Logistic — symmetric life with a ceiling on the hazard

Menu: Life Data ▸ Time Dependence ▸ Logistic distribution…

Part 1 — What the function does

What it calculates. The logistic model spreads failures symmetrically around a centre μ: F(t) = 1/(1 + e^(−(t − μ)/s)). The hazard rises with age but levels off at a ceiling of 1/s, so old units approach a constant worst failure rate. ReliaEn fits the location μ (the median, which is also the MTTF) and the scale s (the spread, in the data's own unit) by maximum likelihood, with bounds, and gives the B-lives with bounds and two plots.

What ReliaEn prints	What it tells you
μ̂ and **ŝ** with bounds	The centre of the failures and their spread, in hours
MTTF, **Median life**	Both equal μ̂: the model is symmetric
B-life and the **percentile table** with bounds	By what age a share of units has failed
Probability plot	Whether the points lie on the logistic line
R(t) and hazard	How reliability falls and the ceiling the hazard approaches

From which data. The failure ages in one worksheet column, one row per failed unit; the ages of units still running, if any, in a different column. The form also reads inspection intervals (chapter 2.9).

When an engineer uses it. When failures gather symmetrically around a typical age - early and late failures about equally likely - and the question is when units fail and how high the failure rate can climb.

When not to use it.

Situation	Use instead
A life cannot be below zero, and the fit puts a share of units below age 0	Life Data ▸ Time Dependence ▸ Loglogistic distribution… (the logistic on ln t)
The hazard keeps rising with age, with no ceiling	Life Data ▸ Time Dependence ▸ Weibull (2P) distribution…
Units last well and then fail in a short, sharp wear-out	Life Data ▸ Time Dependence ▸ Smallest extreme value…

Part 2 — The example's input data

Setting. A plant follows 14 pump couplings in service: ten have failed and four were removed still working. The reliability engineer wants their life and the age by which one in ten has failed.

Input	Value
Failure ages, hours (10)	42, 66, 87, 112, 128, 155, 176, 210, 240, 280
Survivor ages, hours (4)	50, 200, 300, 300
File in the worked-example zip	2-Logistic/Example-1.csv — columns Failure times (10) and Censored times (4)
Confidence % / B-life level %	95 / 10 — the values the form opens with

	① A	② B	C
1	42	50	
2	66	200	
3	87	300	
4	112	300	
5	128		
6	155		
7	176		
8	210		
9	240		
10	280		
11			

The example data in the worksheet

- ① Column A: the 10 failure ages, one per row, in hours.
- ② Column B: the 4 survivor ages.

Part 3 — How to use it, step by step

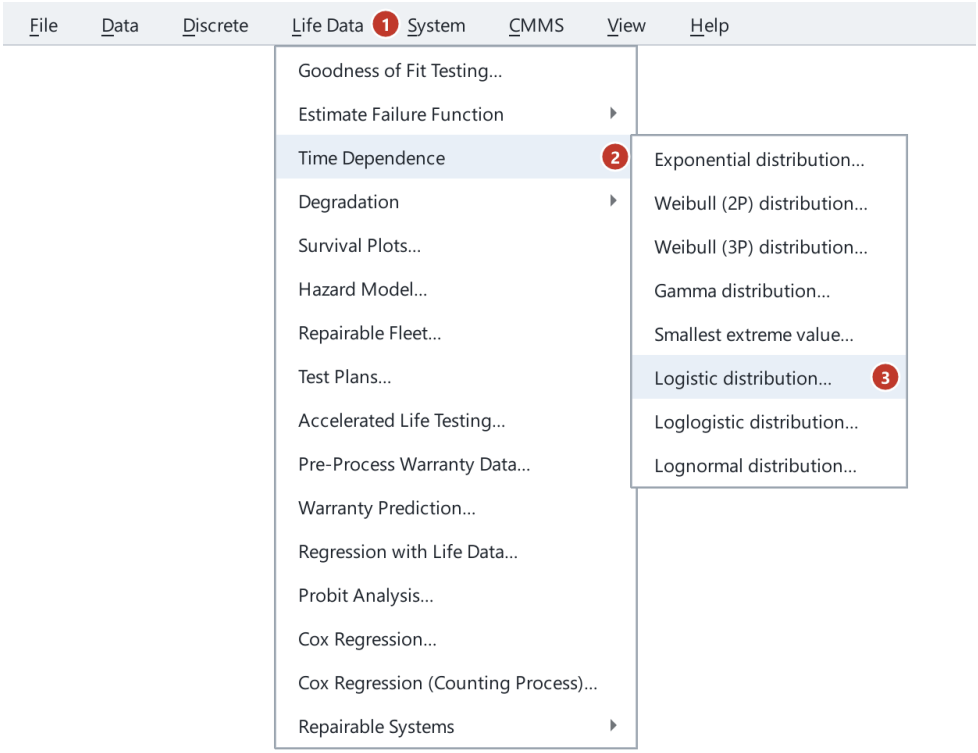
1. **Put the failure ages in column A and the survivor ages in column B.** Copy the values of Example-1.csv that stand under its headings Failure times and Censored times into columns A and B of the worksheet, starting at row 1.

