Awareness Program for Operation Staff
Kotmale Power Station

Water Management

By:

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Electrical Engineer (Operations)

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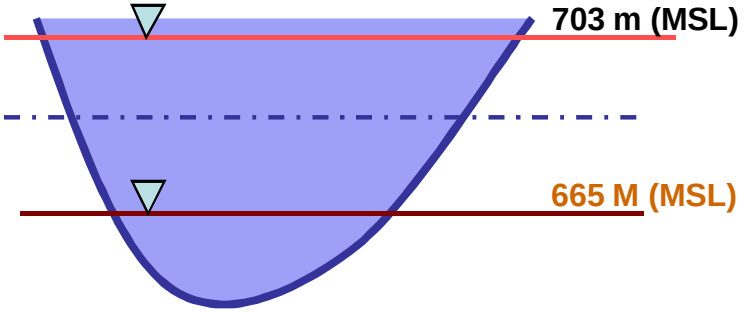
Water Management



Storage / MCM	
703 m	174
665 m	20

1MCM = $1x10^6$ m^3

Spill Level	=	703 m (Above MSL)
Minimum Operating Level	=	665 m (Above MSL)
*Tailrace Level	=	476 m (Above MSL)

Maximum Head = 227 m
Minimum Head = 189 m

•- Refer to the diagram and commissioning reports for a better understanding of the Tailrace Level determination.

Water Management

Power o/p from Generator

Rule of Thumb

$$P = 7HQ \text{ (KW)}$$

Where
H = net head (m)
Q = flow rate (m^3/s)

Correct equation

$$P = \rho g H Q \eta_t \eta_G \text{ (W)}$$

Where
ρ = density of water (1000 kg/m3)
g = gravitational constant (9.81 m/s2)
H = net head (m)
Q = flow rate (m^3/s)
ηt = Turbine efficiency
η_G = Generator efficiency

Water Management

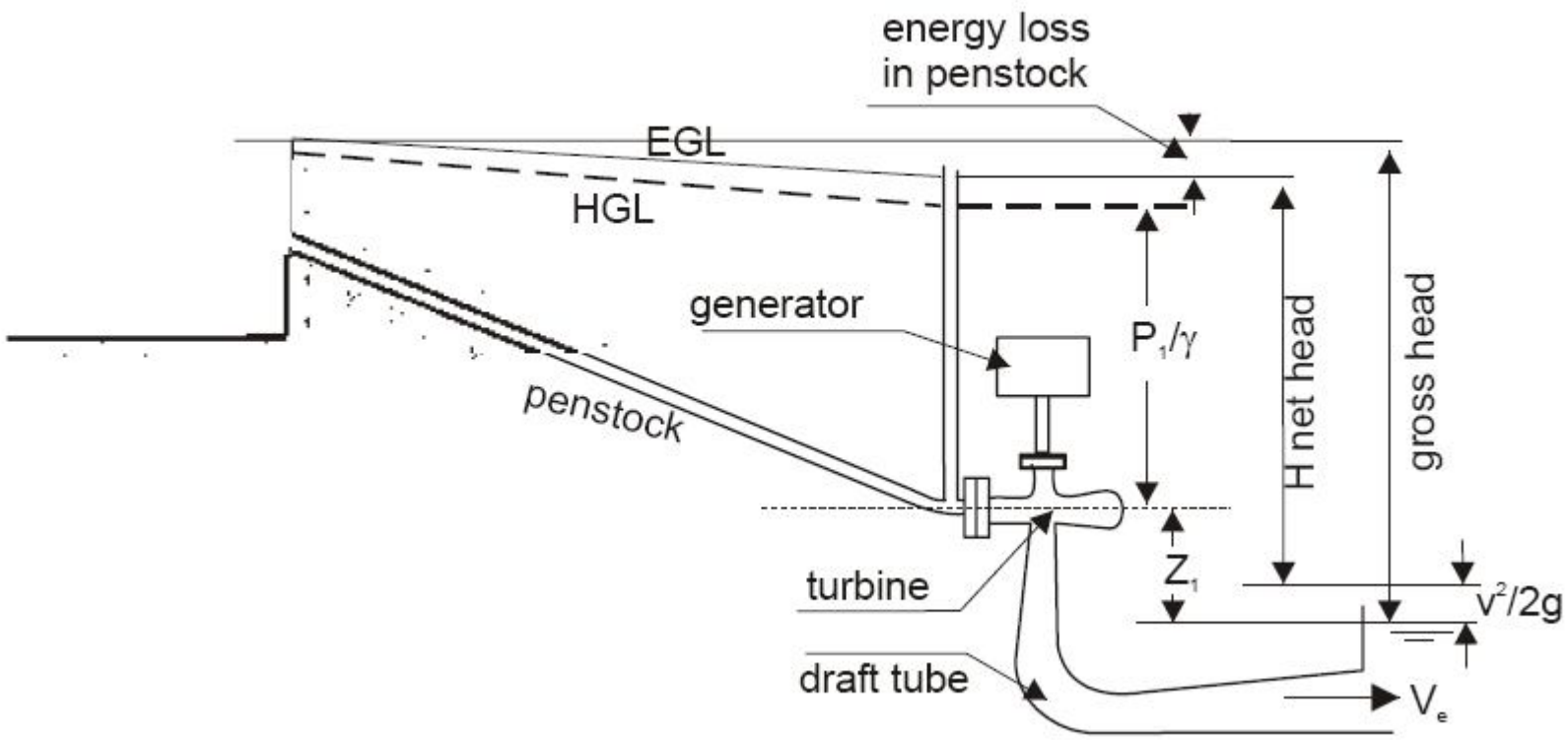
Gross Head

The difference between headwater elevation and tailwater elevation.

Net Head

The effective head on the turbine and is equal to the gross head minus the hydraulic losses before entrance to the turbine and outlet losses.

