
THE SECRET OF ANALYZING FIELD FAILURES

DETAILS OF THE SECRET

- I : NOTE THE NUMBER OF VEHICLES .
- II : NOTE THE FAILURE MILEAGES .
- III : NOTE THE NON-FAILURE MILEAGES IN THE INTERVALS BETWEEN THE FAILURE MILEAGES, AS WELL AS ALL NON-FAILURE MILEAGES PRIOR TO THE EARLIEST FAILURE AND AFTER THE LATEST FAILURE .
- IV : IN EACH MILEAGE INTERVAL BETWEEN FAILURES , AND IN THE MILEAGE INTERVAL PRIOR TO THE FIRST FAILURE, DIVIDE THE NUMBER OF FAILURES BY THE NUMBER OF ACTIVE VEHICLES IN THE MILEAGE INTERVAL .
- V : FORM A CUMULATIVE SUM OUT OF THE QUANTITIES CALCULATED IN EACH OF THE INTERVALS OF (IV), THIS WILL GIVE THE AVERAGE NUMBER OF FAILURES PER VEHICLE ACCUMULATED TO EACH OF THE FAILURE MILEAGES .

DRI STATISTICAL BULLETIN

Volume 14

July , 1984

Bulletin 3

Page 2

EXAMPLE OF 15 VEHICLES		INTERVAL	NO. FAILED	NO. OF ACTIVE VEHICLES
5,350 Miles	unfailed	1	1	$13 + \frac{5,350 + 12,100}{18,805}$
12,100 Miles	unfailed			= 13.93
18,805 Miles	FAILED			
19,200 Miles	unfailed	2	1	$10 + \frac{395 + 8,595}{12,424}$
27,400 Miles	unfailed			= 10.72
31,229 Miles	FAILED			
32,000 Miles	unfailed	3	1	$6 + \frac{771 + 6,571 + 11,171}{18,128}$
37,800 Miles	unfailed			= 7.02
42,400 Miles	unfailed			
49,357 Miles	FAILED	4	1	$3 + \frac{7,548 + 14,743}{16,354}$
56,905 Miles	unfailed			= 4.36
64,100 Miles	unfailed			
65,711 Miles	FAILED			
68,000 Miles	unfailed			
72,000 Miles	unfailed			

ENTROPY INCREMENT ANALYSIS PROGRAM

EXAMPLE OF 15 VEHICLES

The cumulative entropy to the last point in the previous segment = 0
(This would be zero for a first segment)

The number of mileage intervals . . = 4

<u>NUMBER FAILED</u>	<u>NUMBER ACTIVE</u>	<u>LATEST MILEAGE</u>
1	13.93	18,805
1	10.72	31,229
1	7.02	49,357
1	4.36	65,711

<u>LATEST LIFE</u>	<u>CUMULATIVE ENTROPY</u>
18,805	7.179813E-02
31,229	0.1650483
49,357	0.3074733
65,711	0.5366718

GOODNESS-OF-FIT = .9983998

WEIBULL SLOPE = 1.573827

THETA = 100,054.50

B10 = 23,946.98

MEDIAN = 79,268.21

B90 = 169,975.60

GRAPHICAL PRESENTATION OF THE RESULTS
OF THE ANALYSIS

USE LOG , LOG PAPER .

