Predict, Preferences

James A. Harter

Alexander V. Litvinov

LexTech

LexTech, Inc.

8285 Rhine Way

Centerville, OH 45458

User Preferences

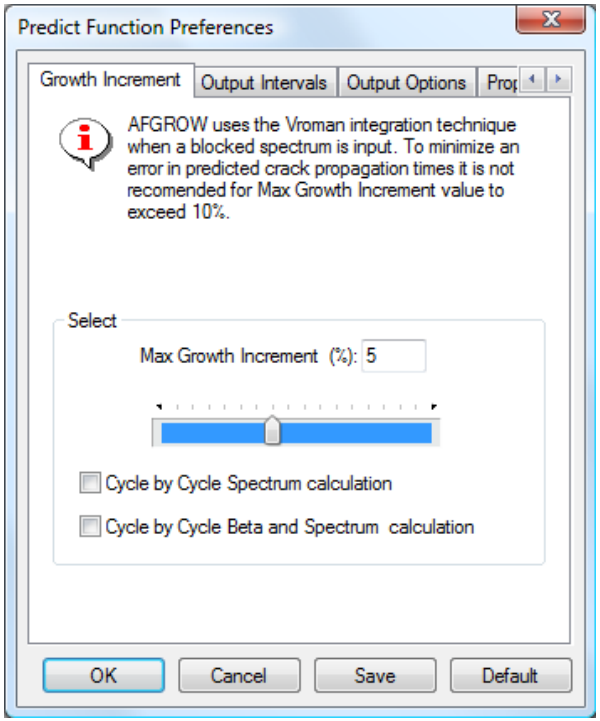
Preferences Are User Selected Options to Control the Life Prediction Process and Output Format

There Are Seven Preference Tabs

- Growth Increment
- Output Intervals
- Output Options
- Propagation Limits
- Transition Options
- Lug Boundary Conditions
- Crack Closure Factor

Growth Increment

(Vroman Increment)

