Modified Coffin-Manson Equation for AF Calculations

- Modified Coffin-Manson (Norris-Landzberg) Equation Used to Determine Acceleration Factor from ATC to Field Conditions:

$$AF = \left[\frac{\Delta T_l}{\Delta T_f}\right]^{1.9} \left(\frac{f_f}{f_l}\right)^{1/3} \exp\left(1414 \left\{\frac{1}{T_{max_f}} - \frac{1}{T_{max_l}}\right\}\right)$$

- Where:

AF = Calculated Acceleration Factor (on a Cycle Basis).

ΔT = Package/Board Temperature Difference Between T_{on} and T_{off} (°K).

T_{max} = Maximum Solder Joint Temperature (°K).

f = Cyclic Frequency (in Cycles per 24 Hour Day). Minimum Number of Six Which Assumes Maximum Damage Takes Place Within Four Hours.

f, l = Subscripts to Denote Field and Lab (i.e., ATC) Conditions, Respectively.

Information and Asssumptions

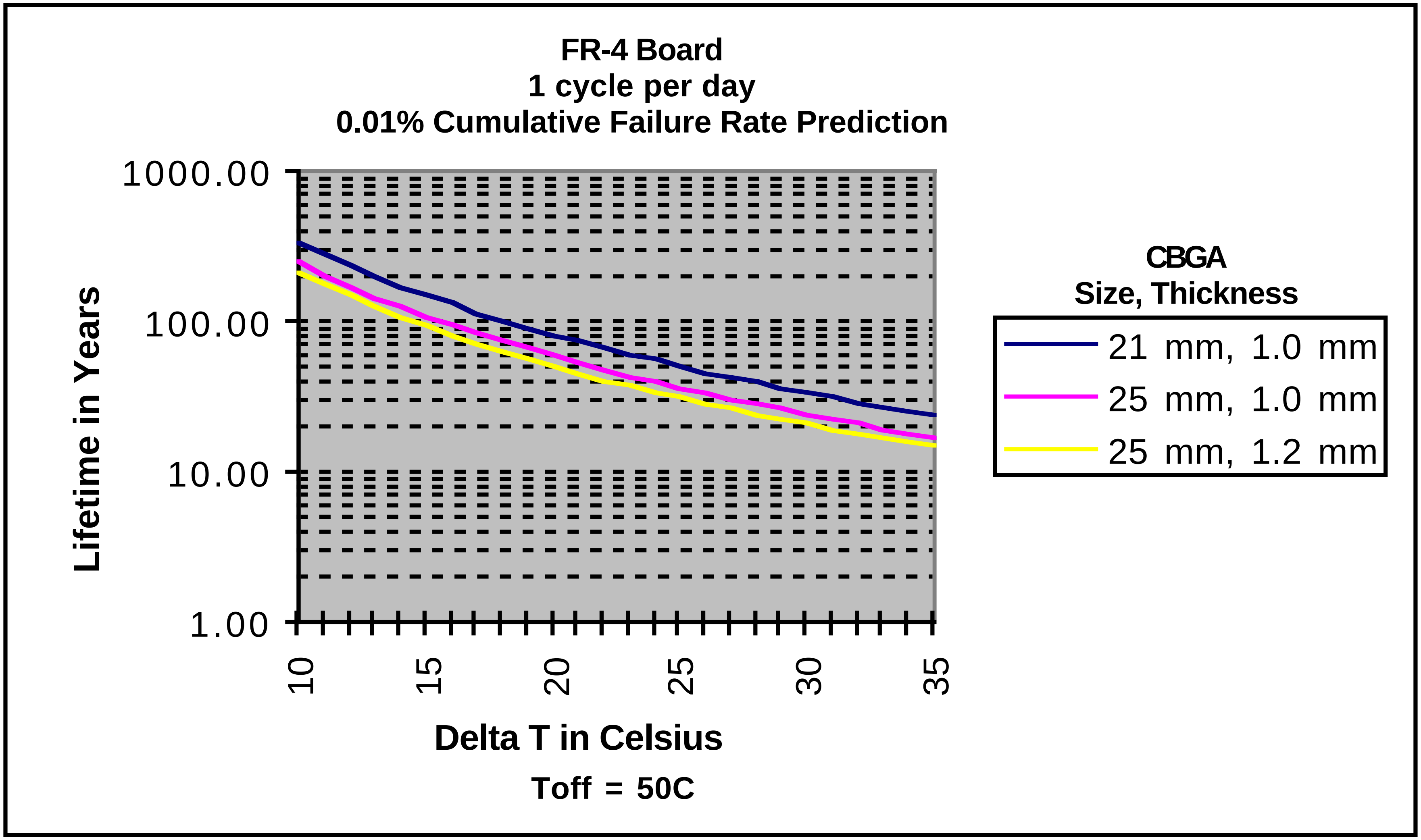
The key temperature for predicting the board level solder joint reliability is the temperature of the solder balls at the board. It is not the device junction temperature.

