

# The Process-Based Early Prediction Software Reliability Model

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This reliability model projects fault/density based upon empirical data correlating fault density to the process capability of the underlying development process. This is most conveniently accomplished using the development organization's Capability Maturity Level (CMM level). The model also transforms the latent fault density into an exponential reliability growth curve over time, as failures surface and the underlying faults are found and removed. Thus removed faults are mapped to the manifestation of failures. Failures occur and these signal the underlying fault. This model has been elaborated upon [1].

The key inputs to this model are the:

- SEI level for the developing organization,
- SEI level for the maintaining organization (as it may differ from the development organization)
- Number of months for the software failure rate to stabilize,
- Number of failure replications expected prior to fault removal,
- Fault activation rate,
- Percentage of all failures that are critical failures, and the
- Projected run time per month.

The reliability of the code has been observed to stabilize after four years in the field [2]. At that point, the software failure rate plateaus at a stable level.

Subsequent releases of the code plateau after two years in the field.

This model has produced a reasonable fit across several applications. The reliability projection can be beneficially refined using the Raleigh fault projection model as inspection and test data becomes available [3]. It can be further refined using execution time models running the operational profile test environment during system test [4].

An Excel model of this process reliability model is shown on the next page.

References:

1. S.J. Keene, "Modeling Software R&M Characteristics," ASQC Reliability Review, Part I and II, Vol 17, No.2&3, 1997 June, pp.13-22.
2. Ram Chillarege, Shriram Biyani, Jeanette Rosenthal, "Measurement of Failure Rate in Widely Distributed Software," Fault Tolerant Computing Symposium (FTCS), 1995, page 424-433].
3. Stephan H. Kan, "Metrics and Models in Software Quality Engineering", Addison-Wesley Publishing, Reading, Mass. 1995, p. 192.
4. John Musa et al, "Software Reliability, Measurement, Prediction, Application", McGraw-Hill, New York, 1988

# DPAM S/W Reliability Prediction Methodology

Version 2.2

Maintainer

input fields in **Yellow**

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## I. PROCESS INPUT PARAMETERS

Data Required	Inputs	Range	Input Instructions:
KSLOCs	750	>0	Number of 1,000 lines of source code (KSLOCs).
SEI Level - Develop	5	1-5	SEI Level factor (1-5).
SEI Level - Maint.	1	1-5	SEI Level factor (1-5).
Months to maturity	24	<=48	Number of months to maturity or failure rate plateau.
Use hrs/week	84	<=168	Number of operational hours per week.
% Fault Activation	100	<=100	Average %population exhibiting fault activation.
Fault Latency	5	>=1	Ave. # of fault reoccurrences/failing-site until corrected.
% Sev 1&2 Fail	60	<=100	Average % severity 1 and 2 or % countable failures.
MTTR	30	>0	Average time to restore system (minutes)

### \*Note for Table III

Fault Expansion Ratio (FER) = %(Fault Activation) X  
 X (Fault Latency) X % (sev 1&2 Category Failures).  
 FER proportions the number of observed failures  
 to removed faults

## II. DESIGN RELIABILITY MEASURE

Fault Density (Faults/KSLOC) =	0.50
Total Faults at Initial Delivery =	375
Fault Plateau % of Initial Faults =	10

## III. APPLICATION RELIABILITY MEASURES

Output Month	Inherent MTBF (hrs)	Duty Cycle	Fault Expansion Ratio*	Operational MTBF (hrs)	Operational Failure Rate	Operational Availability
Month 1	14	0.50	3.000	9	1.08E-01	0.94876504
Month 2	16	0.50	3.000	11	9.29E-02	0.95562771
Month 3	19	0.50	3.000	13	7.98E-02	0.96160836
Month 4	22	0.50	3.000	15	6.87E-02	0.96681091
Month 5	25	0.50	3.000	17	5.90E-02	0.97132947
Month 6	30	0.50	3.000	20	5.08E-02	0.97524859
Month 7	34	0.50	3.000	23	4.36E-02	0.97864377
Month 8	40	0.50	3.000	27	3.75E-02	0.98158202
Month 9	46	0.50	3.000	31	3.23E-02	0.98412258
Month 10	54	0.50	3.000	36	2.77E-02	0.98631758
Month 11	63	0.50	3.000	42	2.39E-02	0.98821277
Month 12	73	0.50	3.000	49	2.05E-02	0.98984815
Month 13	85	0.50	3.000	57	1.76E-02	0.99125864
Month 14	99	0.50	3.000	66	1.52E-02	0.99247465
Month 15	115	0.50	3.000	77	1.30E-02	0.99352260
Month 16	134	0.50	3.000	89	1.12E-02	0.99442544
Month 17	156	0.50	3.000	104	9.64E-03	0.99520305
Month 18	181	0.50	3.000	121	8.29E-03	0.99587264
Month 19	210	0.50	3.000	140	7.13E-03	0.99644909
Month 20	245	0.50	3.000	163	6.13E-03	0.99694528
Month 21	285	0.50	3.000	190	5.27E-03	0.99737232
Month 22	331	0.50	3.000	221	4.53E-03	0.99773980
Month 23	385	0.50	3.000	257	3.90E-03	0.99805598
Month 24	448	0.50	3.000	299	3.35E-03	0.99832801
Beyond	448	0.50	3.000	299	3.35E-03	0.99832801