characteristic values of the geotechnical parameters for design purposes,
- the actual geotechnical units,
- the hydrogeological behaviour of the underlying lithological series and the associated water loss potential,
- the geo-mechanical behaviour of formations below reservoirs,
- the foundation conditions in the Powerhouse area and along the penstocks, and
- the residual geological uncertainty.

3.4.3.1. SURFACE INVESTIGATIONS

No surface investigations have been performed in the area of the Southfield mine pit. In order to obtain a more accurate view of how the geological structure of both the upper reservoir and lower reservoir as well as the waterways, surface non-invasive investigations are recommended, see sub-chapter 6.5.

3.4.3.2. SUB-SURFACE INVESTIGATIONS

The Sub-surface investigation programme comprises boreholes, in situ tests, along with the installation of geotechnical monitoring instruments. In brief, rotary core drilling and sampling was conducted in 27 (twenty-seven) boreholes, and geotechnical instrumentation has been installed in 24 (twenty-four) boreholes which briefly comprise 10 (ten) multi-level vibrating wire piezometers, 5 (five) standpipe groundwater wells, and 9 (nine) inclinometers. Table 3-2 provides a summary of the executed boreholes and Figure 3-9 presents the layout map of the borehole locations.

Further to this, in-situ tests were performed and samples from retrieved cores were tested in the laboratory. The in-situ tests comprise Standard Penetration Tests (SPT) and permeability tests (110 variable head tests, i.e. Maag). Further to the in-situ testing, undisturbed sampling with the aid of Shelby tubes was conducted in twenty (20) boreholes (61 samples), and where lithologies allowed so.

With reference to the tentative allocation of the Project's main structures, Table 3-2 provides a summary of the executed boreholes and Figure 3-9 presents the layout map of the borehole locations. The detailed layout map which shows borehole locations, an analytical table which presents the features of the executed boreholes and all available borehole logs are included in Annex A1 of the Geotechnical Data Report (GDR) [7]. The corresponding available core box photographs are included in Annex A3 of the Geotechnical Data Report (GDR) [7].

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Borehole	Drilled depth	Coordinates		Head altitude (m.a.s.l.)	Sampled	Instrument	Lab
		X	Y				
BP-01p	93.0	316047	4475893	+609.5	✓	×	✓
BP-02p	100.0	316186	4475650	+555.6	✓	Piezometer	✓
BP-02k	101.0	316203	4475674	+542.0	×	Inclinometer	×
KD-03p	125.0	315950	4476206	+614.8	✓	Piezometer	✓
SP-04p	125.0	317421	4474362	+610.9	✓	Piezometer	✓
SP-04k	125.0	317414	4474367	+611.0	×	Inclinometer	×
SP-05p	125.0	317294	4473961	+621.5	✓	Piezometer	✓
SP-05k	125.0	317291	4473953	+622.0	×	Inclinometer	×
AD-06p	170.0	317928	4473995	+639.6	✓	Piezometer	✓
AD-06k	175.0	317924	4474001	+640.0	×	Inclinometer	×
AD-07p	175.0	317552	4473508	+639.2	✓	Piezometer	✓
AD-07k	175.0	317549	4473516	+640.0	×	Inclinometer	×
AD-08p	210.0	318278	4474763	+643.4	✓	Piezometer	✓
KL-09p	162.0	314721	4474353	+626.3	✓	Piezometer	✓
KL-09k	162.0	314730	4474358	+626.0	×	Inclinometer	×
KL-10p	120.5	315640	4474521	+555.2	✓	Piezometer	✓
KL-10k	123.0	315646	4474527	+555.0	×	Inclinometer	×
KL-11p	112.0	315765	4475438	+554.3	✓	Piezometer	✓
KL-12p	85.0	315490	4474778	+552.3	✓	×	✓
KL-13k	111.0	315236	4474956	+571.4	✓	×	✓
SF-L1	30.0	316144	4475129	+514.2	✓	Standpipe	✓
SF-L2	30.0	316956	4474942	+553.6	✓	Standpipe	✓
SF-L3	30.0	316928	4475356	+521.0	✓	Standpipe	✓
SF-L4	30.0	317405	4475694	+521.4	✓	Standpipe	✓
SF-PH	65.0	317605	4475648	+537.1	✓	Standpipe	✓
SF-UR2	181.0	319287	4475779	+660.8	✓	Inclinometer	✓
SF-W5	177.0	318405	4474988	+645.6	✓	Inclinometer	✓

Table 3-2. Summary of subsurface investigation campaigns

In order to determine the physical and mechanical properties of the encountered lithological units, a large number of samples retrieved from boreholes and tested in the laboratory. Table 3-3 summarises the performed laboratory tests.

Further to the aforementioned tests (physical and mechanical properties), samples were tested and analysed aiming to determine mineral components prone to swelling (i.e. types and proportions of minerals that where present, can impact soil properties like strength, compressibility, and swelling potential). The adopted identification technique refers to the X-ray diffraction method (XRD).

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Physical properties	Standard	Mechanical properties	Standard
Gradation	Hellenic Accreditation System (ΕΣΥΔ), E-105:1986 (§7)	Consolidated undrained triaxial comp. test with pore pressure (CU-pp)	ASTM D4767-11
Natural water content	Hellenic Accreditation System (ΕΣΥΔ), E-105:1986 (§2)	Unconsolidated undrained triaxial comp. test (UU)	ASTM D2850-24
Atterberg limits (LL, PL, PI)	Hellenic Accreditation System (ΕΣΥΔ), E-105:1986 (§5, §6)	Residual shear strength test	ASTM D6467-13
Specific gravity	Hellenic Accreditation System (ΕΣΥΔ), E-105:1986 (§4)	Unconfined compressive strength test (UCS)	ASTM D2166-24
Hydrometer	Hellenic Accreditation System (ΕΣΥΔ), E-105:1986 (§9)	One-Dimensional Consolidation Test	ASTM D2435-11 (20)
Mineralogical analysis	X-ray diffraction method (XRD)	One-Dimensional Swell or Collapse of soils	ASTM D2435 / method A
		Double Hydrometer Test	ASTM D4221-99

Table 3-3: Summary of laboratory tests

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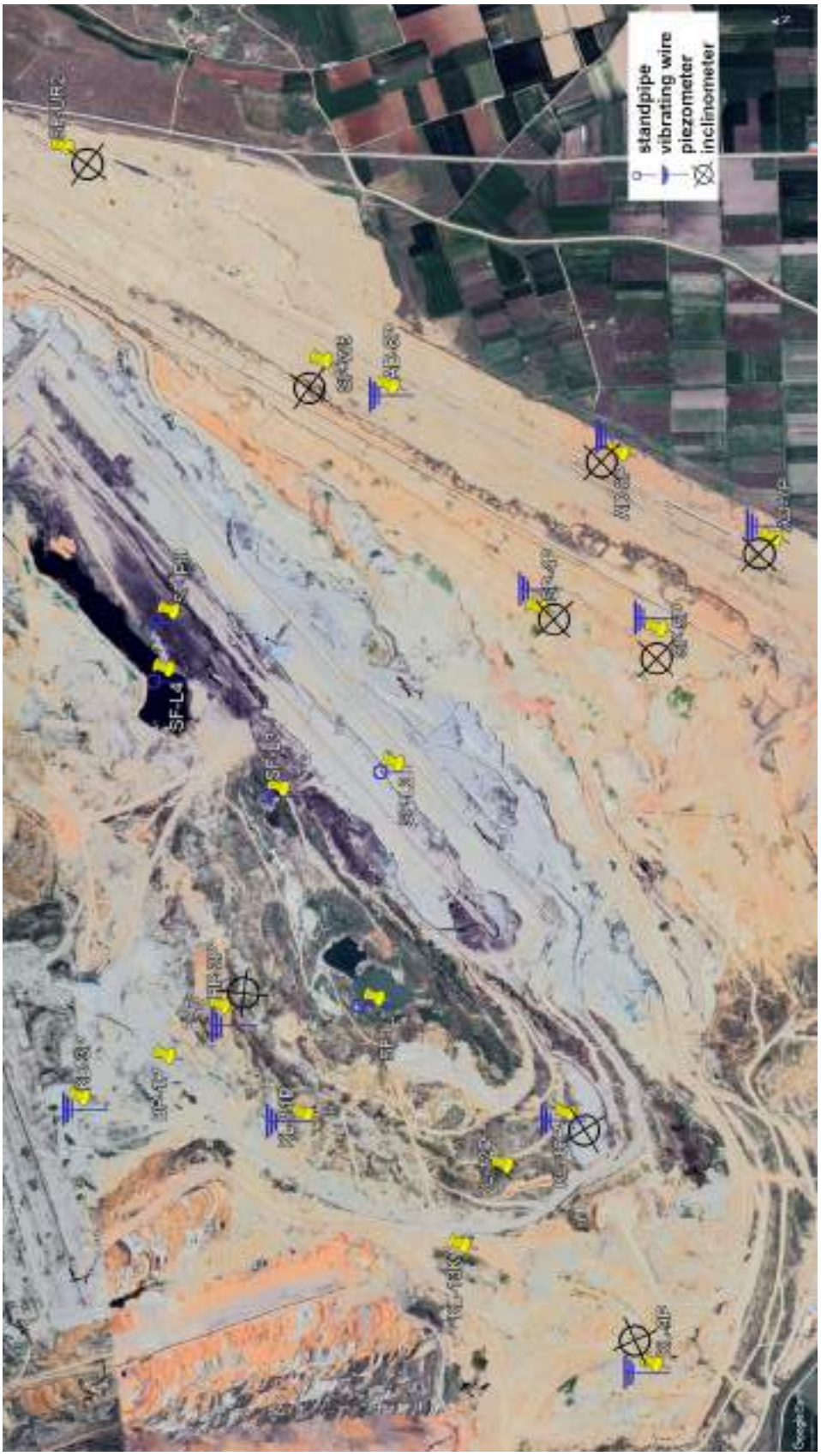


Figure 3-9: Geotechnical investigation (sub-surface) layout map

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3.5. Regional seismic context

According to the revision of the Seismic Hazard Map (Government Gazette 1154/B/12-8-2003) of the current Anti-Seismic Regulation (NEAK 2000), the area is classified as Zone I (Figure 3-10). Based on the recent Seismic Hazard Analysis (SHA) [9], for seismic design purposes, a return period of T=3000 years has been required from the client for the dam and powerhouse structure design, corresponding to a PGA of 0.50 g. Similarly, the desired damping ratio may be considered by scaling the presented time histories, which are given for a 5% damping ratio. This is considered a high risky Peak acceleration and should be considered in the design of the project structures.

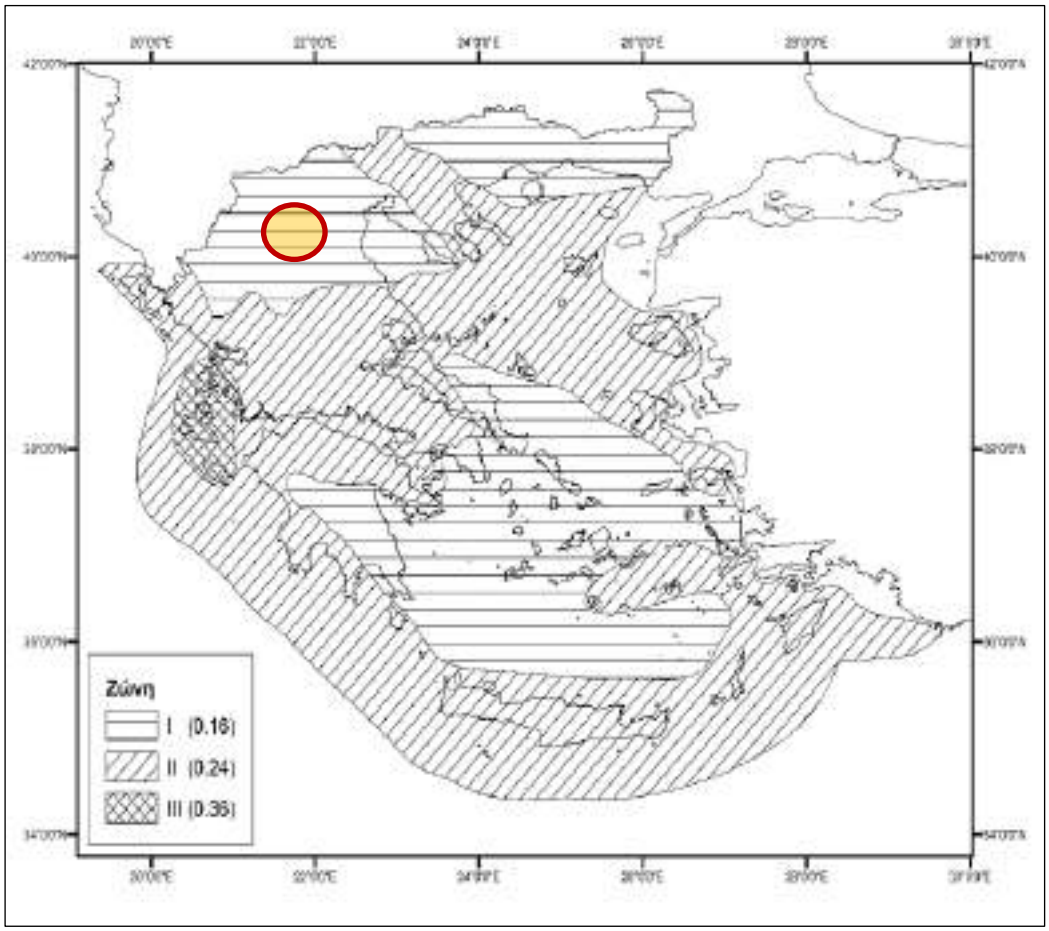


Figure 3-10: Seismic hazard zoning map of Greece (ΟΑΣΠ, 2023 – Project area in the red circle)

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4. INVESTIGATION, INSTRUMENTATION AND LABORATORY DATA RESULTS

4.1. In-situ tests

4.1.1. Standard Penetration Tests (SPT)

Standard Penetration Tests (SPT) were performed in nineteen (19) boreholes, and in depths down to -45m.

The analytical tables of the penetration results (252 tests) along with the permeability tests are attached in Annex B1 [*Field tests SPT´s and Permeability*]

4.1.2. Permeability

To evaluate the permeability and assess the groundwater behaviour of the underlying lithological series below the Upper and Lower Reservoir and the broader vicinity, permeability tests were conducted in 19 (nineteen) boreholes. All permeability tests comprise 110 variable head tests, i.e., Maag method.

The analytical results of Standard Penetration Tests (SPT) and the field records of permeability tests are included in Annex B1 [*Field tests SPT´s and Permeability*]

4.2. Geotechnical monitoring

4.2.1. Inclinometers

To assess the performance and behaviour of the surrounding slopes of South Field mine, 9 (nine) inclinometers have been installed in the Project area, during the investigation campaign of 2025.

Graphs which reflect cumulative displacements over time are generated according to the latest inclinometer readings and presented in Annex C1 of the GDR [7]

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Borehole	Depth	X	Y	Head altitude (m.a.s.l.)	Sensor Azimuths	Installation Date	Location
BP-02k	101.0	316203	4475674	+542.0	A: 187^0 B: 277^0	06/2025	NNW of Lower Reservoir (Creeping zone)
SP-04k	125.0	317414	4474367	+611.0	A: 317^0 B: 047^0	03/2025	S of Upper Reservoir (Out of bounds)
SP-05k	125.0	317291	4473953	+622.0	A: 314^0 B: 044^0	03/2025	S of Upper Reservoir (Out of bounds)
SP-06k	175.0	317924	4474001	+640.0	A: 315^0 B: 045^0	01/2025	S of Upper Reservoir (Out of bounds)
SP-07k	175.0	317549	4473516	+640.0	A: 315^0 B: 045^0	02/2025	S of Upper Reservoir (Out of bounds)
KL-09k	162.0	314730	4474358	+626.0	A: 065^0 B: 155^0	05/2025	SW of Lower Reservoir (Creeping zone)
KL-10k	123.0	315646	4474527	+555.0	A: 058^0 B: 148^0	04/2025	Lower reservoir
SF-UR2	181.0	319287	4475779	+660.8	A: 308^0 B: 038^0	08/2025	Upper reservoir
SF-W5	177.0	318405	4474988	+645.6	A: 306^0 B: 036^0	08/2025	Upper reservoir / Intake

Table 4-1: Inclinometers of South Field mine (PSH Project area)

4.2.2. Piezometers

With reference to the monitoring of groundwater behaviour (i.e. groundwater level and pore pressure within the encountered aquifers) in the open cut slopes as well as the slopes formed by waste fill material, 10 (ten) vibrating wire multi-level piezometers have been installed. Further to this, for the monitoring of groundwater level, 5 (five) standpipe observation wells (i.e. standpipe) have been installed in the project area have been installed during the recent investigation campaign (completion: August 2025).

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Borehole	Depth	X	Y	Head altitude (m.a.s.l.)	Type	Location
BP-02p	100.0	316195	4475672	+542.0	MLVB (2) *	NNW of Lower Reservoir (Creeping zone)
KD-03p	125.0	315946	4476209	+615.0	MLVB (2)	NNW of Lower Reservoir (Creeping zone)
SP-04p	125.0	317425	4474362	+611.0	MLVB (2)	S of Upper Reservoir (Out of bounds)
SP-05p	125.0	317294	4473956	+622.0	MLVB (2)	S of Upper Reservoir (Out of bounds)
AD-06p	170.0	317929	4473998	+640.0	MLVB (2)	S of Upper Reservoir (Out of bounds)
AD-07p	175.0	317551	4473507	+640.0	MLVB (3)	S of Upper Reservoir (Out of bounds)
AD-08p	210.0	318280	4474767	+643.0	MLVB (2)	Upper reservoir
KL-09p	162.0	314730	4474358	+626.0	M LVB (2)	SW of Lower Reservoir (Creeping zone)
KL-10p	120.5	315640	4474522	+555.0	MLVB (2)	Lower reservoir
KL-11p	112.0	315772	4475438	+554.0	MLVB (2)	Lower reservoir
SF-L1	30.0	316144	4475129	+514.2	Standpipe	Lower reservoir
SF-L2	30.0	316956	4474942	+553.6	Standpipe	Lower reservoir
SF-L3	30.0	316928	4475356	+521.0	Standpipe	Lower reservoir
SF-L4	30.0	317405	4475694	+521.4	Standpipe	Lower reservoir / Powerhouse
SF-PH	65.0	317605	4475648	+537.1	Standpipe	Powerhouse

* *MLVB: multi-level vibrating wire piezometer. (x): number of sensors*

Table 4-2: Groundwater monitoring instruments

Graphs which reflect groundwater behaviour and fluctuation over time have been generated according to the latest piezometer and standpipe readings (as of December 2025), and are presented in Annex C2 of the GDR [7]

With reference to human-induced activities, continuous pumping is being carried out at the SW and NE of the South Field mine field through a network of 15 functional borehole wells and 7 surface pumping stations. The discharging activity relates solely to the Sarigöl unconfined aquifer Aq_u, whereas no pumping (discharge) activity is carried out within the underlying confined aquifer Aq_c. The pumping task within Aq_u has been considered essential as control measure to maintain and assure the stability of the surrounding slopes. The allocation of the pumping wells and the surface pumping stations are illustrated in Figure 4-1 and Figure 4-2, below.

Based on the recorded discharge and pumping data (latest detailed report of year 2024, 09/2025, Mertiri - Kasfikis), the total annual pumped volume from the unconfined aquifer and the surface runoff (i.e. wells and surface pumping stations) amounts to $9.9*10^6$ m^3. The vast majority of the pumped quantity (approx. 97%) is discharged to Soylu River. Based on the available record data since 1984, the annual pumped water volumes from pumping wells and surface pumping plants are also summarised in Annex C1 [Pumping wells and the surface pumping stations results]

With reference to the analysis of the available borehole wells and available drilloing data from investigation and mning boreholes over the broader, Kasfikis and Mertiri (2025) have produced the piezometric map of the unconfined aquifer Aq_u. The map is attached in Annex C1, as well.

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Figure 4-1. Pumping wells of the unconfined aquifer (as of 12.2025, after Kasfikis – Mertiri, 2025)

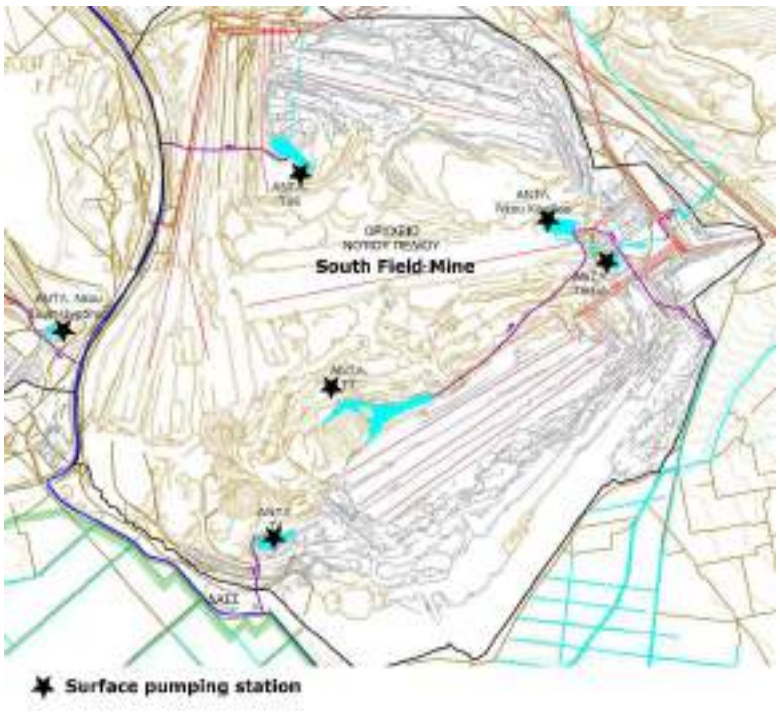


Figure 4-2: Surface pumping stations of South Field mine (as of 12.2025, after Kasfikis – Mertiri, 2025)

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4.3. Investigation Results Summary

In order to determine the physical and mechanical properties of the encountered lithological units, a large number of samples retrieved from the boreholes were tested in the laboratory, see Table 3-3. Due to the shear number of test and results, the detailed overview and the analytical lab sheets can be consulted in Annex C2 [*Laboratory summary*] and C3 [*Laboratory analytical results.*

The summary of the processed and analysed investigation results pertinent to each structure and based on logging and testing (in-situ and laboratory) is presented in the following tables (Table 4-3 to Table 4-5).

