CONCEPT

Hydropower Plant Engineering Course: Turbines, Penstocks, Powerhouse and Pumped Storage

8 – 19 August 2027
Dammam - Eastern Province five-star



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Ref: 1625_25844 **Date:** 8 – 19 August 2027 **Location:** Dammam - Eastern Province five-star **Fees:** 35100 SAR

Introduction:

Hydropower plant engineering, covering turbines, penstocks, powerhouse and pumped storage, is a 2-week course for plant engineering, powerhouse operations, maintenance and owner's engineering teams, ending with a Hydropower Station Upgrade and Pumped-Storage Operating Plan. Many stations run ageing units away from best efficiency, lose head in neglected waterways and miss the balancing value that solar and wind growth creates. Nominees already operate, maintain or assess hydro units; the first week builds turbine, waterway and control skills, the second adds pumped-storage operation, condition monitoring and refurbishment, taught through inspection walkthroughs. CoreConcept Training Center delivers this hydropower plant engineering course.

Course Objectives:

- Estimate the energy output of a hydropower scheme from net head, flow duration and plant factor data
- Select Pelton, Francis or Kaplan turbines for a site duty using specific speed and hill charts
- Calculate penstock and tunnel head losses and check intake, trashrack, surge tank and powerhouse arrangements
- Set governor, excitation and unit control parameters for stable synchronisation and frequency response
- Assess cavitation, erosion, test and condition monitoring data to plan runner refurbishment and uprating
- Plan pumped-storage operating modes that balance solar and wind output and prepare a Hydropower Station Upgrade and Pumped-Storage Operating Plan

Target Audience:

- Hydropower plant engineering teams responsible for turbine, generator and waterway performance
- Powerhouse operations staff who start, load, synchronise and shut down generating units
- Mechanical and electrical maintenance staff who inspect runners, governors and excitation systems
- Owner's engineering staff who review refurbishment, uprating and new unit proposals
- Pumped-storage scheduling staff who plan pump and generate cycles with the grid operator

Course Outline:

Day 1: Hydropower Fundamentals, Scheme Types and Energy Conversion

- Hydropower Power Equation Linking Head, Flow and Efficiency
- Storage, Run-of-River and Pumped-Storage Scheme Comparison
- Flow Duration Curve Construction for Firm and Average Energy
- Gross Head, Net Head and Tailwater Level Variation
- Plant Factor, Availability and Annual Energy Estimation Method

Day 2: Turbine Selection by Head, Specific Speed and Duty

- Specific Speed Chart for Matching Turbine Type to Site
- Pelton and Turgo Impulse Runners for High-Head Schemes
- Francis Reaction Runner Selection for Medium-Head Duty
- Kaplan and Bulb Units With Adjustable Blades for Low Head
- Hill Chart Reading for Efficiency Across Part-Load Operation

Day 3: Intakes, Penstocks and Pressure Tunnel Hydraulics

- Intake Layout, Submergence Depth and Vortex Avoidance Checks
- Trashrack Bar Spacing, Head Loss and Cleaning Arrangements
- Penstock Wall Thickness, Steel Grade and Anchor Block Layout
- Darcy-Weisbach Friction Loss Along Penstocks and Pressure Tunnels
- Surge Tank Role During Load Rejection and Unit Start

Day 4: Governors, Generators, Excitation and Powerhouse Layout

- Digital PID Governor Tuning for Wicket Gate Positioning
- Speed Droop Setting and Isochronous Mode in Islanded Operation
- Synchronous Generator Capability Curve and Reactive Power Limits
- Static Excitation System and Automatic Voltage Regulator Functions
- Powerhouse Layout for Unit Spacing, Crane Reach and Dismantling

Day 5: Guided Case Study on a Medium-Head Francis Station

- Case Station Hydrology Data and Flow Duration Review
- Turbine Type and Unit Number Decision for Case Site
- Penstock Head Loss and Net Head Calculation Exercise
- Governor Response Review From a Recorded Load Rejection
- Week-One Findings Note on Energy Output and Constraints

Day 6: Pumped-Storage Machines and Operating Modes

- Reversible Francis Pump-Turbine Characteristics in Both Flow Directions
- Pumping, Generating and Synchronous Condenser Mode Transitions
- Variable-Speed Doubly-Fed Units Versus Fixed-Speed Machines
- Ternary Sets With Separate Pump, Turbine and Motor-Generator
- Round-Trip Efficiency Accounting Including Conversion and Evaporation Losses

