

E S P A N H A



Hydroelectric development of the catchment areas of the rivers Douro and Cávado

Execution of works

Works for the CARRAPATELO development were basically carried out in two principal stages each one corresponding to the diversion, by means of cofferdams, of the waters from each half of the riverbed thus compelling the rivercourse to follow through the other half.

Before starting the first stage of the work, the central block of the dam was erected up to a suitable level, as well as the separating wall of the stilling pool, which would serve as a longitudinal element common to the main cofferdams of the subsequent construction stages.

The main cofferdam of the first stage, on the left half of the riverbed, was formed upstream and downstream by circular metallic cells and allowed alternately the erection of: the blocks of the dam left half up to levels (17) and (12), half of the stilling pool and respective continuous sill, and the powerhouse and hydraulic circuit structures which should necessarily be achieved before the main cofferdam demolition. Afterwards, recourse was taken to minor cofferdams in order to complete these works.

The second stage of construction regarded the right half of the riverbed and was carried out under the protection of the cellular cofferdams (transferred from the former stage of construction) and of the longitudinal wall, the flow being diverted to the left half blocks of the dam, whose placing has been interrupted at level (12). Thus the whole construction of the right half of the dam, stilling pool and navigation lock was accomplished.

Complementarily and under the protection of the spillway stop logs, the concreting of the left half blocks of the dam was carried out during the low flow periods, when the waters could be totally discharged through the bottom outlets and through an auxiliary tunnel installed in the central block of the dam, to be closed at the end of works.

The construction of CARRAPATELO involved excavation works of 1,500,000 cu. m. and the placing of 760,000 cu. m. of concrete.

HYDROLOGICAL DATA

Catchment area	92,040 sq. km.
Average annual flow (1932-33 to 66-67)	585 cu. m. sec.
Maximum expected flow	22,000 cu. m. sec.
High flood of December 1909	17,000 cu. m. sec.

RESERVOIR

Total storage	140x10 ⁶ cu. m.
Live storage capacity	9x10 ⁶ cu. m.
Length	40 km.
Area	9.6 sq. km.
Maximum retention level	(46.5)

DAM

Maximum height	57 m.
Crest length	400 m.

DISCHARGE WORKS

Sector gates	(6)	26.0x15.4 m.
Flaps of the sector gate	(2)	15.0x 3.5 m.
Bottom discharges	(2)	3.7x 3.7 m.

NAVIGATION LOCK

Vertical lift	34.5 m.
Usable length of the lock chamber	85.0 m.
Width	12.0 m.
Filling time	12.5 min.

ENERGETIC DATA

Maximum rated flow	792 cu. m. sec.
Maximum gross head	34.5 m.
Rated power	201 MVA
Average annual production	1000 GWh

POWERSTATION

No. of sets	3
Distance between generators centerlines	23.6 m.
Nominal rating of the Kaplan turbines	
per unit	95,000 HP
Nominal rating of the generators	
per unit	67 MVA
Nominal speed	115.5 r.p.m.
Travelling cranes	(2) 100/15 t



