Hazard model — a complete life model from a known failure rate

Menu: Life Data ▸ Hazard Model...

Part 1 — What the function does

What it calculates. Sometimes the failure risk of a component is known without fitting it to your own data: from a supplier's data sheet, a handbook, an earlier study or an engineering judgement. The Hazard Model turns that knowledge into a complete life model. You describe the hazard rate λ(t) - the failure rate at age t of a unit that has survived to t - as a named distribution (or a mixture of up to three), as a formula in t, as a bathtub of age segments, or as a table. ReliaEn integrates λ(t) to the cumulative hazard H(t) and gives the reliability R(t) = e^−H(t) on the age range you declare, from 0 to T_max.

What ReliaEn prints	What it tells you
λ(0) and **λ(T_max)**	The hazard at the start and the end of the range: rising means wear-out
MTTF on [0, T_max]	The mean time to failure counted within the range
B10 and **Median**	The ages by which 10 % and 50 % of units have failed
A readout at one age (optional)	λ, H, R, F and the density at that age
Three plots: λ(t), R(t), H(t)	The shape of the model over the range

From which data. No worksheet: the form only - the input mode, the family and its parameters (or the formula, segments or table), T_max, a name and a time-unit label.

When an engineer uses it. When the hazard comes from a source other than your own failure data, when it has a shape no single distribution gives (a bathtub, two failure modes mixed), or to check a model before it is used in a system block.

When not to use it.

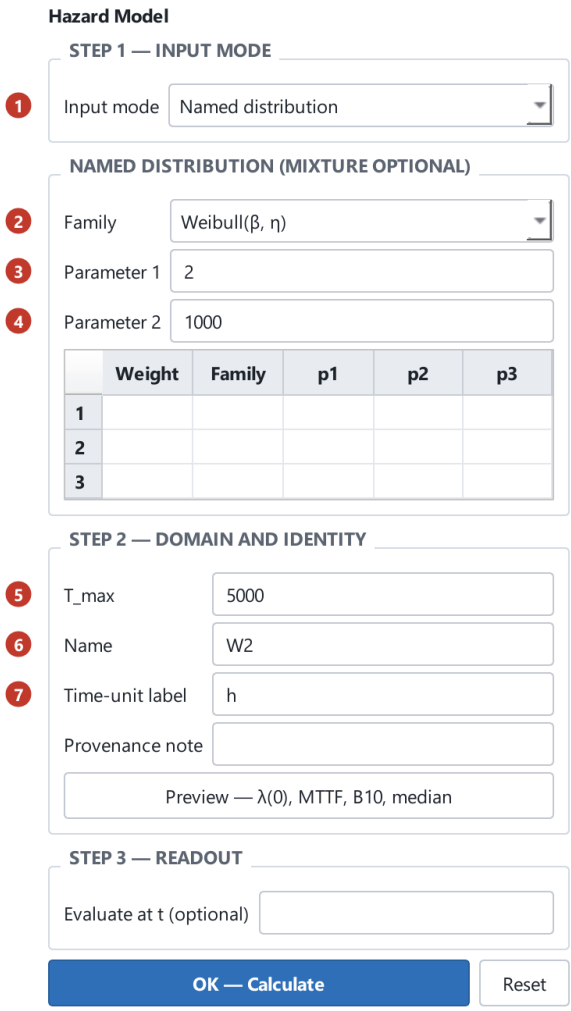
Situation	Use instead
Failure times are at hand and the distribution is to be fitted	Life Data ▸ Time Dependence and the distribution, or Life Data ▸ Survival Plots... (chapter 2.15) to choose one first
The hazard is to be estimated from a survivor table without choosing a distribution	Life Data ▸ Estimate Failure Function ▸ Non-constant rate (survivor regression)... (chapter 3.2)

Part 2 — The example's input data

Setting. A bearing supplier quotes a Weibull distribution with shape 2 and characteristic life 1,000 hours. The reliability engineer wants the bearing's life model - its B10, median and mean life - before using it in a system study.

