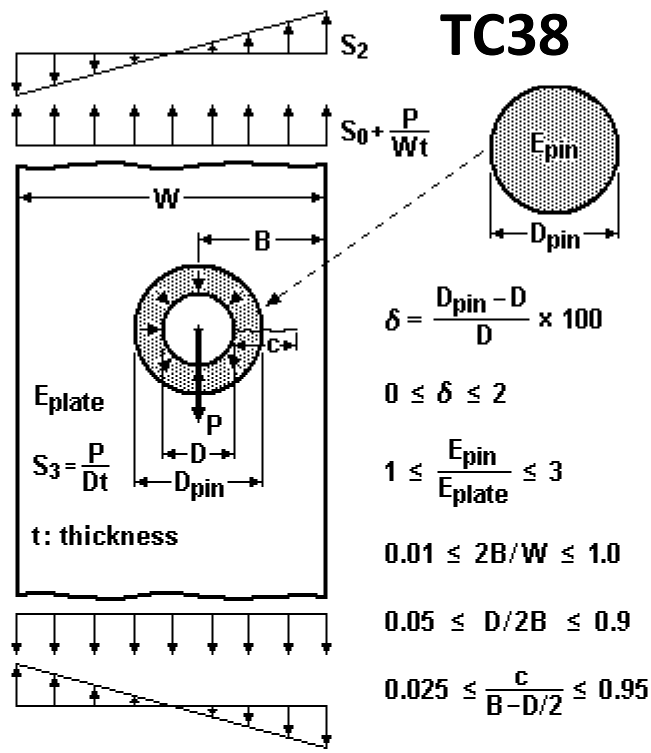
October 12, 2021

NASGRO v10.0 Release Notes

New and Improved Stress Intensity Factor (SIF) Models:

- **New Model for a Through Crack at an Interference Fit Hole (TC38):**

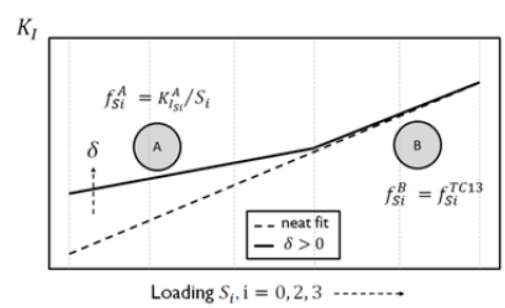
Crack case TC38 is a new solution for a through crack at an off-center hole in a finite width plate with an interference fit pin. The pin diameter in TC38 is larger than the plate hole. The crack is normal to the plate edge; it is located on the short ligament side of the offset hole and propagates along the smaller net-section of the two formed by the hole. This geometry is similar to the through crack in plate with a neat-fit pin (TC03, TC13) solution, although not all geometries supported by TC13 are available in TC38. TC38 is a look-up table solution that does not allow residual stresses or stress gradients defined on the crack plane. TC38 supports configurations with different pin and plate materials.



This solution differs significantly from existing cases. The presence of interference fit leads to a non-zero initial stress intensity factor at the crack tip before any remote/pin loading is applied. Under external loading, the solution is nonlinear and features two distinct phases of behavior: A) an active interference range (Phase A), in which the interference fit reduces the rate of increase for SIFs with loading and, B) once a certain load threshold is reached, the solution reverts to the through-crack in a neat fit pin-plate solution, TC13 (Phase B).

TC38 supports loading by *S*0, remote uniform tension, *S*2, remote in-plane bending and *S*3, pin-loading-induced bearing stress.

Additional detail on the development of this new model is contained in Appendix C of the Reference Manual, including a description of the 2500 finite element models used in the verification process.

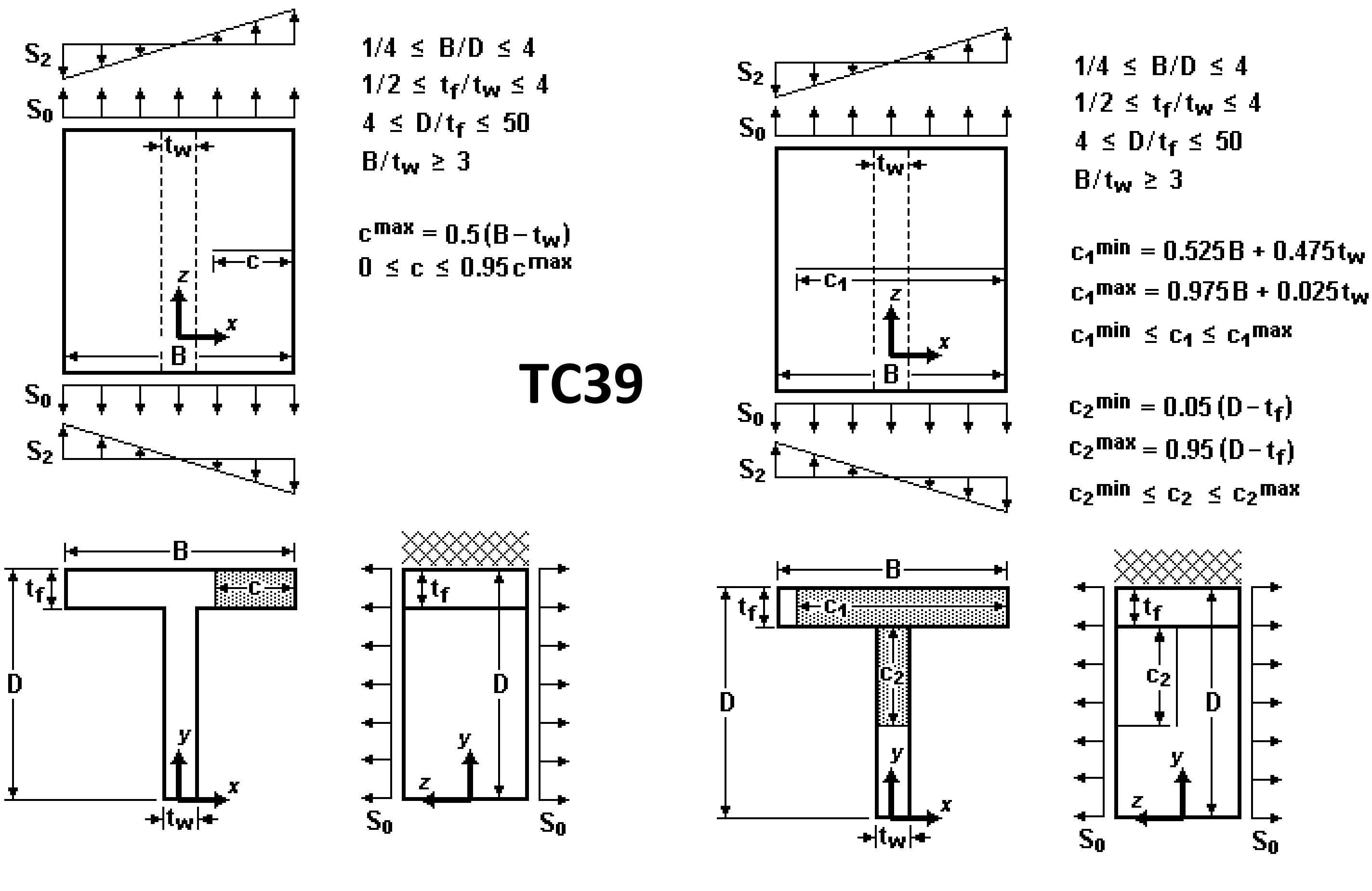


Nonlinear Stress Intensity Factors in TC38

- **New Model for a Through Crack in a T-section (TC39):**

Crack case TC39 is a new solution for a through thickness edge crack in a structural member with a cross-section idealized as a generic T-section. This solution assumes that cracks start in the flange edge and advance towards the intersection of the flange with the web. At this intersection, the crack bifurcates into two cracks with one located on the flange and another located on the web. These two cracks then grow independently. There are two possible loadings due to restraint on the top of the flange: remote uniform tension and remote bending about the Y -axis. This solution restrains the crack front to be straight and perpendicular to the free surface throughout fatigue crack growth. This solution does not support cracks within some distance of the intersection.

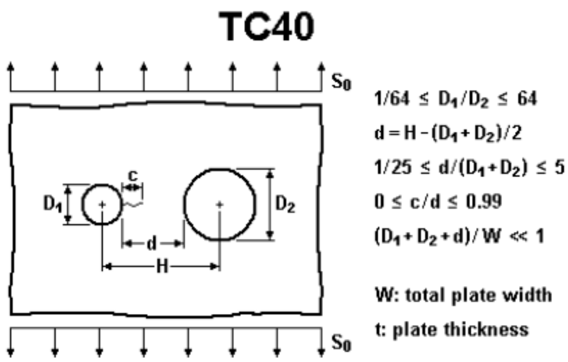
Additional detail on the development and verification of this new model is contained in Appendix C of the Reference Manual.



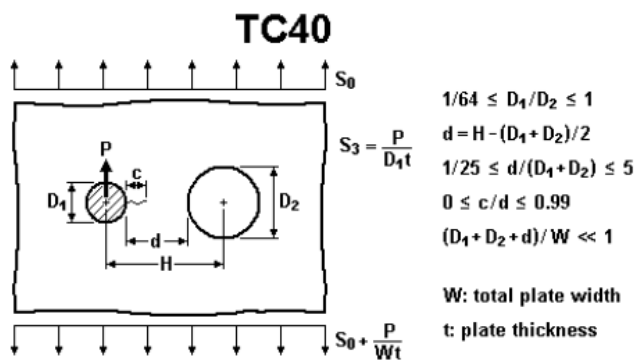
(a) Crack Front in Flange **(b) Crack Fronts in Flange and Web**

- **New Model for a Through Crack Between Two Unequal Holes in Wide Plate (TC40):**

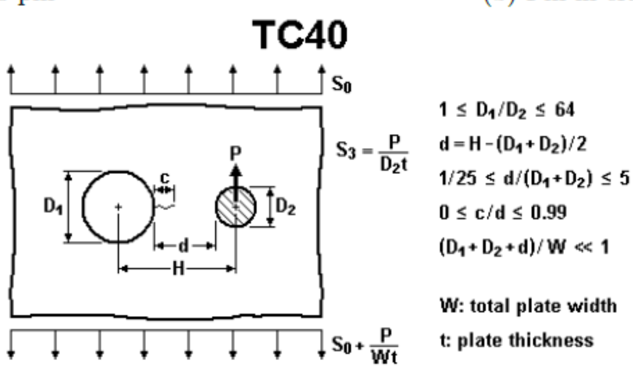
This new model represents a straight-through crack located between two unequal diameter holes in an infinitely wide plate. The crack originates at the edge of the first hole and propagates towards the second hole. This crack case has the following three pin location configurations: (1) no pin (this is the default case), (2) pin in the cracked hole, and (3) pin in the uncracked hole as shown below. If a pin is present, it is always assumed to be located in the smaller hole. All three configurations of TC40 support remote uniform tension, S_0. SIF values with S_0 are different in the three configurations. The configurations with a pin support pin-induced bearing stress, S_3.