SEPTEMBER, 1966 Δ



Δ JUNE, 1968



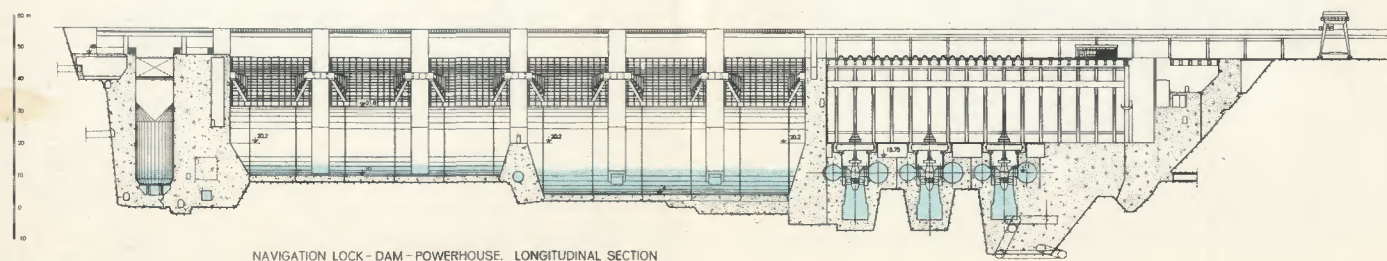
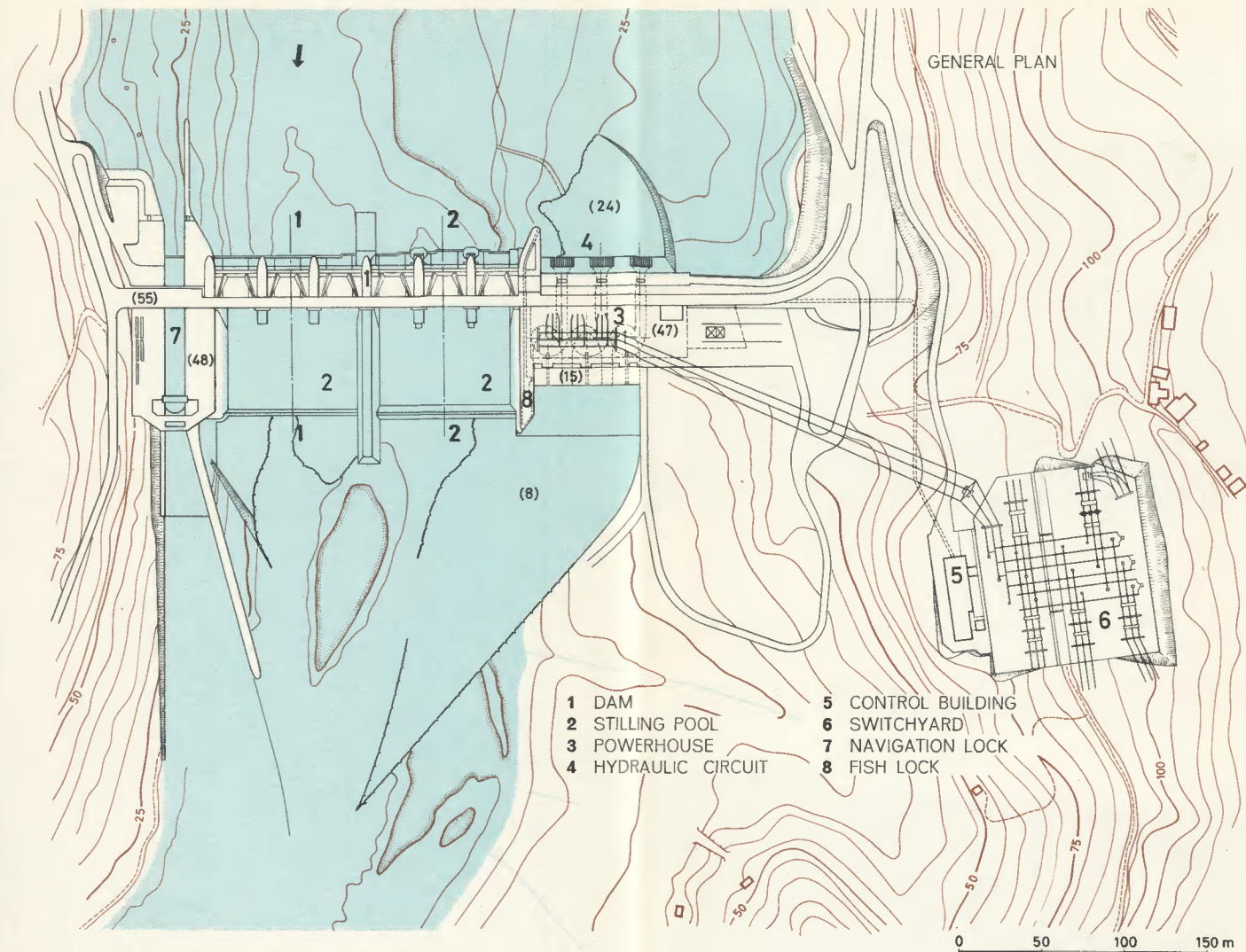
JULY, 1967 ▽