Input	Value
Input mode	Named distribution
Family	Weibull(β, η)
Parameter 1 (β) / Parameter 2 (η)	2 / 1000

T_max	5000
Name / Time-unit label	W2 / h
File in the worked-example zip	None - this function reads no worksheet; every value is typed into the form



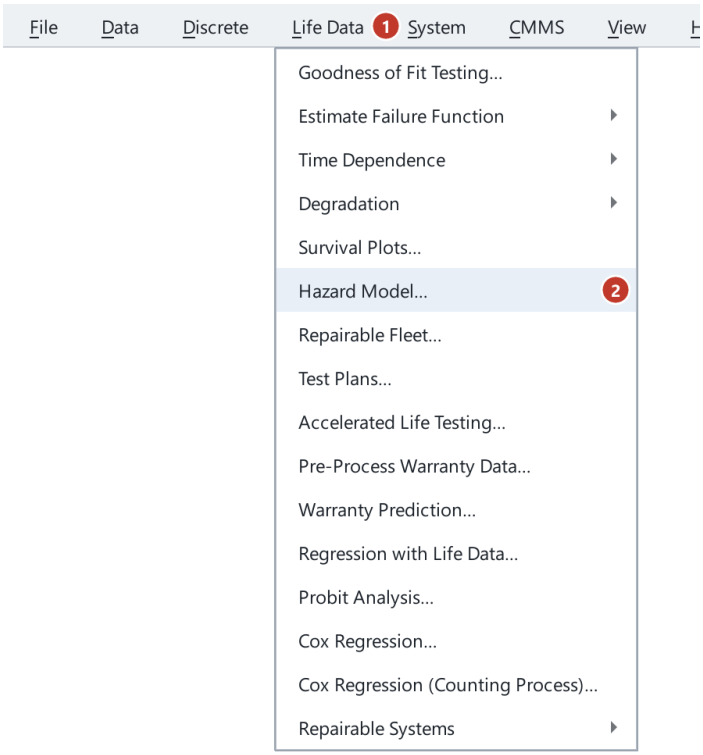
The example's input data, typed into the form

- ① to ⑦ The form's boxes, set as the table above; Part 3 takes them one by one.

Part 3 — How to use it, step by step

This function reads no worksheet: everything goes into the form.

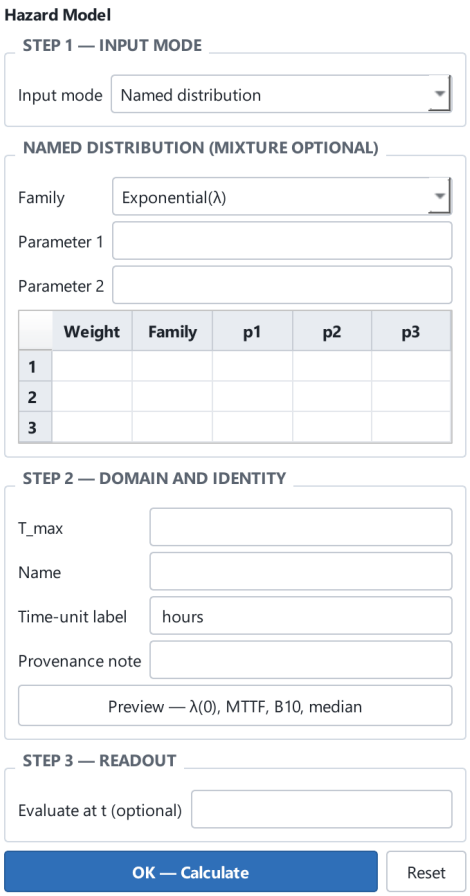
1. **Choose Life Data ▸ Hazard Model…** in the menu bar. The form Hazard Model opens in the left panel.



Step 1 — the menu path

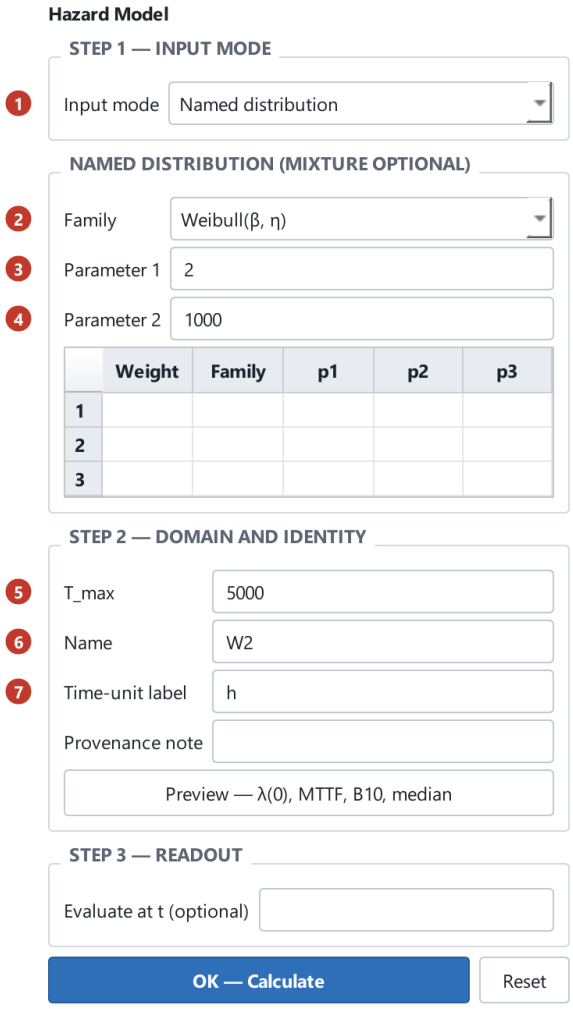
- ① Life Data: the menu.
- ② Hazard Model…: the entry to click.

