Survival plots — the data's own survival curve, and which distribution describes it best

Menu: Life Data ▸ Survival Plots...

Part 1 — What the function does

What it calculates. Before a distribution is chosen, the data should be seen on their own. ReliaEn draws the survival curve S(t) - the fraction of units not yet failed by age t - without assuming any distribution: the Kaplan-Meier product-limit staircase with a confidence band for exact failure and censored times, or the Turnbull estimate for inspection data, where a failure is only known to lie between two inspections. It then fits eight distributions to the same data and ranks them by the corrected Akaike information criterion (AICc), the best marked ★.

What ReliaEn prints	What it tells you
Median and **quartile survival times**	When a quarter, half and three quarters of the units have failed, read off the staircase with no extrapolation
Kaplan-Meier life table with Greenwood SE and band	Each failure age with the units at risk, the survival and its uncertainty
Distribution comparison — ranked by AICc	Each distribution's parameters, log-likelihood, AICc, B10 and median life, and the Q-Q correlation r
The survival staircase with the chosen fit, a four-panel overview, a distribution identification plot	Whether the fitted curve follows the data

From which data. For exact times: a column of failure ages and, optionally, a column of censored ages (units removed or still running without a failure). For inspection data: per unit the last age seen working and the first age seen failed.

When an engineer uses it. As the first look at any set of life data, and whenever a distribution has to be chosen before its own analysis.

When not to use it.

Situation	Use instead
The distribution is chosen and its full analysis is wanted (bounds, B-lives, replacement age)	Life Data ▸ Time Dependence and the distribution, for example Weibull (2P) distribution... (chapter 2.6)
The same repairable system fails again and again	Life Data ▸ Repairable Fleet... (chapter 3.3)
A condition signal is measured, not failures	Life Data ▸ Degradation ▸ Wiener process... (chapter 2.14)

Part 2 — The example's input data

Setting. A maintenance team has the removal ages, in months, of 21 control valves: 9 were removed failed, 12 for other reasons while still working. The team wants to see the survival curve and to know which distribution to fit.

Input	Value
Failure ages (9)	6, 6, 6, 7, 10, 13, 16, 22, 23
Censored ages (12)	6, 9, 10, 11, 17, 19, 20, 25, 32, 32, 34, 35

Data situation / Confidence % / Fitted overlay	Exact + right-censored / 95 / Best by ranking
File in the worked-example zip	2-Survival-Plots/Example-1.csv — columns Failure (9) and Censored (12)

	① A	② B	C
1	6	6	
2	6	9	
3	6	10	
4	7	11	
5	10	17	
6	13	19	
7	16	20	
8	22	25	
9	23	32	
10		32	
11		34	
12		35	
13			

The example data in the worksheet

- ① Column A: the 9 failure ages.
- ② Column B: the 12 censored ages.

Part 3 — How to use it, step by step

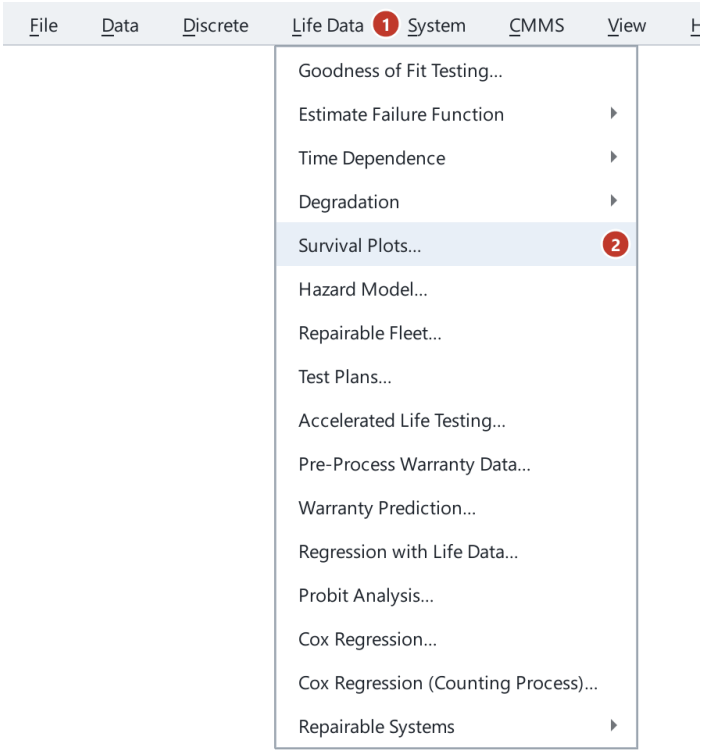
1. **Put the failure ages in column A and the censored ages in column B.** Copy the values of Example-1.csv that stand under its headings Failure and Censored into columns A and B of the worksheet, starting at row 1.