(a) No pin



(b) Pin in cracked hole



(c) Pin in uncracked hole

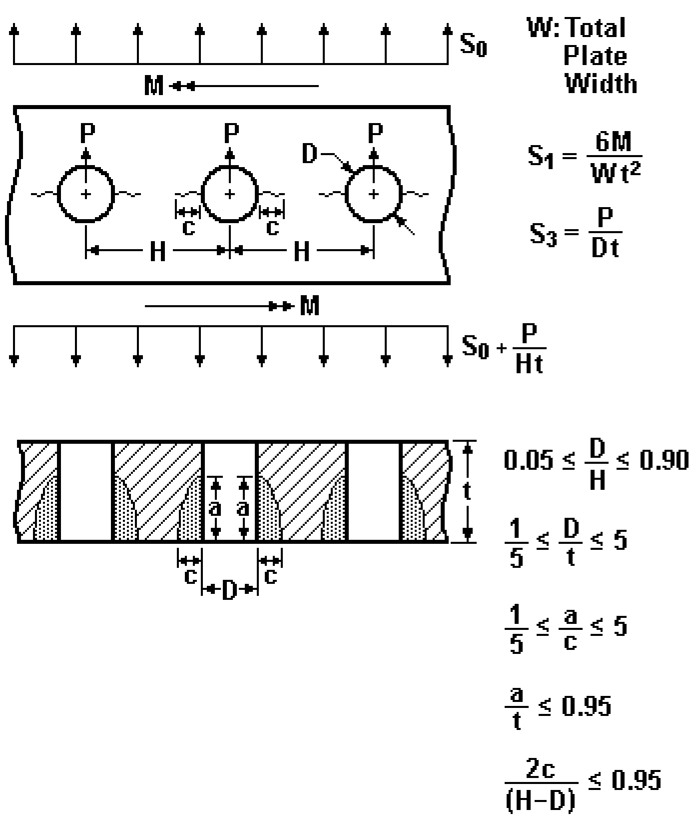
Additional detail on the development and verification of this new model is contained in Appendix C of the Reference Manual. A combination of StressCheck and Abaqus finite element analysis models were used to compute the SIF solutions. Future work is planned to introduce finite plate width and hole offset effects into the TC40 solution.

- **New Model for Corner Cracks at Holes in Plate with Row of Holes (CC24):**

Crack case CC24 represents two equal quarter-elliptical corner cracks located at all holes in a row of holes making it somewhat similar to TC05. This solution features remote tension loading, remote in-plane bending, and pin loading. Corner cracks (CC24) transition to through-thickness cracks (TC05) as *a/t* reaches the upper limit. When this transition occurs, NASGRO will set *D/B* = 0 (with *B* defined as the plate height in TC05) in TC05 as this value (and only this value) permits uniform tension loading in TC05. Out-of-plane bending will be ignored subsequent to the transition to TC05.

CC24 employs a nonlinear regression model based on a large database of 3D finite element solutions to define geometry correction factors. Additional detail on the development and verification of this new model is contained in Appendix C of the Reference Manual. In the future, the solution will be expanded to address one or two corner cracks at ONE hole in a row of holes.

CC24

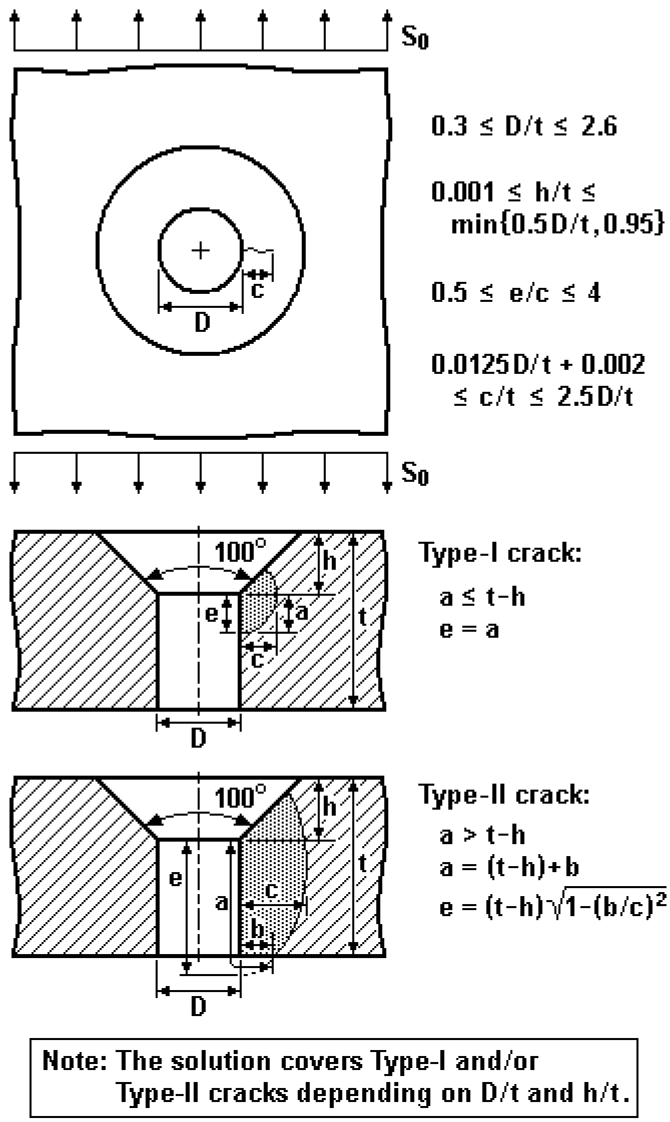


- **New Model for Corner Cracks at Countersunk Hole in Infinite Plate (CC25):**

CC25 is a new stress intensity factor model for a corner crack at the knee of a countersunk hole in an infinite plate subjected to remote tension. The crack front of CC25 is assumed to be part of an ellipse with its origin located at the knee of the countersink in an infinite plate. The major and minor axes of the ellipse are *c* and *e* as shown below. Two crack configurations are considered, labeled type-I and type-II, depending on *D/t* and *h/t*. The *a*-tip (the lower tip) location distinguishes the two types of cracks from each other. The *a*-tip of type-I cracks is always on the hole edge. The *a*-tip of type-II cracks is always on the faying surface. For both types, the upper tip may be on either the countersink or the upper surface, depending on the crack geometry.

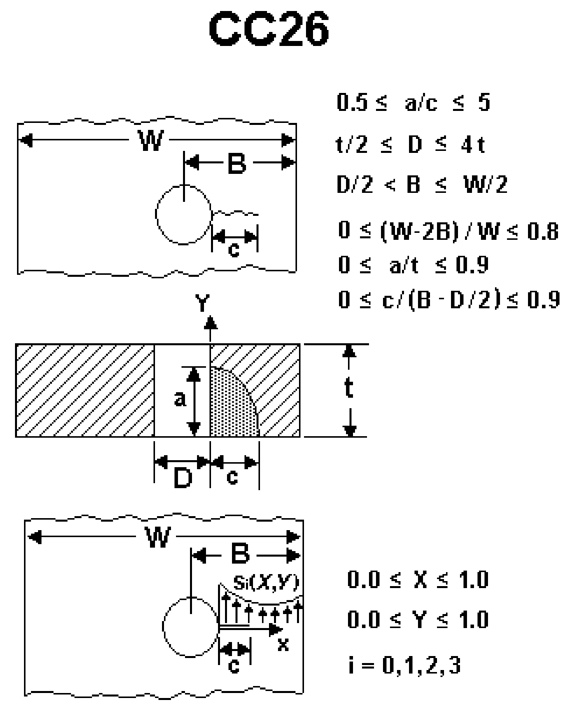
CC25 to TC03 transition occurs when $c>2.5D$ and $a\geq(t-h)$. After transition, the countersink of CC25 is ignored. Additional detail on the development and verification of this new model is contained in Appendix C of the Reference Manual.

CC25



- **New Model for Corner Crack at Hole (Offset) in Plate – Bivariant WF (CC26):**

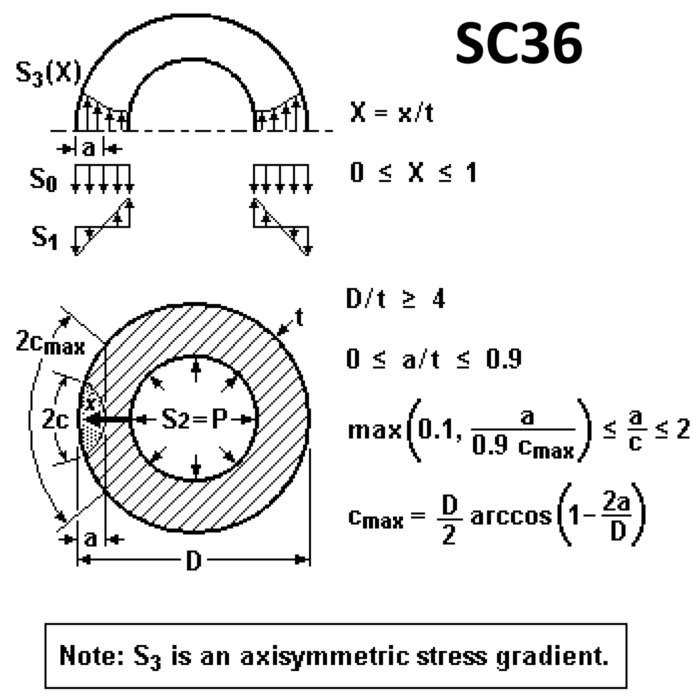
Crack case CC26 is a new, more accurate version of CC10. The development was motivated by a verification study that showed that CC10 was a potentially overly conservative solution for many geometries, and slightly non-conservative for vanishingly small cracks. CC26 is based on the same underlying formulation, but incorporates roughly ten times the number of reference solutions, with higher fidelity than the previous solutions. CC26 supports similar geometric limits as those for CC10. At this time, CC10 has been retained in NASGRO and not yet moved to the superseded solution category.



CC26 is a bivariant weight function (WF) solution for a quarter-elliptical corner crack at a hole in a plate. This solution supports user-defined bivariant stress fields that represent the result of remote loadings on the crack plane. Users can also input either residual stress fields or define compounding factors, though not both simultaneously. In NASGRO v10.0, CC26 transitions to TC13 if the crack tip breaks through the thickness. This solution is available in NASFLA, NASSIF, and NASCCS.

- **New Model for External Surface Crack in a Sphere (SC36):**

Crack case SC36 is a new weight function (WF) solution for an external circumferential surface crack in a sphere. SC36 employs a new geometric parameterization for the crack front that maintains a semi-elliptical crack front for all allowable crack configurations. (This parameterization is identical to that used for SC34 and SC35.) It positions the crack to intersect the free surface at a normal angle and supports two degrees of freedom for the crack front. SC36 employs a new set of reference solutions with much higher fidelity than existing solutions such as SC03. This new solution enables nonlinear stresses applied across the thickness as either a user-defined service stress or as a residual stress. As a result, SC36 provides a wider range of options than SC03 even though they share the same nominal description. SC36 is limited to cracks on the exterior of the sphere and does not transition to any other crack cases.



The SC36 solution supports loading by S_0, S_1, S_2, and S_3, defined as follows:

S_0: Uniform (membrane) tension across the thickness;
S_1: In-plane (linear) bending across the thickness;
S_2: Internal pressure applied uniformly to interior surface of the sphere;
S_3: User-defined axisymmetric stress gradient normal to the crack plane varying from the internal surface to the external surface (input in tabular form).

Since SC36 is a WF solution, it can accept residual stress distributions. Residual stress distributions are considered to be axisymmetric and can be input in a similar manner as the S_3 loading (in tabular form) or as a polynomial function.

A matrix of nearly 400 geometries was analyzed and used to develop the reference solutions for the SC36 WF development. Additional detail on the development and verification of this new model is contained in Appendix C of the Reference Manual. A similar model for an internal surface crack in a sphere is under development.