▽ APRIL, 1970

carrapateiro

COMPANHIA PORTUGUESA DE ELECTRICIDADE CPE S.A.
DIRECCAO DA PRODUCCAO HIDRAULICA DO NORTE



General plan

The plan for exploiting the hydraulic power of the National Douro anticipates the development of its water resources in 5 low-head stations: Crestuma, Carrapateiro, Régua, Valeira and Pocinho, from down to upstream.

The CARRAPATEIRO station, the first to be carried out, comprises mainly: on the left bank an overflow dam occupying the natural riverbed and the block of the powerhouse, intakes and tailrace channel; a navigation lock is placed along the right bank. The switchyard and the control building stand at a higher level also on the left bank.

At the dam site, the valley is wide and asymmetrical, the soil consisting mainly of medium grain granite. On the left bank, where the powerhouse is established, there are zones of highly altered rock. Contacting with strong lodes of quartz the existence was recognized of fractures and faults in the powerhouse foundation. These important geological accidents and the size of the zone of altered granite led to deepening the excavations for the foundation of one of the generating sets and the adoption of suitable means to guarantee the stability of the works.

The dam is a concrete, gravity type structure, with the downstream face disposed as a discharge apron, and its cross-section is lightened by means of a large gallery adjoining the foundation so that the rock is apparent on its floor. The main spillway placed over the dam consists of 6 openings controlled by sector gates. The discharge apron is extended along the riverbed by a stilling pool. The stilling pool

is divided in two parts, with the respective sills at different levels, separated longitudinally by a wall which was used as a side cofferdam during the different stages of construction.

A bottom outlet was installed in each one of the two piers on the left half of the dam. Flaps operating as an auxiliary discharge were provided in each of the two sector gates of the main spillway, one in its left half and the other in the right one.

