PO BOX 2091,
ROSSMOYNE, WA, 6148
AUSTRALIA

Phone: +61 (0) 402 731 563
Fax: +61 8 9457 8642
Email: info@lifetime-reliability.com
Website: www.lifetime-reliability.com

User Guide for Equipment Replacement Optimization Model

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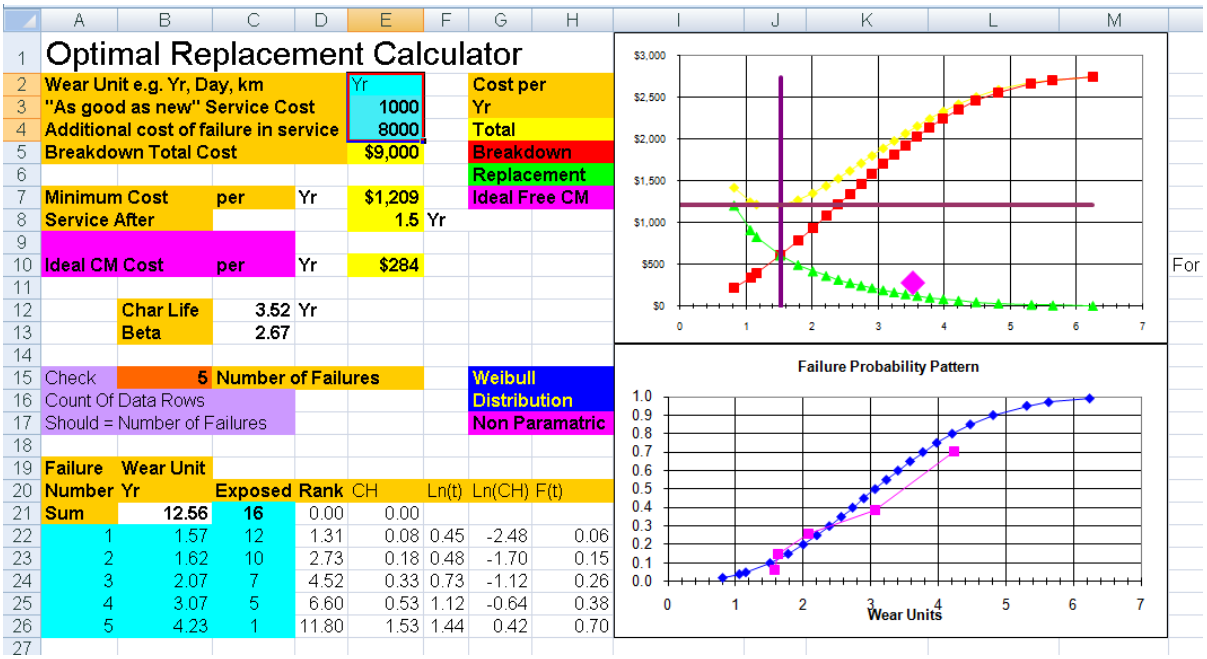
The model is a Microsoft Excel spreadsheet that permits you to do 'what-if' scenarios comparing the cost of replacing equipment with new before it fails (or refurbished 'as good as new'), against the cost of letting it fail and impacting the business. Data is entered into selected fields of the spreadsheet and used to populate the calculation tables, which then return the results shown in the remainder of the table and graphs.

The upper graph in the image below shows cost curves and the period between replacements to prevent 95% of breakdowns. The lower graph shows Weibull distribution plots and is drawn by the model from the failure history data entered for the item failure mode under analysis.

It is vital that the failed item is replaced with an identical new item or it is rebuilt to 'as new' condition. The model does not apply to overhauled equipment returned to service in less than 'as good as new' health. Typical items replaced with identical new items upon failure include: vehicle tyres, cartridge mechanical seals, small drive gearboxes, small pumps, process instruments, small electric motors, etc.



Optimal Replacement Calculator								
Wear Unit e.g. Yr, Day, km				Yr			Cost per	
"As good as new" Service Cost				1000			Yr	
Additional cost of failure in service				8000			Total	
Breakdown Total Cost				$9,000			Breakdown	
							Replacement	
Minimum Cost		per	Yr	$1,209			Ideal Free CM	
Service After				1.5	Yr			
Ideal CM Cost		per	Yr	$284				
	Char Life	3.52	Yr					
	Beta	2.67						
Check	5	Number of Failures					Weibull	
Count Of Data Rows							Distribution	
Should = Number of Failures							Non Paramatric	
Failure Number	Wear Unit Yr	Exposed	Rank	CH		Ln(t)	Ln(CH)	F(t)
Sum	12.56	16	0.00	0.00				
1	1.57	12	1.31	0.08		0.45	-2.48	0.06
2	1.62	10	2.73	0.18		0.48	-1.70	0.15
3	2.07	7	4.52	0.33		0.73	-1.12	0.26
4	3.07	5	6.60	0.53		1.12	-0.64	0.38
5	4.23	1	11.80	1.53		1.44	0.42	0.70

Nomenclature and Definitions

Char Life the Weibull characteristic life duration where 63% of items have failed.

Beta the Weibull probability distribution 'shape factor'.

Exposed the total number of items in the group of items being analysed; allows for censored data

Failure Number the order of failed items. In the image above, 16 items started life, but only 5 failed; the first failure was 1.57 years after the start date. There were 12 items in operation before the first failure. The other four items were replaced before they failed and so there was no failure date. The next failure was at 2.73 years and 10 items were in-service at that time. Two had been renewed without failing, etc

Spreadsheet Inputs Explained

The allowed spreadsheet inputs are those fields coloured 'light blue'. These are:

- **Wear Unit** – the unit of measure
- **'As Good as New' Cost** – the cost of rebuilding the item to 'as good as new' condition or replacing the item with an identical new one
- **Additional Failure Cost** – the total additional business-wide costs resulting from a failure in addition to the direct cost of the repair

Explanation of Theory Behind the Model

The model assumes the equipment is run-to-failure and no condition monitoring is performed to detect impending failure. The presumption made, in order to allow the use of an item's historical failure data, is that an item is replaced just prior to a failure.

While not all failure mechanisms produce failure modes that can be modelled by a Weibull probability distribution plot, a Weibull distribution has been found to be effective for modelling about 90% of industrial situations.

The model calculates the ideal Weibull probability distribution and plots it along with the actual failure data on the same graph to let you judge the wellness of fit to a Weibull plot. The model returns results based on a 5% probability of failure and recommends a replacement frequency where only 5% of items would failed.