Upper Reservoir, Buffer Reservoir & Intake							
Borehole	Head Altitude	Groundwater (altitude)	Permeability (average m/sec)	Lithological unit			Ground characteristics
SP-04p	+610.9	+570.9	$4.13*10^{-5}$	0.0	28.4	(CH)s with Conglomerate and Mudstone interbeds	SPT: 14- Reject (avg. 18) LL: 10-51 PI: 26-70 w%: 19-60 q_u: no data
			$1.33*10^{-4}$	28.4	91.0	CLAY and SAND layers	SPT: 24- Reject (avg. 30) LL: 26-82 PI: NP-54 w%: 20-47 q_u: 85-459 KPa
			$1.8*10^{-5}$	91.0	126.0	Lignite-bearing series and high plasticity CLAY	LL: 76 PI: 49 w%: 44 q_u: no data
SP-05p	+621.5	+579.5	$1.87*10^{-5}$	0.0	43.9	Proasteion series: conglomerate with low to medium plasticity (locally high) CLAY	SPT: 9- Reject (avg. Reject) LL: 43-98 PI: NP-68 w%: 11-64 q_u: 175-357 KPa
			$2.48*10^{-5}$	43.9	99.2	Green series: SM, CL alternate layers	SPT: 32 (one test) LL: 31-72 PI: NP-49 w%: 11-52 q_u: 40-557 KPa
			No data	99.2	125.0	Lean to slightly plastic CLAY and SILT with Lignite	LL: 42-43 PI: NP-22 w%: 17-69 q_u: 9-299 KPa
AD-06p	+639.6	+620.0 (approx.)	No data	0.0	8.0	Waste fill material: (CL)s and CL	SPT: 17- Reject LL: 33-43 PI: 18-26 w%: 27-31 q_u: no data
			$8.7*10^{-6}$	8.0	68.2	Proasteion series: conglomerate with low to medium plasticity (locally high) CLAY with localised sandy fractions	SPT: 2- Reject (avg. 15) LL: 28-83 PI: 11-60 w%: 13-81 q_u: 5-82 KPa
			$2.15*10^{-6}$	68.2	123.1	Green series: SM, CL alternate layers and locally CH	LL: 30-86 PI: NP-74 w%: 19-44 q_u: 61-142 KPa

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Upper Reservoir, Buffer Reservoir & Intake							
Borehole	Head Altitude	Groundwater (altitude)	Permeability (average m/sec)	Lithological unit			Ground characteristics
			No data	123.1	162.7	Lignite	No data
			No data	162.7	170.5	Slightly plastic silty/sandy Marl	LL: no data PI: NP w%: 46 q_u: no data
AD-07p	+639.2	+627.0	No data	0.0	4.0	Waste fill material: CH	LL: 51 PI: 32 w%: 34 q_u: no data
			$1.03*10^{-5}$	4.0	80.5	Proasteion series: conglomerate with low to medium plasticity (locally high) CLAY with localised sandy fractions	SPT: 5-50 (avg. 17) LL: 28-84 PI: NP-58 w%: 15-66 q_u: 12.6 (nno data)
			$7.93*10^{-6}$	80.5	130.7	Green series: SM, CL alternate layers and locally CH and ML	LL: 31-60 PI: NP-36 w%: 18-33 q_u: 128-465 KPa
			$2.19*10^{-5}$	130.7	163.0	Lignite with interlayers of plastic CLAY, slightly plastic SILT	LL: no data PI: NP w%: 22-77 q_u: 85-1500 KPa
			No data	163.0	175.0	Marl base (no lab data)	LL: no data PI: no data w%: 60 q_u: 795 KPa
AD-08p	+643.4	+562.0	$8.5*10^{-6}$	0.0	60.0	Proasteion series: conglomerate with low to medium plasticity (locally high) CLAY with localised sandy fractions	SPT: 5- Reject (avg. 22) LL: 24-73 PI: 8-50 w%: 21-50 q_u: 90-307 KPa
			$7.64*10^{-6}$	60.0	126.0	Green series: CH, CL alternate layers and locally SC, SM	LL:39-93 PI: NP-64 w%: 21-40 q_u: 260-637 KPa
			$2.0*10^{-5}$	126.0	171.0	Lignite with interlayers of slightly plastic SILT (with sand)	LL: no data PI: NP w%: 23-85 q_u: no data
			No data	171.0	210.0	Slightly plastic to elastic clayey/silty Marl	LL: 43-52 PI: NP-16 w%: 31-44 q_u: 900-1200 KPa
SF-W5	+645.6	+561.0	$1.4*10^{-5}$	0.0	61.4	Proasteion series: conglomerate with low to medium plasticity (locally high) CLAY with localised sandy fractions	SPT: 14- Reject (avg. 21) LL: 27-90 PI: 11-56 w%: 22-53 q_u: 205-627 KPa
			$2.28*10^{-5}$	61.4	120.3	Green series: CH, CL alternate layers and locally ML, SM	LL: 34-79 PI: NP-50 w%: 13-40 q_u: 407-605

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Upper Reservoir, Buffer Reservoir & Intake							
Borehole	Head Altitude	Groundwater (altitude)	Permeability (average m/sec)	Lithological unit			Ground characteristics
			$6.73*10^{-5}$	120.3	165.0	Lignite with interlayers of slightly plastic SILT	LL: no data PI: NP w%: 31-38 q_u: 352-1491 KPa
			$3.0*10^{-5}$	165.0	177.0	Silty/clayey Marl	LL: 50-56 PI: 17-23 w%: 36 q_u: no data
SF-UR2	+660.8	no data	$8.65*10^{-4}$	0.0	50.5	Proasteion series: conglomerate with low to medium plasticity CLAY with localised sandy fractions	SPT: Reject LL: 27-44 PI: 12-25 w%: 13-35 q_u: 481-721 KPa
			$4.9*10^{-6}$	50.5	121.0	Green series: CH, CL alternate layers and SAND intervals	LL: 34-71 PI: NP-51 w%: 6-30 q_u: 487-727 KPa
			$2.0*10^{-4}$	121.0	161.9	Lignite with interlayers of slightly (locally high) plastic to elastic SILT and (sandy) SILT intervals	LL: 45-53 PI: 10-18 w%: 32-37 q_u: 1467 KPa
			$3.6*10^{-4}$	161.9	181.0	Silty/clayey Marl	LL: 40-46 PI: 10-27 w%: 27 q_u: 1016 KPa

Table 4-3 : Summary of Upper Reservoir, Buffer Reservoir & Intake investigation results

Lower Reservoir & Surrounding Slopes							
Borehole	Head Altitude	Groundwater (altitude)	Permeability (average m/sec)	Lithological unit			Ground characteristics
SF-L1	+514.2	+511.1	$5.66*10^{-7}$	0.0	26.2	Waste fill material: CL, CH, and locally GC	SPT: 9- Reject (avg. 16) LL: 29-51 PI: 12-26 w%: 23-43 q_u: 96-114
				26.2	30.0	Clayey Marl	LL: 35 PI: 16 w%: 25 q_u: 67 KPa
SF-L2	+553.6	+533.1	$6.6*10^{-7}$	0.0	30.0	Green series: SM, and locally CH, CL, ML	SPT: 22-44 (avg. 29) LL: 32-66 PI: NP-37 w%: 8-39 q_u: 99-241 KPa
SF-L3	+521.0	+514.0	$2.65*10^{-8}$	0.0	30.0	Lignite with slightly plastic (sandy) SILT and silty SAND	SPT: 50- Reject (avg. Reject) LL: 44-65 PI: NP-40 w%: 34-60 q_u: 219-280 KPa

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Lower Reservoir & Surrounding Slopes							
Borehole	Head Altitude	Groundwater (altitude)	Permeability (average m/sec)	Lithological unit			Ground characteristics
SF-L4	+521.4	+515.0	$6.6*10^{-8}$	0.0	6.0	Waste fill material: CL, CH	SPT: 18-41 LL: 47-54 PI: 23-32 w%: 31-36 q_u: 242 KPa
			$9.9*10^{-9}$	6.0	30.0	Silty/clayey Marl, elastic to highly plastic	SPT: 41- Reject (avg. Reject) LL: 44-64 PI: 15-58 w%: 37-54 q_u: 211-307 KPa
BP-01p	+609.5	+558.5	$2.36*10^{-5}$	0.0	84.7	Waste fill material: conglomerate blocks, gravels with fines, sand and SILT/CLAY scattered fractions	SPT: 3- Reject (avg. 7) LL: 28-52 PI: NP-28 w%: 16-36 q_u: 184-225
			No data	84.7	93.0	Silty Marl, elastic to highly plastic	LL: 43-66 PI: 15-28 w%: 41-47 q_u: 178-510 KPa
BP-02p	+555.6	+542.6	$8.26*10^{-6}$	0.0	40.0	Waste fill material: conglomerate blocks, gravels with fines, SAND and SILT/CLAY scattered fractions	SPT: 2- Reject (avg. 12) LL: 34-52 PI: 16-29 w%: 26-59 q_u: 32-152 KPa
			2.6*10-5	40.0	100.0	Silty and locally clayey Marl, slightly plastic	SPT: 23-30 LL: (52-67) PI: NP-(39) w%: 32-59 q_u: 55-1627 KPa
KD-03p	+614.8	+596.8	$2.83*10^{-5}$	0.0	79.4	Waste fill material: conglomerate blocks, gravels with fines, SAND and SILT/CLAY scattered fractions	SPT: 3- Reject (avg. 14) LL: 26-58 PI: NP-36 w%: 12-40 q_u: (250-374) KPa
			$5.33*10^{-6}$	79.4	125.0	Silty Marl, slightly plastic	LL: 39-59 PI: NP-19 w%: 29-64 q_u: 71-824 KPa
KL-09p	+626.3	+604.3	$2.1*10^{-5}$	0.0	36.7	Waste fill material: gravels with fines, SAND and SILT/CLAY fractions of variable plasticity	SPT: 3-40 (avg. 16) LL: 28-48 PI: NP-29 w%: 10-37 q_u: 17-229 KPa
			$2.73*10^{-5}$	36.7	129.0	Green series: CH, CL alternate layers and SAND fractions	SPT: Reject LL: 29-87 PI: NP-38 w%: 18-50 q_u: 181-835 KPa
			$1.58*10^{-5}$	129.0	162.0	Lignite with interlayers of slightly plastic SILT	LL: no data PI: no data w%: no data q_u: no data
KL-10p	+555.2	+549.2	$9.9*10^{-6}$	0.0	23.5	Waste fill material: gravels with fines, SAND and SILT/CLAY	SPT: 6-41 (avg. 18) LL: 30-55 PI: NP-33

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Lower Reservoir & Surrounding Slopes							
Borehole	Head Altitude	Groundwater (altitude)	Permeability (average m/sec)	Lithological unit			Ground characteristics
						fractions of variable plasticity	w%: 7-38 q_u: no data
			$1.3*10^{-5}$	23.5	40.0	Green series: CH, CL alternate layers	SPT: 19-50 (avg. 33) LL: 27-67 PI: 19-32 w%: 22-41 q_u: 123-816 KPa
			$2.73*10^{-5}$	40.0	120.5	Lignite with low to medium plasticity CLAY	SPT: Reject LL: 36-83 PI: NP-53 w%: 22-65 q_u: 372-1011 KPa
KL-11p	+554.3	+539.3	No data	0.0	37.1	Waste fill material: gravels with fines, SAND and SILT/CLAY low plasticity	SPT: 4-23 (avg. 14) LL: 39-57 PI: 15-39 w%: 17-48 q_u: (692) KPa
				37.1	48.7		SPT: 18-29 (avg. 22) LL: 38-45 PI: 21-28 w%: 19-28 q_u: no data
			No data	48.7	112.0	Silty Marl, slightly plastic	LL: no data PI: NP w%: 33-70 q_u: 631-1707 KPa
KL-12p	+552.3	no data	$1.76*10^{-5}$	0.0	45.5	Waste fill (no lab data)	SPT: 3-32 (avg. 18) No data
				45.5	81.0	Waste fill (no lab data)	No data
KL-13k	+571.4	no data	$1.03*10^{-5}$	0.0	63.5	Waste fill material: gravels with fines, SAND and SILT/CLAY fractions of variable plasticity, CL with SAND fractions	SPT: 5-50 (avg. 20) LL: 25-60 PI: NP-39 w%: 12-99 q_u: 17-250 KPa
				63.5	105.2		LL: 28-36 PI: NP-18 w%: 18-48 q_u: (95) KPa
			artesianism	105.2	111.0	Lignite with interlayers of slightly plastic SILT and SAND intervals	LL: no data PI: NP w%: 21-59 q_u: (44) KPa

Table 4-4 : Summary of Lower Reservoir & surrounding slopes investigation results

Powerhouse & Penstock							
Borehole	Head Altitude	Groundwater (altitude)	Permeability (average m/sec)	Lithological unit			Ground characteristics
SF-W5	+645.6	+561.0	$1.4*10^{-5}$	0.0	61.4	Proasteion series: conglomerate with low to medium plasticity (locally	SPT: 14- Reject (avg. 21) LL: 27-90 PI: 11-56

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						high) CLAY with localised sandy fractions	w%: 22-53 q_u: 205-627 KPa
			$2.28*10^{-5}$	61.4	120.3	Green series: CH, CL alternate layers and locally ML, SM	LL: 34-79 PI: NP-50 w%: 13-40 q_u: 407-605
			$6.73*10^{-5}$	120.3	165.0	Lignite with interlayers of slightly plastic SILT	LL: no data PI: NP w%: 31-38 q_u: 352-1491 KPa
			$3.0*10^{-5}$	165.0	177.0	Silty/clayey Marl	LL: 50-56 PI: 17-23 w%: 36 q_u: no data
SF-L4	+521.4	+515.0	$6.6*10^{-8}$	0.0	6.0	Waste fill material: CL, CH	SPT: 18-41 LL: 47-54 PI: 23-32 w%: 31-36 q_u: 242 KPa
			$9.9*10^{-9}$	6.0	30.0	Silty/clayey Marl, elastic to highly plastic	SPT: 41- Reject (avg. Reject) LL: 44-64 PI: 15-58 w%: 37-54 q_u: 211-307 KPa
SF-PH	+537.1	+509.4	$1.06*10^{-7}$	0.0	16.6	Lignite with organic low plasticity SILT/CLAY	SPT: no tests LL: no data PI: NP w%: 32-80 q_u: no data
			$3.16*10^{-8}$	16.6	65.0	Silty locally clayey Marl, slightly plastic and locally elastic to highly plastic, with clayey intervals	SPT: no tests LL: 43-66 PI: 10-30 w%: 28-69 q_u: 42-511 KPa

Table 4-5 : Summary of Powerhouse & Waterway investigation results

Results into parentheses typically correspond to single tests and cannot be considered as representative.

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5. INTERPRETIVE GROUND MODEL

5.1. Geological structures & features

After interpreting the available data, it was possible to identify localised medium-scale tectonic activity within the Project's area. This activity is expressed as medium-scale faulting and has resulted to the partition and the differential vertical movement of the submerged units. In addition, most of the assumed lineaments exhibit very steep to vertical dip attitude and intersect perpendicular the horizontal - sub horizontal deposits. Apart from the aforementioned medium-scale identified and/or assumed lineaments, a SW-NE (40˚-60˚) trending fault exists approximately 13 Km NW of South Field mine field (i.e. Proasteion – Asvestopertra fault), of an approximate 11 Km fault trace. The fault belongs to a broader sub-group of normal faults which segregate the ligniferous basin into several horsts and grabens. Figure 5-1 depicts the overall geotectonic regime of the Project's broader area.

Apart from the aforementioned medium-scale faults in the broader Project area, the interpretation of the encountered lithostratigraphy based on the executed field investigation (i.e. reconnaissance, boreholes and geophysical profiles) does not indicate lineaments which may corroborate to the presence of significant neo tectonic features, which may entail geological risk.

On the other hand, subvertical to vertical small-scale normal lineaments (could be also considered as large-scale joints) perpendicularly intersect the sub horizontal ligniferous as well as the overlying Pleistocene series. Such lineaments are observed on the SW area of the excavated slopes (i.e. mining work fronts) and expressed as very low apparent displacements. These small-scale lineaments form individual blocks without or with insignificant traces of separation, or significant movements. Furthermore, the available instrumentation data do not indicate movements that may relate to those features. Seasonal groundwater flow is observed through the features, which mainly constitutes the discharge of precipitation and runoff activity.

In general, the available instrumentation data (inclinometers which are installed within the Project area) do not indicate significant movements that may relate to those features. With respect to the ongoing monitoring data (between January and November 2025), minor scattered and localised displacements which do not exceed 10mm (aggregate) are observed. Considering the relatively short monitoring period, such values do not also indicate an alarming case. Nonetheless, monitoring should continue and further evaluation and assessment for potential failure or creeping zones is considered necessary.

With reference to the identified geotechnical and lithological units, the contact between the **base Marl (GU-Mb)** and the sequence of Lignite-bearing series **(GU-L)** is depositional. A sub-horizontal to gentle depositional conformity constitutes the contact between Lignite-bearing units and the overlying "*green*" series **(GU-Gsc).** The Proasteion series (**GU-Gcg)** rest with paraconformity over the "*green*" series. Finally, the recent Holocene human-induced earthfill unit (GU-F) cover extended parts over the Project area as disconformity.

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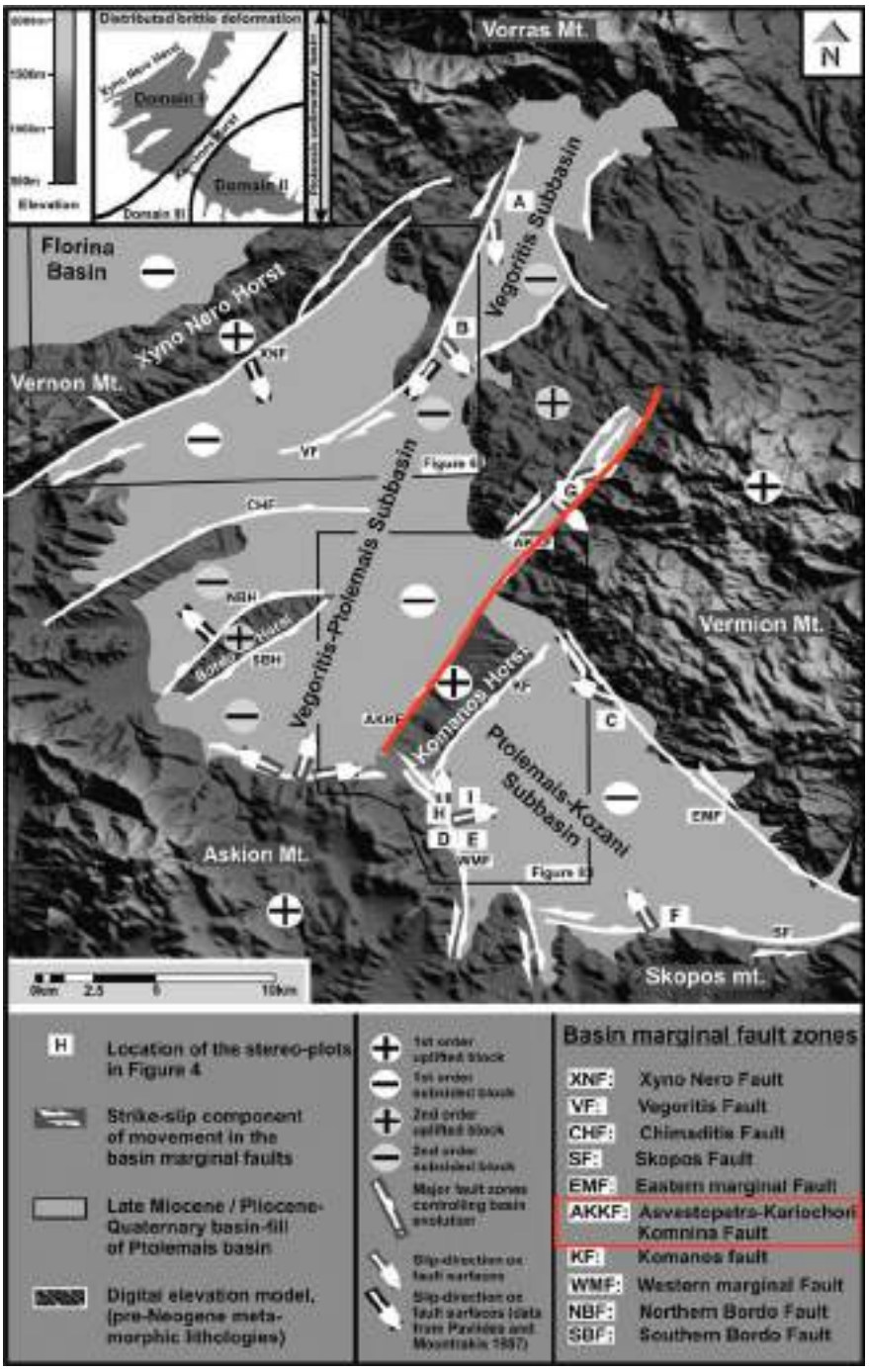


Figure 5-1: Asvestopetra fault within the context of the broader Ptolemais basin (A. Diamantopoulos, 2013)

Furthermore, with respect to the presence of small to medium-scale lineaments within the broader Project area and their impact to the identified stratigraphy, the available information does not indicate scarps of considerable magnitude that may locally alter the geometry of the anticipated geotechnical units (scarp may range in the order of few metres, e.g. 1- 4 m).

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5.2. Geotechnical units

Based on the evaluation of the available data inputs (i.e. boreholes, instrumentation, in-situ and laboratory tests) and in line with the general geology, the Project area comprises five (5) geotechnical units (GU) of particular composition and the associated geo-mechanical properties.

- **GU-F** corresponds to human induced, polygenetic, uncompacted to partially self-compacted waste deposits (fill material), characterised by distinct heterogeneity. The unit comprises poorly-graded clayey/silty GRAVELS with sand, clusters of low plasticity and locally fat CLAY with sand and gravels, poorly-graded gravely/silty SANDS, and scattered blocks of heterochthonous Conglomerate and Sandstones. The unit is deposited mainly at the W and NW area that surrounds the Lower reservoir, and rests on the autochthonous units, whereas it is in contact with various units due to the mining activity and the associated excavation activity of the natural ground. The thickness of the unit ranges between few metres (e.g. 4 - 6 m) and more than 85 m.

- **GU-Pcg** corresponds to the Quaternary Proasteion fluvial and lake formation. The unit primarily consists of intact to medium loose Conglomerates and Mudstones, intercalated with fat to low-medium plasticity sandy/gravely CLAY, and clayey GRAVELS with sand and silt. The apparent thickness of the Proasteion series ranges between 28 m and 75 m.

- **GU-Gcs** corresponds to the Upper Pleistocene deposits of the "*green*" series, characterised by low to medium or high plasticity sandy CLAY, with interlayers of silty/clayey SAND with gravels, and interbeds of slightly plastic clayey/sandy SILT. The thickness of "*green*" series can vary between 10 m and 92 m.

- **GU-L** corresponds to thick Lignite-bearing layers; either these are represented by thick uniform Lignite layers or Lignite-dominant series interbedded with Marl (i.e. pure Lignite series) and other thinner "barren" deposits (e.g. inorganic content of sands, clays, silts, conglomerates, and low organic fraction, etc.), i.e. known as Sterile interlayers which are wedged by and lie with conformity within the Lignite-rich layers. The unit is characterised by slight to low plasticity clayey SILT, fat silty CLAY (locally organic), and interbeds of clayey/silty fine SAND. The thickness of the unit (Lignite-bearing and Sterile series) is ranging between 17 m and 80 m.

- **GU-M_b** corresponds to the base Marl, which mainly consists of silty Marl of variable strength, and few alternations of clay, sand and conglomerates. The unit is characterised by slightly plastic to locally elastic sandy/clayey SILT and interlayers of lean to high plasticity sandy/silty CLAY which gradually transitions to slightly plastic sandy/clayey SILT and interlayers of lean sandy/silty CLAY, and very weak to weak silty Marls. The executed boreholes did not penetrate the entire thickness of the unit, and based on the available desk study and the drilling data, the thickness of the base Marl exceeds 100 m.

NOTE: The aforementioned determination of geotechnical units, including their parametrisation links to the data collection and statistical processing of a preliminary investigation programme. Therefore, it may entail uncertainties and subsequently is subject to revision, based on the proposed upgraded geotechnical investigation programme (refer to subchapter 6.5).

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5.3. Geotechnical zoning

With reference to the Project's structures and the proposed excavation and foundation preconditions, the anticipated spatial allocation of the identified geotechnical units is summarised in Table 5-1, below.

Structure	Geotechnical Unit
Lower reservoir	The NW-W Lower reservoir partially rests on mining waste landfills (**GU-F**) of various thickness and variable properties (i.e. high degree of heterogeneity), which in turn overlie the remainder Lignite-bearing thin layer (**GU-L**) and/or the base Marl (**GU-Mb**). The South portion are mining waste landfills (**GU-F**), locally over "green" series (**GU-Gcs**) and eventually allocated over Lignite-bearing thin layers (**GU-L**; a thin leftover of the mining activity) overlying the base Marl (**GU-Mb**), the east part of the lower reservoir is relatively thin "green" series (**GU-Gcs**) overlaying a Lignite-bearing layer (**GU-L**) and/or the base Marl (**GU-Mb**)
Upper reservoir	Upper reservoir exclusively rests on unsaturated Proasteion series (**GU-Pcg**).
Power intake	Similar to the Upper Reservoir, the Power Intake structure will be founded on and also allocated in unsaturated Proasteion series (**GU-Pcg**).
Penstocks/Waterway	The Waterways' alignment is running as well as intersecting various units.
	Chainage (*) • 0+980 to 1+360 Foundation within the stretch will encounter the upper Proasteion series, i.e. **GU-Pcg**, with a variable thickness from 60m to 5m. • 0+590 to 0+980 Foundation within the stretch will encounter lower "*green*" series, i.e. **GU-Gcs**. • 0+000 to 0+590 Foundation will get through Lignite-bearing layers (**GU-L**; gradually reduced thickness) and will transitionally rest on the upper layers of the Marl base unit (**GU-Mb**).
Powerhouse	Similar to the foundation conditions of the last 150 m of the waterway, the anticipated foundation conditions of the Powerhouse area comprise a 16 m thick Lignite-bearing layer (which is planned for excavation) which in turn rests base Marl (**GU-Mb)**. Base marl is the anticipated foundation medium of the structure. The presence of groundwater is considered moderately shallow and lies ~20 m above the foundation level (groundwater is observed at +510 m.a.s.l.).

(*) *Chainages constitute approximations to be confirmed with field mapping. Chainage starts with downstream-upstream direction*.

Table 5-1 : Spatial distribution of geotechnical units

NOTE: The aforementioned determination of geotechnical units, including their parametrisation links to the data collection and statistical processing of a preliminary investigation programme, especially for the Marl base at the powerhouse and the W-NW heterogeonic **GU-F** material. Therefore, it may entail uncertainties and subsequently is subject to revision, based on the proposed upgraded geotechnical investigation programme (refer to subchapter 6.5).

The Stratigraphy and geological cross-sections can be consulted in Annex D1

5.4. Hydrogeology

Based on the hydrogeological reports and the existing groundwater monitoring information (see sub-chapter 4.2.2, four (4) aquifers are identified in the broader area:

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- Aq_u: The upper unconfined aquifer of the sedimental series which superimpose the Lower ligniferous series (II series; lignite, clay, marl). The aquifer is hydraulically connected to the groundwater of the talus cones of the basin's margins.
- Aq_c: An aquifer that develops within the granular sediments, confined under the Lignite and the Marl series.
- Aq_{k1}: A deep karst aquifer within the Mesozoic (Triassic Jurassic) bedrock limestones.
- Aq_{k2}: Medium to small-scale perched karst aquifers within the Cretaceous limestones, mainly located at the SW margins of the basin.

With reference to the particular area of South Field mine, the presence of the first two aquifers dominates the groundwater activity of the area (the upper unconfined Aq_u, and the aquifer within the granular sediments Aq_c). The Lower ligniferous series and the underlying Marl base separate these aquifers. The upper unconfined aquifer (Aq_u) is connected to the broader Sarigöl area aquifer. Aq_c is connected to and being charged by the Vermion massif.

