

GRANDE DIXENCE

TECHNICAL DOCUMENTATION





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HYDROELECTRIC COMPLEX** 6-17

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THE GRANDE DIXENCE HYDROELECTRIC COMPLEX

Grande Dixence is not only the tallest gravity dam in the world, it is also a masterpiece of technical sophistication and daring devoted entirely to energy. Standing shoulder to shoulder with the highest mountains in Switzerland's Valais region, the structure is the keystone of a vast hydroelectric complex which includes five pumping stations, over 100 km of headrace tunnels cut into the rock and three power plants. Come and discover the Grande Dixence complex!

GRANDE DIXENCE HYDROELECTRIC COMPLEX



The tallest gravity dam in the world

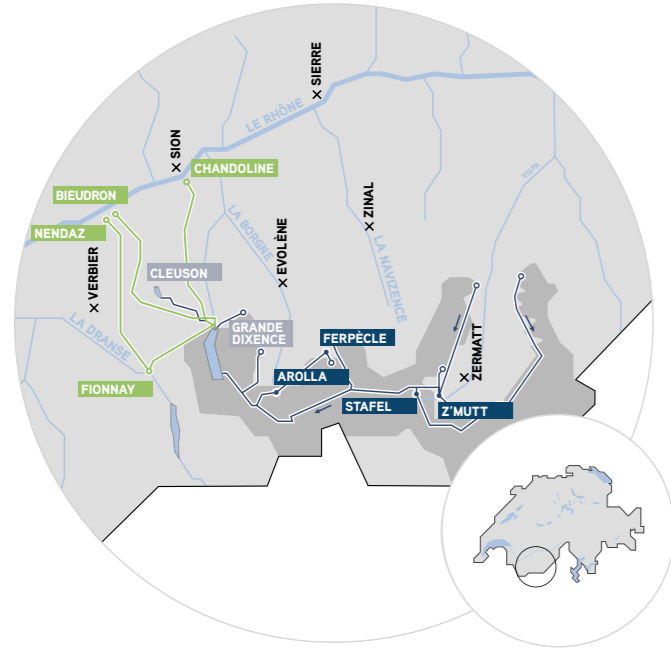
Grande Dixence is not only the tallest gravity dam in the world, it is also a living legend.

Level with the highest mountains in the Valais, this structure is a masterpiece in technical skill and audacity channelled into energy. At first sight, you will be astounded by the 285 m of concrete towering above you; once you reach the top of the facility, the stunning view of the Lac des Dix and the valley will take your breath away. The top of the dam forms a gigantic panoramic terrace 15 m wide and nearly 700 m long at an altitude of 2,365 m.

Grande Dixence was built in 1961 to replace the first Dixence dam, which is now at the bottom of the Lac des Dix. It took over 10 years to build this new structure, which is located in a vast hydroelectric complex completed in 1965. The reservoir holds all the water from a catchment area of 420 km² half covered by glaciers. It is these 35 glaciers which, via 75 water intakes, 5 pumping stations (Z'Mutt, Stafel, Ferpècle, Arolla and Cleuson) and 100 km of tunnels, feed the Lac des Dix.

The 400 million m³ of water stored behind the Grande Dixence dam represent 20% of the electricity generated in Switzerland. To make the hydraulic force of the Lac des Dix as profitable as possible, Grande Dixence drives water through its turbines at two levels. The first is at an altitude of 1490 m in the Fionnay plant. The second is level with the Rhône, 1000 m lower at the Nendaz plant. To transform this vast quantity of water into electricity and harness this tranquil force into billions of kWh, the Fionnay and Nendaz power stations work in relay.

PANORAMIC VIEW OF THE FACILITIES



■ CATCHMENT AREA

— HEADRACE GALLERY

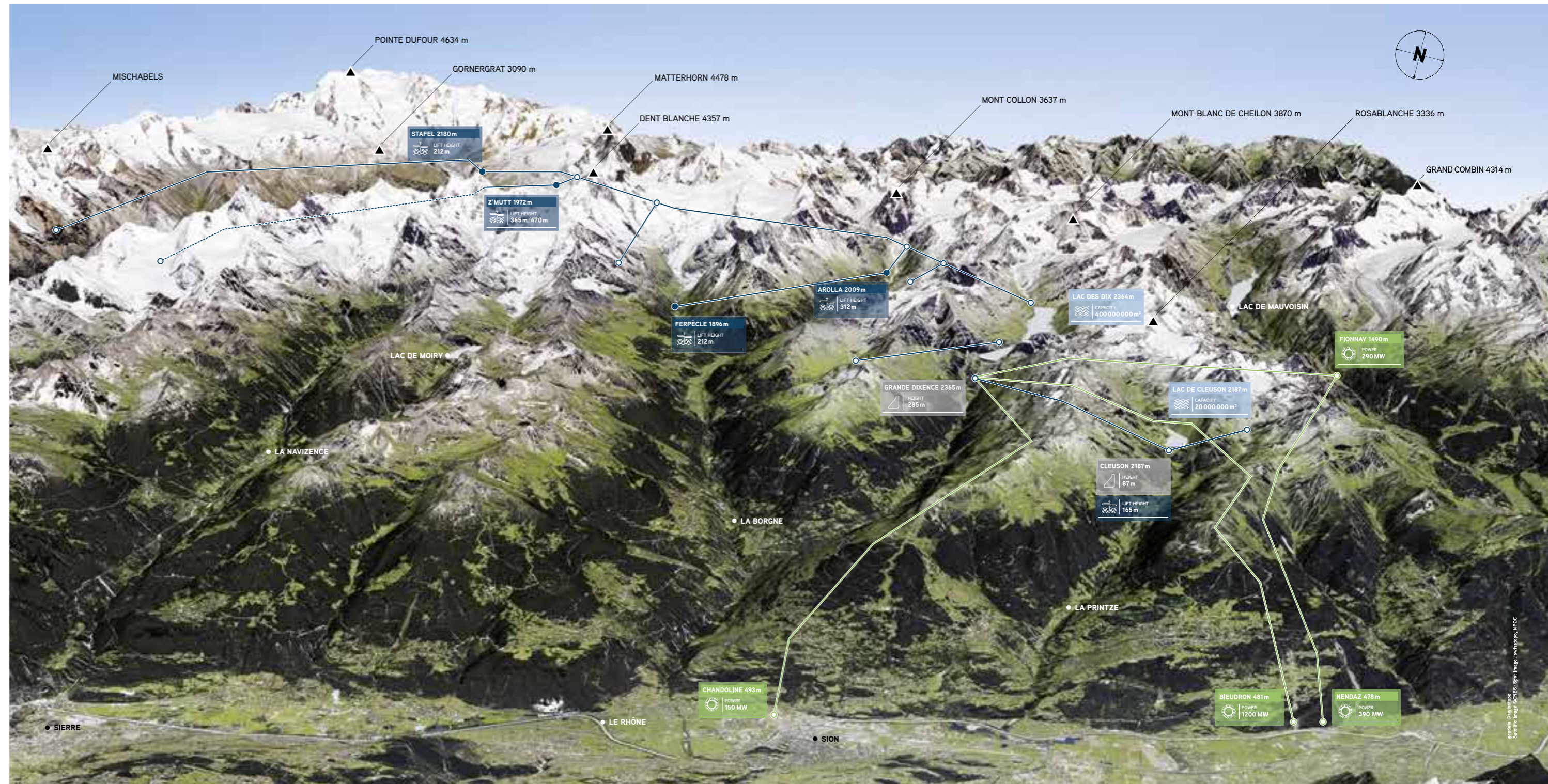
— PENSTOCK

▲ DAM

☞ LAKE

☀ PRODUCTION PLANT

⚡ PUMPING STATION



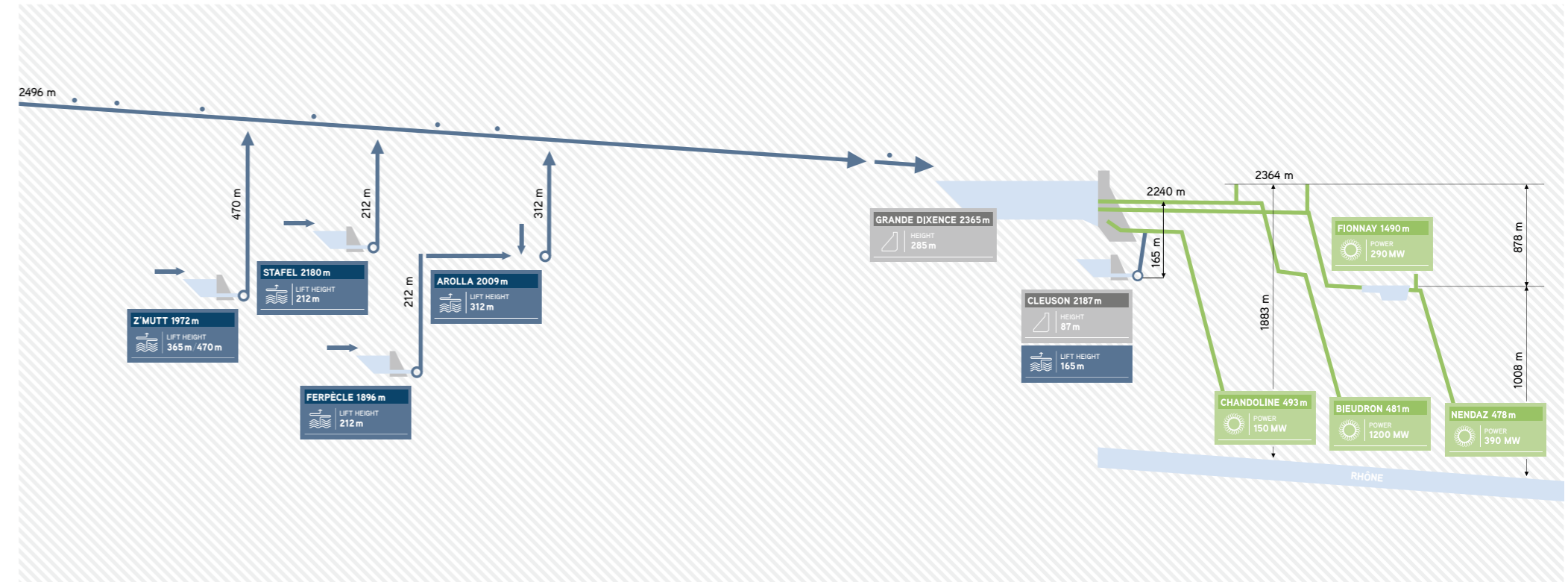
GRANDE DIXENCE HYDROELECTRIC COMPLEX LONGITUDINAL PROFILE

With the current installations at Fionnay and Nendaz, the Grande Dixence complex produces a total power output of 800 MW. The Bieudron power plant enables this power output to be increased by 1,200 MW, thereby taking the total power output of the complex to 2,000 MW. Like other hydroelectric facilities, the main purpose of Cleuson-Dixence is to provide power instantly, on demand. In just 4 minutes, the installation is able to provide the network with power equivalent to that of a nuclear power station!

The energy produced across all the Grande Dixence-Cleuson-Dixence facilities reaches approximately 2 billion kWh per year, which corresponds to the average annual consumption of 400,000 households.

Grande Dixence SA does not stop at using a renewable energy source. The trustee of an exceptional natural reserve, it has made firm commitments to a policy of sustainable development. This has been undertaken to ensure the use of natural resources is constantly optimised and to limit the actual or possible impact of its installations on the environment. The energy produced by Grande Dixence is certified by several environmental labels.

- █ COLLECTING WORK
- █ STORAGE
- █ PRODUCTION





COLLECTING WORK

The conveyance network collects water from a 420 km² reservoir bordered by the Mischabel, Matterhorn and Mont Gelé mountains, two thirds of which is covered by glaciers. Through 100 kilometres of galleries, including a main tunnel which is 24 kilometres long, at an altitude of 2400 metres in the heart of the mountain, 35 glaciers supply the facility's raw material via 75 water intakes and 5 pumping stations. Together they supply on average 500 million m³ of water every year.

PUMPING STATION Z'MUTT

Set at the foot of the Mattertal, the Z'Mutt pumping station (alt. 1972 m) is the most powerful within the Grande Dixence complex. It is fed by water from the Bis and Schali glaciers which rise above the Visp river, and from the Gorner glacier.

Four pumps with a total power of 88 MW are used at Z'Mutt to pump around 140 million m³ of water every season. This water is pumped to a penstock which carries it to the Trift tunnel (altitude of 2400 metres) in the main collector.

The impact of the concrete on the environment has been kept to a minimum. The only major visible element is the arch dam which crosses the gorge. Apart from the service building, all of the facilities (gravel traps, sand traps and pumping station) are underground.

TECHNICAL SPECIFICATIONS

AFTERBAY RESERVOIR

CONSTRUCTION	1961 - 1964
HEIGHT	74 m
CREST	144 m
THICKNESS AT THE CREST	3 m
VOLUME OF CONCRETE	32,000 m ³
CAPACITY	800,000 m ³
TYPE	Arch dam

PUMPING STATION

POWER	2 x 30 MW; 2 x 14 MW
FLOW RATE	17.4 m ³ /s
DISCHARGE HEAD	365 m / 470 m



Z'Mutt afterbay reservoir at the foot of the Matterhorn

Z'MUTT PUMPING STATION

PLAN OF LOCATION

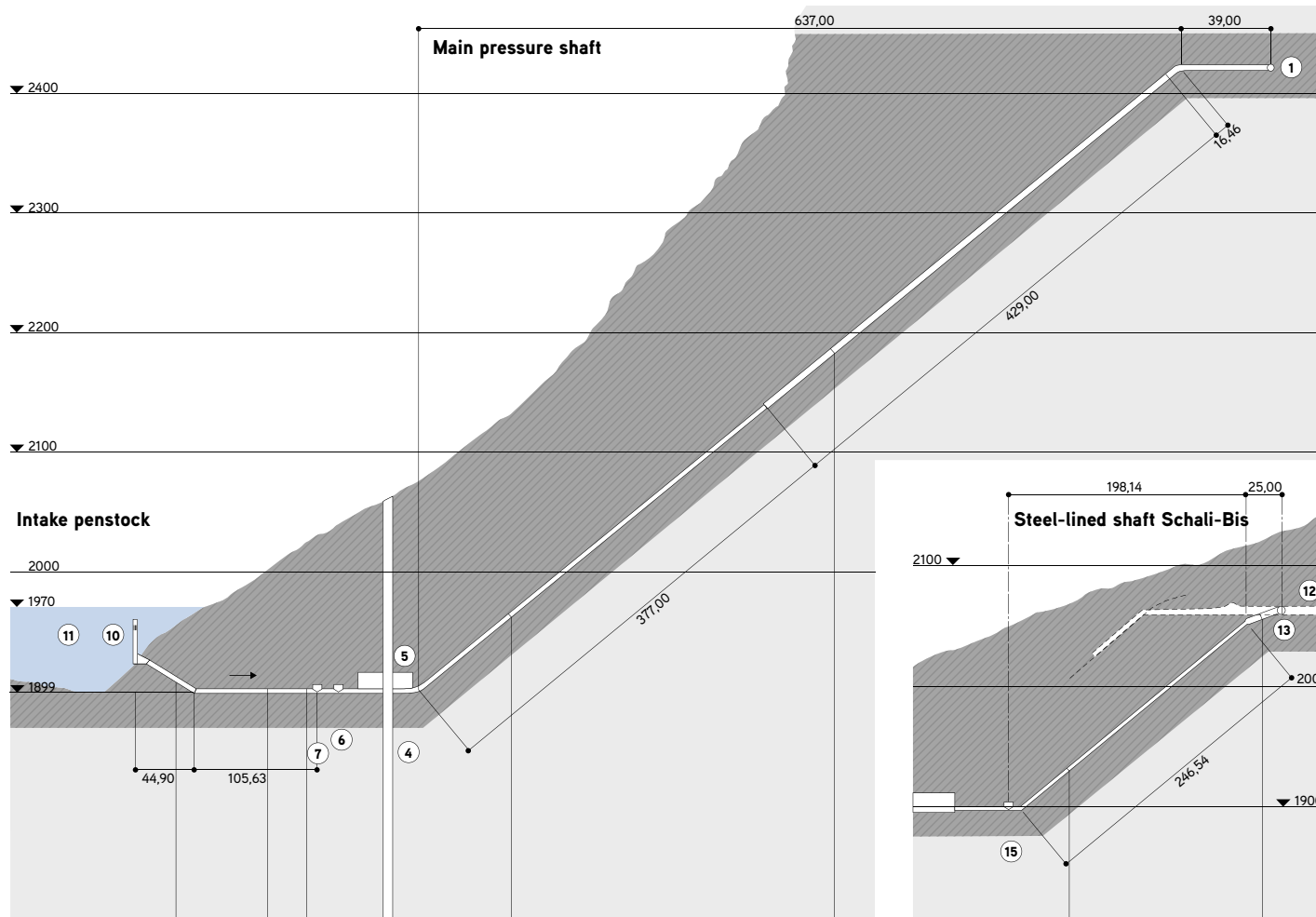


Z'Mutt arch dam on the edge of the Mattertal

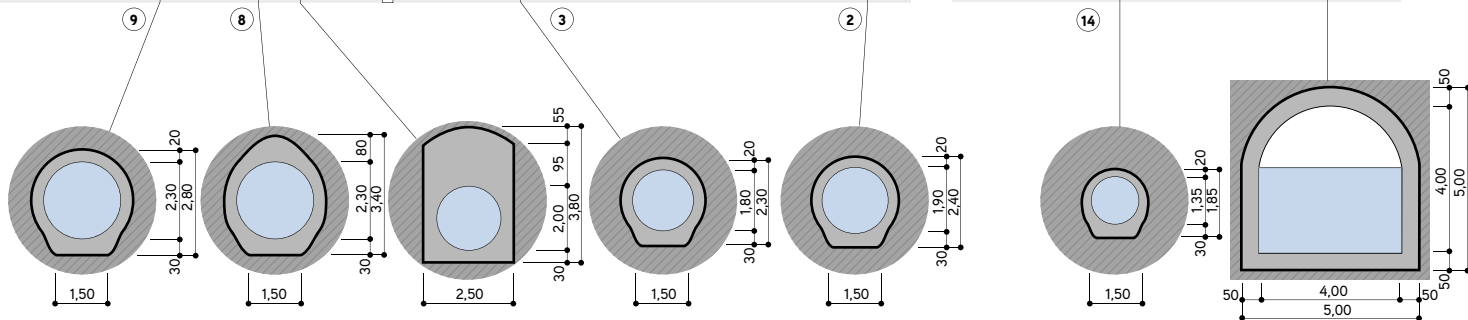
- | | | |
|--------------------------------------------------------------------------------------|--------------------------------------------------------------------|--------------------------------------------------|
| 1 ARCH DAM | 8 BODMEN COMPENSATING CHAMBER, CAPACITY APPROX. 2000m ³ | 15 BOTTOM GALLERY |
| 2 Z'MUTT COMPENSATING BASIN, USEFUL CAPACITY APPROX. 800,000m ³ | 9 SCHALI-BIS CATCHMENT DIVERSION TUNNEL, Q = 8.0m ³ /s | 16 ACCESS TUNNEL TO DAM |
| 3 FLOATING WATER INTAKE | 10 COMPENSATING CHAMBER TUNNEL AND OVERFLOW PIPE | 17 DAM VALVE CHAMBER |
| 4 2.30m Ø CATCHMENT DIVERSION TUNNEL | 11 ADMINISTRATION AND CONTROL BUILDING | 18 CABLES SHAFT |
| 5 UNDERGROUND PUMPING STATION | 12 ZERMATT - Z'MUTT CABLEWAY | 19 SUBSTATION |
| 6 STEEL-LINED DISCHARGE SHAFT TO UPPER MAIN TUNNEL (TRIFT) Q = 17.4m ³ /s | 13 ACCESS TUNNEL TO PUMPING STATION | 20 130kV TRANSMISSION LINE |
| 7 BIS SHAFT, STEEL-LINED, 1.35m Ø | 14 BRIDGE | 21 ROAD TUNNEL |
| | | 22 HEADRACE TUNNEL TO THE MUTT POWER PLANT (EWZ) |

Z'MUTT PUMPING STATION

LONGITUDINAL AND TRANSVERSAL PROFILES OF Z'MUTT CONDUITS AND SHAFTS



- 1 TRIFT TUNNEL
- 2 STEEL-LINED 1.90m Ø, LINING THICKNESS 14 - 11.5 mm
- 3 STEEL-LINED 1.80m Ø, LINING THICKNESS 24 - 14 mm
- 4 HIGH-PRESSURE VALVES
2x 0.80m Ø
2x 0.70m Ø
- 5 Z'MUTT PUMPING STATION
- 6 LOW-PRESSURE VALVES
1x 1.60m Ø
2x 1.20m Ø
- 7 2.00m Ø INLET VALVE
- 8 STEEL-LINED 2.30m Ø
GRADIENT 2%
- 9 STEEL-LINED 2.30m Ø
GRADIENT 60%
- 10 FLOATING WATER INTAKE
- 11 Z'MUTT COMPENSATING BASIN,
USEFUL CAPACITY
APPROX. 800,000 m³
- 12 SCHALI-BIS TUNNEL
- 13 BODMEN COMPENSATING CHAMBER
USEFUL CAPACITY,
APPROX. 2000 m³
- 14 LINED OVER 246.54m, 1.35m Ø
LINING THICKNESS 9mm
GRADIENT - 80%
- 15 SCHALI-BIS LOW-PRESSURE VALVES
1x 1.00m Ø
1x 1.40m Ø