	① A	② B	C
1	42	50	
2	66	200	
3	87	300	
4	112	300	
5	128		
6	155		
7	176		
8	210		
9	240		
10	280		
11			

Step 1 — the failure and survivor ages in columns A and B

- ① Column A: the 10 failure ages, 42 to 280.
- ② Column B: the 4 survivor ages, 50 to 300.

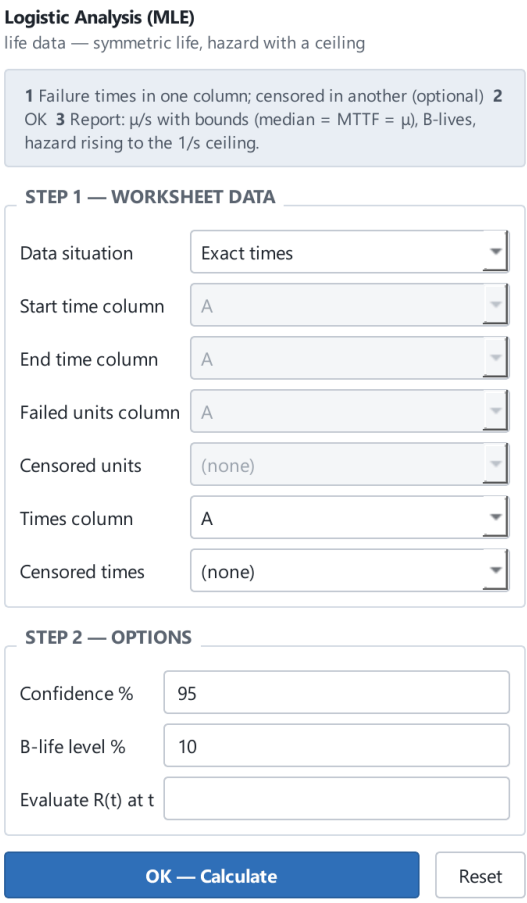
2. **Choose Life Data ▸ Time Dependence ▸ Logistic distribution…** in the menu bar. The form Logistic Analysis (MLE) opens in the left panel.



Step 2 — the menu path

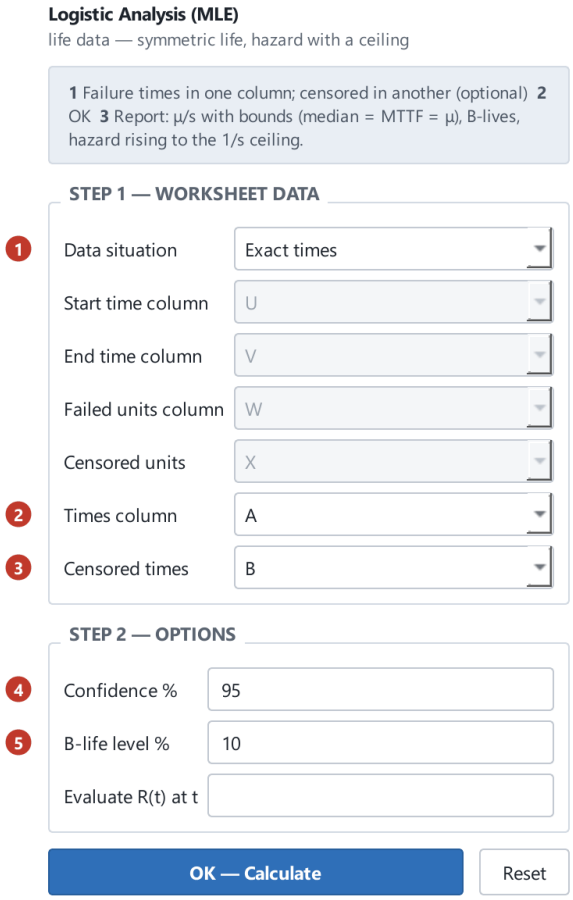
- ① Life Data: the menu.
- ② Time Dependence: the submenu.
- ③ Logistic distribution…: the entry to click.