Area	Borehole	Drilled depth	Head alt (m.a.s.l.)	Groundwater		
				Depth (m)	Elevation	Source
NNW slope of Lower Reservoir	BP-01p	93.0	+609.5	51.0	+558.5	vibrating wire
NNW slope of Lower Reservoir	BP-02p	100.0	+555.6	13.0	+542.6	vibrating wire
NNW slope of Lower Reservoir	KD-03p	125.0	+614.8	18.0	+596.8	vibrating wire
N of Buffer Reservoir	SP-04p	125.0	+610.9	40.0	+570.9	vibrating wire
NW of Buffer Reservoir	SP-05p	125.0	+621.5	42.0	+579.5	vibrating wire
S of Buffer Reservoir	AD-06p	170.0	+639.6	-	+620.0	assumed (piezometric map)
W of Buffer Reservoir	AD-07p	175.0	+640.0	-	+627.0	assumed (piezometric map)
W Upper reservoir	AD-08p	210.0	+643.4	(82.0)	+561.4	vibrating wire
WNW slope of Lower Reservoir	KL-09p	162.0	+626.3	22.0	+604.3	vibrating wire
WNW slope of Lower Reservoir	KL-10p	120.5	+555.2	6.0	+549.2	vibrating wire
NNW slope of Lower Reservoir	KL-11p	112.0	+554.3	15.0	+539.3	vibrating wire
NW slope of Lower Reservoir	KL-12p	85.0	+552.3	-	-	no data
NW slope of Lower Reservoir	KL-13k	111.0	+571.4	-	-	no data
NW Lower Reservoir	SF-L1	30.0	+514.2	3.1	+511.1	standpipe (destroyed)

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Area	Borehole	Drilled depth	Head alt (m.a.s.l.)	Groundwater		
				Depth (m)	Elevation	Source
S Lower Reservoir	SF-L2	30.0	+553.6	20.5	+533.1	standpipe (destroyed)
N Lower Reservoir	SF-L3	30.0	+521.0	7.0	+514.0	drilling logs (assumed)
Lower reservoir / Powerhouse	SF-L4	30.0	+521.4	6.0	+515.4	drilling logs (assumed)
Powerhouse	SF-PH	65.0	+537.1	27.7	+509.4	standpipe
E Upper reservoir	SF-UR2	181.0	+660.8	-	-	no data
W Upper reservoir / Intake	SF-W5	177.0	+645.6	-	+561.0	proximity to AD-08p (assumed)

Table 5-2 : Summary of groundwater observation

For the initial evaluation of the hydrogeological regime, either direct (standpipes and vibrating wire piezometers) or indirect (piezometric data and drilling logs) information has been utilised. Considering the integrity of both inputs, the piezometric (PPC) data indicates a higher degree of reliability and thus, are used as reference values. In addition, indirect input data from drilling logs should be used with caution and thus require further verification (i.e. installation of additional standpipes in their vicinities). Moreover, based on the available hydrogeological references provided by PPC (Figure 5-2, a higher definition version can be found in Annex C1 [*Pumping wells and the surface pumping stations results]),* the overall piezometric trend exhibits a northbound decline (from +850; N to +630~610; S and SW).

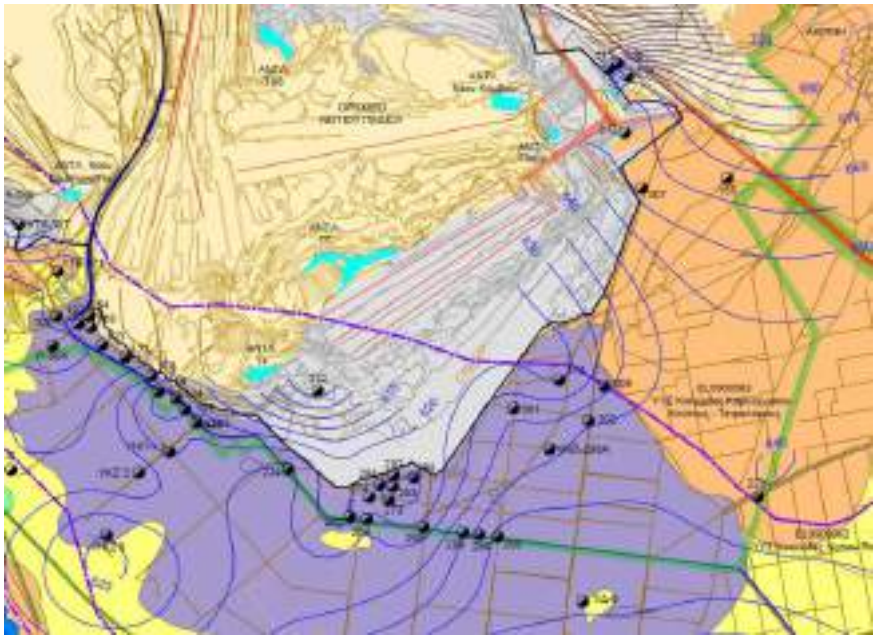


Figure 5-2: Piezometric map (excerpt) of Sarigol basin (2024, PPC)

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Permeability tests conducted in various layers of the lithological units exhibit a wide range of hydraulic conductivity, from high ($1.7x10^{-4}$ m/sec) to practically impervious layers. Table 5-3 summarises the hydraulic conductivity properties of the tested units-layers (in line with Freeze & Cherry, 1979, DIN18130, 1972 and ISO 14688), and the anticipated permeability conditions underneath the Project's key-structures (upper 50 metres). It should be noted that the number of available results necessitates further field testing, consequently, the current assessment should be considered "preliminary" and subject to revision, pending the new investigation program, see chapter 6.5

Geotechnical Unit	Hydraulic conductivity (m/sec)		
	minimum	maximum	average
Uncompacted to self-compacted mining waste (GU-F)	$2.3*10^{-8}$	$6.1*10^{-5}$	$1.5*10^{-5}$ medium
Proasteion series (GU-Pcg)	$7.5*10^{-8}$	$8.7*10^{-4}$	$6.3*10^{-5}$ medium
"*Green*" series (GU-Gsc)	$1*10^{-7}$	$1.7*10^{-4}$	$2.7*10^{-5}$ medium
Lignite-bearing strata (GU-L)	$1.2*10^{-8}$	$3.9*10^{-4}$	$4.2*10^{-5}$ medium
Base Marls (GU-Mb)	$9.9*10^{-9}$	$3.6*10^{-4}$	$3.6*10^{-5}$ medium
Project Structures (-50m)	**minimum**	**maximum**	**average**
Lower Reservoir	$9.9*10^{-9}$	$6.1*10^{-5}$	$1.4*10^{-5}$ medium
Upper Reservoir	$1*10^{-7}$	$8.7*10^{-4}$	$7.5*10^{-5}$ medium
Waterway - Powerhouse	$9.9*10^{-9}$	$2.5*10^{-5}$	$3.1*10^{-6}$ medium

Table 5-3 : Summary of hydraulic conductivity

5.5. Ground model assessment

According to the site reconnaissance, the executed boreholes, and the associated in-situ and laboratory tests, the Project area consist of horizontal/sub horizontal layers-units of particular characteristics. In general, Lignite-bearing strata (**GU-L**) (uniform or interbedded) of thickness which exceeds 80 m are resting on Marly series **GU-Mb** (also known as base or "terminal" Marl). The Lignite-bearing strata are overlain by silty-clayey deposits and other coarser series **GU-Gsc** ("*green*" series and Proasteion series). The presence of "*green*" and Proasteion series is characterised by variable thickness, whereas outcrops are exposed and have also been identified over the entire the S area of the Project. In addition, manmade deposits **GU-F** of mining and earthfill activity cover the N and NW outskirts of the proposed Lower reservoir.

The overall trend of the basin's bedding is towards SW to WSW, gently dipping horizontally to sub-horizontally. In particular, the Marl base is dipping 02˚-03˚, and the boundary where the Lignite-bearing series are overlain by the "*green*" series is dipping 03˚-04˚.

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5.5.1. Upper reservoir area- including Buffer reservoir

5.5.1.1. RING DAM FOUNDATION MATERIAL

Seven boreholes (SF-UR2, SF-W5, AD-8P, SP-4P, AD-6P, SP-5P, AD-7P) of various depths have been currently executed in the broader Upper reservoir and the Buffer reservoir area. Moreover, monitoring instruments (piezometers and inclinometers) have been installed, see Table 3-2,Table 4-1,Table 4-2.

The upper reservoir and buffer reservoir area is located on the plateau south-east of the mine pit. The boundaries of the potential area which may be occupied by the upper reservoir were given by the Client at the outset of the study. The buffer reservoir was introduced as an additional requirement from PPC.

Due to the proximity of the planned Upper reservoir foorprint with the SE slopes of the southfield open cut pit slopes, the loads induced by the Ring dam embankment fill could generate some stability problems on the slopes of the open pit. Due to the anticipated excavation waste material volumes from the upper reservoir and buffer reservoir, the filling of this with uncompacted waste material will help mitigate any stability problem from the Embankment´s fill load, as shown below.

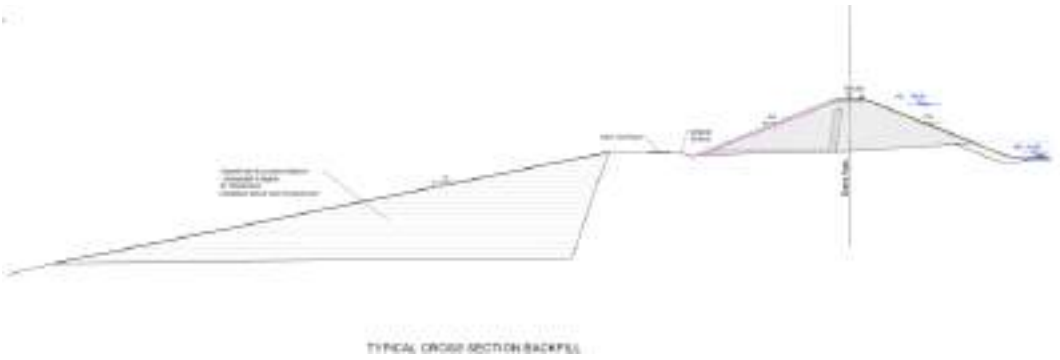


Figure 5-3: Cross section with backfill on the SE slopes of the open pit

Based on the information interpretation, the entire area rests on thick Upper Pleistocene “green” series/**GU-Gsc**, and the Quaternary deposits of Proasteion/ **GU-Pcg** which overly the Lignite-bearing strata (being visible along the SE mine slopes). The lithology mainly comprises alternate layers of non-plastic to plastic fine as well as coarse polymixed soils, locally organic, with conglomerate, marl and mudstone interbeds. The anticipated apparent thickness of the Quaternary deposits range between 90 and 120 m, with the upper **GU-Pcg** varying between 50 to 80 m thickness. The Proasteion series geotechnical unit has a measured medium average permeability of $6.3*10^{-5}$ m/s.

According to the available information and data results, this material is deemed competent enough as foundation for the ring dam embankment, but in order to adequately storage high volumes of water, a watertight sealing will be necessary.

No groundwater was initially registered during the drillhole excavation. According to the piezometer measurements. The water table on the area can be assumed at a minimum depth of more than 40 m -50 m below NGL.

The prospective drainage Gallery should be running below the bottom of the upper reservoir and connect the Intake and Spillway structure. It should not be overlooked the

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importance of the suitable construction material for filters, drainage and slope protection. Its availability should be also a determining factor.

5.5.1.1.1. Buffer reservoir

The Buffer reservoir is set on a plateau south of the upper reservoir that is lower than the natural ground. Four boreholes (SP-4P, AD-6P, SP-5P, AD-7P) of various depths have been currently executed at the buffer reservoir area. A buffer reservoir is introduced as a safety measure that shall be used as a temporary storage in the case of a need such as overpumping. Based on the information interpretation, the entire buffer reservoir area rests on thick Upper Pleistocene “green” series/**GU-Gsc**, up to a depth of around 570 m.a.s.l and overlays the Quaternary deposits of Proasteion/ **GU-Pcg** which overly the Lignite-bearing strata (being visible along the SE mine slopes). As stated before, the lithology mainly comprises alternate layers of non-plastic to plastic fine as well as coarse polymixed soils, locally organic, with conglomerate, marl and mudstone interbeds. The Proasteion series geotechnical unit has a measured medium average permeability of $6.3*10^{-5}$ m/sec. The water table on the area can be assumed at a minimum depth of more than 40 m -50 m below NGL, so around 20 m below the designed bottom level of the buffer reservoir.

The buffer reservoir is envisioned as a self-draining emergency storage reservoir, that also acts an excess water management discharge structure, so it will not be watertight sealed. The safe water discharge of the buffer reservoir is planned through one or more pipelines crossing the solar farms into the Soulou river. A pumping station, not part of the current scope, shall pump out water from the buffer reservoir, with possibility to empty the upper reservoir in case of need, which is not part of the scope of the present phase.

5.5.1.2. UPPER INTAKE

The Upper Intake is located in the south-west of the Upper Reservoir do to is closest location to the envisioned powerhouse, as shown on Figure 0-1. The invert level is set at elevation 630.70m to prevent any vortex entering the penstocks. Foundation levels are between 623 m.a.s.l and 630 m.a.s.l. In the foundation level, dense to very dense gravel and sand conglomerate with very little content of fines can be expected below elevation 653 m.a.s.l. according to the closest borehole Sf-W5. Such in-situ material (**GU-gp)** is regarded suitable for bearing the structure, but further characterization of the density and bearing capacity and the expected coarse gradation before concreting of the Upper intake foundation area is advised.

5.5.1.3. SPILLWAY

To comply with the Greek legislation, a spillway will be implemented on the upper reservoir at the southern end of the upper reservoir. The layout selected by PPC comprises a spillway installed on the upper reservoir, which will convey discharged water into buffer reservoir, see Figure 0-1. . The spillway structure is a light concrete structure with foundation levels on Quaternary deposits of Proasteion/ **GU-Pcg.** Such in-situ material is regarded suitable for bearing the bottom outlet and the gate shaft under consideration that the foundation area is checked for density and expected coarse gradation before concreting. The spillway is located on elevation 654 m.a.s.l. and will be founded in the upper portion of the dam cross section. For that purpose, the material of the standard dam cross section will be replaced in the spillway section by a more suitable dense gravel and sand fill.

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5.5.2. Penstocks/Waterway area

Two boreholes (SF-PH and SF- W5) have been currently drilled on the edges of the proposed the proposed waterway (penstocks) and downstream to the Powerhouse foundation area. In addition, monitoring instruments (piezometers and inclinometers) have been installed, see Table 3-2, Table 4-1 and Table 4-2. The upstream intake structure is allocated at SE slopes of the mine, and the penstock alignment is planned to transfer water resources from SE towards NW. Subsequently, the alignment in its approximately 35 - 40% extends over the Proasteion alternate conglomerate and fine deposits series, for the 30-35% extends over the “green” series, and for the remainder 25-30%, it reaches the Powerhouse structure through Lignite-bearing strata.

As the geological conditions are considered to poor, no underground structures are considered for the waterway. Therefore, no surge shaft is planned for the waterway.

With respect to the Powerhouse area, the upper 16.6 metres (down to elevation +520.5 m.a.s.l.) comprise of Lignite-bearing series with Marly impurities which overlie Marl base (investigation results show it reaches down to +472 m.a.s.l; approximately 18 metres below the proposed foundation level). The Marl base resembles slightly to locally highly plastic, very stiff to hard Silt to sandy Silt/Clay.

The design of the waterways should consider the exerted loads of the surrounding ground and any potential differential movements / settlements along the waterways which would induce additional stress in the conduits. If higher forces are expected, additional measures such as anchors into the foundation may be required. This could be in particularly the case for the 90° bend located at the downstream end of the waterway, just upstream of the powerhouse. If identified. Any the self-compacted mining waste **GU-F** should be removed, if encountered, before the foundation of the penstock. The lignite layers below the backfilled penstocks could also be removed as well and replaced by backfill, see subchapter 6.4.1.1. No specific ground treatment is expected for high dynamic load structures such as open-air penstocks. However differential settlement could be expected along the penstocks due to the difference between the possible backfilled eventually replacing **GU-L** material and open-air penstocks foundation behaviour.

Therefore:

- The concrete conduits should be reinforced adequately and equipped with watertight flexible joints every 15 m to 20 m along their full length to accommodate the global differential settlement of the conduit. The joints must be capable of limiting and absorbing the impact of differential settlement.
- In case of long-term settlement during operation, regular monitoring and realignment of the components are required during the service life. The high rigidity of the raft and structure is crucial. Alternatively, ground improvement measures accelerating the occurrence of the settlement such as installing drains could be planned.
- In case the high differential settlements at the connection between the waterways and the powerhouse, the final connection between the waterways and powerhouse can be delayed until most of the settlement occurs.
- For foundation blocks to be supported on natural ground level, the accurate stratigraphy of the foundation remains uncertain at this stage of the study, as no boreholes have yet been carried out along the waterway aligment. Further geotechnical investigations of the foundation are highly recommended to characterize the foundation ground in the area, as proposed in Sub-chapter 6.5.

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5.5.3. Lower reservoir area

The lower reservoir shall be created in the lowest part of the South field open mine, where it performs as a drainage sump for the entire mining pit, see Figure 0-1. Thirteen boreholes of various depths have been currently (as of November 2025) executed and provide information for the Lower reservoir area and the surrounding slopes. Moreover, monitoring instruments (piezometers and inclinometers) have been installed, see Table 3-2, Table 4-1 and Table 4-2. Based on the available information, the South and West part of the Lower Reservoir area is covered by polygenetic, uncompacted to partially self-compacted waste deposits (fill material) **GU-F** of variable content. These deposits mainly comprise organic Silts, silty Clays, residual Lignite, silty Sands, Pebbles, sandy Silts of variable plasticity and level of compaction. Being a mining waste byproduct, the series are characterised by significant degree of heterogeneity, where the upper layers appear soft to very soft. The underlying base Marl that can be found at 520 to 525 m.a.s.l.

The central are dominated by the autochthonous lower Lignite-bearing **GU-L** strata and the underlying base Marl. The exposure and thickness of Lignite strata vary between 0 and 30 m (i.e. Marl base is exposed in several areas), due to the ongoing mining activity. On the other hand, the Eastern parts are characterised by thin “green” series (**GU-Gcs**) overlaying a Lignite-bearing layer (**GU-L**) and/or the base Marl (**GU-Mb**).

The Lignite bearing strata has a measured permeability of around $4.10*10^{-5}$ m/s in average while the base marl shows a $3.6*10^{-5}$ m/s average permeability

As stated in the subchapter 2.2.1, the Client has to comply with obligations imposed by the authorities to ensure the stability of the slopes in the mine, mostly with in the elevation range between FSL of 535.0 m.a.s.l. and MOL of 528.0 m.a.s.l.

No sealing is foreseen for the lower reservoir, because it covers the deepest area of the pit like a pump sump, thus corresponding with the groundwater. The ground water level has been measured around 515 to 525 m.a.s.l. The operation of the PHS results in daily fluctuations of the water table, so any sealing would require an outside drainage system to provide safety against uplift of the sealing when the lower reservoir is empty inside, and the groundwater level is high outside. Installation of such an outside drainage system in the bottom of the pit is technically impossible, so the reservoir slopes should be the necessary steepness to be stable under the fluctuating water levels.

5.5.4. Powerhouse and lower intake area

The powerhouse is located at the toe of the Southeastern slope of the mine -forming the excavation workfront - and positioned toward its northern section to align with the location of the upper reservoir on the northern part of the upper plateau.

Two boreholes (SF-PH and SF-L4) were drilled over and adjacent the proposed Powerhouse, aiming to determine the geo-mechanical properties for the excavation and/or foundation of the Project’s key-structure. Based on the available site survey (sub-chapter 3.4.2), available laboratory results (sub-chapter 4.3) and stratigraphy (sub-chapter 5.3), the resultant poor geology for an underground solution is considered as unfeasible. A surface powerhouse is therefore considered.

In the selected area of the future lower reservoir, the available width is limited to approximately 300 m. Given the considerable height of the powerhouse (nearly 50 m) and the outlet configuration (direct discharge into the lower reservoir), backfilling the excavation against the upstream powerhouse only is considered unsuitable due to the imbalance between upstream and downstream thrusts, potentially leading to stability

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issues -sliding under seismic loading - in addition to differential settlements. Consequently, the powerhouse was positioned at the foot of the slope to avoid discharge and pumping operations near the opposite bank, which could potentially become unstable. The envisioned the top of the powerhouse is set at EL. 537 m and constructed through an open excavation, with the lowest bottom elevation set at 490 m to meet the pump's submergence requirements.

The upper 16.6 metres (down to elevation around +520.5 m.a.s.l.) comprise of Lignite-bearing series with Marly impurities which overlie Marl base (investigation reaches down to +472 m.a.s.l.; approximately 18 metres below the proposed foundation level). The Marl base resembles slightly to locally highly plastic, very stiff to hard Silt to sandy Silt/Clay. The powerhouse is built near the lower reservoir but into the foot of the slope, to avoid discharge and pumping too close the opposite bank which could be liable to become unstable.

The **GU-Mb** is based on the preliminary evaluation of its measured properties (i.e. laboratory tests), from mainly the samples of drill hole SF-PH. Accordingly, the Marl base unit may be distinguished into two sub-units: a top transitional sub-unit (**GU-Mbt**) which generally resembles hard to very hard soil, is characterised by slightly plastic to locally elastic sandy/clayey SILT and interlayers of lean-to high plasticity sandy/silty CLAY. The sub-unit layer corresponds to the transition top layer (<10m) to the main Marl base unit. The identification of this upper sub-unit (with respect to its thickness and especially its differentiation from the typical underlying Marl, stiffness, deformability, and strength) currently derives from a relatively small number of laboratory results, and thus, entails a high degree of uncertainty. Its presence and requires further investigation, and considering the nature of the particular formation, primarily this requires in-situ testing such as pressuremeter and crosshole seismic refraction.

Subsequently a subjacent main Marl base unit (**GU-Mb**) is identified, characterised by slightly plastic sandy/clayey SILT and interlayers of lean sandy/silty CLAY, gradually transitioning to very weak to weak silty Marl. With the available information, the main Marl base unit corresponds to a very weak to weak rock.

A further analysis shows that the primary objective of foundation design for a powerhouse is to develop a robust, reliable, and cost-effective foundation system that ensures the safe transfer of the superstructural load to the founding medium while satisfying structural design criteria.

Concurrently, the foundations of hydro powerhouse must satisfy additional onerous requirements / constraints related to the operational requirement of E&M equipment. As such, the foundation design at powerhouse area must ensure the following paramount requirements:

- the alignment of the turbine-generator (T-G) shaft under all operating conditions. This criterion implies limiting the differential settlement / angular distortion at the T-G unit to a strict minimum that can be tolerated by the E&M design. The order of magnitude of the differential settlement is usually millimetric.
- seamless and watertight structural connection between the powerhouse and low- and high-pressure waterways. This criterion also implies controlling the differential settlement at the connections waterways / powerhouse to an acceptable limit tolerated by the connection design.
- Foundation-structure natural frequencies different from the E&M operational frequencies to prevent resonance. In addition, the founding ground must be able to withstand vibrational loading without loss of its properties.

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The geotechnical data currently available does not enable to confidently characterise the quality of the rest of the foundation, i.e. the lignite and marls, especially due to the difficulty of coring and testing marls without disturbance. The number and depth of the boreholes do not cover the influence zone of the powerhouse. It is worth noting that the marl layer is sensitive to sampling and water content which render undisturbed sampling difficult and affects the results of laboratory testing.

There is an alarming lack of information from both Surface and subsurface geological investigations to accurately classified both the base marl and the **GU-L** lignite layer. A robust geotechnical investigation programme is recommended in sub-chapter 6.5.

Several alternatives may be expected for the foundation of the powerhouse and will depend on the quality of the in-situ prevailing ground conditions / geology. Thus, the feasibility study was developed considering a likely scenario of ground conditions which have been chosen based on the available data, interpreted with engineering judgment.

Since ground conditions might be different – and it is not possible to state to which extent – and may have an impact on the time and cost estimate of the project, it is recommended to undertake more extensive and detailed investigations to cope with the uncertainty before the next stages of the project, as explained in sub-chapter 6.5.

Therefore, based on the available information, a multi-analysis for the foundation design is recommended (see subchapter 6.4.1), including several treatment options depending on hypothetical foundation conditions, ranging from leaving the soil as-is for a good quality foundation, to soil replacement (substitution), or even revisiting the design for a poor-quality foundation—each weighed against the likelihood of occurrence and associated costs.

Thus, the powerhouse being very close to the reservoir, the water table can be directly influenced by the reservoir levels. Therefore, the powerhouse being more than 40 m deep under the water levels, a high under-pressure is experienced by the powerhouse and requires enough concrete volumes to counter the uplift forces. The excavation around the powerhouse should be filled with concrete till the top level of the base marls and then further filled by engineered backfill. This configuration allows stability against sliding and pivoting of the powerhouse, with a particular attention to seismic conditions, and mitigate the risk of differential displacements of the connected waterways.

Based on the monitoring of groundwater in the Powerhouse area, groundwater level lies in -27 m within the Marl base unit (GU-Mb). It is very likely that this groundwater does not relate to the unconfined aquifer which has been observed at the upstream higher parts of the waterway area (i.e. borehole SF-W5). Hence, the presence of groundwater in the Powerhouse vicinity most probably emerges from the percolation of precipitation and run-off activity, forming a pressurized confined aquitard due to a possible unidentified impermeable layer on the area. In this context, the earthworks for the construction of the Powerhouse complex (i.e. excavation, temporary slope supports, and backfill) below +512, will take place in saturated conditions; a fact that necessitates special attention and care for the control and mitigation of ingress.

To optimise excavation conditions and ensure mid-term stability of the foundation slopes, the proposed supplementary investigation programme (Chapter 6.5) should account for thorough groundwater monitoring and the determination of permeability. The outcome of this investigation will also determine possible groundwater control measures (e.g. dewatering strategy, isolation, protection, etc.).

The elevation of the powerhouse foundation driven by the pump-turbine axis elevation and the draft tube dimensions. The necessary excavations to reach that foundation

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elevation can be performed either by diaphragm walls either by a standard open excavation with slopes and berms ensuring the stability of the excavations.

Nevertheless, despite an appropriate foundation treatment, settlements are anticipated due to the compressibility of the ground layers and the heavy load imposed by the powerhouse backfill. Consequently, construction schedule and design arrangements are also planned to prevent damaging the powerhouse equipment and to ensure proper connection with the upstream & downstream waterways.