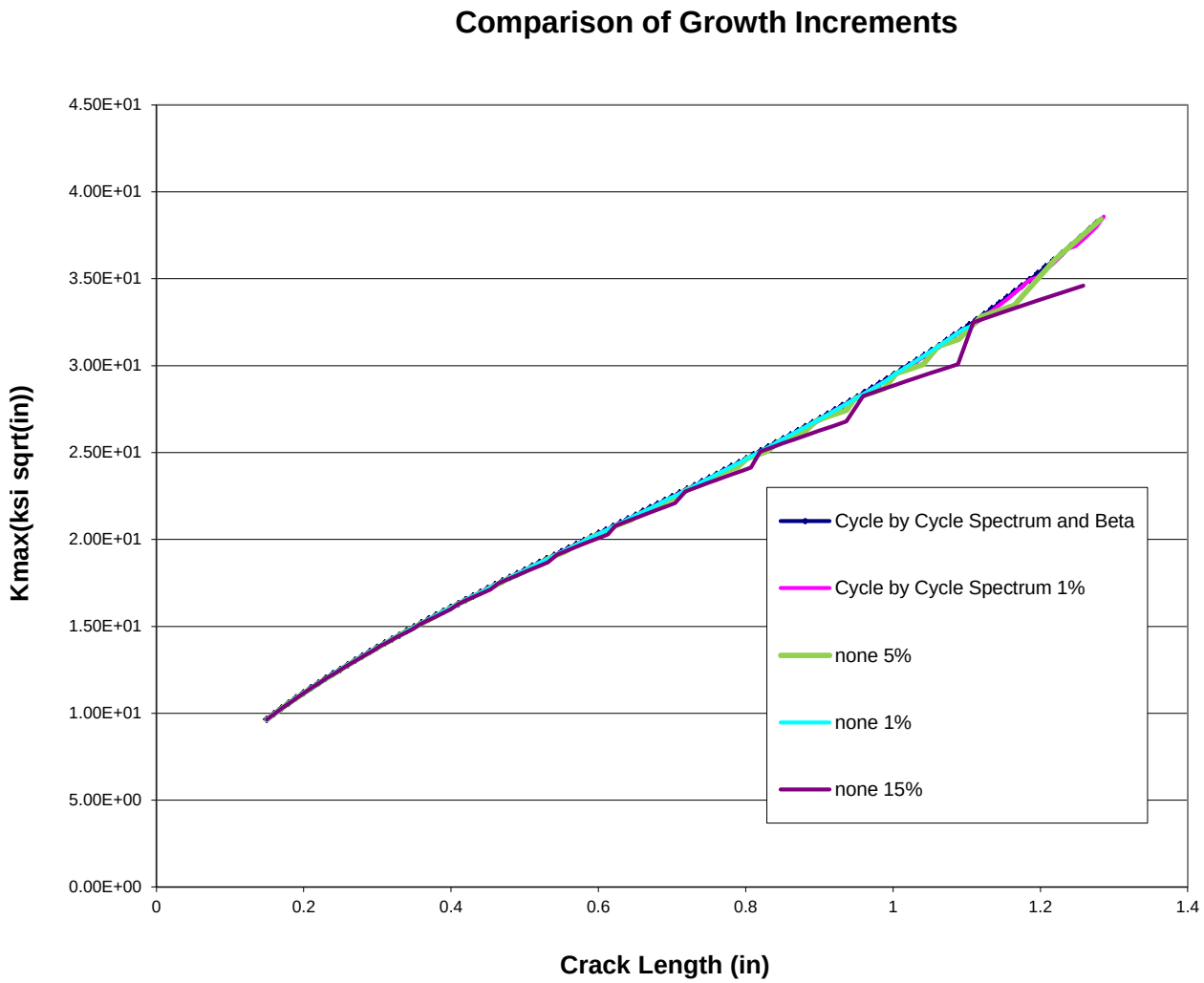


3 choices:

- Max Growth Increment (0.25 – 15%)
- Cycle by Cycle Spectrum Calculation (0.25 – 5%)
- Cycle by Cycle Beta and Spectrum Calculation

Variation in Kmax

Due to the Vroman Increment



$$K = \sigma \sqrt{\pi x}\ \beta$$

Cycle x Cycle Spectrum:

Crack Length Updated for Each Cycle

Cycle x Cycle Spectrum & Beta:

Crack Length & Beta Updated for Each Cycle

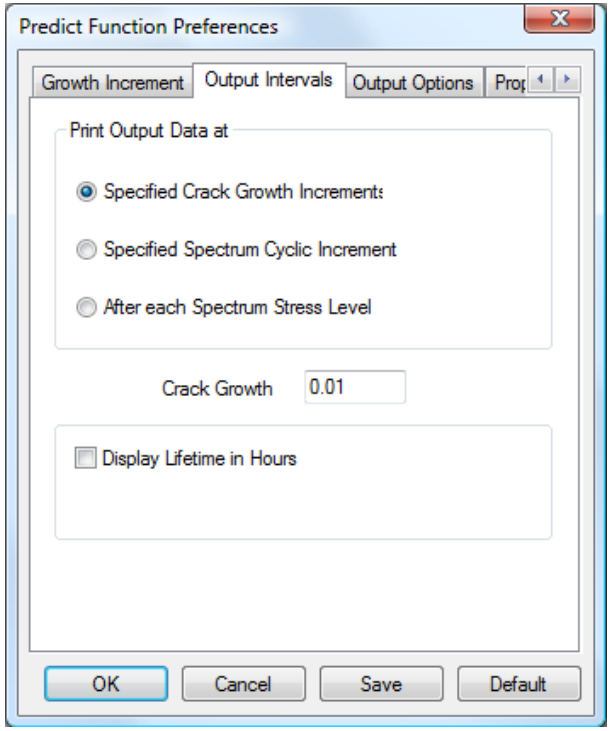
Output Intervals

Print Output Data at:

- Specified Crack Growth Increments
- Specified Spectrum Cyclic Increments
- After Each Spectrum Stress Level