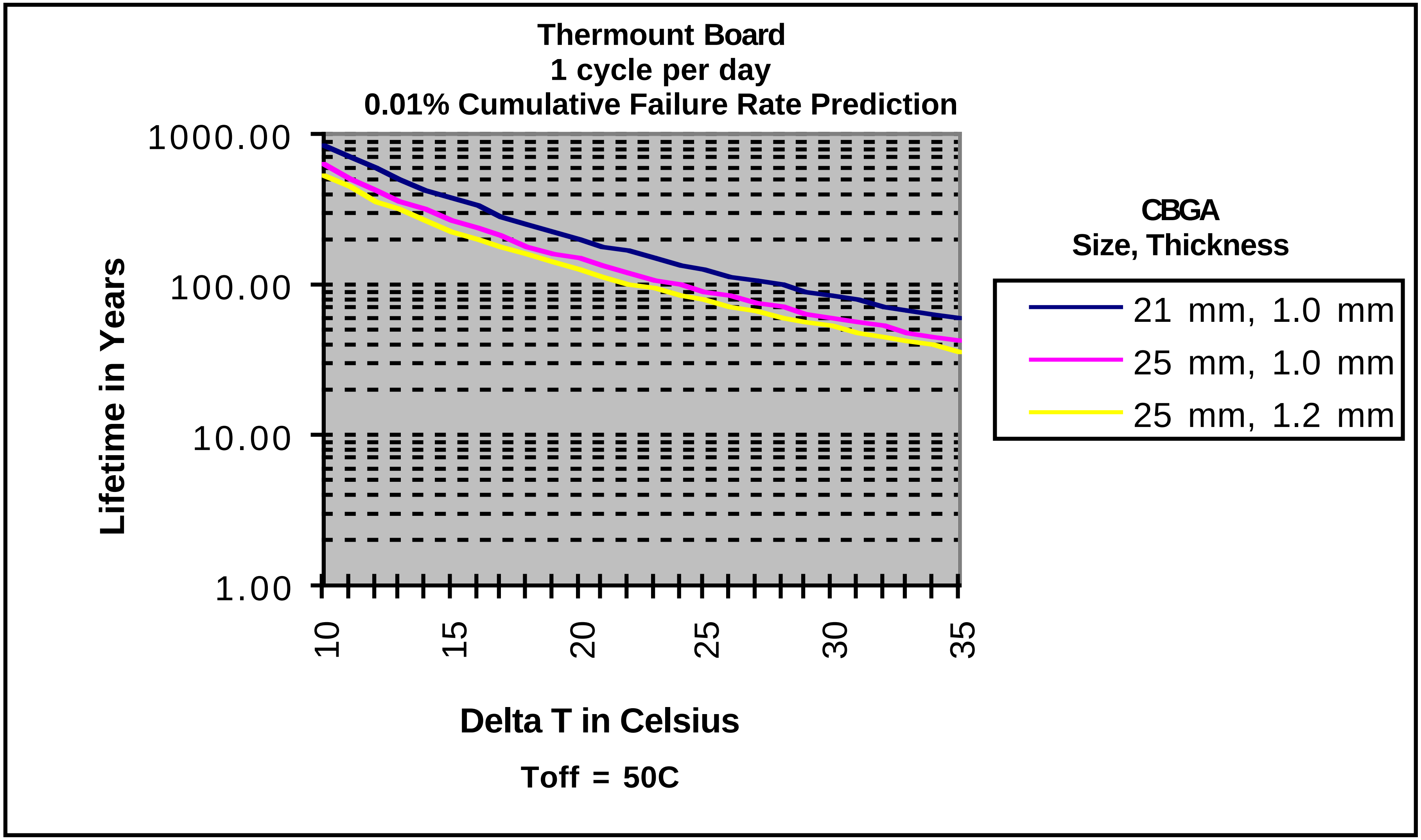
The examples given are for illustration. Individual applications can be addressed by contacting the Customer Applications Support department.

The Coffin-Manson predictions are generally recognized as “conservative” or to pessimistically predict failures under most long term use conditions.

New data and process improvements are an ongoing effort and for the latest information please contact your SPS Sales contact or the Customer Applications Support department.

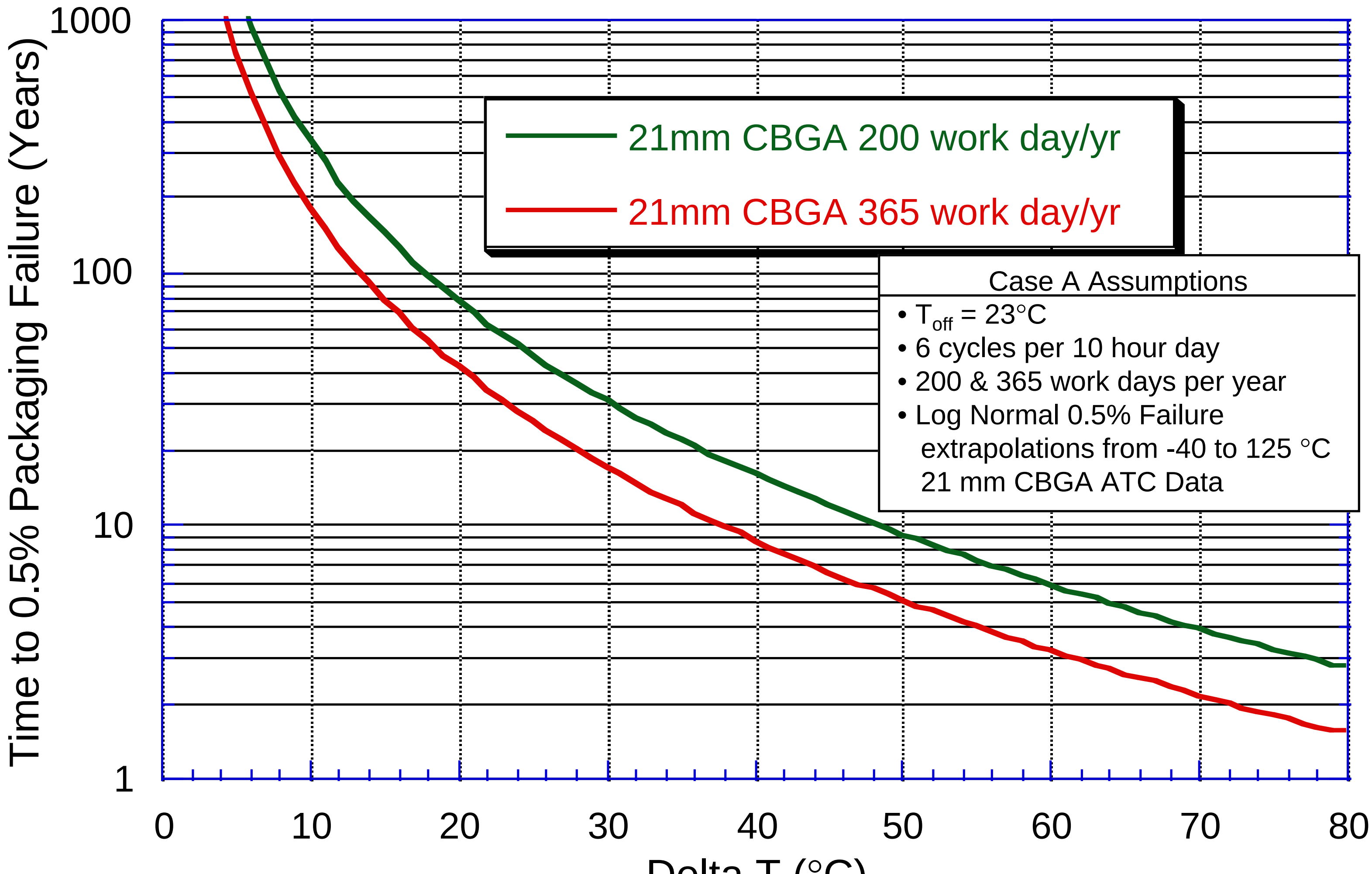
The design of the board that the CBGA is assembled to affects the solder joint reliability as well as attachment of heat sinks. Most life testing is done on an FR-4 2S,2P board that is 0.062 inches thick and the components are assembled on one side. Other materials and configurations can be tested by special request through your SPS Sales contact.