The form as it opens, before any box is set:



Step 1 — the form as it opens

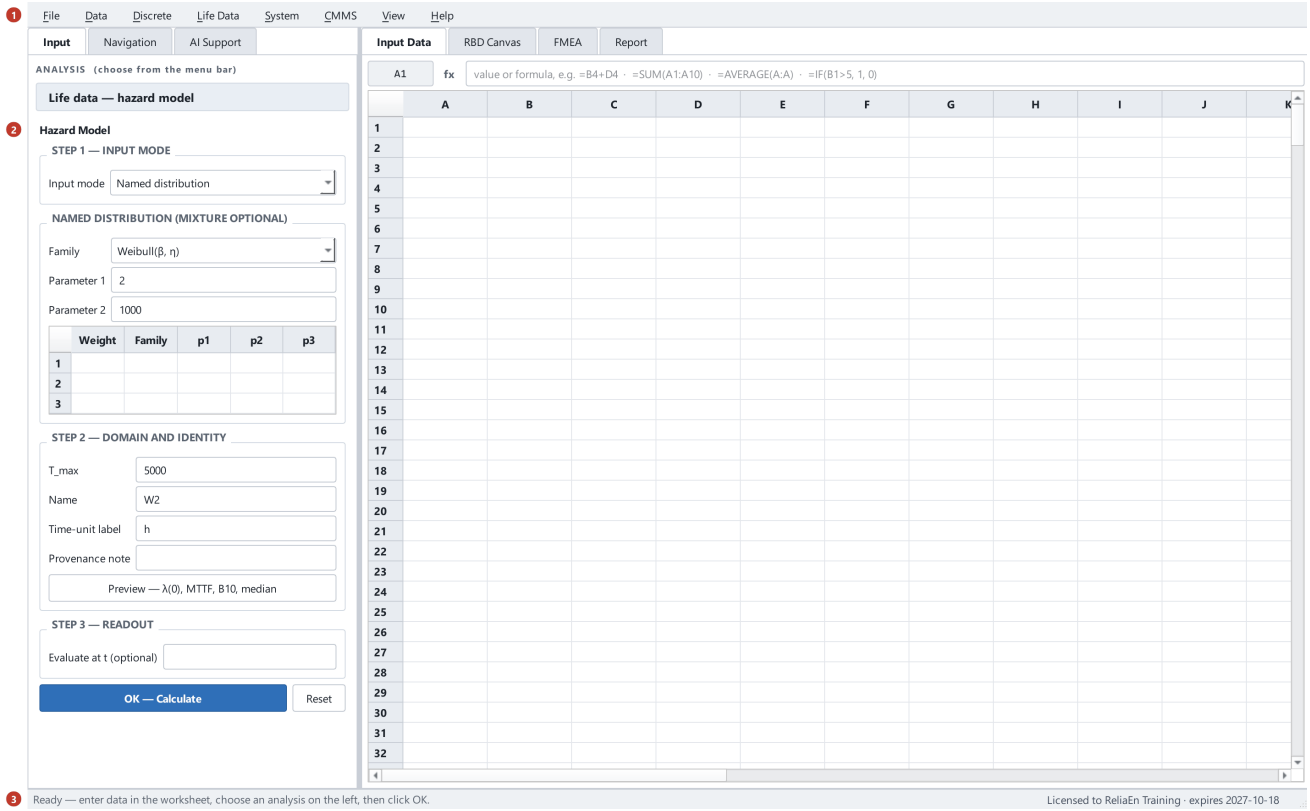
Steps 2 to 8 set or check the form's seven boxes, marked ① to ⑦ in the picture:



Steps 2 to 8 — the form set for this example

2. ① **Check that Input mode reads Named distribution.**
3. ② **In Family, choose Weibull(β, η).** The box opens on Exponential(λ).
4. ③ **In Parameter 1, type 2.** The shape β.
5. ④ **In Parameter 2, type 1000.** The characteristic life η, in hours.
6. ⑤ **In T_max, type 5000.** The model holds from age 0 to this age.
7. ⑥ **In Name, type W2.** The name on the report and the plots.
8. ⑦ **In Time-unit label, type h.** The box opens on hours.

