

PUNATSANGCHHU-I HYDROELECTRIC PROJECT AUTHORITY

Standard Operating Procedure (SOP)

1.0 Purpose

This SOP defines the minimum safety requirements and procedures for all personnel working on the construction of 1200 Mega Watt Punatsangchhu-I Hydroelectric Project (including Dam, Powerhouse, Tunnels, Adits, Water Conductor Systems and Electro-Mechanical etc.). Its aim is to mitigate risks of accidents, fatalities, and environmental damage while ensuring structural integrity, safety, and compliance with environmental, social, and technical standards.

All contractors, consultants, and PHPA-I personnel shall comply with the provisions of this SOP.

2.0 Scope

It covers site preparation, civil excavation, concrete work, and underground excavation during the construction phase namely the following but not limited to:

- Dam and spillway works
- Excavation
- Slope stabilization works
- Electro-mechanical installation
- Switchyard construction
- Infrastructure works
- Temporary construction facilities

3.0 Policy Statement

PHPA-I is committed to:

- Zero fatality objective
- Compliance with national laws and approved standards
- Leadership-driven safety culture
- Employee participation in safety improvement
- Continuous monitoring and improvement

No task shall be performed unless it is safe to do so.

4.0 Legal and Regulatory Compliance

All works shall comply with:

- Applicable Laws of the Kingdom of Bhutan
- Environmental clearance conditions
- Approved Detailed Project Report (DPR)
- Dam safety guidelines
- National building and electrical codes
- Contract agreements

Non-compliance shall attract disciplinary and contractual action.

5.0 Roles and Responsibilities

- **Managing Director:** Bears final responsibility for safety and provides resources for mitigating risks.
- **Engineer-In-Charges/Site Engineers/Supervisors:** Monitors daily operations, ensures PPE usage, and verifies that work follows this SOP.
- **Resident Geologist:** Monitoring of slope stability and foundation safety.
- **Safety Officer:** Ensures compliance, conducts audits, and manages emergency responses. Responsible for ensuring adherence to safety protocols (PPE, scaffolding, blasting safety).
- **Quality Control (QC) personnel:** Conducts sampling, testing, and inspection of materials (e.g., concrete, steel).
- **Environment Focal:** Responsible for ensuring compliance with Environmental Management Plans (EMP).
- **Contractors/Workers:** Adhere to all safety instructions and immediately report hazards.

6.0 Site Access Control

No person shall enter the construction site without:

- Valid identification
- Safety induction certification
- Mandatory PPE

Restricted Areas:

- Underground tunnels
- Active blasting zones
- High slope stabilization zones
- Heavy lifting zones
- High voltage areas

Unauthorized access is strictly prohibited.

7.0 Site Safety Procedures (General)

- **Induction Training:** All personnel must complete a site-specific safety induction before starting work.
- **Permit to Work (PTW):** A mandatory PTW system is required for high-risk activities (e.g., confined space, blasting, working at height, excavation).
- **Morning Safety Talk:** Daily 15-minute briefings to communicate risks for the day's tasks.
- **Work Zone Setup:** Demarcate excavation, lifting, or high-voltage zones with barricades and warning signs.
- **PPE Requirement:** Hard hat, safety boots, high-visibility vest, and safety glasses are mandatory, with specialized PPE (harnesses, respirators) as needed. Additional PPE as per task risk assessment. Defective PPE shall be replaced immediately.
- **Depth Risk Precaution:** Sloping, shoring, or shielding must be used for trenches deeper than 1.5 meters.

8.0 Specific Construction Activity SOPs

8.1 Underground Areas

- **Ventilation:** Active ventilation must be maintained to ensure safe breathing air quality.
- **Monitoring:** Daily geological mapping and continuous monitoring for water ingress.
- **Emergency Escape:** Independent escape routes and refuge chamber must be marked and functional in underground, powerhouse, or dam areas.
- **Oxygen Level:** Shall not fall below permissible lower limit.
- **Group Working:** No lone working permitted

8.2 Explosives and Blasting

- **Authorized Personnel:** Only licensed blasters may handle explosives.
- **Warning System:** Strict siren/warning system to evacuate the area before blasting.
- **Storage:** Explosives must be stored in specialized, secure magazines.