The Matterhorn overlooking the Zermatt hydroelectric facilities

Z'MUTT PUMPING STATION HYDRAULIC DIAGRAM

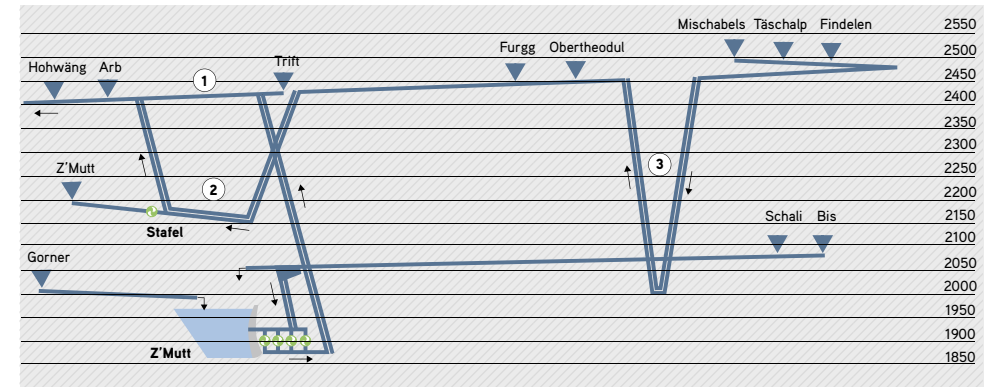
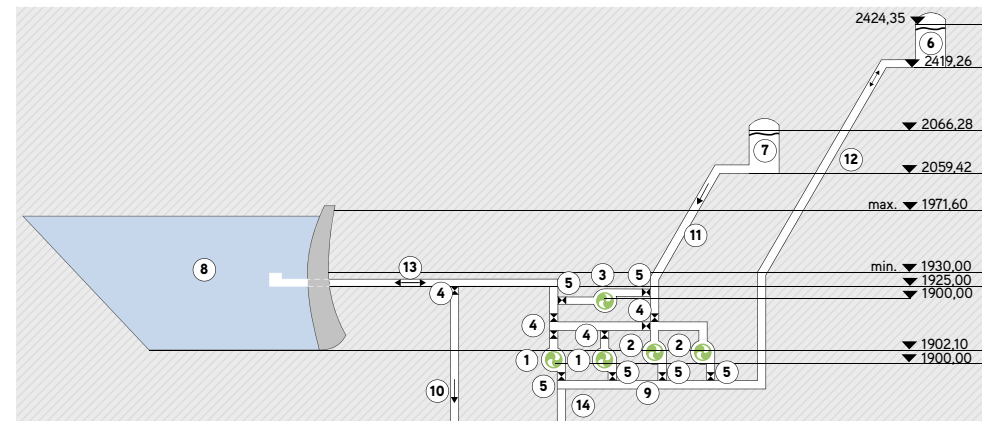


DIAGRAM OF ZERMATT VALLEY INSTALLATIONS

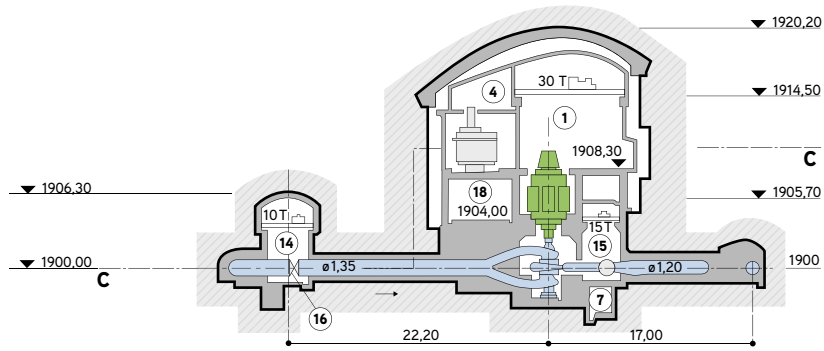
- 1 MAIN DIVERSION TUNNEL
- 2 Z'MUTT SYPHON
- 3 GORNER SYPHON
- FREE FLOWING TUNNELS
- PRESSURE SHAFTS
- ▼ INTAKES
- ⊕ PUMPING STATIONS



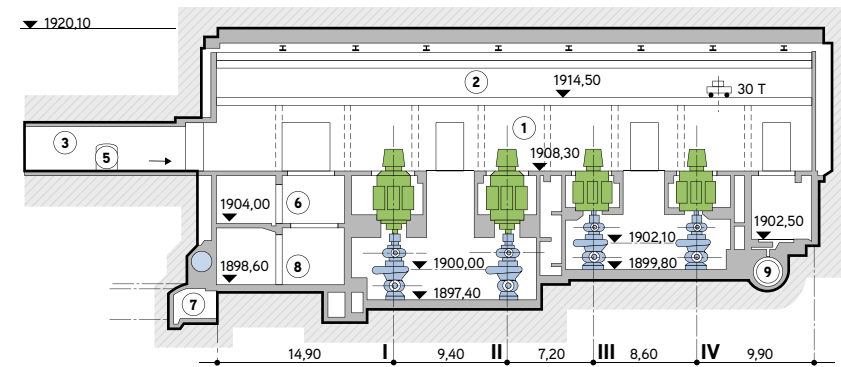
DETAILED VIEW OF Z'MUTT PUMPING STATION

- 1 VERTICAL-SHAFT PUMP
Q = 5.5 m³/s, H = 470 m
- 2 VERTICAL-SHAFT PUMP
Q = 3.2 m³/s, H = 365 m
- 3 PUMP
Q = 2 m³/s, H = 90-130 m
- 4 BUTTERFLY VALVES
- 5 SPHERICAL VALVES
- 6 TRIFT TUNNEL
- 7 SCHALI-BIS TUNNEL
- 8 Z'MUTT COMPENSATING BASIN,
USEFUL CAPACITY
APPROX. 800,000 m³
- 9 Z'MUTT PUMPING STATION
- 10 OUTLET
- 11 STEEL-LINED SHAFT SCHALI-BIS
- 12 MAIN PRESSURE SHAFT
- 13 INTAKE PENSTOCK
- 14 DEPARTURE MUTT (EWZ)

Z'MUTT PUMPING STATION INSTALLATION PLANS



CROSS-SECTION A-A



LONGITUDINAL SECTION B-B

STATION EQUIPMENT AND OPERATION

SUMMER PUMPING

- A. 2 SETS EACH CONSISTING OF:
 - 1 pump discharging 5.5 m³/s against 470 m head, and
 - 30 MW motor
- B. 2 SETS EACH CONSISTING OF:
 - 1 pump discharging 3.2 m³/s against 365 m head, and
 - 14 MW motor

- C. 1 REGULATING SET CONSISTING OF:
 - 1 pump discharging 2 m³/s against 90-130 m head, and
 - 3 MW motor
 Total discharge of pumps: 17.4 m³/s

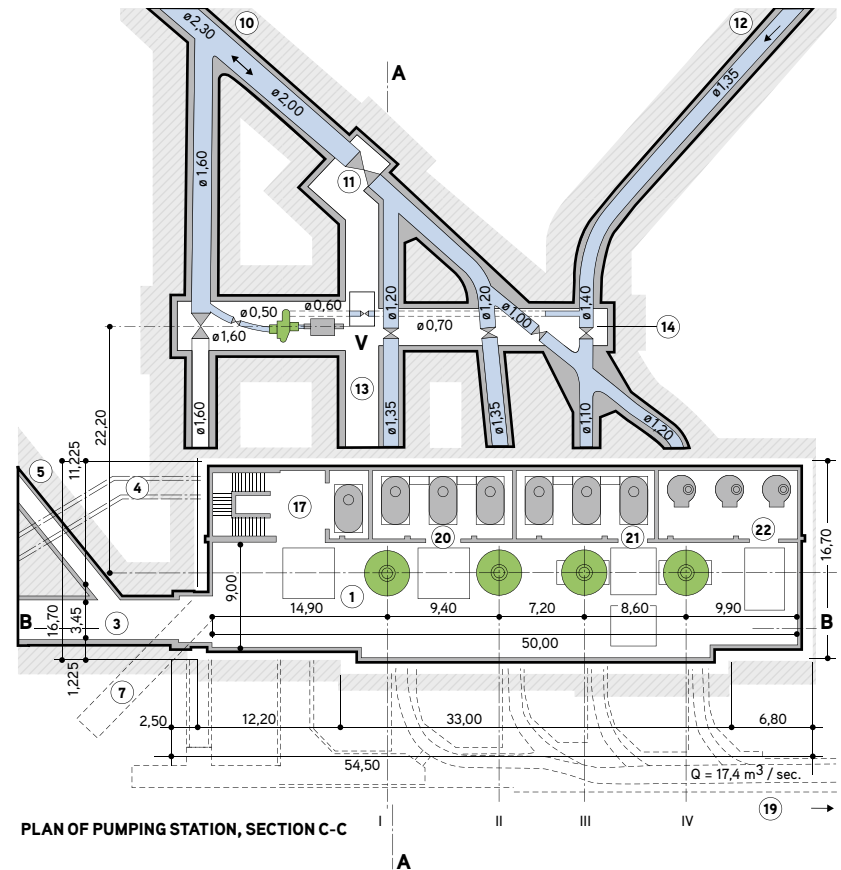
WINTER GENERATION

In winter water from the Trift tunnel is used by sets B, acting as turbines and is returned to the Z'Mutt compensating basin.

10 SINGLE-PHASE TRANSFORMERS 130/10 KV

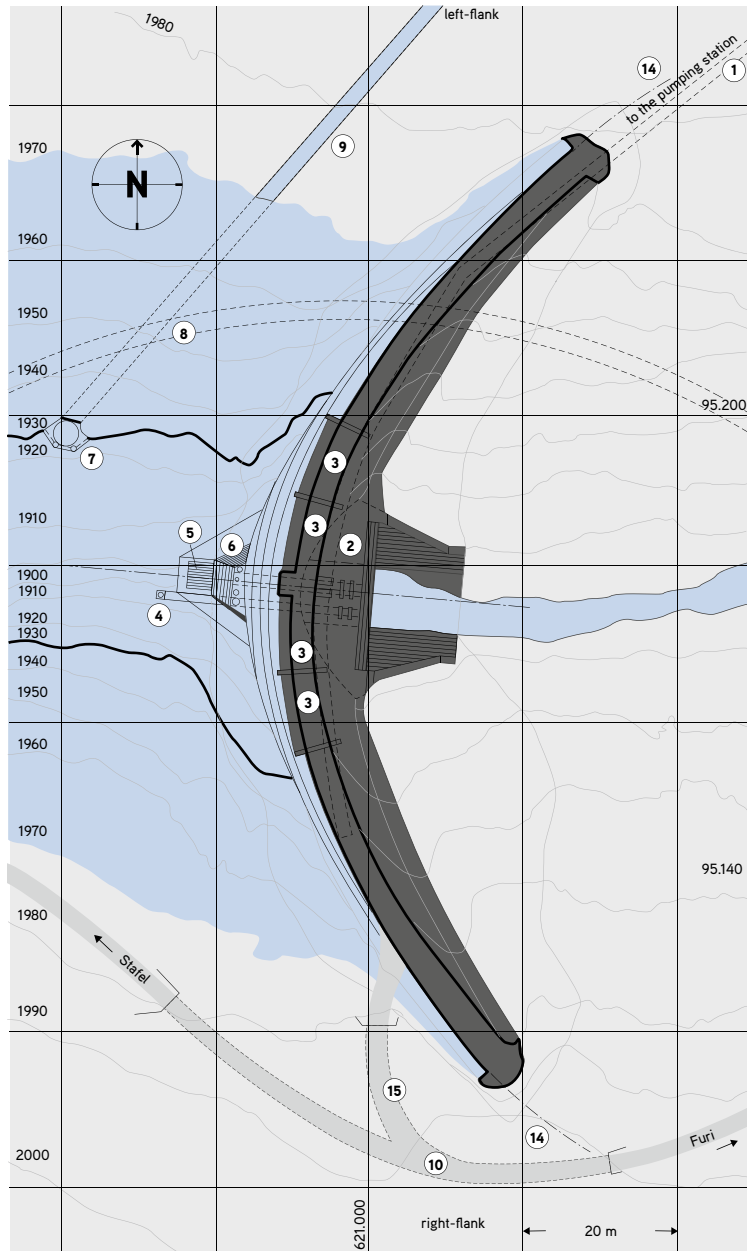
(including 1 standby unit) rated at $\frac{30\text{ MVA}}{3}$

- | | | |
|--------------------------------|-------------------------------------------------------|------------------------|
| 1 MACHINES HALL | 11 INLET VALVE | 20 TRANSFORMERS I |
| 2 RAILS FOR 30T OVERHEAD CRANE | 12 BIS SHAFT ~80% GRADIENT, Q = 8.4 m ³ /s | 21 TRANSFORMERS II |
| 3 MAIN ACCESS TUNNEL | 13 ACCESS TO VALVES | 22 TRANSFORMERS III-IV |
| 4 CABLES TUNNEL | 14 LOW-PRESSURE VALVES GALLERY | |
| 5 DAM ACCESS TUNNEL | 15 HIGH-PRESSURE VALVES GALLERY | |
| 7 BOTTOM TUNNEL | 16 1.20 m Ø VALVE | |
| 8 STORE | 17 STANDBY TRANSFORMER | |
| 9 OIL SUMP | 18 AUXILIARIES | |
| 10 SUPPLY PIPE | 19 TRIFT SHAFT | |

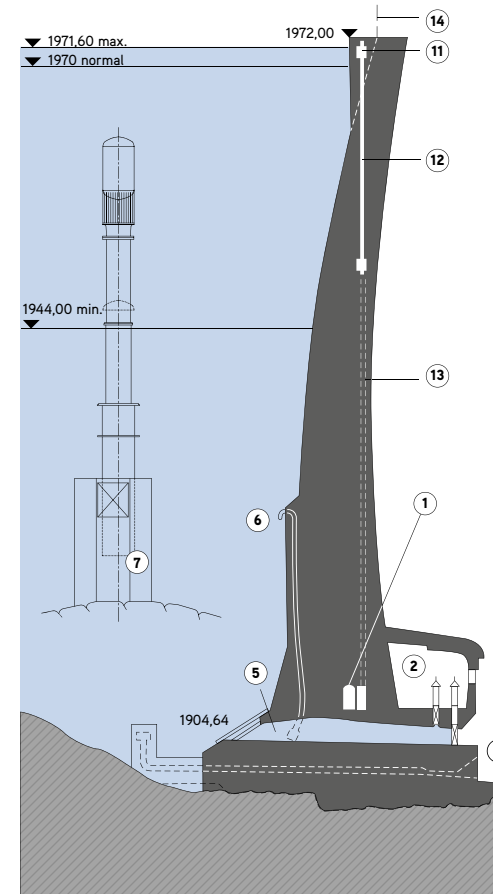


PLAN OF PUMPING STATION, SECTION C-C

Z'MUTT PUMPING STATION Z'MUTT DAM



PLAN OF DAM



SECTION THROUGH AXIS OF DAM

- | | | |
|---------------------------------|-------------------------------------------|-----------------------------------|
| 1 ACCESS TUNNEL | 8 DIVERSION TUNNEL | 14 REFERENCE CYLINDER |
| 2 VALVES HOUSE | 9 2.30 m Ø SUPPLY PIPE TO PUMPING STATION | 15 ACCESS TUNNEL TO THE DAM CREST |
| 3 OVERFLOWS | 10 FURI-STAFEL ROAD TUNNEL | |
| 4 RESTITUTION SLUICE | 11 PENDULUM SUSPENSION CHAMBER | |
| 5 BOTTOM SLUICE | 12 0.80-0.60 m Ø ACCESS SHAFT | |
| 6 PURGE PIPES FOR BOTTOM SLUICE | 13 0.40 m Ø PENDULUM SHAFT | |
| 7 FLOATING WATER INTAKE | | |

PUMPING STATION

STAFEL

Located at the foot of the Matterhorn (alt. 2180 m), the Stafel station pumps 70 million m³ of water every year. It is supplied with water from the Z'Mutt glacier. The station pumps the water up to the collector, which is located 250 metres higher. Two large sand traps and an afterbay reservoir complete the infrastructure.

TECHNICAL SPECIFICATIONS

AFTERBAY RESERVOIR

CAPACITY 80,000 m³

PUMPING STATION

POWER 3 x 8.8 MW
FLOW RATE 9.9 m³/s
DISCHARGE HEAD 212 m
TRANSFORMERS 4 x 9.5 MVA (single phase) – 130/5 KV



Sand traps for the Stafel pumping station

STAFEL PUMPING STATION

PLAN OF LOCATION

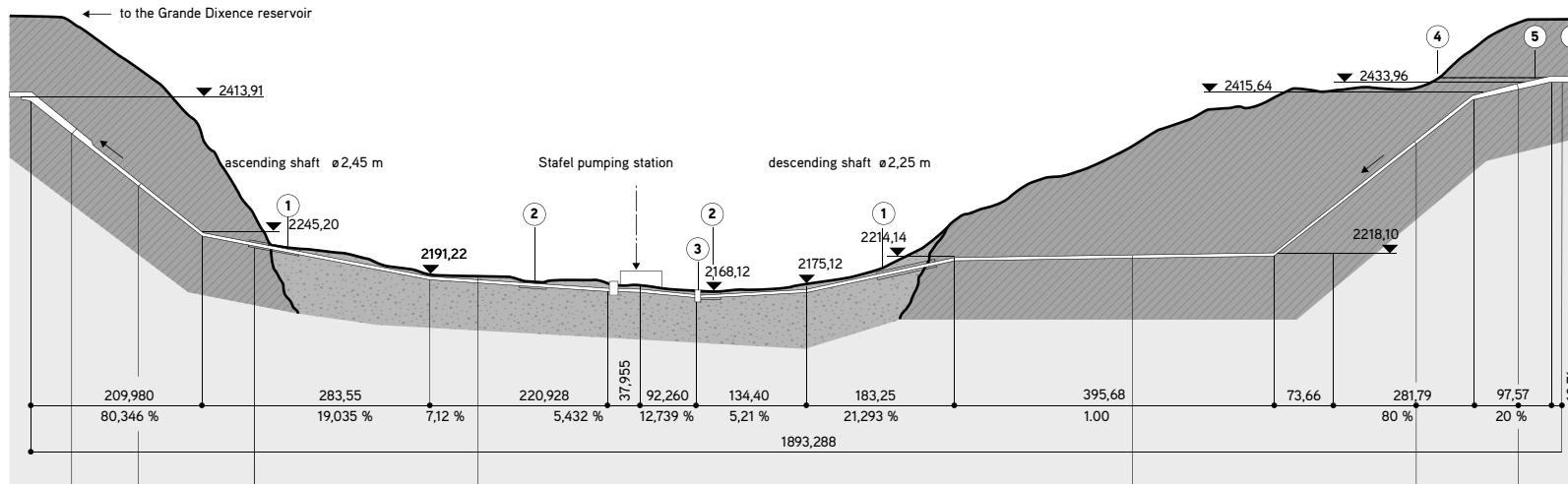


Stafel afterbay reservoir

- | | | |
|--------------------------------------------------|--------------------------------------------------------------------|-------------------------------------|
| 1 EMBANKMENTS | 9 EMPTYING AND OVERFLOW TUNNEL | 15 ACCESS ROAD |
| 2 DAM | 10 STILLING BASIN | 16 STREAM CONTROL STRUCTURES |
| 3 INTAKE | 11 BURIED 1.80m Ø PENSTOCK, Q = 9.9m³/s | |
| 4 FORE CANAL | 12 BURIED 2.25 AND 2.45m Ø SYPHON PIPE, Q = 21.3 - 31.2m³/s | |
| 5 2 GRAVEL TRAPS
Q = 2 x 7.5m³/s | 13 SYPHON EMPTYING AND PURGING STRUCTURE | |
| 6 GRAVEL TRAP PURGE TUNNEL | 14 END OF 130 kV LINE AND SUBSTATION | |
| 7 WINTER SUPPLY CANAL | | |
| 8 INTAKE, EMPTYING AND OVERFLOW STRUCTURE | | |

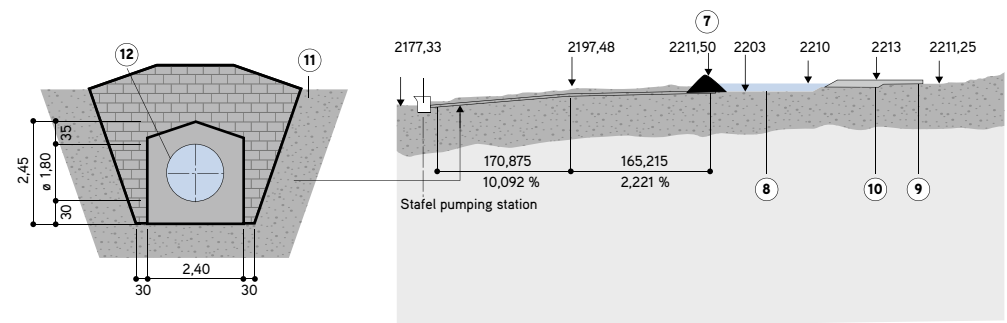
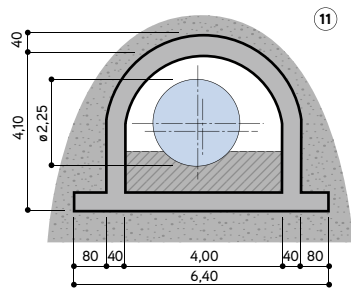
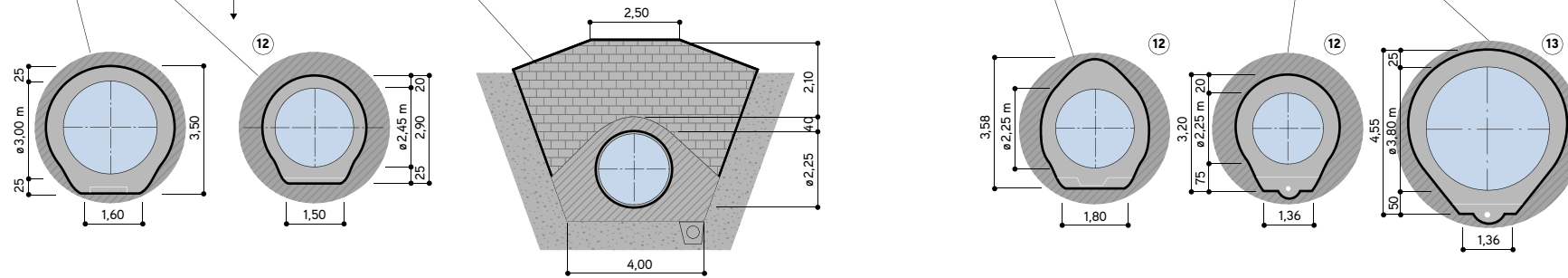
STAFEL PUMPING STATION

