Life-Cycle Cost — what a fleet costs to own over a horizon

Menu: System ▸ Life-Cycle Cost…

Part 1 — What the function does

What it calculates. You run a fleet of identical machines, each carrying one component of the same type, over a horizon - a contract period, a campaign, the years to the next overhaul. Life-Cycle Cost tells you what owning and maintaining that fleet costs over the horizon, and where the money goes. ReliaEn adds up five components:

Component	What it is
ACQ	Acquisition: machines × the acquisition cost per machine, plus a fixed installation cost
CM (or CM+PM)	Corrective maintenance: the expected failures over the horizon × the repair cost; under preventive replacement, the corrective and preventive cost together
SPARES	The holding cost of the spares stock and the cost of the failures it cannot cover
DOWN	Downtime: the expected failures × the hours each one stops a machine × the cost per hour
SALV	The salvage value of the fleet at the end of the horizon, subtracted

The report gives the total, the cost per machine and per machine-hour, a breakdown in which every row shows how it was calculated, the share of each component, a 41-point cumulative cost curve, and a sentence naming the component that dominates.

From which data. No worksheet: every value is typed into the form - the component's life distribution (exponential, two-parameter Weibull, gamma, lognormal or three-parameter Weibull, typed or taken from a fit made earlier in the session), the number of machines, the horizon, and the prices: acquisition, installation, salvage, a corrective repair, downtime and, optionally, spares. The maintenance policy is run to failure or preventive replacement at a fixed interval τ.

When an engineer uses it. To put one number on a fleet's ownership cost over a horizon, to see which component drives it, and to test what a change of price, policy or stock does to the total.

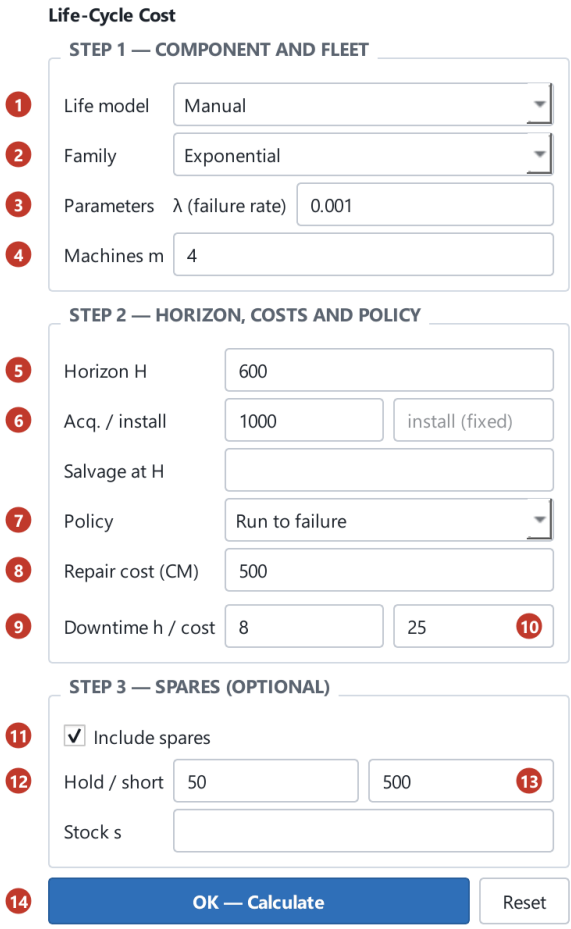
When not to use it.

Situation	Use instead
You only need the number of spares to stock for one planning window	System ▸ Spare Parts Optimization…
You do not yet know the component's life distribution	Fit it first, for example Life Data ▸ Time Dependence ▸ Weibull (2P) distribution…; the fit then appears in this form under From analysis
You need discounted or inflated costs, or two designs compared in one report	Not covered in version 1.0.0: totals are undiscounted sums over the horizon; run the form once for each design and compare the totals

Part 2 — The example's input data

Setting. A plant runs four pumps, each with one mechanical seal, over a 600-hour campaign. The seal has a constant failure rate of 0.001 per hour and is repaired when it fails. The reliability engineer wants the campaign's cost and where it goes. Ages and the horizon are in operating hours; costs are in baht.