Display Lifetime in Hours

- Input Hours/Pass

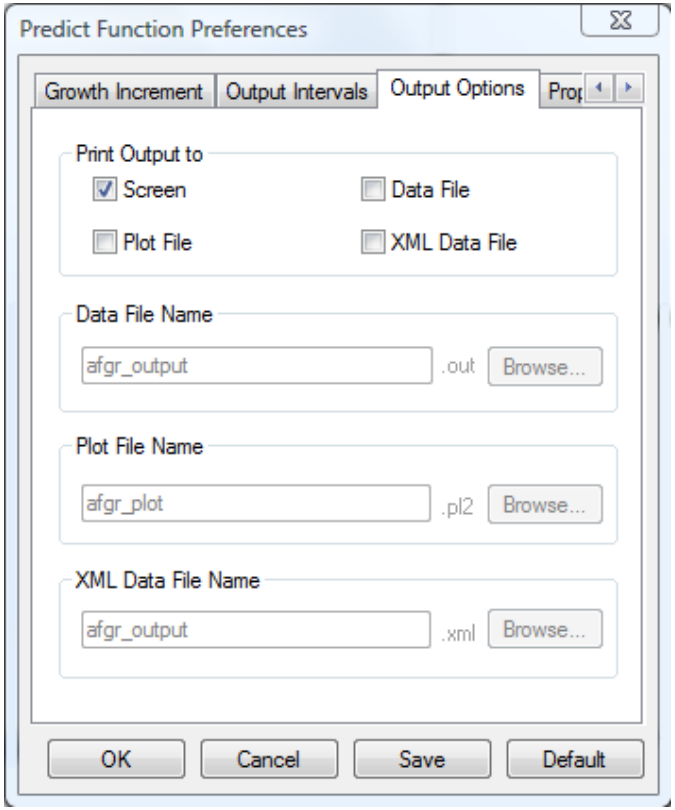


Output Options

Print Output to:

- Screen
- Data File (Text Output)
- Plot File (Single Header)
- XML Data File

Default File Names Are Automatically Overwritten



What is the Purpose of the XML File?

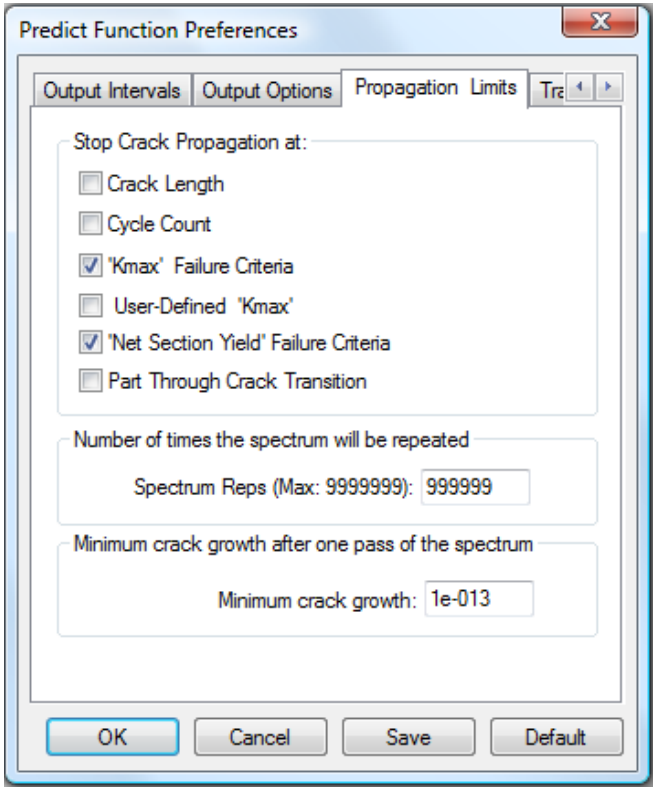
XML file format uses a tagging system that identifies the type of data being stored. This allows the information to be used in many different ways that can be very useful:

- **Identifies the data in a standardized manner**
- **The XML format is widely used (i.e. Microsoft Word, Explorer, etc.)**
- **It is very easy to insert new items in the file as new capabilities are added**
- **Facilitates post-processing of the data**
- **XML output files can also be used as AFGROW input files**

Propagation Limits

Stop Crack Propagation at:

- Crack Length (C-Dimension)
- Cycle Count
- ‘Kmax’ Failure Criteria
- User-Defined ‘Kmax’
- ‘Net Section Yield’ Failure Criteria
- Part Through Crack Transition



Default – ‘Kmax’ and ‘Net Section Yield’

Propagation Limits

Number of times the spectrum will be repeated

- 999,999 (Default)
- 9,999,999 (Max)

Minimum crack growth after one pass

- 1e-013 inch/cycle (English) default
- 2.54e-015 m/cycle (Metric) default

Transition Options

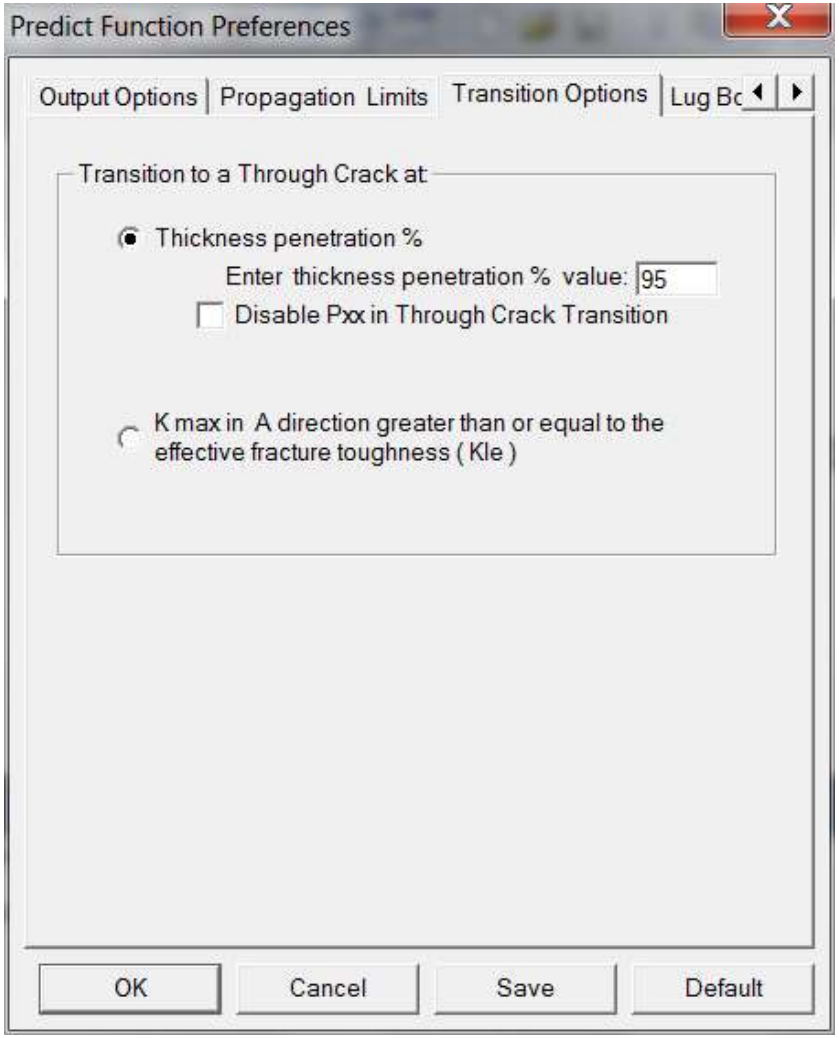
Transition Criteria:

- Thickness Penetration (%)

  95% (Default)

  Option to disable transition based on Pxx criterion

- Kmax > KIe (in the A-direction)