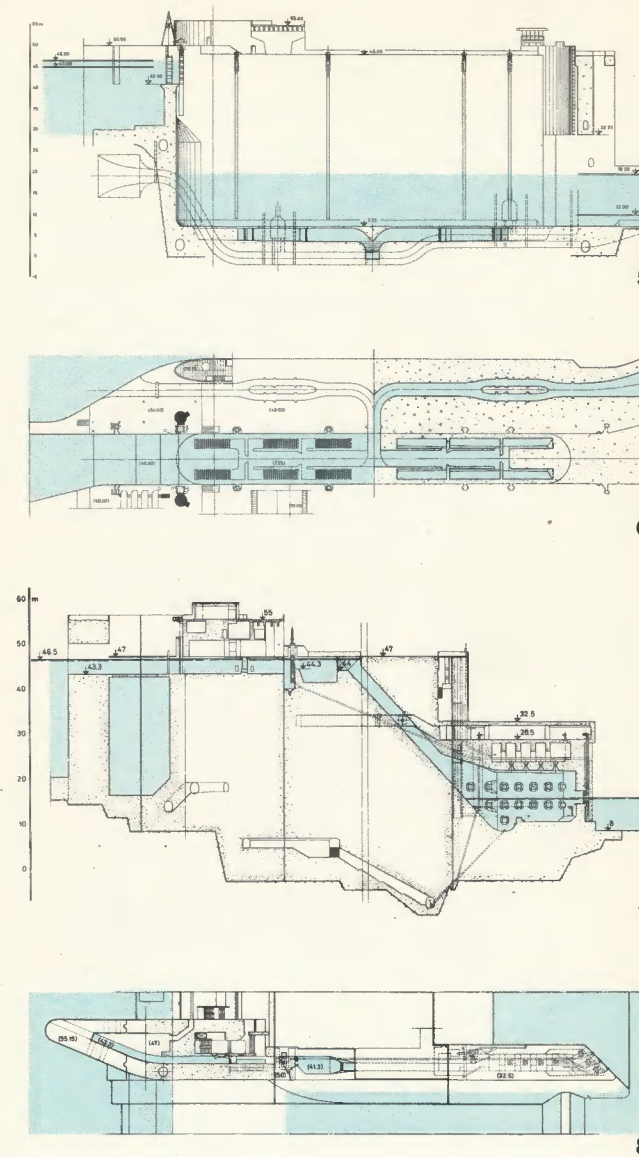
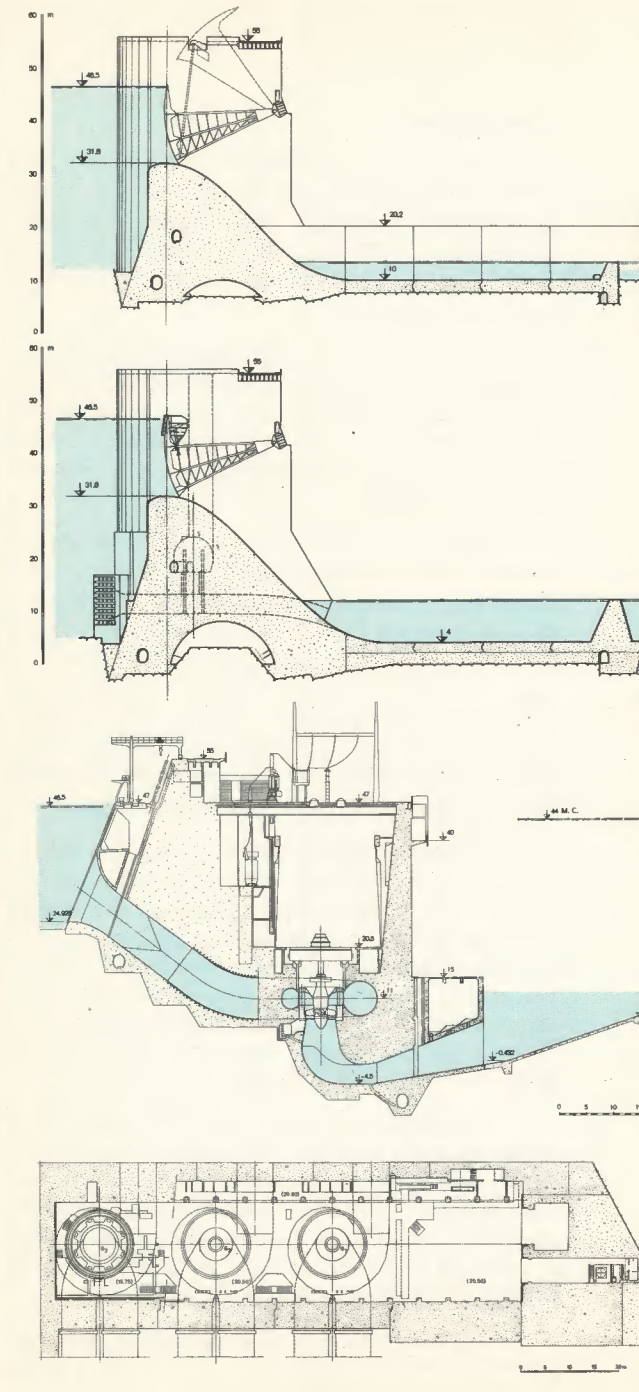
A road viaduct formed by reinforced and prestressed concrete structures was established over the crest of the dam.

The block including the powerhouse and intakes, on the left bank, was designed as a structural whole keeping in mind the reservoir hydrostatic pressure and also that corresponding to the downstream water level, which nearly reach the upstream level, when very high floods occur.