Input	Value
Seal life	Exponential, λ (failure rate) 0.001 per hour
Pumps, campaign	4 machines, 600 hours
Acquisition	1000 baht per pump; no installation cost, no salvage value
Policy, repair	Run to failure, 500 baht per repair
Downtime	8 hours per failure at 25 baht an hour
Spares	50 baht to hold one seal, 500 baht per seal short; the stock left to ReliaEn
File in the worked-example zip	None - this function reads no worksheet; every value is typed into the form

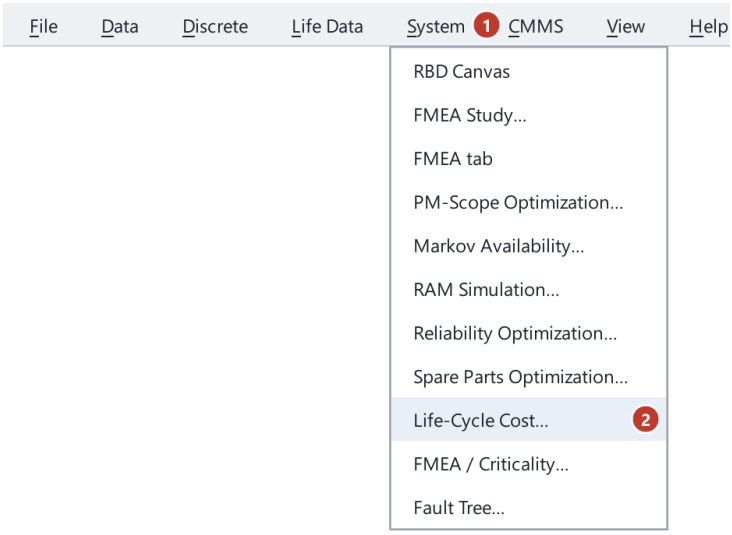


The example's input data, typed into the form

- ① to ④ STEP 1 — COMPONENT AND FLEET: the seal's life model and the four pumps.
- ⑤ to ⑩ STEP 2 — HORIZON, COSTS AND POLICY: the campaign, the prices and the policy.
- ⑪ to ⑬ STEP 3 — SPARES (OPTIONAL): the spares prices.
- ⑭ OK — Calculate.

Part 3 — How to use it, step by step

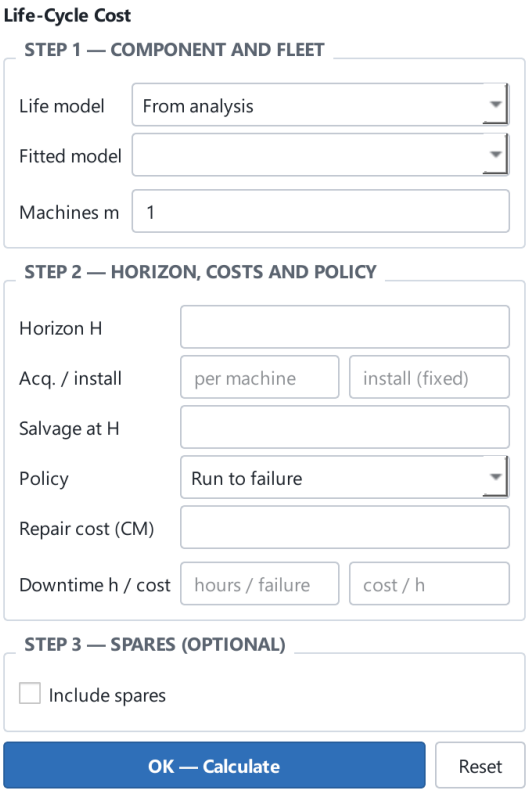
1. **Choose System ▸ Life-Cycle Cost…** in the menu bar. The form Life-Cycle Cost opens in the left panel.