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



Step 2 — the form as it opens

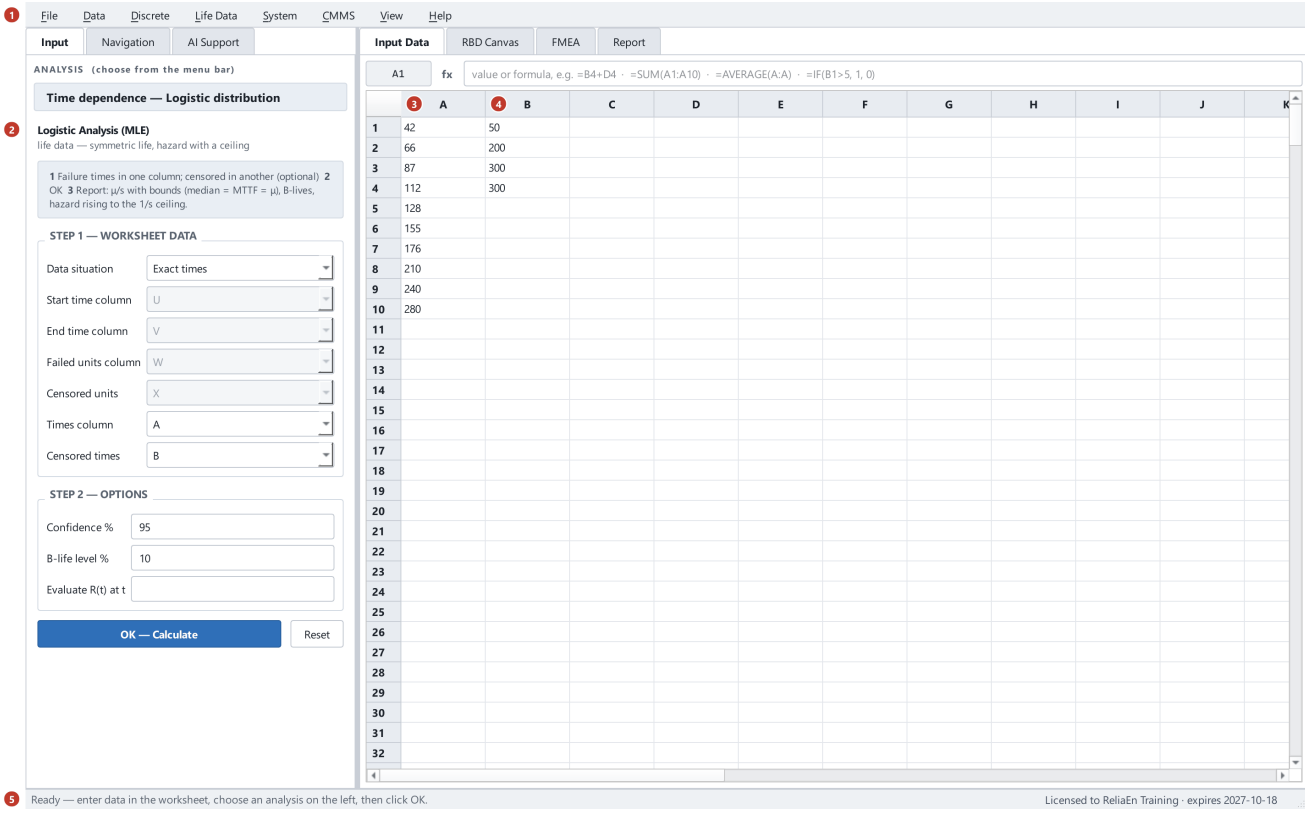
Steps 3 to 7 set or check the form's five boxes, marked ① to ⑤ in the picture:



Steps 3 to 7 — the form set for this example

3. ① **Check that Data situation reads Exact times.**
4. ② **In Times column, choose A.**
5. ③ **In Censored times, choose B.** Column B holds the four couplings removed still working.
6. ④ **Check that Confidence % reads 95.**
7. ⑤ **Check that B-life level % reads 10.** It sets the B-life in the results. Evaluate R(t) at t stays empty.