	① A	② B	C
1	6	6	
2	6	9	
3	6	10	
4	7	11	
5	10	17	
6	13	19	
7	16	20	
8	22	25	
9	23	32	
10		32	
11		34	
12		35	
13			

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

- ① Column A: the 9 failure ages, 6 to 23.
- ② Column B: the 12 censored ages, 6 to 35.

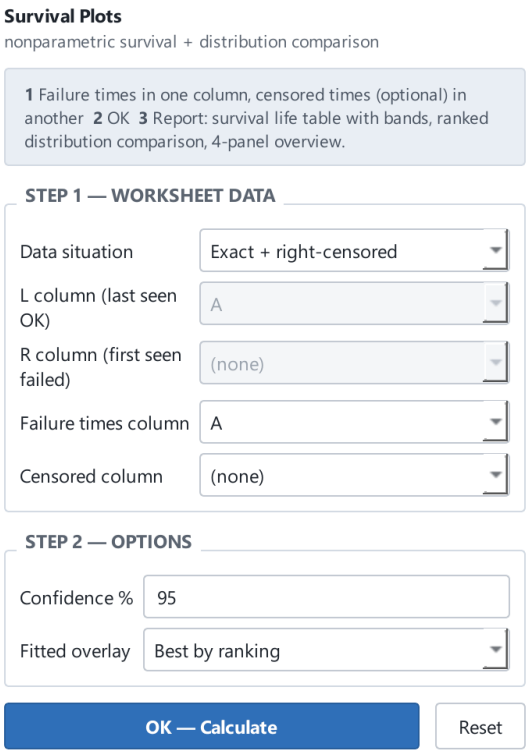
2. **Choose Life Data ▸ Survival Plots...** in the menu bar. The form Survival Plots opens in the left panel.



Step 2 — the menu path

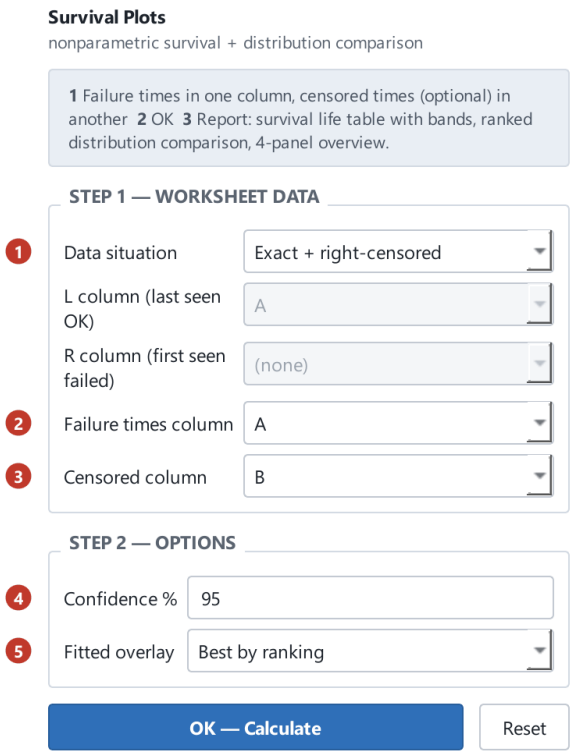
- ① Life Data: the menu.
- ② Survival Plots...: the entry to click.