8.3 Concrete Work (RCC/Gravity Dam)

- **Surveying:** Survey and mark excavation boundaries.
- **Excavation:** Execute excavation work (soil/rock blasting) as per design drawings.
- **Removal:** Transport excavated materials to designated disposal areas.
- **Inspection:** Perform geotechnical inspection of the foundation, obtain approval from the geological team, and remove loose rock.
- **Pouring:** RCC to be spread within permissible time period of dumping and compacted in the prescribed layers.
- **Crane Operation:** Tower cranes or high-capacity hydraulic cranes to be used for shifting formwork/reinforcement. Crane operation plans must be approved.
- **Removing Water:** Ensure continuous dewatering of the riverbed within the cofferdams to enable excavation.
- **Vigilance:** Monitor water levels and reinforce cofferdams as required.
- **Batching:** Mix concrete according to approved mix design (Grade and strength).
- **Transportation & Placement:** Transport concrete to the site and place it within approved time limits to prevent cold joints.
- **Compaction:** Utilize vibrators for adequate compaction.
- **Curing:** Maintain concrete curing for the specified period as prescribed.
- **Material Inspection:** Verify steel quality, aggregate, and cement against specifications.
- **Testing:** Take concrete cubes for strength testing as stipulated.
- **Non-Conformance Report (NCR):** If work does not meet specifications, an NCR is issued, and work is halted until corrective action is verified.

- **Material Storage:** Cement must be stored in dry conditions, and steel raised off the ground to prevent corrosion.

8.4 Working Near Water

- **Cofferdam Integrity:** Regular inspection of cofferdams, especially during monsoon, to prevent premature failure.
- **Safety Barriers:** High-visibility barricades and warning signs must be placed along all excavation edges, steep slopes, and water bodies.
- **Water Safety:** Lifejackets are mandatory for work over or near water.
- **Monitoring:** Upstream water levels must be monitored periodically.

8.5 Lifting & Heavy Equipment

- **Lift Plan:** A written and approved lift plan is required for critical lifts (e.g., turbines, penstocks).
- **Signaler:** A dedicated signaler must be used if the operator's view is obstructed.
- **Safe Working Load (SWL):** No crane or hoist shall be loaded beyond its SWL.
- **Certified operators:** Only certified operators shall be allowed to operate cranes, excavators, and dump trucks.
- **Danger Zone:** "No-Go" zones must be established around operating machinery.
- **Records:** Daily maintenance logs for equipment must be signed off.
- **Line of Fire Prevention:** Tag lines to be used during the lifting operations of suspended loads to control rotation, swinging, and positioning from a safe distance

8.6 Working at Height

- **Requirement:** Certified scaffolding only.
- **Safety:** Full body/double lanyard harness mandatory.
- **Records:** Daily scaffold inspection log required.
- **Weather:** To be monitored as and when required
- **Fall Protection:** Guardrails & toe boards

8.7 Electrical Safety

- Lock-Out/Tag-Out (LOTO) mandatory
- Authorized electricians only
- Earthing verification
- Insulated tools

9.0 Environmental Safeguards

- Solid waste must be disposed of at designated areas. No waste to be dumped into the river.
- Sedimentation tanks to be used for water contaminated with tunnel debris (muck).
- Controlled muck disposal
- Dust suppression measures
- Waste segregation
- Oil spill containment

- Maintenance of minimum environmental flow

10.0 Quality Control (QC)

- **Material Inspection:** Test steel, cement, and aggregate before use.
- **Routine Checks:** Ensure daily monitoring of construction activity.
- **Tests:** Concrete strength tests must be recorded and approved before proceeding with subsequent structures.
- **Mandatory testing includes:**
 - i) Cement quality
 - ii) Reinforcement steel tensile strength
 - iii) Aggregate grading
 - iv) Grout strength
 - v) Shotcrete core testing
- **Non-Conformance Report (NCR):** If work does not meet specifications, an NCR is issued, and work is halted until corrective action is verified.
- **Documentation:** Maintain daily logs of excavation volumes, concrete placed, and testing results.

11.0 Permit to Work (PTW) System

Mandatory permits required for:

- Working at height (>2m)
- Confined space entry
- Hot work
- Blasting
- Electrical isolation (LOTO)
- Heavy lifting
- Excavation
- Energization & commissioning

Permit validity: One shift only unless revalidated or otherwise.

12.0 Hazard Identification

- Job Safety Analysis (JSA) prior to high-risk activities
- Daily toolbox talks
- Periodic safety inspections

13.0 Risk Assessment

Risk = Severity × Likelihood

Categorization:

- Low
- Medium
- High
- Critical

High and Critical risks require management approval before work.