9. **Click OK — Calculate** at the foot of the form. ReliaEn calculates and shows the report.



Step 9 — the window just before OK

- ① The menu bar: File, Data, Discrete, Life Data, System, CMMS, View, Help.
- ② The form, set as in steps 2 to 8.
- ③ The status bar: Ready — enter data in the worksheet, choose an analysis on the left, then click OK. and Licensed to ReliaEn Training · expires 2027-10-18.

Part 4 — The report, card by card

Life Data — Hazard Model

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$H(t) = \int_0^t \lambda(u)\,du$; $R(t) = e^{-H(t)}$; $F(t) = 1 - e^{-H(t)}$

The report's head

- The title Life Data — Hazard Model, the date and time of the run, and the three relations the report rests on: H(t), the integral of λ(u) from 0 to t; R(t) = e^(−H(t)); F(t) = 1 − e^(−H(t)).

INPUT DATA	
1 Name	W2
2 Time unit	h
3 Input mode	Named distribution
4 Family	Weibull(β, η)
5 β	2
6 η	1000
7 T_max	5000

Input data

- ① Name W2.
- ② Time unit h.
- ③ Input mode Named distribution.
- ④ Family Weibull(β, η).
- ⑤ β 2.
- ⑥ η 1000.
- ⑦ T_max 5000.

RESULTS	
1 λ(0) — hazard rate at t = 0	0
2 λ(5000) — hazard rate at T_max	0.01
3 MTTF on [0, 5000] = ∫ R(t) dt over the domain	886.227
4 B10 = $H^{-1}(-\ln 0.9)$ — 10% failed	324.593
5 Median = $H^{-1}(\ln 2)$ — 50% failed	832.555

Results

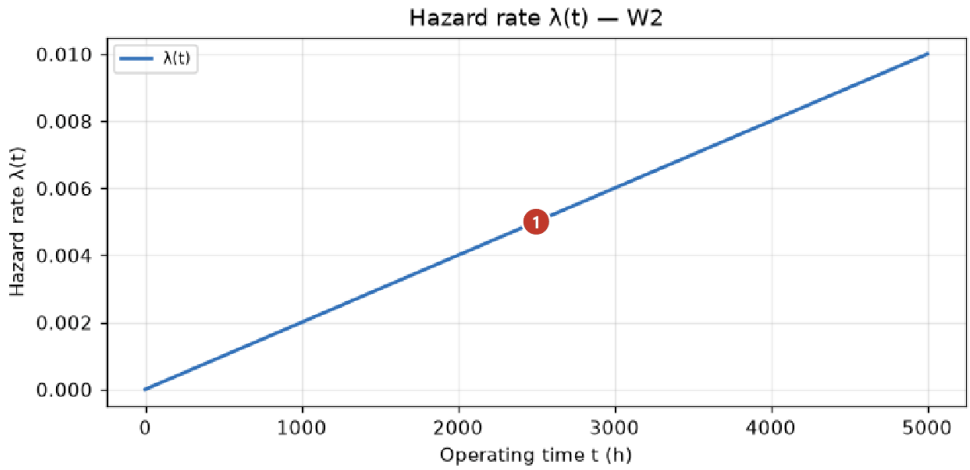
- ① λ(0) — hazard rate at t = 0 0.
- ② λ(5000) — hazard rate at T_max 0.01.
- ③ MTTF on [0, 5000] = ∫ R(t) dt over the domain 886.227.
- ④ B10 = $H^{-1}(-\ln 0.9)$ — 10% failed 324.593.
- ⑤ Median = $H^{-1}(\ln 2)$ — 50% failed 832.555.

INTERPRETATION

1 Over [0, 5000] h the hazard rate goes from λ(0) = 0 to λ(5000) = 0.01: the hazard rate rises with age — failure risk grows as the unit gets older (wear-out). The mean life within the domain is MTTF on [0, 5000] = 886.227 h; 10% of units have failed by B10 = 324.593 and half by the median = 832.555.