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



Step 2 — the form as it opens

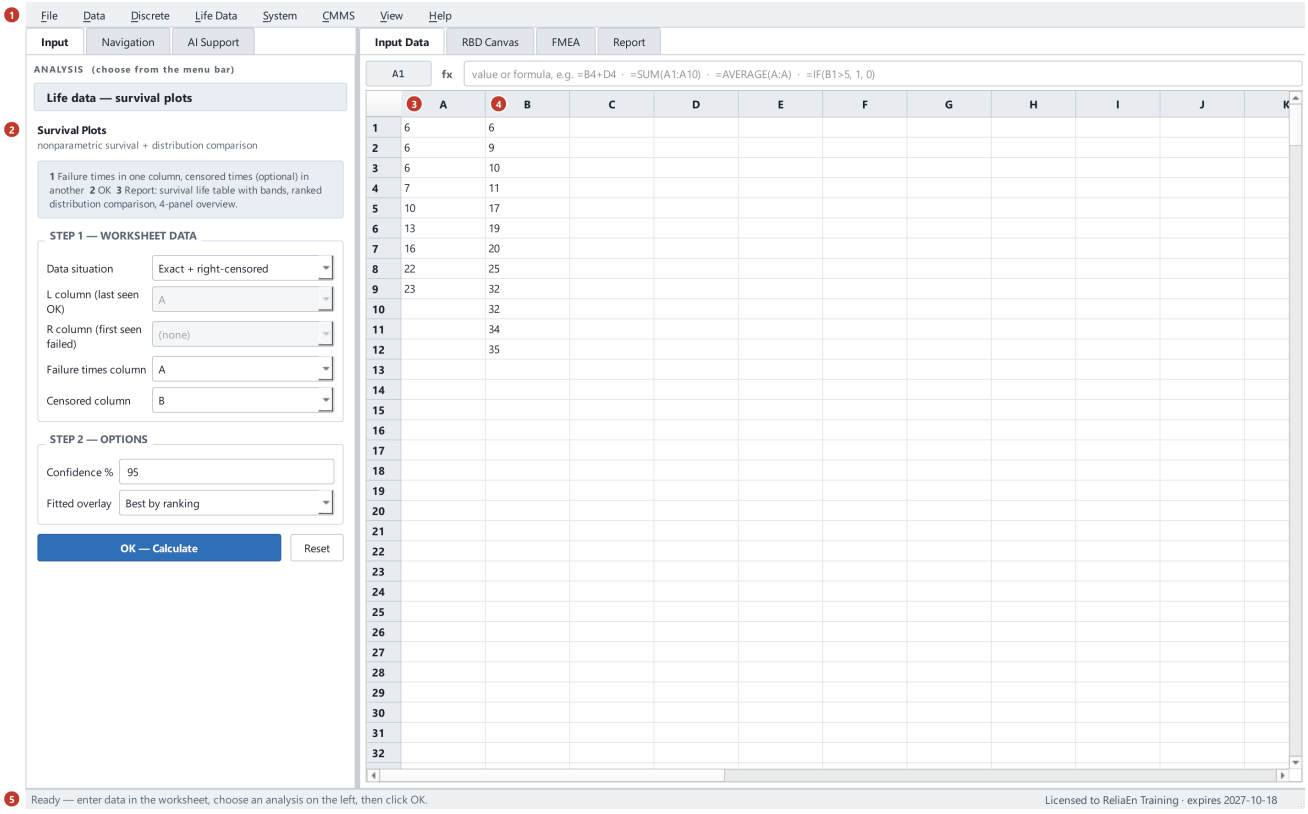
Steps 3 to 7 set or check the form's five boxes, marked ① to ⑤ in the picture:



Steps 3 to 7 — the form set for this example

3. ① **Check that Data situation reads Exact + right-censored.**
4. ② **Check that Failure times column reads A.**
5. ③ **In Censored column, choose B.**
6. ④ **Check that Confidence % reads 95.**
7. ⑤ **Check that Fitted overlay reads Best by ranking.** The top row of the comparison is drawn over the staircase; a distribution can also be named here.

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 9 failure ages.
- ④ Column B: the 12 censored 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 — Survival Plots

2026-11-04 08:12:47

S(t) = Π (1 − d_i/n_i) ; Var = S²·Σ d_i/(n_i(n_i − d_i)) (Greenwood)

The report's head

- The title Life Data — Survival Plots, the date and time of the run, and the estimator in one line: S(t) = Π (1 − d_i/n_i); Var = S²·Σ d_i/(n_i(n_i − d_i)) (Greenwood).

INPUT DATA

1	Units	21 (9 failures, 12 censored)
2	Confidence level	95%
3	Fitted overlay	Lognormal

Input data

- ① Units 21 (9 failures, 12 censored).
- ② Confidence level 95%.
- ③ Fitted overlay Lognormal: with Best by ranking, the distribution ReliaEn drew.