LONGITUDINAL AND TRANSVERSAL PROFILES OF CONDUITS



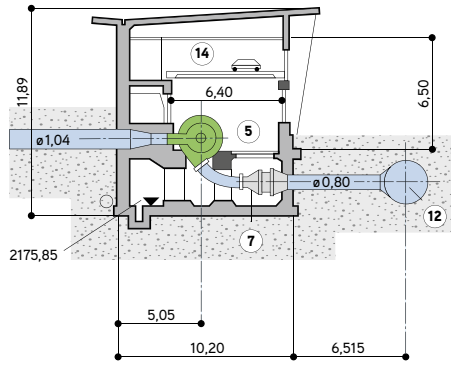
- 1 STRUCTURE AT TRANSITION FROM ROCK TO MORAINE
- 2 PASSAGE UNDER STREAM
- 3 SYPHON EMPTYING AND PURGING ARRANGEMENTS
- 4 ADIT
- 5 FURGG TUNNEL
- 6 BULKHEAD GATE
- 7 EARTHFILL EMBANKMENT
- 8 STAFEL COMPENSATING BASIN, USEFUL CAPACITY 80 000 m³
- 9 INTAKE
- 10 2 GRAVEL TRAPS
Q = 2 x 7.5 m³/s
- 11 MORAINE
- 12 STEEL LINING
- 13 REINFORCED GUNITE

LONGITUDINAL PROFILE OF SYPHON

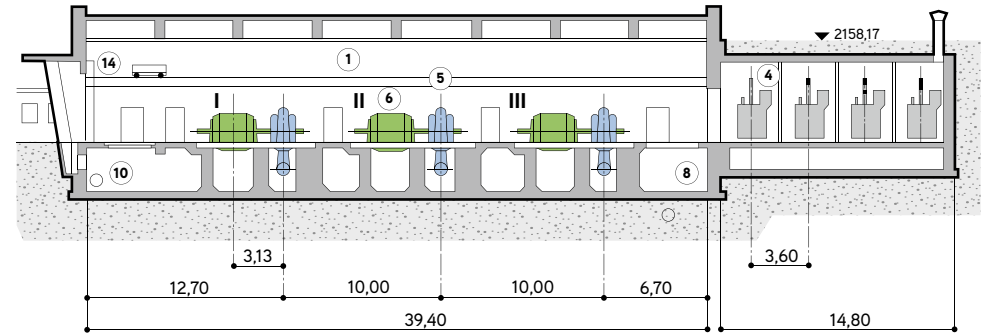


LONGITUDINAL PROFILE OF BURIED PIPELINE BETWEEN BASIN AND PUMPING STATION

STAFEL PUMPING STATION INSTALLATION PLANS

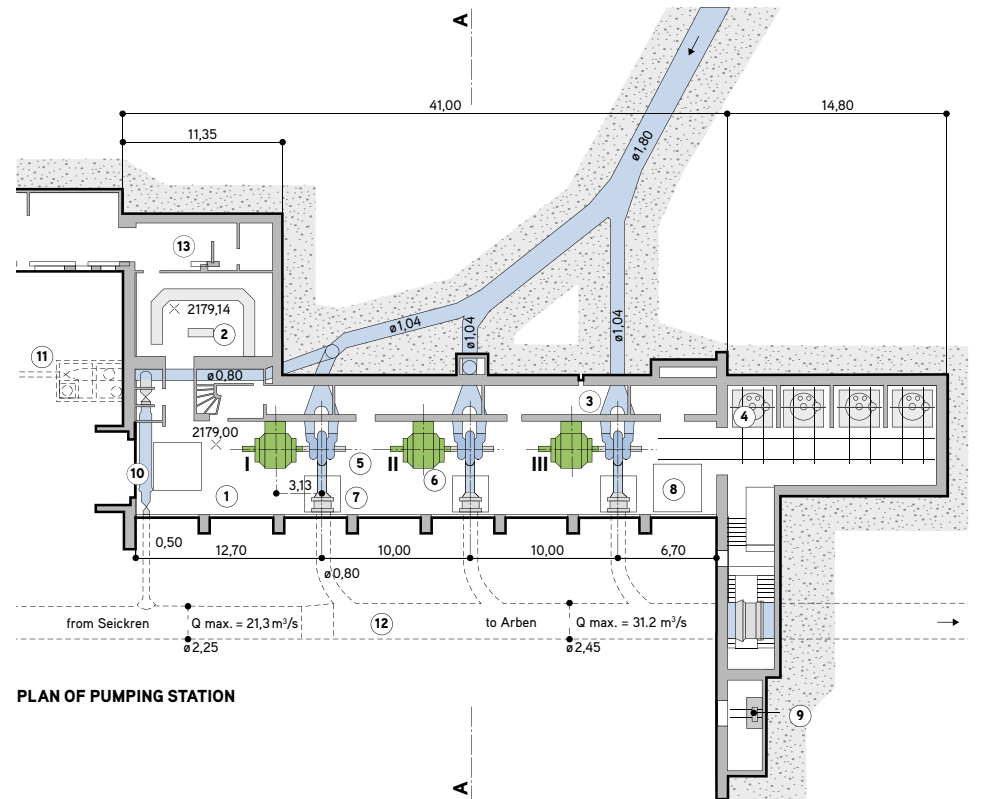


CROSS-SECTION A-A



LONGITUDINAL SECTION

- 1 MACHINES HALL
- 2 CONTROL ROOM
- 3 5kV SWITCHGEAR
- 4 TRANSFORMERS
- 5 PUMPS
- 6 MOTORS
- 7 3 0.70m Ø VALVES
- 8 UNTANKING AREA
- 9 20kV STANDBY TRANSFORMER FOR STATION AUXILIARIES
- 10 0.50 m Ø BY-PASS VALVE WITH ENERGY DISSIPATOR
- 11 0.40m Ø PENSTOCK EMPTYING VALVE
- 12 2.45m Ø SYPHON
- 13 AUXILIARIES
- 14 OVERHEAD CRANE



PLAN OF PUMPING STATION

PUMPING STATION FERPÈCLE

Located deep in the Hérens valley (alt. 1896 m), the Ferpècle pumping station collects the water from the Ferpècle and Mont Miné glaciers. Every year, 3 pumps transfer around 60 million m³ of water up the 212-metre gully to the Arolla pumping station via the Maya reservoir. The total output from the facility is 8.4 m³/second.

The power station is hidden inside the mountain. Only a dam, two sand traps and a gravel trap are visible. To prevent floodwater entering the installations, the Ferpècle water intake is equipped with a restrictor on the sand trap.

TECHNICAL SPECIFICATIONS

AFTERBAY RESERVOIR

CONSTRUCTION	1962 - 1964
HEIGHT	25.5 m
CREST	91 m
VOLUME OF CONCRETE	6000 m ³
CAPACITY	100,000 m ³
SURFACE AREA	1.1 ha
TYPE	Arch dam

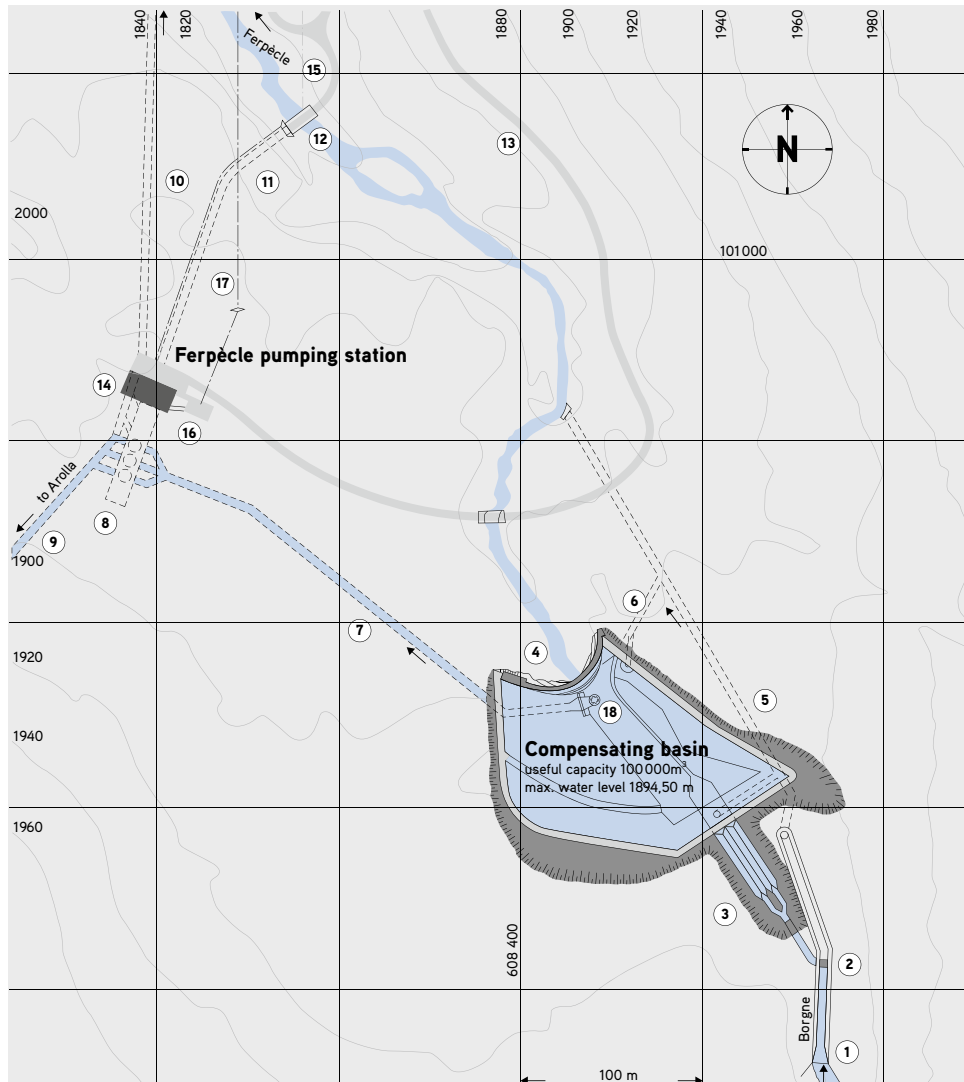
PUMPING STATION

POWER	3x7.1 MW
FLOW RATE	8.4 m ³ /s
DISCHARGE HEAD	212 m



Ferpècle pumping station water intake

FERPÈCLE PUMPING STATION PLAN OF LOCATION



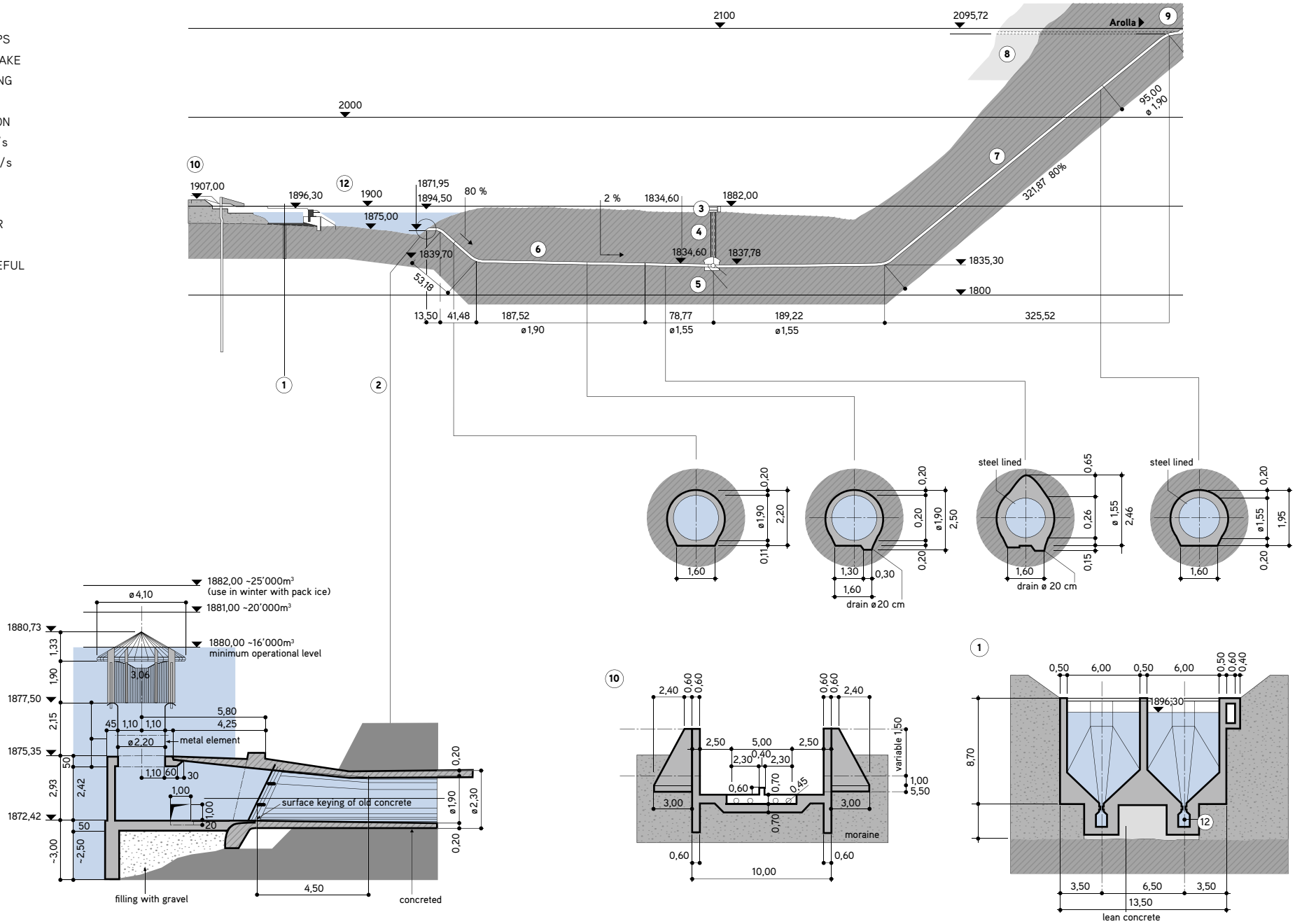
Ferpècle afterbay reservoir in the Hérens valley

- | | | |
|----------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| 1 WATER INTAKE IN THE RIVER | 8 UNDERGROUND PUMPING STATION | 14 SERVICE BUILDING |
| 2 INTAKE, $Q = 11 \text{ m}^3/\text{s}$ | 9 INCLINED DELIVERY SHAFT
GRADIENT 80%, 1.55m \emptyset ,
$Q = 0.15 \text{ m}^3/\text{s}$ | 15 MOURTI DIVERSION PIPE 0,25m \emptyset ,
$Q = 0.15 \text{ m}^3/\text{s}$ |
| 3 2 SAND TRAPS | 10 BOTTOM STATION GALLERY | 16 SUBSTATION |
| 4 25.5m HIGH ARCH DAM | 11 STATION ACCESS TUNNEL | 17 LES HAUDÈRES-FERPÈCLE
130kV LINE |
| 5 SPILLWAY TUNNEL, $Q = 200 \text{ m}^3/\text{s}$ | 12 STATION ACCESS BRIDGE | 18 POWER STATION WATER INTAKE |
| 6 DEWATERING AND
OVERFLOW TUNNEL | 13 ACCESS ROAD TO SERVICE
BUILDING | |
| 7 1.90m STEEL-LINED SUPPLY
TUNNEL TO PUMPING STATION | | |

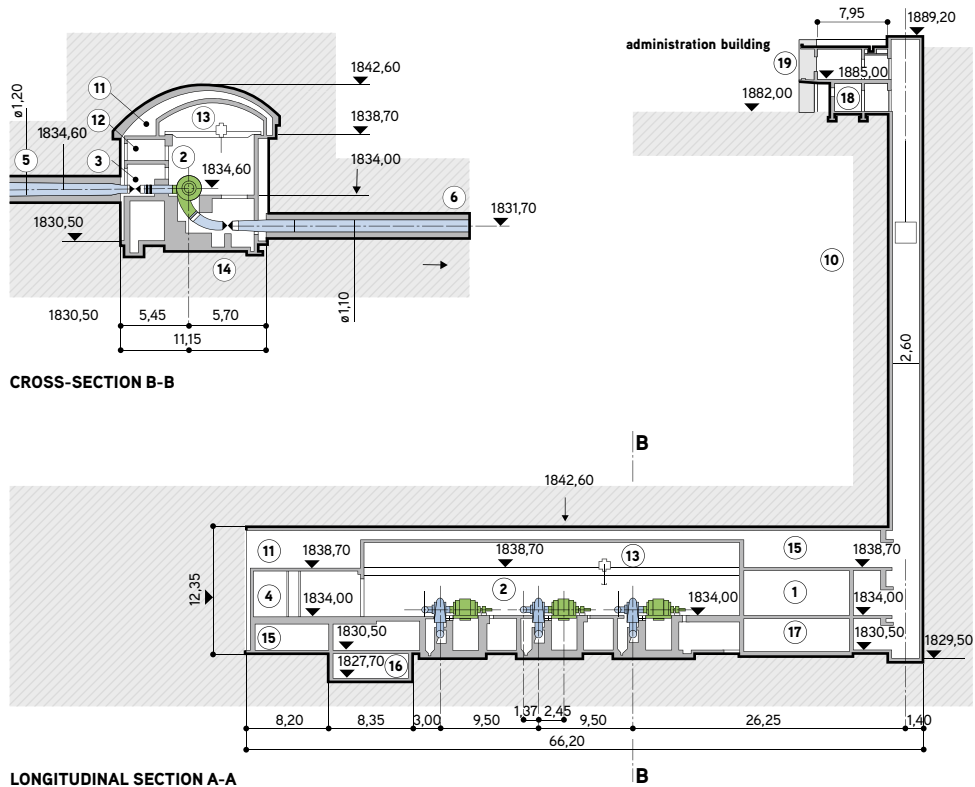
FERPÈCLE PUMPING STATION

LONGITUDINAL AND TRANSVERSAL PROFILES OF CONDUITS

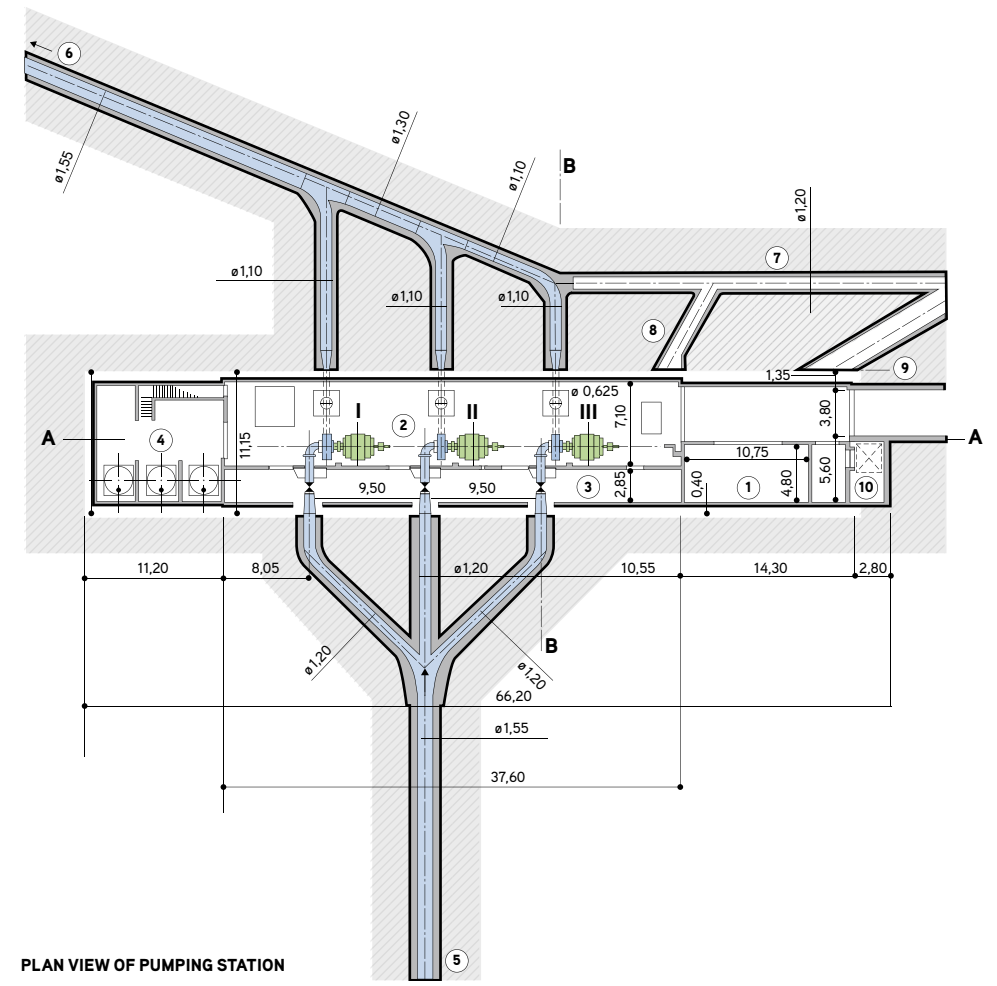
- 1 TWO 2x5.5m³/s SAND TRAPS
- 2 POWER STATION WATER INTAKE
- 3 FERPÈCLE SERVICE BUILDING
- 4 ACCESS TO LIFT
- 5 FERPÈCLE PUMPING STATION
- 6 SUPPLY TUNNEL, Q=8.4m³/s
- 7 DELIVERY SHAFT, Q=8.4m³/s
- 8 ADIT
- 9 VEISIVI TUNNEL
- 10 WATER INTAKE IN THE RIVER
- 11 PURGE FLUME
- 12 COMPENSATING BASIN, USEFUL CAPACITY 100,000m³