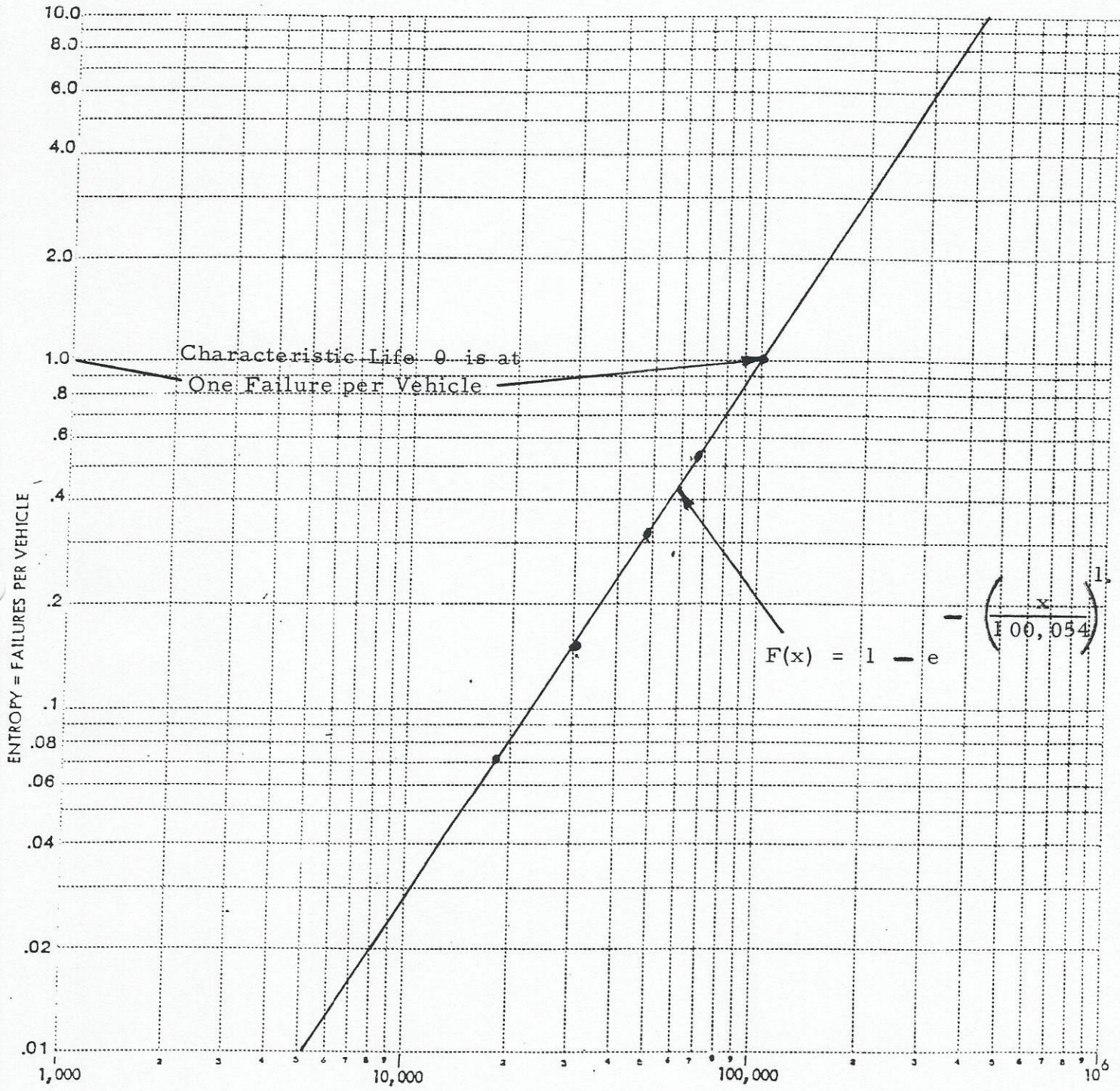
Take each FAILURE MILEAGE as an ABSCISSA on Log , Log Paper .

Take the accumulated FAILURES PER VEHICLE as the ORDINATE
on Log , Log paper corresponding to the FAILURE MILEAGE .

THEN :

The SLOPE of the line passing through the points plotted on Log , Log
paper as the WEIBULL SLOPE of the distribution of the miles to failure.

The CHARACTERISTIC LIFE of the distribution of miles-to-failure
is at that point on the Log, Log Plot which has its ORDINATE at
ONE FAILURE PER VEHICLE .



MILES ◊

Weibull Slope = 1.574

Characteristic Life = 100,054 Miles

HOW FAILURE PERCENTAGES
AND ENTROPIES ARE RELATED

<u>F</u>	<u>ENTROPY</u>
<u>PERCENT FAILED</u>	<u>ENTROPY</u>
0%	0
1%	0.01005
2%	0.02020
5%	0.05129
10%	0.10536
25%	0.28768
39.35%	0.50000
50%	0.69315
63.2%	1.00000
75%	1.38629
90%	2.30259
95%	2.99573
98%	3.91202
99%	4.60517
100%	∞

$$\mathcal{E} = \ln \frac{1}{1-F}$$

$$F = 1 - e^{-\mathcal{E}}$$

CONCLUSION

The ENTROPY technique turns out to be very useful in estimating the reliability to any target for any collection of similar vehicles which have been monitored for failure mileages and repairs.