Hydro Unit Water Starting Time and Mechanical Starting Time

Water inertia starting time of the waterway from section lengths and areas, mechanical starting time of the unit, and their ratio as a governing stability check.

Method: Waterway and rotor inertia time constants

Input parameters

Unit system: SI

Parameter	Value	Unit
Rated flow	72,000	m³/h
Rated net head	100.00	m
Penstock length	300.00	m
Penstock area	4.9000	m²
Other waterway length (spiral case, draft tube)	30.000	m
Its mean area	8.0000	m²
Moment of inertia of unit (turbine + generator)	120,000	kg·m²
Rated speed	428.60	rpm
Rated power	17.000	MW

Calculated results

Parameter	Value	Unit
Water starting time	1.3251	s
Mechanical starting time	14.220	s
Inertia constant (T_m/2)	7.1099	s
Ratio for governing stability	10.731	

Notes for this case

• T_w = ΣL_iv_i/(gH) = (Q/gH)ΣL_i/A_i: the time for the head to accelerate the water column to rated flow. T_m = Jω²/P: the time for rated torque to accelerate the unit to rated speed. Stable isolated governing typically needs T_w below about 2–3 s and T_m/T_w above about 4–6; long waterways need a surge tank or more inertia.

Formula and method

$$T_w = \frac{Q}{gH}\sum\frac{L_i}{A_i}, \quad T_m = \frac{J\omega^2}{P}, \quad H_i = \frac{T_m}{2}$$

Variables

Q	Rated flow	m³/s
H	Rated net head	m
L_1	Penstock length	m
A_1	Penstock area	m²
L_2	Other waterway length (spiral case, draft tube)	m
A_2	Its mean area	m²
J	Moment of inertia of unit (turbine + generator)	kg·m²
n	Rated speed	rad/s
P	Rated power	W

T_w	Water starting time	s
T_m	Mechanical starting time	s
H_i	Inertia constant (T_m/2)	s
T_m/T_w	Ratio for governing stability	-

Method and standards

Starting times.

Assumptions and limits

- Rigid water column; rated conditions.

References

Waterway and rotor inertia time constants

Report details

Report reference	FCC-TMHH-TCR7 (the same inputs always give the same reference)
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Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/boilers-power-plant/hydro-power/hydro-unit-starting-times

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.