Schematic view of the Energy Losses in an hydro power scheme



BOVING KMW turbin ab	COMMISSIONING PROGRAM	KOTMALE	
	RECORD SHEET	Unit No. 3	
	OBJECT: See below	Date	Sheet 5

Appr. Sign.

PRESSURE- AND WINTER KENNEDY TAPS IN SPIRAL CASE.

TEST NO	1	2	3	4	5
DATE	17-2-88	29-2-88	17-3-88	17-3-88	17-3-88
HWL	[illegible]6.42	680.8[illegible]	[illegible]74.69	674.70	674.66
[illegible]	477.74	[illegible]3.03	[illegible]80	[illegible]3.0	[illegible]8.20
U/S HEAD LOSS	0.91	1.48	0.16	0.42	1.30
VEL HEAD AT INLET	-	5.14	0.65	2.22	5.38
NET HEAD	[illegible].77	[illegible]1.66	[illegible]6.73	[illegible].28	195.05
MW (INDIC)	60	65	20	40	62
MW (MW-HR)	59.88	64.06	20.45	39.3	62.9
GEN η	[illegible]98	[illegible]8	[illegible].97	[illegible]76	[illegible]98
MW (TURBINE)	61.1	65.4	[illegible]	40.3	64.2
EST TURBINE η	[illegible]45	[illegible].94	[illegible]8	0.91	[illegible]35
Q (ACC TO η)	3[illegible].75	35.2	13.7	23.0	3[illegible]
Q (ACC TO WK)	-	34.8	12.4	22.9	35.6
Q (INDICATED)	32	36.5	9.8	22.5	36.5

686.42	HWL
477.74	TWL
208.68	
- 0.91	U/S loss
207.77	Net

Contractor

Engineer 18.2.88

BOVING KMW turbin ab	COMMISSIONING PROGRAM RECORD SHEET OBJECT: ACCEPTANCE TEST	KOTMALE Unit No. 3 Date	Sheet 14

Appr. Sign.

a Capacity test

TEST NO	1	2	3		
DATE	16.2.88	29.2.88	17.3.88		
HWL	686.69	680.89	674.66		
TWL	478.20	478.05	478.20		
U/S HEAD LOSS	1.19	1.18	1.30		
NET HEAD	201.3	201.66	195.06		
ACTUATOR POS %	77.5	79	85		
GVO (av) mm	88	89.5	95		
MAX STABLE MW (G) (INDIC)	66	65	63		
MAX STABLE MW (G) (MAN. HE)	65.7	64.06	62.9		
GENERATOR η	0.98	0.98	0.98		
MAX STABLE MW (T)	67.0	65.4	64.2		

686.69 HWL
478.20 TWL
208.49
− 1.19 Loss
207.3 Net

Gross [illegible]
net head [illegible]
[illegible]

Contractor

Engineer 23.3.88

BOVING KMW turbin ab	COMMISSIONING PROGRAM RECORD SHEET OBJECT: ACCEPTANCE TEST	KOTMALE Unit No. 3 Date	Sheet: 4

a Capacity test

TEST NO	1	2	3		
DATE	16.2.88	29.2.88	17.3.88		
HWL	686.69	680.89	674.66		
TWL	478.20	478.05	478.30		
U/S HEAD LOSS	1.19	1.18	1.30		
NET HEAD	207.3	201.66	195.06		
ACTUATOR POS %	77.5	79	85		
GVO (a0) mm	88	89.5	95		
MAX STABLE MW (G) (INDIC)	66	65	63		
MAX STABLE MW(G) (MW-HE)	65.7	64.06	62.9		
GENERATOR η	0.98	0.98	0.98		
MAX STABLE MW(T)	67.0	65.4	64.2		

Appr. Sign.

686.69 Gross
478.20 Tail
208.49
-1.19 Loss
207.3 Head

Gross = static
net head ... head

BOVING KMW turbin ab

COMMISSIONING PROGRAM
RECORD SHEET
OBJECT: ACCEPTANCE TEST

KOTMALE
Unit No. 3
Date
Sheet 14

Appr. Sign.