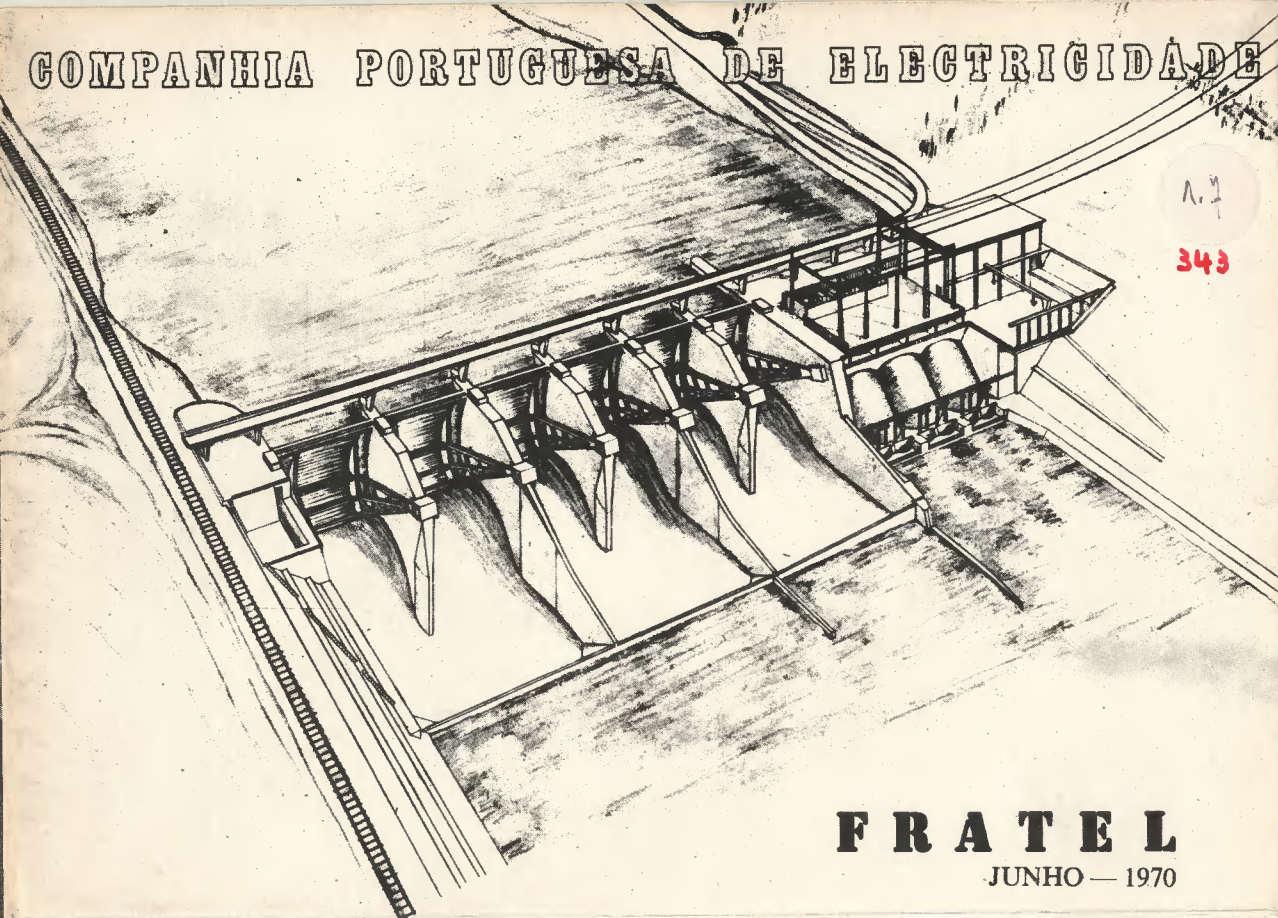
The switchyard and the control building, on the left bank slope, are located slightly downstream the dam.

The navigation lock, on the right bank, provides navigation facilities to barges loaded up to 1,400 tons. To erect this lock, it was necessary to cut the rock through a large and high face.