FR-4 Board
1 cycle per day
0.01% Cumulative Failure Rate Prediction
1000.00
100.00
10.00
1.00
Lifetime in Years
10
15
20
25
30
35
Delta T in Celsius
Toff = 50C
CBGA
Size, Thickness
21 mm, 1.0 mm
25 mm, 1.0 mm
25 mm, 1.2 mm


Thermount Board
1 cycle per day
0.01% Cumulative Failure Rate Prediction
1000.00
100.00
10.00
1.00
Lifetime in Years
10
15
20
25
30
35
Delta T in Celsius
Toff = 50C
CBGA
Size, Thickness
21 mm, 1.0 mm
25 mm, 1.0 mm
25 mm, 1.2 mm

Case A: 21 mm, 1mm Thick CBGA Solder Joint Reliability

Norris-Landzberg Predictions from Accelerated Thermal Cycling Data



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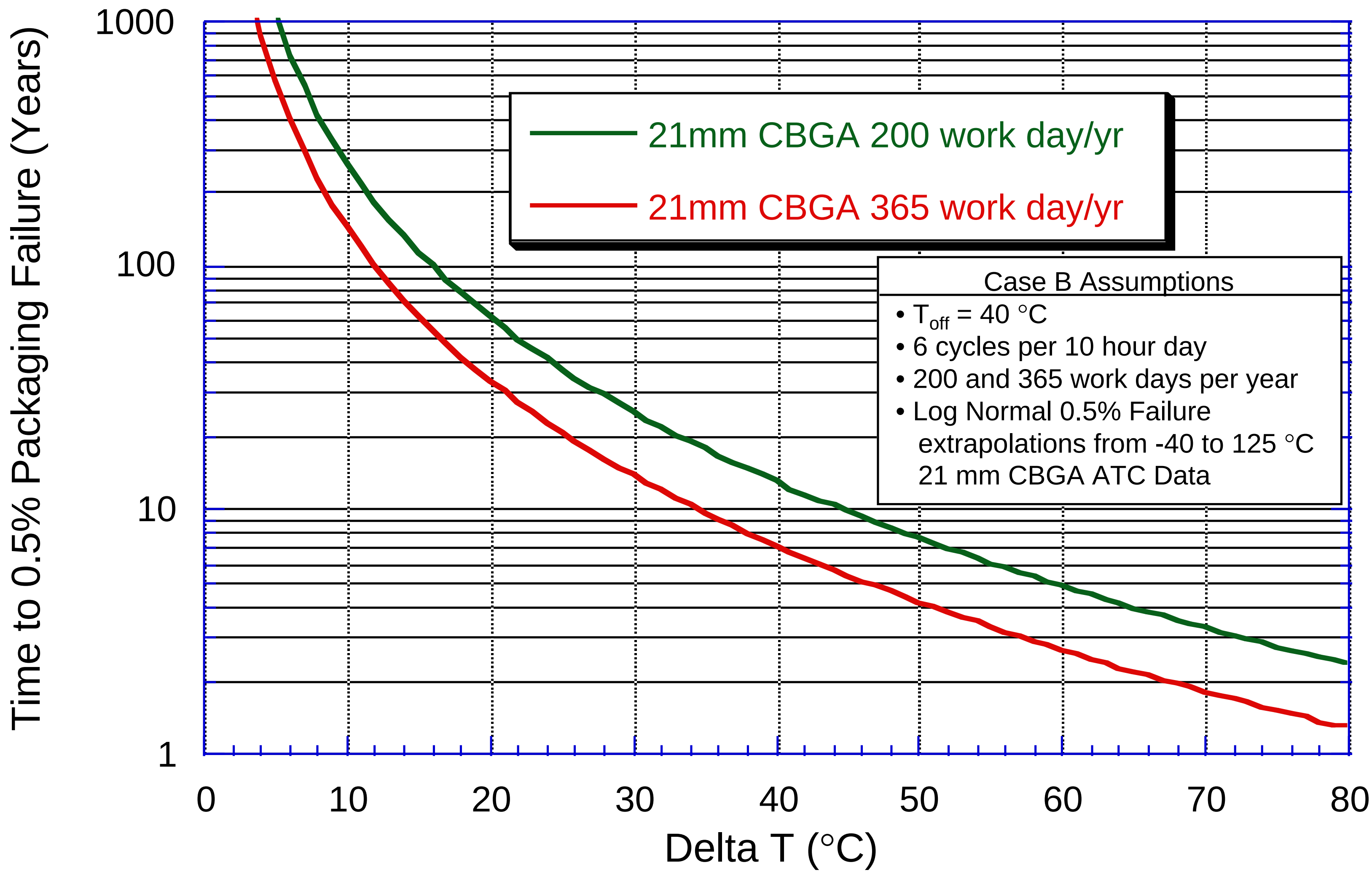
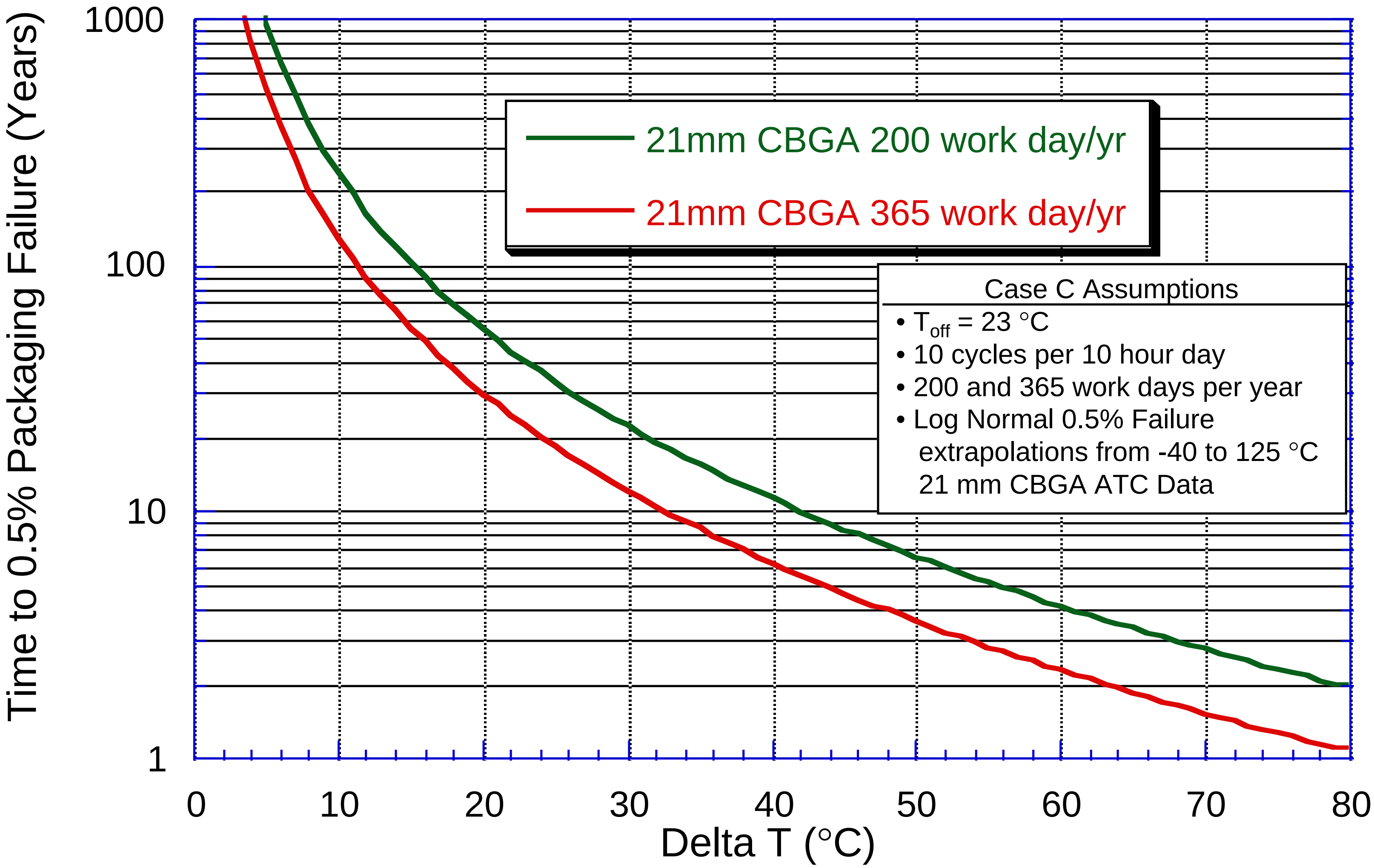
Case B: 21 mm, 1mm Thick CBGA Solder Joint Reliability