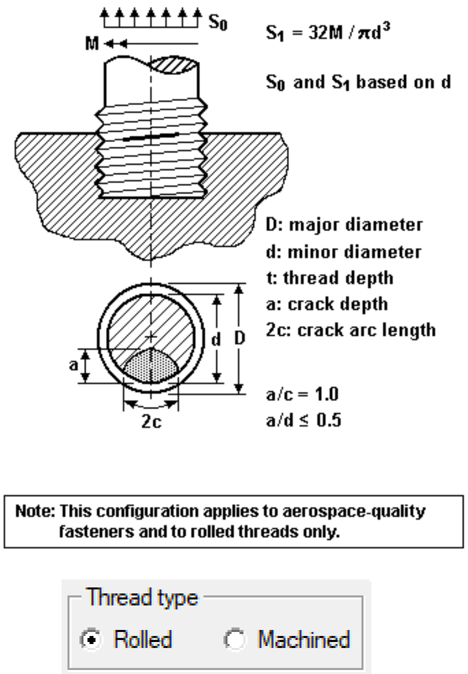
- **Addition of In-Plane Bending (S_2) for CC16, Based on CC08**

The corner crack at a hole model based on the Fawaz-Andersson solution (CC16) has been upgraded to accommodate an applied in-plane bending stress, S_2. The in-plane bending solution, which applies to the one-crack option only, is implemented in version 10.0. The S_2 solution of CC16 is borrowed from CC08 and identical to the S_2 solution of CC08. The S_2 solution is implemented in a "flexible" way, which allows the user to include or exclude S_2 in the analysis. In order to include S_2, the user needs to check a checkbox "Include S_2" on the CC16 Geometry tab. Note that the solution limits of CC16 with S_2 included can be significantly reduced when the crack is on the long ligament side ($B > W/2$). This flexible approach prevents the solution limits from being reduced for cases when S_2 is not applied.

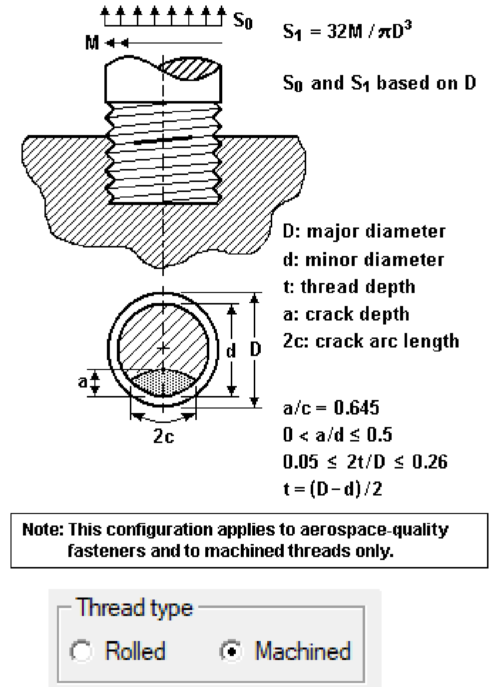
- **Addition of New Machined (Cut) Thread Option for Semi-Elliptical Circumferential Surface Crack in Threaded Solid Cylinder (SC08)**

In previous versions of NASGRO, SC08 was applicable to rolled threads only and the crack front shape was constrained to be a circular arc with a fixed aspect ratio $a/c = 1$. For v10.0, solutions were developed for machined threads with a surface crack having a fixed aspect ratio $a/c = 0.645$. The rolled thread option is the default and the machined thread option can be chosen using a radio button in the GUI as shown below.

SC08



Rolled Thread (default)



Machined Thread

Additional detail on the development and verification of the SC08 machined thread model is contained in Appendix C of the Reference Manual.

- **Expanded Solution Limits and Other SIF Model Improvements:**

  - ***Corner Crack(s) at a Hole based on Fawaz-Andersson Solution (CC16 & CC17)***

    The lower limit of B/D was extended down to 0.75 (from 1.0) for crack cases CC16 and CC17 under remote tension (S0), out-of-plane bending (S1) and pin load (S3).

    In addition, the limits for crack sizes are extended:
    For both CC16 and CC17, the limit of *c* is extended from $(D+c)/(2B-c) \le 0.7$ to $(R+c)/B \le 0.9$.
    For CC17, the limit of *c1* is extended from $(D+c1)/[2(W-B)-c1] \le 0.7$ to $(R+c1)/(W-B) \le 0.9$.

  - ***Edge Crack in Stepped Plate (TC35)***

    For the case of bending *unrestrained* at the remote ends:
    The lower limit of W_2/W_1 was extended down to 0.05 (from 0.10).
    The lower limit of t_1/W_1 was extended down to 0.005 (from 0.10).
    There was no change to these limits for the bending restrained condition; however, in the future we plan to do this extension.

New Option for the Failure Assessment Diagram Module (NASFAD)

Background

The NASFAD module enables the user to employ the Failure Assessment Diagram (FAD) approach[1] for assessment of crack-like flaws. This module is somewhat analogous to the existing NASSIF and NASCCS modules in NASGRO, but in "FAD space" and was initially implemented in NASGRO v9.2. The NASFAD module provides the following capabilities as options, with the option listed in bold below being new for v10.0:

- Plot (L_r, K_r) assessment point(s) vs FAD failure assessment line [v9.2]
- Compute critical crack size (for a given load and material) [v9.2]
- **Compute failure stress (for a given crack size and material) [v10.0]**
- Use API 579 Level 3/Method A or B
- Use FITNET Option 1 or 3

The features of the NASFAD module share many of the capabilities contained in other NASGRO modules. These include geometry selection and definition, material selection, stress intensity factor and limit load calculation, and FAD plotting and output. Complete documentation of the NASFAD module is provided in Appendix L of the NASGRO Reference Manual; however, these release notes describe only the new option to compute the failure stress.

Option to Compute Failure Stress in NASFAD

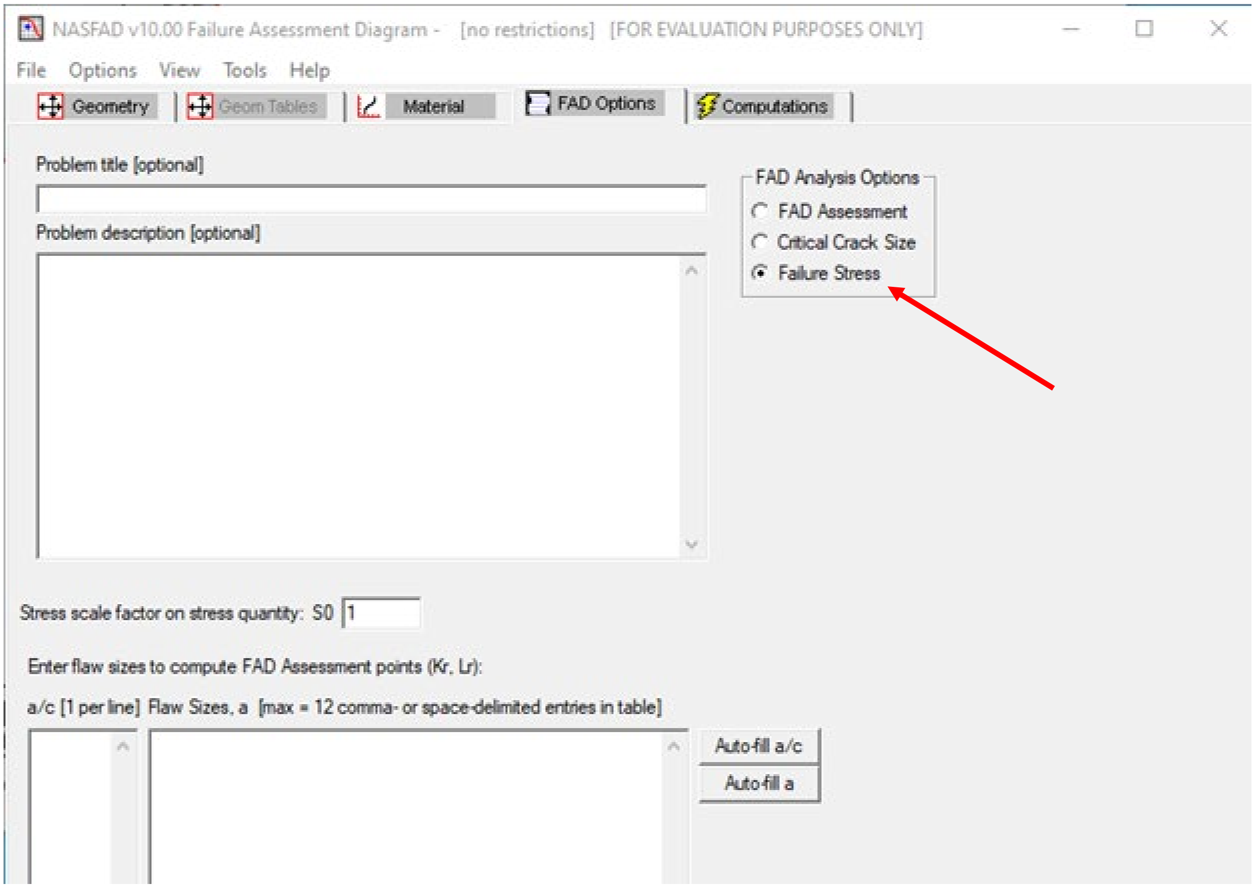
The primary objective of the NASFAD module is to provide the capability to compute and plot assessment points (L_r, K_r) for known (detected or assumed) crack sizes and graphically compare them to the FAD failure assessment line (FAL). Here $Kr = Kapp/Kmat$ = ratio of the applied stress intensity factor to the appropriate material fracture toughness value (such as Kc or KIe), and $Lr = P/P$L = ratio of the total applied load contributing to the primary stresses to the plastic limit load of the cracked structure.

The option to compute the failure stress for a given crack size/shape and material in NASFAD for v10.0 builds on the options developed for v9.2. This option computes the assessment point for a given crack size that lies on the FAL and then back-solves for the stress that would produce this critical point, $(\mathrm{Lr}, \mathrm{Kr})_{\mathrm{critical}}$. The $(\mathrm{Lr}, \mathrm{Kr})_{\mathrm{critical}}$ point is found by computing the intersection of the FAL curve with a curve defined by a number of (Lr, Kr) points in FAD space. These points are computed for a number of different applied stress levels and the curve must go through (0, 0). The numerical method to compute the intersection of these two curves was developed and implemented for NASFAD in NASGRO v10.0. Once the $(\mathrm{Lr}, \mathrm{Kr})_{\mathrm{critical}}$ point is determined, the applied stress corresponding to the critical point can be back-calculated.

The figure below shows the NASFAD failure stress option screen. For the failure stress calculation option, similar to the FAD assessment option, there is an input for crack shape and crack size as

[1] Details of the FAD approach can be found elsewhere, i.e., Appendix X of the NASGRO Reference Manual, API 579-1 / ASME FFS-1, and FITNET.

shown in the figure. Note, however, that specific values of stresses are not specified. Stresses should be input in normalized (tabular) form on the geometry screen or with unit scale factors on the FAD Options screen.