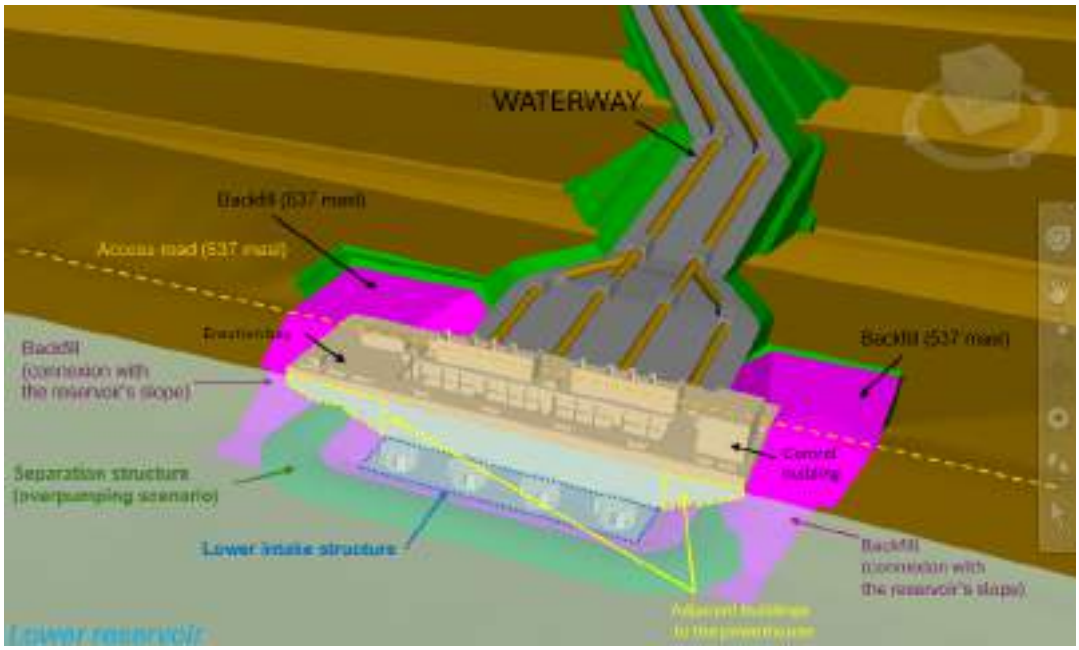


Figure 5-4: 3D view of the powerhouse area

5.5.5. Access roads and earthworks

5.5.5.1. UPPER RESERVOIR

Access to the reservoirs is provided primarily via the existing road located between the two solar farms, which serves as the main approach to the site. This road is used up to the southern side of the upper reservoir, where it connects to a permanent embankment crest road constructed along the top of the upper reservoir embankment.

The toe road, with a typical width of approximately 4 m (elevation 640 m.a.s.l.), provides access around the Buffer Reservoir. This road gradually descends along the southern side of the buffer basin, allowing convenient access to the planned location of the future pumping station. From this point, the road reconnects with the existing access road, thereby forming a complete route around both the upper and the buffer reservoirs.

This access road arrangement ensures efficient construction logistics, operational accessibility, and long-term maintainability of all key reservoir and pumping facilities.

5.5.5.2. LOWER RESERVOIR

Access to the lower reservoir is provided by a continuous ring road constructed around the reservoir perimeter at an elevation of 537 m.a.s.l. This road forms the primary access

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route for construction, operation, and maintenance activities associated with the Lower Reservoir facilities.

The ring road is directly connected to the powerhouse plateau located at elevation 537 m.a.s.l., ensuring efficient access between the reservoir and the powerhouse area. From the powerhouse plateau, connectivity to structures located outside the mine area is provided via the existing mine road network, which is retained and utilized with minimal modifications.

This access arrangement ensures robust and reliable access to the lower reservoir and associated infrastructure while maximizing the use of existing roads and minimizing the need for new road construction.

5.5.5.3. EARTHWORKS

The information as this derives from the available investigation campaigns has set the basis for the geological model of the Project area, and consequently allows with an acceptable accuracy level to determine the anticipated geotechnical units which are presented in sub-chapter 5.2. With reference to the proposed excavation works, and with consideration of the assessed geo-mechanical properties, the preliminary evaluation for the proposed slope cuts is summarised in Table 5-4, below.

To optimise excavation conditions and ensure mid-term stability of the foundation slopes, a mid-term groundwater control programme should be considered. The proposed supplementary investigation programme (Chapter 5.6) should account for thorough groundwater monitoring and the determination of permeability. The programme may comprise staged drawdown with the construction of several dewatering pumping wells of various depth The outcome of this investigation will also determine possible groundwater control measures (e.g. dewatering strategy, isolation, protection, etc.).

Small diameter precast structures are embedded into the ground, gradually extending deeper. The dewatering concept will also provide information regarding the hydraulic conductivity of the geotechnical units and the recharging capacity of the aquifer, and will also determine whether a cofferdam structure is still necessary during the main excavation stage

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Structure	Chainage from	Chainage to	Slope cut	Berm height	Berm width	Remarks
Waterways	1+360	0+980	1:1	10m	10m	Unsaturated; Groundwater below -30m (assumed)
	0+980	0+590	1:1	10m	10m	Unsaturated or very low saturation; Groundwater below -15 and -30m (assumed)
	0+590	0+000	1:2	10m	10m	Dry to low saturation; Groundwater below -20m (assumed)
Structure	**Elevation from**	**Elevation to**	**Slope cut**	**Berm height**	**Berm width**	**Remarks**
Powerhouse	+537	+520	1:1	10m	5m	Dry conditions or low saturation; Groundwater level below -27m
	+520	bottom	1:0.5	10m	5m	Groundwater level at +512 masl

Slope inclination ratios are determined as vertical: horizontal (v:h)

Table 5-4 : Preliminary evaluation of earthworks (Slope cuts)

5.6. Derived geotechnical parameters

With reference to the available laboratory results and the determination of the Geotechnical Units referred in sub-chapter 5.2, the following tables summarise the outcome of the statistical analyses and processing of the geo-mechanical and physical properties for each unit. It shall be noted that for a more representative analysis extreme outliers (minimum and maximum values) have been excluded and are not taken into consideration.

Parameter		Value range min	Value range max	Weighted average	Preliminary proposed parameter
Specific gravity (Gs)		2.62	2.78	2.69	2.65 (γb: 18 KN/m3)
Natural water content (%)		7.0%	52%	29%	30%
Liquid Limit (LL)		25	60	40	40
Plasticity Index (PI)		Non-plastic	26	16	18
Classification (USCS)		CH/CL (41%), GC/GM (24%), SM/SC (19%), ML/MH (8%), Conglomerate/Sandstone (8%)			
Direct shear (CD)	c´ (KPa)	0	19	13.2	20-25*
	φ´ (^{0})	20.8	33.0	24.9	25.0*
UCS (q_u) (KPa)		17	874	374	188*

*** these partially self-compacted waste deposits (fill material) are intrinsically very hetereogenic, so establishing a absolute value for its geotechnical characteristics could not be the best way to accurately the material behaviour in the field.**

Table 5-5 : Characteristic geotechnical parameters for GU-F

Parameter	Value range min	Value range max	Weighted average	Preliminary proposed parameter
Specific gravity (Gs)	2.68	2.80	2.74	2.8 (γ_b: 19 KN/m^3)
Natural water content (%)	11%	83%	34.3%	34%
Liquid Limit (LL)	36	61	48	48
Plasticity Index (PI)	Non-plastic	68	28	28
Classification (USCS)	CL/CH (65%), Conglomerate/Mudstone (18%), GP/GC/GM/GW (14%), SP/SM/SC (4%)			

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Direct shear (CD)	c´ (KPa)	0	99.4	39	50
	φ´ (^{0})	10.0	28.5	21.5	27
UCS (q_u) (KPa)		5	357	157	285
UCS (rock specimens) (MPa)		5	20	12.4	14
Point Load (rock specimens) (MPa)		0.2	2.4	1.5	1.5

Table 5-6 : Characteristic geotechnical parameters for GU-Pcg (Proasteion series)

Parameter		Value range		Weighted average	Preliminary proposed parameter
		min	max		
Specific gravity (Gs)		2.4	2.8	2.72	2.72 (γb: 18.5 KN/m3)
Natural water content (%)		11%	52%	27.3%	27%
Liquid Limit (LL)		11	93	44	41
Plasticity Index (PI)		Non-plastic	64	20.5	20
Classification (USCS)		CL/CH (64%), SP/SM/SC (25%), ML/MH (8%), GW/GC (3%)			
Direct shear (CD)	c´ (KPa)	0	177	63.3	55
	φ´ (0)	14.3	35.8	24.8	25
UCS (qu) (KPa)		40	835	381	360

Table 5-7 : Characteristic geotechnical parameters for GU-Gsc (“green” series)

Parameter		Value range		Weighted average	Preliminary proposed parameter*
		min	max		
Specific gravity (Gs)		2.1	2.8	2.63	2.5 (γ_b: 16 KN/m^3)
Natural water content (%)		31.6%	60.1%	45.5%	45%
Liquid Limit (LL)		0	83	18.5	20
Plasticity Index (PI)		Non-plastic	83	18.4	18
Classification (USCS)		Lignite (31%) - ML/MH (30%), CL/CH (15%), SM/SP (14%), OL/OH (11%)			
Direct shear (CD)	c´ (KPa)	0	210	68.9	68
	φ´ (^{0})	12.5	30	25.1	28
UCS (q_u) (KPa)		152	866	632	600
Φr (c'=0) (^{0})		10.5	25.7	15.5	18

Table 5-8 : Characteristic geotechnical parameters for GU-L (Lignite-bearing series)

Parameter*		Value range		Weighted average
		min	max	
Specific gravity (Gs)		2.57	2.81	2.7
Natural water content (%)		25%	69%	42.3%
Liquid Limit (LL)		35	69	49
Plasticity Index (PI)		Non-plastic	59	13
Classification (USCS)		ML (55%), MH (25%), CH (12%), CL (9%)		
Direct shear (CD)	c´ (KPa)	10	126	69.5
	φ´ (^{0})	24	33	29.1
UCS (q_u) (KPa)		42	1197	469
UCS (rock specimens (MPa)		1.0	2.2	1.8

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Table 5-9 : Characteristic geotechnical parameters for GU-M_b (Base Marl)

The parametrisation of the Marl base unit considers the available laboratory results and the corresponding statistical analysis of boreholes in the Powerhouse vicinity in conjunction with relevant technical references. The parametrisation approach is analytically described in the document "*Powerhouse design – Preliminary Geotechnical Note*" (W004668-N2 v.2; 2025.11.06). Based on the available data, site specific investigations do not provide factual, direct, and reliable information concerning the strength and deformability parameters of the foundation unit. On the other hand, comparison with data from literature (which prove to be limited), indicate that granulometry and plasticity conditions of the ground are similar, and thus, the base Marl layer can be characterized by rather good strength and deformability parameters, even in saturated conditions. In line with the aforementioned, the proposed parameters for the Powerhouse area are presented in Table 5-10 below.

Cohesion (c_d)	Friction Angle (φ_d)	Reference stiffness modulus (E_{50}^ref)	Undrained Cohesion (c_u)
72 kN/m²	31°	138 MPa – 172 MPa	275 kPa

***Pending supplementary investigation program in the powerhouse zone (see sub-chapter 6.5)**

Table 5-10 : Design parameters for Marl base (GU-Mb) in the Powerhouse area

It is important that these parameters necessitate confirmation by a campaign of suitable and tailor-planned investigations, see sub-chapter 6.5, aiming validate the proposed set of parameters in the following stages of the Project. It shall be underlined that the implication of different geotechnical parameters could reflect important impacts on the Project.

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6. GEOTECHNICAL RISKS, UNCERTAINTITIES AND RECOMMENDATIONS

Based on the features, size, volume, loads, and operational characteristics of the South Filed PHS project and after interpreting the available gathered data from Geological, geophysical and laboratory test data, the following risks, uncertainties and recommendations have been identified and proposed.

6.1. Upper reservoir, Ring dam, Buffer reservoir, Upper intake, Spillway

Risk	Description	Impact	Relevant Geotechnical Unit	Recommendation
Ring dam Settlement	The differential settlement of the foundation soil could lead to leak or breakages in the reservoir's impermeable layer	Seepage, dam slope stability, loss of stored water, environmental impacts.	**GU-Pcg**	The differential settlement should be calculated, using the most accurate geotechnical parameters.
Downstream slope protection of the ring dam	The outside slope under risk to unexpected against wave action and surface erosion.	dam slope stability, dam stability integrity.	**Earthfill Class B**	The outside slope should be protected against wave action and surface erosion by a dedicated slope protection layer, consisting of rockfill or equivalent durable material, placed over a bedding layer.
Location spillway	The location of spillway must be carefully arranged under consideration of safe discharge possibilities.	Possible slope stability issues due to run-off, water table, as well as ecological impact.	**All**	The spillway will be located at the South end of the reservoir where it discharges to the buffer reservoir and then adequately be evacuated to the Solou River. (Not part of this study at the feasibility phase)
Buffer reservoir excess water should be adequately and lawful discharged	The whole water drainage system of the PHS is based on the efficient, adequate and reliable discharge of the buffer reservoir excesses water to the Solou river.	Excess water that overflows any of the reservoirs and/or floods the powerhouse will be catastrophic for the integrity of the project.	**All**	The buffer reservoir is envisioned as a self-draining emergency storage reservoir, so it will not be watertight sealed. The safe water discharge of the buffer reservoir is planned through one or more pipelines crossing the solar farms into the Soulou river.

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Risk	Description	Impact	Relevant Geotechnical Unit	Recommendation
The additional loads from the ring dam could generate stability problems on the superior SE lower reservoir open cut slopes.	Due to the proximity between the open pit/lower reservoir slopes and the upper reservoir footprint, the additional weight loads from the ring dam embankment fill could generate stability problems on the superior SE lower reservoir open cut slopes.	Stability problems that could affect both the ring dam stability, and the Lower reservoir slope stability.	**GU-Pcg**	To use the anticipated excavation waste material to fill the slope berm ana increase the stability of the upper slopes of the lower reservoir, as show in Figure 5-3.

Table 6-1: Geotechnical risks Upper reservoir, Ring dam, Buffer reservoir, Upper intake, Spillway, Bottom outlet

6.2. Penstocks and waterways

Risk	Description	Impact	Relevant Geotechnical Unit	Recommendation
Underground penstock	The Observed and interpreted characteristics of the soil show a low stiff soil with poor resistance to this type of structures.	Structural stability of an underground penstock could become compromised	**ALL**	Due to the poor conditions of the ground and to avoid hazardous behaviour, and high dynamics loads envisioned, an underground penstock is not recommended.
The **GU-L** layers below the backfilled penstocks	The lignite layers below the backfilled penstocks not suitable for foundation of this structure.	High settlements or sinking of the foundation soil.	**Gu-F and GU-L**	The mine waste material (**Gu-F)** below the penstock must be removed and backfilled. The lignite layers below the backfilled penstocks could be removed as well and replaced by backfill, pending investigations

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Risk	Description	Impact	Relevant Geotechnical Unit	Recommendation
Differential settlement potential between the powerhouse backfill and Penstock	There is a big possibility of differential settlement potential between powerhouse backfill and Penstock, especially at the connection.	Differential settlements that compromise the penstock structure.	**ALL**	No specific ground treatment is expected for high dynamic load structures such as open-air penstocks. However differential settlement is expected along the penstocks due to the difference between the backfilled and open-air penstocks foundation behaviour. Therefore, several mitigation measures such as reinforced concrete with watertight flexible joints to accommodate the global differential settlement of the conduit, regular monitoring and realignment of the components or ground improvement measures an accelerating the occurrence of the settlement or in high settlement cases, the final connection between the waterways and powerhouse can be delayed until most of the settlement occurs.
Exerted loads can lead to the deterioration of the structural integrity of the water ways.	The design of the waterways should consider the exerted loads of the surrounding ground and any potential differential loads / settlements along the waterways which would induce additional stress in the conduits.	The concrete foundation slab maybe not be enough to support the excentric loads at the elbows of the waterways, leading to compromising the structural stability of the concrete structure.	**ALL**	If higher forces are expected, such as in case of of a seismic event, additional measures such as anchors into the foundation may be required for the stability of the water ways.
Lack of information from geological investigations in the area of the penstock and water ways alignment.	For foundation blocks to be supported on natural ground level, the accurate stratigraphy of the foundation remains uncertain at this stage of the study, as no boreholes have yet been carried out along the waterway aligment.	Lack of reliable data regarding the foundation ground for the waterways, specially in bends or under sesimci forces.	**ALL**	Further geotechnical investigations of the foundation are highly recommended to characterize the foundation ground in the area, as proposed in Sub-chapter 6.5.

Table 6-2: Geotechnical risks Penstocks and Waterways

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6.3. Lower Reservoir

Risk	Description	Impact	Relevant Geotechnical Unit	Recommendation
Fluctuating water level impact on slope stability	Fluctuations of the water table because of daily operation.	Slope stability	**GU-F, GU-L, and GU-Gcs**	The reservoir slopes should be the necessary steepness to be stable under the fluctuating water level.
The additional loads from the ring dam could generate stability problems on the superior SE lower reservoir open cut slopes.	Due to the proximity between the open pit/lower reservoir slopes and the upper reservoir footprint, the additional weight loads from the ring dam embankment fill could generate stability problems on the superior SE lower reservoir open cut slopes.	Stability problems that could affect both the ring dam stability, and the Lower reservoir slope stability.	**GU-Pcg**	Use the anticipated excavation waste material to fill the slope berm ana increase the stability of the upper slopes of the lower reservoir, as show in Figure 5-3.

***This solution requires the ability to transfer water from the upper reservoir and pump it to the Soulou river. This will be made possible by a spillway installed on the upper reservoir, which will discharge into a buffer reservoir. A pumping system, connected to a pipeline crossing the solar farms, will then discharge the water from this basin into the Soulou River.**

Table 6-3: Geotechnical risks Lower Reservoir

6.4. Powerhouse and lower Intake

Risk	Description	Impact	Relevant Geotechnical Unit	Recommendation
Non suitable material for an underground powerhouse	The different layers of overlaying materials are deemed not suitable enough for large underground excavations	Very poor stability during underground excavations, high cost and time consuming.	**ALL**	An underground powerhouse is considered unfeasible, not recommended.
Non-suitable material for the foundation of the Powerhouse.	The **GU-L** (16 – 20 m thick) and the **GU-Mb** foundation material is not stiff and dense enough to bear the loads of the powerhouse	Structural integrity and stability of the powerhouse, total settlement, differential settlements, sinking, concrete breakage, damaged machinery	**GU-L**	The **GU-L** material should be removed depending on situation. The **GU-L** lignite layer and the base Marl **GU-Mb** needs further studies to more accurately determine its characteristics. A multi-analysis of the different situations and mitigation measures is further developed in subchapter 6.4.1

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Risk	Description	Impact	Relevant Geotechnical Unit	Recommendation
There is high risk associated with the lack of data to confidentially define the quality of the foundation soil of the powerhouse	There is not enough data to correctly define the density, stiffness and bearing capacity of the soils in the powerhouse area, especially lignite layer **GU-L** and the base Marl-**GU-Mb.**	Total settlement and differential settlement that could compromise the structural integrity of the concrete structures on the powerhouse, including its impact on costly equipment.	**ALL**	To confirm the ground condition hypothesis and better assess the foundation characteristics in order to reduce the risks and optimize the design, conducting a thorough investigation program and specially adapted to the marls layer, is highly recommended. An investigation program principle for the powerhouse is suggested in that purpose in the present report (see sub-chapter 6.5).

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Risk	Description	Impact	Relevant Geotechnical Unit	Recommendation
The area selected as optimal for the powerhouse is only 300 m width..	The limited available footprint for the powerhouse constraints the size of the support structures for the powerhouse structure stability	Stability of the powerhouse due to insufficient space for support	**GU-L** and **GU-Mb**	The powerhouse should be positioned at the foot of the slope to avoid discharge and pumping operations near the opposite bank, which could potentially become unstable ·bifurcations located on the upper part of the slope (existing berm), taking advantage of the natural topography and limiting the excavation volumes, and should additionally contemplate·bifurcations located on the existing berm, taking advantage of the natural topography and limiting the excavation volumes, an upstream connection with the waterway integrated into the powerhouse building and·an outlet structure fully integrated into the powerhouse building, minimizing the impact on the reservoir..
The powerhouse layout and dimensiosn could led to instability due to imbalance between upstream and downstream trusts.	Given the considerable dimensions of the powerhouse and the outlet configuration (direct discharge into the lower reservoir), backfilling the excavation against the upstream powerhouse is considered unsuitable due to the imbalance between upstream and downstream thrusts,	Stability issues - sliding under seismic loading - in addition to differential settlements.	**GU-L** and **GU-Mb**	The excavation should be completely backfilled with cyclopean/ mass concrete or similar up to the depth of the marls, This solution ensures the overall stability of the powerhouse structure (eliminating sliding risks) and reduces differential settlements, especially between the powerhouse itself and the waterways.
Risks associated with the high-water level in the zone of the powerhouse	Secondary permeability through fractures and random jointing network has been identified in the area, forming an aquitard that can be considered pressurized and confined and that supplies water from precipitation and surface runoff, leading to powerhouse´s water table to be directly influenced by the reservoir levels.	The powerhouse could be more than 40 m deep under the water levels; a high under-pressure is experienced by the powerhouse and requires enough concrete volumes to resist uplift, sliding and stability.	**GU-F, Earthfill B, and concrete for powerhouse**	The excavation around the powerhouse should be filled with concrete till the top level of the base marls and then further filled by engineered backfill. This configuration allows stability against sliding and pivoting of the powerhouse, with a particular attention to seismic conditions, and mitigate the risk of differential displacements of the connected waterways.

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Risk	Description	Impact	Relevant Geotechnical Unit	Recommendation
High piezometer pressure in the powerhouse zone due to runoff-percolated precipitation water storage in the area.	Possible pressurized and confined aquitard given to the storage of run-off and precipitation water due to a possible unidentified impermeable layer.	Complications and higher risk during earthworks and construction of the powerhouse. Excavations under saturated conditions.	**ALL**	It is very likely that this groundwater does not relate to the unconfined aquifer which has been observed at the upstream higher parts of the waterway area (i.e. borehole SF-W5). In this context, the earthworks for the construction of the Powerhouse complex (i.e. excavation, temporary slope supports, and backfill) below +512, will take place in saturated conditions; a fact that necessitates special attention and care for the control and mitigation of ingress.

Table 6-4: Geotechnical risks Powerhouse and lower intake

6.4.1. Multi-Analysis: possible ground condition situations and associated mitigation design measures

Site specific investigations conducted so far do not provide reliable information concerning the strength and deformability parameters of the basal marl layer (**Gu-Mb**). The only reliable information gathered from site specific investigations indicates that nature of the top part of the layer is characterized by medium to high plasticity. Further literature research (rather limited) concerning the same basal marl layer from nearby sites seems to indicate a rock mass material with strength and deformability parameters that can be considered competent enough, even under saturated conditions, and therefore, the marl layer might be suitable as a founding medium.

Thus, is important to consider that these assumptions, as well the ground model, shall be validated through appropriate investigations, see sub-chapter 6.5. These investigations will confirm or refute the validity of the proposed parameters during subsequent phases of the project. It should be noted that the influence of various geotechnical parameters could have significant, including negative, repercussions on the project.

One of the main identified risks with the project area the uncertainties and associated risks in the powerhouse are and the foundations stringent requirements (see subchapter 5.5.4), Therefore, a risk analysis is proposed in order to define mitigation measures in order to provide an overview of the possible ground conditions and situations, and corresponding risks and mitigation measures which may be encountered

6.4.1.1. SUMMARY OF GEOHAZARDS

This is obviously only a preliminary assessment, based on the information available at this stage. As seen in document “W.004668-N2 v2 - Powerhouse Design - Preliminary Geotechnical Note” [4], there are few geotechnical data available and reliable to characterize the behaviour of the foundation soil.

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- **Heterogeneity:** Heterogeneous soils are distinguished by the spatial variability of the geotechnical characteristics (compositions, shear strength, deformability, permeability, etc.). Heterogenous soils are often associated with high differential settlements particularly when the ground is highly compressible.
- **Presence of Organic material:** the hazard related to the presence of organic material is mainly to its decomposition with time leading to subsidence. In addition, layers including organic materials possess usually high-water content and might include / lead to chemical composition aggressive to concrete and steel.
- **Compressibility:** Compressible soils are characterized by high void ratio and low elastic modulus leading to significant volume change and settlement under exerted surcharge. These soils typically have poor load-bearing capacity and undergo rather important subsidence.
- **Water content sensitivity:** Sensitive soils are soils that experience significant strength and stiffness loss upon disturbance, remoulding or variation of water content.
- **Liquefaction:** Liquefaction is the phenomenon consisting of the transformation of a loose to medium loose granular / cohesionless material from solid to liquid state in effect of increased pore water pressure & reduced effective stress due to earthquake or vibrations.
- **Collapsibility:** Collapsible soils consist of soil particles / aggregates arranged in an open metastable structure developed thorough various bonding mechanisms. When bond in-between the aggregates is altered – through wetting in cases or by applying stresses exceeding the strength of the bond, collapse occurs. These soils are characterized by a high void ratio.

A summary of the likelihood of the various geohazards for each geotechnical layer – considering the scale in Table 6-5 are presented in Table 6-6.