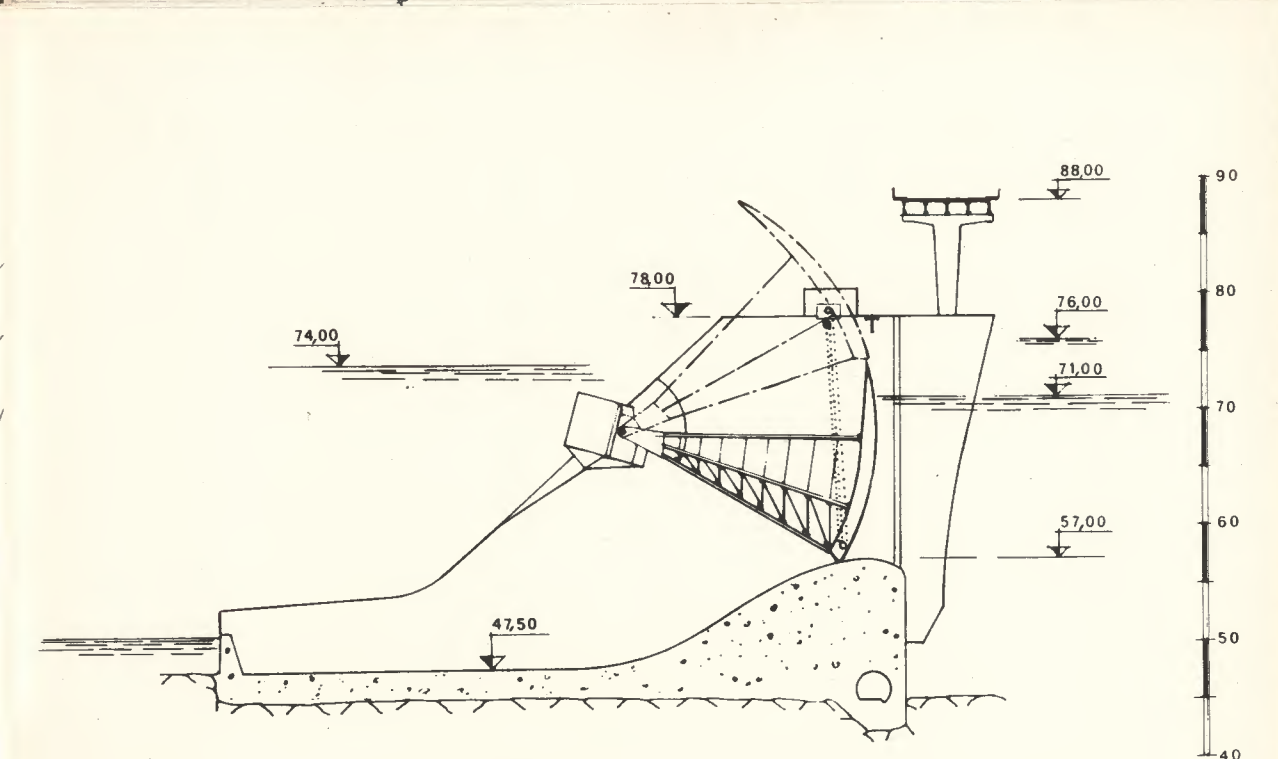
A Borland fish lock essentially consisting of two chambers, an upper and a lower one connected by a sloping shaft, was embedded in the concrete wall which separates the dam from the powerhouse. So migratory halieutic fish in river Douro, specially shad and lamprey, were granted the necessary means to overpass the dam.