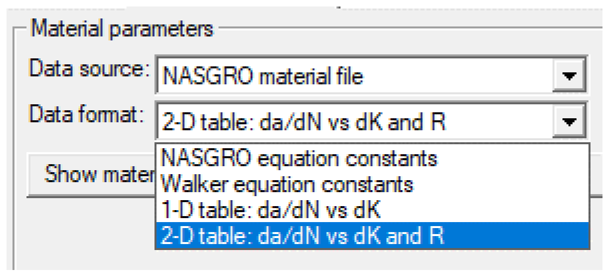


Once the flaw shapes and sizes are specified, the “Computations” tab can be clicked to run the FAD analysis. The output is displayed by the NASFAD GUI output screen and the *out1* file contains the NASGRO header information, problem title, an echo of the crack case and loading information, the FAD method used and material ID and properties information. For the FAD failure stress option, the *out1* file also contains the results of the iteration and convergence to the failure stress. NASFAD generates an *out2* file that contains geometry information for each input crack for the crack case being considered. Each crack analyzed has a separate line in the *out2* file and the number of columns depends on the crack case being analyzed (i.e., the number of crack tips from one to four). There is no plotting output for the failure stress option; the output is simply the failure stress value (or stress scale factor) and the critical point on the FAL, $(Lr, Kr)_{critical}$, for the specified crack size and shape.

<u>**Additions to Material Property Databases and New GUI Features:**</u>

- **New Capability in NASFLA Material Database for Tabular da/dN Data**

  Previously in NASFLA, the NASGRO material file contained fits (parameters) for the NASGRO and Walker equations; however, there were no tabular data sets available in the NASFLA database. A new capability has now been added to the NASGRO material file "Data source" option to allow for the selection of 1-D and 2-D tabular representaions of da/dN vs ΔK data in the "Data format" pull-down menu. This capability now allows for tabular data to be encrypted and stored in the NASFLA material property database (just like the NASGRO equation and Walker equation fits). A screen shot of these choices is shown below.



  Currently, in v10.0, the NASGRO material database does not contain any 1-D tabular data sets. The new 2-D tabular data sets now included in the database are for layered pressure vessel steels and welds as summarized below.

- **New Material Tabular da/dN Data Sets for Layered Pressure Vessel (LPV) Steels in NASFLA**

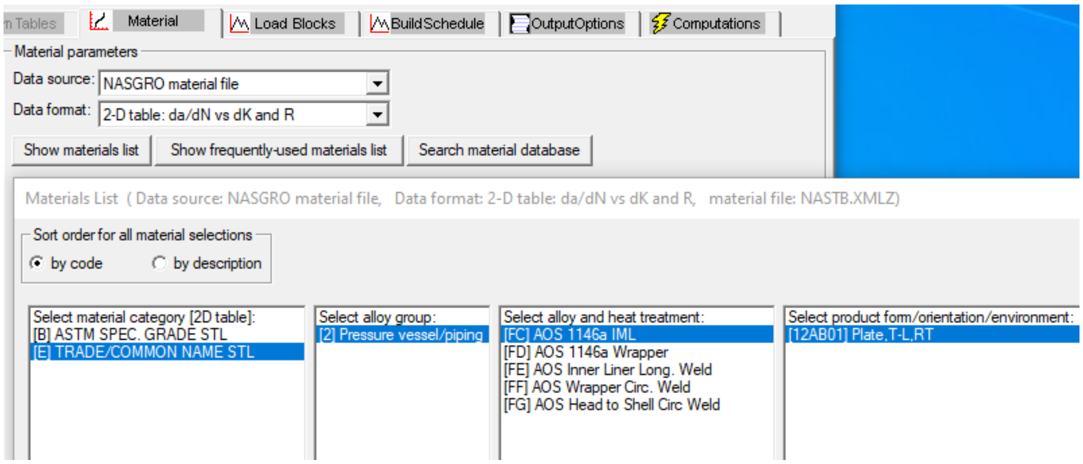
  NASA MSFC has recently performed a large amount of material characterization testing on steels extracted from their fleet of layered pressure vessels. MSFC engineers developed 2-D tabular representaions of da/dN vs ΔK for eight different sets of LPV test data and these are now included in the NASGRO material file as 2-D tabular data sets. NASFLA material IDs for these new materials are listed in the following table.

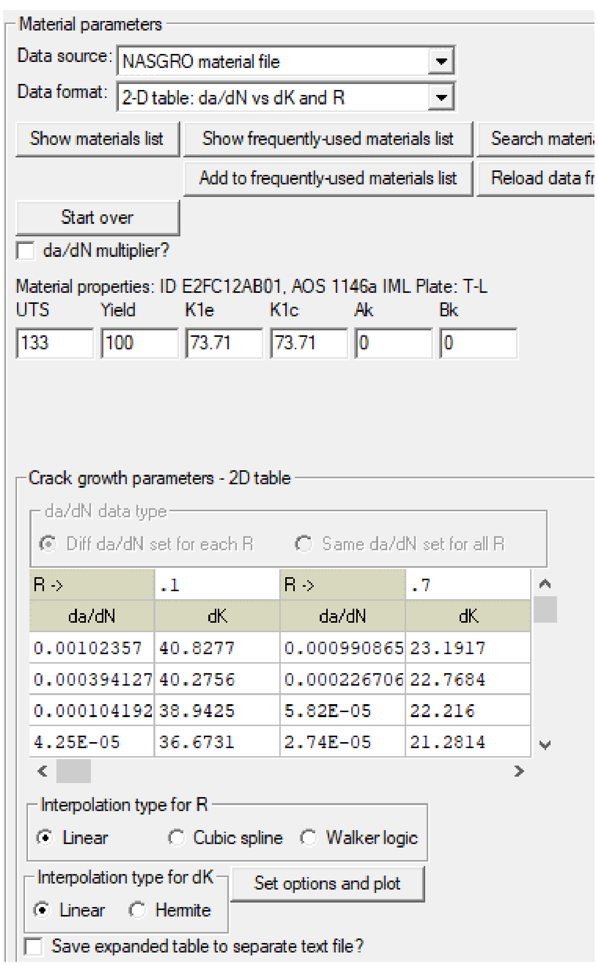
New LPV Material 2-D Tabular Data Sets Available in NASFLA

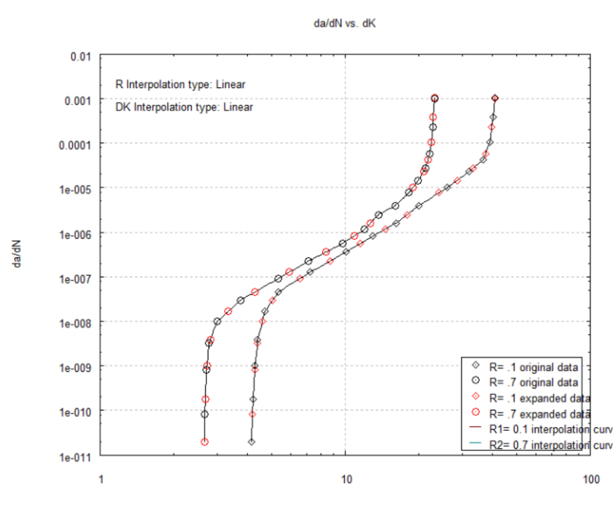
Material ID	Description	R	Orientation
B2IB19AB01	A225 Head	0.1, 0.7	C-M
B2IBA7AB01	A225 Head-to-shell Weld HAZ	0.1, 0.7	C-M
B5DF11AB01	T-1 Wrapper Layer	0.1, 0.7	L-T
E2FC12AB01	1146a Inner Layer	0.1, 0.7	T-L
E2FD12AB01	1146a Wrapper Layer	0.1, 0.7	T-L
E2FEA1AB01	1146a Inner Weld	0.1, 0.7	T-L
E2FFA1AB01	1146a Wrapper Weld	0.1, 0.7	T-L
E2FGA1AB01	1146a-A225 Head-to-shell Weld	0.1, 0.7	C-M

As an example, below are screen shots of the materials GUI showing a choice of the AOS 1146a inner layer material. Once this choice is accepted, the user can display the material properies from the database and plot the 2-D tabular data in a similar fashion to that used for user-defined tabular data.

Example of Choosing an LPV Material 2-D Tabular Data Set in NASFLA







- **New Material Data Sets for Layered Pressure Vessel Steels in NASMAT**

  Corresponding to the 2-D tabular data sets added to NASFLA and listed above, the raw da/dN vs ΔK data for these eight different IDs were added to the NASMAT database. Eighteen crack growth rate data sets were added to the NASMAT database for these eight new LPV steel material IDs. In additon, 159 toughness data sets were added to the NASMAT toughness database for 37 different LPV material IDs. The table below shows a list of the LPV material IDs now contained in the NASMAT toughness database. All of the LPV material toughness values are upper shelf toughnesses.

New LPV Material Toughness Data Sets Available in NASMAT

Material ID	Description	Orient
B1AX10AB01	A105 Head Nozzle	C-R
B2FB10AB01	A212 Head	C-M
B2IB10AB01	A225 Head	C-M, M-C
B2IB10AB07	A225 Head	C-M
B2IB10AB08	A225 Head	C-M, R-M
B2IBA7AB01	A225 Head-to-shell HAZ	N-P
B2IBADAB01	A225 Head-to-shell HAZ	N-Q
B3AE10AB01	A302 Head	C-M
B5DF11AB01	T-1 Wrapper Layer	L-T
B5DF12AB01	T-1 Wrapper Layer	T-L
B5DF12AB08	T-1 Wrapper Layer	T-L
B5DFA1AB01	T-1 Wrapper Weld	N-P
E2FC11AB01	1146a Inner Layer	L-T
E2FC12AB01	1146a Inner Layer	T-L
E2FC12AB07	1146a Inner Layer	T-L
E2FC12AB08	1146a Inner Layer	T-L
E2FC12AB09	1146a Inner Layer	T-L
E2FD11AB01	1146 Wrapper Layer	L-T