Day 7: Cavitation, Runner Erosion, Condition Monitoring and Unit Safety

- Cavitation Damage Patterns on Runner Blades and Draft Tubes
- Silt Abrasion Assessment and Martensitic Stainless Steel Overlays
- Fatigue Cracking Inspection Using Dye Penetrant and Ultrasonic Testing
- Online Vibration, Air Gap and Partial Discharge Monitoring
- Unit Isolation, Watered-Up Entry and Permit-to-Work Procedure

Day 8: Grid Balancing With Solar and Wind and Operator Coordination

- Hydro Ramping Capability for Firming Solar and Wind Output
- Frequency Response, Spinning Reserve and Black Start Services
- Daily Pump-Generate Scheduling Against Renewable Surplus Periods
- Dispatch Instruction Interface With the Transmission System Operator
- Reservoir Level Coordination With Irrigation and Water Supply Users

Day 9: Performance Testing, Station KPIs, Refurbishment and Uprating

- Index Testing and Relative Efficiency Measurement of Units
- Unit Availability, Forced Outage Rate and Start Reliability Metrics
- Runner Replacement and Uprating Feasibility With Efficiency Gain
- Generator Rewind and Stator Insulation Renewal Planning
- Station Benchmarking of Water-to-Wire Efficiency Between Units

Day 10: Inspection Walkthrough and Station Upgrade and Operating Plan Build

- Powerhouse Walkthrough Checklist for Turbine, Generator and Auxiliaries
- Condition Findings Ranking for Case Station Upgrade Scope
- Uprating Option Selection Using Hill Chart and Index Test Data
- Pumped-Storage Mode Schedule Against Case Renewable Profile
- Hydropower Station Upgrade and Pumped-Storage Operating Plan Completion

Skills You Will Gain:

- Turbine Type Selection
- Net Head and Energy Estimation
- Penstock Hydraulic Assessment
- Governor and Excitation Tuning
- Runner Cavitation Diagnosis
- Hydro Condition Monitoring
- Pumped-Storage Scheduling
- Unit Uprating Appraisal

Why Attend This Course:

- Deliver a Hydropower Station Upgrade and Pumped-Storage Operating Plan to the station manager and the asset investment committee
- Decide whether a worn runner should be repaired, replaced like for like or uprated to a new hydraulic profile
- Avoid forced outages, cavitation damage and lost grid services caused by units run outside their efficient range
- Brief operators and maintenance crews on governor settings, mode transitions and inspection priorities

Conclusion:

Back at work, the participant gives the station manager and the asset investment committee a Hydropower Station Upgrade and Pumped-Storage Operating Plan for one of the organisation's stations. Managers use it to decide which units to refurbish or uprate first, which governor and excitation settings to revise, and how pumped-storage or flexible units are scheduled against solar and wind output. After the first outage season or scheduling cycle, the unit should compare measured efficiency, availability and forced outages with the plan's targets and update its priorities.

Frequently Asked Questions FAQ:

What should participants know before a hydropower plant engineering course?

Participants should already work on the operation, maintenance or assessment of hydro units and read basic hydraulic and electrical drawings. Bringing anonymised unit data, test records or an inspection report from their own station makes the walkthrough and case work more useful.

How does hydropower plant engineering differ from a dam safety or general rotating equipment course?

It concentrates on the generating chain: turbines, waterways, governors, generators, powerhouse and pumped-storage operation. Dam safety courses cover structures, spillways and emergency planning, and general rotating equipment courses cover process pumps and compressors, which this course touches only briefly.

Why does pumped storage matter in hydropower plant engineering today?

Pumped storage absorbs surplus solar and wind output by pumping water to an upper reservoir and returns it as generation when demand rises. Its fast ramping, reserve and frequency support make it a practical balancing resource as variable renewable output grows.

What do participants take back from the hydropower plant engineering course?

Participants take back a Hydropower Station Upgrade and Pumped-Storage Operating Plan built on a case station, with a walkthrough checklist, a condition findings ranking, an uprating option comparison and a mode schedule to adapt for their own plant.