RESULTS

1	Median survival time (S ≤ 0.50)	23
2	Upper quartile time (S ≤ 0.75)	13
3	Lower quartile time (S ≤ 0.25)	not reached (curve stays above — no extrapolation)
4	Final S(t) at the last event	0.4482 at t = 23
5	Best-ranked distribution	Lognormal(μ = 3.203, σ = 0.9787) (lowest AICc)

Results

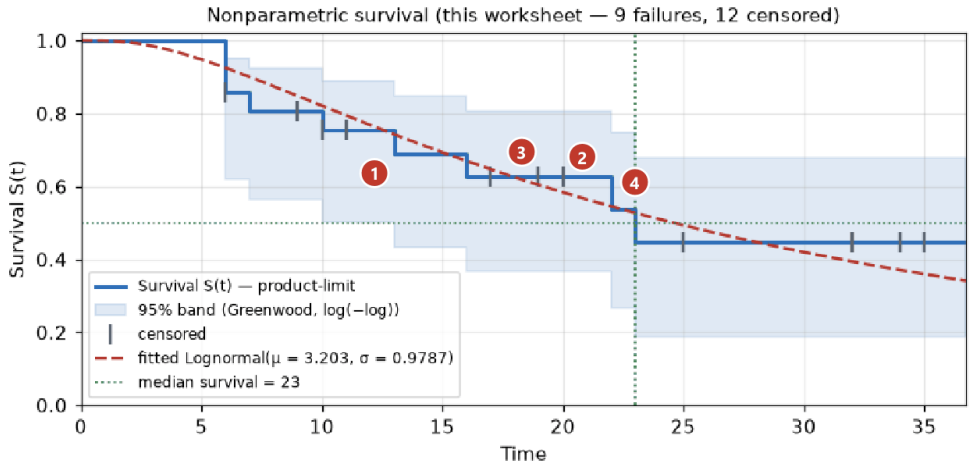
- ① Median survival time (S ≤ 0.50) 23.
- ② Upper quartile time (S ≤ 0.75) 13.
- ③ Lower quartile time (S ≤ 0.25) not reached (curve stays above — no extrapolation).
- ④ Final S(t) at the last event 0.4482 at t = 23.
- ⑤ Best-ranked distribution Lognormal(μ = 3.203, σ = 0.9787) (lowest AICc).

INTERPRETATION

1 The staircase is the data speaking for itself — no distribution assumed. Each step multiplies by the fraction surviving that event among units still at risk; censored units leave the risk set without a step. The distribution comparison then asks which family reproduces that staircase with the fewest parameters (lowest AICc).

Interpretation

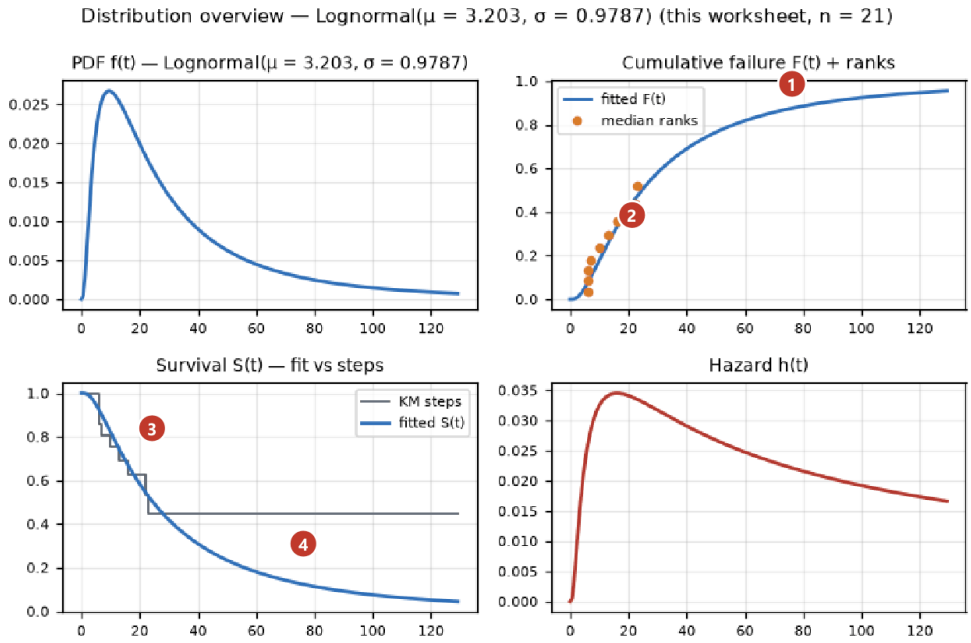
- ① ReliaEn's reading: The staircase is the data speaking for itself — no distribution assumed. Each step multiplies by the fraction surviving that event among units still at risk; censored units leave the risk set without a step. The distribution comparison then asks which family reproduces that staircase with the fewest parameters (lowest AICc).