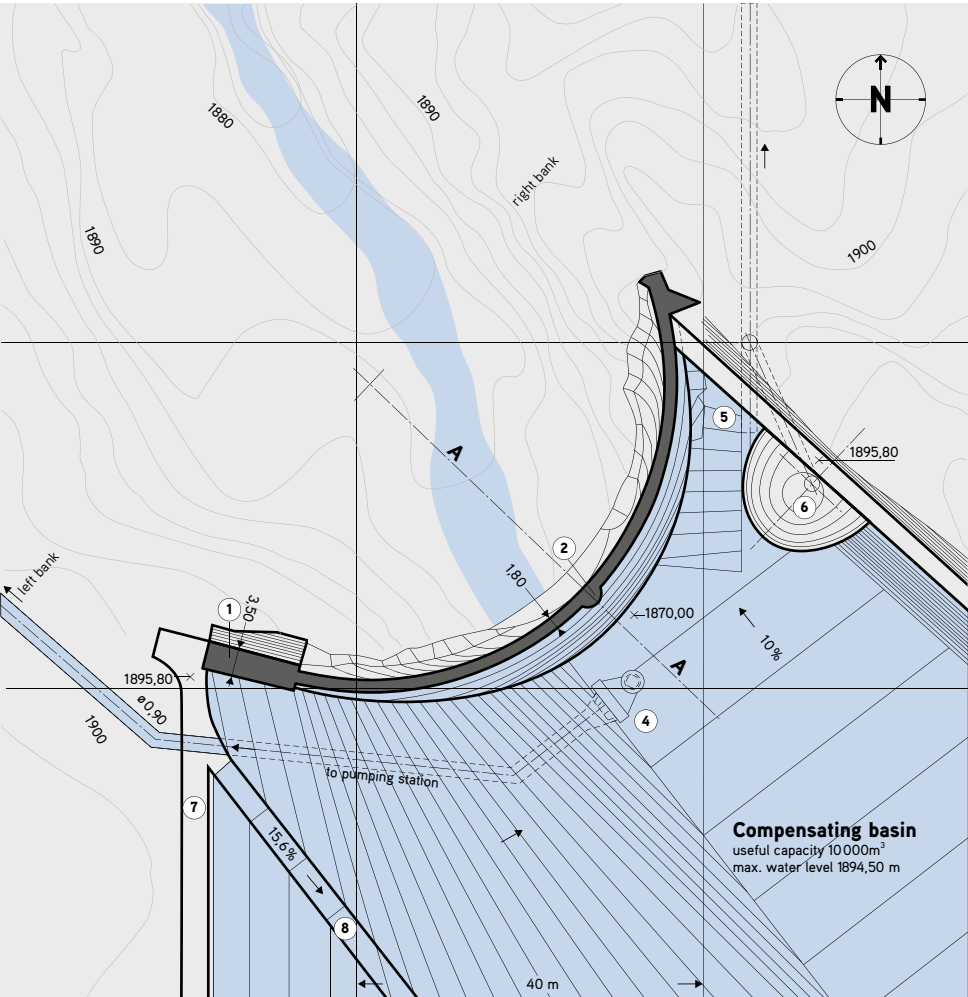
FERPÈCLE PUMPING STATION INSTALLATION PLANS



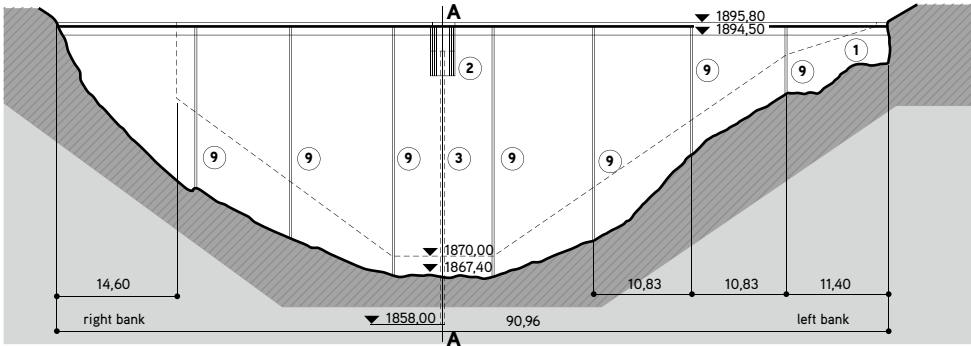
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|------------------------------------------------------|--------------------------------------------------------|------------------|
| 1 CONTROL ROOM | 9 VENTILATION TUNNEL | 16 LOW WATER PIT |
| 2 MACHINES HALL | 10 SHAFT FOR LIFT TO SERVICE BUILDING AND 130kV CABLES | 17 DISTRIBUTOR |
| 3 LOW-PRESSURE VALVES GALLERY - THREE 0,80m Ø VALVES | 11 130kV CABLES | 18 WORKSHOPS |
| 4 THREE 7800kVA TRANSFORMERS - 130/5KV | 12 5kV BUSBAR GALLERY | 19 APARTMENT |
| 5 SUPPLY TUNNEL, Q = 8.4m³/s | 13 25TON OVERHEAD TRAVELLING CRANE | |
| 6 DELIVERY SHAFT, Q = 8.4m³/s | 14 THREE 0.625m Ø HIGH-PRESSURE VALVES | |
| 7 SCOUR TUNNEL | 15 STORES | |
| 8 DEWATERING TUNNEL | | |



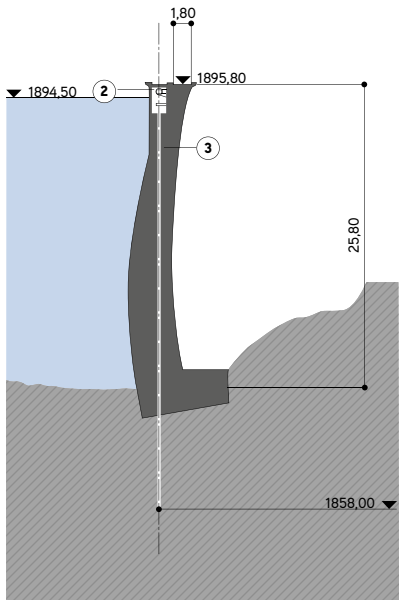
FERPÈCLE PUMPING STATION FERPÈCLE DAM



PLAN VIEW OF DAM



DOWNSTREAM ELEVATION



SECTION A-A

- 1 ABUTMENT
- 2 PENDULUM OBSERVATION CHAMBER
- 3 INVERTED PENDULUM SHAFT
- 4 WATER INTAKE
- 5 BOTTOM SLUICE
- 6 OVERFLOW WEIR
- 7 ROADWAY
- 8 RAMP TO BOTTOM OF BASIN
- 9 TRANSVERSAL CONTRACTION JOINTS

PUMPING STATION

AROLLA

After the Z'Mutt pumping station, Arolla is the most powerful station at the Grande Dixence site. It receives the water already pumped via Ferpècle, supplementing it with water from the Tsidjiore Nouve and Bertol glaciers. The Arolla facility collects and discharges around 90 million m³ of water every year. Three 16.2 MW dual-inlet pumps each transfer 4.2 m³ of water per second a height of 312 metres.

TECHNICAL SPECIFICATIONS

MAYA AFTERBAY RESERVOIR

CAPACITY 17,300m³

PUMPING STATION

POWER 3x16.2 MW

FLOW RATE 12.6m³/s

DISCHARGE HEAD 312m



Lower Bertol water intake

AROLLA PUMPING STATION

PLAN OF LOCATION



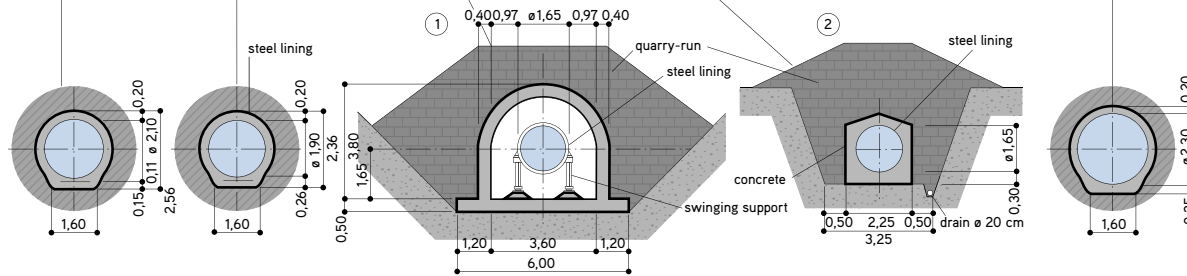
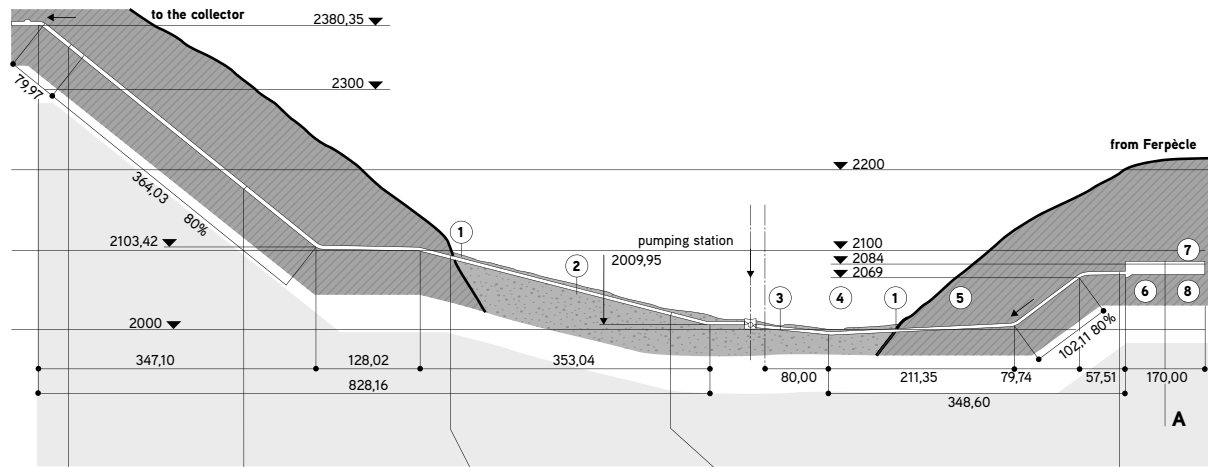
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|--------------------------------------------------------------------------|--------------------------------------------------------------------------|--------------------------------------------------------|
| 1 FERPÈCLE SUPPLY TUNNEL,
GRADIENT 2%, $Q = 8.4 \text{ m}^3/\text{s}$ | 9 ROCK TO MORAINÉ TRANSITION
STRUCTURE | 18 AROLLA P4 CABLEWAY
(ACCESS TO MAIN UPPER TUNNEL) |
| 2 LOWER BERTOL SUPPLY TUNNEL
$Q = 2.0 \text{ m}^3/\text{s}$ | 10 1.80m Ø BURIED SUPPLY PIPE | 19 AROLLA-BERTOL ROAD |
| 3 OVERFLOW SYPHON | 11 CULVERT UNDER THE BORGNE | 20 BRIDGE |
| 4 COMPENSATING CHAMBER
DEWATERING AND SCOUR VALVES | 12 SUPPLY PIPE DEWATERING AND
SCOUR VALVES | |
| 5 DEWATERING, SCOUR AND
OVERFLOW TUNNEL | 13 TSIDJIORE-NOUVE BURIED SUPPLY
PIPE, $Q = 2.0 \text{ m}^3/\text{s}$ | |
| 6 ACCESS TUNNEL | 14 PIPE DEWATERING
AND SUPPLY VALVES | |
| 7 ACCESS TO VEISIVI TUNNEL | 15 1.65m Ø BURIED DELIVERY PIPE | |
| 8 1.80m Ø STEEL-LINED SHAFT TO
PUMPING STATION, GRADIENT 80% | 16 130kV LINE | |
| | 17 SUBSTATION | |



Arolla pumping station machines room

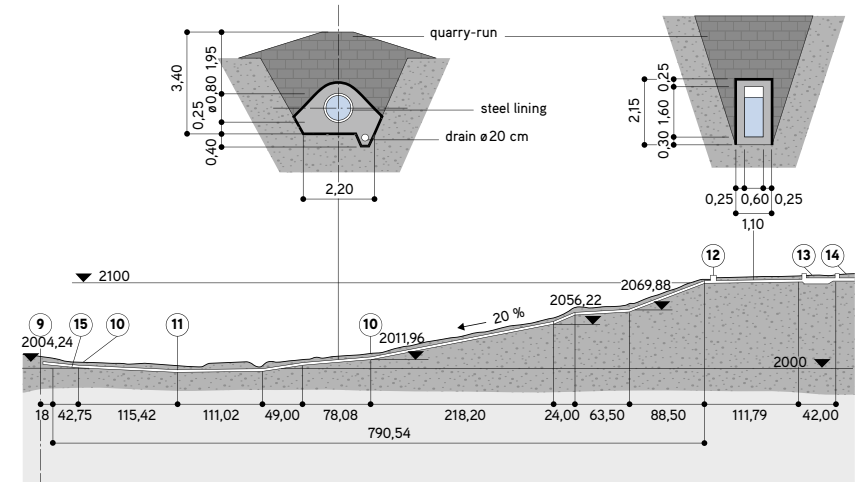
AROLLA PUMPING STATION

LONGITUDINAL AND TRANSVERSAL PROFILES OF CONDUITS

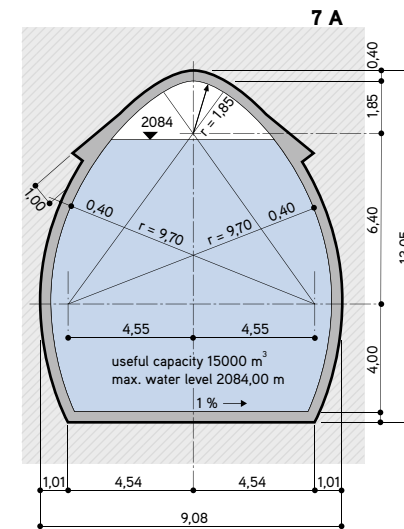


LONGITUDINAL PROFILE OF SUCTION AND DISCHARGE PIPES

- | | | |
|----------------------------------------|----------------------------------------------------------------------------------------|-----------------------------------------|
| 1 ROCK TO MORAINÉ TRANSITION STRUCTURE | 7 AROLLA COMPENSATING CHAMBER MAX. LEVEL 2084 m, USEFUL CAPACITY 15,000 m ³ | 11 PIPE DEWATERING AND SCOUR VALVES |
| 2 BURIED DELIVERY PIPE | 8 VEISIVI TUNNEL | 12 FOREBAY |
| 3 ROAD | 9 AROLLA STATION | 13 SAND TRAP, Q = 2.0 m ³ /s |
| 4 CULVERT UNDER THE BORGNE | 10 MANHOLE | 14 FORE CANAL |
| 5 SUPPLY PIPE | | 15 0.80 m Ø BUTTERFLY VALVE |
| 6 LOWER BERTOL WATER INTAKE | | |

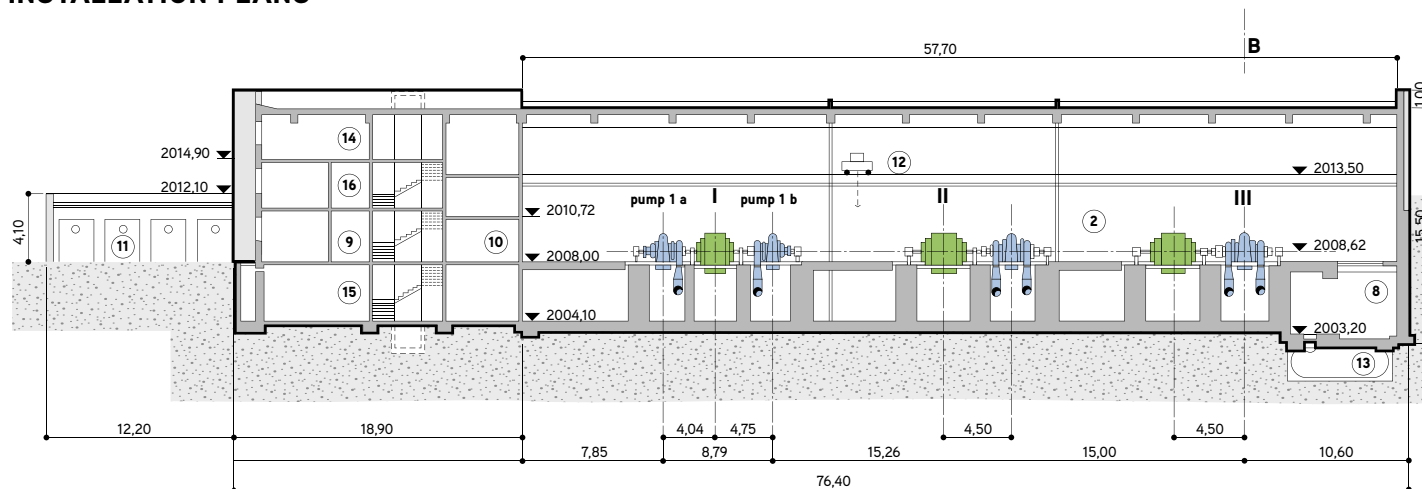


LONGITUDINAL PROFILE OF TSIDIJORE-NOUVE BURIED PIPELINE

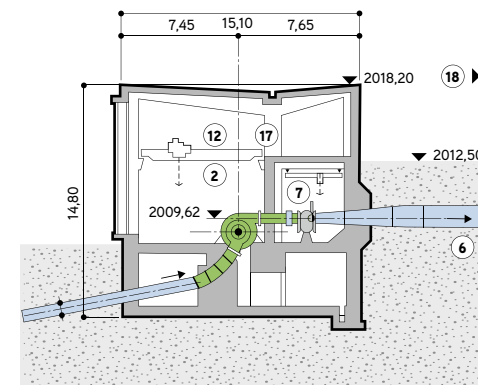


COMPENSATING CHAMBER

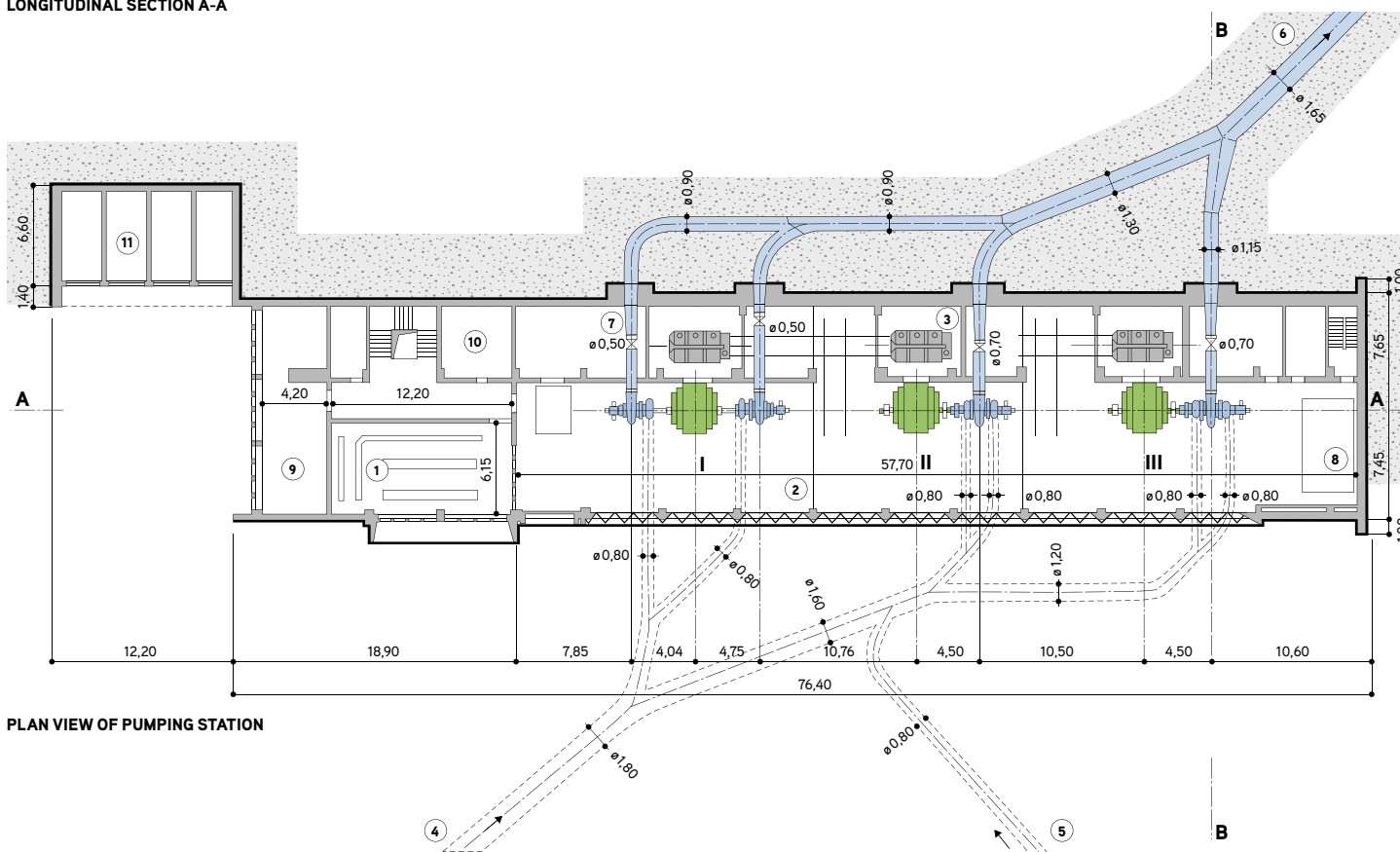
AROLLA PUMPING STATION INSTALLATION PLANS



LONGITUDINAL SECTION A-A



CROSS-SECTION B-B



PLAN VIEW OF PUMPING STATION

- 1 CONTROL ROOM
- 2 MACHINES HALL
- 3 TRANSFORMERS 130/7,5KV
- 4 SUPPLY PIPE
- 5 FROM TSIDIJORE-NOUVE
- 6 DELIVERY, Q = 12.6m³/s
- 7 VALVES CHAMBER
- 8 UNTANKING PIT
- 9 WORKSHOP
- 10 HOSPITAL
- 11 GARAGES
- 12 40 TON OVERHEAD TRAVELLING CRANE
- 13 STORAGE FOR OIL FROM UNTANKED TRANSFORMERS STORES
- 14 STORES
- 15 HEATING
- 16 LIVING ACCOMMODATION
- 17 CABLES TUNNEL
- 18 SUBSTATION



STORAGE

The water collected by the conveyance network is stored behind the Grande Dixence dam.