Norris-Landzberg Predictions from Accelerated Thermal Cycling Data



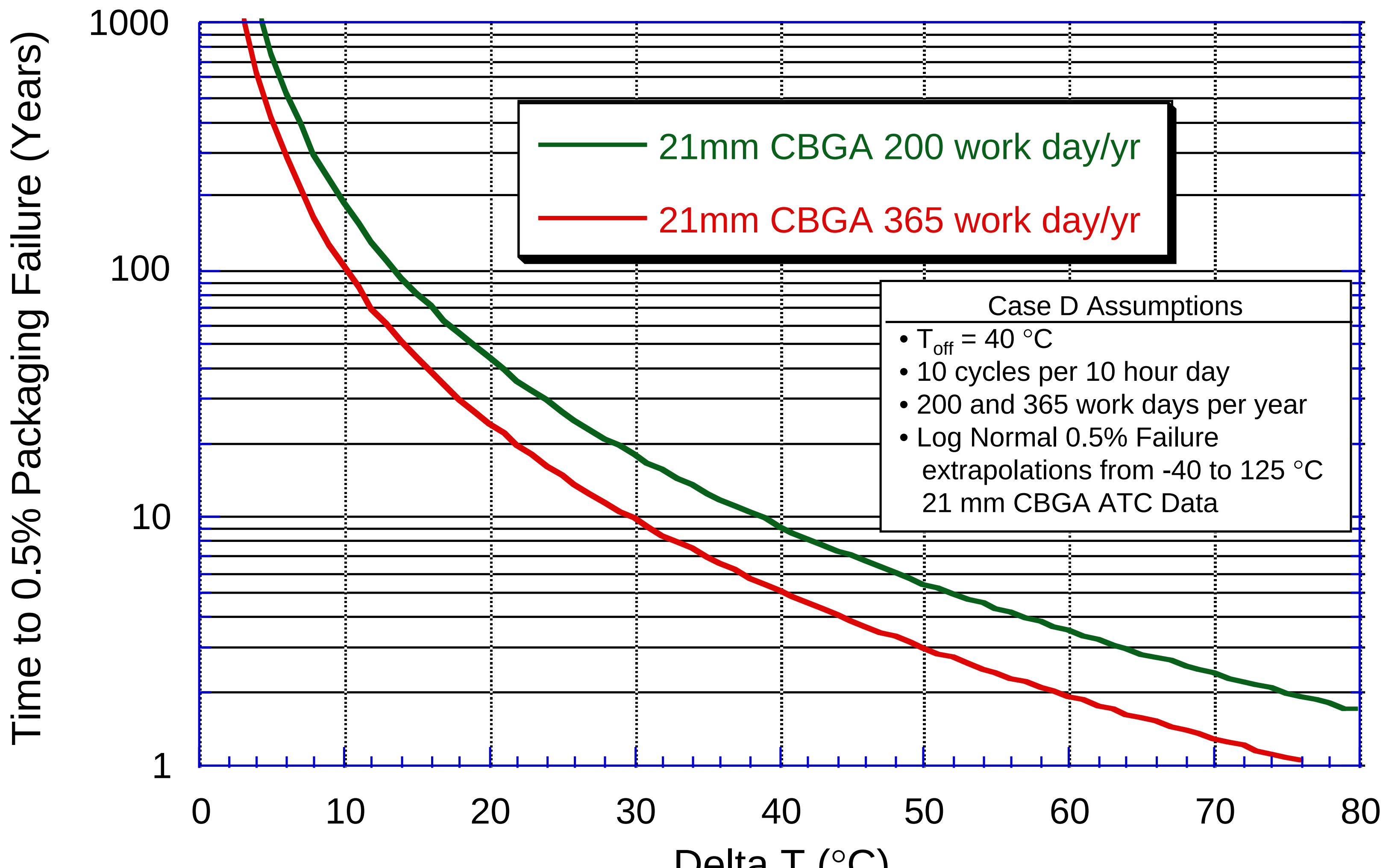
Case C: 21 mm, 1mm Thick CBGA Solder Joint Reliability