a Capacity test

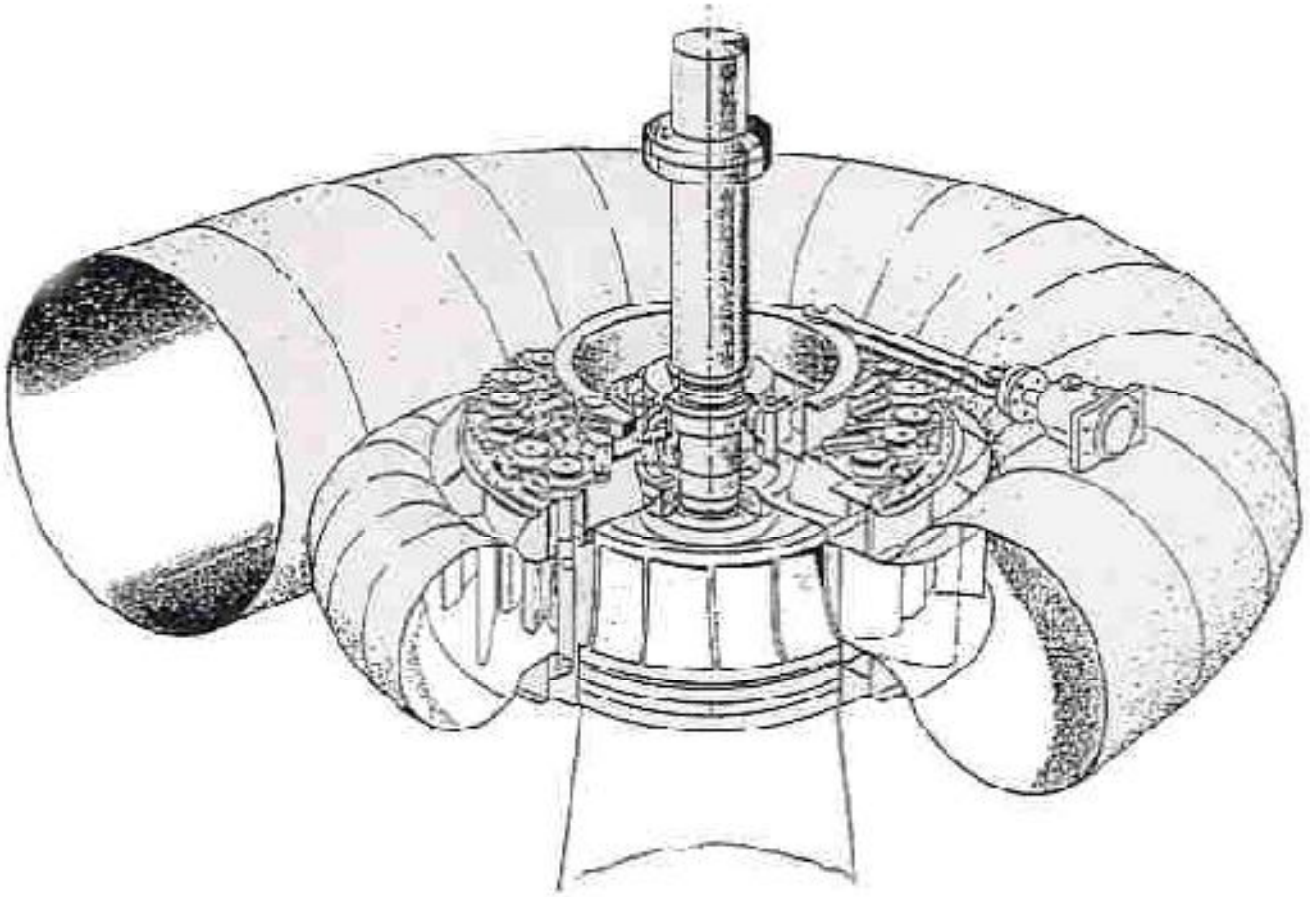
TEST NO	1	2	3		
DATE	16.2.88	29.2.88	17.3.88		
HWL	686.69	680.89	674.66		
TWL	478.20	478.05	478,50		
U/S HEAD LOSS	1.19	1.18	1.30		
NET HEAD	207.3	201,66	195,06		
ACTUATOR POS %	77.5	79	85		
GVO (a₀) mm	88	89.5	95		
MAX STABLE MW (G) (INDIC)	66	65	63		
MAX STABLE MW(G) (MW-HE)	65.7	64.06	62.9		
GENERATOR η	0.98	0.98	0.98		
MAX STABLE MW(T)	67.0	65.4	64.2		