Step 1 — the menu path

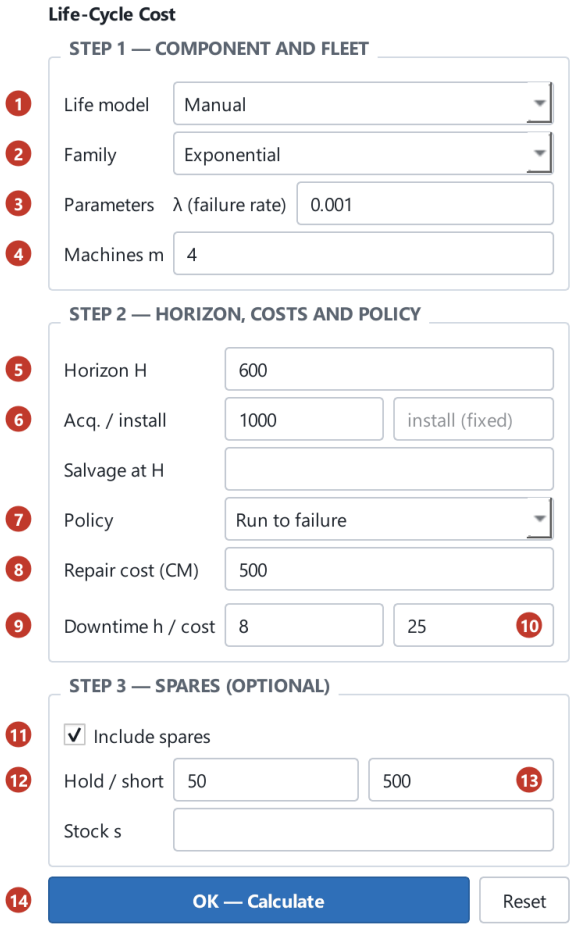
- ① System: the menu.
- ② Life-Cycle Cost…: the entry to click.

