# STATISTICAL BULLETIN
Reliability & Variation Research

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Volume 26
Bulletin 2

May, 1996



## A COMPUTER PROGRAM FOR EVALUATING IMPROVEMENT RATIOS OF A DESIGN'S LIFE WHEN COMPARED TO A BASELINE TARGET LIFE BY USING STANDARD PROCEDURES OF CONFIDENCE INTERPOLATION

### INTRODUCTION

It's a famous procedure which is now almost half a century old since it was invented by Detroit Research Institute's reliability consultant Leonard Johnson. What we are discussing in this bulletin is the topic of ***Confidence Interpolation*** as formulated in the construction of ***Confidence Interpolation Graph Paper,*** which has a linear horizontal scale for ***Life Ratios*** starting at ***Unity*** in the lower left corner and proceeding linearly to the right until reaching the ***Observed Life Ratio*** (at 50% confidence). The vertical scale of this same graph paper consists of percentages from 50% and upward (just like Weibull paper). These percentages represent ***Confidence Numbers*** for the ***Life Improvement Ratios*** with respect to the particular target (i.e., baseline life) of the design life under study.

This type of confidence interpolation graph paper is shown in Figure 1, in which the ***Upper Point #1*** is the ***Significance Level***, i.e., confidence of at least a ***Unit Ratio*** of life improvement over the ***Baseline Target Life.*** The ***Lower Point #2*** is the ***Observed Life Ratio*** of the design over the baseline life (i.e., at 50% confidence). All intermediate life improvement ratios will then have confidence indices between the ***Significance Level*** (at unit life ratio) and 50% confidence at the ***Observed Life Ratio*** as determined by connecting point #1 to point #2 by a straight line.

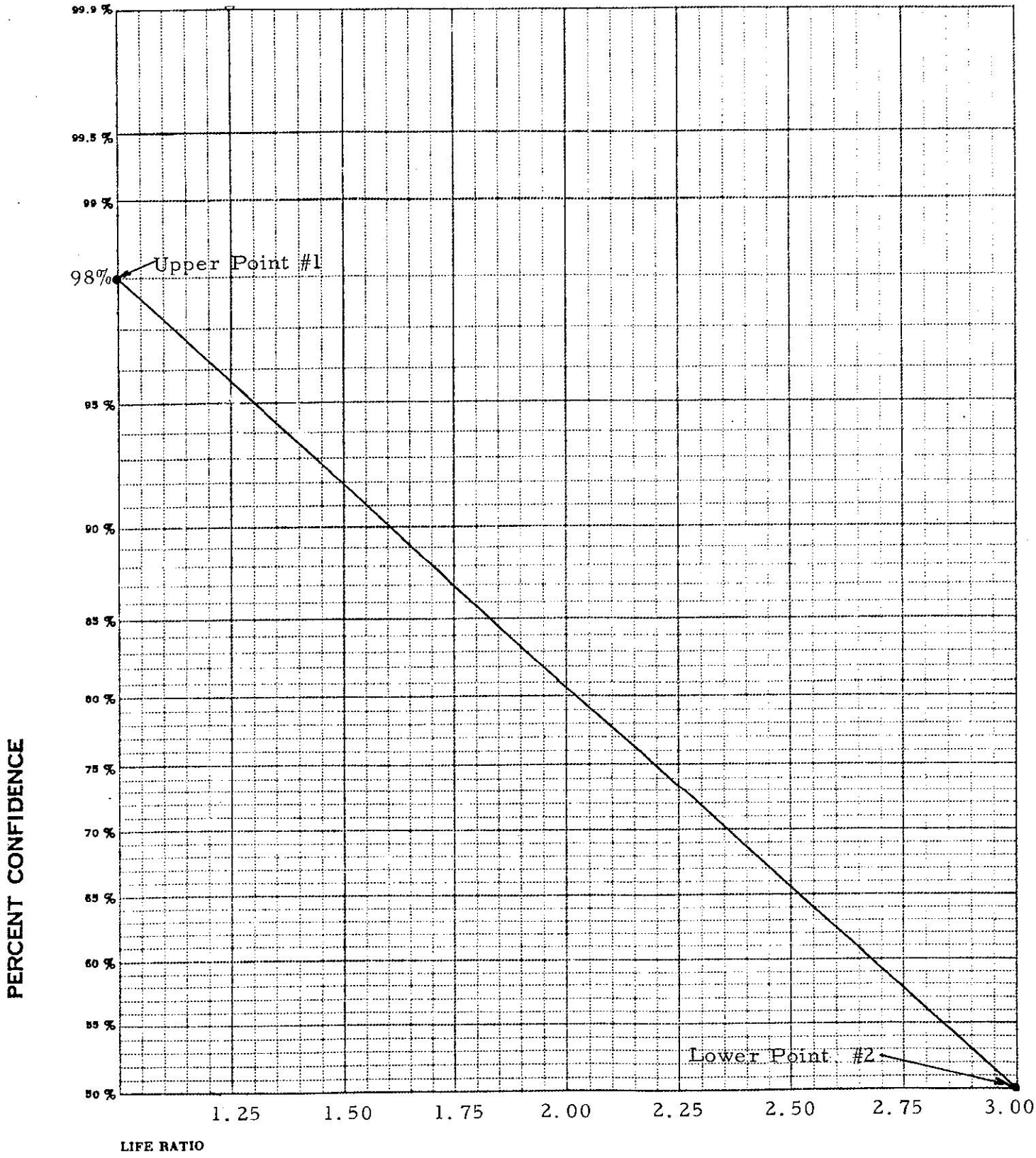
The computer program calculates the exact numerical value of confidence for any intermediate life improvement ratio falling between points 1 and 2, as would be indicated on the confidence interpolation line drawn on the graph paper.