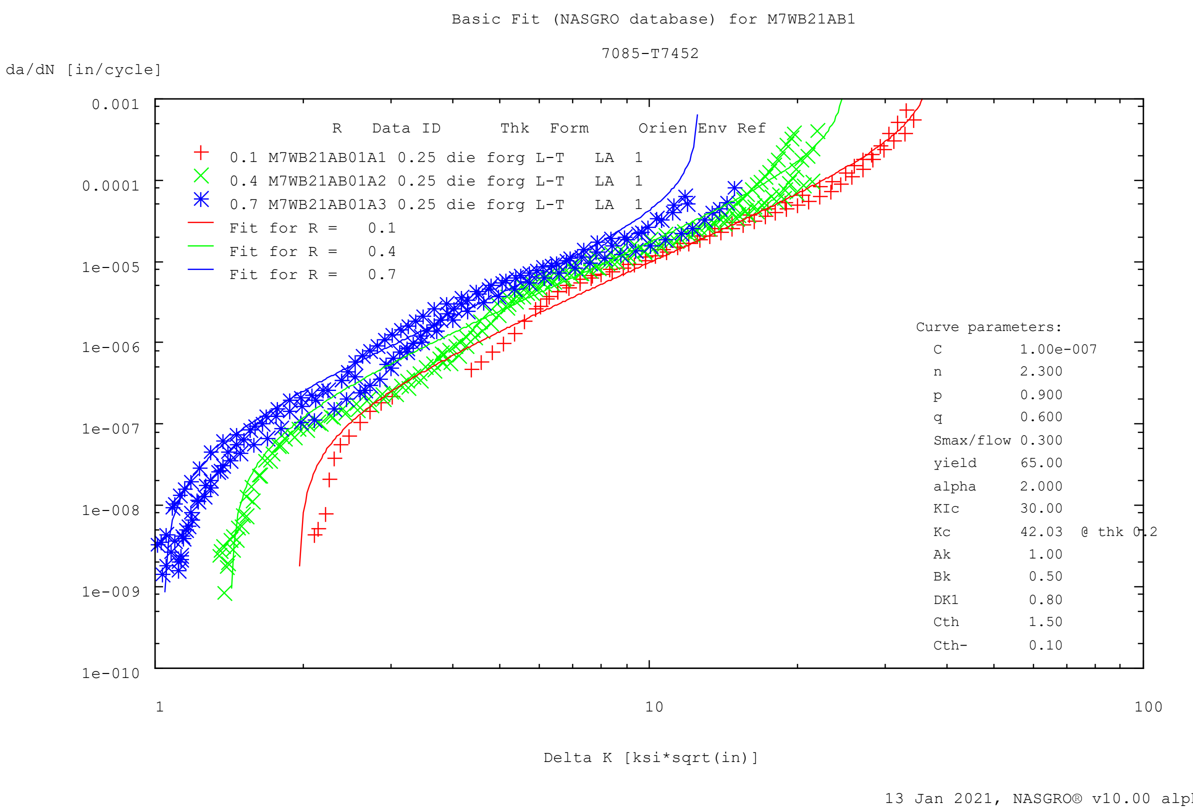
Material ID	Description	Orient
E2FD12AB01	1146 Wrapper Layer	T-L
E2FFA1AB01	1146 Wrapper Layer Weld	N-P
E2FEA1AB01	1146a Longitudinal Weld	N-P
E2FFA1AB01	1146a Wrapper Layer Weld	N-P
E2FFA1AB07	1146a Wrapper Layer Weld	N-P
E2FFA1AB08	1146a Longitudinal Weld	N-P
E2FFA7AB01	1146a Wrapper HAZ	N-P
E2FFA7AB07	1146a Longitudinal HAZ	N-P
E2FFA7AB08	1146a Wrapper HAZ	N-P
E2FGA1AB01	1146 Head-to-shell Weld	N-P
E2FGA1AB08	1146a Head-to-shell Weld	N-P
E2FGA7AB01	1146 Head-to-shell HAZ	N-P
E2GB10AB01	AOS 5002 Head Nozzle	C-R
E2HA11AB01	1143 Inner Layer	L-T
E2HA12AB01	1143 Inner Layer	T-L
E2HA12AB07	1143 Inner Layer	T-L
E2HAA1AB01	1143 Inner Layer Weld	N-P
E2HAA1AB07	1143 Inner Layer Weld	N-P
E2HAA7AB01	1143 Head-to-shell HAZ	N-P

The rectangular and cylindrical orientations are defined as in ASTM E399. For clarification, the hemispherical and weld orientations used above are explained in the following table:

Orientation	Load direction	Crack direction
C-M	Circumferential	Meridional
M-C	Meridional	Circumferential
R-M	Radial	Meridional
N-P	Normal to weld	Parallel to weld
N-Q	Normal to weld	Through thickness

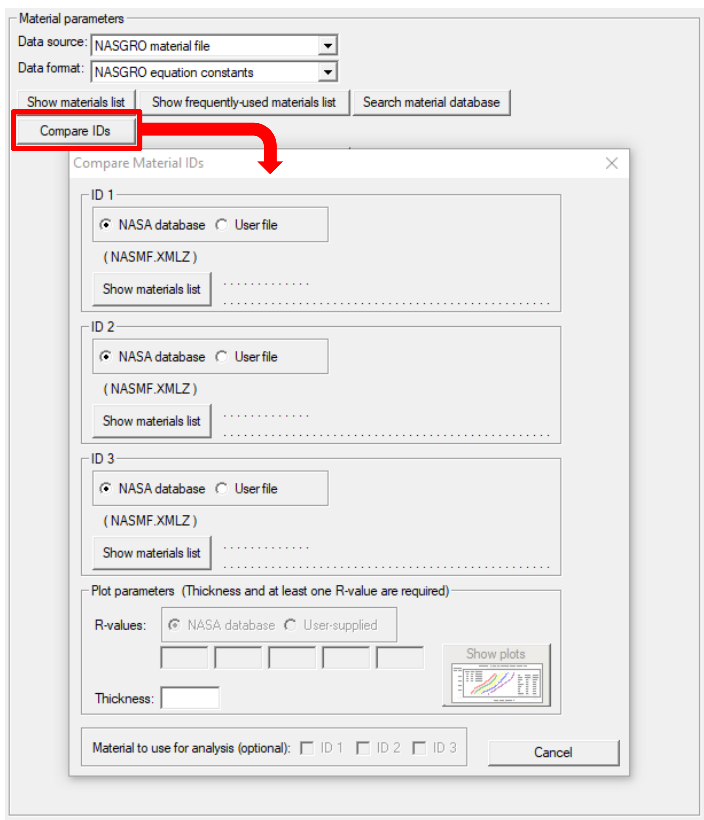
- **New NASGRO Equation Fit for 7085-T7452 L-T Aluminum**

  The previously existing 7085-T7452 data in the NASMAT database (M7WB21AB01A) were used to develop a new NASGRO Equation fit for the L-T direction. This fit is now available in NASFLA and is shown below.



- **New NASFLA GUI Capability to Compare Three Different Materials on a Single Plot**

  Previous versions of NASGRO allowed for comparison of NASGRO equation fits from two different materials within the NASFLA GUI by clicking on the "Compare two IDs" button on the Material screen. The program has been updated to now allow for the comparison of three different materials. The button has been renamed "Compare IDs" and allows for the comparison of two or three IDs, as shown in the screen shot below. The material, stress ratio, and thickness selections are performed identically as in previous versions.



- **New Color Scheme for Plotting Multi-Temperature da/dN Data by Individual R-values in NASFLA**

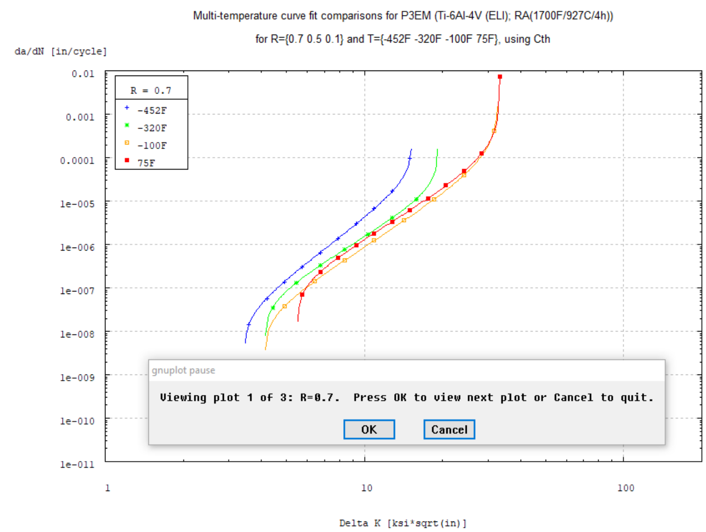
  The NASFLA GUI provides three options for plotting multiple temperature da/dN data. These options are as follows:

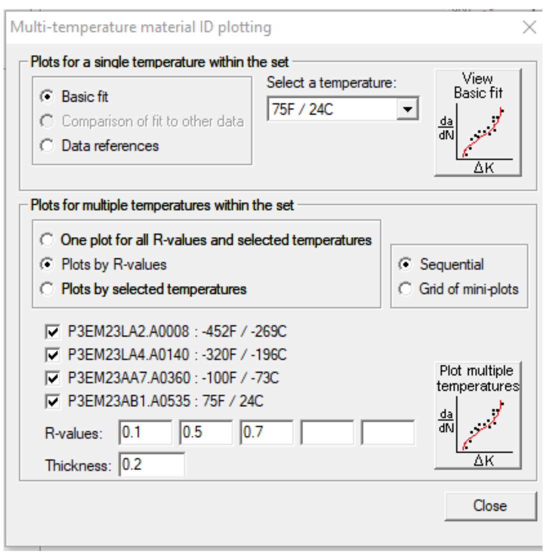
  1. One plot for all R-values and selected temperatures:
     - This option allows the user to plot all data (all temperatures and all R-values) on a single plot.

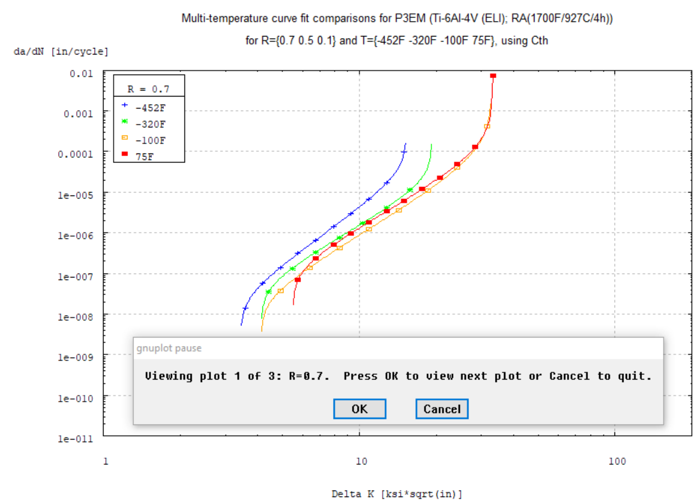
  2. Plots by individual R-values:
     - This option allows the user to plot da/dN data for a single R-value and multiple temperatures. The user can cycle through individual plots for each R or display a grid of individual mini-plots for each R by selecting the appropriate radio button in the GUI.

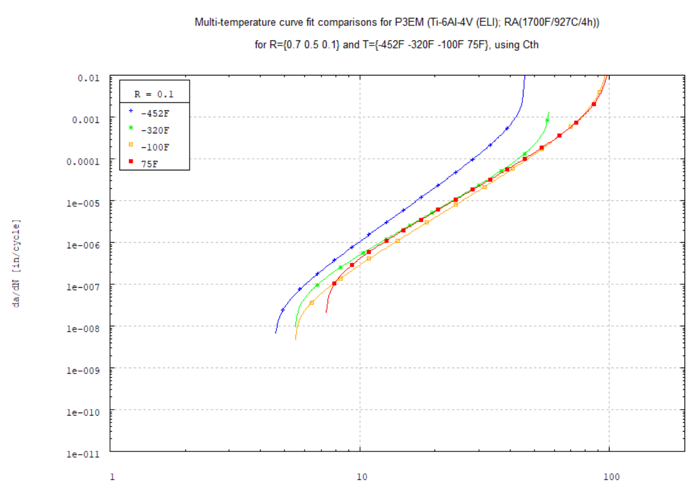
  3. Plots by selected temperatures:
     - This option allows the user to plot da/dN data for a single temperature and multiple R-values. The user can cycle through individual plots for each temperature or display a grid of individual mini-plots for each temperature by selecting the appropriate radio button in the GUI.

  Each of these multi-temperature plotting options was functional in NASGRO v9.2 and earlier versions. For NASGRO v10.0, the *second* option has been modified to plot the data with a color scheme based on the temperature. The plotting options are the same as in previous versions, with the only change being the colors of the lines in the plots. The plots for the second option now show each temperature with a different symbol and color. The colors transition in rainbow order to make the differences between temperatures clearer, with higher temperatures in red gradually transitioning to colder temperatures in blue. An example is shown below for the case of three R-values and four temperatures. In this example, the "sequential" display option was selected creating three individual plots.