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



Step 1 — the form as it opens

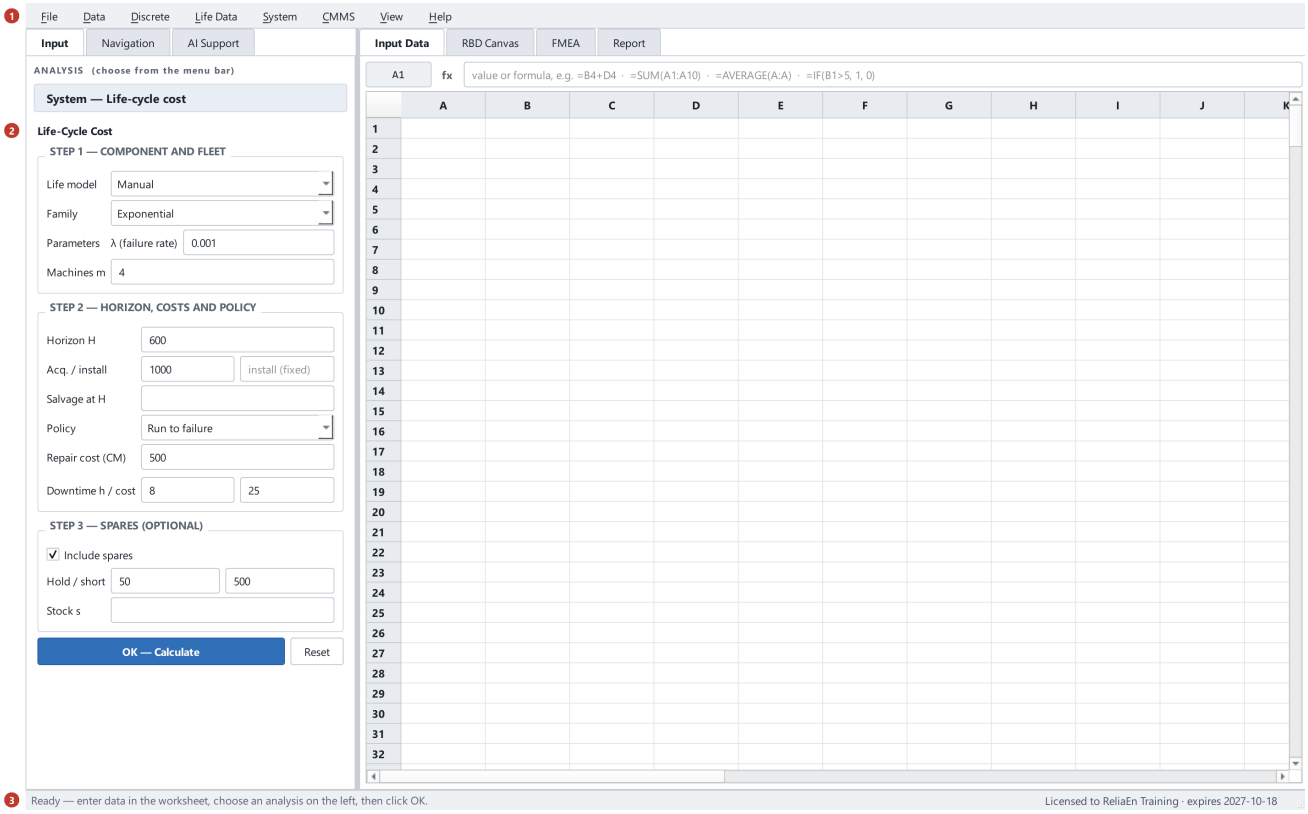
Steps 2 to 14 set the form's boxes, marked ① to ⑬ in the picture; ⑭ is the button of step 15:



Steps 2 to 14 — the form set for this example

2. ① **In Life model, choose Manual.** From analysis would take a life distribution fitted earlier in this session.
3. ② **In Family, choose Exponential.**
4. ③ **In λ (failure rate), type 0.001.**
5. ④ **In Machines m, type 4.**
6. ⑤ **In Horizon H, type 600.** The horizon is in the time unit of the life distribution: hours here.
7. ⑥ **In Acq. / install, type 1000 in the first box.** The second box, install (fixed), stays empty, and so does Salvage at H: blank counts as 0.
8. ⑦ **In Policy, choose Run to failure.**
9. ⑧ **In Repair cost (CM), type 500.**
10. ⑨ **In Downtime h / cost, type 8 in the first box** - the hours one failure stops a pump.
11. ⑩ **Type 25 in the second box** - the cost of one hour of downtime.
12. ⑪ **Tick Include spares.** The spares boxes appear.
13. ⑫ **In Hold / short, type 50 in the first box** - the cost of holding one spare seal over the horizon.
14. ⑬ **Type 500 in the second box** - the cost of each failure that finds no spare. Stock s stays empty: ReliaEn chooses the cost-optimal stock.

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



Step 15 — 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 14; OK — Calculate at its foot.
- 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

	INPUT DATA	
1	Component	Exponential(λ = 0.001)
2	Machines in fleet m	4
3	Horizon H	600
4	Policy	Run to failure
5	Acquisition / install / salvage	1000 / 0 / 0
6	Cost per corrective repair	500
7	Downtime	8 h × 25/h
8	Spares	holding 50 / shortage 500

Input data

- ① Component Exponential(λ = 0.001): the seal's life model, a constant failure rate of 0.001 per hour.
- ② Machines in fleet m 4: four pumps.
- ③ Horizon H 600: a 600-hour campaign.
- ④ Policy Run to failure: a seal is replaced only when it fails.
- ⑤ Acquisition / install / salvage 1000 / 0 / 0: each pump costs 1,000 baht to buy; no installation cost, no salvage value.
- ⑥ Cost per corrective repair 500 baht: one seal repair.
- ⑦ Downtime 8 h × 25/h: each failure stops the pump for 8 hours at 25 baht an hour.
- ⑧ Spares holding 50 / shortage 500: a spare seal costs 50 baht to hold for the campaign; a failure without a spare costs 500 baht.