Norris-Landzberg Predictions from Accelerated Thermal Cycling Data



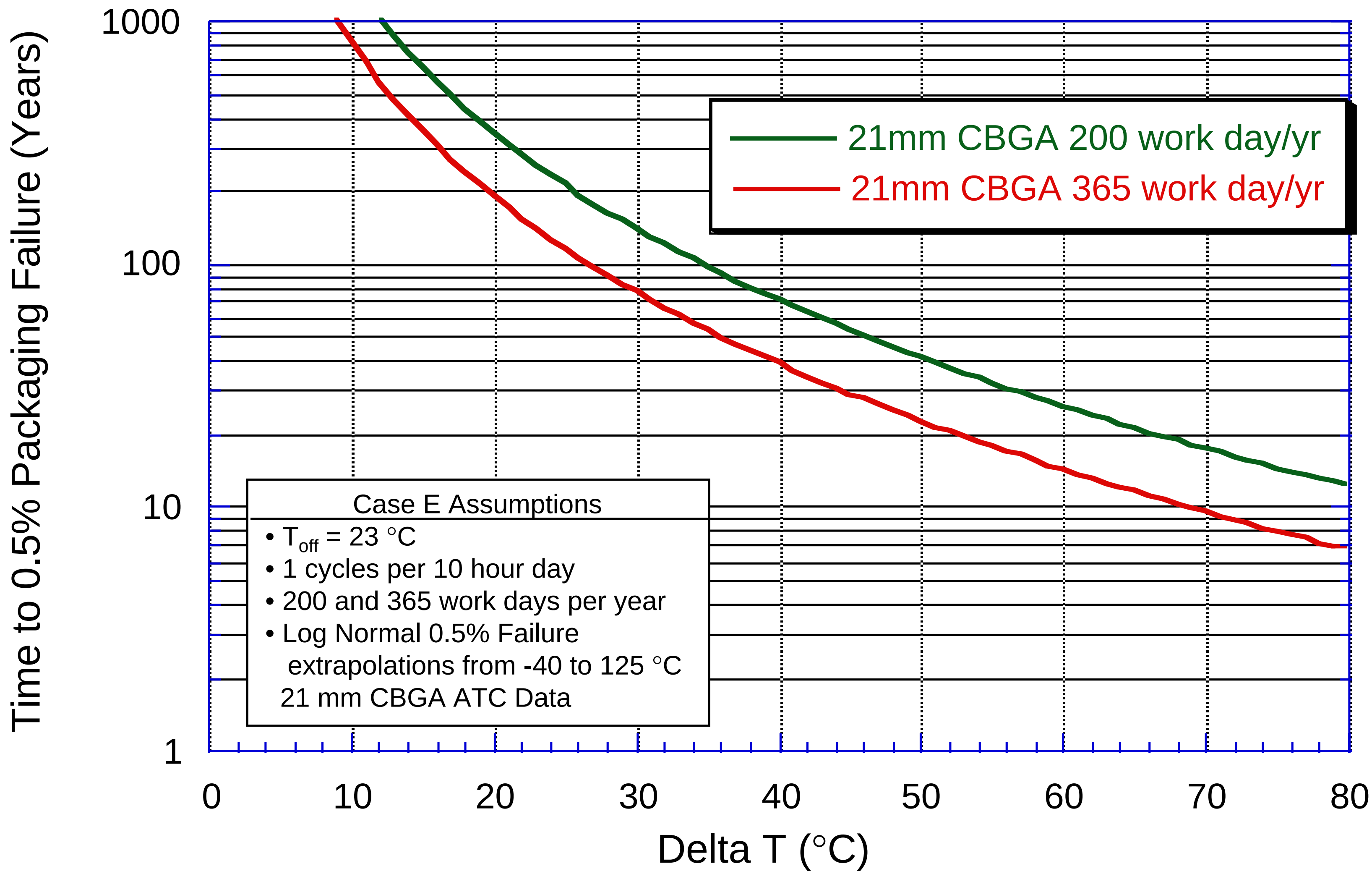
Case D: 21 mm, 1mm Thick CBGA Solder Joint Reliability