Interactive Plot

Nonparametric survival (this worksheet — 9 failures, 12 censored)

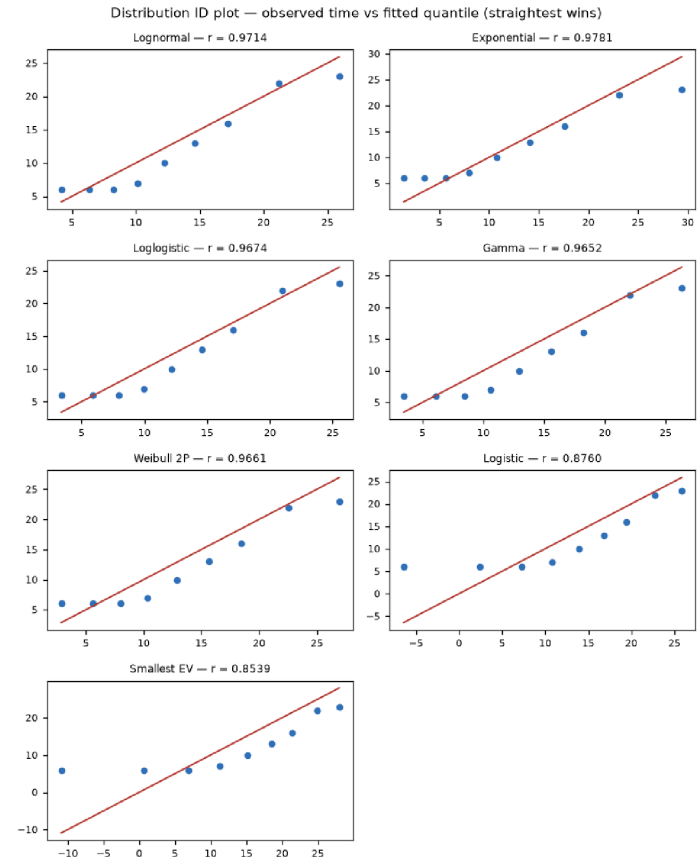
- ① Survival S(t) — product-limit: the Kaplan-Meier staircase, inside its shaded 95% band.
- ② censored: the ticks where valves left the risk set.
- ③ fitted Lognormal(μ = 3.203, σ = 0.9787): the overlay, following the steps.
- ④ median survival = 23: the dotted line where S first falls to 0.5 or below.



Interactive Plot

Distribution overview — Lognormal(μ = 3.203, σ = 0.9787) (this worksheet, n = 21)

- Four panels of the overlay: the density, the cumulative failure with the plotted points, the survival against the steps, and the hazard - for the lognormal it rises, then falls.
- ① fitted F(t) and ② median ranks: the fitted cumulative failure and the failures' plotted points.
- ③ KM steps and ④ fitted S(t): the staircase against the fitted survival.



Interactive Plot

Distribution ID plot — observed time vs fitted quantile (straightest wins)

- One panel per fitted distribution, the observed failure ages against its fitted quantiles, with its r: Lognormal 0.9714, Exponential 0.9781, Loglogistic 0.9674, Gamma 0.9652, Weibull 2P 0.9661, Logistic 0.8760, Smallest EV 0.8539. The exponential is the straightest, although the lognormal ranks first by AICc.

KAPLAN-MEIER LIFE TABLE (THIS WORKSHEET — 9 FAILURES, 12 CENSORED)

1 Units censored AT an event time stay at risk for that event (textbook tie rule). Bands use the log(−log) transform, so they stay inside [0, 1].

2 Time	3 At risk	4 Failed	5 Censored after	6 S(t)	7 Greenwood SE	8 95% band
6	21	3	1	0.8571	0.0764	[0.6197, 0.9516]
7	17	1	1	0.8067	0.0869	[0.5631, 0.9228]
10	15	1	2	0.7529	0.0963	[0.5032, 0.8894]
13	12	1	0	0.6902	0.1068	[0.4316, 0.8491]
16	11	1	3	0.6275	0.1141	[0.3675, 0.8049]
22	7	1	0	0.5378	0.1282	[0.2678, 0.7468]
23	6	1	5	0.4482	0.1346	[0.1881, 0.6801]

Kaplan-Meier life table (this worksheet — 9 failures, 12 censored)

- ① Units censored AT an event time stay at risk for that event (textbook tie rule). Bands use the log(−log) transform, so they stay inside [0, 1].
- ② to ⑧ The columns Time, At risk, Failed, Censored after, S(t), Greenwood SE, 95% band: seven rows, from age 6 (21 at risk, 3 failed, S 0.8571, band [0.6197, 0.9516]) to age 23 (S 0.4482, band [0.1881, 0.6801]).

DISTRIBUTION COMPARISON — RANKED BY AICC (THIS WORKSHEET — 9 FAILURES, 12 CENSORED)

1 Every row is the SAME verified fitter used by that family's own analysis — identical numbers there. AICc = 2k − 2lnL + 2k(k+1)/(n−k−1): fit quality with an honest small-sample parameter penalty; ★ = lowest.

2 Family	3 Fitted parameters	4 log-likelihood	5 AICc	6 B10	7 Median	8 r (Q-Q)
Lognormal ★	Lognormal(μ = 3.203, σ = 0.9787)	-40.680	86.027	7.02	24.61	0.9714
Exponential	Exponential(λ = 0.0250696)	-42.175	86.560	4.203	27.65	0.9781
Loglogistic	Loglogistic(μ = 3.189, s = 0.5938)	-41.144	86.955	6.582	24.27	0.9674
Gamma	Gamma(k = 1.677, θ = 18.5414)	-41.439	87.545	6.902	25.18	0.9652
Weibull 2P	Weibull(β = 1.354, η = 33.7652)	-41.659	87.984	6.405	25.76	0.9661
Logistic	Logistic(μ = 25.03, s = 9.476)	-44.840	94.347	4.205	25.03	0.8760
Smallest EV	Smallest EV(μ = 31.91, σ = 12.83)	-45.855	96.377	3.039	27.21	0.8539
Weibull 3P	not fitted (threshold at the data boundary)	–	–	–	–	–

9 A close AICc race (within ~2) means the data cannot separate the families — pick by engineering physics, not by the third decimal.

Distribution comparison — ranked by AICc (this worksheet — 9 failures, 12 censored)

- ① Every row is the SAME verified fitter used by that family's own analysis — identical numbers there. AICc = 2k − 2lnL + 2k(k+1)/(n−k−1): fit quality with an honest small-sample parameter penalty; ★ = lowest.
- ② to ⑧ The columns Family, Fitted parameters, log-likelihood, AICc, B10, Median, r (Q-Q): Lognormal ★ 86.027, then Exponential 86.560, Loglogistic 86.955, Gamma 87.545, Weibull 2P 87.984, Logistic 94.347, Smallest EV 96.377; the Weibull 3P row is not fitted.
- ⑨ A close AICc race (within ~2) means the data cannot separate the families — pick by engineering physics, not by the third decimal.

DISTRIBUTION COMPARISON — NOT-FITTED FAMILIES

1 Weibull 3P: not fitted (threshold at the data boundary)

Distribution comparison — not-fitted families

- ① Weibull 3P: not fitted (threshold at the data boundary).

1 Licensed to ReliaEn Training · RL-2026-0017

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

The data on their own. At age 6 three of the 21 valves fail - the one removed working at 6 still counts at risk for them - so S drops to 18/21 = 0.8571. Each later failure multiplies S by the share surviving among those still at risk, and the 12 removed valves leave the risk set without a step. A quarter of the valves have failed by 13 months (S 0.6902) and half by 23 (S 0.4482). The curve never falls to 0.25, so the lower quartile is not stated: ReliaEn does not extrapolate.

How sure. At 23 months the 95 % band runs from 0.1881 to 0.6801: with only 9 failures the survival is known roughly. Plan from the lower edge of the band when a failure is costly.

Which distribution. The lognormal ranks first, μ = 3.203 and σ = 0.9787, AICc 86.027, with a B10 of 7.02 months and a median of 24.61. But four more lie within about 2 of it - the exponential (AICc 86.560), the loglogistic (86.955), the gamma (87.545) and the two-parameter Weibull (87.984, β = 1.354): the data cannot separate them, and the report says so. Choose by the failure mechanism - a wear-out mechanism points to the Weibull - and then run that distribution's own analysis for its bounds.

Why no three-parameter Weibull. Its threshold would sit at the edge of the data, so it is listed as not fitted, with that reason.