NASFLA GUI Displays Plotting Multi-Temperature da/dN Data by Individual R-values showing Temperature-based Color Scheme

Current Limitations in Multi-Temperature Mode with Shakedown and FAD:

An issue has been identified that involves the use of the shakedown option in combination with a multiple temperature mode analysis (this problem does not exist with shakedown in single temperature mode). When the multiple temperature mode was first introduced, shakedown was not enhanced to address all of the complexities of elastic-plastic deformation under changing temperatures. Therefore, even in multiple-temperature mode, shakedown calculations are performed at a single fixed temperature. The temperature used for shakedown calculations is the temperature for which properties were displayed on the Materials tab at the time the run was started (at which time the FLABAT file was written). Currently, logic is not in place to perform an interpolation of temperatures/properties for shakedown.

This limitation will be addressed in the not-too-distant future. A larger effort to upgrade the high temperature capabilities of NASGRO in several different places is underway, and shakedown enhancements are part of that process. These will not be trivial changes, and so it will not be a quick process to ensure these capabilities are correctly implemented.

Note that FAD calculations in NASFLA in multiple-temperature mode have a similar limitation. The current FAD capabilities were designed to work with a single temperature. FAD parameters are not stored at different temperatures. The FAD parameters written to the FLABAT file are those appearing in the GUI at the time the run was started. Some FAD calculations also use the Ramberg-Osgood properties, and these values are handled as described in the earlier description of shakedown. This FAD plus multiple-temperature mode limitation is also planned to be addressed in the future, but non-trivial work will be needed to determine how to modify the FAD formulation appropriately.

Corrections to NASMAT Material Property Database Files and Material IDs:

A review was performed of the file containing the material IDs (*identify.dat*) and the NASMAT da/dN and toughness databases. Updates were made to make them consistent with each other to ensure that all data in the databases can be found using the "Build NASA ID" feature in NASMAT.

- **Updates to *identify.dat***

Forty-three codes were found that are used in the data that were not available in *identify.dat*. Therefore, *identify.dat* was updated to add these codes. Most of the updates were for alloys or heat treats, but there was also one environment and one temperature added.

Action required	ID	Details
Add alloy	B1KA	A148
Add alloy	C3RD	4147 140-160 UTS
Add alloy	C4BF	4330 200-220 UTS
Add alloy	C4BH	4330 220-240 UTS
Add alloy	C4BI	4330 240-260 UTS
Add alloy	C4BJ	4330 260-280 UTS
Add alloy	C4CT	4335V 200-220 UTS
Add alloy	C6CA	52100 (1562F)
Add alloy	D6AA	MIL-S-16113 Type 1
Add alloy	D6BA	MIL-S-22698 Class A
Add alloy	D6CA	MIL-S-23284 Class 1
Add alloy	D6CB	MIL-S-23284 Class 2
Add alloy	E1PB	C-250 (Ann 1675F/Age 900F)
Add alloy	E3DA	MAN-TEN
Add alloy	F4UC	HT 850F/4hr
Add alloy	G8CA	INVAR 36
Add alloy	I3MA	Ni 12-5-3(180) Maraging
Add alloy	J1GA	M2 Aus/T(2175F/OQ/1040Fx3)
Add alloy	J1GB	M2 Aus (2225F)
Add alloy	J1GG	M7 Aus (2200F)
Add alloy	K3AA	SM50A
Add alloy	K5AB	EN30A (220-240 UTS)
Add alloy	K5BZ	BS 111959 Rail Steel
Add alloy	L6AB	Jethane M152
Add alloy	M6DE	6082-T651
Add alloy	M7UA	7129-T5
Add alloy	O2AA	A201-T7
Add alloy	P5HB	160 UTS
Add alloy	P5HC	180 UTS
Add alloy	P5KB	Ti-4-8-6-4-3

Action required	ID	Details
Add alloy	P5SC	Beta-21S (1564F/967F/AC)
Add alloy	R3CB	MP98T
Add alloy	S1BM	C10200 Annealed
Add alloy	S1BT	C10200 Fine Grain OS015
Add alloy	S1BV	C10200 Coarse Grain OS050
Add alloy	S1JB	C11000 1/4 Hard
Add alloy	S1JE	C11000 Full Hard
Add alloy	S1JZ	C11000 Annealed
Add alloy	S1KZ	C15000 Annealed 30% WW
Add alloy	S2IT	C26000 Fine Grain OS015
Add alloy	S8FF	C86500 Mn-Bronze
Add environment	xxxxxxCF	NAPHTHA
Add temp	xxxxxxxx23	1550F air

Seventeen other IDs were modified in *identify*.dat to match codes for data existing in the databases.

File	ID	Data	identify.dat
Kc	B7EB26AB01	EB	EX
Kc	I5FA50AA18	FA	FZ
Kc	I5FA50AB01	FA	FZ
dadN	P3FB10AB01	FB	FX
dadN	P3FB10WB01	FB	FX
dadN	P4EA12AB01	EA	EX
dadN	P4EA12WB01	EA	EX
Kc	P4QB11AA07	QB	QX
Kc	P4QB11AB01	QB	QX
dadN	P5MA10AA16	MA	MX
dadN	P5MA10AF16	MA	MX
dadN	Q2YB12AA18	YB	YX
dadN	Q4AA51AA19	AA	AX
dadN	Q4KZ50AA19	KZ	KX
dadN	Q4KZ50AF19	KZ	KX
dadN	Q6IB50AB01	IB	IX
dadN	S1AB11AB01	AB	AX

- **Updates to the crack growth rate database**

Twenty-one IDs, shown in the table below, were corrected in the da/dN database (*nasadata.dat* and *nasahead.dat*).

Action required	ID	Details
Correct ID	B5AB22W909	W9 should be WL
Correct ID	C7GK11AB01	K should be J
Correct ID	C7GM11AB01	M should be L
Correct ID	C7GN11AB01	N should be M
Delete	E1BN25AB01	Duplicate with incorrect code
Correct ID	E1DB25ABO1	O should be 0
Correct ID	E2FFA1A01	A01 should be AB01
Delete	F3DA10AA18F	No data
Correct ID	F3DA11A109	A109 should be AA19
Correct ID	I1RF1OLA02C	O should be 0
Correct ID	J1G211AB01	G2 should be GA
Delete	M21C11AB01I	Duplicate with incorrect code
Remove right portions of text	M7HA11AB01S	Malformed
Delete	M7TEST00001	Test entry
Correct ID	O1CC72AB01	CC should be CA
Correct ID	P4IB12AA07	IB should be IA
Correct ID	P4IB12AA09	IB should be IA
Correct ID	P4IBD1AA09	IB should be IA
Correct ID	P4IBD1AB01	IB should be IA
Delete	P5FS11AB01	No data
Delete	Q4V816AB01	Duplicate with incorrect code

- **Updates to the toughness database**

Thirty-six IDs were corrected in the toughness database (*nasakcdta.dat*). The majority of these are duplicate IDs, where datasets were entered with IDs that were given the same ID as an already existing dataset.

Action required	ID	Details
Correct ID	E1BF11AB01B01	Change to C01
Correct ID	E1BF11AB01B02	Change to C02
Delete	E1GB201AB01	Duplicate with incorrect code
Correct ID	E2FFA1AB01A	E2FF should be E2FD
Correct ID	E2FFA1AB01B	E2FF should be E2FD
Correct ID	E2FFA1AB01C	E2FF should be E2FD
Correct ID	E2FFA1AB01D	E2FF should be E2FD

Action required	**ID**	**Details**
Correct ID	E2FFA1AB01E	E2FF should be E2FD
Correct ID	E2FFA1AB01F	E2FF should be E2FD
Correct ID	F4MF12AB01A01	Change to A03
Correct ID	G4AH11AB01A01	Change to A07
Correct ID	G4AH11AB01A02	Change to A08
Correct ID	G4AH11AB01A03	Change to A09
Correct ID	G4AH11AB01A04	Change to A10
Correct ID	G4AH11AB01A05	Change to A11
Correct ID	G4AH11AB01A06	Change to A12
Correct ID	GREE11AB01	GR should be G2
Correct ID	M2GC11AB01E01	Change to M01
Correct ID	M2IC12AB01D02	Change to D03
Correct ID	M7GJ15AB01A01	Change to F01
Correct ID	M7HA11AB01C10	Change to C11
Correct ID	M7HB11AB01F06	Change to F10
Correct ID	M7HG22AB01A01	Change to H01
Correct ID	M7HG25AB01A01	Change to A03
Correct ID	M7HH12AB01C02	Change to C09
Correct ID	M7HH12AB01C03	Change to C10
Delete the malformed	M7HJ32AB01E01	Malformed and duplicated
Delete one	M7HJ32AB01G01	Duplicated
Correct ID	M7HM11AB01B07	Change to B12
Correct ID	M7HN31AB01A01	Change to C01
Correct ID	M7HN31AB01B01	Change to D01
Correct ID	P3EA20AB01A01	Change to B06
Correct ID	P3EA22AB01C01	Change to H01
Correct ID	P3EAJ1AB01A01	Change to A02
Correct ID	P3EB21AB01A01	Change to B01
Correct ID	S0BA19AB01A02	Change to B01