Interpretation

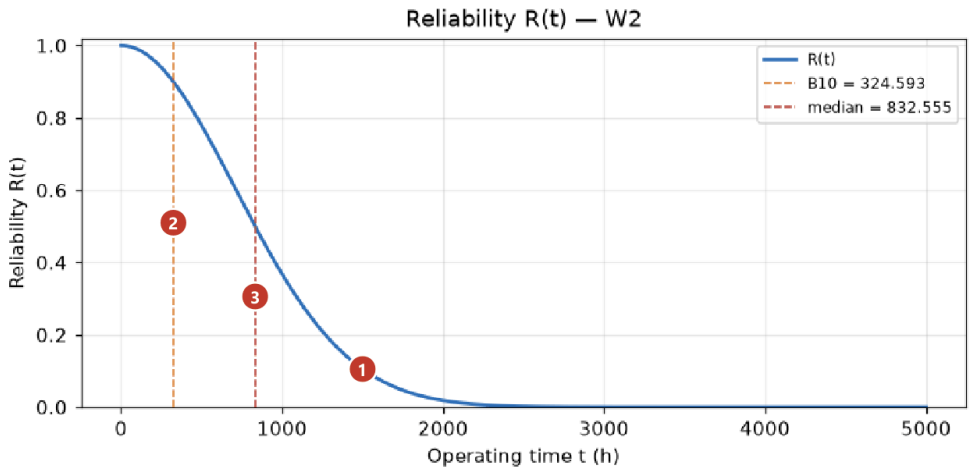
- ① ReliaEn's reading: Over [0, 5000] h the hazard rate goes from λ(0) = 0 to λ(5000) = 0.01: the hazard rate rises with age — failure risk grows as the unit gets older (wear-out). The mean life within the domain is MTTF on [0, 5000] = 886.227 h; 10% of units have failed by B10 = 324.593 and half by the median = 832.555.



Interactive Plot

Hazard rate λ(t) — W2

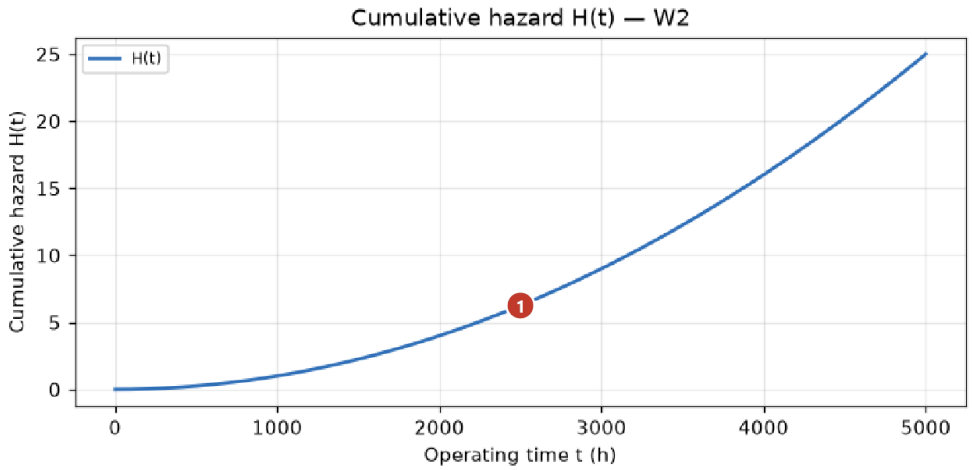
- ① λ(t): the hazard rate, a straight line from 0 to 0.010 at 5,000 hours.



Interactive Plot

Reliability R(t) — W2

- ① R(t): the reliability, from 1.0 down to nearly 0 by 2,500 hours.
- ② B10 = 324.593: the line crosses R(t) at 0.90.
- ③ median = 832.555: the line crosses R(t) at 0.50.



Interactive Plot

Cumulative hazard H(t) — W2

- ① H(t): the cumulative hazard, curving up to 25 at 5,000 hours.

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The report's foot

- ① The licence line Licensed to ReliaEn Training · RL-2026-0017: the licence this report was made under.

Part 5 — How to interpret the results

The shape. For a Weibull with β = 2 the hazard is λ(t) = (β/η)·(t/η)^(β−1) = 2t / 1000^2: it starts at 0 and rises in a straight line to 0.01 per hour at 5,000 hours. A rising hazard is wear-out - the older the bearing, the more likely it fails in the next hour.

When the bearings fail. One bearing in ten has failed by 324.593 hours (B10 = 1000·√(−ln 0.9)) and half by 832.555 (median = 1000·√(ln 2)). The mean life within the range is 886.227 hours, the area under R(t) from 0 to 5,000 - practically the full Weibull mean, η·Γ(1.5), because almost no bearing survives 5,000 hours.

What to decide. A replacement interval below 324.593 hours keeps the failure risk under 10 %. Planning from the mean, 886.227 hours, would let more than half of the bearings fail first.

The range matters. Ages outside 0 to T_max are refused. If a meaningful share of units survives T_max, the mean life within the range is shorter than the true mean, and the report says so.