Norris-Landzberg Predictions from Accelerated Thermal Cycling Data



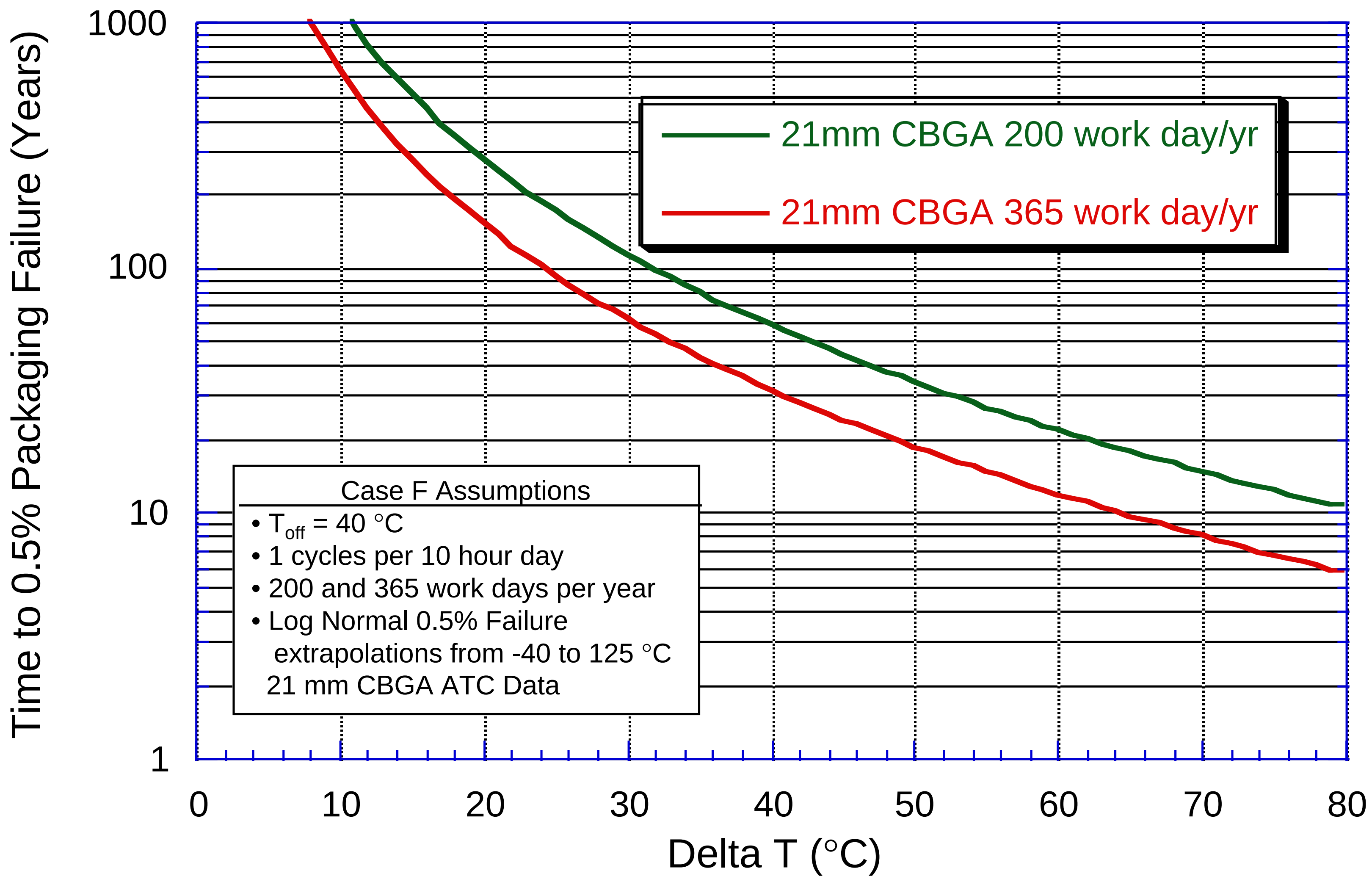
Case E: 21 mm, 1mm Thick CBGA Solder Joint Reliability

Norris-Landzberg Predictions from Accelerated Thermal Cycling Data



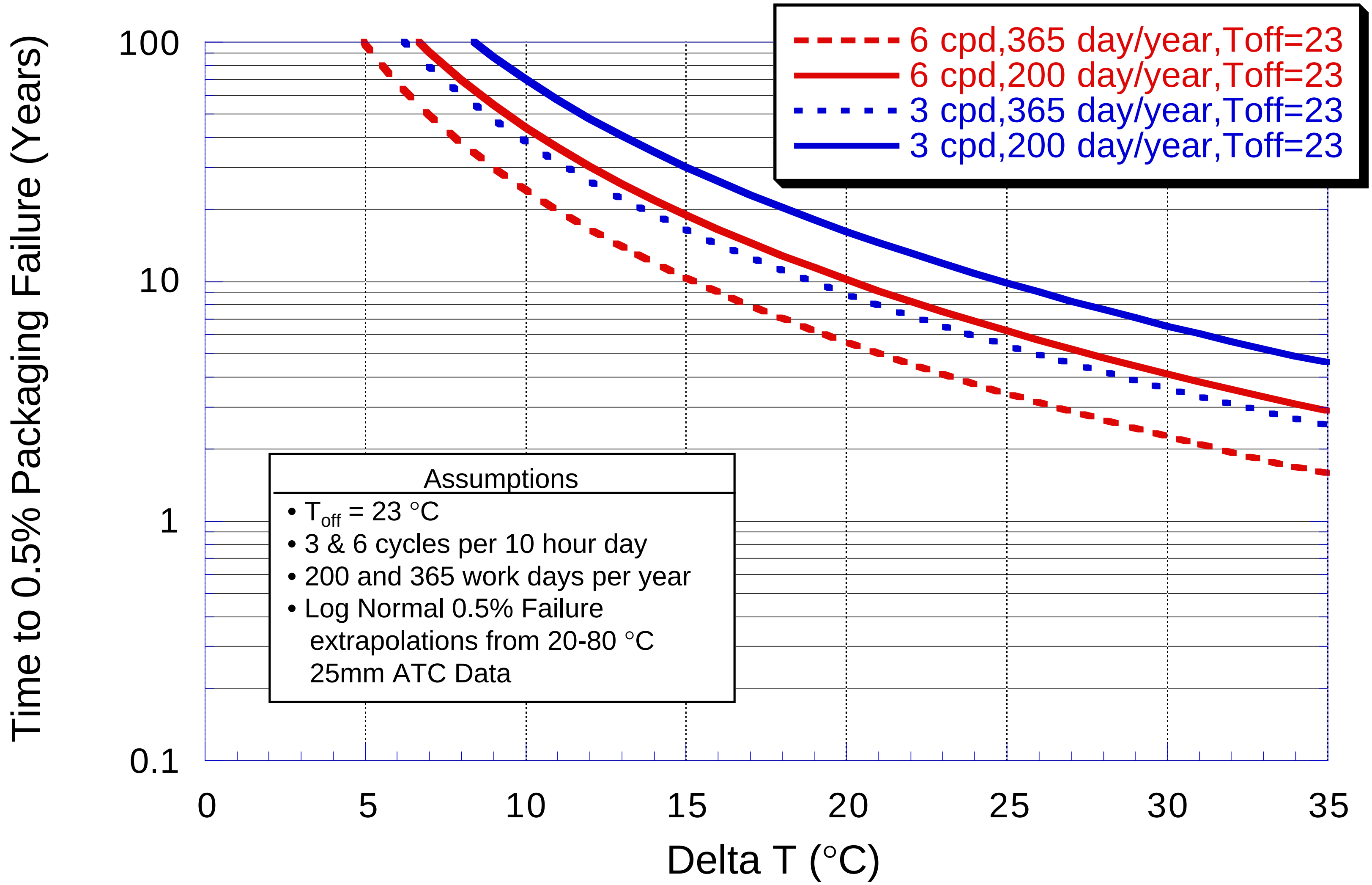
Case F: 21 mm, 1mm Thick CBGA Solder Joint Reliability

