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SAMPLE SIZE TABLES FOR SOME REALISTIC PARABOLIC TYPES OF ATTRIBUTE SUCCESS RUN TESTS TO A BOGEY

INTRODUCTION

This bulletin consists of a tabulated list of success run sizes which can form a realistic basis for reliability testing of a product to any desired life goal (bogey) with specified degrees of confidence The results are derived from the computer program "ITEREL", which is an abbreviation for ITERATIVE RELIABILITY, and is based on the reasonable assumption that the prior distribution of possible failure rates in a Bayesian statistical approach can be taken to be some kind of parabolic curve with high frequencies near zero failure rate and decreasing frequencies for higher failure rates approaching the worst failure rate possible. It is truly surprising how much smaller these success run sample sizes are than any of the conventional sample sizes used in the old time established industrial and military standards, which were based on binomial probabilities generated from rectangular priors, where minimum reliabilities are considered vulnerable enough to drop all the way down to zero. The tabulated sample sizes for success runs in this bulletin clearly indicate that the old fashioned sample sizes are exceedingly large and, in reality, totally absurd.

RELIABILITY TABLE I
(For a Parabolic Exponent = 0)

Success Run	Confidence Level (Percent) 90%	95%	99%	99.9%
2	.7321	.6842	.6077	.5500
3	.8429	.7892	.7265	.6711
4	.8770	.8498	.7994	.7504
5	.9089	.8877	.8469	.8046
6	.9299	.9130	.8795	.8432
7	.9444	.9306	.9027	.8715
8	.9549	.9434	.9199	.8928
9	.9626	.9529	.9329	.9093
10	.9685	.9603	.9430	.9223
11	.9731	.9660	.9510	.9327
12	.9768	.9706	.9574	.9411
13	.9798	.9743	.9626	.9481
14	.9822	.9774	.9670	.9539
15	.9843	.9799	.9706	.9588
16	.9859	.9820	.9736	.9629
17	.9874	.9839	.9762	.9665
18	.9886	.9854	.9785	.9695
19	.9896	.9868	.9804	.9722
20	.9906	.9879	.9821	.9745

RELIABILITY TABLE II
(For a Parabolic Exponent = 2)

Success Run	Confidence Level (Percent) 90%	95%	99%	99.9%
2	.8598	.8259	.7590	.6864
3	.9852	.9059	.8658	.8186
4	.9536	.9412	.9148	.8822
5	.9685	.9598	.9412	.9175
6	.9772	.9708	.9570	.9390
7	.9827	.9779	.9672	.9531
8	.9865	.9826	.9741	.9629
9	.9891	.9860	.9791	.9698
10	.9911	.9885	.9827	.9750
11	.9925	.9904	.9855	.9790
12	.9936	.9918	.9877	.9821
13	.9945	.9930	.9894	.9845
14	.9953	.9939	.9908	.9865
15	.9958	.9946	.9919	.9881
16	.9963	.9953	.9928	.9895
17	.9967	.9958	.9936	.9906
18	.9971	.9962	.9943	.9915
19	.9974	.9966	.9948	.9924
20	.9976	.9969	.9954	.9931

MATHEMATICAL FORMULATION OF THE PROGRAM "ITEREL"

For Parabolic Exponent = 0

Let N = Success Run Sample Size

Then, Minimum Reliability = $A = 1 - 2 / (N + 2)$

And, Reliability with Confidence C = $A + (1 - A)(1 - C)^{\frac{1}{N+1}}$

For Parabolic Exponent = 2

Let N = Success Run Sample Size

Then, Minimum Reliability = $A = 1 - 4 / (3N + 2)$

And, Reliability with Confidence C = $A + (1 - A)(1 - C)^{\frac{1}{3N+1}}$

NOTE: For the most general treatment of the "ITEREL" Program the reader is referred to DRI Bulletin #4 of Volume 24, published in August 1994

REALISTIC SUCCESS RUN SAMPLE SIZE PROGRAM (REALTCSR)

REL.	CONF.	MIN. SUCCESS RUN SAMPLE SIZE	MAX. SUCCESS RUN SAMPLE SIZE
.9	.9	3	5
.9	.95	4	6
.9	.99	5	8
.9	.999	6	10
.95	.9	4	8
.95	.95	5	9
.95	.99	6	12
.95	.999	7	14
.99	.9	10	19
.99	.95	11	22
.99	.99	14	28
.99	.999	17	35
.999	.9	31	65
.999	.95	36	74
.999	.99	45	93
.999	.999	55	114

NOTE: TO PLAY IT SAFE, USE THE MAX. SUCCESS RUN SAMPLE SIZE.
AS A GENERAL RULE, A SAMPLE SIZE SOMEWHERE BETWEEN THE MIN. AND MAX. WILL BE MORE THAN ADEQUATE FOR COMPLIANCE CONFIRMATION.
THE MIN. SAMPLE SIZE IS JUSTIFIED ONLY IN THOSE CASES WHERE TIME AND TESTING COSTS WOULD BE PROHIBITIVE FOR LARGER SAMPLES.

CONCLUSION

We have been discussing a very common problem encountered in testing a product for its reliability to survive to some desirable life goal (bogey) by taking a certain size sample and having every specimen in the sample successfully running to the life goal. This is known as SUCCESS RUN TESTING. The big question in all such cases is HOW LARGE SHOULD THE TEST SAMPLE BE?. Of course, it all depends on what RELIABILITY and CONFIDENCE levels would be considered good enough to assure sufficient compliance with the product's life goal.

The bothersome thing about the sample sizes for success runs obtained by using classical binomial probabilities is their huge size For example, RELIABILITY .99 with CONFIDENCE .99 requires a sample of 458 successes. Our realistic modern theory requires at most a sample of 28 successes. Because of this fact, i.e., the excessively large sample sizes required by classical methods, it has been found , upon the examination of many industrial testing programs, that people in charge of them have generally refused to test such large samples due to the extra expense and testing time they would require. Instead, reasonable people have become convinced of their product's required reliability by testing much smaller samples , say, a dozen, or at most, two dozen. In this bulletin we have presented a more realistic approach, with a logical basis , for using the much smaller sample sizes actually employed in success run testing. This, again, goes to show us that common sense is the best guarantee for avoiding foolish theoretical extremism in any such testing programs.