NASGRO v10.0a Changes and Fixes by NASGRO Module

February 22, 2021

	Applicable NASGRO Module											
Category	**NASGRO Main**	**Config Control**	**NASFLA**	**NASSIF**	**NASCCS**	**NASGLS**	**NASFAD**	**NASMAT**	**NASBEM**	**NASFORM**	**Users Manual**	**Description**
Addition			X	X	X						X	Enhanced NASFLA inverse calculation of initial flaw size to handle non-monotonic functions of fatigue life vs. initial flaw size.
Change											X	Added crack transition info of CC19 to TC27 in Table 2.2.2 of the main manual and in AppD.
Change											X	NASGRO main reference manual has been converted to LaTeX format. The new content makes use of consistent formatting and equation/figure/table numbering throughout the document. The new document has new features such as active hyperlinking in Table of Contents and references in the text along with the pdf document outline for easier and more convenient navigation through the content. This transition will pave the way for further revisions and updates to the document content in the near future.
Change											X	The following updates were made to AppC: - The crack case names were added to the Table of Contents of the document - Several crack case names were updated to be consistent with the GUI - Added a new crack case section for TC40 - Expanded the SC08 section with new content about the new machined thread SIF solution
Fix			X									Corrected an error in the code that validates data in the parameter analysis (multirun) grid, which erroneously stated that there were missing entries.
Fix		X		X	X	X						Crack case CC08: For the configration of the crack on the long ligament, the upper limit for "c" has been corrected, to be normalized with respect to "B-D/2", instead of "W-B-D/2."
Fix			X									Negative combined load leading to indefinite loop in CC08 NASFLA computation. The revision allows the computation to keep going if the pin load is zero with the assumption that its initiation angle is zero.
Fix			X	X								No error was being issued for geometric dimensions exceeding the CC08 solution limits. The check condition in the routine has been revised for consistency.
Fix			X		X							Fixed a bug in setting the maximum allowed crack size for CC16, which can impact NASCCS calculation and NASFLA inverse calculation of initial flaw size.
Fix			X									Plotting "Beta Factor f" from the 'Computations' tab would not generate a plot.
Fix			X									Materials added in 9.10f were unable to be viewed via the 'view basic fit' plots on the 'Material' tab.
Fix			X									Under a bivariant case with no residual stress, users would see an erroneous error stating the 'residual stress file name is not specified,' blocking computation even though no residual stress was selected.
Fix			X									Crack case SC29: The xmax and ymax values for validating the alt-2D stress input file were not being validated correctly, effectively setting the maximum x value to zero.
Fix			X									Crack case SC19: Shakedown was erroneously shown as an option when tabular data is selected.
Fix				X								Output in OUT1 files for CC23 crack model revised to have consistent line spacing at short ligament and at long ligament. The revision has been implemented.
Fix				X	X							When using metric unit system M1 and loading a US units input file, the units conversion was erroneously skipped, leading to incorrect values.
Fix			X									Switching stress scale factors (SSFs) at t1 and t2 time points leading to different FCG life result from bivariant shakedown. The numerical scheme to support bivariant shakedown with negative load increments was not in place.
Fix					X							Input echo shown incorrectly in old OUT1 file and missing in new OUT1 file when NASCCS with pin load assumption was used.
Fix			X	X								NASFLA was terminating computation with error due to non-existing SIF compounding tables. The requirement had been revised due to the conflict scenario between enabled SIF compounding option and non-existing compounding tables. The program now assumes the SIF compounding with the tip and the stress quantity is disabled if compounding tables contain no data.
Fix			X	X								NASFLA with SIF compounding terminating computation after just one step. Part of the root cause was found from a bug where the crack length used to check against the upper and lower bounds in the compounding table was inconsistent. The immediate termination was from incorrect programmatic re-direction when encountering an error.
Fix			X	X	X							Problem with geometry factors for CC15. Incorrect load flag to invoke the determination of loads as well as a few un-initialized variables were identified.
Fix			X									CC11 output issue relating to c-tip in OUT2 file after transitioning into TC28. The number of columns in OUT2 file has been expanded to include the extra output with c-tip in connection with this scenario.
Fix			X									NASFLA was producing an error when "Perform bolt joint analysis" feature was turned on and multiple load blocks were used in crack cases SC08 and SC14.
Fix			X									NASFLA with centered SC27 crack terminated with error message shown in SCREEN.OUT file. The culprit was an incorrect check for the two-symmetric cracks feature.
Fix			X									When using the parameter analysis (multirun) grid, an error was erroneously issued stating "missing entries in geomety grid" (referring to the multirun grid) due to improper handling of column indices in the error checking code for the grid contents.
Fix						X						NASGLS with SC04 was not working; appearing from inconsistency in batch file format. The inconsistency appeared from the change in NASFLA batch file format to include more versatile features that were not reflected in NASGLS batch file format, while the DLLs did contain the revisions. This inconsistency has been corrected on the DLLs end to prevent further revision on the GUI side.
Fix			X									Undetermined behavior was seen when using the parameter analysis (multirun) grid for more than 25 runs due to an internal storage array that was too small.

NASGRO v10.0a Changes and Fixes by NASGRO Module

February 22, 2021

Category	Applicable NASGRO Module											Description
	NASGRO Main	Config Control	NASFLA	NASSIF	NASCCS	NASGLS	NASFAD	NASMAT	NASBEM	NASFORM	Users Manual	
Fix			X	X	X							Incorrect CC23 surface tip result for corner crack at large ligament when a/c>1 due to un-initialized parameter. This was a bug identified during development for API functions. The adjustment was found not being applied when a/c > 1 for CC at large ligament due to un-initialization.
Fix				X								All zeros for computed correction factors with CC23 at large ligament through the usage of API function calls.
Fix			X									Fixed an error in TC03-to-TC02 transition for K calculation of the post-transition model.
Fix			X	X	X							Anomalous F2 variation for TC35 crack depth on the thick section with initiation crack site on the thin section. The interpolation approach has been revised to remove such irregularities, and a similar approach was also applied for crack initiation site at the thick section.
Fix				X								Plot solutions option for SIFs with TC33 was not working, while working for plotting correction factors (CFs). A conditional check for TC33 in the plot SIF routines was incorrectly programmed.
Fix				X								Crack case CC18: On the 'OutputOptions' tab, the 'plot solutions' output format did not generate a working plot.
Fix				X								Crack cases EC04, EC05, SC19, SC29, SC31, TC34: The "Plot solutions" feature has been disabled for these solutions since the feature is not supported for solutions having more than two DOFs.
Fix			X	X	X							Crack cases SC13/SC14: The bolt major and minor diameter dropdown box on the 'Geometry' tab would duplicate entries when switching unit types.
Fix				X								Crack cases SC17, SC18, SC26, SC27, SC28, SC30, SC32: The NASSIF GUI has been adjusted to not allow "plot solutions" for these univariant surface crack solutions when the crack is offset, since this feature is not supported. Previously, the GUI allowed a run, which would then have no results.
Fix			X	X	X							CC11 results were shown remaining constant for c/W > 0.9. Two issues were reported with this report. One was the constant CC11 issue as c/W > 0.9. The other was that the column showing the Sn values was all zeros. The first was derived from improper interpolation and the second was from the usage of an incorrect flag to invoke the Sn computation because of a revision for new features.
Fix				X								The crack case CC19 upper limit value for "a/t" has been corrected from 0.90 to 0.95.
Fix			X	X	X						X	Implemented net section stress (Sn and G3) calculation for the two-crack option of crack cases TC27 and CC19.
Fix			X									Material tab controls did not display properly when loading an elastic-plastic input file.
Fix			X									Material M7HA11AB1 did not plot 'view basic fit' properly.
Fix							X					Corrected the textual description of the Secondary Stress checkbox, removing the term "cyclic," which was used in error.
Fix			X									Material M2EF11AB1 did not plot 'view basic fit' properly.
Fix			X	X	X	X		X				If user had not previously saved the menu options before, NASFLA/SIF/CCS/GLS/FAD would not automatically save the most recently used directory.
Fix			X									When changing the 'post-transition geometry option' setting in TC28, the material tab layout was not properly being redisplayed, causing overlap of the failure criteria controls.
Fix			X				X					Computed (Lr, Kr) falling outside FAL was designated as SAFE. This inconsistency was uncovered when plotting (Lr,Kr) data points against FAL using the developed NASFAD-failure stress feature. The pitfall was from the approximation for f(Lr) with very small strain where appreciable discontinuities could occur.
Fix			X									Crack case SC34/SC35: When selecting and unselecting residual stress, the OPS checkbox would erroneously stop displaying when 'residual stress' was unselected.
Fix			X	X	X	X						Reselecting the same crack case a second time in the Show Crack Case Library dialog, then changing the tab view, erroneously caused the Geometry tab's geometry grid values to be cleared.
Fix				X								Crack case SC18: The values for cmin and cmax, used for run-time error checking, were not being properly calculated from geometry values.
Fix			X	X	X							Fixed a bug in net section stress calculation for crack case SC05, which resulted in the program crashing for a tiny crack due to floating-point errors.
Fix			X	X	X	X						Crack case SC04: The descriptions for the stresses Si(X): "other stresses" and S0(X): "stress due to internal pressure" were erroneously interchanged in the diagram.
Fix			X									Loading input files with multi-temperature materials could cause corruption of internal memory states, leading to unwanted program behavior such as corrupted data values, incorrect controls being shown, and crashes.
Fix			X									User defined material fits were unable to be saved to the user material file due to a crash that attempted to re-initialize table variables that had not yet been created.
Fix			X									NASFLA-S (scale factor multiplier) crashing DLLs when residual stress was included. The error was found from an altered flag value used to designate the usage of residual stress. The altered flag then mistakenly triggered the shakedown algorithm and crashed the code.
Fix			X									NASFLA results with SC34 crack model using two different SSFs for the same polynomial residual stress were found identical. The implementation relating to this feature was found not being completed with cracks at cylindrical components; i.e., SC34 and SC35.
Fix			X									NASFLA scale factor multiplier crashing when shakedown was enabled and also triggered. A file access error was found as the culprit during iterations.

NASGRO v10.0a Changes and Fixes by NASGRO Module

February 22, 2021

Category	NASGRO Main	Config Control	NASFLA	NASSIF	NASCCS	NASGLS	NASFAD	NASMAT	NASBEM	NASFORM	Users Manual	Description
	Applicable NASGRO Module											
Fix			X									Loading an input file with HCF controls and then switching analysis type to "Calculate Stress scale multiplier, given target life" could erroneously display some of the HCF controls on the 'Load Blocks' tab.
Fix			X	X	X							Crack cases SC34 and SC35: the text descriptions for these solutions have been updated, changing "univariant WF" to "WF solution."
Fix		X	X									The "Cth value option" was not able to be locked or hidden, or set to a specific value in the Configuration Control GUI, which affected how that radiobox was controlled in NASFLA.
Fix				X								Crack case SC34/SC35: The S3 stress controls on the 'OutputOptions' would erroneously show in some cases when 'correction factors' was selected.
Fix				X								Temperature interpolation for FCG properties showing too low toughness values with varying "q" value in NASGRO equation from 0.05 to 0.15. A bug was found when determining DK values for two bounding temperatures to support further interpolation for DK with an intermediate temperature.