Norris-Landzberg Predictions from Accelerated Thermal Cycling Data



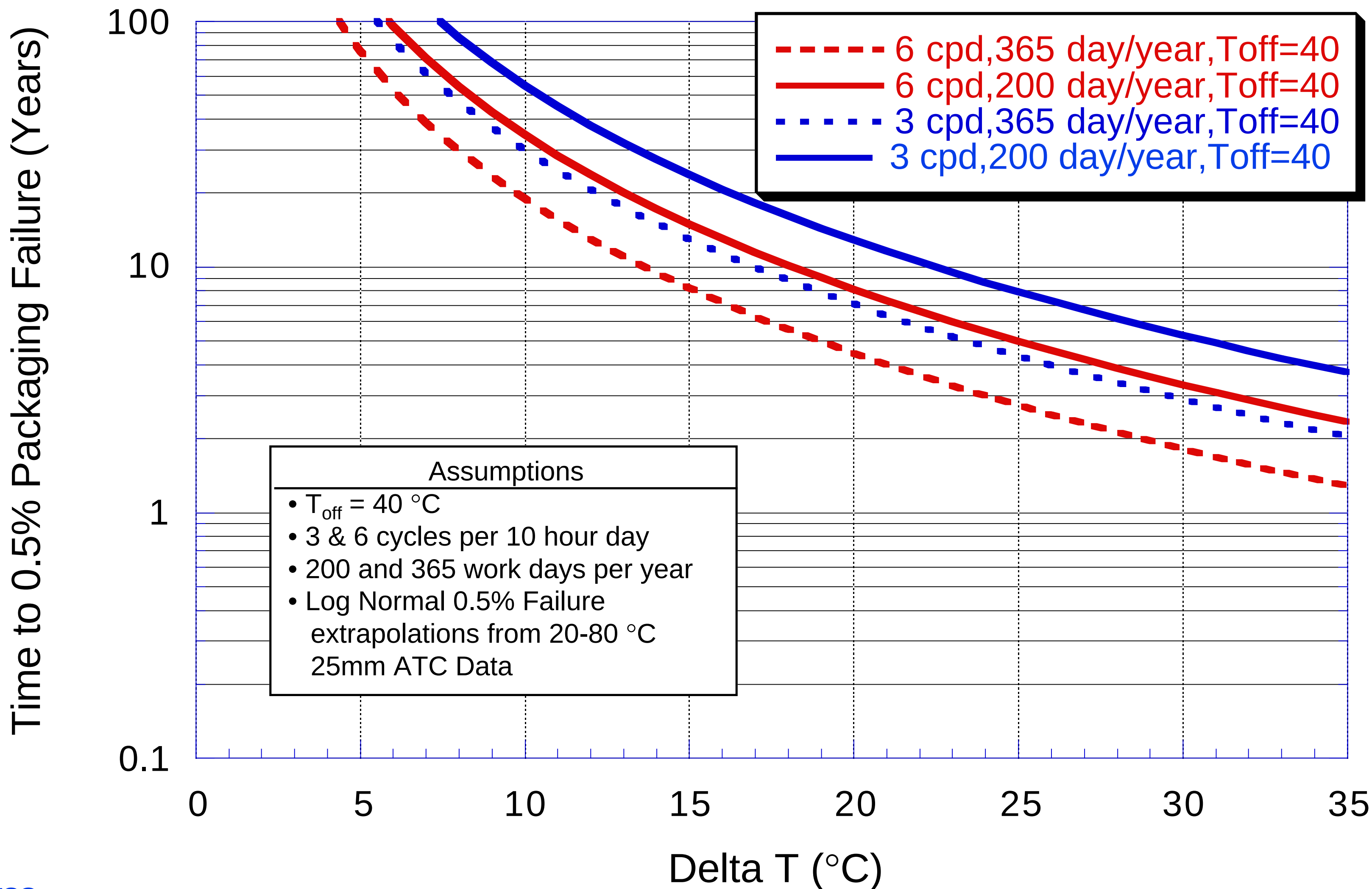
25 mm, 1mm Thick CBGA Solder Joint Reliability With 4 Balls Off

Norris-Landzberg Predictions from Accelerated Thermal Cycling Data



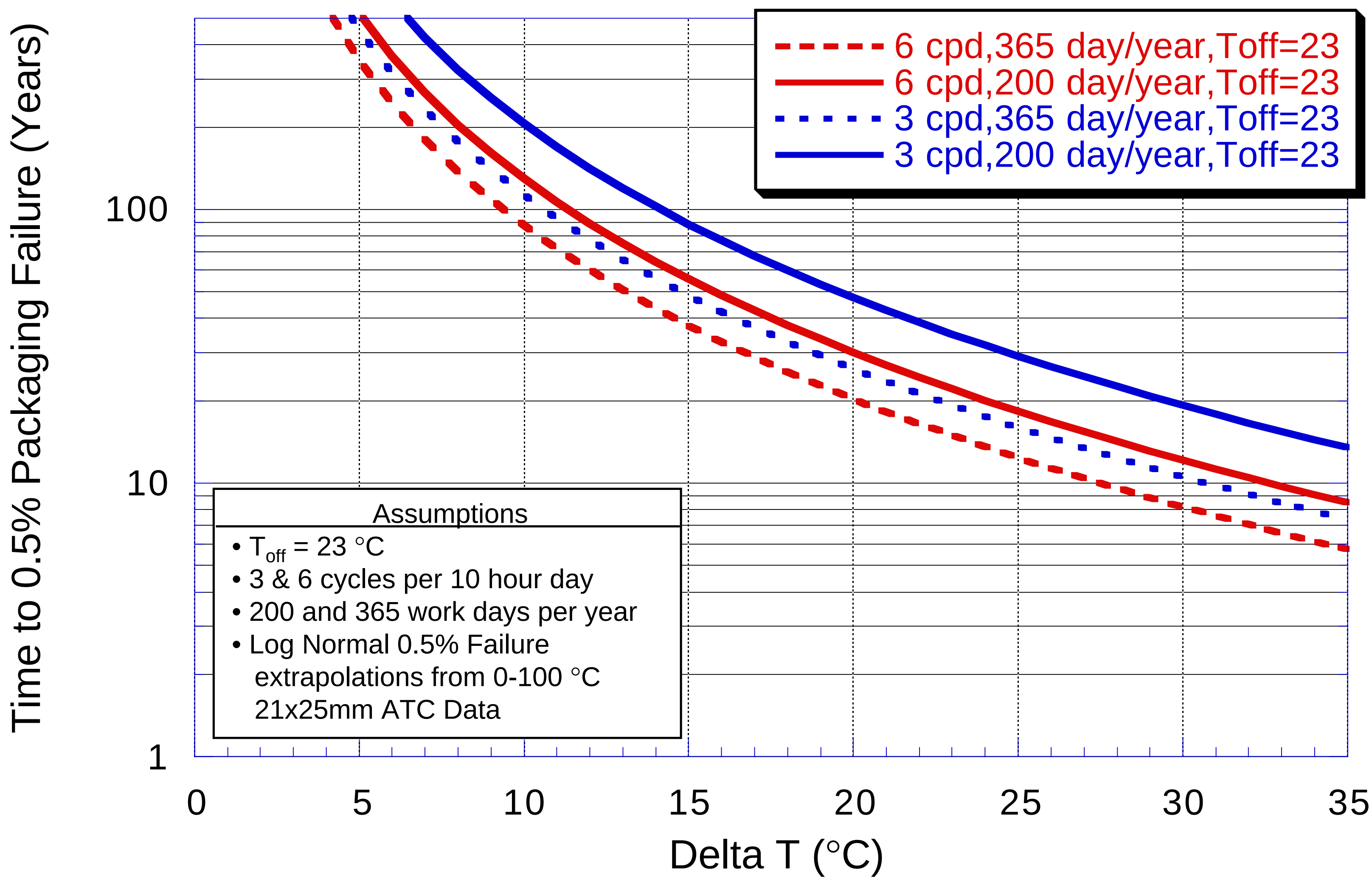
25 mm, 1mm Thick CBGA Solder Joint Reliability With 4 Balls Off