Likelihood	Unlikely (U)	Possible (P)	Likely (L)

Table 6-5: Geohazards likelihood scale

Layer	Heterogeneity	Organic content	Compressibility	Water content sensitivity	Collapsibility	Liquefaction
GU-L	L	L	P	L	L	U
GU-Mb	U	U/P	P/L	L	U/P	U

Table 6-6: Geohazards likelihood

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6.4.1.2. CONSIDERED GROUND CONDITION SITUATIONS

- **GC1**

The foundation of the powerhouse consists of a homogeneous lignite (**GU-L**), to be excavated and conform the walls of the powerhouse, and a foundation soil of base-marl (**GU-Mb**) layers characterized both by high shear strength and stiffness with no geohazards risks.

- **GC2**

Consists of a lignite layer (**GU-L**) underlain by a transitional heterogenous foundation marl layer (**GU-Mb**), see sub-chapter 5.2, characterized by intermediate shear strength and stiffness with possible geohazards.

- **GC3**

Consists of a lignite layer (**GU-L**) underlain by a transitional heterogenous foundation marl layer (**GU-Mb**), charaterized by very low shear strength or stiffness. In this case, the settlement and differential settlements of the powerhouse are expected to be excessive and either the technical solutions for adapting the design could result in excessive additional costs relative to the overall economics and profitability of the project, or in technical impossibility.

- **All GC**

At this phase of the design and without additional information, the duration for the completion of settlement of the base marl (**GU-Mb**) cannot be evaluated. Two assumptions can be made.

- The foundation settlement is achieved during construction and before installation of E&M sensitive equipment.
- The settlement of foundation is time-dependent and is achieved during operational phase of the project.

The situations are summarized in the

Assumed ground condition	Marl (GU-Mb)	Likelihood
GC1	• Hard homogeneous layer • High shear strength • High stiffness	Likely
GC2	• Heterogeneous layer or • Intermediate shear strength or • Intermediate stiffness	Possible
GC3	• Heterogeneous layer or • Insufficient shear strength or • Low stiffness	Can’t be excluded

Table 6-7

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Assumed ground condition	Marl (GU-Mb)	Likelihood
GC1	• Hard homogeneous layer • High shear strength • High stiffness	Likely
GC2	• Heterogeneous layer or • Intermediate shear strength or • Intermediate stiffness	Possible
GC3	• Heterogeneous layer or • Insufficient shear strength or • Low stiffness	Can't be excluded

Table 6-7: Assumed ground conditions

6.4.1.3. SITUATION MITIGATION MEASURES

- **GC1**

In case of GC1, i.e., homogeneous lignite (**GU-L**) and marl (**GU-Mb**) layers characterized both by high shear strength and stiffness with no geohazards, the settlement at the powerhouse and along the waterways can be assumed as homogeneous and is in decimeters range. In this case, a raft foundation for the powerhouse can be considered, although the raft settlement considering the load powerhouse and backfill is foreseen to be in the order of decimetres. The settlement is expected to be more pronounced at the edges of the raft. It is to consider that the raft and structure must be rigid enough to smooth out the settlement across the raft and reduce the differential settlement.

- **GC2**

In this case, the loading exerted by the foundation system on lignite layer shall be limited and should consider:

- the Soil replacement / substitution with engineered material over a certain deep, may consist of cyclopean concrete or treated backfill. This option requires deeper excavation and dewatering. This option requires deeper excavation and dewatering to reach the top of the marl layer (**GU-Mb**).
- Rigid inclusions (piles or barrettes).
- Or Deep foundations (piles or barrettes) to transfer the load to a more compact deep layer.

The proposed measures will contribute to lower the expected settlement, but it remains in the order of decimetres given the important loading resulting from the backfilling around the powerhouse and its deep influence zone.

- **GC3**

In case of GC3, i.e., soil conditions would be so poor to imply either technical solutions for adapting the design that result in excessive additional costs relative to the overall economics and profitability of the project, or in a technical impossibility. The foundation should be treated and reinforced. Alternatively, the penstocks could be placed in a concrete gallery equipped with watertight flexible joints. The penstocks alignment could

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be adjusted to cater for the differential settlements. Very deep foundations and reducing the backfilling height and extent around the powerhouse might also be viable. It is important to highlight that in this case, it could be necessary to change the overall design. This is an extreme case, which however cannot be ruled out at this stage.

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Table 6-8: Multi-analysis summary

Situation	Condition	Ground condition Likelihood	Foundation System	Additional high level cost estimate	Residual risks with respect to foundation system
GC1	Homogeneous marl (GU-Mb) layer characterized by good shear strength and stiffness	Likely	The foundation of the powerhouse consists of a rigid raft foundation without specific treatment of the founding medium.	None	• Encountering unsuitable marl layer (GC2) requiring another foundation system or • Foundation settlement and differential settlement not tolerated by the structure and E&M equipment.
GC2	Heterogeneous marl (GU-Mb) layer or marl layer characterized by intermediate shear strength and stiffness	Possible	• If the thickness of the weak material is limited to a few meters, this can be excavated and replaced with engineered material under the full extent of the powerhouse, the foundation of the powerhouse still consisting of a rigid raft. • If the weakening of the mechanical parameters concerns a very thick layer, rigid inclusion or deep foundations shall be adopted. • Deterioration of parameters, or acceptable parameters but with fracturing, which can be addressed either by extending soil nailing over a larger area or by adopting a gentler excavation slope.	• Soil replacement below the powerhouse: 15 – 20 million euros. • Deep foundations for the powerhouse: 30 million euros And Design & extra time in Schedule for installation • Extended soil nailing or excavation slope flattening : 2.5 million euros.	• Encountering unsuitable marl layer (GC3) or • Foundation settlement and differential settlement not tolerated by the structure and E&M equipment
GC3	Heterogeneous marl (GU-Mb) layer or marl layer characterized by low shear strength and stiffness	Can't be excluded	To be assessed based on: • Modification of the general layout, • Choice of a different location. Additional studies are required.	Cannot be assessed at this stage	N/A
Long-term set *	Settlement of foundation is time-dependent and achieved after completion of partial or full construction works or during operations	Possible	Complementary measures should be considered depending on the adopted foundation system. These include but not limited to: • Phased schedule to manage settlements • Design specificities to cope with long term settlements • Ground improvement to accelerate the settlement • regular monitoring and realignment of the components are required during the service life.	Cannot be assessed at this stage	N/A
Non tol set **	Stringent requirements for foundation settlements	Possible	Additional studies are required.	Cannot be assessed at this stage	N/A

**Long-term time dependent settlement; **Non tolerated settlement: Foundation settlement and differential settlement not tolerated by the structure and E&M equipment*

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6.5. Supplementary investigation program

The following recommended supplementary investigation program main objective is to provide sufficient information related to mechanical and deformation characteristics of the foundation medium, especially in the area of the powerhouse. This additional information would allow to consolidate assumptions and offer essential information to assess the settlement and differential settlements of the Powerhouse complex.

A proposed analytical GI programme has been communicated, including a recent optimised version (as of December 2025), and foresees eighteen (18) boreholes. Two of these boreholes have been executed and tested as of December 2025.

Borehole	Depth	Instrument	Area
SF-UR1	60m	Standpipe	Upper Reservoir SE-corner
SF-UR2*	(150)m	Inclinometer	Upper Reservoir NNW-corner
SF-UR3	50m	Standpipe	Upper Reservoir NW-toe
SF-UR4	50m	-	Upper Reservoir NW-toe
SF-UR5	50m	-	Upper Reservoir NW-toe
SF-W1	100m	Piezometer	Waterway
SF-W2	50m	-	Waterway
SF-W3	50m	Standpipe	Waterway
SF-W4	50m	-	Waterway
SF-W5*	(150)m	Inclinometer	Waterway-Intake
SF-PH*	80m	Standpipe	Powerhouse
SF-LR1	55m	-	Lower Reservoir SE-corner
SF-LR2	55m	Piezometer	Lower Reservoir S-corner
SF-LR3	55m	Piezometer	Lower Reservoir W-corner
SF-LR4	55m	Piezometer	Lower Reservoir NW-side
SF-LR5	55m	Standpipe	Lower Reservoir center
SF-LR6	60m	Piezometer	Lower Reservoir NW, extension of waterway
SF-LR7	50m	Standpipe	Lower Reservoir NE-side

(*) SF-UR is complete and drilled down to -181m, SF-W5 is complete and drilled down to -177m, SF-PH was prematurely terminated down to -65m.

Table 6-9 : Summary of geotechnical investigation programme

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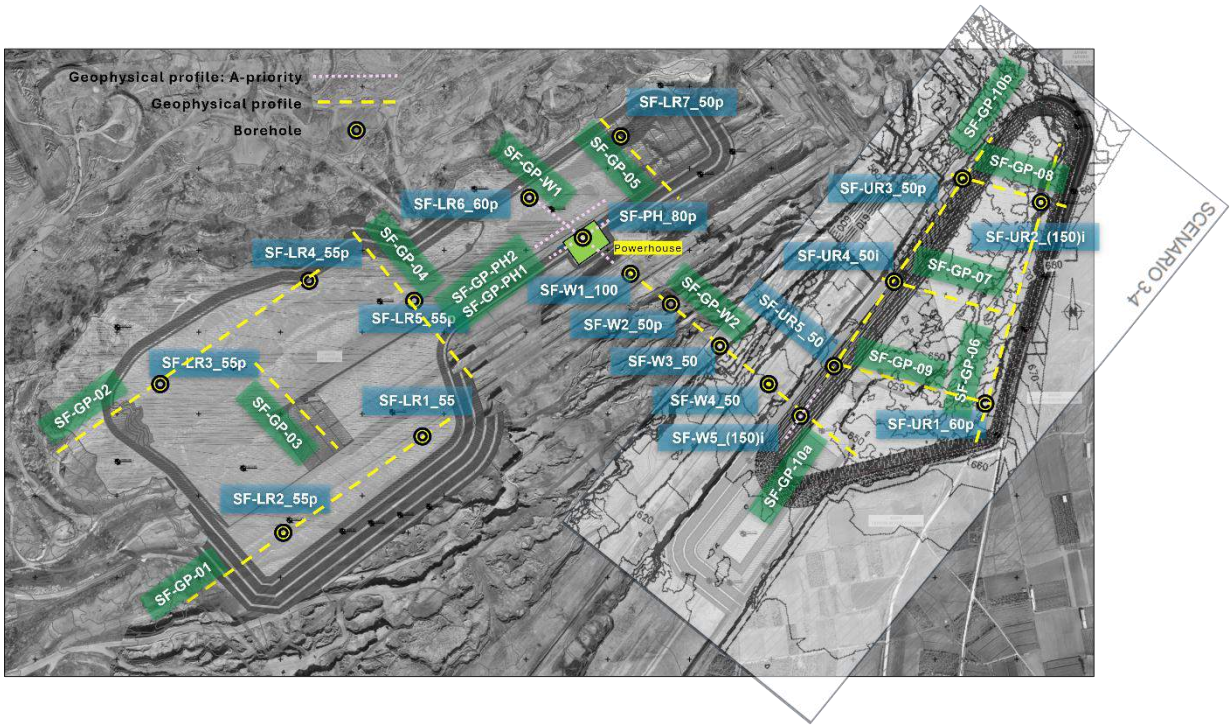


Figure 6-1. Preliminary map with the proposed investigation Programme

The programme is described in detail in the official submission. In brief, it consists of undisturbed sampling (Shelby tubes), standard penetration tests (SPT), permeability tests (Maag or Lefranc), pressuremeter tests (e.g. Menard), followed by the installation of monitoring instruments (i.e. vibrating wire piezometers, standpipe wells, and inclinometers). Particular attention shall be given for the sensitive Marl core samples. The sampling, handling and extraction of the cores should align with best practice and international standards. In that respect, the drilling task in sections where pressuremeter tests are foreseen, core sampling should aim to produce as less disturbance as practicable to the sample and the borehole walls, as well. To limit disturbance, the use of water-aided stepped diamond drill bits and a double split sampler (DT-S), with slow torque and penetration rate are considered essential.

A series of laboratory tests should be conducted in selected soil and “rock” samples from the executed boreholes. Special attention should be paid to the preservation of samples for laboratory testing, in order to retain their natural properties. Test specimens (representative, disturbed or undisturbed) should be selected according to in-situ assessment and in consideration of the permeability and the SPT outcomes. Tests to be considered are: a) gradation/classification tests including Atterberg Limits, natural water content, and x-ray mineral (determination of soil type and plasticity, and the affirmation of absence of swelling parts); b) shear strength tests including Consolidated-Drained (CD) or Consolidated-Undrained (CU) triaxial tests on undisturbed samples; c) direct shear tests as alternative, if triaxial tests are not practically feasible.

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Pressuremeter tests should focus on the Lignite-bearing and Marl base units, and where these are encountered in relatively shallow levels (shallower than 40-45 m). Based on this criterion, pressuremeter tests are presumably anticipated in boreholes SF-LR2, SF-LR3, SF-LR6, SF-W1, and less likely in SF-W3. Pressuremeters will not be required in UR boreholes due to the very deep levels where the Lignite-bearing and Marl units are encountered (deeper than 80 m). Further to the invasive programme, an indicative non-destructive geophysical exploration programme has been communicated and should remain under consideration. This part of the GI scheme includes surface and borehole investigation methods, such as seismic refraction or MASW surface profiling and crosshole seismic profiling in boreholes along the waterway and the Powerhouse foundation area. The key-objective of the crosshole geophysical investigation refers to the assignment of realistic parameters with regards to the elastic properties of the Marl base and the Lignite-bearing strata (determination of V_p and V_s).

Focusing to the vicinity of the Powerhouse area, a realistic set of design parameters with respect to strength, compressibility, and stiffness are of utmost importance. Consequently, should the proposed programme prove inadequate to cover the objectives of a detailed design study, an additional detailed investigation programme in the Powerhouse area should be considered. This programme may foresee a grid of deeper boreholes (e.g. below +457 m.a.s.l.), including pressuremeter/dilatometer tests and crosshole seismic refraction exploration (for the determination of the actual global properties of the Marl unit), as well as laboratory tests on representative or undisturbed samples. Data which may be retrieved from adjacent boreholes of the Project or data of the same units/formations from the neighbouring Project of Kardia (Marl and Lignite-bearing series) could be used for cross-validation and reference purposes.

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7. CONCLUSIONS AND OVERALL SUITABILITY OF SITE

Based on the interpretation of the Geological conditions, hydrogeology behaviour, and the in-situ, surface and sub-surface investigation results, in can then be concluded that:

- In general, it can be concluded that the area of the project is mostly comprised of Lignite-bearing strata (uniform or interbedded) of thickness which may exceeds 100 m that overlays a base Marl. In some areas the Lignite-bearing strata are overlain by *green*" series and Proasteion series at the N and E of the Project area. In addition, resulting manmade deposits cover the SW and W-NW outskirts of the proposed lower reservoir.
- The available information does not indicate scarps of considerable magnitude that may locally alter the geometry of the anticipated stratigraphy in the area of the project (scarp may range in the order of few metres, e.g. 1- 4 m).
- The encountered lithostratigraphy does not suggest the presence of significant neo tectonic features, with the geological risk they may entail.
- The available instrumentation does not indicate current instability on the slopes of the open-cut mine, although there where documented slide on the NW zone of the lower reservoir, which was addressed, see chapter 2.2.2.2.
- The groundwater level beneath the Upper reservoir area lies at more than 40 - 50 m deep on the upper reservoir. The groundwater level with reference to the actual ground level is considered moderately shallow (10 to 18 m deep) at the slopes surrounding the Lower reservoir, and relatively shallow (4 to 8 m deep) at the open pit that will constitute the lower reservoir pit.
- The upper reservoir lays on thick Upper Pleistocene "green" series/**GU-Gsc**, and the Quaternary deposits of Proasteion/ **GU-Pcg** which overly the Lignite-bearing strata (being visible along the SE mine slopes). The anticipated apparent thickness of the Quaternary deposits range between 90 and 120 m, with the upper **GU-Pcg** varying between 50 to 80 m thickness. According to the available information and data results, this material is deemed competent enough as foundation for the ring dam embankment, but in order to adequately storage high volumes of water, a watertight sealing will be necessary.
- To achieve the required Ring dam stability criteria, the clayey portion should have a content of fines between 20% and 50% and a wide gradation, If the material quantities of that kind turn out to be insufficient, adequate procedures such as mixed borrowing procedures or blending of material should be performed. This also apply for the prospective backfill of the lower reservoir powerhouse.
- A buffer reservoir is introduced as a safety measure that shall be used as a temporary storage in the case of a need such as overpumping. Based on the information interpretation, the entire buffer reservoir area rests on thick Upper Pleistocene "green" series/**GU-Gsc**, up to a depth of around 570 m.a.s.l and overlays the Quaternary deposits of Proasteion/ **GU-Pcg** which overly the Lignite-bearing strata (being visible along the SE mine slopes).
- The buffer reservoir is envisioned as a self-draining emergency storage reservoir to manage and discharge excess water on the area of the project so it will not be watertight sealed. The safe water discharge of the buffer reservoir is planned through one or more pipelines crossing the solar farms into the Soulou river. A pumping station, not part of the current scope, shall pump out water from the buffer reservoir, with possibility to empty the upper reservoir in case of need, which is not part of the scope of the present phase.

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- Due to the poor conditions of the ground and to avoid hazardous behaviour, and high dynamics loads envisioned, an underground penstock is not recommended.
- The upstream intake structure is allocated at SE slopes of the mine, and the penstock alignment is planned to transfer water resources from SE towards NW. Subsequently, the alignment in its approximately 35 - 40% extends over the Proasteion alternate conglomerate and fine deposits series, for the 30-35% extends over the “green” series, and for the remainder 25-30%, it reaches the Powerhouse structure through Lignite-bearing strata (**GW-L**).
- The mine waste material (**GU-F**) below the penstock must be removed and backfilled. The lignite layers (**GW-L**), below the backfilled penstocks could be removed as well and replaced by backfill, pending investigations, see chapter 6.5.
- The South and West part of the Lower Reservoir area are partially self-compacted waste deposits (fill material) **GU-F** of variable content. The central are dominated by the autochthonous lower Lignite-bearing **GU-L** strata and the underlying base Marl. And the Eastern parts are characterised by thin “green” series (**GU-Gcs**) overlaying a Lignite-bearing layer (**GU-L**) and/or the base Marl (**GU-Mb**). Based on the available data, the reservoir slopes should be stable under fluctuating water levels during the operation of the PSP.
- No sealing is foreseen for the lower reservoir, because it covers the deepest area of the pit like a pump sump, thus corresponding with the groundwater.
- The reservoir slopes should be the necessary steepness to be stable under the fluctuating water level.
- The lower reservoir excess water is forecasted to be transferred water from the upper reservoir and pump it to the Soulou river (To be designed in further stages of the project).
- The powerhouse is located at the North-east end of the lower reservoir to have the shortest waterway between the two reservoirs. The upper 16.6 metres (down to elevation +520.5 m.a.s.l.) comprise of Lignite-bearing series with Marly impurities which overlie Marl base (**GU-Mb**) (investigation reaches down to +472 m.a.s.l.; approximately 18 metres below the proposed foundation level). T
- The **GU-Mb** is based on the preliminary evaluation of its measured properties (i.e. laboratory tests), from mainly the samples of drill hole SF-PH. Accordingly, the Marl base unit may be distinguished into two sub-units: a top transitional sub-unit (**GU-Mbt**) which generally resembles hard to very hard soil (<10 m depth).
- Given the available data, an underground powerhouse is considered unfeasible, and therefore is not recommended
- The identification of this upper sub-unit (with respect to its thickness and especially its differentiation from the typical underlying Marl, stiffness, deformability, and strength) currently derives from a relatively small number of laboratory results, and thus, entails a high degree of uncertainty. Its presence and requires further investigation, and considering the nature of the particular formation, primarily this requires in-situ testing such as pressuremeter and crosshole seismic refraction, see sub-chapter 6.5.
- Limiting the volume of the backfill surrounding the powerhouse would have a considerable positive impact on the powerhouse foundation, waterways and connections with powerhouse since it would lower the settlement and differential settlements at the **GU-Mb** expected foundation units and waterway connections.

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- There is high risk associated with the lack of data to reliably define the quality of the foundation soil of the powerhouse. The available number and depth of boreholes do not cover the influence zone of the powerhouse and the majority of laboratory tests related to the marl layer were carried out on disturbed samples which are not representative of the in-situ marl characteristics. It is worth noting that the marl layer is sensitive to sampling and water content which render undisturbed sampling difficult and affects the results of laboratory testing.
- The high water level registered around the powerhouse area is probably from percolation of precipitation and run-off activity, forming a pressurized confined aquitard due to a possible unidentified impermeable layer on the area. In this context, the earthworks for the construction of the Powerhouse complex (i.e. excavation, temporary slope supports, and backfill) below +512, will take place in saturated conditions; a fact that necessitates special attention and care for the control and mitigation of ingress.
- Given the uncertainties and associated risks in the powerhouse area and the foundations stringent requirements (see subchapter 6.4.1), a multi-analysis is carried out to provide an overview of the possible ground conditions and situations, and corresponding risks and mitigation measures which may be encountered. This will be included in the feasibility analysis.
- To confirm the ground condition hypothesis and better assess the foundation characteristics to reduce the risks and optimize the design, conducting a thorough investigation program and specially adapted to the marls layer, is highly recommended. An investigation program principle for the powerhouse is suggested in that purpose in the present report (see sub-chapter 6.5)
- At this phase and with the available information, the base marl layer (**GU-Mb**) could be considered as convenient bearing stratum despite that the outcomes of the ground investigations are not conclusive / sufficient to allow the characterization of the marl layer with confidence.

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8. ANNEX AND REFERENCES

8.1. References

[1] W.004668-D1 v1 – Site visit report

[2] W.004668-D2 v2 – Review of conceptual study report

[3] W.004668-D3 v2 – Basis of design report

[4] W.004668-N2 v2 - Powerhouse design – set of assumptions

[5] W.004668-N3 v1 – Preliminary geotechnical note

[6] W.004688-N4 v1 – Seismic Hazard Assessment

[7] W.004688-N5 v1 – Geotechnical Data Report (GDR)

[8] W004668 D7 v2– Feasibility Study

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8.2. Annexes

- A0 [*Regional geological map*].
- B1 [*Field tests SPT´s and Permeability*]
- C1 [*Pumping wells and the surface pumping stations results*]
- C2 [*Laboratory summary*]
- C3 [*Laboratory analytical results*]
- D1 [*Stratigraphy and geological cross-sections*]

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MANDATORY SPARE PARTS LIST - MAIN EQUIPMENT

Item ID	System / subsystem	Generic spare part description	Minimum qty	Unit	Applicability / sizing basis	Employer requirement / clarification
EM-001	Turbine - distributor	Guide vane bushings, each installed type	4	pc	Each installed type	Complete with any sleeves/retainers required for replacement.
EM-002	Turbine - distributor	Guide vane operating mechanism pins and bushings, each type	4	set	Each installed type	Interchangeable with installed components.
EM-003	Turbine - distributor	Shear pins / safety links / friction elements, each type	4	pc	Each installed type	Include associated indication element where applicable.
EM-004	Turbine - distributor	Guide vane servomotor seal and wear-ring kit	1	set	Per servomotor type	One complete overhaul kit.
EM-005	Turbine - distributor	Servomotor position transmitter / feedback device	1	pc	Each installed type	Including mating connector and configuration data.
EM-006	Turbine - distributor	Proximity / limit switch, each type	2	pc	Each installed type	For guide vane and locking mechanisms.
EM-007	Turbine	Static seals, O-rings and gaskets	2	set	One complete turbine unit	Complete unit overhaul set; exclude generic workshop stock only if clearly identified.
EM-008	Turbine shaft seal	Main shaft seal wearing elements	1	set	One complete shaft seal	All segments/elements required for one complete replacement.
EM-009	Turbine shaft seal	Maintenance seal element	1	set	One complete maintenance seal	Including inflatable seal where applicable.
EM-010	Turbine shaft seal	Seal water filter elements	4	pc	Each installed type	Quantity per filter element type.
EM-011	Turbine bearing	Bearing pad / shell set	1	set	Each turbine guide bearing type	Complete bearing set for one bearing.
EM-012	Turbine bearing	Bearing temperature sensor	2	pc	Each installed type	Calibrated and compatible with monitoring system.
EM-013	Turbine bearing	Oil level switch / transmitter	1	pc	Each installed type	
EM-014	Turbine bearing lubrication	Oil pump complete with motor	1	set	Each non-identical pump type	Where no installed standby provides full duty.
EM-015	Turbine bearing lubrication	Oil filter elements	4	set	Each installed type	
EM-016	Governor / hydraulic power unit	Main oil pump complete with motor	1	set	Each non-identical pump type	
EM-017	Governor / hydraulic power unit	Pressure and return filter elements	8	set	Each installed type	Minimum combined stock; bidder to allocate by type.
EM-018	Governor / hydraulic power unit	Proportional / servo valve	1	pc	Each installed type	Factory-configured where required.
EM-019	Governor / hydraulic power unit	Solenoid valve	2	pc	Each installed type	Complete valve or cartridge/coil assembly as applicable.
EM-020	Governor / hydraulic power unit	Pressure/level/temperature instrument	1	pc	Each installed type	One of each installed type.
EM-021	Governor	Speed sensing pickup	2	pc	Each installed type	Including cable/connector.
EM-022	Governor	Controller, I/O and power-supply modules	1	set	Each replaceable module type	One of each installed replaceable type, with software/configuration backups.
EM-023	Main inlet valve and its HPU	Seal and gasket kit	1	set	One complete valve and one actuator	Includes trunnion/operating seal items applicable to offered valve type.
EM-024	Main inlet valve and its HPU	HPU filter elements	4	set	Each installed type	
EM-025	Main inlet valve and its HPU	HPU oil pump complete with motor	1	set	Each non-identical pump type	
EM-026	Main inlet valve and its HPU	Control / solenoid valve	1	pc	Each installed type	
EM-027	Main inlet valve and its HPU	Position, pressure and limit instrument	1	pc	Each installed type	One of each type.
EM-028	Draft tube gates and its HPU	Packing/seal set for one gate	1	set	Each gate type	
EM-029	Draft tube gates and its HPU	HPU oil pump complete with motor	1	pc	Each non-identical pump type	
EM-030	Draft tube gates and its HPU	HPU filter elements	4	set	Each installed type	
EM-031	Draft tube gates and its HPU	Control / solenoid valve	1	pc	Each installed type	
EM-032	Draft tube gates and its HPU	Position, pressure and limit instrument	1	pc	Each installed type	One of each type.
EM-033	Generator stator	Stator bars/coils with associated insulation, wedges and fixing materials	200	pc	100 inner bars and 100 outer bars	Bidder to define transport/storage arrangement.
EM-034	Generator rotor	Complete field pole including winding and connection	1	pc	Each pole design/type	
EM-035	Generator rotor	Pole and rim wedges	2	set	Each installed type	Set quantity sufficient for one pole position / local rim sector.
EM-036	Generator bearings	Thrust bearing pad complete with support parts	1	pc	Each installed pad type	If pads are not fully interchangeable, one of each type.
EM-037	Generator bearings	Guide bearing pads	1	set	Each bearing type	Complete set for one bearing.
EM-038	Generator brakes and lifting	Brake lining / pad set	1	set	One complete unit	
EM-039	Generator brakes and lifting	Complete brake/lifting jack	1	pc	Each installed type	Bidder shall state whether complete jack or overhaul kit is proposed.
EM-040	Generator cooling	Air-water cooler element	1	pc	Each non-identical cooler type	Complete interchangeable cooler section/unit.
EM-041	Generator bearing oil system	Oil-water cooler element	1	pc	Each non-identical cooler type	
EM-042	Generator collector system	Brush holder	1	set		Complete set for one collector system
EM-043	Generator collector system	Brush	1	set		Complete set for one collector system
EM-044	Generator auxiliaries	Flowswitch/flowmeter, pressure switch, level device and RTD	1	pc	Each installed type	One of each type.
EM-045	Generator auxiliaries	Motor for high pressure oil system	1	pc		