688.69 Tail
478.20 Tail
208.49
- 1.19 Loss
207.3 Net

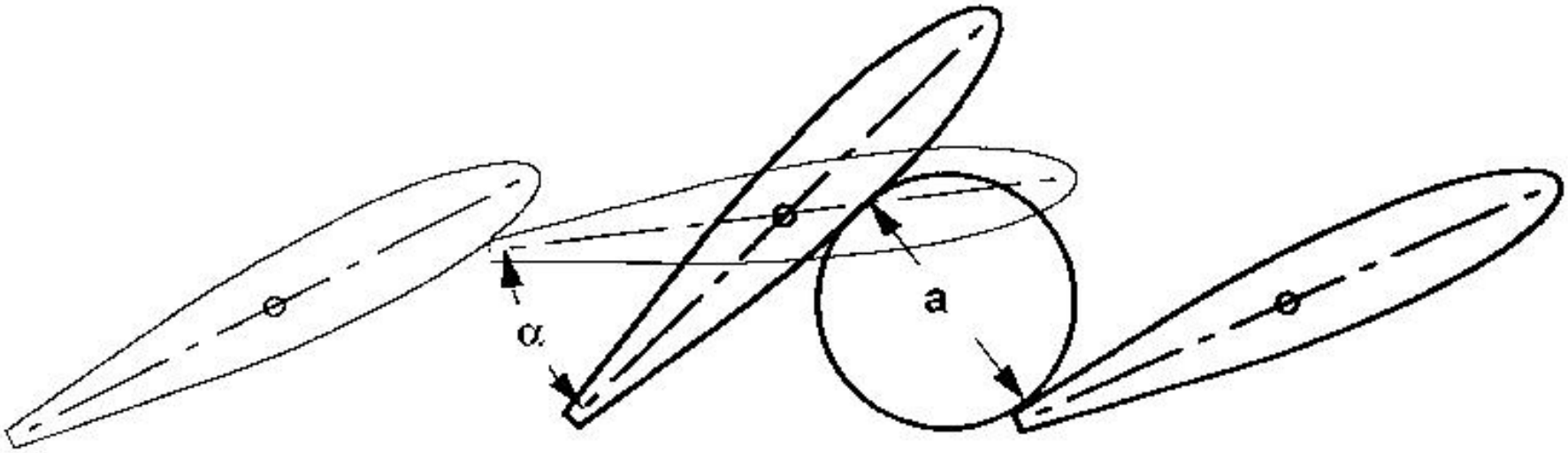
Gross = Max net head = design head

23.3.88

View of a Francis Turbine



Guide vane functioning principle



Draft Tube

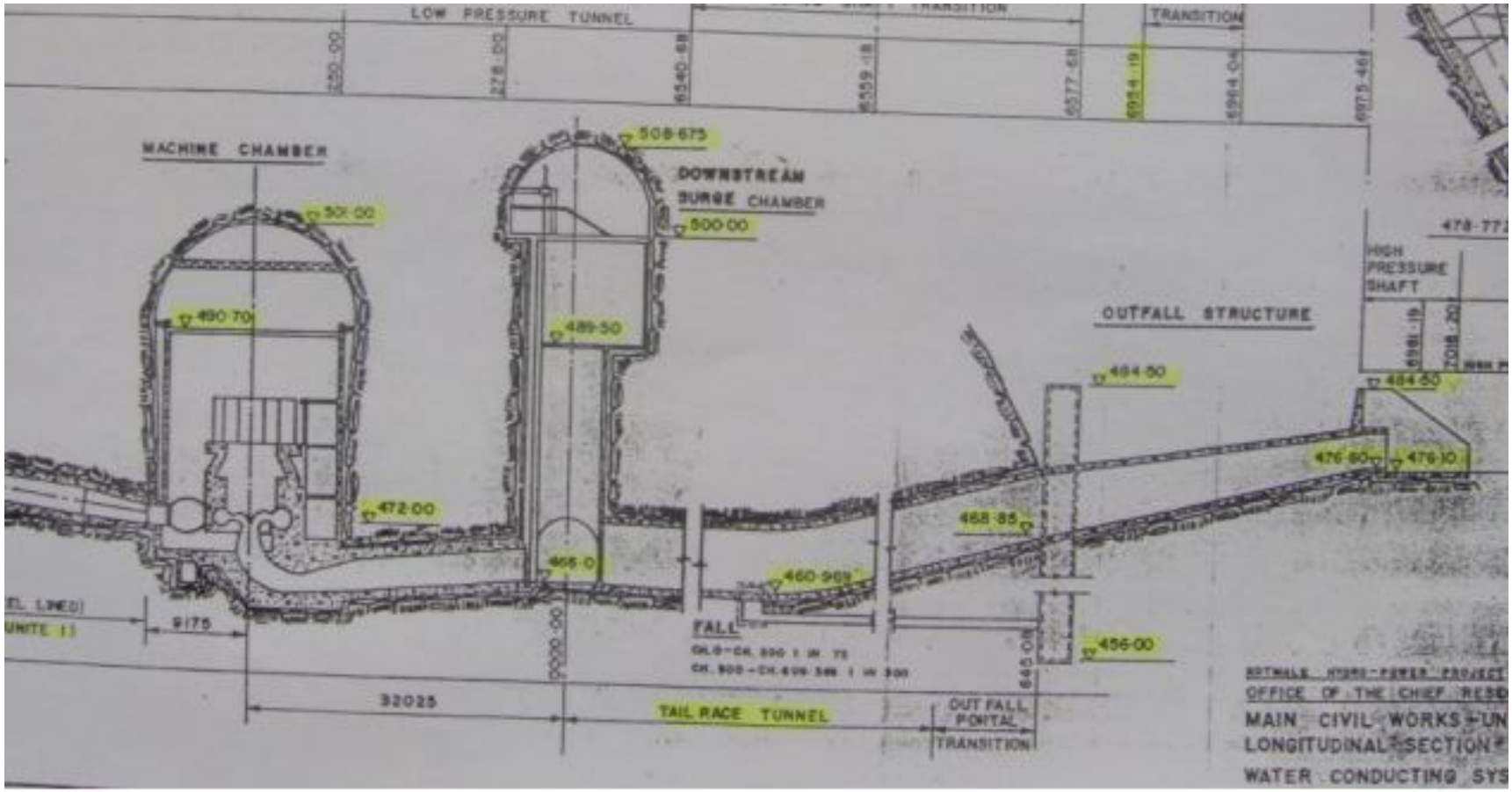
The draft tube of a reaction turbine aims to recover the kinetic energy still remaining in the water leaving the runner.

As this energy is proportional to the square of the velocity one of the draft tube objectives is to reduce the turbine outlet velocity. **($V^2/2g$)**