Grande Dixence has a capacity of 400 million m³. Its 285-metre wall makes it the tallest gravity dam in the world. The structure is made from 6 million m³ of concrete and weighs 15 million tonnes. It is 200 metres wide at the base and 15 metres wide at the crest. The two shores are 700 metres apart at the crest. Inside the wall of the dam, there are 32 kilometres of tunnels and inspection chambers which allow the dam supervisors to continuously inspect the facility.

GRANDE DIXENCE DAM

Towering above the Val des Dix, Grande Dixence holds many records. The gravity dam's 285-metre wall remains the tallest in the world. At around 15 million tonnes, it is heavier than the Great Pyramid of Cheops.

To contain the more than 400 million m³ of water stored each year, no fewer than 6 million m³ of concrete were laid between the mountains. The same amount of concrete could be used to build a 1.5-metre high, 10-centimetre wide wall right around the equator!

TECHNICAL SPECIFICATIONS

GRAVITY DAM

CONSTRUCTION	1951 - 1961
COMMISSIONED	in 1961
HEIGHT	285 m
CREST	15 m wide, 700 m from one side to the other
VOLUME OF CONCRETE	5,960,000 m ³
LENGTH OF INSPECTION TUNNELS	15,200 m
LENGTH OF INJECTION WELLS	14,500 m
CAPACITY OF RESERVOIR	400,000,000 m ³
SURFACE AREA OF RESERVOIR	4.04 km ²
LENGTH OF RESERVOIR	5.3 km
LENGTH OF BASE TUNNELS, DRAINAGE TUNNELS AND THALWEG	2160 m

The dam is 200 metres wide at its base. As it rises, it tapers to a width of 15 metres. A 200-metre deep grout curtain surrounds the dam to make the soil foundation watertight. It penetrates 100 metres into the valley sides.

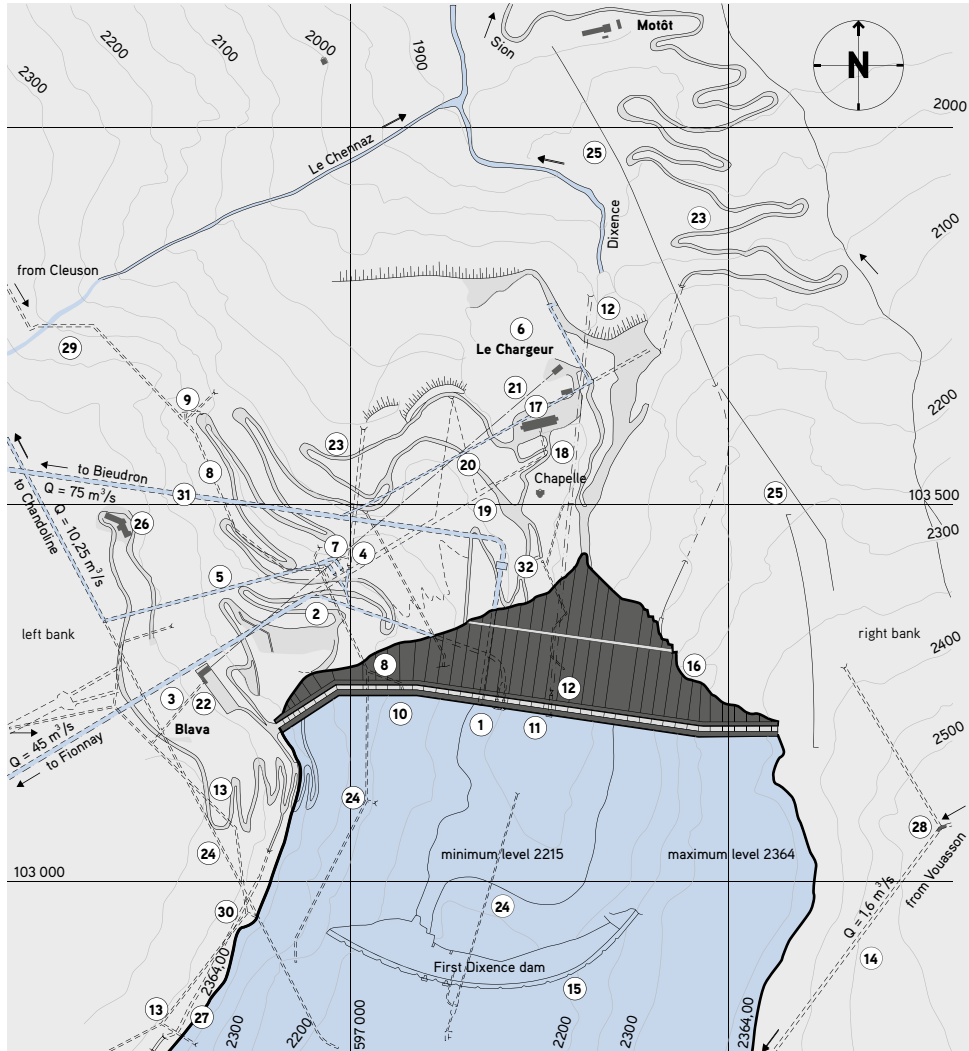
The wall itself is made up of 16m square concrete blocks jointed together so as to ensure maximum cohesion, strength and impermeability.



The Grande Dixence dam, the keystone of the hydroelectric complex

GRANDE DIXENCE DAM

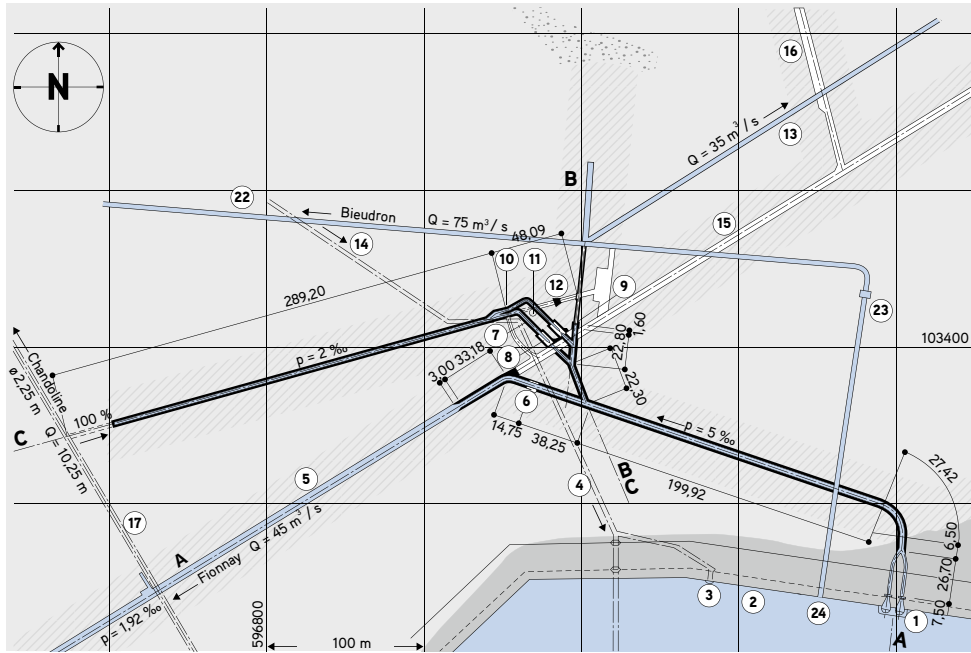
PLAN OF LOCATION



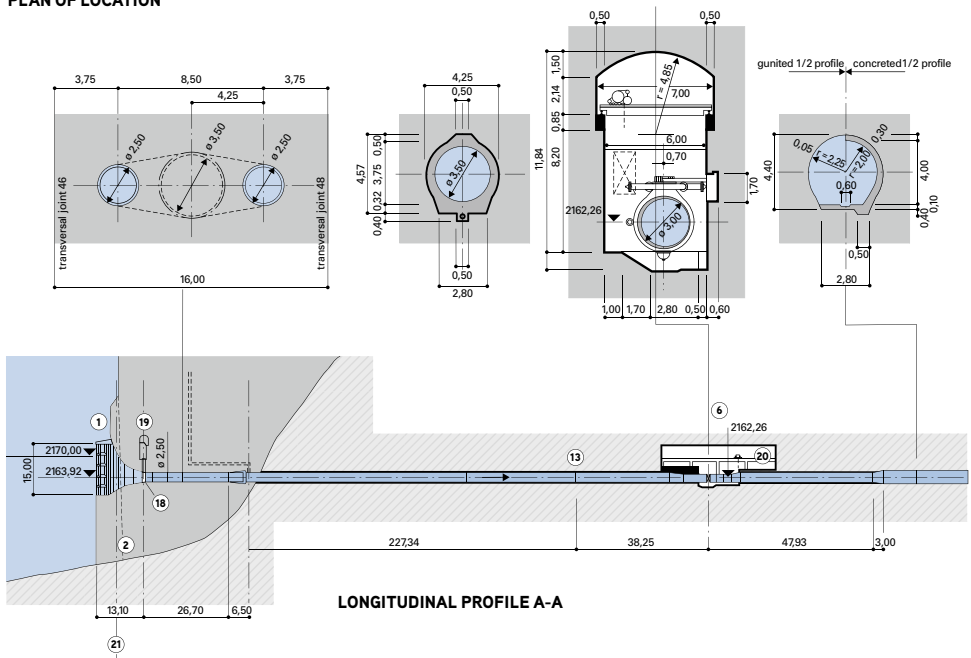
- | | |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ol style="list-style-type: none"> 1 WATER INTAKE AND MAIN DISCHARGE INLET 2 GUARD GATE 3.00 m Ø 3 HEADRACE TUNNEL TO THE FIONNAY POWER PLANT Q = 45 m³/s 4 PRESSURE REDUCING SYSTEMS FOR THE OLD CHANDOLINE INSTALLATIONS 5 HEADRACE TUNNEL TO THE CHANDOLINE POWER PLANT (ALPIQ) Q = 10.25 m³/s 6 MAIN DISCHARGE INLET Q = 35 m³/s 7 REDUCTION SYSTEM REGULATION WELL AND INFLOW OF WATER FROM CLEUSON (ALPIQ) 8 HEADRACE TUNNEL FOR WATER FROM CLEUSON Q = 2.7 m³/s 9 SAND TRAP - GRAVEL TRAP FOR WATER FROM CLEUSON 10 SHIELD FOR DIRECT INTRODUCTION OF WATER FROM CLEUSON INTO THE RESERVOIR (LAKE BELOW 2240.50) 11 INLET STRUCTURE FOR BOTTOM OUTLET 12 VALVES CHAMBER AND BOTTOM OUTLET TUNNEL Q = 10 m³/s 13 HEADRACE TUNNEL FOR WATER FROM CHENNAZ Q = 1.5 m³/s | <ol style="list-style-type: none"> 14 HEADRACE TUNNEL FOR WATER FROM VOUASSON Q = 1.6 m³/s 15 OPENING IN THE OLD DAM 16 TRANSVERSE DAM CONTRACTION JOINTS EVERY 16 m 17 OPERATIONS BUILDING (RITZ) 18 HELIPORT 19 ACCESS TUNNEL TO VALVES AND PRESSURE REDUCING SYSTEMS 20 UNDERGROUND WORKSHOP AND SUBSTATION 65kV 21 CHARGEUR-BLAVA CABLE CAR 22 VISITOR PLATFORM 23 MOTÔT-CHARGEUR-BLAVA ROAD 24 OLD DECOMMISSIONED TUNNELS 25 OLD DECOMMISSIONED SERVICE FUNICULARS 26 MIRADOR 27 PASTURE TRACKS TO CHEILON 28 MEASUREMENT STATION FOR WATER FROM VOUASSON 29 MEASUREMENT STATION FOR WATER FROM CLEUSON 30 MEASUREMENT STATION FOR WATER FROM CHENNAZ 31 HEADRACE TUNNEL TO THE BIEUDRON POWER PLANT Q = 75 m³/s 32 VALVE CHAMBER CLEUSON-DIXENCE |
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GRANDE DIXENCE DAM

FALL OUTLETS AND MAIN DISCHARGE INLET



PLAN OF LOCATION



LONGITUDINAL PROFILE A-A

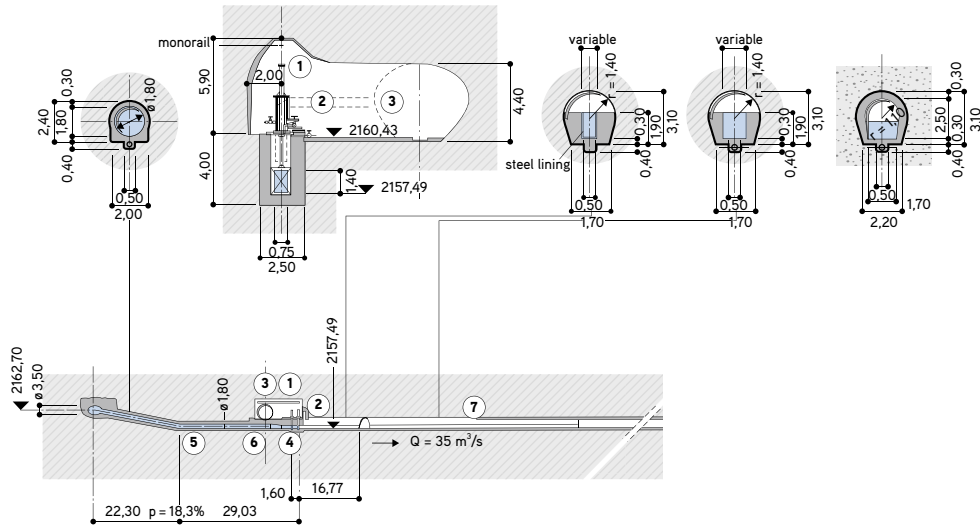


400 million m³ of water, ready to drive the turbines

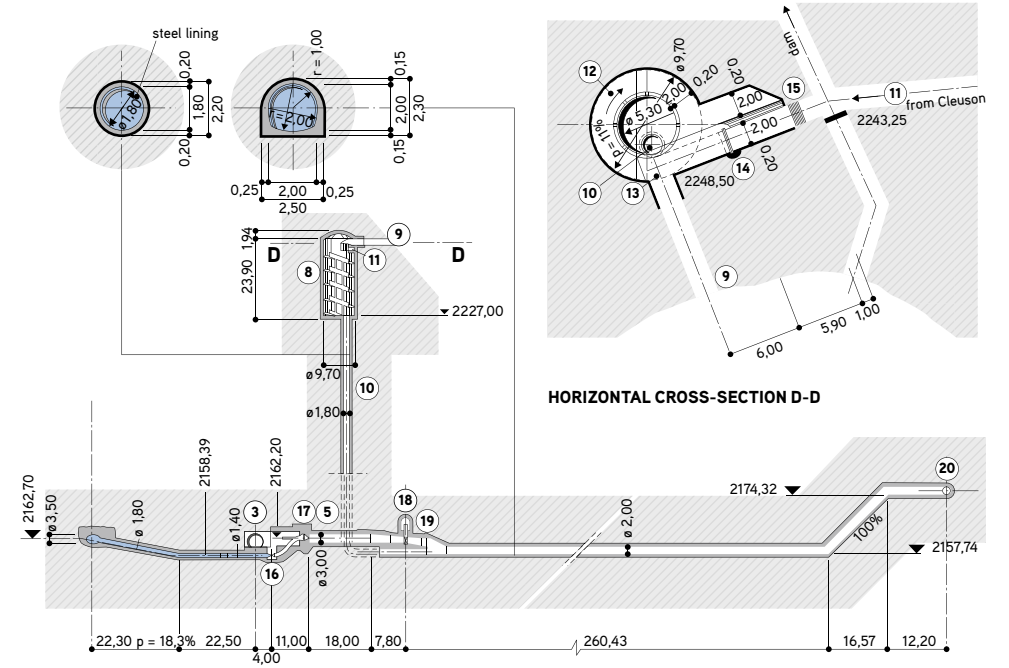
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|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> 1 WATER INTAKE AND MAIN DISCHARGE INLET 2 UPSTREAM FACE OF DAM 3 REMOVABLE SHIELD FOR INFLOW OF WATER FROM CLEUSON INTO THE RESERVOIR 4 CLEUSON TUNNEL (ALPIQ) 5 DIX-BAGNES TUNNEL 6 GUARD GATE, 3.00 m Ø 7 BUTTERFLY VALVE, 1.40 m Ø 8 2 PRESSURE REDUCING SYSTEMS, 3.00 m Ø, LENGTH 18.00 m | <ul style="list-style-type: none"> 9 2 MAIN DISCHARGE VALVES, 0.75x1.40 m 10 BULKHEAD GATE, 1.40x1.00 m 11 REDUCTION SYSTEM REGULATION WELL AND INFLOW OF WATER FROM CLEUSON (ALPIQ) 12 PLUG AND WATERTIGHT DOOR 13 MAIN DISCHARGE TUNNEL 14 INFLOW OF WATER FROM CLEUSON (ALPIQ) 15 ACCESS TUNNEL 16 WORKSHOP, UNDERGROUND STORE AND SUBSTATION 65 kV | <ul style="list-style-type: none"> 17 DECOMMISSIONED TUNNEL SECTION 18 2 BULKHEAD GATES, 3.00x2.00 m 19 VALVES CONTROL ROOM 20 VALVE CHAMBER 21 AXIS OF DAM 22 CHARGEUR-TRACOUET HEADRACE TUNNEL 23 CLEUSON-DIXENCE BUTTERFLY VALVE CHAMBER, 3.30 m Ø 24 BIEUDRON WATER INTAKE |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

GRANDE DIXENCE DAM

FALL OUTLETS AND MAIN DISCHARGE INLET



LONGITUDINAL PROFILE B-B, REFERS TO PLAN OF LOCATION P.64

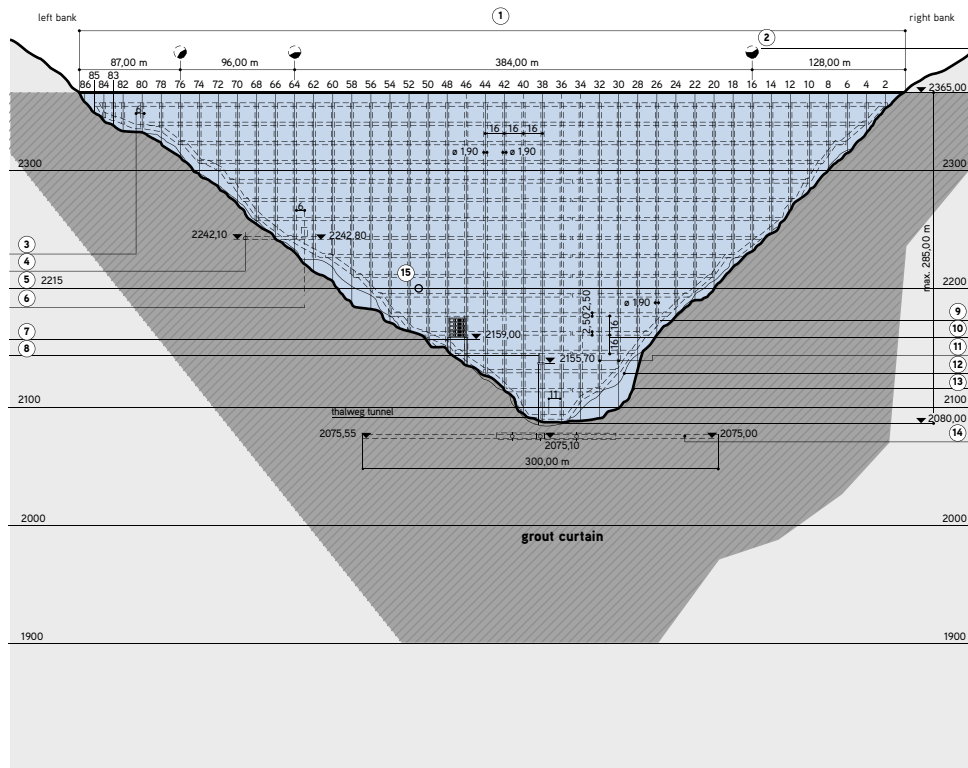


LONGITUDINAL PROFILE C-C, REFERS TO PLAN OF LOCATION P.64

- | | | |
|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|------------------------------|
| 1 MAIN DISCHARGE INLET VALVES CHAMBER | 8 AFTERBAY CHAMBER WITH SPIRAL RAMP FOR DIRECT INFLOW OF WATER FROM CLEUSON INTO THE PRESSURE REDUCING SYSTEM REGULATION SHAFT | 13 SERVICE WALKWAY |
| 2 VENT PIPE | 9 ACCESS TUNNEL | 14 BYPASS VALVE |
| 3 DIX-BAGNES TUNNEL | 10 REGULATION SHAFT, Ø 1.80m | 15 THRESHOLD SPILLWAY |
| 4 2 SLIDE VALVES, 1.40x0.75m | 11 INFLOW OF WATER FROM CLEUSON | 16 BUTTERFLY VALVE, Ø 1.40m |
| 5 REDUCING SYSTEM I | 12 SPIRAL RAMP | 17 NEEDLE VALVE |
| 6 REDUCING SYSTEM II | | 18 VALVE CHAMBER |
| 7 MAIN DISCHARGE INLET
Q = 35 m³ / s | | 19 BULKHEAD GATE, 1.40x1.00m |
| | | 20 TUNNEL TO CHANDOLINE |