These are your entries as ReliaEn read them; a blank field shows as 0 or not included.

	RESULTS	
1	Total life-cycle cost	5953.7953
2	Cost per machine	1488.4488
3	Cost per machine-hour	2.4807481
4	Roll-up check (L1)	exact match

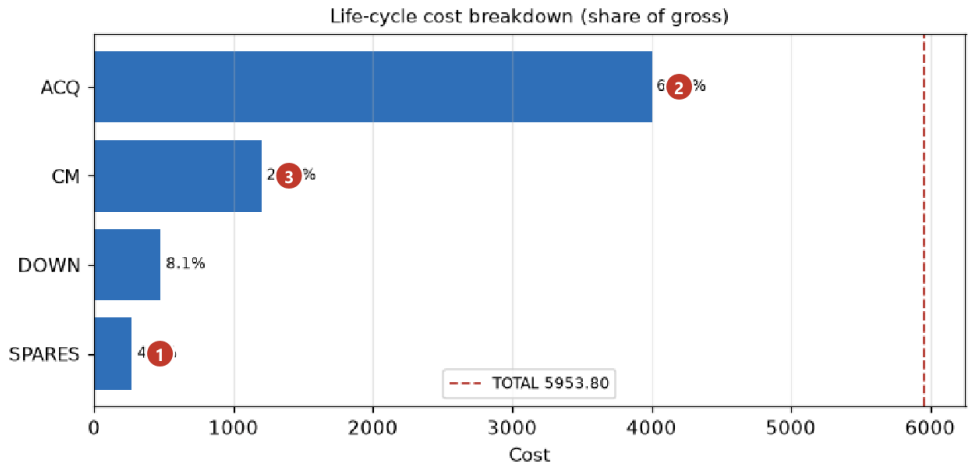
Results

- ① Total life-cycle cost 5953.7953 baht: what the four pumps cost to buy and run for the 600 hours, undiscounted.
- ② Cost per machine 1488.4488 baht: the total ÷ 4.
- ③ Cost per machine-hour 2.4807481 baht: the total ÷ (4 × 600).
- ④ Roll-up check (L1) exact match: the total recomputed from the rows of the breakdown equals the total.

	INTERPRETATION
1	ACQ dominates the life-cycle cost at 67.18% of gross cost — the fleet is cheap to own relative to buy; ownership cost is secondary to purchase price. Stock level 4 chosen by
2	the cost-optimal rule (D93); a user stock overrides it in the dialog. Single-fleet, single-scenario life-cycle cost — comparison of alternatives is a named v2.

Interpretation

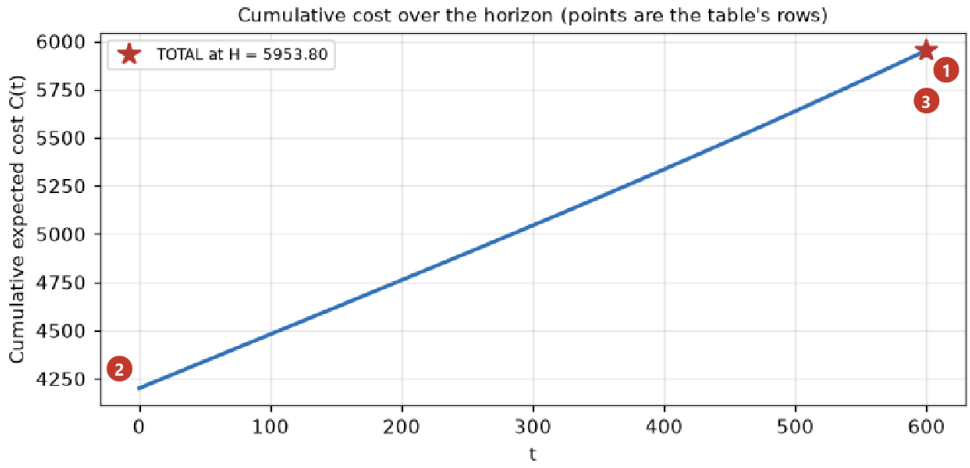
- ① The dominant component: ACQ dominates the life-cycle cost at 67.18% of gross cost — the fleet is cheap to own relative to buy; ownership cost is secondary to purchase price.
- ② The stock and the scope: Stock level 4 chosen by the cost-optimal rule (D93); a user stock overrides it in the dialog. and Single-fleet, single-scenario life-cycle cost — comparison of alternatives is a named v2.