## NUMERICAL EXAMPLE OF TYPICAL PROBLEM

Suppose a certain design of a component (or system) has a B-10 Life of 1500 hours in a life test. This means that on a Weibull Plot of the test data of the design we would read 10% failed at 1500 hours (at a specified load or stress level). Now, suppose that the design needs only a B-10 Life of 500 hours at the specified load in order to be acceptable. Furthermore, in order to illustrate our procedure, suppose that from the *Sample Size* and from the 1500 hour performance at B-10 level it is determined that there is 98% confidence of having a B-10 Life of at least 500 hours, together with 50% confidence of a B-10 Life of at least 1500 hours. Then, as shown in Figure 1, we draw a line from the ***Upper Point #1*** (at 98% confidence, called the ***Significance Level***) to the ***Lower Point #2*** at the ***Observed Life Ratio*** (1500/500) = 3 [at 50% confidence because of ***Median Rank Plotting*** on Weibull Paper].

For intermediate life improvement ratios, such as 1.25, 1.50, 1.75, 2.00, 2.25, 2.50, and 2.75, the computer output is printed on Page 4 for this design example.

Figure 1




**RATIO OF TEST LIFE TO BASELINE LIFE**

CONFIDENCE INTERPOLATION PROGRAM - CONFINT

THIS CALCULATION INVOLVES A SIGNIFICANCE LEVEL = .98
THE OBSERVED LIFE TEST RATIO = 3

| CONFIDENCE | LIFE RATIO |
|---|---|
| 0.98000 | 1.00 |
| 0.95719 | 1.25 |
| 0.92098 | 1.50 |
| 0.87054 | 1.75 |
| 0.80731 | 2.00 |
| 0.73456 | 2.25 |
| 0.65643 | 2.50 |
| 0.57707 | 2.75 |
| 0.50000 | 3.00 |

## CONCLUSION

What was started as a graphical procedure half a century ago is now totally mathematically quantified so as to give precisely interpolated numerical values for confidence indices corresponding to life ratios between the upper and lower points on a confidence interpolation line for any design under study in a life test which compares design life to a desired goal life. Thus, this new computer program removes the inaccuracies of eyeballing interpolated confidence numbers on a graphical confidence interpolation plot.