8. **Click OK — Calculate** at the foot of the form (② in the picture below). ReliaEn calculates and shows the report.



Step 8 — 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 3 to 7; OK — Calculate at its foot.
- ③ Column A: the 10 failure ages.
- ④ Column B: the 4 survivor ages.
- ⑤ 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 — Logistic Analysis (MLE)

2026-11-02 20:30:47

F(t) = 1/(1 + e^{−(t−μ)/s})

The report's head

- The title Life Data — Logistic Analysis (MLE), the date and time of the run, and the model in one line: F(t) = 1/(1 + e^{−(t−μ)/s}).

	INPUT DATA	
1	n — units on test	14
2	r — failures	10
3	censored (survivors)	4
4	Data situation	exact times
5	Estimation	MLE (censored location-scale)

Input data

- ① n — units on test 14.
- ② r — failures 10.
- ③ censored (survivors) 4: the couplings removed still working.
- ④ Data situation exact times.
- ⑤ Estimation MLE (censored location-scale).

	RESULTS	
1	μ̂ — location	187.5162 (SE 30.8858) [126.9812, 248.0511]
2	ŝ — scale	62.3998 (SE 15.8984) [37.8715, 102.8145] (log-scale CI)
3	MTTF	187.52
4	Median life	187.52
5	B10 life	50.41 [-34.41, 135.23]

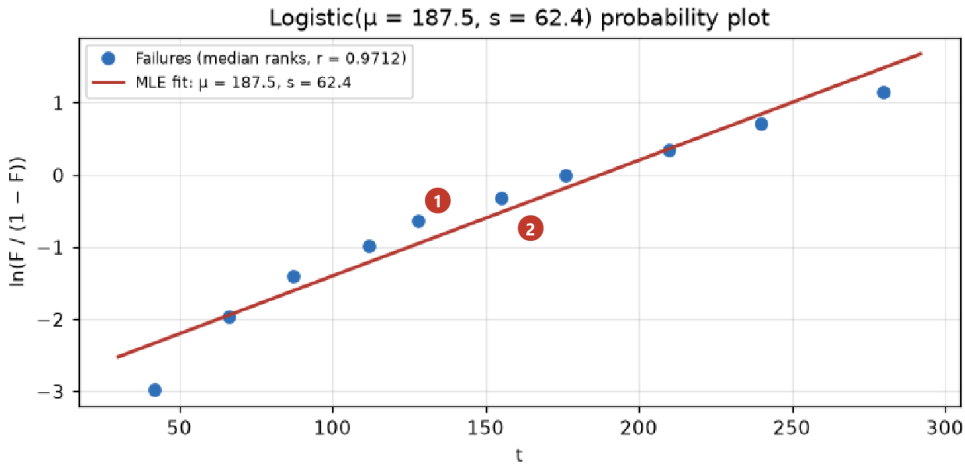
Results

- ① μ̂ — location 187.5162 (SE 30.8858) [126.9812, 248.0511]: the centre of the failures; half the couplings have failed by this age.
- ② ŝ — scale 62.3998 (SE 15.8984) [37.8715, 102.8145] (log-scale CI): the spread, in hours; the bounds are taken on the log scale, so the lower one stays above zero.
- ③ MTTF 187.52.
- ④ Median life 187.52: equal to the MTTF and to μ̂ - the model is symmetric.
- ⑤ B10 life 50.41 [-34.41, 135.23]: one coupling in ten has failed by 50 hours - and the lower bound is below zero.

	INTERPRETATION
1	Logistic life model: symmetric around μ (median = MTTF = μ exactly); the hazard rises with age toward a CEILING of 1/s = 0.01603 — old units approach a constant worst rate. NOTE: the model supports negative times; low percentiles can go below zero — check them against physics.