GRANDE DIXENCE DAM

DEVELOPED LONGITUDINAL CROSS-SECTION OF THE DAM



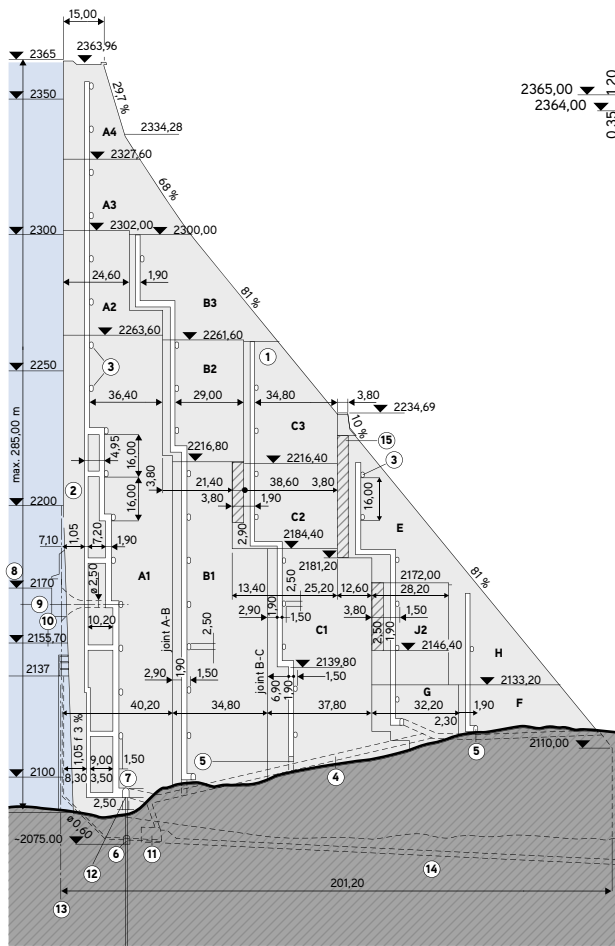
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|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>1 DEVELOPED LENGTH
APPROX. 695 m</p> <p>2 DIRECTION CHANGE PLAN VIEW</p> <p>3 MAIN ACCESS
TO THE BOTTOM TUNNEL</p> <p>4 OLD CLEUSON TUNNEL CLOSED
BY A CONCRETE PLUG</p> <p>5 MINIMUM LEVEL 2215.00</p> <p>6 1.50 m Ø SHIELD FOR DIRECT INFLOW
OF WATER FROM CLEUSON (ALPIQ)
INTO THE RESERVOIR</p> | <p>7 WATER INTAKE AND MAIN
DISCHARGE INLET
(AXIS ALTITUDE 2163.93)</p> <p>8 INLET STRUCTURE
FOR BOTTOM OUTLET</p> <p>9 BOTTOM TUNNEL
HEIGHT 3.50 m, WIDTH 2.50 m</p> <p>10 LONGITUDINAL INSPECTION TUNNEL
HEIGHT 2.50 m, WIDTH 1.50 m,
DISTANCE BETWEEN TUNNELS 16 m</p> | <p>11 COOLING AND INJECTION SHAFT,
1.90 m Ø</p> <p>12 GROUND PROFILE AT THE AXIS
OF THE BOTTOM TUNNEL</p> <p>13 GROUND PROFILE
AT THE UPSTREAM FACE</p> <p>14 GROUT CURTAIN DRILLING
AND INJECTION TUNNEL</p> <p>15 CLEUSON-DIXENCE
WATER INTAKE</p> |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|



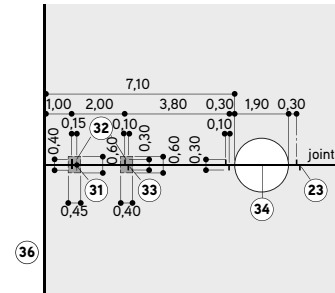
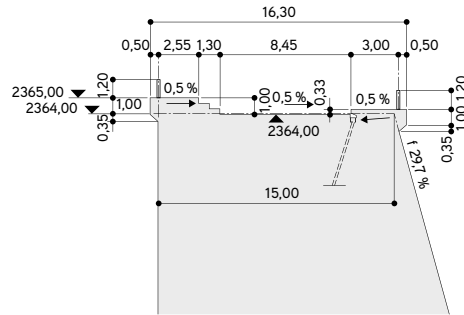
Grande Dixence and the first Dixence dam (left) which is usually submerged under the Lac des Dix

GRANDE DIXENCE DAM

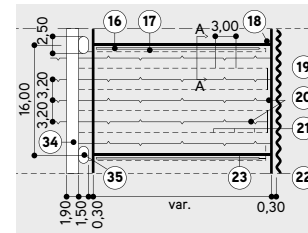
TYPICAL PROFILE AND DETAILS OF THE DAM



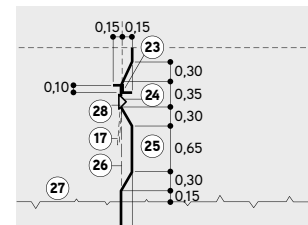
CREST OF THE DAM



DETAIL OF UPSTREAM SEAL, HORIZONTAL CROSS-SECTION



DETAIL OF AN INJECTION PANEL

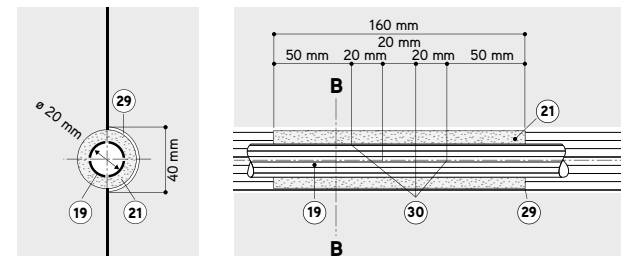
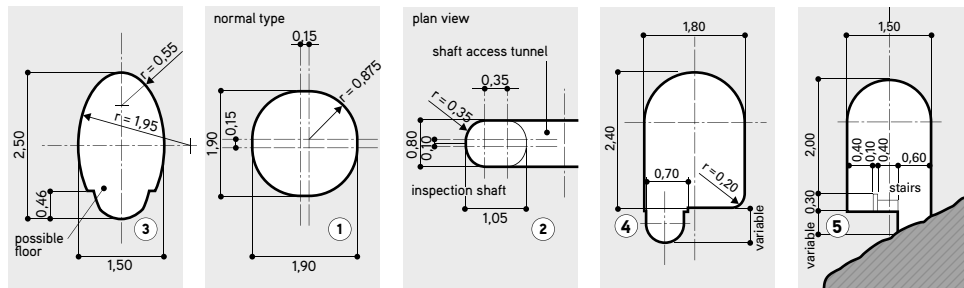


DETAIL OF COLLECTOR, CROSS-SECTION A-A

- 1 INSPECTION SHAFT
- 2 SEAL INSPECTION
- 3 INSPECTION TUNNEL
- 4 THALWEG TUNNEL
- 5 DRAINAGE TUNNEL
- 6 DRILLING AND INJECTION TUNNEL
- 7 LOW-LEVEL TUNNEL
- 8 MINIMUM RESERVOIR DIMENSION
- 9 WATER INTAKE AND MAIN DISCHARGE INLET
- 10 BOTTOM OUTLET
- 11 BOTTOM OUTLET VALVES CHAMBER
- 12 GROUT CURTAINS
- 13 AXIS OF THE DAM
- 14 BOTTOM OUTLET TUNNEL
- 15 KEYING SPACE

- INJECTION AND SEALING OF THE TRANSVERSE JOINTS**
- 16 SAMPLING COLLECTOR
 - 17 COLLECTOR RETURN PIPE
 - 18 PIPE FOR CLEANING THE COLLECTOR DURING CONCRETING
 - 19 STEEL TUBE INJECTION RAIL 20-22 mm Ø
 - 20 LAYERS OF CONCRETE HEIGHT: 3.20m (5x0.64m)
 - 21 INJECTION PIPES DISTANCE 3.00m
 - 22 LONGITUDINAL JOINT
 - 23 INJECTION STOP PLATE THICKNESS 1.5mm
 - 24 COLLECTOR (CASED CHANNEL)
 - 25 TENON
 - 26 THEORETICAL JOINT PLANE
 - 27 CONCRETING LIMIT
 - 28 CHANNEL PROTECTION PANEL
 - 29 CONCRETE-CASED CHANNEL
 - 30 8 HOLE, 5mm Ø
 - 31 1.5mm THICK V-SHAPED COPPER SHEET SEAL
 - 32 CONCRETE WITH A GRAIN SIZE OF 0-40mm
 - 33 Z-SHAPED COPPER SHEET
 - 34 INJECTION SHAFT, 1.90m Ø
 - 35 HORIZONTAL TUNNELS EVERY 16m
 - 36 UPSTREAM FACE OF DAM

TYPICAL CROSS-SECTION OF A JOINT



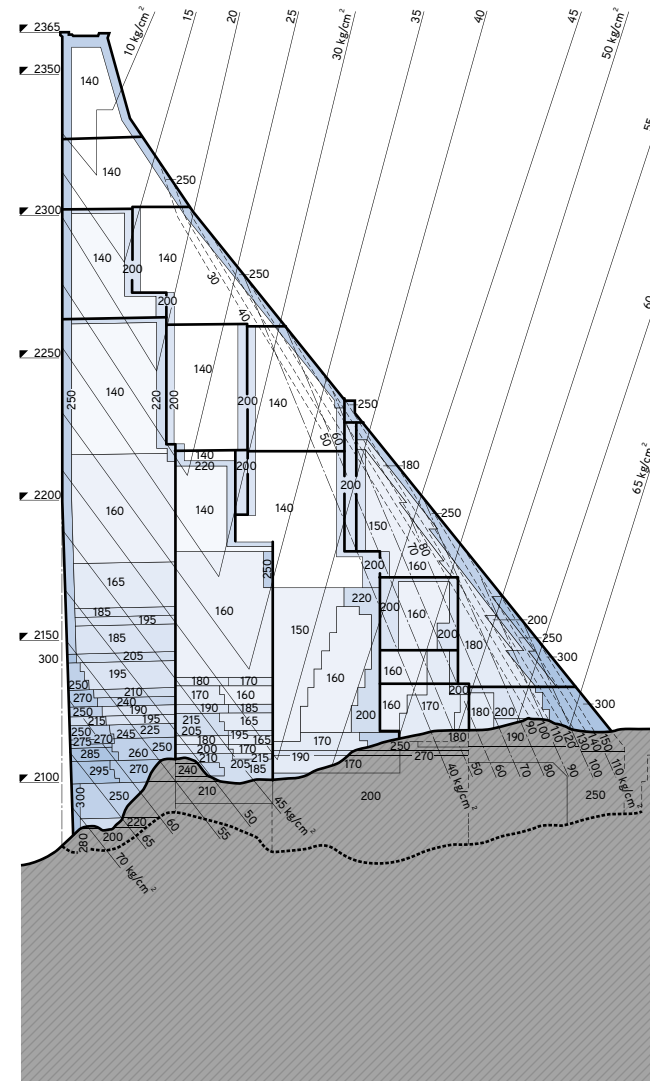
DETAIL OF AN INJECTION PIPE, CROSS-SECTION B-B



The Val des Dix, upstream of the dam

GRANDE DIXENCE DAM

CALCULATED CONSTRAINTS AND EFFECTIVE METERING



- LOAD SCENARIO**
- Ordinary load scenario: lake empty or full, safety coefficient varying between 2.55 and 3.80 (on cyl.) based on dispersions obtained for the results of the concrete tests.
 - Exceptional load scenario: lake empty or full and earthquake, safety coefficient 2.25 (on cyl.)
 - Constraint concentrations at end of footings: lake empty or full and earthquake, safety coefficient 1.75 (on cyl.)

- CONCRETE METERING**
- Metering indicated in kg of normal Portland cement per m³ of finished concrete (kg/m³)
- 140 kg/m³
 - from 141 to 160 kg/m³
 - from 161 to 180 kg/m³
 - from 181 to 200 kg/m³
 - from 201 to 220 kg/m³
 - from 221 to 240 kg/m³
 - from 241 to 260 kg/m³
 - from 261 to 280 kg/m³
 - from 281 to 300 kg/m³

GRANDE DIXENCE DAM

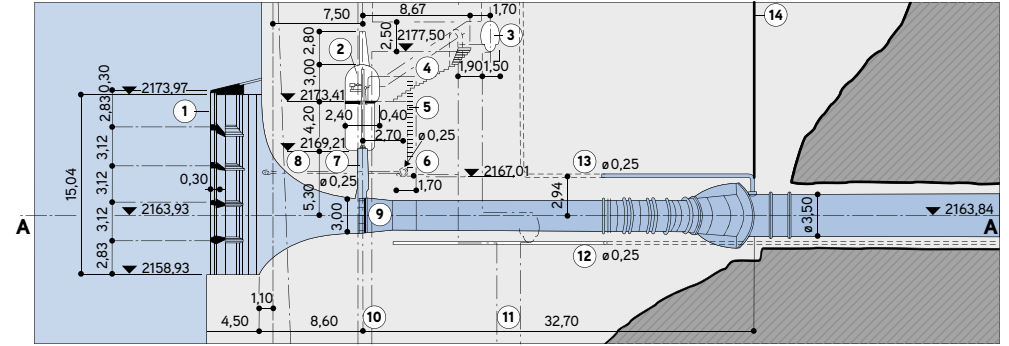
BOTTOM OUTLET



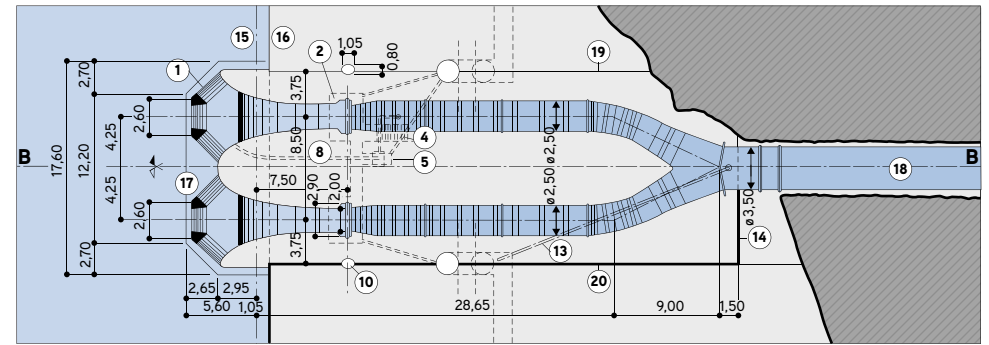
LONGITUDINAL CROSS-SECTION B-B

- 1 INLET STRUCTURE FOR BOTTOM OUTLET
- 2 PROVISIONAL INLETS
- 3 BOTTOM TUNNEL
- 4 THALWEG TUNNEL
- 5 VALVES CHAMBER ACCESS SHAFT
- 6 VALVES CHAMBER
- 7 VENT
- 8 BOTTOM OUTLET EVACUATION TUNNEL LENGTH APPROX. 505m
- 9 GABIONS
- 10 AXIS OF DAM
- 11 UPSTREAM FACE OF DAM
- 12 CONDUIT, \varnothing 0.60 m
- 13 SHIELDED AIRLOCK

WATER INTAKE AND MAIN DISCHARGE INLET



LONGITUDINAL CROSS-SECTION B-B



HORIZONTAL CROSS-SECTION A-A

- 1 GRIDS
- 2 BULKHEAD GATE CONTROL CHAMBER
- 3 HORIZONTAL INSPECTION TUNNEL
- 4 ACCESS TUNNEL
- 5 BYPASS VALVE ACCESS SHAFT
- 7 SEALED CASING
- 8 BYPASS 0.25m \varnothing
- 9 2.00 x 3.00m BULKHEAD GATE
- 10 SEAL INSPECTION SHAFT
- 11 INSPECTION CHAMBER
- 12 DRAIN 0.25m \varnothing
- 13 VENT 0.25m \varnothing
- 14 LONGITUDINAL JOINT
- 15 AXIS OF THE DAM
- 16 UPSTREAM FACE
- 17 CONCRETE TRAINING WALLS
- 18 AXIS OF BLOCK XXIV
- 19 TRANSVERSE JOINT N° 48
- 20 TRANSVERSE JOINT N° 46



PRODUCTION

The water stored behind the Grande Dixence dam is transferred as required to the three surrounding underground power plants: Fionnay, Nendaz and Bieudron. These power plants represent a total of 2000 MW and produce around 2 billion kWh every year. Once it has passed through the turbines, the water is returned to the Rhône.

POWER PLANT FIONNAY

The water held behind the Grande Dixence dam is transformed into electricity in two stages. The first stage takes place at the Fionnay underground power plant. An underground and gently sloping tunnel stretching over nine kilometres had to be constructed to carry the water to the turbines.

The surge chamber, which is located at Louvie in the Val de Bagnes, becomes a penstock which descends 800 metres at a gradient of 73%. The penstock runs to the distributor at the Fionnay facility, a vast cavern hollowed out of the rock.

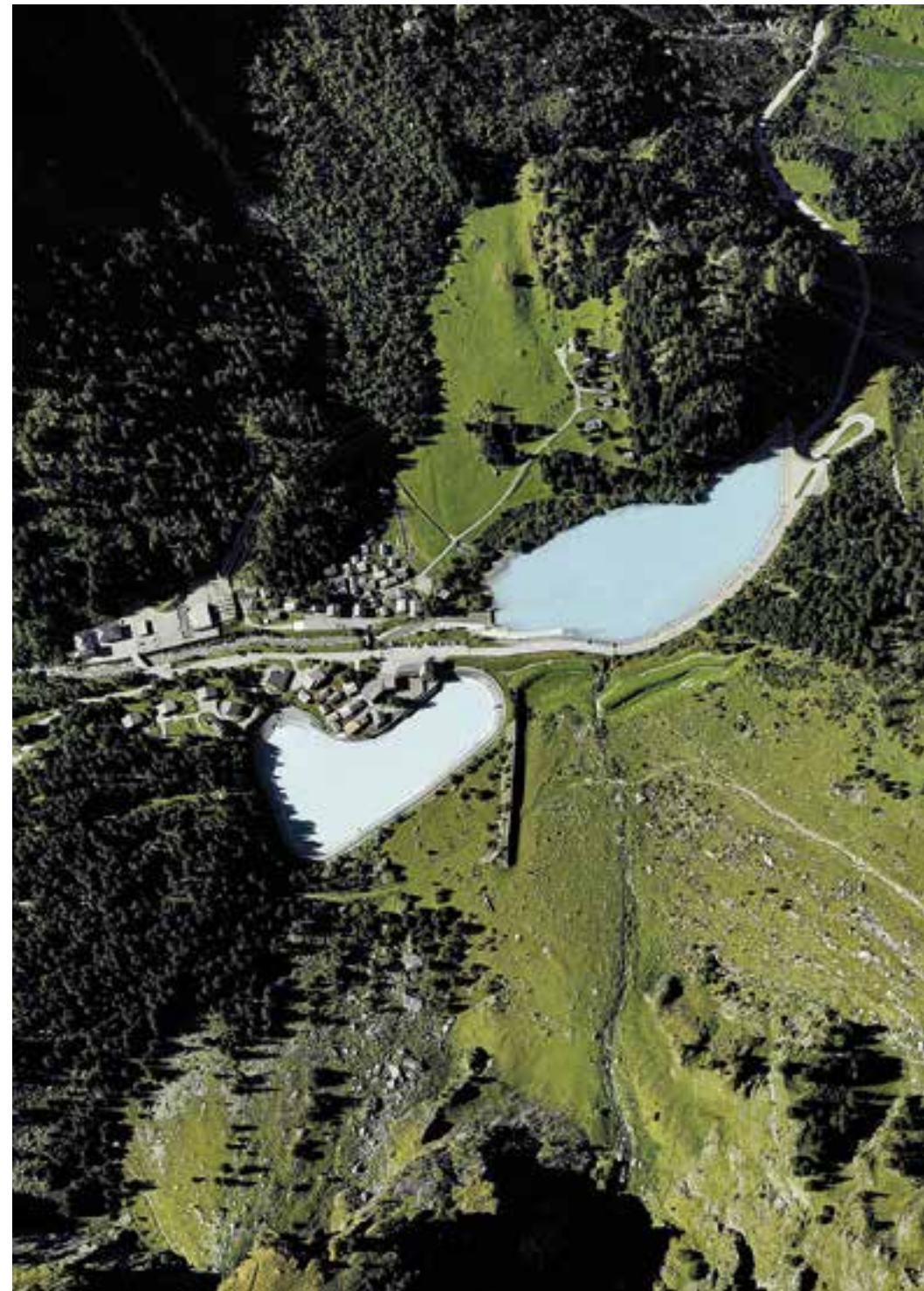
TECHNICAL SPECIFICATIONS

AFTERBAY RESERVOIR

CAPACITY 166,000 m³

POWER PLANT

NUMBER OF TURBINES 6 x 2 Pelton
INSTALLED POWER CAPACITY 290 MW
FLOW RATE 45 m³/s max.
MAX. DROP HEIGHT 873.8 m
MIN. DROP HEIGHT 679.8 m
TRANSFORMERS 9 x 40 MVA (single phase) – 220/15 KV



Fionnay afterbay reservoir (right: Grande Dixence reservoir; left: Mauvoisin reservoir)