NASGRO v10.0b Changes and Fixes by NASGRO Module

June 8, 2021

Category	NASGRO Main	Config Control	NASFLA	NASSIF	NASCCS	NASGLS	NASFAD	NASMAT	NASBEM	NASFORM	Users Manual	Description
	Applicable NASGRO Module											
Addition			X	X	X						X	Implemented net section yield (NSY) analysis for SC34, SC35, SC36, CC24, TC38 and TC39.
Addition			X				X					Crack case SC36 was enabled for use with the failure assessment diagram (FAD) in NASFLA and NASFAD.
Addition				X								NASSIF GUI parameter limit checks for flaw size were added for TC39 and TC25.
Change								X				Fixed a number of compiling and run-time errors of the NASMAT Fortran code for da/dN vs dK curve fitting under Intel Fortran compiler. The modified code does not impact the curve fitting results if the NASMAT DLL is built by Lahey Fortran.
Change				X								Provided more informative description for error encountered when plotting SIF or CF variations in NASSIF. The enhancement provides two sections of information relating to this specific feature; one describes the parameters to support the selected plotting option and the other is the error message, if it's triggered.
Change			X									EPFM analysis crashed when the number of steps (blocks) increased above 60. The upper limit was increased from 60 to 600 and the maximum allowable number of stacked blocks increased from 80 to 1000.
Change						X						On the material tab, the radiobox "K1c value to use" has been expanded to unclude a fourth option: "mean value - 3 sigma".
Change											X	Nineteen material codes were identified to be missing from material tables of the Appendix G, and were added to the documentation.
Change											X	Appendix B of the documentation was converted to LaTeX system
Change		X									X	The configuration control manual has been revised and expanded with more detail.
Fix			X									NASFLA analysis showing no progress and stuck with increasing memory usage. The root cause was from the non-converging iteration in OPS routine due to a bug resulting in increasing memory allocation. It's fixed in both DLLs and the routine to support GUI stress plotting.
Fix				X								NASSIF plotting CC11 SIF solutions crashed with the selection of "a/c" for x-axis and "c" for curve values. For all the six combinations to plot SIFs, there were two combinations that failed: (1) x: a/c and curve: c, and (2) x: a/c and curve: a.
Fix				X								Crack Case TC39: Corrected a number of issues impacting the "plot solutions" including issues involving the non-dimensionalized flaw options, the crack tip labeling, and the plot labels
Fix			X									Crack length inconsistency at failure after CC24 to TC05 transition scenario. It was found from a typo in the statement used to define the distance between two centers of the holes in the routine to handle crack transition.
Fix			X									Missing message in the "Analysis Results" section of OUT1 files when TC39 crack case was used. The description was found not being provided when crack dimensions exceeded the upper and lower solutions limits during crack growth computation, although the computation had been terminated correctly.
Fix				X								Miscalculation led to a discrepancy in computed force from S3 between SC34 and SC36.
Fix							X					NASFAD for EC05 crashing in Debug mode; but not in Release mode. This fix will not affect the release. The revision is for v9.2 and v10 branches.
Fix				X								Puzzling upturn in CC08 SIF values as W increases or D/B decreases for a small crack depth. The interpolation for stress gradient with small D/B ratios was revised to resolve this issue.
Fix				X								Crack Case TC39: Corrected issue where the crack labels were incorrect when selecting fixed crack size on the OutputOptions tab.
Fix			X									The calculation of net section stress for the machined thread option of SC08 was updated so that the stress input is converted to the net section uncracked stress before calling the net section stress routine.
Fix			X									Removed the prior restriction of disallowing Express mode for various crack case models when the Shakedown option was used. Now, Express mode will be offered for Shakedown and non-Shakedown analyses for all crack case models.
Fix			X									Ensure Express mode (EM) is disabled when cyclic shakedown is invoked automatically with univariant crack models. Since cyclic shakedown can not be identified upfront, the revision would ensure DLLs to internally overwrite the EM option if cyclic shakedown is encountered and the EM option is enabled.
Fix			X									Indirect NASFLA analysis invoking cyclic shakedown to compute initial flaw size was crashing the DLLs. The error was from prematurely closing the backup file for residual stress gradients per step pair during cyclic shakedown, resulting in inconsistency during data readback.
Fix			X	X	X							Crack case TC35: Corrected the lower bound in the limits equation from "0.05 <= t1/W1 <= 1" to "0.005 <= t1/W1 <= 1" for unrestrained bending at remote ends.
Fix			X									Crack case CC16: Incorrect B/W check inadvertantly blocking computation.
Fix			X	X	X							Crack case TC39: Corrected a source code error that prevented the allowed input condition of B/tw = 3.
Fix			X									Material M7WB21AB1 description updated to add "Forging; L-T; LA"
Fix						X						NASGLS computation with TC12 subjected to remote loads completed without result. The pitfall was from inconsistent data lines in GLSBAT file.
Fix						X						NASGLS analysis with TC13 subjected to remote loads crashed the DLLs (not GUI).

NASGRO v10.0b Changes and Fixes by NASGRO Module

June 8, 2021

Category	Applicable NASGRO Module											Description
	NASGRO Main	Config Control	NASFLA	NASSIF	NASCCS	NASGLS	NASFAD	NASMAT	NASBEM	NASFORM	Users Manual	
Fix			X									For EPFM (elastic-plastic) calculation mode, increased the size of the "Distinct block case repetition table on the Build Schedule tab from 400 to 1000 rows. [Note: for LEFM (linear-elastic) calculation mode, the table remains unchanged, at 400 rows.]
Fix			X									For the Material tab's Compare IDs dialog, corrected a source code error causing incorrect values being used in the calculation of DK threhsold for the second and third ID that is plotted.
Fix				X								Different F3 result with TC10 crack case between v8.21 and v9.0/v9.1/v9.2/v10.0. This was erroneous from the very beginning when NASGRO software structure was revised; i.e., v9.0.
Fix			X	X	X		X					Crack case TC15: Corrected the limits equation from "0 <= c/W <= 0.9" to "0 < c/W <= 0.9".
Fix				X								Revised DLLs to allow SIF computation for c/W=0.9 with TC15 crack model. A tolerance was implemented with the exact c/W=0.9 ratio in this enhancement.
Fix				X								Providing TC16 SIF solution when extrapolation is utilized as described in the NOTE section of OUT1 files. The enhancement has revised the approach to support the output.
Fix						X						Corrected the text descriptions in the menu "Options, Units" to be "in/hr" for US, and "mm/hour" for M1 (from the incorrect "in/cycle", "mm/cycle").
Fix						X						Material file updated to show correct ALON material data
Fix			X									CC10 with flat stress gradient and not invoking OPS failed the computation right after transitioning to TC13. This scenario was also reproducible with the "old" CC10 in v9.2. The program was pointing to a disabled feature in the TC13 SIF module.
Fix			X									Fixed a NASFLA problem with CC16 (one crack) in Express mode -- the crack failed immediately after CC16 transitioned to TC23.
Fix			X									When defining Kc values at tips with multi-temperature data, changes to the tip location or tip class were not being saved properly when immediately switching tabs. Further, the "through tip" location was not being correctly written to the batchfile.

NASGRO v10.0f Changes and Fixes by NASGRO Module

October 12, 2021

	Applicable NASGRO Module											
Category	NASGRO Main	Config Control	**NASFLA**	**NASSIF**	**NASCCS**	**NASGLS**	**NASFAD**	**NASMAT**	**NASBEM**	**NASFORM**	Users Manual	**Description**
Addition			X								X	Implemented CC25-to-TC03 transition
Change			X	X	X						X	CC16: Extended the limit of crack size "c" from $(D+c)/(2B-c) \le 0.7$ to $(R+c)/B \le 0.9$
Change			X	X	X						X	CC17: Extended the limit of crack size "c" from $(D+c)/(2B-c) \le 0.7$ to $(R+c)/B \le 0.9$ and the limit of crack size "c_1" from $(D+c_1)/[2(W-B)-c_1] \le 0.7$ to $(R+c_1)/(W-B) \le 0.9$
Change											X	Enhanced the introduction of Appendix B
Change			X									TC28 updated to continue fatigue crack growth computation when c2/c limit is exceeded. In previous versions, the computation would be terminated right away when such a limit was violated. This enhancement continues the crack growth by utilizing the SIFs in conjunction with an adjusted crack shape ratio, with an advisory message indicating such an adjustment was deployed in the simulation.
Fix			X									When switching between multi-temperature data sets, user-defined Kc tip data was not being properly stored for each temperature set.
Fix			X									Crack case TC40: Negative pin-load erroneously showing "sign independent" as an option.
Fix			X	X	X							"Plot stress" showing two identical gradients for both internal and external SC04 crack from pressurization. This bug existed only in pre-API step where DLLs generated stress gradient for GUI to plot. The revision correctly includes the effort from internal pressurization on crack surfaces.
Fix					X							Different in-plane bending gradients found with two different bases for TC13 subjected to remote loads. The peak stresses with S2 were found smaller when Basis #4 invoking fatigue crack growth threshold was deployed.
Fix			X									SC18 with automatic shakedown and limit stress check failing to complete computation using API calls. The regular interfacing deployed in NASGRO with GUI works fine with this scenario. This error was only found when API interfacing was used. The root cause was from a flag for API call to use service stress not being updated after the call for the shakedown stress from limit stress, which triggered an internal check, terminating the computation.
Fix			X									Computation for SC35 fatigue crack growth continuing but not generating any OUT2 result. The iteration for convergence to adjust a crack shape as the crack became deep was found unsuccessful and got stuck in a "suspension" state. The iteration algorithm was revised to prevent this scenario.
Fix						X						Crack case SC30: S0 Stress quantity input options not displaying when selecting tabular data.
Fix			X									Crack case SC18: When loading an input file, the residual stress options were initially missing the tabular data and several input options.
Fix			X									Removing iterative shakedown information in OUT1 files encountered in indirect NASFLA analysis with shakedown for scale factor. The program was incorrectly handling the backup file units.
Fix			X									SC29 indirect NASFLA analysis for initial flaw size crashing the DLLs. The cause was prematurely unloading of the stress arrays.
Fix						X						The drop-down material selection combobox did not always display properly.
Fix			X		X							Crack case TC13: SIF Compounding tables were being saved correctly in the GUI input file, but were not being written to the batchfile, preventing SIF compounding analyses from running.
Fix			X									Redundant information was shown in the iteration table shown in OUT1 files for TC13 implicit analysis to compute initial flaw. The information was generated and disposed incorrectly after the crack grew deeper than the limits imposed by the SIF compounding table.
Fix										X		Fixed an error in the code for finding the maximum and minimum stresses and calculating stress ratio for NASFORM stress-life analysis
Fix			X									Elastic modulus information not properly loading from multi-temperature files, and "mean E" FAD options not properly configuring with the stress-strain grid.
Fix			X									SC34 and SC36 did not work with GW and CW load interaction models.
Fix			X									10.00a and 10.00b input files with "constant closure" not properly loading, triggering an erroneous error message about loading an older input file.
Fix							X					Inconsistent local bending formulation found in SC36 FAD implementation for Lr.
Fix				X								Slight inconsistencies found between hand-calculated global total force and local bending and the internally computed ones. The flag used internally for the integration approach with the input request; i.e., USS (user-specified spacing) was inconsistent. This discrepancy was further amplified by the nearly discontinuous stress gradient.
Fix			X					X				Material M7HA11AB1 would not properly show the basic plot in NASFLA due to a malformed material entry.
Fix				X								Crack case EC05: a/c lower limit error checking erroneously using 0.1 instead of 0.01.
Fix				X								Crack case TC28: Tabular grid for residual stress not displaying properly when selecting residual stress.
Fix			X									Crack case TC11: With a centered crack, the SIF compounding options were not displaying the correct stress quantities under remote tension/bend.
Fix							X					Crack case SC30: Computation could not be completed for symmetric cases due to an incorrect batchfile.

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Fix			X									Incorrect post-transition crack length from SC30 to TC12. This scenario occurred during transition into TC12 on the left corner of the plate. The displayed message was found inconsistent showing the crack sizes relating to a-, c-, a1- and c1-tips instead of just c-tip only. The final result remains the same.
Fix			X									Implicit NASFLA computation for flaw size from CC11 to TC28 crack transition not working. In addition, the similar implicit approach for scale factor was not working. The issue was from incomplete implementation of indirect analysis.
Fix			X									Sequential computations by stacking five batch runs could not complete; showing error in pre-API parsing.
Fix			X									Two sequential NASFLA runs with shakedown enabled using Fortran driver fail in the second run.
Fix			X									CC08 NASSIF crashes when a/c ratio is exactly equal to 0.1. This crash is only observed in Debug mode. Using the Release mode, the program runs, but with incorrect result. This was a tolerance issue resulting in an error code.
Fix			X					X				Material M7GJ12AC1: Product form has been corrected from "Clad .064 in sht" to "3/8 in Plt."
Fix			X									When trying to "plot stresses" from the Geometry tab, with either "tens/comp" and "t1/t2" data and residual stress data, the residual stress data was not being plotted.
Fix					X							Final description on the threshold crack size contained unspecified crack tip information. An output bug was introduced when the new TC39 crack case was implemented.
Fix			X									Tiny cycles right after major cyclic shakedown cycles still resulting in crack growth. The error was found from a speed-up flag in connection with long block specification being incorrectly triggered, which resulted in using the same cyclic shakedown gradients from major cycles to compute the crack growth increments.
Fix			X									When running the NASFLA GUI in "batch files only" analysis mode, some batch files were not being copied to the input file directory. Additionally, the outdated status line message that indicated the batch files were copied to a named directory was removed. "Batch files only" analysis mode was changed in 7.10 final, to write the batch files to the input file directories, and no longer to the data files directory called "Multiple Batch Files Directory." However, the GUI status line still indicated the old directory.