Interpretation

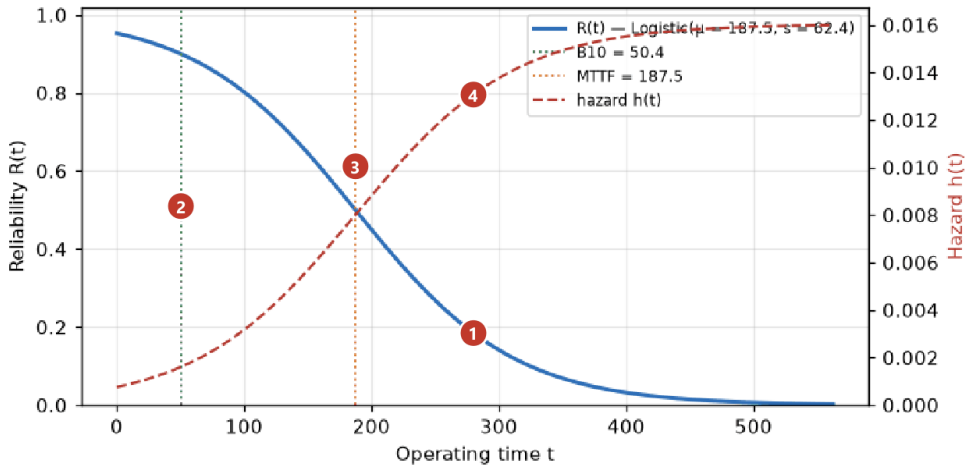
- ① ReliaEn's reading: Logistic life model: symmetric around μ (median = MTTF = μ exactly); the hazard rises with age toward a CEILING of 1/s = 0.01603 — old units approach a constant worst rate. NOTE: the model supports negative times; low percentiles can go below zero — check them against physics.



Interactive Plot

Logistic(μ = 187.5, s = 62.4) probability plot

- ① Failures (median ranks, r = 0.9712): the 10 failure ages on logistic paper.
- ② MLE fit: μ = 187.5, s = 62.4: the fitted line.



Interactive Plot

Reliability and hazard

- ① R(t) — Logistic(μ = 187.5, s = 62.4): the share of couplings still working at each age. It starts at about 0.95 at age 0, not at 1.
- ② B10 = 50.4: where R crosses 90%.
- ③ MTTF = 187.5: where R crosses 50%.
- ④ hazard h(t): rising, then flattening towards its ceiling of 0.016 per hour.

PERCENTILE TABLE — B-LIVES WITH BOUNDS

1 B_p = the age by which p% of units fail. Bounds by each family's own interval machinery; a — cell means no bound machinery exists for that family — the point estimate stands alone.

2 Percentile	3 B-life	4 95% bounds
1%	-99.22	[-246.7, 48.25]
5%	3.784	[-98.84, 106.4]
5 10%	50.41	[-34.41, 135.2]
25%	119	[53.71, 184.2]
50%	187.5	[127, 248.1]
75%	256.1	[182.5, 329.7]
90%	324.6	[227.1, 422.1]
95%	371.2	[254.5, 488]
99%	474.3	[311.2, 637.3]

Percentile table — B-lives with bounds

- ① B_p = the age by which p% of units fail. Bounds by each family's own interval machinery; a — cell means no bound machinery exists for that family — the point estimate stands alone.
- ② to ④ The columns Percentile, B-life, 95% bounds.
- ⑤ The 10% row: 50.41 [-34.41, 135.2] - the B10 of the results card. The 1% row above it is below zero: -99.22.

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The report's foot

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

Part 5 — How to interpret the results

When the couplings fail. Half the couplings have failed by 187.52 hours - the median, the MTTF and $\hat{\mu}$ are one number, because the model is symmetric. The spread $\hat{s}$ is 62.3998 hours. One coupling in ten has failed by 50.41 hours (B10).

How high the failure rate climbs. The hazard rises with age but levels off at 1/s = 0.01603 per hour: an old coupling fails at about 1.6% per hour of further running, and no worse. If the plant's records show the rate still climbing past that, the logistic model is the wrong frame and the Weibull (2P) fits better.

Where the model stops making sense. The R(t) curve starts at about 0.95: the fitted model counts about 5% of the couplings as failed before age 0, and the 1% life is -99.22 hours. B10's lower bound, -34.41, is below zero too: ten failures do not defend a positive B10. For an early-failure figure to plan with, fit the same ages with the Loglogistic distribution, which cannot go below zero.