14.0 Risk Management

Major risks shall be continuously monitored including:

- Slope instability
- Geological uncertainties
- Monsoon flooding
- Supply chain delays

Mitigation measures shall be documented in the Risk Register.

15.0 Control Hierarchy

- i) Eliminate hazard
- ii) Substitute
- iii) Engineering controls
- iv) Administrative controls
- v) PPE

16.0 Incident Reporting & Investigation

16.1 Reporting

- Immediate notification for serious incidents
- Preliminary report within 12 hours
- Detailed report within 7 days

16.2 Investigation

- Root cause analysis
- Corrective and preventive actions
- Lessons learned dissemination

17.0 Traffic and Logistics Management

- Designated traffic routes
- Speed control/limit enforcement
- Flagmen at hazardous points
- Equipment parking regulation
- Reverse alarm systems
- Certified operators
- Separate pedestrian paths

18.0 Emergency Response Procedures

- **Communication:** A reliable, 24/7 radio/telephone communication system must be established.
- **Evacuation:** Clearly marked, unobstructed escape routes for all work areas, especially tunnels.
- **Route:** All staff must move to the designated/respective "Safe Assembly Point".
- **Emergency Team:** An on-site medical first aid station and rescue team must be available.
- **Alarm System:** A three-tone siren indicates immediate evacuation.

- **Incident Reporting:** Any incident, near-miss, or accident must be reported to the Safety Officer as soon as possible.

19.0 Emergency Preparedness

Emergency Action Plan (EAP) applicable for:

- Landslides
- Tunnel collapse
- Major injury
- Fire
- Flood
- Seismic event

Emergency facilities:

- First aid centers
- Ambulance (24/7)
- Fire extinguishers
- Rescue kits
- Emergency communication system

Quarterly drills mandatory.

What to do:

- **Landslide:** Immediate work stoppage and geotechnical inspection.
- **Flood Event:** Evacuation of riverbed works and monitoring of water levels.
- **Major Injury:** Activation of medical response within one hour.
- **Seismic Event:** Evacuation of underground areas and structural inspection prior to restart.

20.0 Documentation

- Daily Progress Report (DPR).
- Geological mapping of excavations.
- Concrete pouring records.
- Safety incident reports.

21.0 Document Control

Maintain records of:

- Permits
- Incident reports
- Medical records
- Training logs
- Inspection checklists
- Audit reports

Retention period: Minimum 5 years.

22.0 Audit and Review

- Periodical internal safety audit

- Periodical QA audit
- Periodic third-party geotechnical review
- Annual SOP review

23.0 Occupational Health Management

23.1 Medical Examination

- Pre-employment medical check
- Annual health screening
- Fitness certification for high-risk work

23.2 Occupational Exposure Monitoring

- Dust monitoring
- Noise level measurement
- Vibration assessment
- Illumination checks

23.3 9.3 Preventive Measures

- Dust suppression
- Adequate ventilation
- Hydration points
- Heat stress management
- Hearing conservation program

24.0 Employees'/Workers' Welfare

24.1 Accommodation

- Safe and structurally sound housing
- Fire safety compliance
- Adequate lighting and ventilation

24.2 Sanitation

- Clean toilets (separate for men & women)
- Safe drinking water
- Regular waste disposal

24.3 Mess/Canteen Facilities

- Hygienic cooking
- Food safety inspection
- Clean dining area

24.4 Grievance Redressal

- Complaint register
- Anonymous reporting system
- Non-retaliation policy

25.0 Safety Performance Monitoring

Key Performance Indicators (KPIs):

- Lost Time Injury Frequency Rate (LTIFR)
- Total Recordable Incident Rate (TRIR)
- Near-miss reporting frequency
- PPE compliance rate
- Training coverage percentage

26.0 Non-Compliance

Violation of this SOP will result in immediate suspension of work and disciplinary action.

27.0 Review & Continuous Improvement

This SOP shall be:

- Reviewed annually
- Revised after major incident
- Updated based on audit findings
- Approved by Managing Director

28.0 Effective Date

This SOP shall come into force on the date of approval and shall remain valid until revised or superseded.

Prepared by:



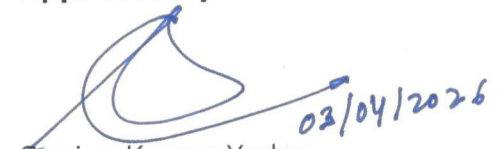
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