GLOBAL INTERVENTION

Engineering Sheet of Analysis

Basis for Parameters Calculation in Operations

Energy Formula Access

P&ID / 1-Page Sketch — Mining Container Cooling System (≈1.04 MW, ΔT = 10 K)

Single-phase immersion cooling in racks → dielectric fluid circuit → plate heat exchangers (PHE) → secondary water loop → external sink (river / chiller).
Designed for Q = 1.04 MW (320 × 3.25 kW).

1. Core Data

- **Q:** 1.04 MW (thermal load)
- **ΔT:** 10 K (example: supply 20 °C / return 30 °C)
- **c□, w:** 4.186 kJ/kg·K
- **Mass flow:** m = Q / (c□ · ΔT) = 24.85 kg/s ≈ 89.4 m³/h

2. Component Schematic (Simplified P&ID – flow direction →)

[Miner Racks (Immersion Tanks)] → [Primary Pumps (Skid) (N+1)] → [Fine Filter/Strainer] → [Plate Heat Exchangers (PHE) 2× in parallel] → [Secondary Water Loop (DN100–150, 89.4 m³/h)] → [External Sink: River/Lake or Chiller/Cooling Tower] → return to PHE

Additional components:
Reservoir/expansion tank (2–4 m³) on dielectric side, air vent, PLC/HMI, leak detectors, temperature & flow sensors.

3. Component List

- Immersion Racks fluid-filled, single-phase dielectric tanks
- Pump Skid**:** 2× duty (N+1) vertical centrifugal pumps, motors **11 kW** each (recommended)
- Plate Heat Exchangers: 2× PHE (each ≈ 0.6 MW capacity)
- Reservoir / Expansion Vessel: 2–4 m³
- Main Piping: DN100–DN150 (steel / stainless steel), ball valves, strainers

- Flow meters: ultrasonic / vortex, temperature sensors PT100, differential pressure across PHE
- PLC + HMI + BMS Gateway, alarm box, emergency shut-off relay
- Leak detectors (immersion tanks), drip trays
- Optional: Chiller ≈ 1.2 MW / Cooling tower (if no free sink available)

4. Hydraulic Design

- Water flow rate: **V̇ = 89.4 m³/h**
- Chosen velocity: v ≈ 1.5–3.0 m/s → pipe size ≈ DN100–150
- System head (assumed): H_V ≈ 20 m (incl. PHE, filters, friction losses)
- Pump shaft power (theoretical): P_a = ρ · g · Q · H / η
  - with ρ = 1000 kg/m³, Q = 24.85 kg/s, H = 20 m, η ≈ 0.70 → P_a ≈ 6.97 kW
  - Selected motor: **11 kW** (incl. reserve & losses)

5. Heat Exchanger Design

- Target: Q_total = 1.04 MW
- Recommendation: 2 × PHE in parallel ≈ 1000–1500 W/(m²·K)
- LMTD: ≈ 8–12 K (for supply 20 / return 30 on secondary side ± external sink)
- Approx. surface area: A ≈ Q / (U · LMTD) → ≈ 70–120 m² (total, both PHE combined)

6. Control & Safety Logic

- Pump start/stop: PLC with fallback (auto sequence Pump 1 → Pump 2 → Alarm)
- Temperature limits: Return > 35 °C → Alarm + Controlled Power Throttle / Graceful Shutdown
- Flow loss: Δflow > 20% → Alarm + Emergency Shutdown
- Leak detector: Immediate safe shutdown (power off, pumps stop)
- Routine tests: Weekly pump run, monthly filter check, annual PHE inspection

7. Installation Notes

- Place PHE and pumps preferably in external technical shed or at container end → reduces heat and fire load inside miner container.
- Immersion tank sealing: Check IP/ingress ratings and O-ring specifications; install drip trays.
- EMC: Separate power supply for pump controls & PLC with surge protection.
- Hydraulics: Flange connections, air vents at high points, flush / bypass line for maintenance.

8. Acceptance Checks

- Q_measured (temperature + flow): within ± 5% of Q_calc
- ΔT stable at 10 K under full load
- Redundancy: Pump failure → backup operational within 30 s without over-temperature
- Leak detector function verified

Legend / Abbreviations

- **Q:** Heat load (W)
- **ṁ:** Mass flow (kg/s)
- **V̇:** Volumetric flow (m³/h)
- **PHE:** Plate Heat Exchanger
- **PLC:** Programmable Logic Controller

Cost Estimate – Cooling Architecture for 1 MW Mining Container

Pos.	Component / Module	Description / Function	Cost [USD] (≈)
1	Immersion Racks / Tanks (≈ 16 units)	Liquid cooling baths with ASIC mounts	**32 000**
2	Dielectric coolant (≈ 3 200 L)	Non-conductive thermal transfer fluid	**16 000**
3	Main pump system (3 × 11 kW, N+1)	Heat transfer circuit, stainless centrifugal pumps	**3 000**
4	Plate heat exchangers (2 × 0.6 MW)	Container ↔ coolant heat exchange	**30 000**
5	Hydraulic skid (filters, valves, instrumentation)	Complete intermediate module with fittings	**10 000**
6	Control / PLC / sensors	Temperature and flow control, alarm functions	**3 000**
7	Air-/water cooler (dry cooler / optional chiller support)	Heat dissipation to ambient / return loop	**15 000**
8	Piping, insulation, fittings (DN 100–150)	Complete container piping system	**8 000**
9	Container modification & installation works	Structural adaptations, openings, drip trays	**30 000**
10	Electrical distribution (PDU, wiring, protection)	Load distribution and safety systems	**20 000**
11	On-site installation & commissioning	Setup, functional tests, documentation	**40 000**
–	**Subtotal**		**207 000**
12	Engineering / Commissioning (≈ 10 %)	Design, P&ID, testing, acceptance	**20 700**
13	Transport/Customs/Reserve(≈15 %)	Logistics and risk buffer	**34 200**

→ Total (CAPEX, complete system): ≈ 261 900 USD