Item ID	System / subsystem	Generic spare part description	Minimum qty	Unit	Applicability / sizing basis	Employer requirement / clarification
EM-046	Generator neutral / earthing	Replaceable resistor, CT/VT or monitoring module	1	pc	Each critical non-redundant type	As applicable to the offered design.
EM-047	Excitation system	Power semiconductor / converter arm replaceable unit	1	set	Each installed type	Including associated fuses and mounting hardware.
EM-048	Excitation system	Converter cooling fan	2	pc	Each installed type	
EM-049	Excitation system	AVR controller, I/O, firing and communication modules	1	pc	Each replaceable module type	One of each type; loaded configuration and firmware compatibility required.
EM-050	Excitation system	Power supply module	1	pc	Each installed type	
EM-051	Excitation system	AC excitation breaker	1	pc		
EM-052	Excitation system	DC excitation breaker	1	pc		
EM-053	Excitation system	De-excitation resistor / overvoltage protection element	1	set	Each installed type	
EM-054	Static frequency converter / starting system	Power semiconductor and associated high-speed fuse	1	set	Each installed type / one converter phase position	Quantity sufficient to restore one failed power position.
EM-055	Static frequency converter / starting system	Control, firing, I/O, CPU and power-supply boards	1	pc	Each replaceable board/module type	One of each installed replaceable type.
EM-056	Static frequency converter / starting system	Cooling fan complete with motor	1	pc	Each installed type	
EM-057	Static frequency converter / starting system	Air filter mats/elements	10	set	Each installed type	

MANDATORY SPARE PARTS LIST - MECHANICAL BOP

Item ID	System / subsystem	Generic spare part description	Minimum qty	Unit	Applicability / sizing basis	Employer requirement / clarification
MB-001	General piping and valves	Hand operated valves, check valves	1	pc	Each unique type, pressure class and size DN100 and above	Below DN100: 5% of installed quantity, minimum 2 of each type/size/class.
MB-002	General piping and valves	Check valve repair kit / internal assembly	1	set	Each unique type and size	
MB-003	General piping and valves	Automatic valves with actuator (electric, solenoid…)	1	pc	Each unique type, pressure class and size DN100 and above	Below DN100: 5% of installed quantity, minimum 2 of each type/size/class.
MB-004	General piping and valves	Actuated valve seal/packing and actuator repair kit	1	set	Each unique actuator/valve type	
MB-005	General piping and valves	Gaskets	2	pc	Each installed type and size	
MB-006	General piping and valves	Wearing parts	1	set	Each installed type and size	
MB-007	General instrumentation	Pressure, level, flow and temperature transmitter/switch/sensor	2	pc	Each installed type and calibrated range	Minimum 10% of installed quantity, but not less than 2 of each type.
MB-008	General control	LV apparatus: MCCB, test blocks, indicating lamps, heating & anti-condensation device, control switches	2	set	Each installed type/range	
MB-009	Water cooling system	Main pump complete with motor	1	set	Each non-identical duty pump type	Required where common interchangeability and installed standby do not ensure restoration.
MB-010	Water cooling system	Pump mechanical seal kit	2	set	Each installed pump type	
MB-011	Water cooling system	Pump bearing and flexible coupling kit	1	set	Each installed pump type	
MB-012	Water cooling system	Filter elements / strainer screens	4	set	Each installed type	
MB-013	Water cooling system	Plate heat exchanger gasket set	1	set	Each exchanger type	Complete plate pack gasket requirement.
MB-014	Water cooling system	Sacrificial anodes	1	set	One complete exchanger/system replacement	
MB-015	Drainage and dewatering	Drainage pump complete with motor	1	set	Each non-identical pump type	
MB-016	Drainage and dewatering	Dewatering pump complete with motor	1	set	Each non-identical pump type	
MB-017	Drainage and dewatering	Pump seal, bearing and impeller overhaul kit	1	set	Each installed pump type	
MB-018	Drainage and dewatering	Level transducer / float switch	2	pc	Each installed type	
MB-019	Drainage and dewatering	Inlet strainer / debris basket	1	pc	Each installed type	
MB-020	Oil handling system	Fine and standard filter elements	4	set	Each installed type	For dielectric and mechanical oils, as applicable.
MB-021	Oil handling system	Flexible hose seal/O-ring and coupling kit	2	set	Each installed hose/coupling type	
MB-022	Oil handling system	Vacuum/dehydration unit gasket and seal kit	1	set	Each installed type	
MB-023	Oil handling system	Pump seal / solenoid / instrument spare set	1	set	Each installed type	
MB-024	Fire protection	Fire pump complete with motor	1	set	Each non-identical pump type	
MB-025	Fire protection	Deluge valve complete trim/actuation repair kit	1	set	Each installed valve type	
MB-026	Fire protection	Flexible hose seal/O-ring and coupling kit	2	set	Each installed hose/coupling type	
MB-027	Fire protection	Fire/heat/smoke detector	2	pc	Each installed type	Minimum 10% of installed quantity, but not less than 2 of each type.
MB-028	Fire protection	Solenoid valve, pressure switch and pressure gauge	1	pc	Each installed type	One of each type.
MB-029	Fire protection	Notification device / horn-strobe / indicator	2	pc	Each installed type	
MB-030	Fire protection	System backup battery	1	set	Each installed battery type	
MB-031	Main overhead crane	Hoist and travel brake lining/pad set	1	set	Each brake type	
MB-032	Main overhead crane	Hoist wire rope complete set	1	set	Each hoist arrangement	Preserved and packaged for long-term storage.
MB-033	Main overhead crane	Limit switch, contactor, brake rectifier and pendant/control component	1	pc	Each installed type	One of each type.
MB-034	Compressed air system	HP/LP compressor service and valve/gasket kit	2	set	Each compressor type	
MB-035	Compressed air system	Air dryer maintenance kit	2	set	Each dryer type	
MB-036	Compressed air system	Air and oil filter elements	4	set	Each installed type	
MB-037	Compressed air system	Condensate drain valve / solenoid coil	2	pc	Each installed type	
MB-038	Compressed air system	Pressure transmitter / relief valve	1	pc	Each installed type	One of each type.
MB-039	Compressed air system	Pressure reducing valves	1	pc	Each installed type	

MANDATORY SPARE PARTS LIST - ELECTRICAL BOP

Item ID	System / subsystem	Generic spare part description	Minimum qty	Unit	Applicability / sizing basis	Employer requirement / clarification
EB-001	Main power transformer	HV and LV bushing	1	pc	Each installed bushing type	One of each type, including gaskets and connection hardware.
EB-002	Main power transformer	Buchholz relay	1	pc	Each installed type	
EB-003	Main power transformer	Pressure relief device	1	pc	Each installed type	
EB-004	Main power transformer	Oil/winding temperature indicator or sensor	1	pc	Each installed type	
EB-005	Main power transformer	Cooling fan complete with motor	1	pc	Each installed type	
EB-006	Main power transformer	Breather	1	set	Each installed type	
EB-007	Main power transformer	Complete gasket set	1	set	Each installed type	For the whole transformer
EB-008	Generator circuit breaker / phase reversal / braking switch	Closing/tripping coil kit	1	set	Each mechanism type	
EB-009	Generator circuit breaker / phase reversal / braking switch	Spring-charging / operating motor	1	pc	Each installed type	
EB-010	Generator circuit breaker / phase reversal / braking switch	Mechanism seal/tightness kit	1	set	Each installed type	
EB-011	Generator circuit breaker / phase reversal / braking switch	Auxiliary switches / contact blocks	1	set	Each installed type	
EB-012	Generator circuit breaker / phase reversal / braking switch	Gas density monitor / pressure gauge	1	pc	Each installed type	For gas-insulated equipment where applicable.
EB-013	Generator circuit breaker / phase reversal / braking switch	LV auxiliary components	10	%	Each type, minimum 2 pc	Relays, electronic cards, lamps, indicators, MCBs, fuses, contactors, push-buttons, selector switches, anticondensation heater with thermostat, fans, filters, terminal accessories, etc.
EB-014	Bus ducts and auxiliary buses	Post / support insulator	3	pc	Each installed type	
EB-015	Bus ducts and auxiliary buses	Flexible connector / braid / expansion joint	1	set	Each installed type	For all phases of one location.
EB-016	Bus ducts and auxiliary buses	Gasket and O-ring set	1	set	One complete bus-duct joint/manhole type	
EB-017	Bus ducts and auxiliary buses	Non-magnetic bolts, joint hardware, insulation sleeves and disc springs	5	%	Of installed quantity for each type	Minimum one complete joint set.
EB-018	MV switchgear	LV auxiliary components	10	%	Each type, minimum 2 pc	Relays, electronic cards, lamps, indicators, MCBs, fuses, contactors, push-buttons, selector switches, anticondensation heater with thermostat, fans, filters, terminal accessories, etc.
EB-019	MV switchgear	Current transformer	3	pc	Each installed ratio/class/type	
EB-020	MV switchgear	Voltage transformer	3	pc	Each installed ratio/class/type	
EB-021	MV switchgear	MV circuit-breaker / disconnector / contactor	1	pc	Each installed type	
EB-022	Auxiliary and service transformers	Temperature detector/indicator, RTD and control relay	1	pc	Each installed type	One of each type.
EB-023	Auxiliary and service transformers	Bushing / insulator kit	1	pc	Each installed type	
EB-024	Emergency diesel generator	Filters (fuel, oil and air)	5	set	Each installed type	
EB-025	Emergency diesel generator	Belts and hoses	2	set	Complete engine set	
EB-026	Emergency diesel generator	Gaskets, O-rings and seals	2	set	Complete engine overhaul set	
EB-027	Emergency diesel generator	Fuel injector assembly	2	set	Complete engine	
EB-028	Emergency diesel generator	Instruments, sensors, pressure switches, solenoid valves, transducers and relays	2	pc	Each installed type	
EB-029	Emergency diesel generator	Electronic control/interface module	1	pc	Each installed type	Configured spare or software/configuration supplied.
EB-030	Emergency diesel generator	Starting motor/crank assembly	1	set	Each installed type	
EB-031	Emergency diesel generator	LV auxiliary components	10	%	Each type, minimum 2 pc	Relays, electronic cards, lamps, indicators, MCBs, fuses, contactors, push-buttons, selector switches, anticondensation heater with thermostat, fans, filters, terminal accessories, etc.
EB-032	DC and UPS system	Rectifier / charger power module	1	pc	Each installed type	
EB-033	DC and UPS system	UPS inverter / static switch module	1	pc	Each installed type	As applicable.
EB-034	DC and UPS system	Monitoring/controller, display and I/O module	1	pc	Each installed type	One of each type.
EB-035	DC and UPS system	Fuse, MCB, MCCB and RCD	10	%	Each installed rating/type, minimum 2 pc	
EB-036	DC and UPS system	Battery cell/block	2	pc	Each installed battery type	Include intercell connectors and repair materials.

Item ID	System / subsystem	Generic spare part description	Minimum qty	Unit	Applicability / sizing basis	Employer requirement / clarification
EB-037	DC and UPS system	Battery intercell connectors	2	set	Each installed connector type	
EB-038	DC and UPS system	LV auxiliary components	10	%	Each type, minimum 2 pc	Relays, electronic cards, lamps, indicators, contactors, push-buttons, selector switches, anticondensation heater with thermostat, fans, filters, terminal accessories, etc.
EB-039	LV AC system / MCC	Circuit breaker / load switch complete	1	pc	Each installed type	Including tripping unit. Including draw-out unit for withdrawable apparatus
EB-040	LV AC system / MCC	Breaker operating motor, trip/closing coil and auxiliary contact kit	1	set	Each installed breaker type	
EB-041	LV AC system / MCC	LV auxiliary components	10	%	Each installed type/rating, minimum 2 pc	Relays, electronic cards, lamps, indicators, MCBs, fuses, contactors, push-buttons, selector switches, anticondensation heater with thermostat, fans, filters, terminal accessories, etc.
EB-042	Protection and metering	Protection relay / bay controller	1	pc	Each installed unique type	With settings files, firmware and licensed engineering software.
EB-043	Protection and metering	Meter/transducer	1	pc	Each installed type	
EB-044	Protection and metering	LV auxiliary components	10	%	Each installed type/rating, minimum 2 pc	Auxiliary relays, test blocks, electronic cards, lamps, indicators, MCBs, fuses, contactors, push-buttons, selector switches, anticondensation heater with thermostat, fans, filters, terminal accessories, etc.
EB-045	Plant communication / SCADA	Server / workstation / storage drive / laptop / PC screen / GPS clock and power supply	1	pc	Each installed type	As applicable; include system image and licences.
EB-046	Plant communication / SCADA	Network switch / gateway / communication interface / converter	1	pc	Each installed type	Configured spare or configuration backup supplied.
EB-047	Plant communication / SCADA	Controller modules / panel view	1	pc	Each installed type	Including racks, wiring interfaces + licences
EB-048	Plant communication / SCADA	LV auxiliary components	10	%	Each installed type/rating, minimum 2 pc	Relays, lamps, indicators, MCBs, fuses, contactors, push-buttons, selector switches, anticondensation heater with thermostat, fans, filters, terminal accessories, etc.
EB-049	Cables and terminations	MV cable termination and joint kit	1	set	Each cable type/voltage/size	One complete three-phase set.
EB-050	Cables and terminations	Special connectors, fibre patch cords and transceivers	2	pc	Each installed type	
EB-051	Unit control and protection	PLC/CPU/controller	1	pc	Each installed type	With licensed software and backed-up application.
EB-052	Unit control and protection	Digital, analogue, RTD and communication I/O modules	2	pc	Each installed type	Two of each type, except CPU/controller covered separately.
EB-053	Unit control and protection	Operator panel / HMI	1	pc	Each installed type	Configured spare or image/configuration supplied.
EB-054	Unit control and protection	Industrial Ethernet switch / communication processor	1	pc	Each installed type	
EB-055	Unit control and protection	Auxiliary relays, contactors, selector switches, pushbuttons and indication lamps	10	%	Of each type, minimum 2 pc	Percentage of installed quantity, rounded up.
EB-056	Condition monitoring	Radial/axial proximity probe complete with cable and conditioner	2	set	Each installed type/range	
EB-057	Condition monitoring	Bearing vibration velocity/acceleration sensor complete with cable	2	set	Each installed type/range	
EB-058	Condition monitoring	Air-gap, phase-reference, magnetic-flux, stator-vibration or partial-discharge sensor	1	set	Each installed specialist sensor type	
EB-059	Condition monitoring	Monitoring/input module	1	pc	Each replaceable module type	One complete measurement channel and one card of each type, as applicable.

Call for Tenders **NGAPD-2048**

Scope: **«South Field Mine Pumped Hydro Storage: Early Technology Provider Involvement for Design, Supply, Erection and Commissioning of Pump, Turbine, Generator and Auxiliary Systems»**

ANNEX III

SCHEDULE OF GUARANTEES

CONTENTS

SCHEDULE OF GUARANTEES 3

SCHEDULE OF GUARANTEES

No	Name	Guaranteed Value	Measured at	Rejection Limit	Performance LD	Performance LD rate	Comment
1	Turbine Weighted Average Efficiency (WAE) on turbine shaft	[to be filled by Tenderer] Min 91.00%	Model Test and Tests on completion	Condition precedent for Taking Over is to achieve at least the following Rejection Limit: 1 percentage point lower than the guaranteed value	Yes	1.5% of Lot 1 Contract Value per each 0,1% of efficiency shortfall	If during Model Test the Turbine WAE falls short of the rejection limit, the Lot 1 Contractor will have to improve the design and repeat the Model Test. If during Model Test the Turbine WAE, is higher than the rejection limit, but falls short of the guaranteed value, Performance LD's will be calculated and paid, unless the Contractor decides to improve the design and repeat the Model Test. If LD's are paid at this stage, the Model Test Turbine WAE will become the new Turbine WAE guarantee. During Tests On Completion a combined turbine and generator efficiency test will be performed. The actual WAE of turbine and generator will be compared against the Turbine WAE guarantee (as it may have been modified after Model Test) after applying the Generator's Guaranteed Performance curve. In case of shortfall additional Performance LD's will be calculated and paid. It is explicitly clarified that no double penalization for Turbine and Generator shall apply during Tests on Completion. The guaranteed value for the combined test shall be the Turbine WAE (as may be altered if LDs were paid at the model test) after applying on top of it the Generator guaranteed efficiency. If the measured value is lower, LDs shall be paid regardless if the shortfall is due to turbine or generator (same LD rates for turbine and generator).
2	Pump Weighted Average Efficiency (WAE) on turbine shaft	[to be filled by Tenderer] Min 92.50%	Model Test and Tests on completion	Condition precedent for Taking Over is to achieve at least the following Rejection Limit: 1 percentage point lower than the	Yes	1,5% of Lot 1 Contract Value per each 0,1% of efficiency shortfall	If during Model Test the Pump WAE falls short of the rejection limit, the Lot 1 Contractor will have to improve the design and repeat the Model Test. If during Model Test the Pump WAE, is higher than the rejection limit, but falls short of the guaranteed value, Performance LD's will be calculated and paid, unless the Contractor decides to improve the design and repeat the Model Test. If LD's are paid at this stage, the Model Test Pump WAE will become the new Pump WAE guarantee. During Tests On Completion a combined pump and motos efficiency test will be performed. The actual WAE of pump and motor will be compared against the Pump WAE guarantee (as it may have been modified after Model Test) after applying the

No	Name	Guaranteed Value	Measured at	Rejection Limit	Performance LD	Performance LD rate	Comment
				guaranteed value			Motor's Guaranteed Performance curve. In case of shortfall additional Performance LD's will be calculated and paid. It is explicitly clarified that no double penalization for Pump and Motor shall apply during Tests on Completion. The guaranteed value for the combined test shall be the Pump WAE (as maybe altered if LDs were paid at the model test) after applying on top of it the Motor guaranteed efficiency. If the measured value is lower, LDs shall be paid regardless if the shortfall is due to pump or motor (same LD rates on pump and motor). It is explicitly clarified that no double penalization for Pump and Motor shall apply during Tests on Completion. The guaranteed value for the combined test shall be the Pump WAE (as maybe altered if LDs were paid at the model test) after applying on top of it the Motor guaranteed efficiency. If the measured value is lower LDs shall be paid regardless if the shortfall is due to pump or motor.
3	Turbine mechanical output under max head	[to be filled by Tenderer] Min 62 MW	Model Test and Tests on completion	No Rejection Limit. No condition precedent for Taking Over. Make Good during DNP.	No LD. No condition precedent for Taking Over. Make Good during DNP.	Not Applicable	
4	Turbine mechanical output under 115m head	[to be filled by Tenderer] Min 56 MW	Model Test and Tests on completion	No Rejection Limit. No condition precedent for Taking Over. Make Good during DNP.	No LD. No condition precedent for Taking Over. Make Good during DNP.	Not Applicable	
5	Pump mechanical input under max head (on shaft*)	[to be filled by Tenderer] Min 55.7 MW	Model Test and Tests on completion	No Rejection Limit. No condition precedent for Taking Over. Make Good during DNP.	No LD No condition precedent for Taking Over. Make Good during DNP.	Not Applicable	**Pump-Turbine guide bearing losses included. Net head including the MIV losses.*

No	Name	Guaranteed Value	Measured at	Rejection Limit	Performance LD	Performance LD rate	Comment
6	Turbine mode minimum stable operation output ratio	[to be filled by Tenderer] Min 50% of maximum power output	Model Test and Tests on completion	No Rejection Limit. No condition precedent for Taking Over. Make Good during DNP.	No LD No condition precedent for Taking Over. Make Good during DNP.	Not Applicable	
7	Motor efficiency, pump mode, under min head (mechanical losses included*)	[to be filled by Tenderer] Min 98.50%	Tests on completion	Condition precedent for Taking Over is to achieve at least the following Rejection Limit: 1 percentage point lower than the guaranteed value	Yes	1,5% of Lot 1 Contract Value per each 0,1% of efficiency shortfall (combined with pump)	Efficiency will be measured at the site as per IEC 60034-33 standard. During Tests on Completion the combined pump and motor test will be performed and the stipulations of line 2 above will apply. **Motor-Generator guide and thrust bearings losses included (for thrust bearing, the whole shaft line weight and hydraulic thrust are to be considered in motor-generator efficiency)*
8	Generator efficiency, turbine mode at 100% max output (mechanical losses included*)	[to be filled by Tenderer] Min 98.40%	Tests on completion	Condition precedent for Taking Over is to achieve at least the following Rejection Limit: 1 percentage point lower than the guaranteed value	Yes	1,5% of Lot 1 Contract Value per each 0,1% of efficiency shortfall (combined with turbine)	Efficiency will be measured at the site as per IEC 60034-33 standard. During Tests on Completion the combined turbine and generator test will be performed and the stipulations of line 1 above will apply. **Motor-Generator guide and thrust bearings losses included (for thrust bearing, the whole shaft line weight and hydraulic thrust are to be considered in motor-generator efficiency)*
9	Generator efficiency, turbine mode	[to be filled by Tenderer] Min 97.50%	Tests on completion	1 percentage point lower than the	NO	Not Applicable	Same as above

No	Name	Guaranteed Value	Measured at	Rejection Limit	Performance LD	Performance LD rate	Comment
	at 50% max output (mechanical losses included*)			guaranteed value			
10	Main power transformer (Tier-2) efficiency	(EU Tier-2)	Shop Test	EU Tier-2. If not reached during shop test, the transformer shall not be released for shipment.	Not Applicable	Not applicable	EU Tier 2 means Tier 2 efficiency level as per EU legislation 548/2014 and 2019/1783. If rejection level is not reached during shop test, the transformer shall not be released for shipment. If transformer is not under Lot 1 (relevant option not selected by PPC), this guarantee shall not apply.
11	Cavitation Pitting depth per runner (function of runner low pressure diameter D)	[to be filled by Tenderer] Max $2.5*D^{0.4}$ mm (for 3000 hours of operation in pumping mode) If 3000 hours of pumping are not reached at the end of the original (or extended as the case may be) DNP, the guaranteed value will be proportionally adapted to the effective	Tests After Completion. After each 3000 hours of operation in pumping mode, or at the end of Defects Notification Period, whichever comes later.	Not Applicable	Not Applicable	Not Applicable	Lot 1 Contractor will have to repair the pitting by grinding and welding, maximum one time. This will trigger an extension of DNP, up to the maximum aggregate of 4 years. If cavitation still occurs after the first repair (which is to be checked after 3000 hours of operation in pumping mode after the first repair, but not later than 2 years after the end of the original DNP), then the Lot 1 Contractor must provide at his own cost a new hydraulic design, new model test, and new runners.