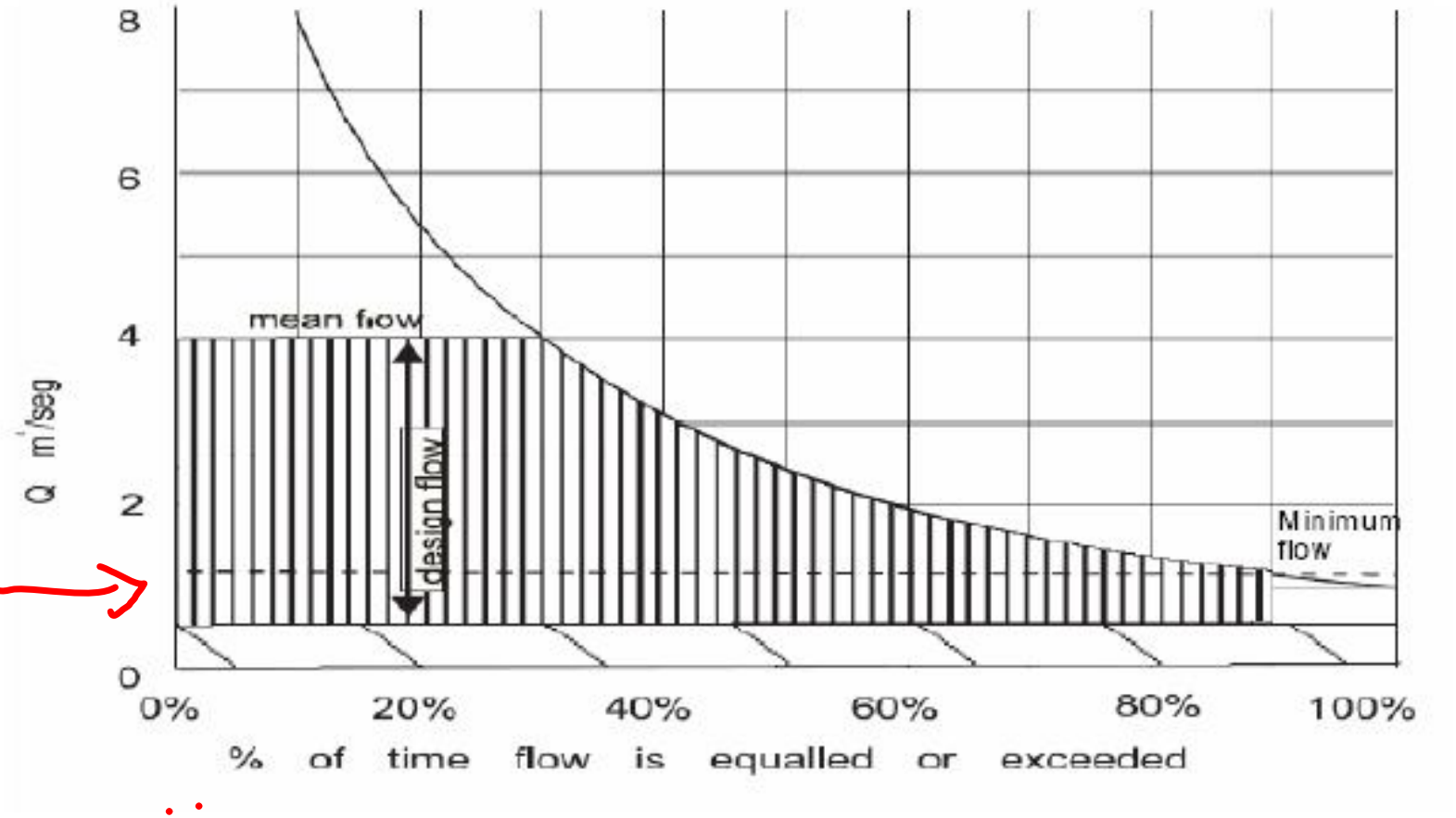
An efficient draft tube would have a conical section but the angle cannot be too large, otherwise flow separation will occur. The optimum angle is 7º but to reduce the draft tube length, and therefore its cost, sometimes angles are increased up to 15º

Types
- Elbow type
- Straight conical type

Draft Tube


LOW PRESSURE TUNNEL
TRANSITION
MACHINE CHAMBER
508·675
DOWNSTREAM
SURGE CHAMBER
500·00
501·00
490·70
489·50
OUTFALL STRUCTURE
HIGH
PRESSURE
SHAFT
484·50
484·50
476·60
476·10
472·00
468·85
465·0
460·909
FALL
456·00
32025
TAIL RACE TUNNEL
OUT FALL
PORTAL
TRANSITION
OFFICE OF THE CHIEF
MAIN CIVIL WORKS
LONGITUDINAL SECTION
WATER CONDUCTING SYS

Flow duration curve



Firm energy

Firm energy is defined as the power that can be delivered by a specific plant during a certain period of the day with at least 90 –95% certainty. A run-of-river scheme has a low firm energy capacity. A hydropower plant with storage does, however, have considerable capacity for firm energy.

If the hydropower scheme is to be connected to an electrical network that includes several types of power and where the hydropower installations are geographically distributed, as is the case in Europe, the firm power capacity of singular plants may, not be important.

Kotmale Firm Energy ???