Norris-Landzberg Predictions from Accelerated Thermal Cycling Data



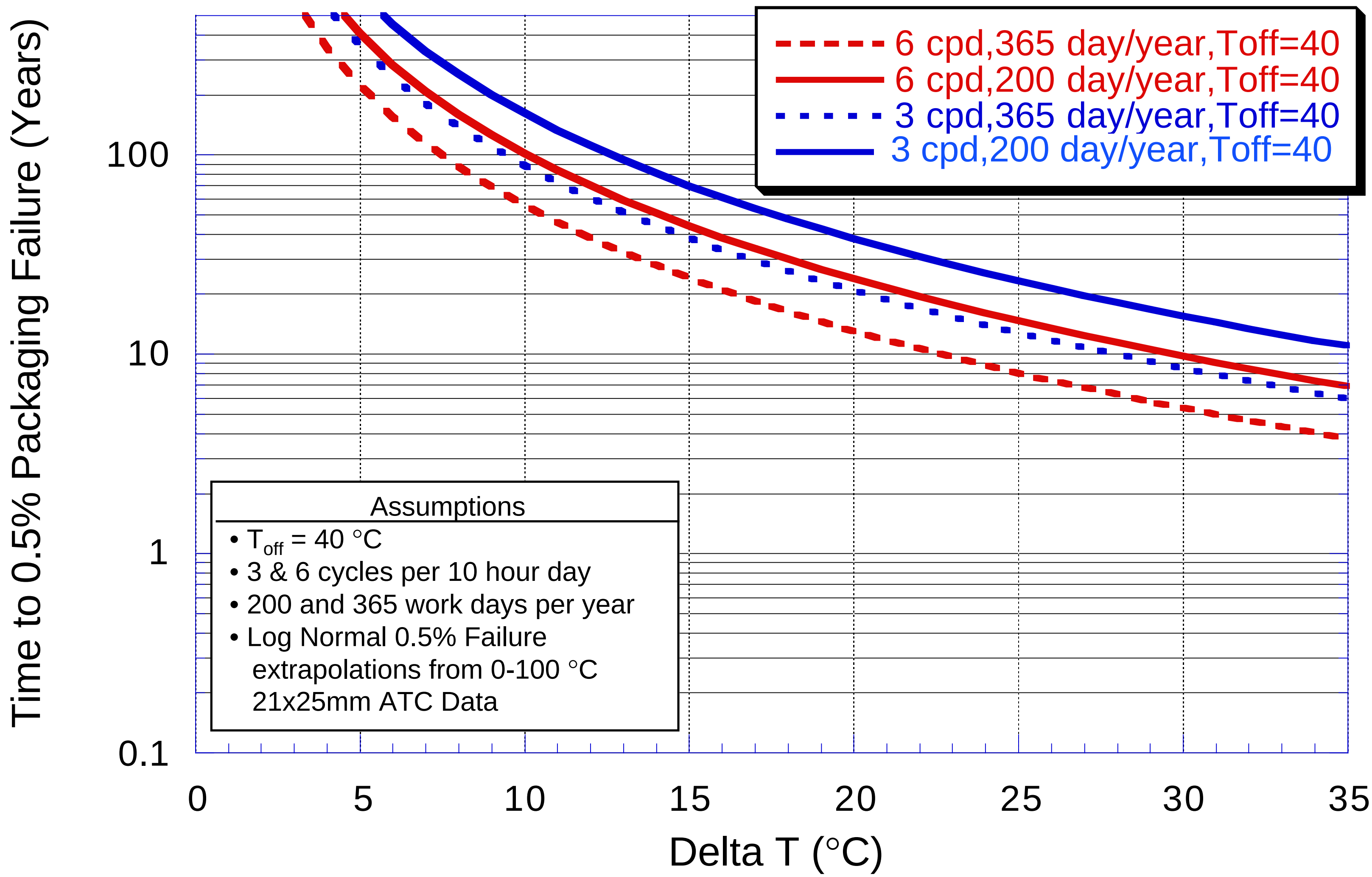
21x25 mm, 1mm Thick CBGA Solder Joint Reliability

Norris-Landzberg Predictions from Accelerated Thermal Cycling Data



21x25 mm, 1mm Thick CBGA Solder Joint Reliability

Norris-Landzberg Predictions from Accelerated Thermal Cycling Data



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Customer Applications Support 512-933-7289

10 April , 1998