No	Name	Guaranteed Value	Measured at	Rejection Limit	Performance LD	Performance LD rate	Comment
		operated time, as per IEC 60609-1.					
12	Cavitation Pitting volume per runner (function of runner low pressure diameter D)	[to be filled by Tenderer] Max $5*D^2$ cm^3 (for 3000 hours of operation in pumping mode) If 3000 hours of pumping are not reached at the end of the original (or extended as the case may be) DNP, the guaranteed value will be proportionally adapted to the effective operated time, as per IEC 60609-1.	Tests After Completion. After each 3000 hours of operation in pumping mode, or at the end of Defects Notification Period, whichever comes later.	Not Applicable	Not Applicable	Not Applicable	Lot 1 Contractor will have to repair the pitting by grinding and welding, maximum one time. This will trigger an extension of DNP, up to the maximum aggregate of 4 years. If cavitation still occurs after the first repair (which is to be checked after 3000 hours of operation in pumping mode after the first repair, but not later than 2 years after the end of the original DNP), then the Lot 1 Contractor must provide at his own cost a new hydraulic design, new model test, and new runners.
13	Standstill to Generating (100%) transition time	[to be filled by Tenderer] Max 100 sec	Tests on completion	No Rejection Limit. No condition precedent for Taking Over. Make Good during DNP.	No LD No condition precedent for Taking Over. Make Good during DNP.	Not Applicable	

No	Name	Guaranteed Value	Measured at	Rejection Limit	Performance LD	Performance LD rate	Comment
14	Standstill to Pumping transition time	[to be filled by Tenderer] Max 350 sec	Tests on completion	No Rejection Limit. No condition precedent for Taking Over. Make Good during DNP.	No LD No condition precedent for Taking Over. Make Good during DNP.	Not Applicable	
15	Noise guarantees	Plant areas with unrestricted access: < 85 dB(A) with no tolerance Transformer: According to ELOT EN 60076-10 standard	Tests on completion	No, to the extent that the plant can safely operate according to applicable legislation	No LD, Make Good, either before Taking Over or during DNP	Not Applicable	**Plant areas with unrestricted access will be defined jointly at the Early Engineering phase but they will include as a minimum the generator floor at the powerhouse.** **Restricted access areas, requiring PPE or limited exposure and the corresponding sound levels will be defined jointly at the Early Engineering phase**
16	Vibration guarantees	Action limit 2 according to ISO 20816-5 Table A.3 In addition to the above, during Early Engineering Phase a "Make Good" threshold will be mutually agreed to set the rejection limit.	Tests on completion	No, to the extent that the plant can safely operate according to applicable legislation	No LD, Make Good, either before Taking Over or during DNP	Not Applicable	Evaluation of the vibration will be done in line with ISO 20816-5, considering the concept of Action limits and the defined normal operating range.

For items expressly subject to Performance Liquidated Damages, where the measured performance meets the applicable Rejection Limit but falls short of the Guaranteed Value,, the Contractor shall, at Contractor's discretion, either:

a) pay the applicable performance liquidated damages, or
b) make a proposal for improvement works and provide a method statement describing the said works including the anticipated time that one or more Units will be offline.

If the Contractor opts for item (b), it shall be at Employer's discretion to accept or reject the Contractor's proposal. In case of rejection, the Contractor shall pay the applicable performance liquidated damages as per item (a).

Tender Procedure **NGAPD-2048**

Scope: **«South Field Mine Pumped Hydro Storage: Early Technology Provider Involvement for Design, Supply, Erection and Commissioning of Pump, Turbine, Generator and Auxiliary Systems»**

ANNEX IV

DECLARATION FORMS

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DECLARATION OF LEGAL STATUS AND AUTHORITY TO REPRESENT AND BIND THE TENDERER [1]

(Covers Clause 3.8.1 of the Call for Tenders)

I, the undersigned, acting as the legal representative or duly authorized representative of the Tenderer ……[2]……, hereby declare that:

1. - (For Greek tenderers)

   The tenderer is registered ……[3]……

   - (For foreign tenderers)

The tenderer is registered with the Registry of ……

(the corresponding registry, the relevant legislation of their country of establishment and the necessary data for their access – internet address, etc. – are indicated)

2. The ……[4] of the Tenderer - legal person are:
   ……
   ……
   ……

3. The legal representative(s) of the Tenderer - legal person is/are ……

4. The tenderer - legal person legally:

   4.1 decided to participate in Call for Tenders NGAPD-2048;

   4.2 appointed …… to sign and submit the Proposal.

5. In the event of any subsequent change to the information relating to the absence of exclusion grounds during the validity period of our Proposal and/or any contract concluded following this Tender Procedure, we undertake to notify PPC without delay; otherwise, PPC may:
   - reject our Proposal;
   - if the relevant contract has already been concluded, terminate it and enforce the Performance Guarantee, where applicable and in accordance with its terms.

Date: ……
The Declarant
(Full name - capacity - signature)

INSTRUCTIONS

1. Where the tenderer is a natural person, this Declaration should, in an appropriate configuration, cover paragraphs 1 and 5 thereof

2. The participant shall indicate the name of the tenderer - counterparty

3. To be completed depending on the scope:

   -"with the General Commercial Registry (G.C.R.) under registry no. ..... and complies with all publicity obligations in accordance with the applicable legislation in force»

   -"in the Contractors Register (M.E.EP.) for the period that the transitional provisions of article 65 of Presidential Decree No 71/2019 remain in force or the Contractors Register for Public Works (MI.E.E.D.E.), since the entry into force of the latter", where the participation of public works contractors is provided for.

4. Indicate, depending on the legal form of the tenderer, "members of the Board of Directors ....." or "managers ...."

DECLARATION OF ACCEPTANCE OF TERMS OF THE TENDER PROCEDURE AND VALIDITY OF THE OFFER

(Covers Clauses 1.3, 3.8.1 and 3.17 of the Call for Tenders)

I, the undersigned, acting as the legal representative or duly authorized representative of the Tenderer .....,[1] hereby declare that the Tenderer:

1. Has been fully informed about Call for Tenders NGAPD-2048, including all Tender Documents specified in Sub-Clause 3.1.2(c) thereof.
   .....[2].....

2. Expressly, fully and unconditionally accepts and agrees to be bound by the Mandatory Terms specified in Clause 3.17 of the Call for Tenders NGAPD-2048, without any deviation, reservation, exclusion, qualification or condition. The Tenderer also accepts the other terms and conditions of the Tender Procedure and confirms compliance with its specifications and requirements, subject to any deviations documented in its Proposal as permitted by the Call for Tenders, and to any clarifications issued in accordance with Clause 3.3 [Clarifications on Tender Documents].

3. Its Proposal shall remain valid and binding for the period specified in Clause 1.3 of the Call for Tenders NGAPD-2048 and shall not be withdrawn, amended or supplemented during that period, except as expressly permitted or requested under the Tender Procedure.

4. Has taken note of the conditions governing electronic submission of Proposals and financial offers through the Electronic Procedures System and accepts those conditions unconditionally.

Date: .....

The Declarant

(Full name - capacity - signature)

INSTRUCTIONS

1. Indicate the name of the tenderer

2. In the event that Addenda to the Call have been issued, the declarant must indicate "and the Addendum / Addenda thereof No ... to No..."

DECLARATION OF NON-EXISTENCE OF EXCLUSION GROUNDS OF THE TENDERER

(Covers Clauses 3.7 and 3.8.1 of the Call for Tenders)

The undersigned, acting as the legal representative or duly authorized representative of the Tenderer, ... [1], hereby declares, under penalty of rejection of the Proposal, that:

1. As at the date of submission of its Proposal, the Tenderer does not fall under any of the grounds for exclusion from participation in a contract award procedure and fully complies with the provisions detailed in paragraph 4 of Article 4 of PPC's Works, Supplies and Services Regulation (RWSS/PPC), as applicable, summarized as follows:

   1.1 The Tenderer has no outstanding tax or social security contributions.
   1.2 The Tenderer has not been convicted by a final judgment of breaches of environmental, social or labour law.
   1.3 The Tenderer has not made any serious false statements and has not shown serious or repeated irregularities in the performance of material obligations under a prior contract relating to the tendered scope, resulting in early termination of that contract, damages or similar penalties.
   1.4 The Tenderer is neither bankrupt nor subject to bankruptcy proceedings, liquidation or a liquidation order.
   1.5 The Tenderer has not been convicted by a final judgment of serious professional misconduct or offences involving corruption or bribery, participation in a criminal organization, terrorist offences, child labour, money laundering or fraud, in accordance with applicable law.
   1.6 The Tenderer has not entered into agreements intended to distort competition.
   1.7 The Tenderer has not unduly influenced decision-making, obtained confidential information or provided misleading information that is materially relevant to the selection procedure.
   1.8 No penalties have been imposed on the Tenderer for violations of labour legislation.

2. There is no conflict of interest within the meaning of the Conflict of Interest Policy published on PPC's website, which the Tenderer has read, understood and agrees to comply with.

3. The Tenderer has read, understood and agrees to comply with the principles of the Suppliers / Partners Code of Conduct, as published on PPC's website.

4. The Tenderer undertakes, if requested by the competent PPC Division, to submit, within ten (10) days of being notified of the request, the relevant supporting documents substantiating the above declarations.

Date: .....

The Declarant

(Full name - capacity - signature)

INSTRUCTIONS

[1] Please indicate the legal name of the Tenderer.

JOINT RESPONSIBILITY DECLARATION

In the case of an Association of Economic Operators

We, the undersigned members of the ....., submitting a Proposal[1] for Call for Tenders NGAPD-2048 for the Scope "South Field Mine Pumped Hydro Storage Plant: Early Technology Provider Involvement for Design, Supply, Erection and Commissioning of Pump, Turbine, Generator and Auxiliary Systems", namely:

1. .....

2. .....

3. .....

declare that, within the framework of our Proposal for the above Tender Procedure and, in the event of award of a contract to the Association, we shall be solely, indivisibly, jointly and severally liable towards PPC for all obligations arising from our participation in the Tender Procedure and all respective agreements with PPC.

Date: .....

The Declarants

(Full name - capacity - signature)

INSTRUCTIONS

1. Depending on the form of the tenderer, e.g. "Partnership" or "Association" or "joint venture" etc. shall be indicated

Tender Procedure **NGAPD-2048**

Scope: **«South Field Mine Pumped Hydro Storage: Early Technology Provider Involvement for Design, Supply, Erection and Commissioning of Pump, Turbine, Generator and Auxiliary Systems»**

ANNEX V

ADVANCE PAYMENT GUARANTEE SAMPLE

ADVANCE PAYMENT GUARANTEE SAMPLE

Date:

To

PUBLIC POWER CORPORATION S.A.
30 Chalkokondyli str., 104 32 ATHENS

We inform you that we irrevocably and unreservedly guarantee to you on behalf of your Counterparty:

……[1]…… (the "Counterparty")

waiving expressly irrevocably and unconditionally the right to discuss and divide, as well as the non-personal objections of the primary debtor, being liable in full and as self-debtors and up to the amount of ……[2]……, which represents the advance payment given by you to the Counterparty to Contract No ……
The object of the Contract is …… with a contractual budget of ……

In any event where, under the guarantee, you would consider that the above Counterparty has breached any of their obligations from those undertaken with the above Contract, we hereby undertake to pay you without delay and without any objection the amount of the guarantee in whole or in part, in accordance with your instructions and within seven (7) days from your demand in writing (the Demand) in which you state that the Counterparty has not fulfilled its obligations, without any authorization, action or consent of the Counterparty being required for the above payment and without regard to any objection or reservation or recourse to the Courts or Arbitration, with a request for the non-forfeiture of the present or its place under judicial sequestration.

Finally, we hereby declare that our guarantee will be in force if and so far as the Counterparty has received the advance payment amount of …… in his account IBAN …. SWIFT code….. without reserve and will remain valid until the Counterparty has fulfilled all of their obligations under the relevant Contract and any addendums thereto, but not later than the earliest of:

a) [3] XX.XX.XXXX (date).
b) upon we receive by you copies of invoices referencing the Contract, evidencing that the total of the payments listed therein reaches or exceeds at least 50% of the Contract Price, i.e. EUR XXX.

Upon the expiration of the guarantee period, this guarantee will be returned to us.

The rights and obligations resulting from this guarantee are neither transferable nor assignable.

Our guarantee shall be governed by the laws of Greece. The competent courts of Athens, Greece shall have exclusive jurisdiction to settle any dispute, claim or matter arising out of or in connection with this Guarantee, including any issue relating to its validity, interpretation, performance, payment, expiry, termination or enforcement. The Uniform Rules for Demand Guarantees, ICC Publication No. 758 ("URDG 758"), shall apply.

ΟΔΗΓΙΕΣ
INSTRUCTIONS

[1] Depending on the form of the Counterparty, the issuer of the letter of guarantee shall indicate one of the following options:

- In the case of a natural person: …… (full name, father's name) ……, …… (TIN) ……, …… (address) …… or

- In case of a legal person: …… (name) ……, ……(TIN) ……, …… (headquarters address) …… or

- In case of a Partnership/Association: of natural or legal persons

  a) …… (name) ……, …… (TIN) ……, …… (address of residence or headquarters) ……
  b) …… (name) ……, …… (TIN) ……, …… (address of residence or headquarters) ……
  …… etc ……
  acting in this case as Partnership/Association and each member is jointly liable towards PPC

[2] The amount in Euros shall be written in full and in numbers

[3] The appropriate number of months shall be completed by the PPC Division that carries out the selection procedure, taking into account the time frame for the completion of payments of the Contract plus a margin for any delays (e.g. in a project with a time horizon of completion of payments or temporary acceptance thereof of eight (8) months, the maximum validity of the guarantee may be set at ten (10) months)

Call for Tenders **NGAPD-2048**

Scope: **«South Field Mine Pumped Hydro Storage: Early Technology Provider Involvement for Design, Supply, Erection and Commissioning of Pump, Turbine, Generator and Auxiliary Systems»**

ANNEX VI

COLLABORATION ENGAGEMENT AGREEMENT

CONTENTS

COLLABORATION ENGAGEMENT AGREEMENT 3

COLLABORATION ENGAGEMENT AGREEMENT

THIS COLLABORATION ENGAGEMENT is dated _____

BETWEEN:

PPC (the **Employer**); and

_____ (the "**Early Engineering Contractor**")

each a **Party** and together the **Parties.**

IT IS AGREED as follows:

1 INTERPRETATION

1.1 In this **Agreement:**

Affiliates means any subsidiary or holding company of either **Party** or a subsidiary of the holding company of such company

Base Price: means the starting point for the value of the Lot 1 Contract, which will be equal to:

a) The Offered Price; plus
b) The Selected Options Price; minus
c) 2.5% of the Base Price; minus
d) 2.5% Selected Options Price

Early Engineering Contract: means the contract between the **Employer** and the **Early**

Engineering Contractor to advance the project's design and contribute to the preparation of the Employer's Requirements towards finalization of the **Lot 1 Contract** under the FIDIC Yellow Book and tendering the **Lot 2 Contract**.

Exclusivity Period means the period starting on the date of this **Agreement** and ending on the earlier of (i) the day falling fifteen (15) months after the date of this **Agreement** (or any longer period agreed in writing between the **Parties**) and (ii) termination of this **Agreement**

Heads of Terms means the key terms that the **Lot 1 Contract** will be based on, detailed in **Annex 1**

Information means any information of whatever nature relating to the **Project** or the **Process** supplied either prior to or after the date of this **Agreement** by a **Party** or its **Affiliates** or **Representatives** to the other **Party** in writing, orally or otherwise together with any reports or other documents prepared by either **Party** or on either **Party**'s behalf which contain or otherwise reflect any such information

Insolvent means being unable to pay debts as they fall due, becoming bankrupt, going into liquidation (either voluntary or compulsory unless as part of a bona fide scheme of reconstruction or amalgamation), being dissolved, compounding with its creditors or having a liquidator, supervisor, receiver, administrative receiver, administrator, compulsory manager, trustee or other similar officer appointed for the whole or any part of its assets or the taking of any corporate action, legal proceedings or other procedure or step (including the making of an application, the presentation of a petition, the filing or service of a notice or the passing of a resolution) in relation to

dissolution, liquidation, provisional liquidation, administration, administrative receivership or receivership, or any local equivalent of any of the foregoing

Initial Lot 1 Scope: engineering, procurement/fabrication, erection and commissioning and all other services and works relevant to the pump, turbine, generator and relevant auxiliaries of the **South Field PHS,** including all underlying assumptions, as further detailed in Annex 2, Appendix 8 [Initial Lot1 Scope]

Lot 1 Scope: will be the **Initial Lot 1 Scope** appropriately adjusted, due to any evolution in the design, specifications, division of works and battery limits that will have been agreed by both **Parties** at the end of the **Early Engineering Agreement**

Lot 1 Contract: means the binding engineering, procurement and construction agreement that will be based on the Heads of Terms to be entered into between the **Employer** and the **Early Engineering Contractor**, for the **Lot 1 Scope** of the **South Field PHS**

Lot 1 Accepted Contract Amount: means the price that will be mutually agreed for **Lot 1 Contract**, which will be determined as per the stipulations of Article 4.2 hereunder.

Lot 2 Scope: means the earthworks, architectural, civil works and electromechanical balance of plant of the **South Field PHS**

Lot 2 Contract: means the engineering, procurement and construction contract for **Lot 2 Scope** to be entered into between the **Employer** and an EPC contractor

South Field PHS means the proposed pumped hydro storage plant that meets the technical specifications detailed in Annex 2, Appendix 8 [Initial Lot1 Scope]

Project means the development of the **South Field PHS** and associated infrastructure.

Representatives means, with respect to a **Party** and its **Affiliates**, its employees, directors, officers, consultants, contractors, subcontractors, agents and professional advisers.

Tractebel: means the consultant that has been contracted by the **Employer** to perform the feasibility study and prepare the technical specifications of the **South Field PHS**, that will work together with the **Early Engineering Contractor** and the **Employer** to further develop the design and specifications for **Lot 1 Scope** and to prepare the necessary design, specifications, quantities and drawings that will allow a tender for **Lot 2 Contract** to be issued.

Process means the negotiation of the **Lot 1 Contract** between the **Employer** and the **Early Engineering Contractor**, and the agreement on the final draft of **Lot 1 Contract** including all technical and commercial schedules.

1.2 The headings in this **Agreement** do not affect its interpretation.

2 THE STATUS OF THIS AGREEMENT AND THE LOT 1 CONTRACT

2.1 On the date on which the **Lot 1 Contract** is executed by both **Parties**, the terms of the Lot 1 Contract will automatically supersede this **Agreement** and this **Agreement** will cease to have any further effect and both **Parties** hereby waive all rights to claim against the other in connection with any actual or contingent liabilities under this **Agreement** which exist at the date of such cessation.

2.2 The **Parties** agree to use the **Heads of Terms** as the starting point for the **Process**.

2.3 Following completion of the **Early Engineering Contract** and subject to clause 6.3, the **Parties** hereby agree to work together in good faith to conclude the **Process** and sign the **Lot 1 Contract**, as soon as reasonably practical but in any event within the **Exclusivity Period**.

3 EMPLOYER'S OBLIGATIONS

3.1 During the **Exclusivity Period** the **Employer** must not solicit or otherwise encourage an offer for, or negotiate terms relating to, the **Process** or enter into the **Process** with anyone other than the **Early Engineering Contractor**.

3.2 During the **Exclusivity Period**, the **Employer** will use reasonable endeavours to:

a. Ensure that **Tractebel** collaborates with the **Early Engineering Contractor** and timely and diligently performs the feasibility study and prepares the technical specifications of the **South Field PHS.**
b. Prepare and launch a tender for **Lot 2** and nominate a preferred bidder for the **Lot 2 Contract**.

4 CONTRACTOR'S OBLIGATIONS

4.1 The **Early Engineering Contractor** agrees to assist the **Employer** in good faith in the development of the **Project** during the **Exclusivity Period** in all activities which may require its input, including but not limited to the fulfilment of the **Early Engineering Contractor's** obligations under the **Early Engineering Contract**.

4.2 The **Early Engineering Contractor** commits that the **Lot 1 Accepted Contract Amount** will not be higher than the **Base Price**, as reasonably adjusted to reflect:

i. mutually agreed differences between the Initial Lot 1 Scope and the Lot 1 Scope,
ii. any mutually agreed differences between the Heads of Terms of Annex 1 and the final terms and conditions of the Lot 1 contract, and
iii. the indexation mechanism, based on the mutually agreed revision formula in Annex 1. The Reference Date for the price adjustment indices will be the date of submission of the Offer.

4.3 The **Early Engineering Contractor** commits to finalize the **Process** and, upon agreement of all relevant particulars, to sign the **Lot 1 Contract**, as soon as reasonably practical after the completion of the Early Engineering Contract, or at such time as requested by the Employer after such completion and in any case within the Exclusivity Period.

5 CONFIDENTIALITY OBLIGATIONS

5.1 The **Employer** and the **Early Engineering Contractor** acknowledge that the **Information** is confidential, and each **Party** receives the **Information** under a duty of confidentiality to the other **Party** and for the exclusive purpose of discussions and negotiations about the **Process** and, in the case of the Employer, for the development, procurement, financing and implementation of the Project, including the Lot 2 Contract (the "Intended Purpose").

5.2 Each **Party** must:

a. keep confidential and not, directly or indirectly, disclose to any person, other than as permitted under paragraph (d), each **Party**'s interest in, and its discussions and negotiations with the other **Party** in connection with, the Intended **Purpose**;
b. keep all **Information** confidential and not disclose any **Information** to any person, other than as permitted under paragraph (d);
c. use the Information solely for the Intended **Purpose** and not for any other purpose;

d. without the other **Party**'s prior written consent, not disclose any **Information** to any person other than:
    I. to its **Representatives** who, in each case, need to know the **Information** for the purpose of negotiating, advising on, executing or financing the **Process**;
    II. to the extent required by law or by the regulations of a recognized stock exchange or any other regulatory body;
    III. to any of its **Affiliates** directly involved in the Project; or
    IV. **Information** which is already in the public domain or has otherwise come into the possession of the relevant **Party** other than as a result of a breach of this **Agreement** or disclosure by the other **Party; or**
    V. in the case of the Employer, to any consultants, lenders, insurers, authorities, or other persons to whom disclosure is reasonably required for the Intended Purpose. However, disclosure of any information to bidders, tenderers and/or contractors, is subject to prior written consent by the Early Engineering Contractor.
e. procure that each person to whom disclosure of **Information** is made as permitted under paragraph (d) is made aware (in advance of disclosure) of the **Confidentiality Obligations** of this **Agreement** and use all reasonable endeavours to procure that each such person adheres to those **Confidentiality Obligations**; and
f. on written request by either **Party** made at any time after the end of the **Exclusivity Period**, destroy promptly all **Information** without keeping any copies.

Notwithstanding Clause 5.2(f) above, either **Party** and its **Affiliates** and **Representatives** may retain the **Information** if required to do so by law, rule or regulation, including the rules of an applicable professional body, or its bona fide internal document retention policies, provided that any such **Information** is kept confidential in accordance with the terms of this **Agreement**.

6 STEPWISE BINDING NEGOTIATION MECHANISM FOR LOT 1 SCOPE

6.1 The **Parties** agree that negotiations regarding the **Lot 1 Scope** shall take place in distinct and sequential rounds, each following the progress and findings of the **Early Engineering Contract**. The scope, price and time schedule elements agreed upon in each round shall be recorded in writing and signed by both **Parties**, becoming binding and irrevocable for all subsequent rounds and for the final **Lot 1 Contract**. The **Early Engineering Contractor** shall not be entitled to dispute or delay the incorporation of such scope elements into the final contract.

6.2 The **Early Engineering Contractor** shall not have the right to modify, revoke, or renegotiate any agreed scope or price or time schedule elements from a previous round, unless the Employer has given its prior written approval.
The Early Engineering Contractor may request a modification to a previously agreed scope, price and time schedule element only to the extent that it demonstrates that such modification is directly and specifically linked to findings of the Early Engineering Contract, to material changes in assumptions introduced by the Employer or Tractebel, or to additional input data that were not previously available. Any such request shall be fully substantiated and shall identify the technical, programme, cost and risk impact of the proposed modification.

The Parties shall negotiate in good faith. The Employer shall have no obligation to accept any such request and may reject it with reasonable substantiation, where the Employer considers that the proposed modification materially alters previously agreed terms, or is not sufficiently justified by the relevant Early Engineering findings, or leads to an unjustified increase in cost or risk.

6.3 The **Early Engineering Contractor** shall not withdraw from, alter, or renegotiate an agreed scope element in subsequent rounds, otherwise the **Employer** shall have the right to immediately suspend further negotiations until compliance is restored.

6.4 If the **Early Engineering Contractor** persistently fails to comply with prior agreements on scope, the **Employer** shall have the right to (i) terminate negotiations unilaterally and exclude the **Early Engineering Contractor** from the final **Lot 1 Contract**; (ii) seek alternative procurement solutions for the relevant scope elements; (iii) recover costs associated with the breach, including expenses from the **Early Engineering Contract** and potential cost differentials from engaging an alternative contractor with similar scope of services as the Early Engineering Contract.

7 TERMINATION

7.1 Either **Party** may serve a notice of termination on the other **Party** on any of the grounds set out in clause 7.3, upon receipt of which this **Agreement** will automatically terminate with immediate effect and save clause 6.4 (iii) neither **Party** will be liable to the other for any costs and/or losses arising out of or in connection with such termination.

7.2 This **Agreement** may only be terminated in accordance with the express provisions of this clause 7.

7.3 The Employer may terminate at any time if:

a. during the **Exclusivity Period**, it decides not to proceed with the **Project**
b. the **Exclusivity Period** has expired and the **Process** has not completed
c. during the **Exclusivity Period** the **Contractor** fails to comply with any of its obligations under Clause 4 and Clause 6
d. The **Early Engineering Contractor** becomes **Insolvent**

The **Early Engineering Contractor** may terminate at any time if:

a. the **Exclusivity Period** has expired and the **Process** has not completed.
b. the **Employer** becomes **Insolvent**

7.4 Notwithstanding clause 7.1, the **Employer** is entitled to claim from the **Early Engineering Contractor** the entire value of the **Early Engineering Contract** if the **Employer** terminates this **Agreement** as a result of the **Early Engineering Contractor's** failure to comply with its obligations under 4.2 or 4.3.

7.5 Clauses 1, 5 and 9 to 12 inclusive of this **Agreement** remain in full force notwithstanding service of a termination notice. Clause 5 shall remain in force until the date falling five (5) years after the date of this **Agreement**. A termination notice does not affect the **Employer's** accrued rights in connection with any breach of this **Agreement** by the **Early Engineering Contractor**, or the **Early Engineering Contractor's** accrued rights in connection with any breach of this **Agreement** by the **Employer**, which may have occurred before the termination notice is served.

7.6 For the avoidance of doubt all of the rights in, and any materials produced in connection with, the works carried out under this **Agreement** shall belong to the **Employer**.