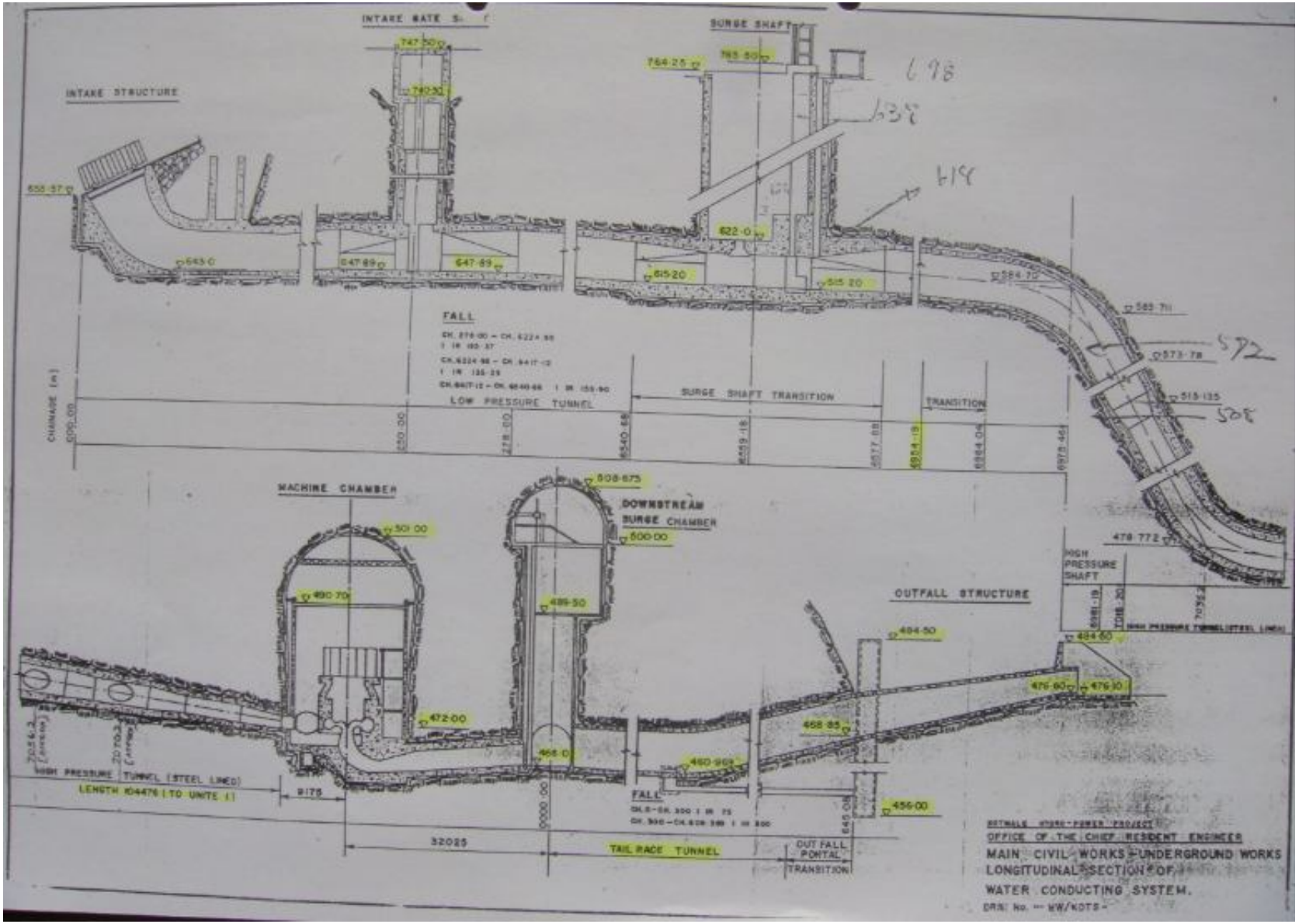
310 GWh

The efficiency guaranteed by turbine manufacturers is that which may be verified in accordance with the "International Code for the field acceptance tests of hydraulic turbines" (publication IEC 60041) or, if applied, in accordance with the "International Code for model acceptance tests" (publication IEC 60193).

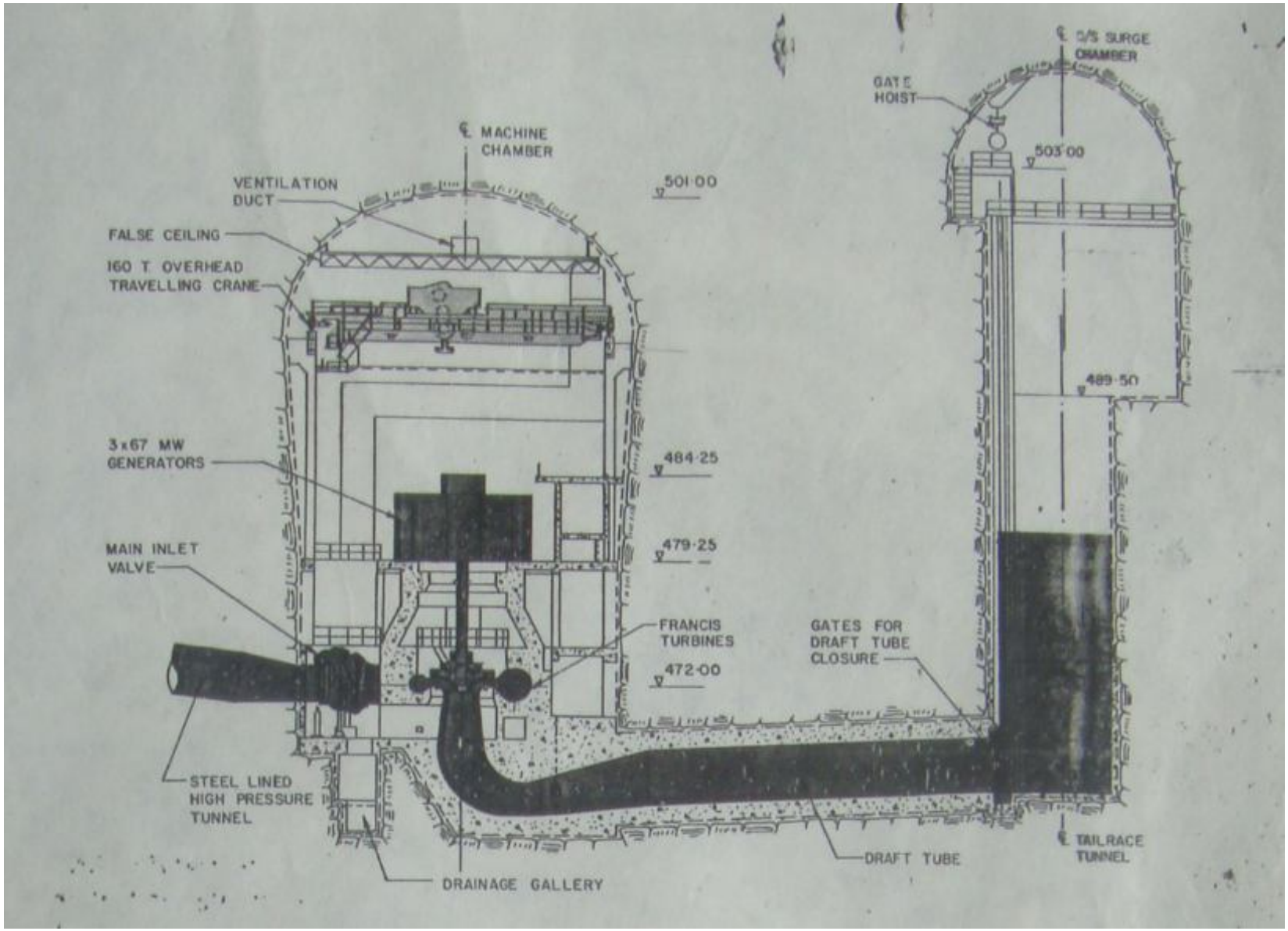
It is defined as the ratio of power supplied by the turbine (mechanical power transmitted by the turbine shaft) to the hydraulic power.

