Pressure-Pipe Head Loss — Validation Report

Independent verification of the Kouzouki calculation engine against closed-form statics, published design-standard values and worked examples

Engine	Kouzouki — Pressure-Pipe Head Loss
Basis	Velocity V = Q/A; Darcy-Weisbach h_f = f (L/D) V^2/2g with the Swamee-Jain friction factor f; minor losses h_m = sum(K) V^2/2g; h_L = h_f + h_m.
Validation type	Independent validation
Report date	2026-06-20
Result	**PASS** — 3/3 checks within tolerance

1. Validation cases

Each case feeds the tool a defined input set and compares its output against a value derived independently of the engine (cited per row). Tolerance is 1% unless noted.

PF1. Velocity from continuity

Inputs: loss_method=Darcy-Weisbach, flow=2.0, pipe_diameter=8.0, pipe_length=200.0, roughness=0.0102, hazen_c=130.0, sum_k=2.0, viscosity=1.21e-05, available_head=0.0

Checked quantity	Independent value	Tool output	Dev.	Verdict
V = Q / (pi D^2/4) Continuity	5.73 ft/s	5.73 ft/s	0.01%	**PASS**

PF2. Minor (fitting) losses

Inputs: loss_method=Darcy-Weisbach, flow=2.0, pipe_diameter=8.0, pipe_length=200.0, roughness=0.0102, hazen_c=130.0, sum_k=2.0, viscosity=1.21e-05, available_head=0.0

Checked quantity	Independent value	Tool output	Dev.	Verdict
h_m = sum(K) V^2/2g Minor losses	1.02 ft	1.02 ft	0.05%	**PASS**

PF3. Total head loss (Darcy + minor)

Inputs: loss_method=Darcy-Weisbach, flow=2.0, pipe_diameter=8.0, pipe_length=200.0, roughness=0.0102, hazen_c=130.0, sum_k=2.0, viscosity=1.21e-05, available_head=0.0

Checked quantity	Independent value	Tool output	Dev.	Verdict
h_L = h_f + h_m (Swamee-Jain f) Darcy-Weisbach	4.35 ft	4.35 ft	0.00%	**PASS**

2. Assumptions

- Full-flowing circular pipe, steady incompressible flow.
- Swamee-Jain explicit f (turbulent); roughness eps is an input.
- Minor losses lumped as sum(K) V^2/2g.

3. Limitations

- Roughness eps / Hazen-Williams C and sum K are design inputs.
- Single pipe segment; no pump/elevation energy here (see Bernoulli).

4. Sources of the independent values

How the independent values are obtained. Every value in the Independent-value column of Section 1 is computed in a validation harness (validation/cases.py) written and run separately from the calculation engine. Each is an independent re-derivation of the governing closed-form equation, or a value read from a cited published worked example or design-standard table - never copied from the engine's own output. The match therefore confirms the engine reproduces the cited source within tolerance. The source beside each value (Section 1) and the references below identify the

governing standard section, equation, or publication.

Basis of the independent values
Velocity V = Q/A; Darcy-Weisbach h_f = f (L/D) V^2/2g with the Swamee-Jain friction factor f; minor losses h_m = sum(K) V^2/2g; h_L = h_f + h_m.

Per-check citations (Section 1): Continuity; Minor losses; Darcy-Weisbach.

5. Conclusion

All 3 independent checks reproduce the reference values within tolerance. The engine correctly implements the governing equations for this tool.

Reproduce: **python scripts/run_tool_validation.py** → **python scripts/make_tool_validation_pdfs.py**. This report is for verification/demonstration; results are for preliminary design and must be confirmed by a licensed engineer against the current adopted code and project-specific conditions.