Interactive Plot

Cost breakdown plot

- ① The bars: one per component of the cost breakdown card.
- ② The tallest bar, ACQ: 4,000.0000 baht.
- ③ The CM bar 1,200.0000 baht, the DOWN bar 480.0000 baht and the SPARES bar 273.7953 baht.



Interactive Plot

Cumulative cost plot

- ① The points: the cumulative cost C(t) at the 41 times of the cumulative cost card, from 0 to 600 hours.
- ② The start, at time 0: 4,200.0000000 baht, the purchase of the four pumps plus the holding cost of the seal stock.
- ③ The end, at 600 hours: 5,953.7953261 baht, the total of the results card.

FAILURE EXPECTATION

1 Expected fleet failures over the horizon: 2.4000000 (route: m·λ·H, exact)

Failure expectation

- ① Expected fleet failures over the horizon: 2.4000000 (route: m·λ·H, exact): four pumps × 0.001 × 600 hours, 2.4000000 seal failures expected in the campaign.

COST BREAKDOWN — EVERY ROW CITES ITS ENGINE

1 Totals are undiscounted sums over the horizon.

2 Component	Basis	Engine	Cost	Share % of G
3 ACQ	4·1000 + 0	plain	4000.0000	67.1840
4 CM	μ = 2.4000000 fleet failures × 500	renewal_function (exact branch)	1200.0000	20.1552
5 SPARES	s = 4; 4·50 + 500·0.1475907	optimize_spares (D93)	273.7953	4.5987
6 DOWN	2.4000000 failures × 8 h × 25/h	same expectation as the CM row	480.0000	8.0621
7 SALV	−0	plain	0.0000	0.0000% of gross

Cost breakdown

- ① Totals are undiscounted sums over the horizon.
- ② The columns: Component, Basis (the calculation written out), Engine, Cost and Share % of G.
- ③ The ACQ row: 4·1000 + 0, 4,000.0000 baht, share 67.1840.
- ④ The CM row: μ = 2.4000000 fleet failures × 500, 1,200.0000 baht, share 20.1552.
- ⑤ The SPARES row: s = 4; 4·50 + 500·0.1475907, 273.7953 baht, share 4.5987.
- ⑥ The DOWN row: 2.4000000 failures × 8 h × 25/h, 480.0000 baht, share 8.0621.
- ⑦ The SALV row: −0, 0.0000 baht, 0.0000% of gross.

SPARES — THE D93 MACHINERY

1 Stock s	2 Source	3 Service P(N ≤ s)	4 E[shortage]	5 Holding	Shortage
4	engine cost-optimal s* (D93 rule)	0.9041314	0.1475907	200.0000	73.7953

Spares

- ① Stock s: 4. Four spare seals.
- ② Source: engine cost-optimal s* (D93 rule). ReliaEn chose the stock with the lowest holding plus shortage cost.
- ③ Service P(N ≤ s): 0.9041314. The probability that four seals cover every failure of the campaign.
- ④ E[shortage]: 0.1475907. Expected failures that find no spare.
- ⑤ Holding: 200.0000 baht and Shortage: 73.7953 baht. Together the 273.7953 baht of the SPARES row.