Kotmale Turbine Name Plate Data

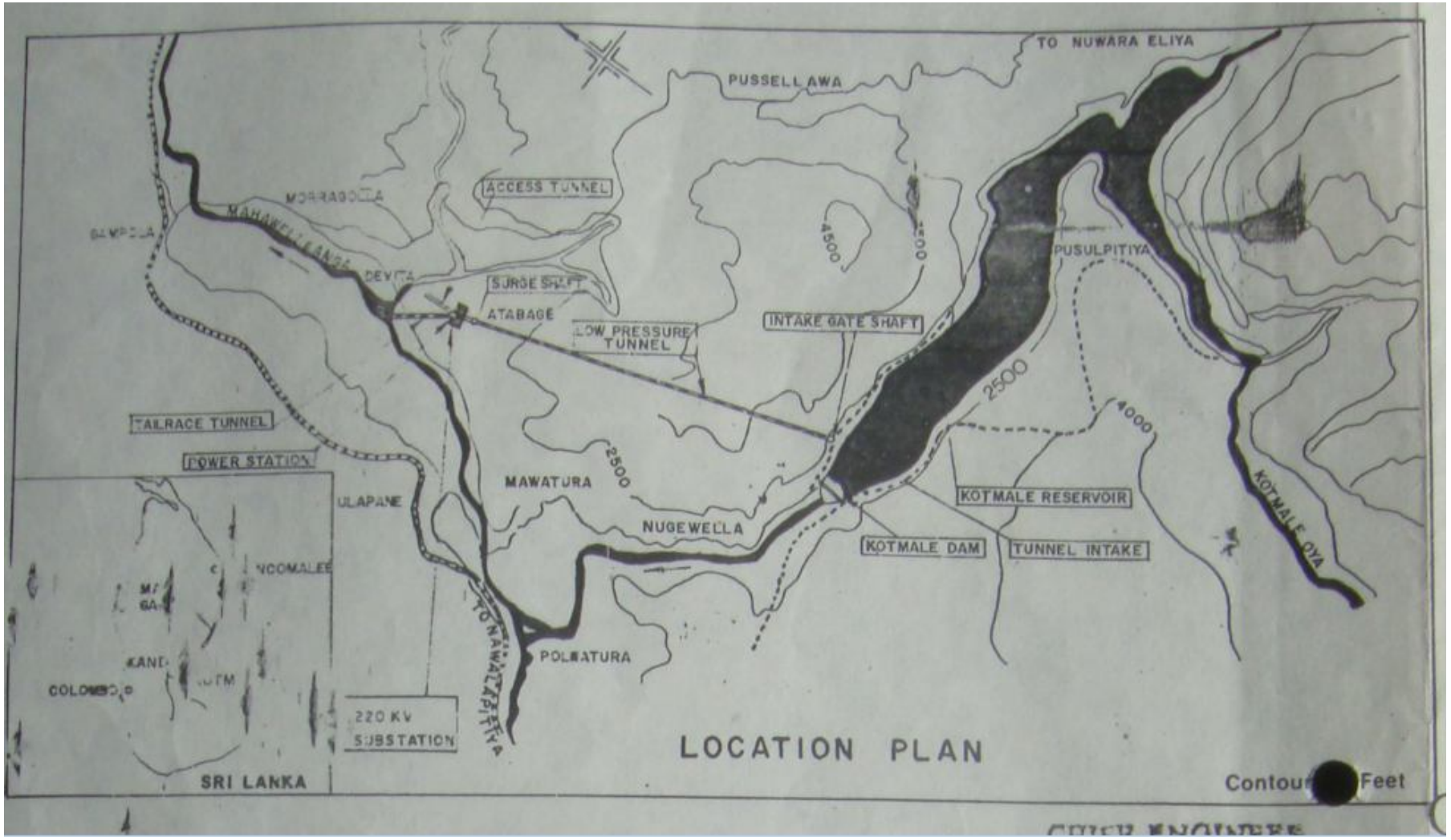
LONGITUDINAL SECTION OF THE WATER CONDUCTING SYSTEM



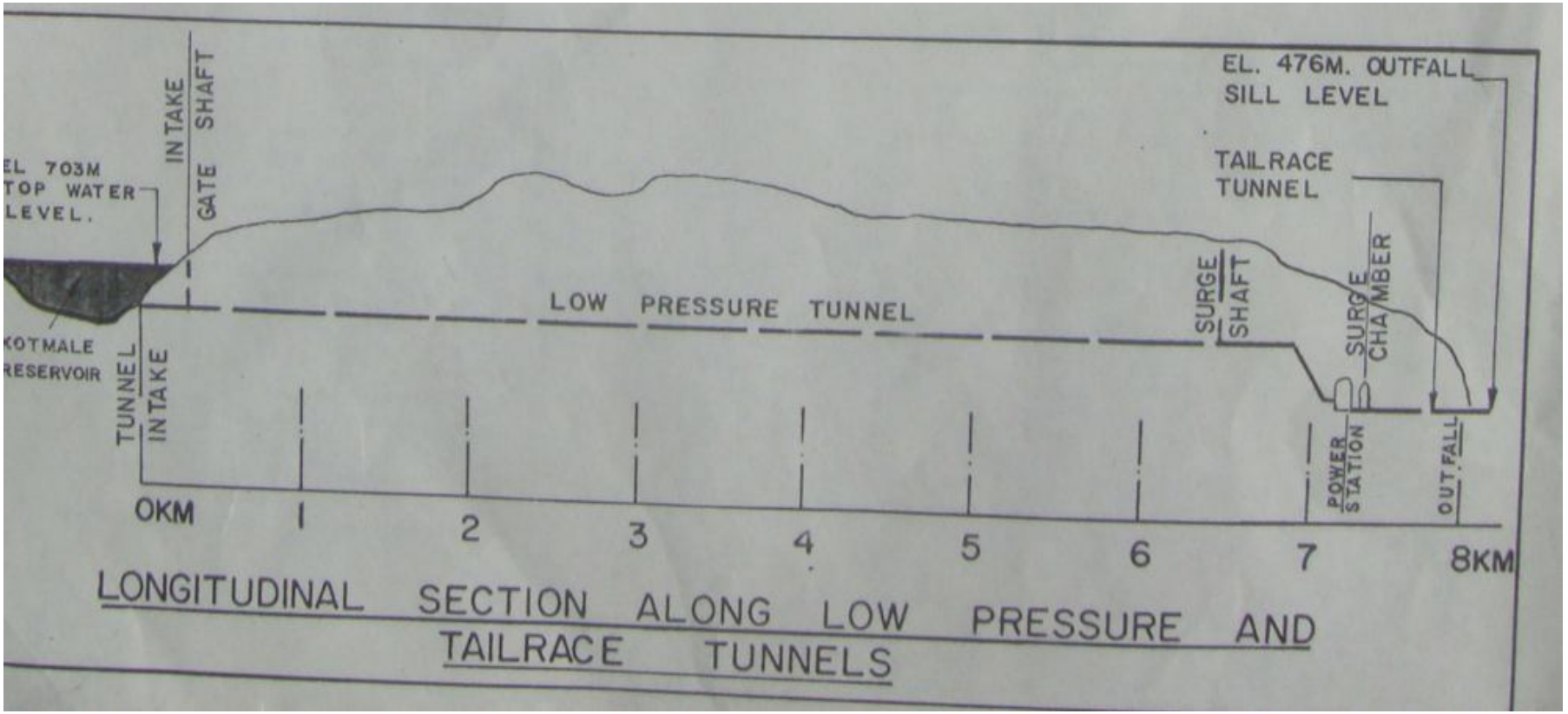
CROSS SECTION THROUGH MACHINE AND SURGE CHAMBER