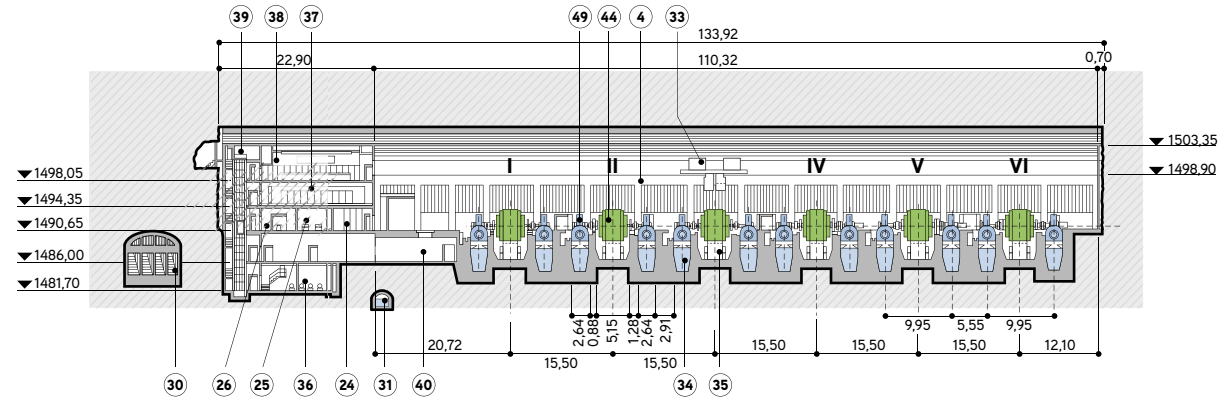
FIONNAY POWER PLANT

PLAN OF LOCATION



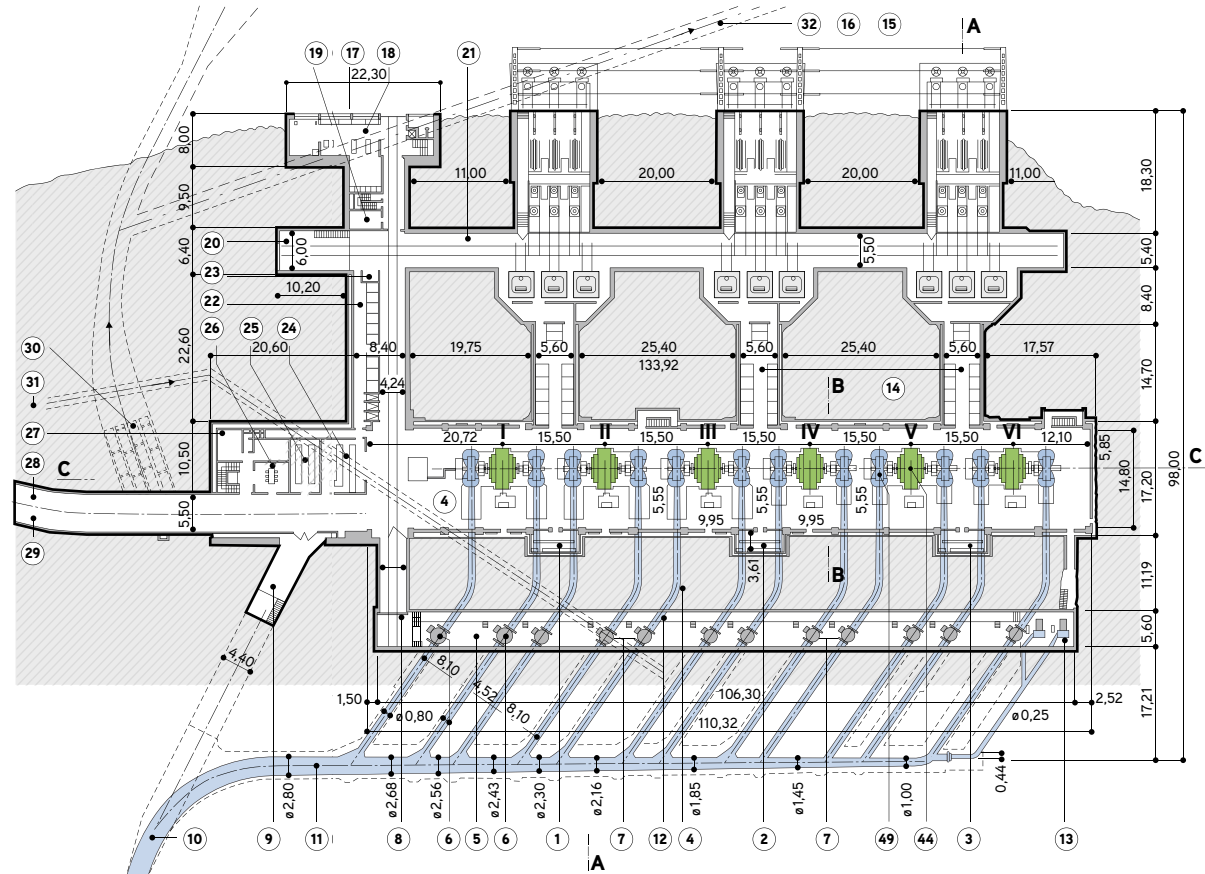
- | | |
|---------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 1 LOUVIE STEEL-LINED SHAFT
3 TO 2.80 m Ø, Q = 45 m³ / s | 15 FMM TAILPOND DISCHARGE TUNNEL |
| 2 VALVES CHAMBER | 16 DEWATERING STRUCTURE
WITH PUMP |
| 3 MACHINES HALL | 17 CHAMPSEC POWER PLANT INTAKE |
| 4 TRANSFORMERS AND HIGH
VOLTAGE SWITCHGEAR CHAMBERS | 18 SUPPLY TUNNEL TO CHAMPSEC
POWER PLANT (FMM) |
| 5 SURFACE SERVICE BUILDING | 19 ORIGINAL RIVER BED IN TAILPOND |
| 6 ACCESS TUNNEL AND TAILRACE
TUNNEL ONE ABOVE THE OTHER | 20 ACCOMMODATION FOR PERSONNEL |
| 7 TAILRACE TUNNEL | 21 WINTER ACCESS TUNNEL
TO PLANT |
| 8 TAILRACE TUNNEL OVERFLOW
SYPHON AND OUTLET SHAFT | 22 CABLEWAY TO LOUVIE SHAFT
SHUT-OFF VALVE |
| 9 TAILRACE TUNNEL OUTLET INTO
TAILPOND AND NENDAZ POWER
PLANT INTAKE | 23 AVALANCHE PROTECTIONS |
| 10 NENDAZ TUNNEL SHUT-OFF
VALVE 3.00 m Ø | 24 FIONNAY-CHAMOSON 220 kV LINE |
| 11 4.10 m Ø VERTICAL SHAFT AND
SUPPLY TUNNEL TO NENDAZ
POWER PLANT. Q = 45 m³ / s | 25 FIONNAY-LOURTIER ROAD |
| 12 TAILPOND DIVERSION, DISCHARGE
AND OVERFLOW STRUCTURE | 26 GD TAILPOND,
LIVE CAPACITY: 166,000 m³;
MAXIMUM LEVEL 1486,00 |
| 13 OUTLET TUNNEL
FROM STRUCTURE 12 | 27 FMM TAILPOND |
| 14 EXCHANGE TUNNEL BETWEEN
FORCES MOTRICES DE MAUVOISIN
(FMM) AND GRANDE DIXENCE (GD) | |

FIONNAY POWER PLANT INSTALLATIONS PLANS



LONGITUDINAL SECTION C-C

- | | |
|-------------------------------------------------------|-------------------------------------------|
| 1 CONTROL ROOM FOR SETS I AND II | 29 TAILRACE TUNNEL |
| 2 CONTROL ROOM FOR SETS III AND IV | 30 SYPHON BANK (TAILRACE TUNNEL OVERFLOW) |
| 3 CONTROL ROOM FOR SETS V AND VI | 31 CHAMPSEC TUNNEL |
| 4 MACHINES HALL | 32 OVERFLOW OUTLET TUNNEL |
| 5 VALVES GALLERY | 33 2 x 70 TON OVERHEAD TRAVELLING CRANES |
| 6 2 x 0.80 m Ø SPHERICAL VALVES | 34 TURBINES PIT |
| 7 10 x 0.65 m Ø SPHERICAL VALVES | 35 GENERATOR PIT |
| 8 STEEL-LINED DOOR | 36 COOLING WATER PUMPS |
| 9 ACCESS TUNNEL TO STEEL-LINED SHAFT | 37 DISTRIBUTION ROOM |
| 10 LOUVIE-FIONNAY SHAFT, STEEL-LINED 3.00 TO 2.80 m Ø | 38 CONTROL ROOM |
| 11 DISTRIBUTOR | 39 LIFT EQUIPMENT |
| 12 WALKWAY | 40 STORE FOR HEAVY COMPONENTS |
| 13 AUXILIARY SET | 44 GENERATOR |
| 14 15 kV SWITCHGEAR | 49 TURBINES |
| 15 TRANSFORMERS CHAMBER | |
| 16 220 kV SWITCHGEAR | |
| 17 SERVICE BLOCK | |
| 18 WORKSHOP | |
| 19 HEATING | |
| 20 UNTANKING CHAMBER | |
| 21 ACCESS TUNNEL | |
| 22 PLANT SERVICES | |
| 23 FIREFIGHTING EQUIPMENT | |
| 24 PLANT SERVICES CONTROL ROOM | |
| 25 BATTERIES | |
| 26 RECEPTION ROOM | |
| 27 INFIRMERY | |
| 28 MAIN ACCESS TUNNEL | |

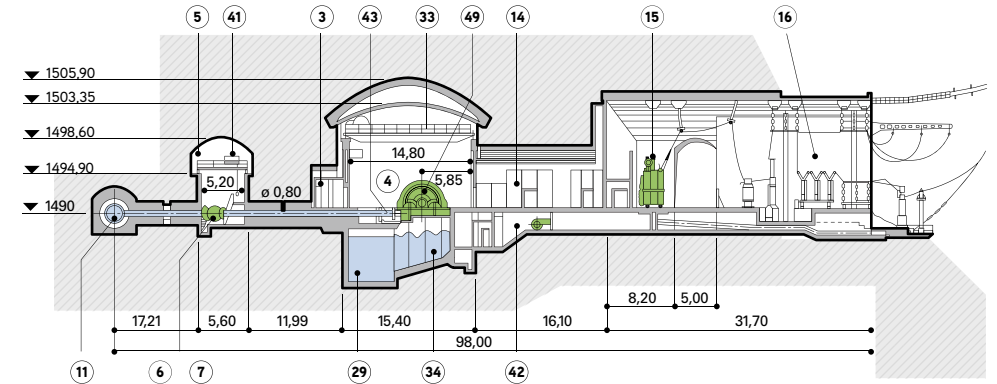


HORIZONTAL SECTION

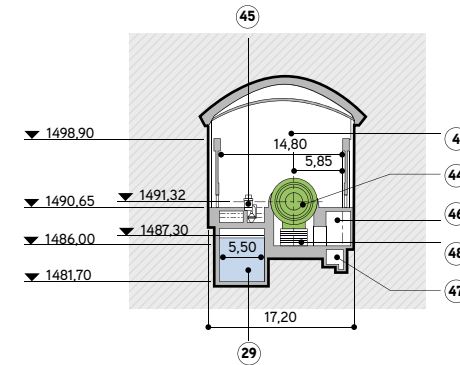


Valves chamber, Fionnay power plant

FIONNAY POWER PLANT INSTALLATIONS PLANS



TRANSVERSE CROSS-SECTION A-A, REFERS TO THE HORIZONTAL CROSS-SECTION P.83



TRANSVERSE CROSS-SECTION B-B, REFERS TO THE HORIZONTAL CROSS-SECTION P.83

- | | |
|----------------------------------|-------------------------|
| 3 CONTROL ROOM FOR SETS V AND VI | 34 TURBINES PIT |
| 4 MACHINES HALL | 41 25 TON OVERHEAD |
| 5 VALVES GALLERY | 42 TRAVELLING CRANE |
| 6 2x0.80m Ø SPHERICAL VALVES | 43 NOZZLE |
| 7 10x0.65m Ø SPHERICAL VALVES | 44 GENERATOR |
| 11 DISTRIBUTOR | 45 GOVERNOR |
| 14 15kV SWITCHGEAR | 46 SERVICE GALLERY |
| 15 TRANSFORMERS CHAMBER | 47 DRAINAGE GALLERY AND |
| 16 220kV SWITCHGEAR | COOLING WATER PIPES |
| 29 TAILRACE TUNNEL | 48 COOLING PIPES |
| 33 2x70 TON OVERHEAD | 49 TURBINES |
| TRAVELLING CRANES | |

POWER PLANT

NENDAZ

After passing through the turbines at Fionnay, the water from Grande Dixence is transferred to the Nendaz power plant. It enters a pressure tunnel which leads to the Péroua surge chamber 1000 metres above the power plant. The tunnel linking Fionnay and Nendaz is 16 kilometres long. At its end is a penstock.

Deep in the mountain between Aproz and Riddes, the Nendaz power station is – after the Bieudron plant – the largest hydroelectric power plant in operation in Switzerland. It operates on the cascade principle with the Fionnay power station, which means its capacity and output are regulated by the latter.

TECHNICAL SPECIFICATIONS

POWER PLANT

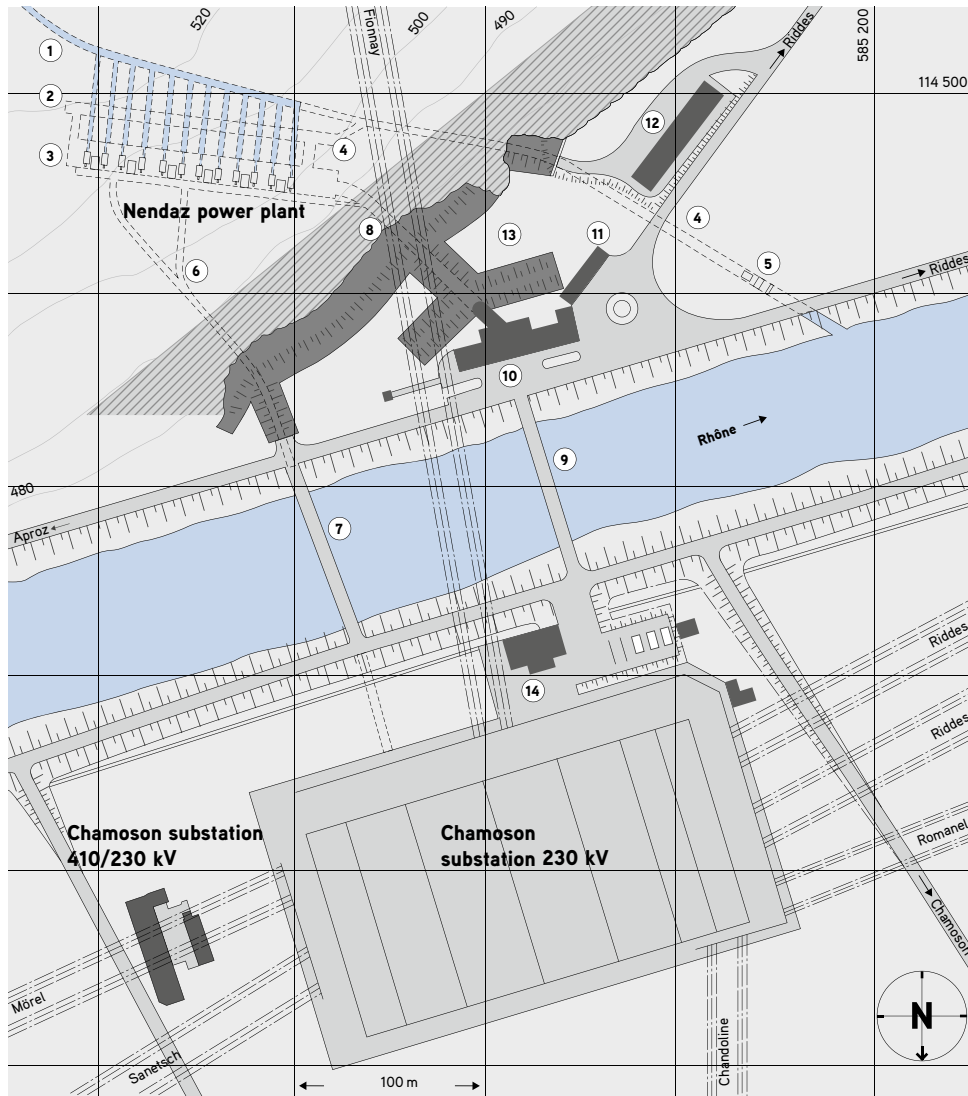
NUMBER OF TURBINES	6 x 2 Pelton
INSTALLED POWER CAPACITY	390 MW
FLOW RATE	45 m ³ /s max.
MAX. DROP HEIGHT	1007.8 m
MIN. DROP HEIGHT	1001.8 m
TRANSFORMERS	6 x 80 MVA (three-phase) – 220/13 KV



Machines room, Nendaz power plant

NENDAZ POWER PLANT

PLAN OF LOCATION

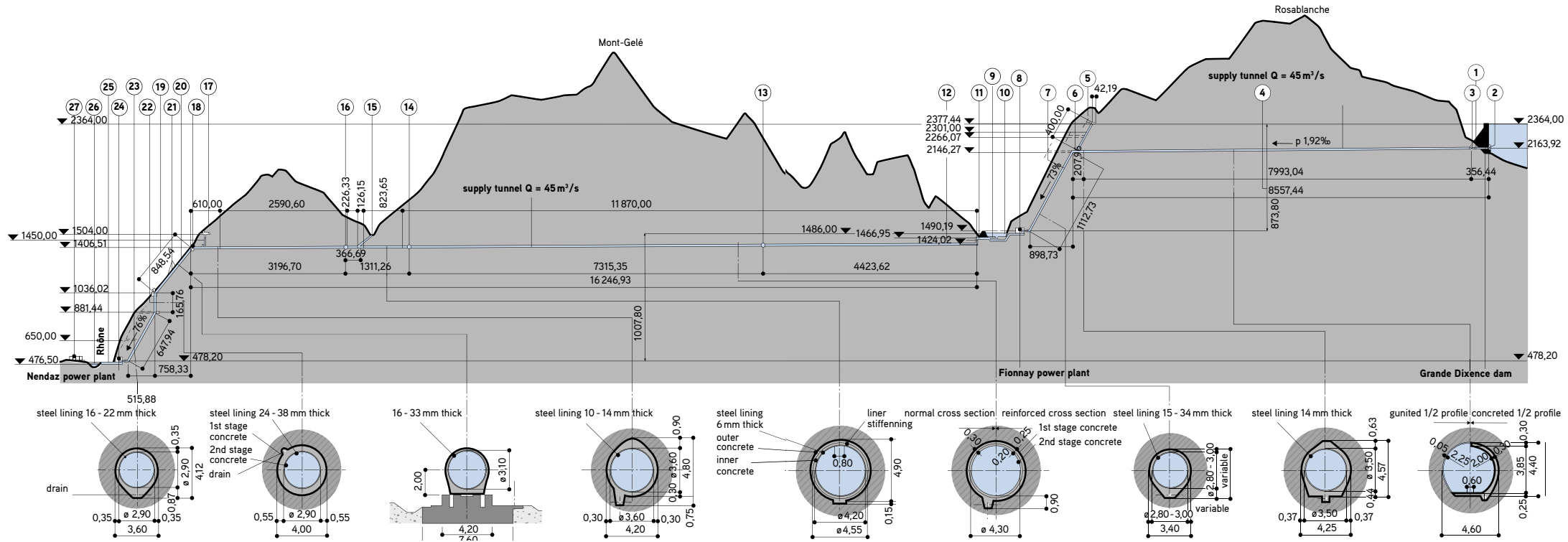


Valves chamber, Nendaz power plant

- | | |
|---------------------------------------------------------------------|---------------------------------------------------------------------------|
| 1 NENDAZ SHAFT, STEEL-LINED,
2.90 m Ø, Q = 45 m ³ / s | 10 SERVICE BUILDING, WORKSHOP,
UNTANKING ROOM AND ENTRANCE
TO PLANT |
| 2 VALVES GALLERY | 11 GARAGES |
| 3 MACHINES HALL | 12 MAIN STORE AND VEHICLES
WORKSHOP |
| 4 TAILRACE CANAL | 13 PROTECTIVE FILL |
| 5 TAILRACE CANAL BULKHEAD GATE | 14 SUBSTATION SERVICE BUILDING
WITH CONTROL ROOM |
| 6 220 kV CABLES TUNNEL
FOR SETS I TO III | |
| 7 CABLES BRIDGE FOR SETS I TO III | |
| 8 PLANT ACCESS TUNNEL AND
CABLES ROUTE FOR SETS IV TO VI | |
| 9 BRIDGE OVER RHÔNE AND CABLES
ROUTE FOR SETS IV TO VI | |

NENDAZ POWER PLANT

OVERALL LONGITUDINAL PROFILE AND TRANSVERSE PROFILE



- 1 1.80 m Ø BIFURCATION FOR CHANDOLINE (ALPIQ) $Q = 10.25 \text{ m}^3/\text{s}$ AND MAIN DISCHARGE $Q = 35.00 \text{ m}^3/\text{s}$
- 2 $2 \times 2.00 \times 3.00 \text{ m}$ BULKHEAD GATES
- 3 3.00 m Ø BUTTERFLY VALVE
- 4 MAXIMUM STATIC HEAD 873.8 m

- 5 LOUVIE SURGE CHAMBER 70% SLOPE, 13-23 mm THICK STEEL LINING TO ELEVATION 2301 m
- 6 3.00 m Ø BUTTERFLY VALVE
- 7 STEEL-LINED SHAFT VARYING FROM 3 TO 2.80 m Ø, SLOPE 73%
- 8 FIONNAY POWER PLANT, MAXIMUM GROS HEAD: 873.8 m, MAXIMUM DISCHARGE: $45.0 \text{ m}^3/\text{s}$, INSTALLED CAPACITY: 290 MW

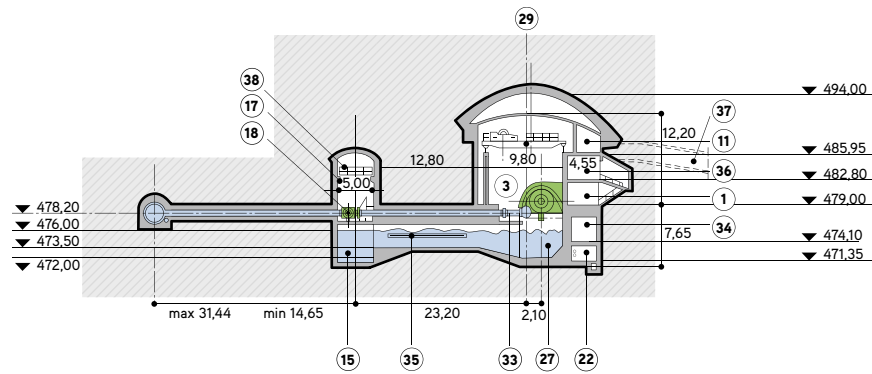
- 9 $2 \times 2.82 \text{ m}$ Ø SLIDE GATES
- 10 FIONNAY TAILPOND CAPACITY $166,000 \text{ m}^3$
- 11 3.00 m Ø BUTTERFLY VALVE FROM 8-12 mm THICK STEEL LINING IN LINED ZONE
- 12 4.10 m Ø VERTICAL SHAFT
- 13 SARREYER ADIT, LENGTH 1219.97 m
- 14 ISÉRABLE ADIT A) LENGTH 1121.19 m
- 15 FARA INTAKE, $Q = 1.00 \text{ m}^3/\text{s}$