8 COSTS

8.1 Each **Party** at its exclusive risk shall bear its own costs related to this **Agreement**, unless otherwise mutually agreed in advance in writing.

9 CONSEQUENTIAL LOSS

9.1 No **Party** shall be liable to the other **Party** for any loss of profits, loss of revenue, loss of contract, loss of permit, loss of use, loss of goodwill, loss of opportunity (including where

such losses are considered foreseeable or direct losses) or any other indirect, consequential or special loss or damage of any nature whatsoever. For the avoidance of doubt Employer's claims under clauses 6.4 (iii) and 7.4 do not fall under this clause 9.1 under any circumstances.

9.2 The total aggregate liability of each Party under or in connection with this Agreement, whether in contract, tort (including negligence) or statutory law, shall be limited to the Contract Price, as defined in the Early Engineering Contract, Appendix 3. Either Party hereby waives any claims for damages against the other Party's and its affiliates' directors, executives, employees, other personnel or vicarious agents. The above exclusions and limitations of liability shall also apply to the benefit of the legal representatives, directors and officers, subcontractors, subprocessors and other vicarious agents of the other Party.

10 WARRANTIES

10.1 Each of the **Parties** warrants to the other that it has full power and authority to enter into this **Agreement** and carry out the actions contemplated under this **Agreement**, and that its entry into and performance under the terms of this **Agreement** will not infringe the rights of any third party or cause it to be in breach of any obligations to a third party.

11 GENERAL

11.1 None of the **Parties** shall be entitled to hold itself out as being the agent of the other **Party** for any purpose whatsoever without receiving the prior written consent of the other.

11.2 Nothing in this **Agreement** shall create a partnership between the **Parties**.

11.3 The **Employer** shall not assign, transfer, novate, or otherwise dispose of any or all of its rights and obligations under this **Agreement**, in whole or in part, without the prior written consent of the **Early Engineering Contractor**, which shall not be unreasonably withheld or delayed, to (a) any Affiliate of the **Employer**; or (b) any financial institution, lender, or security agent providing debt financing, refinancing, or Project-related funding, including any trustee or nominee acting on their behalf. The **Early Engineering Contractor** shall, upon request by the **Employer**, execute all necessary documents and provide all reasonable cooperation to effect any such assignment, transfer, or novation, provided that such assignment does not materially increase the **Early Engineering Contractor's** obligations or liabilities under this **Agreement**.

11.4 The **Early Engineering Contractor** shall not assign, transfer, novate, or subcontract any of its rights or obligations under this Agreement without the prior written consent of the **Employer**, which shall not be unreasonably withheld.

12 GOVERNING LAW AND JURISDICTION

12.1 This **Agreement** and any non-contractual obligations arising out of or in connection with it shall be governed by and construed in accordance with laws of Greece.

12.2 In the event that any disputes may arise between the Parties, under or in connection with the present Agreement (including any dispute relating to non-contractual obligations) that may not be resolved amicably within thirty (30) business days, or at a later date as may be mutually agreed, such disputes will be resolved in accordance with the Rules of Arbitration of International Chamber of Commerce (ICC) by three arbitrators to be appointed in accordance with such Rules. The Arbitration will take place in Athens, Greece.

This **Agreement** has been signed by the **Parties** (or their duly authorised representatives) on the date stated at the beginning of this **Agreement**.

SIGNATORIES

ANNEX 1
Heads of Terms

ANNEX 2
Early Engineering Contract

Call for Tenders **NGAPD-2048**

Scope: **«South Field Mine Pumped Hydro Storage: Early Technology Provider Involvement for Design, Supply, Erection and Commissioning of Pump, Turbine, Generator and Auxiliary Systems»**

ANNEX VII

INTERFACE AGREEMENT HEADS OF TERMS

Interface Agreement for South Field Mine Pumped Hydro Storage Project

Heads of Terms

1. Purpose and overall structure

The Project will be executed through two separate EPC contracts:

(a) Lot 1 Contract, covering the design, supply, erection and commissioning of pump-turbine, generator, auxiliary systems and balance of plant electromechanical works (Lot 1 Contractor); and

(b) Lot 2 Contract, covering earthworks, civil works and building related electromechanical works (Lot 2 Contractor).

Both Parties (Lot 1 Contractor and Lot 2 Contractor) shall be named Lotee for the purposes of this Interface Agreement.

Although the two Lot Contracts will be legally separate, the Lots are technically, programmatically and operationally interdependent. The purpose of the Interface Agreement is to establish a clear and practical framework for the coordination of those interdependencies, including the allocation of interface obligations, the delivery of Interface Data, the achievement of Interface Milestones, recovery actions and consequences of non-compliance.

The Interface Agreement shall form part of each Lot Contract and shall be binding on each Lotee as an obligation owed to the Employer under the relevant Lot Contract. It shall not create direct contractual claims between Lot 1 Contractor and Lot 2 Contractor.

2. Parties and contractual architecture

The Interface Agreement shall be entered into, or incorporated by reference into the Lot Contracts, so as to bind the Employer, the Engineer, the Lot 1 Contractor and the Lot 2 Contractor.

Each Lotee shall remain contractually liable only to the Employer under its own Lot Contract. The other Lotee shall not become a contractual counterparty for the purpose of claims, damages, extensions of time, payment, set-off, deductions or termination. No Lotee shall be jointly or severally liable with the other Lotee for the obligations of such other Lotee under its respective Lot Contract. No Lotee shall bear liability for, suffer deductions in respect of, or have payments withheld or delayed under its own Lot Contract by reason of any act, omission, delay, default or breach by the other Lotee, except to the extent that such act, omission, delay, default or breach has been determined under this Interface Agreement or either of the Lot Contracts to give rise to an entitlement of that Lotee under its own Lot Contract. There shall be no cross liability, cross default or solidarity of any kind between the Lotees, whether under this Interface Agreement, the Lot Contracts or otherwise.

Any interface-related entitlement or liability shall be pursued only through the relevant Lot Contract.

3. Key definitions

The Interface Agreement shall include, at least, the following definitions:

Engineer: means the person or entity appointed as the Engineer pursuant to Sub-Clause 3.1 [The Engineer] of each of the respective Lot Contracts, who shall be the same entity for both Lot Contracts.

Interface Agreement: means the contractual framework governing coordination, co-operation, interface obligations, Interface Programme, Interface Milestones, Interface Data, interface meetings, recovery actions and interface claims between the Employer, the Engineer and the Lotees.

Interface Claim: means a claim submitted by a Lotee to the Employer under its Lot Contract, alleging that it has been delayed, disrupted or otherwise affected by an interface related act, omission, delay or default caused or contributed by the other Lotee.

Interface Data: means any technical, design, construction, installation, testing, commissioning, programme or other information, document, drawing, calculation, specification, model, report, schedule, certificate or data required from one Lotee in order to allow the design, procurement, construction, erection, testing, commissioning or completion of the other Lot or of the Project interfaces.

Interface Determination: means a determination made by the Engineer under the relevant Lot Contract in respect of an Interface Claim.

Interface Liquidated Delay Damages: has the meaning given to it in Clause 9.

Interested Lotee: means the Lotee whose acts, omissions, delay, Interface Data or compliance with an Interface Milestone may be relevant to an Interface Claim under the other Lot Contract.

Interface Milestone: means any milestone, date, activity, handover, delivery of Interface Data, access obligation, design freeze, construction readiness date, testing dependency or commissioning dependency allocated to either Lotee in the Interface Programme or the Interface Agreement.

Interface Programme: means the programme identifying the interface activities, dependencies, access dates, handover dates, design inputs, Interface Data, Interface Milestones and other coordination requirements between Lot 1 and Lot 2.

LD-bearing Interface Milestone: means an Interface Milestone expressly identified as such in the Interface Milestones Table agreed at the date of the relevant Lot Contract as subject to Interface Liquidated Delay Damages.

Tracking Interface Milestone: means an Interface Milestone not expressly identified as LD-bearing.

4. General cooperation obligations

Each Lotee shall:
(a) perform its works in coordination with the Employer, the Engineer and the other Lotee;

(b) comply with the Interface Agreement, the Interface Programme and all Interface Milestones allocated to it;

(c) provide Interface Data by the dates, in the format and at the level of detail required by the Interface Agreement or the Interface Programme;

(d) ensure that its Interface Data is complete, accurate, coordinated and suitable for the purpose for which it is provided;

(e) promptly notify the Engineer of any actual or likely interface delay, inconsistency, omission, discrepancy or coordination risk;

(f) attend interface coordination meetings and provide competent representatives with authority to discuss technical and programme matters;

(g) take reasonable steps to avoid, mitigate and recover interface delays; and

(h) update its own programme so as to reflect the Interface Programme and all relevant interface dependencies.

5. Interface Programme

The Interface Programme shall show how the activities of the two Lotees interact. It shall include, as applicable:

(a) design input dates;

(b) design freeze dates

(c) Interface Data delivery dates

(d) civil guide drawing dates

(e) overall access, area access and area handover dates

(f) erection readiness and construction readiness dates

(g) embedded parts delivery and readiness dates

(h) testing and commissioning dependencies

(i) energization and water availability dependencies

(j) Taking-Over dependencies

(k) any other interface activities required for the coordinated execution of the Project and

(l) any other interface activities as per the Interface Matrix of Appendix [●]

Each Lotee's programme under its Lot Contract shall incorporate the Interface Programme and shall be consistent with the Interface Milestones allocated to that Lotee.

6. Categories of Interface Milestones

The Interface Agreement shall distinguish between two categories of Interface Milestones.

6.1 Tracking Interface Milestones The purpose of the Tracking Interface Milestones shall be coordination, monitoring, early warning and recovery planning.

Failure to meet a Tracking Interface Milestone shall not create any independent entitlement to payment, reimbursement, compensation, extension of time, relief from liquidated damages, indemnity or damages under this Interface Agreement. Any such entitlement shall be preserved, claimed and determined exclusively under the affected Lotee's own Lot Contract with the Employer.

Failure to achieve a Tracking Interface Milestone shall not automatically give rise to delay liquidated damages. However, it may constitute a breach of the relevant Lot Contract and may entitle the Engineer or the Employer to require:

(a) a recovery plan

(b) additional or corrected Interface Data

(c) re-sequencing proposals

(d) reasonable mitigation measures required under the respective Lot Contract

(e) increased coordination meetings

(f) acceleration or reallocation of resources, where required under the relevant Lot Contract and/or

(g) any other contractual remedy available under the relevant Lot Contract.

6.2 LD-bearing Interface Milestones

A limited number of critical Interface Milestones shall be designated as LD-bearing Interface Milestones. These shall be expressly identified in the Interface Milestones Table.

Failure by a Lotee to achieve an LD-bearing Interface Milestone by the required date shall give rise to Interface Liquidated Delay Damages payable by that Lotee to the Employer, unless and to the extent that the failure is caused by (i) an event entitling that Lotee to relief under its Lot Contract, or (ii) any act, omission, delay, default or breach by the other Lotee, the Employer, the Engineer or any third party for whom the affected Lotee is not responsible. Any entitlement to EoT and/or Cost shall be determined exclusively in accordance with the respective Lot Contract.

The LD-bearing regime shall apply only to selected critical interface failures where delay would materially affect the other Lot or the overall Project sequence. It shall not apply to ordinary coordination slippage.

7. Interface Milestones Table

The Interface Agreement shall include an Interface Milestones Table identifying, for each relevant milestone:

(a) the relevant Interface Milestone

(b) whether it is a Tracking Interface Milestone or an LD-bearing Interface Milestone

(c) the responsible Lotee

(d) the dependent Lotee or dependent Project activity

(e) the required date

(f) the evidence required to confirm achievement

(g) the consequences of non-achievement

(h) the applicable LD rate, if any, and

8. Indicative LD-bearing Interface Milestones

The LD-bearing Interface Milestones for Lot 1 may include, without limitation and subject to final technical validation, the following:

8.1 Design Milestones

(a) Model Test Report non-objection

(b) Interface Level 1 – Basic Design

(c) Interface Level 2 – Intermediate Detailed Design

(d) Interface Level 3 – Final Detailed Design

8.2 Embedded Parts Milestones

(a) Draft Tube and Draft Tube Gate ready for concreting, with piping, per unit

(b) Turbine Pit Liner and Spiral Case ready for concreting, with piping, per unit

(c) Common embedded piping ready for concreting

(d) Generator anchoring plates ready for concreting, per unit

(e) MIV anchoring plates ready for concreting, per unit

8.3 Other Interface Milestones

(a) MIV ready for connection with penstock, per unit

(b) Transformer ready for energization, per transformer

Corresponding Employer / Lot 2 dependencies shall include and shall be designated as LD-bearing Interface Milestones in the Interface Milestones Table, the following:

(a) civil readiness and access readiness for each powerhouse area, per unit;

(b) penstock readiness for connection with MIV, per unit;

(c) availability of water for wet commissioning;

(d) energization readiness and back-feed / back-energization availability, per unit; and

(e) any other Lot 2 activity upon which a Lot 1 LD-bearing Interface Milestone is dependent, provided that such activity is expressly designated as Lot2 LD-bearing Interface Milestone in the Interface Milestones Table.

The applicable LD rates and evidence of achievement for such Lot 2 LD-bearing Interface Milestones shall be stated in the Interface Milestones Table, having regard to the nature and consequences of each interface delay.

8.4 Taking-Over Milestones

(a) Section U1-U2 Taking Over;

(b) Section U3-U4 Taking Over.

8.5 Interface Data levels

Interface Level 1 may include final loads of main equipment, earthing data for Lot 2, embedded parts details, over-speed / pressure transient / critical speed calculations, preliminary powerhouse arrangement drawings, major openings / trenches / block-outs, and main routing of large cable trays, pipework and ductwork.

Interface Level 2 may include final loads, weights and sizes of equipment, heat loads for HVAC, remaining embedded elements not covered by Level 1, final arrangement drawings, medium-size openings / trenches / block-outs, and detailed routing of medium-size cable trays, pipework and ductwork.

Interface Level 3 may include miscellaneous openings, block-outs and embedment elements not covered by Levels 1 and 2, final routing of smaller cable trays, pipework and ductwork, and telecontrol / protection signal lists.

The following conditions shall apply to all LD-bearing Interface Milestones:

(a) the responsible Lotee shall only be liable for Interface Liquidated Delay Damages if it has received all Interface Data, access and other prerequisites from the other Lotee, the Employer and the Engineer required for the achievement of the relevant milestone in sufficient time to enable it, acting reasonably and in accordance with the Programme, to achieve the respective milestone by the applicable Milestone Date;

(b) if such prerequisites are not provided in time, the respective Milestone Date shall be extended only to the extent that, and for the period by which, the failure to provide such prerequisite has actually delayed the responsible Lotee's achievement of the Milestone; and

(c) the responsible Lotee shall not be liable for Interface Liquidated Delay Damages to the extent that its failure to achieve such Milestone was caused by defects, errors or omissions in Interface Data provided by the Employer, the Engineer or the other Lotee.

9. Interface Liquidated Delay Damages

Interface Liquidated Delay Damages shall be payable only for failure to achieve LD-bearing Interface Milestones expressly identified as such.

The Interface Liquidated Delay Damages shall be a pre-agreed contractual remedy payable by the defaulting Lotee to the Employer for the relevant critical interface delay. They shall be calculated at the rates and subject to the overall cap on delay liquidated damages stated in the relevant Lot Contract. The aggregate of all Interface Liquidated Delay Damages and all general delay liquidated damages payable by a Lotee under its Lot Contract shall not exceed the overall cap on delay liquidated damages stated in the relevant Lot Contract.

Payment of Interface Liquidated Delay Damages for a specific LD-bearing Interface Milestone shall constitute the Employer's sole monetary compensation for the specific loss caused by that failure to meet the LD-bearing Interface Milestone, including any compensation, cost or amount paid or properly payable by the Employer to the affected Lotee as a consequence of that same interface failure, subject always to the overall cap on delay liquidated damages and aggregate liquidated damages cap stated in the relevant Lot Contract.

For the avoidance of doubt, where Interface Liquidated Delay Damages apply to an LD-bearing Interface Milestone, the Employer's monetary recovery for the specific delay and interface loss covered by that milestone shall be limited to those Interface Liquidated Delay Damages, without prejudice to any separate general delay damages for failure to achieve Time for Completion or Taking Over, to the extent such general delay damages compensate a different head of loss.

There shall be no double recovery for the same loss.

10. No direct claims between Lotees

Neither Lotee shall have any direct contractual claim against the other Lotee.

If one Lotee considers that it has been delayed, disrupted or otherwise affected by the other Lotee, its sole contractual route for relief shall be through its own Lot Contract against the Employer, in accordance with the claims procedure of that Lot Contract.

The Employer shall remain the contractual counterparty of each Lotee. Any EoT, Cost, payment, deduction, recovery, set-off or liquidated damages shall be dealt with only under the relevant Lot Contract.

11. Claims caused by another Lotee

Where a Lotee submits an Interface Claim alleging delay, disruption, additional Cost or other impact caused by the other Lotee, the claim shall be submitted under the affected Lotee's own Lot Contract.

The Engineer shall manage the determination process. The allegedly defaulting Lotee shall be notified and invited to participate as an Interested Lotee. The Interested Lotee shall be given a reasonable opportunity to:

(a) receive the relevant allegations and particulars, subject to confidentiality restrictions

(b) submit written comments

(c) provide supporting records, programmes, delay analysis and other evidence

(d) attend joint or separate meetings convened by the Engineer and

(e) respond to the matters alleged against it

The Interested Lotee's participation shall not make it a party to the other Lot Contract and shall not create any direct claim between the Lotees.

Without prejudice to the applicable Interface Liquidated Delay Damages, and subject always to the caps stated in the relevant Lot Contract, the Employer will not pass through, set off or otherwise recover from the Interested Lotee any amount paid or

relief granted to the affected Lotee under an Interface Claim, arising out of or relating to delay.

12. Engineer's Interface Determination

The Engineer's determination of an Interface Claim shall identify, to the extent relevant:

(a) the relevant interface event

(b) the relevant Interface Milestone or Interface Data

(c) the party responsible for the relevant act, omission, delay or default

(d) causation

(e) delay impact

(f) mitigation

(g) concurrency, if any

(h) the amount of proven direct Cost, if any and

(i) any EoT or other relief due under the affected Lotee's Lot Contract

No finding adverse to an Interested Lotee shall be made unless that Interested Lotee has been given a reasonable opportunity to be heard. An Interface Determination shall be subject to the dispute resolution provisions of the relevant Lot Contract. Each Lotee under its Lot Contract, or the Employer, may refer an Interface Determination for resolution in accordance with the dispute resolution procedure under the relevant Lot Contract.

13. Effect of determinations across Lot Contracts

An Interface Determination issued under one Lot Contract shall not be automatically binding under the other Lot Contract, regardless if it contains findings concerning the other Lotee.

Such findings shall not operate as an automatic cross-contract mirroring mechanism. However, they shall be taken into account — but only after independent assessment by the Engineer under the other Lot Contract — in a corresponding determination under the other Lot Contract, provided that the relevant Lotee had notice of the claim and a reasonable opportunity to participate, unless that Lotee demonstrates that:

(a) it was not given a reasonable opportunity to be heard

(b) the relevant findings contain a manifest error

(c) material evidence has become available which could not reasonably have been provided in the earlier process, or

(d) adoption of the findings would be inconsistent with an express provision of the relevant Lot Contract.

14. Employer's Claim for LD-bearing Interface Milestones

Where a Lotee fails to achieve an LD-bearing Interface Milestone by the required date, the Employer shall be entitled to submit an Employer's Claim against the responsible Lotee under Sub-Clause 2.5 [Employer's Claims] of the relevant Lot Contract, for payment of the corresponding Interface Liquidated Delay Damages.

The Interface Liquidated Delay Damages shall be calculated at the rates and subject to the overall cap on delay liquidated damages stated in the relevant schedule to the Lot Contract.

Payment or recovery of the applicable Interface Liquidated Delay Damages shall constitute the Employer's sole monetary compensation from the responsible Lotee for the specific delay and interface loss covered by the relevant LD-bearing Interface Milestone, including any compensation, Cost, loss, expense or amount paid or properly payable by the Employer to the affected Lotee as a consequence of that same interface delay.

Accordingly, in respect of the same LD-bearing interface delay, the Employer shall not be entitled to recover from the responsible Lotee, in addition to the applicable Interface Liquidated Delay Damages, any further actual damages, reimbursement, indemnity, Cost, loss or expense.

For the avoidance of doubt:

(a) nothing in this HoT shall limit the Engineer's right to require recovery plans, mitigation measures, corrected Interface Data, programme updates, attendance at coordination meetings or other non-monetary measures available under the Interface Agreement or the relevant Lot Contract; and

(b) nothing in this HoT shall affect the Employer's entitlement to general delay damages for failure to achieve Time for Completion or Taking Over under the responsible Lotee's own Lot Contract, to the extent such general delay damages compensate a different head of loss.

15. Recovery plans and mitigation

If an Interface Milestone is missed or is likely to be missed, the Engineer may require the responsible Lotee to submit a recovery proposal.

The recovery proposal shall include:

(a) the cause of the delay or likely delay

(b) the affected interface

(c) the affected Interface Milestone or Interface Data

(d) the impact on the Interface Programme

(e) mitigation measures already taken

(f) proposed recovery measures

(g) any required decision, access, information or approval from the Employer, Engineer or other Lotee and

(h) the revised forecast dates

The Engineer may require the Lotee to revise the recovery proposal if it is incomplete, unrealistic or inconsistent with the Interface Programme.

Any entitlement to payment for recovery measures, including acceleration, re-sequencing or additional resources, and whether such measures constitute a Variation, shall be determined in accordance with the relevant Lot Contract. All claims, extensions of time, costs, or remedies arising from a suspension or termination event shall be pursued by the affected Lotees and the Employer exclusively under each Lotee's individual Lot Contract with the Employer, and the terms of this Interface Agreement shall be without prejudice to, and shall fully preserve, each Lotee's independent rights and remedies under its respective Lot Contract.

16. Concurrent delay

Where both Lotees are concurrently in delay in respect of interface-related obligations affecting the same interface path or Project sequence, neither Lotee shall be entitled to an extension of time to the extent that its own concurrent delay would in any event have delayed the relevant activity, milestone, Section or Time for Completion.

Each Lotee shall remain liable for the consequences of its own delay in accordance with its Lot Contract.

Where concurrent delay arises from causes unrelated to interface issues between the Lotees, including Employer-risk events, authority delays or other events giving rise to relief under the relevant Lot Contract, the matter shall be assessed under the ordinary EoT and relief provisions of the relevant Lot Contract.

17. Interface meetings and governance

The Interface Agreement shall establish a structured governance process, including:

(a) regular interface coordination meetings

(b) ad hoc meetings for critical interface risks

(c) attendance by competent representatives of both Lotees

(d) updated interface action lists

(e) tracking of Interface Data

(f) tracking of Interface Milestones

(g) escalation to senior project management where required and

(h) Engineer-led decisions or determinations where agreement is not reached

Minutes of interface meetings shall record action owners, deadlines, open issues, decisions and risk items.

18. Interface Data control

Each Lotee shall be responsible for the accuracy, completeness and timely delivery of the Interface Data allocated to it.

The receiving Lotee shall promptly review the Interface Data provided and notify the Engineer and the providing Lotee of any apparent inconsistency, omission or insufficiency.

Review or use of Interface Data by the Employer, the Engineer or the other Lotee shall not relieve the providing Lotee from responsibility for the accuracy, completeness and suitability of its Interface Data.

19. Changes to Interface Milestones and Interface Programme

The Interface Programme and Interface Milestones may be updated where required by the evolution of the Project, design development, approved variations, Engineer's determinations or agreed recovery measures.

No update shall relieve a Lotee from liability for an existing breach, delay or failure to provide Interface Data unless expressly stated.

Where a proposed Variation may materially affect an interface, the affected Lotee shall be informed by the Engineer and given a reasonable opportunity to provide relevant interface comments.

20. Confidentiality and document sharing

Each Lotee shall consent to the disclosure to the other Lotee of such parts of its notices, claims, programmes, records, Interface Data and supporting particulars as are reasonably necessary for interface coordination or for the determination of an Interface Claim.

Such disclosure shall be subject to confidentiality obligations consistent with the Lot Contracts and the Interface Agreement.

The Lotees will be subject to confidentiality restrictions in respect of information exchanged under and in connection with the Interface Agreement, on the same terms as those in the Lot Contracts.

21. No partnership, agency or joint venture

Nothing in the Interface Agreement shall create any partnership, agency, joint venture or direct contractual relationship between the Lotees.

No Lotee shall have authority to bind the other Lotee or to make representations on behalf of the other Lotee.

22. Limitation of Liability

All liabilities arising out of or in connection with the Interface Agreement shall be subject to the liability regime, limitations and exclusions applicable under the relevant Lotee's Lot Contract.

23. Priority and incorporation into Lot Contracts

The Interface Agreement, the Interface Programme, the Interface Milestones Table and the Interface Data schedule shall be incorporated into each Lot Contract.

In the event of inconsistency, the order of priority shall be stated in the relevant Lot Contract. As a general principle, the Interface Agreement shall be interpreted

consistently with the Lot Contracts and shall not derogate from the Employer's rights under either Lot Contract unless expressly stated.

24. No Novation

No Lot Contract will be novated, transferred or assigned between the Lotees, and any purported novation or transfer between the Lotees in breach of this provision will be void and of no effect. For the avoidance of doubt, nothing in the Interface Agreement will be construed as effecting, or having the effect of, a novation of either Lot Contract.

25. Term of the Interface Agreement

The Interface Agreement will enter into force upon execution of, or notice to proceed (if applicable) under, both Lot Contracts and will, unless terminated in accordance with its own terms, remain in force until all of the obligations and liabilities of Lot 1 and Lot 2 under their respective Lot Contracts have been fully performed, discharged and satisfied.