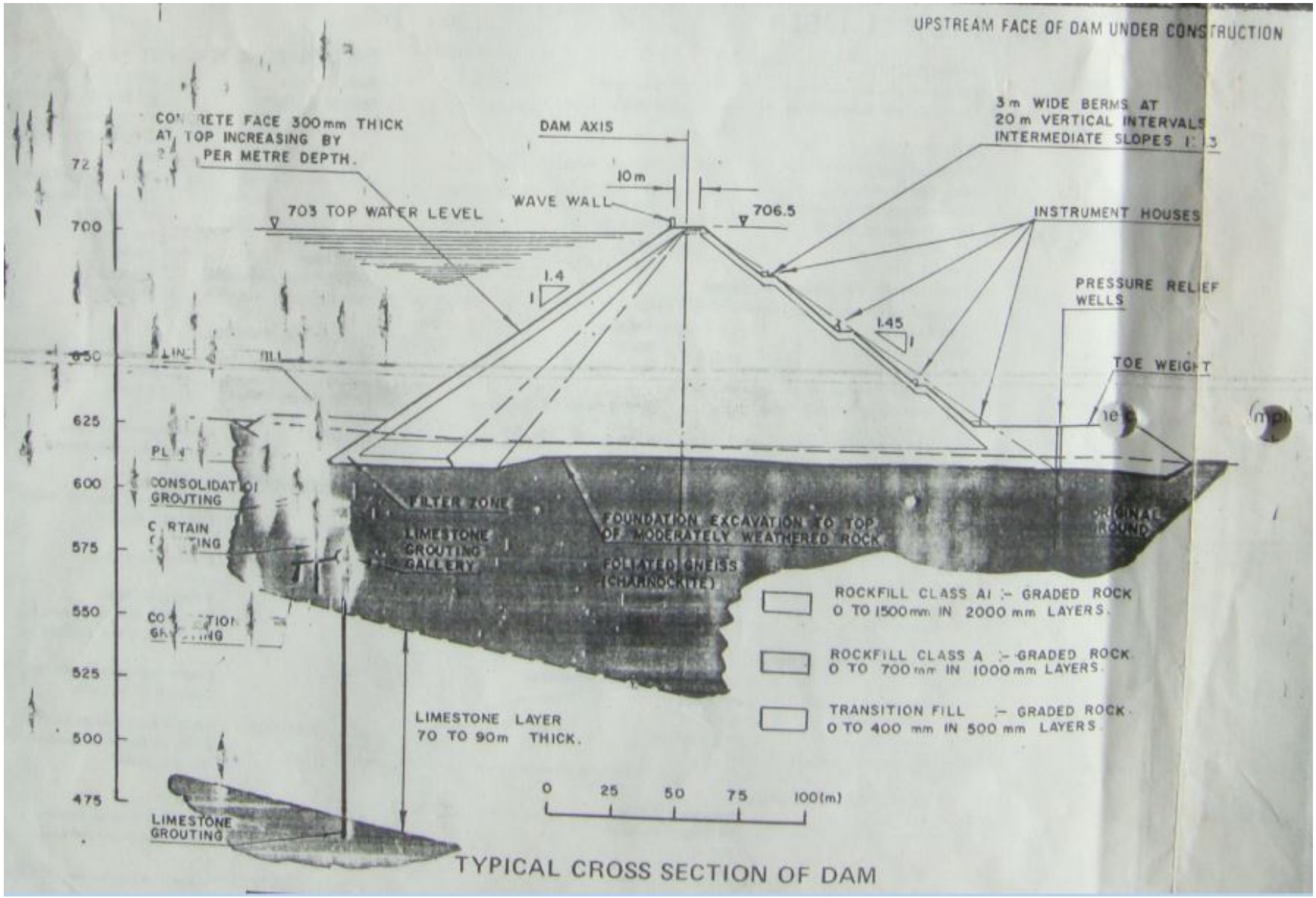
LOCATION PLAN



LONGITUDINAL SECTION ALONG
LOW ORESSURE AND TAILRACE TUNNELS



TYPICAL CROSS SECTION OF DAM



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