- 16 ISÉRABLES ADIT B) LENGTH 512.47 m
- 17 PÉROUA SURGE CHAMBER, STEEL-LINED TO ELEVATION 1450.00 m
- 18 VALVE CHAMBER
- 19 3.00 m Ø BUTTERFLY VALVE
- 20 3.10 m Ø PENSTOCK
- 21 ANCHOR BLOCKS

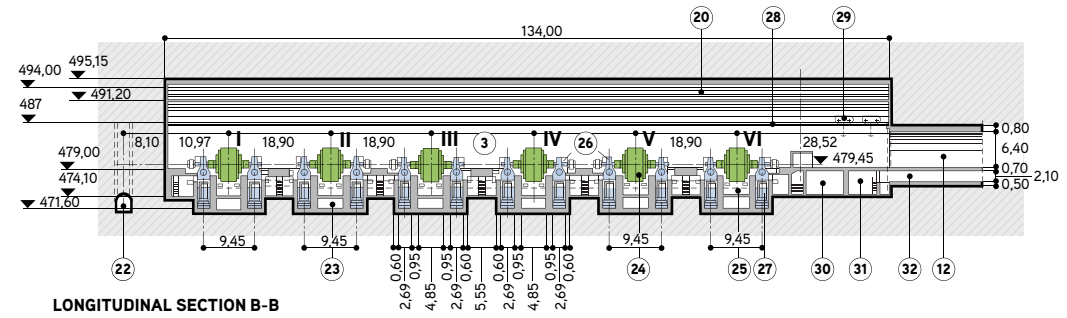
- 22 2.90 m Ø VERTICAL STEEL-LINED SHAFT
- 23 2.90 m Ø INCLINED STEEL-LINED SHAFT, LINING THICKNESS 16-22 mm, BANDED
- 24 NENDAZ POWER PLANT, MAXIMUM GROSS HEAD: 1007.8 m, MAXIMUM DISCHARGE: $45.0 \text{ m}^3/\text{s}$, INSTALLED CAPACITY: 390 MW

- 25 TAILRACE CANAL
- 26 WALKWAY AND BRIDGE FOR 220 kV CABLES
- 27 220 kV SUBSTATION

NENDAZ POWER PLANT INSTALLATIONS PLANS

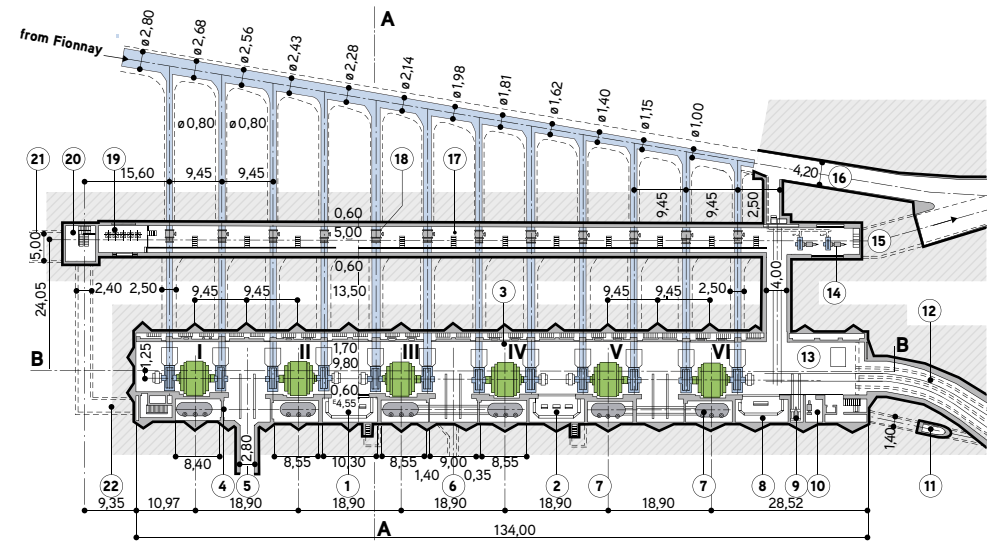


TRANSVERSE CROSS-SECTION A-A, REFERS TO THE HORIZONTAL CROSS-SECTION P.93



LONGITUDINAL SECTION B-B

- | | | |
|---------------------------------------------|---------------------------------------------------------------------------|------------------------------------------|
| 1 CONTROL ROOM FOR SETS I TO III | 17 VALVES GALLERY AND TAILRACE TUNNEL ONE ABOVE THE OTHER | 32 AERATION |
| 2 CONTROL ROOM FOR SETS IV TO VI | 18 0.65m Ø SPHERICAL VALVE | 33 GOVERNORS |
| 3 MACHINES HALL | 19 COOLING PUMPS ROOM | 34 SERVICE GALLERY |
| 4 STEEL-LINED DOOR | 20 VERTICAL SHAFT FOR COOLING PIPES | 35 TRAINING WALLS |
| 5 SECONDARY ACCESS TUNNEL FOR SETS I TO III | 21 1000m ³ COOLING WATER RESERVOIR. FLOOT AT ELEVATION 495.00m | 36 AIR CONDITIONING |
| 6 220kV CABLES TUNNEL FOR SETS I TO III | 22 COOLING PIPES GALLERY | 37 220kV CABLES TUNNEL FOR SETS I TO III |
| 7 80 MVA THREE-PHASE TRANSFORMERS | 23 TRANSFORMERS OIL PITS | |
| 8 PLANT SERVICES CONTROL ROOM | 24 GENERATOR | |
| 9 PLANT SERVICES TRANSFORMERS | 25 GENERATOR PIT | |
| 10 HYDRAULIC ROOM | 26 TURBINES | |
| 11 220kV CABLES TUNNEL FOR SETS V TO VI | 27 TURBINES PIT | |
| 12 MAIN ACCESS TUNNEL | 28 TRAVELLING CRANE TRACK | |
| 13 ERECTION BAY | 29 2x80 TON OVERHEAD TRAVELLING CRANES | |
| 14 HOUSE SETS | | |
| 15 TAILRACE TUNNEL | | |
| 16 ACCESS TO STEEL-LINED SHAFT | 30 VENTILATION ROOM | |
| | 31 STORE FOR HEAVY COMPONENTS | |



HORIZONTAL SECTION

POWER PLANT

BIEUDRON

The Bieudron facility is Switzerland's most powerful hydroelectric power plant. The underground power station, which is adjacent to the Nendaz power plant, was built between 1993 and 1998 to more than double the power capacity of the Grande Dixence complex. It can inject as much power as a nuclear power station into the grid in just a few minutes! The Bieudron power plant holds three world records: the drop height (1883 m), the power per Pelton turbine (3 x 423 MW) and the power per generator pole (35.7 MVA).

TECHNICAL SPECIFICATIONS

POWER PLANT

NUMBER OF TURBINES	3 Pelton
INSTALLED POWER CAPACITY	3 x 423 MW
POWER PER GENERATOR POLE	3 x 35.7 MVA
FLOW RATE	75 m ³ /s max.
MAX. DROP HEIGHT	1883 m
TRANSFORMERS	3 x 465 MVA (three-phase) – 410 / 21 KV

FOR MORE INFORMATION ON THE BIEUDRON POWER STATION:

CLEUSON - DIXENCE DISCOVER A HYDROELECTRIC FACILITY UNIQUE IN THE WORLD

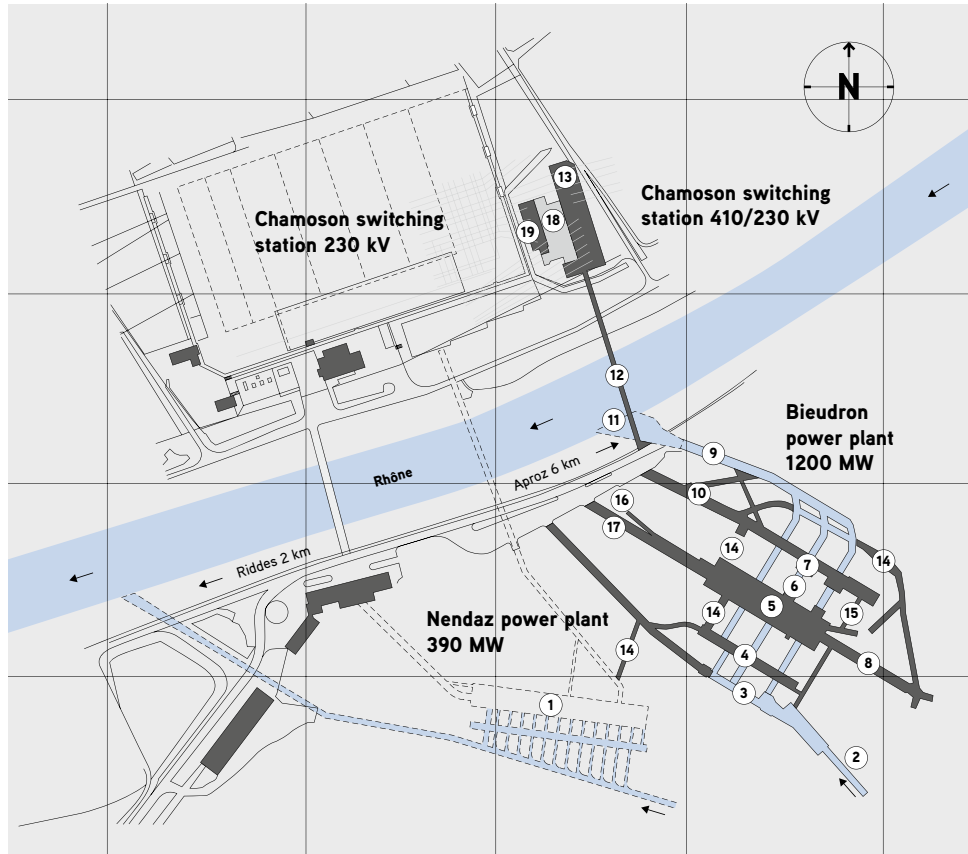
Technical brochure, 44 pp.



Machines room, Bieudron power plant

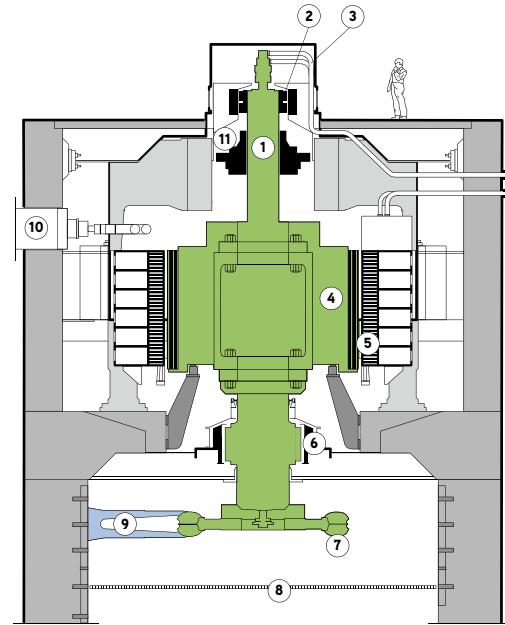
BIEUDRON POWER PLANT

PLAN OF LOCATION



- | | | |
|-----------------------------------------------------------|----------------------------------------------------|-----------------------------------------------------|
| 1 NENDAZ PLANT, 390 MW | 10 410 kV CABLES TUNNEL AND ACCESS TO TRANSFORMERS | 17 ACCESS TUNNELS |
| 2 PENSTOCK INLET, 75 m ³ /s | 11 RESTITUTION WORK TO THE RIVER RHÔNE | 18 COMMAND AND CONTROL SYSTEM FOR SWITCHING STATION |
| 3 DISTRIBUTOR, 3 x 25 m ³ /s | 12 CABLES GATEWAY | 19 AUTO-TRANSFORMER (600 MVA/230/410 kV) |
| 4 SPHERICAL VALVES CHAMBER | 13 CHAMOSON SWITCHING STATION (410/230 kV) | |
| 5 BIEUDRON MACHINES ROOM | 14 CONNECTING TUNNELS | |
| 6 BAR TUNNELS | 15 EMERGENCY TUNNEL | |
| 7 TRANSFORMER CELLS | 16 VENTILATION TUNNELS | |
| 8 COOLING WATER RESERVOIR, CAPACITY 21,000 m ³ | | |
| 9 TAILRACE TUNNEL | | |

INSTALLATIONS PLAN

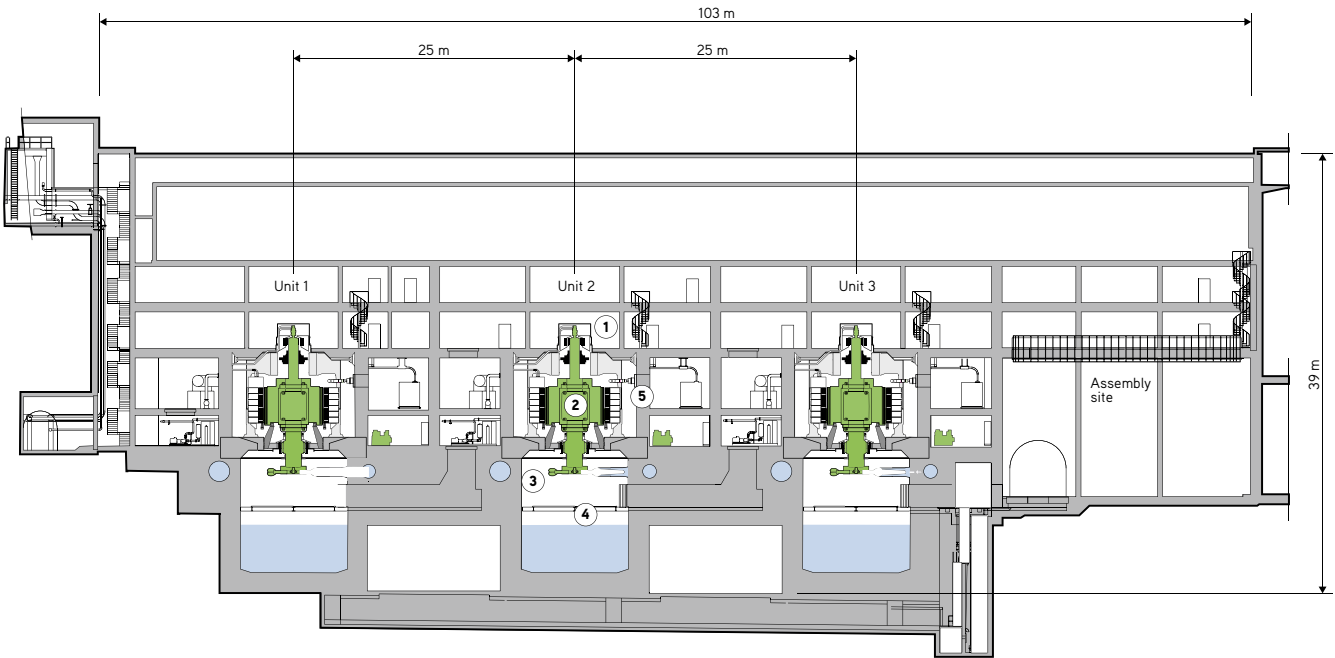


TURBINE-GENERATOR UNIT

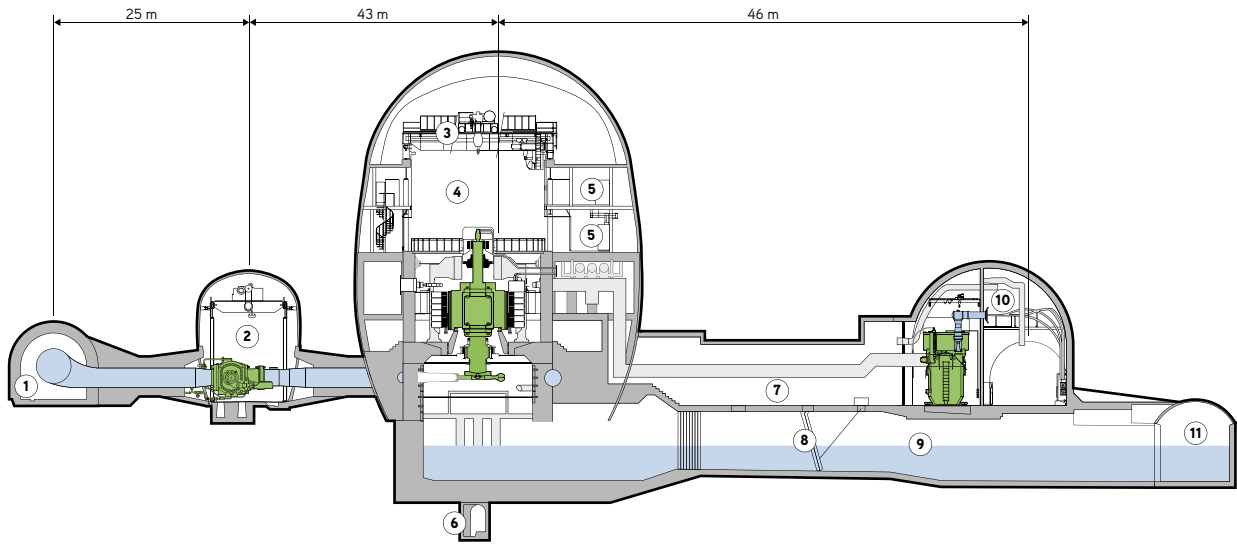
- | | |
|-------------------------|---------------------------------------|
| 1 GENERATOR SHAFT | 8 RACK AND PLATFORM |
| 2 EXCITER | 9 INJECTOR |
| 3 ROTOR - COOLING WATER | 10 BUSBARS |
| 4 ROTOR | 11 COMBINED TRUST AND BEARING SUPPORT |
| 5 STATOR | |
| 6 TURBINE GUIDE BEARING | |
| 7 PELTON TURBINE | |

BIEUDRON POWER PLANT

INSTALLATIONS PLANS



- 1 EXCITER
- 2 GENERATOR
- 3 PELTON TURBINE AND INJECTOR
- 4 RACK AND PLATFORM
- 5 BUSBARS



- 1 DISTRIBUTOR
- 2 VALVES CHAMBER
- 3 250 TONS OVERHEAD CRANE
- 4 MACHINES ROOM
- 5 TUNNEL FOR LOW AND MEDIUM VOLTAGE CABLES
- 6 LOW WATER TUNNEL
- 7 BAR TUNNEL
- 8 FLAP GATE
- 9 TAILWATER BRANCH
- 10 TRANSFORMER CELLS
- 11 TAILRACE

INFORMATION

For many years, Grande Dixence SA has welcomed visitors to its dam, as well as its pumping and power stations. The Grande Dixence dam is open to visitors from mid-June to the end of September. Four guided tours inside the wall take place every day. The pumping and power stations on the Grande Dixence complex can be visited on every working day of the year (for more information, visit www.grande-dixence.ch).



The crest of the Grande Dixence dam is the starting point for many a beautiful mountain walk

The energy produced by Grande Dixence SA is supplied in its entirety to the four partner companies which have the share capital of the company (300 million CHF), i.e.:

60%

ALPIQ SUISSE SA, LAUSANNE



13 1/3%

AXPO POWER AG, BADEN



13 1/3%

BKW ENERGIE AG, BERNE



13 1/3%

IWB INDUSTRIELLE WERKE BASEL, BÂLE



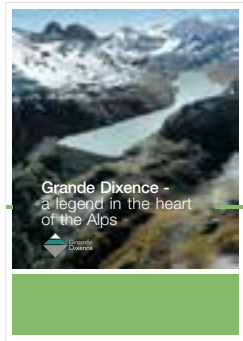
- **Elektrizitätswerk Zermatt AG (EWZ)**, industrial services for the municipality of Zermatt, with 45% of the share capital held since November 2001. This partnership has allowed EWZ and Grande Dixence SA to develop synergies to exploit and process the water in the Zermatt basin.
- **HYDRO Exploitation SA**, created in June 2002 jointly by EOS Holding and FMV SA, to manage their installations. Grande Dixence SA holds 35% of the share capital. Established in 2003, HYDRO Exploitation SA was one of the first companies to focus entirely on the use of hydroelectric energy. Primarily designed for its shareholders, the company's services could also be offered to the owners of other hydraulic facilities in Valais or elsewhere.
- **Cleuson-Dixence**, an ordinary partnership created jointly with EOS in 1992 to increase the capacity for electricity production. Grande Dixence SA's holding is 15/22.
- **Forces Motrices de la Borgne SA (FMdB)**, with 29% of the share capital since January 2009. FmdB owns the Bramois development, located downstream of the Grande Dixence installations, and uses the waters of the Borgne river. FmdB's other shareholders are the communes of Hérémece, St-Martin, Vex, Mont-Noble and Sion (51%) and the company FMV SA (20%).

CONTACT INFORMATION

Grande Dixence SA, Sion

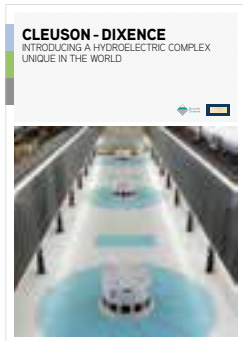
+41 27 328 43 11 www.grande-dixence.ch

FOR MORE INFORMATION:



GRANDE DIXENCE, A LEGEND IN THE HEART OF THE ALPS

General brochure, 72 pp, A4



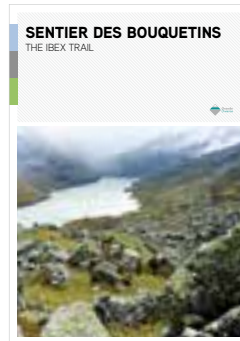
CLEUSON - DIXENCE INTRODUCING A HYDROELECTRIC COMPLEX UNIQUE IN THE WORL

Technical brochure, 44 pp, A5



GRANDE DIXENCE EXPERIENCE THE ENERGY AT THE HEART OF THE ALPS

General brochure, 52 pp, A5



EDUCATIONAL ROUTE THE IBEX TRAIL

Discovery brochure, 86 pp, A5

NOTES:

