Warranty data pre-processing — a shipment/return triangle turned into grouped life data

Menu: Life Data ▸ Pre-Process Warranty Data...

Part 1 — What the function does

What it does. Warranty returns usually arrive as a shipment/return triangle: one row per production period (a cohort), the units shipped in that period, and the units returned in each period of service since; the newest cohort has the shortest row. ReliaEn turns the triangle into grouped life data and writes it onto the worksheet in four columns you choose: the start and end age of each service period (a bin), the returns in it added over every cohort, and the units still in the field whose cohort has reached exactly that age. Each return is recorded in its period (start, end], with no invented exact failure time; each unit still in the field is censored at its cohort's current age.

What ReliaEn prints and writes	What it tells you
Cohorts, **Units shipped**	What was read from the triangle
Bins written, **Failed units pooled**, **Censored units pooled**	What was written to the four columns
Conservation	Failed plus censored equals shipped: every unit is in the bins exactly once
Pooled bins table	The rows now on the worksheet, ready for a grouped analysis

From which data. The triangle on the worksheet: a shipments column, oldest cohort first, and the returns of the first service period in the next column, the later periods in the columns to its right. Four empty columns outside the triangle receive the bins.

When an engineer uses it. When warranty returns are known only by period of service, and a distribution is to be fitted to them with any grouped-data analysis - for example to compare the Weibull, lognormal and gamma fits of the same returns.

When not to use it.

Situation	Use instead
The forecast of future returns, the warranty reserve or a warranty length is wanted	Life Data ▸ Warranty Prediction... (reads the triangle directly)
The exact age at failure of every returned unit is known	The ages as exact times in a Life Data ▸ Time Dependence analysis

Part 2 — The example's input data

Setting. A maker of a household appliance has four months of production in the field and the returns so far by month of service. The reliability engineer wants the returns as grouped life data, to fit and compare distributions.

Cohort	Shipped (column I)	Returns, month 1 (J)	2 (K)	3 (L)	4 (M)
1	400	4	7	9	6
2	350	3	6	8	

3	300	4	5		
4	250	2			

Input	Value
Shipments column / First returns column / Return periods k	I / J / 4
Start column / End column / Failed-units column / Censored-units column	O / P / Q / R
File in the worked-example zip	2-Warranty-Pre-Processing/Example-1.csv — the triangle in columns I to M (columns A to H left empty)

	① I	② J	③ K	④ L	⑤ M	N
1	400	4	7	9	6	
2	350	3	6	8		
3	300	4	5			
4	250	2				
5						

The example data in the worksheet

- ① Column I: the units shipped of each cohort, oldest first.
- ② Column J: the returns in the first month of service.
- ③ Column K: the second month; the newest cohort has none yet.
- ④ Column L: the third month.
- ⑤ Column M: the fourth month, the oldest cohort only.

Part 3 — How to use it, step by step

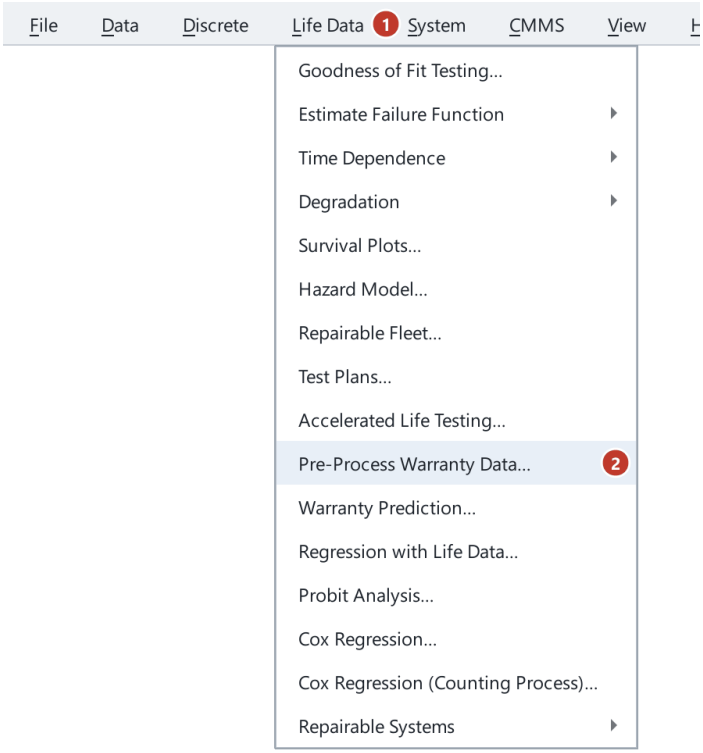
1. **Put the triangle in columns I to M.** Copy the 4 rows of Example-1.csv into the worksheet, starting at row 1 of column I: the shipments in column I, the returns of each month of service to its right. Columns A to H stay empty, and so do O to R - ReliaEn writes the bins there.

	① I	② J	③ K	④ L	⑤ M	N
1	400	4	7	9	6	
2	350	3	6	8		
3	300	4	5			
4	250	2				
5						

Step 1 — the triangle in columns I to M

- ① Column I: the units shipped of each cohort, oldest first - 400, 350, 300, 250.
- ② Column J: the returns in the first month of service - 4, 3, 4, 2.
- ③ Column K: the second month - 7, 6, 5.
- ④ Column L: the third month - 9, 8.
- ⑤ Column M: the fourth month - 6, the oldest cohort only.

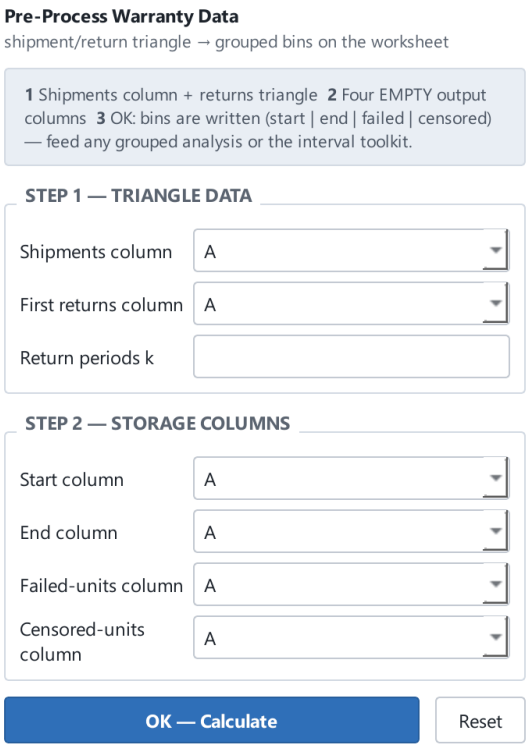
2. **Choose Life Data ▸ Pre-Process Warranty Data...** in the menu bar. The form Pre-Process Warranty Data opens in the left panel.



Step 2 — the menu path

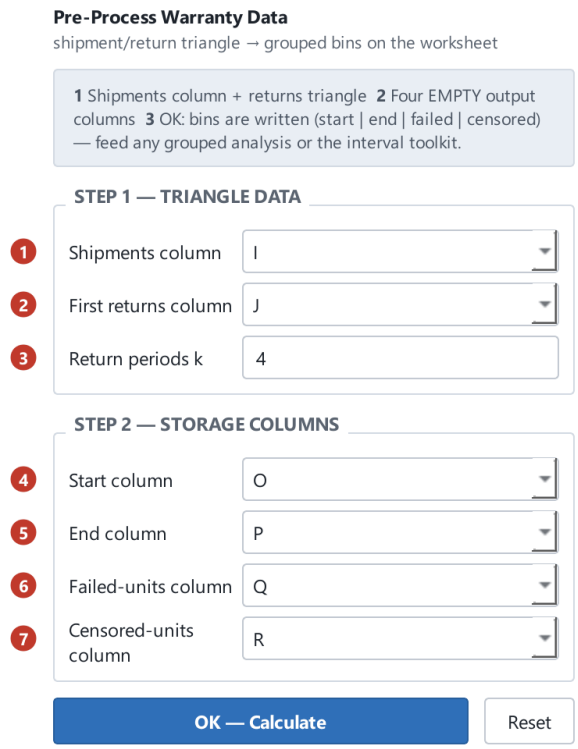
- ① Life Data: the menu.
- ② Pre-Process Warranty Data...: the entry to click.

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



Step 2 — the form as it opens

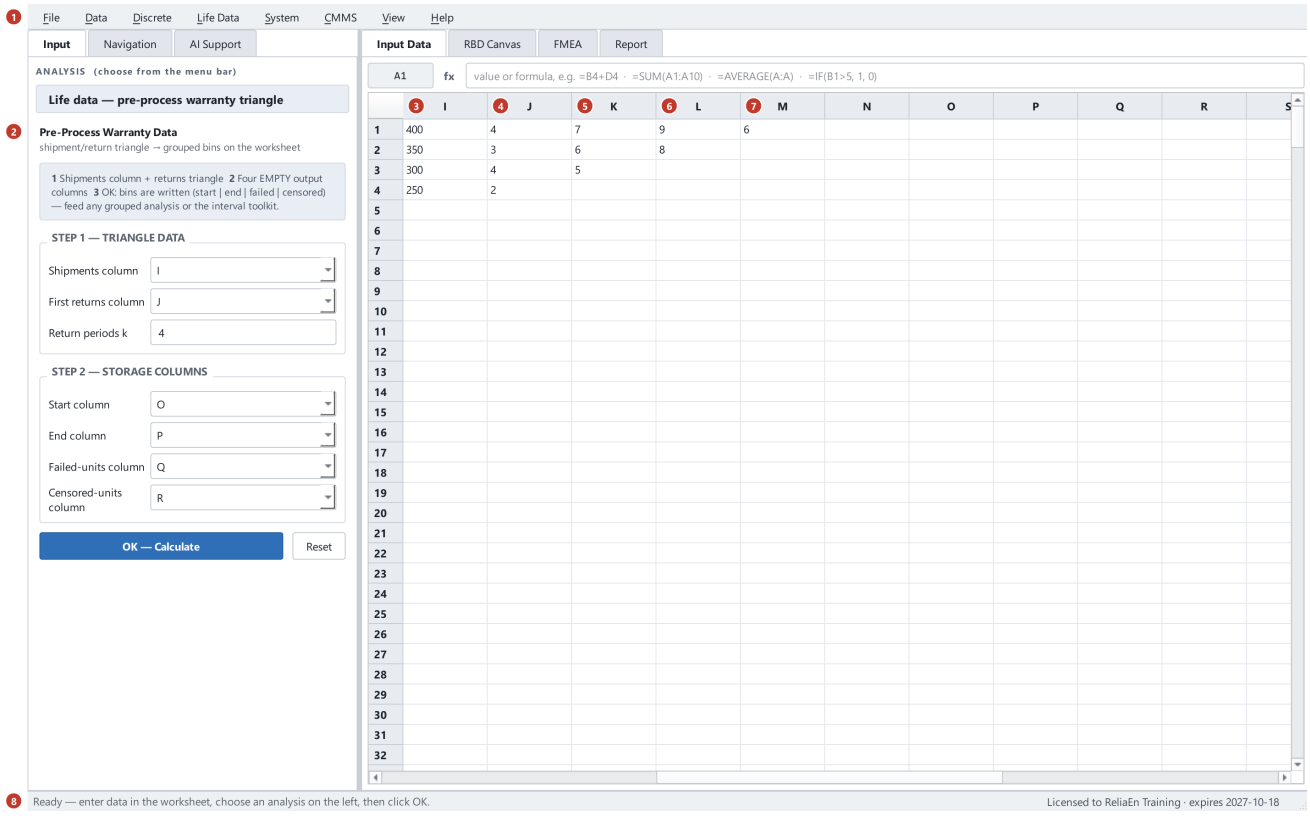
Steps 3 to 9 set the form's seven boxes, marked ① to ⑦ in the picture:



Steps 3 to 9 — the form set for this example

3. ① **In Shipments column, choose I.**
4. ② **In First returns column, choose J.** The later months are read from the columns to its right.
5. ③ **In Return periods k, type 4.**
6. ④ **In Start column, choose O.**
7. ⑤ **In End column, choose P.**
8. ⑥ **In Failed-units column, choose Q.**
9. ⑦ **In Censored-units column, choose R.** The four storage columns must be empty: ReliaEn writes into them.

10. **Click OK — Calculate** at the foot of the form (② in the picture below). ReliaEn writes the four bins into columns O to R and shows the report.



Step 10 — 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 9; OK — Calculate at its foot.
- ③ Column I: the shipments.
- ④ to ⑦ Columns J to M: the returns of months 1 to 4.
- ⑧ 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 — Pre-Process Warranty Data

```
2026-11-04 07:21:29
triangle → pooled (start, end] bins ; censored at cohort age
```

The report's head

- The title Life Data — Pre-Process Warranty Data, the date and time of the run, and the rule in one line: triangle → pooled (start, end] bins; censored at cohort age.

INPUT DATA

1	Cohorts	4
2	Units shipped	1300
3	Output columns (storage)	start → O | end → P | failed → Q | censored → R

Input data

- ① Cohorts 4.
- ② Units shipped 1300: 400 + 350 + 300 + 250.
- ③ Output columns (storage) start → O | end → P | failed → Q | censored → R.

RESULTS

1	Bins written	4
2	Failed units pooled	54
3	Censored units pooled	1246
4	Conservation	54 failed + 1246 censored = 1300 = 1300 shipped

Results

- ① Bins written 4.
- ② Failed units pooled 54: every return in the triangle.
- ③ Censored units pooled 1246: every unit still in the field.
- ④ Conservation 54 failed + 1246 censored = 1300 = 1300 shipped.

INTERPRETATION

1 The shipment/return triangle is pooled into inspection bins: each return happened somewhere inside its service period (start, end]; units still in the field are censored at their cohort's current age — no invented exact times. The four written columns are the D29 grouped layout: feed them to any grouped analysis (Weibull, Lognormal, Gamma, Exponential, SEV, Logistic, Loglogistic) — the grouped Weibull fit on these bins reproduces Warranty Prediction's own Weibull fit exactly.

Interpretation

- ① ReliaEn's reading: The shipment/return triangle is pooled into inspection bins: each return happened somewhere inside its service period (start, end]; units still in the field are censored at their cohort's current age — no invented exact times. The four written columns are the D29 grouped layout: feed them to any grouped analysis (Weibull, Lognormal, Gamma, Exponential, SEV, Logistic, Loglogistic) — the grouped Weibull fit on these bins reproduces Warranty Prediction's own Weibull fit exactly.

POOLED BINS — WRITTEN TO THE WORKSHEET (STORAGE)

1 Censored units sit at their cohort's age — the bin END of that age row (D29 convention).

	2 Start	3 End	4 Failed units	5 Censored units
6	0	1	13	248
7	1	2	18	291
8	2	3	17	333
9	3	4	6	374

Pooled bins — written to the worksheet (storage)

- ① Censored units sit at their cohort's age — the bin END of that age row (D29 convention).
- ② to ⑤ The columns Start, End, Failed units, Censored units - the same four as columns O to R.
- ⑥ 0 to 1: 13 failed, 248 censored.
- ⑦ 1 to 2: 18 failed, 291 censored.
- ⑧ 2 to 3: 17 failed, 333 censored.
- ⑨ 3 to 4: 6 failed, 374 censored.



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

Where each number comes from. The first bin holds every cohort's first-month returns: 4 + 3 + 4 + 2 = 13. Its 248 censored units are cohort 4's units still in the field, 250 − 2, censored at age 1. The last bin's 374 censored units are cohort 1's units still working at age 4: 400 − (4 + 7 + 9 + 6).

The conservation line must close. 54 failed and 1246 censored units make 1300, the units shipped. If it did not close, the triangle was read wrongly: check the columns and k before going on.

What comes next. Columns O to R now hold the four bins, start, end, failed and censored; the triangle in I to M is unchanged. Feed the four columns to any analysis that reads grouped data - a Weibull, lognormal or gamma fit. A grouped Weibull fit on these columns gives the same fit as Life Data ▸ Warranty Prediction… on the triangle (chapter 2.20).