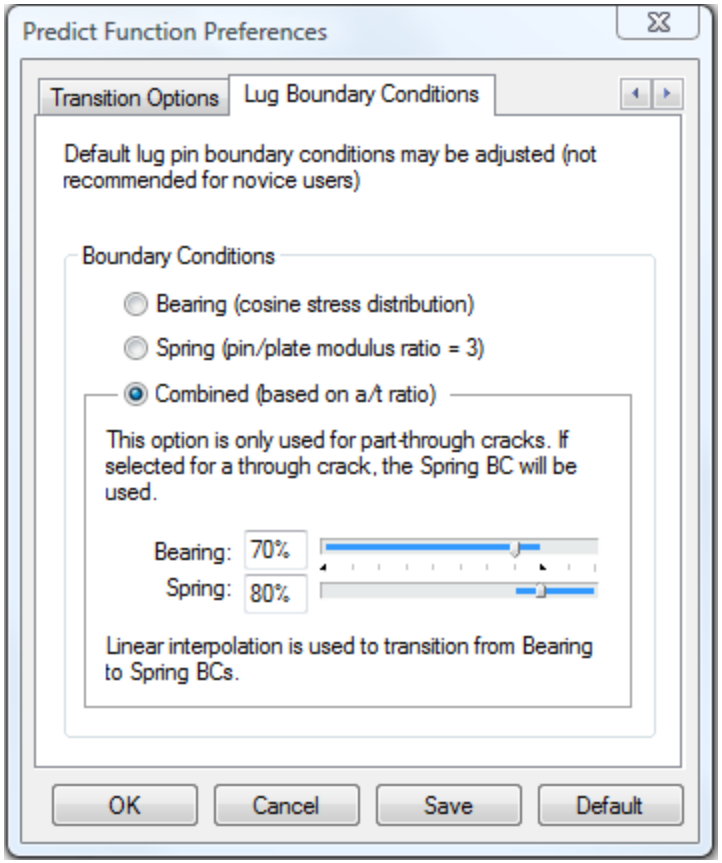


If transition is predicted due to the Kmax criteria in the A-direction, AFGROW automatically transitions to a through crack and re-checks Kmax in the C-direction

Lug Boundary Conditions

Boundary Condition Options:

- **Bearing (Cosine Stress Distribution)**
- **Spring (Pin/Plate Modulus Ratio = 3)**
- **Combination (Based on a/t)**



Bearing and Spring Pin Load FEM Boundary Conditions Were Used to Develop the AFGROW Lug Solutions

Lug Boundary Condition Help Info

The stress intensity solution for the lug geometry is a tabular look-up solution that was generated using the p-version finite element program, StressCheck. Verification testing (performed at Purdue University on aluminum lugs with steel fasteners) indicated that the Spring BC matched the results for through-the-thickness cracks, and the Bearing BC worked best for most corner cracks. The Bearing B.C. allows the hole to deform. This may explain the agreement with the corner cracked tests performed at Purdue, since the average pin clearance was 0.002 inches. While much more work is required to be certain, the AFGROW default case has been set to begin transition from the Bearing to the Spring BC at 70% of the specimen thickness. For through-the-thickness cracks, the default condition is to use the Spring BC.

There is a significant difference between the two BCs. No data were available for pin/plate materials other than the testing performed at Purdue. It is left to the user to determine which BC is more appropriate for any given life prediction. If the user is confident of a neat pin fit, the Spring BC may be a good choice to give a longer predicted life. However, as noted above, this flexibility is intended for experienced users.

Crack Closure Factor

Crack Closure Factor (βr):

Used by NASGRO to lower the beta-value for part-through cracks at any free surface to attempt to make better predictions of the crack shape

$$K = \sigma\sqrt{\pi\ crack\ Length}\ \beta\ \beta_r$$

if R = 0 $\boldsymbol{then}\ \boldsymbol{\beta r}$ = 0.9

else

$$\boldsymbol{\beta r} = \mathbf{0.9} + \mathbf{0.2}\ \boldsymbol{R^2} - \mathbf{0.1}\ \boldsymbol{R^4}$$