- 1 and 2 Dam and stilling pool. Cross sections
- 3 Powerhouse. Cross section
- 4 Powerhouse. Plan
- 5 Navigation lock. Longitudinal section
- 6 Navigation lock. Hydraulic circuit plan
- 7 Fish lock. Longitudinal section
- 8 Fish lock. Plan



JUNHO — 1970



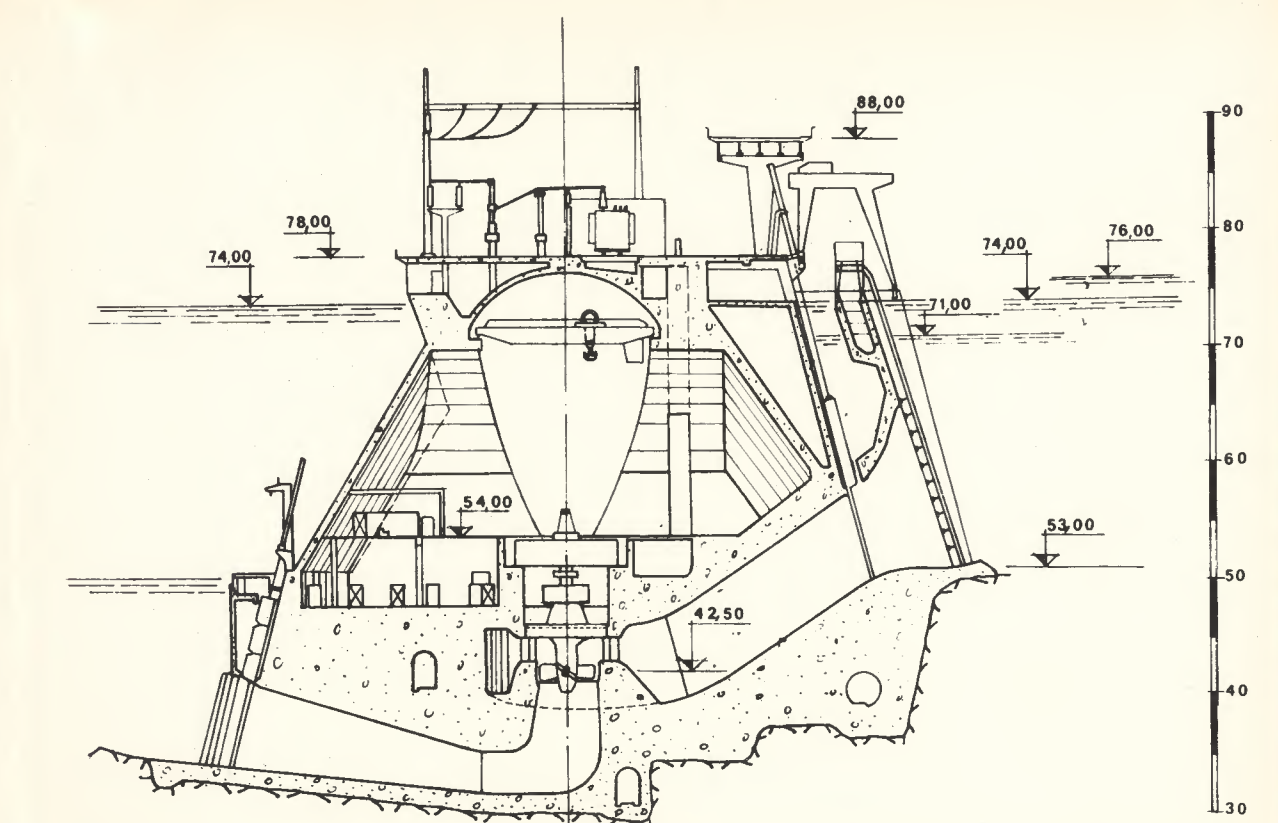
BARRAGEM

CARACTERÍSTICAS GERAIS

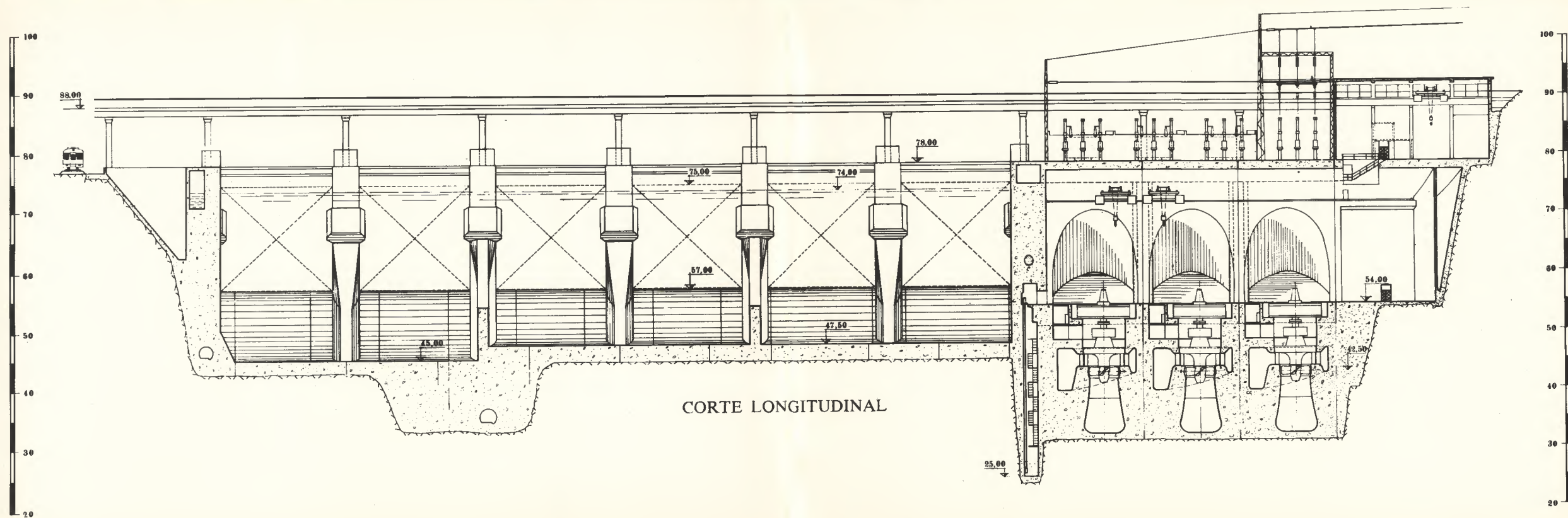
CENTRAL

Caudal máximo turbinável.....	700 m³/s
Nível máximo de exploração.....	74,00 m
Nível mínimo de exploração.....	71,00 m
Capacidade útil (71,00/74,00).....	20,5 × 10⁶ m³
Queda bruta média.....	22 m
Turbinas tipo Kaplan.....	3 × 62 000 CV
Alternadores trifásicos.....	3 × 50 MVA
Produção anual média.....	430 GWh

As comportas apoiam-se no extremo de jussante dos pilares em cabeças de betão armado, amarradas ao corpo destes por tirantes pré-esforçados incorporados nos próprios pilares.



CENTRAL — CORTE TRANSVERSAL



A superestrutura da central é protegida contra as cheias, a montante à cota (76,00 m) e a jusante à cota (74,00 m), por abóbadas múltiplas apoiadas em contrafortes de forma aproximadamente trian-

Os dois órgãos principais do aproveitamento estão separados pelo muro barragem-central de 6 m de espessura, 150 m de comprimento e altura variável. Neste muro está instalado o poço das bombas da central onde convergem os sistemas de drenagem; um poço de entrada para as galerias de drenagem; a galeria de descarga do circuito de limpeza das grades das tomadas de água e ainda a eclusa de peixes.

FRATEL		1967	1968	1969	1970	1971	1972	1973	1974
ESTALEIRO	acessos e infra-est.								
	equipamentos								
DERIVAÇÃO	execução								
	desvio								
BARRAGEM	escavações								
	betões								
	comportas								
CENTRAL E SUBESTAÇÃO	escavações								
	betões								
	pontes rolantes								
	equipamento	1.º grupo							
		2.º grupo							
		3.º grupo							