CUMULATIVE COST — 41 GRID POINTS

1 The plot's points are exactly the rows of this table.

2

i	t	E[failures]	CM	DOWN	SPARES	C(t)
3 0	0	0.0000	0.0000	0.0000	200.0000000	4200.0000000
1	15	0.0600	30.0000	12.0000	200.0000031	4242.0000031
2	30	0.1200	60.0000	24.0000	200.0000957	4284.0000957
3	45	0.1800	90.0000	36.0000	200.0006987	4326.0006987
4	60	0.2400	120.0000	48.0000	200.0028298	4368.0028298
5	75	0.3000	150.0000	60.0000	200.0083016	4410.0083016
6	90	0.3600	180.0000	72.0000	200.0198597	4452.0198597
7	105	0.4200	210.0000	84.0000	200.0412727	4494.0412727
8	120	0.4800	240.0000	96.0000	200.0773802	4536.0773802
9	135	0.5400	270.0000	108.0000	200.1341069	4578.1341069
10	150	0.6000	300.0000	120.0000	200.2184486	4620.2184486
11	165	0.6600	330.0000	132.0000	200.3384351	4662.3384351
12	180	0.7200	360.0000	144.0000	200.5030753	4704.5030753
13	195	0.7800	390.0000	156.0000	200.7222886	4746.7222886
14	210	0.8400	420.0000	168.0000	201.0068252	4789.0068252
15	225	0.9000	450.0000	180.0000	201.3681792	4831.3681792
16	240	0.9600	480.0000	192.0000	201.8184963	4873.8184963
17	255	1.0200	510.0000	204.0000	202.3704796	4916.3704796
18	270	1.0800	540.0000	216.0000	203.0372933	4959.0372933
19	285	1.1400	570.0000	228.0000	203.8324674	5001.8324674
4 20	300	1.2000	600.0000	240.0000	204.7698044	5044.7698044

Cumulative cost — 41 grid points, rows 0 to 20

- ① The plot's points are exactly the rows of this table.
- ② The columns: i, t, E[failures], CM, DOWN, SPARES and C(t).
- ③ The first row, at time 0: no failures yet, the spares column 200.0000000 baht (the stock's holding cost), C(t) 4,200.0000000 baht.
- ④ The row at 300 hours: 1.2000 failures, 600.0000 baht repair, 240.0000 baht downtime, C(t) 5,044.7698044 baht.

	21	315	1.2600	630.0000	252.0000	205.8632882	5087.8632882
	22	330	1.3200	660.0000	264.0000	207.1269974	5131.1269974
	23	345	1.3800	690.0000	276.0000	208.5750218	5174.5750218
	24	360	1.4400	720.0000	288.0000	210.2213844	5218.2213844
	25	375	1.5000	750.0000	300.0000	212.0799683	5262.0799683
	26	390	1.5600	780.0000	312.0000	214.1644490	5306.1644490
	27	405	1.6200	810.0000	324.0000	216.4882316	5350.4882316
	28	420	1.6800	840.0000	336.0000	219.0643941	5395.0643941
	29	435	1.7400	870.0000	348.0000	221.9056362	5439.9056362
	30	450	1.8000	900.0000	360.0000	225.0242332	5485.0242332
	31	465	1.8600	930.0000	372.0000	228.4319954	5530.4319954
	32	480	1.9200	960.0000	384.0000	232.1402326	5576.1402326
	33	495	1.9800	990.0000	396.0000	236.1597237	5622.1597237
	34	510	2.0400	1020.0000	408.0000	240.5006908	5668.5006908
	35	525	2.1000	1050.0000	420.0000	245.1727783	5715.1727783
	36	540	2.1600	1080.0000	432.0000	250.1850358	5762.1850358
	37	555	2.2200	1110.0000	444.0000	255.5459054	5809.5459054
	38	570	2.2800	1140.0000	456.0000	261.2632123	5857.2632123
	39	585	2.3400	1170.0000	468.0000	267.3441597	5905.3441597
5	40	600	2.4000	1200.0000	480.0000	273.7953261	5953.7953261

Cumulative cost — rows 21 to 40, the same columns

- ⑤ The last row, at 600 hours: 2.4000 failures, C(t) 5,953.7953261 baht, the total.

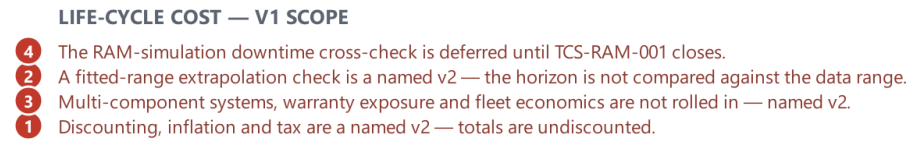
IDENTITY CHECKS — ENGINE-ASSERTED ON THIS RUN

L6 and L7 are pytest-resident (collapse and perturbation); the L8 slot is reserved — discounting is not in v1.

	Id	Check	Status
1	L1	TOTAL recomputed from the row cells in the pinned association	==
2	L2	μ(H) = 2.4 by both routes	==
3	L3	L3 skipped — run-to-failure policy.	skipped
	L4	spares cells vs the D93 result fields	==
	L5	curve endpoint equals the roll-up	==
	L6	L6 skipped — premise unmet (costs beyond acquisition are present).	skipped
	L8	L8 — discounting not in v1	skipped
	L9	gross recomputed; shares recomputed against it	==

Identity checks

- ① L1, L4, L5, L9: the total from the row cells, the spares cells, the curve's last point and the shares. Each reads ==.
- ② L2 μ(H) = 2.4 by both routes, ==. The expected failures agree by two calculations.
- ③ The row L3: L3 skipped — run-to-failure policy., status skipped. The rows L6 (L6 skipped — premise unmet (costs beyond acquisition are present).) and L8 (L8 — discounting not in v1) read skipped too: they do not apply to this run.



Scope

- ① Discounting, inflation and tax are a named v2 — totals are undiscounted.
- ② A fitted-range extrapolation check is a named v2 — the horizon is not compared against the data range.
- ③ Multi-component systems, warranty exposure and fleet economics are not rolled in — named v2.
- ④ The scope card's first line: 1.0.0 does not yet cross-check the downtime against a RAM simulation (the line names an internal test reference, not shown here).

Part 5 — How to interpret the results

What the campaign costs. The four pumps cost 5,953.7953 baht to buy and run for the 600 hours: 1,488.4488 baht per pump, or 2.4807481 baht per pump-hour. Use these figures to compare the plant with an alternative over the same 600 hours.

Where the money goes, and the lever. Acquisition is 67.18% of the gross cost - 4,000.0000 baht, against 1,200.0000 baht for repair, 480.0000 baht for downtime and 273.7953 baht for spares. The purchase price is the lever: negotiate it before you work on repair cost, and work on the other components in that order.

What the failures drive. Every failure-driven cost rests on the 2.4000000 seal failures expected in the campaign: × 500 baht gives the repair row's 1,200.0000 baht, × 8 hours × 25 baht an hour the downtime row's 480.0000 baht. With a constant failure rate the figure is exact, and repair and downtime accrue at an even pace: 600.0000 and 240.0000 baht at 300 hours, half of the campaign's figures. For a mid-campaign budget, read the cumulative cost at 300 hours: 5,044.7698044 baht.

How many seals to stock. Keep four seals in store: they cover every failure of the campaign with probability 0.9041314 for 273.7953 baht - the stock the Spare Parts Optimization chapter finds for the same seals at the same prices.

What the totals are not. Every check that applies reads `==`. The totals are undiscounted: compare alternatives over the same 600 hours only, and for a present value discount the totals yourself.