May 29, 2018

NASGRO v9.0 Release Notes

New NASGRO Software Architecture:

NASGRO 9.0 introduces some very significant changes to the software architecture behind the scenes. The user may not notice these changes now, but they will enable some substantial improvements in capabilities in future years.

One change is the restructuring of the main NASFLA computational engine from a single dynamic link library (DLL) to multiple DLLs organized by function. Previously all of the computations were performed in the "nasfla4" DLL. Now there are separate DLLs for input and output functions, stress intensity factor solutions, and all other calculations, along with additional DLLs for various interfaces. This change may be invisible to the user unless they are calling the DLL directly in batch mode, or unless they look closely at the NASGRO installation directories. In the future, these changes will enable users to access selected NASGRO functionality and NASGRO output much more directly (among other improvements).

The new DLL structure generates the same ASCII output files as before (*.out1, *.out2, etc.), but it does this differently. Previously the NASFLA output files were written incrementally during a crack growth computation. In the new architecture, NASFLA saves all output data during the run to a binary database, and then writes from the database to the output files at the end of the run. For NASGRO 9.0, NASFLA generates two complete sets of output files, one the old way, and one the new way. The GUI reads and uses only the new files. The old files are being written and saved during this transition period to aid in debugging if problems are discovered with the new files. With a few exceptions (most notably the *.screen.out file), the old and new versions of the output files should be essentially identical. The old and new files have the same names except the old files have "_old" appended to their filenames. At the end of the transition period, the old output files will no longer be generated.

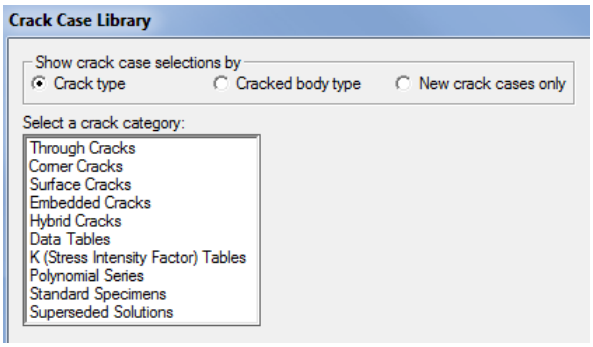
Another major change is that the NASFLA DLLs have been converted from 32-bit to 64-bit architectures. This facilitates significant improvements in memory management. The NASGRO GUIs and some of the NASGRO modules are still using the legacy 32-bit architecture. Again, this change will be largely invisible to most users. We anticipate that more NASGRO components will be converted to 64-bit architectures in the future.

These major changes could possibly cause some new bugs to appear in old features. Please let us know if you identify any problems. We appreciate your assistance in identifying them so that we can get them resolved.

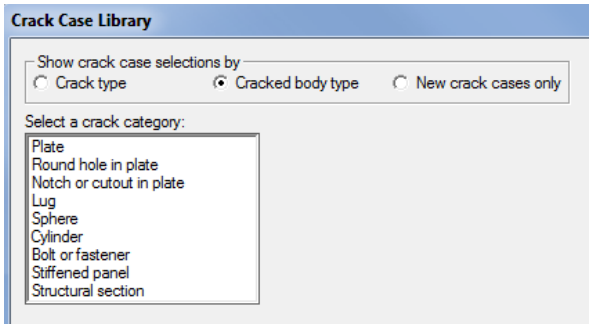
Stress Intensity Factor Models:

- **New Alternatives for Selection of Stress Intensity Factor Models in GUI**

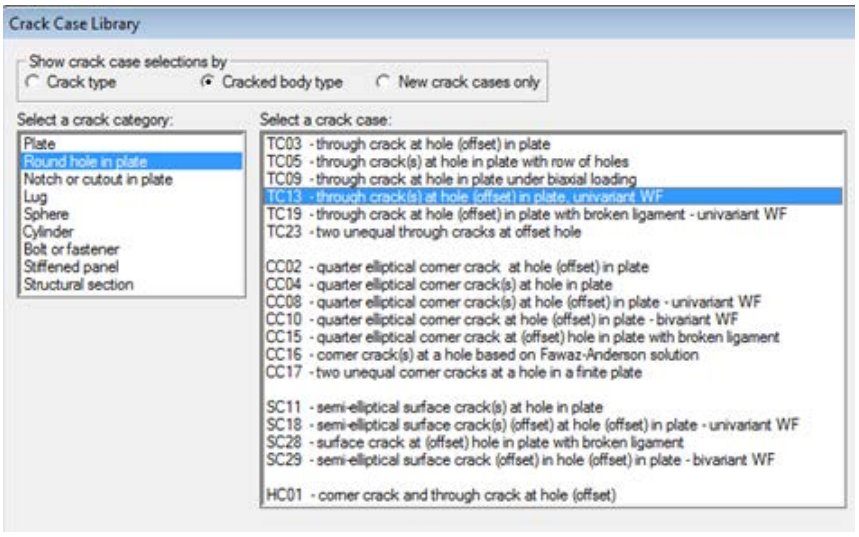
In previous versions of NASGRO, the crack case selection menu was based primarily on crack shape (TC, CC, EC, SC, etc.). Now, beginning with v9.0, two other sortings of crack cases are possible. These are the "Cracked body type" and "New crack cases only" as shown below. The traditional "crack type" list is the default.



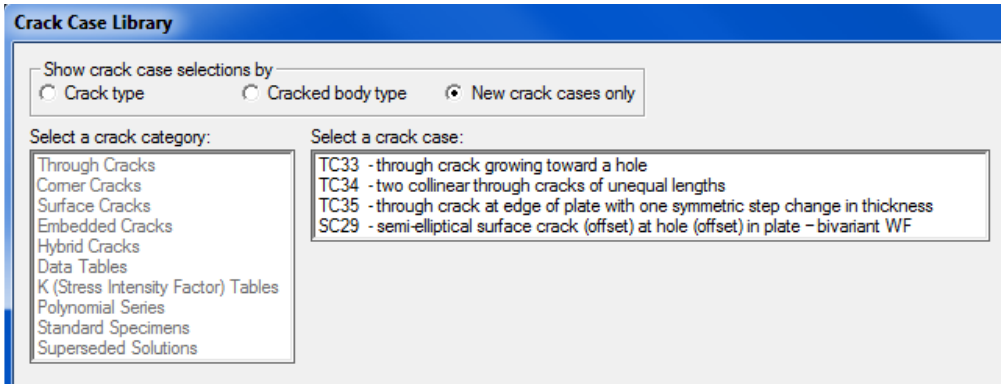
Clicking on the "Cracked body type" radio button displays a list of types of cracked bodies or components (plates, holes in plates, lugs, cylinders, etc.):



Then, for example, clicking on the "round hole in plate" menu item displays all the crack cases available for this type of body regardless of crack shape:



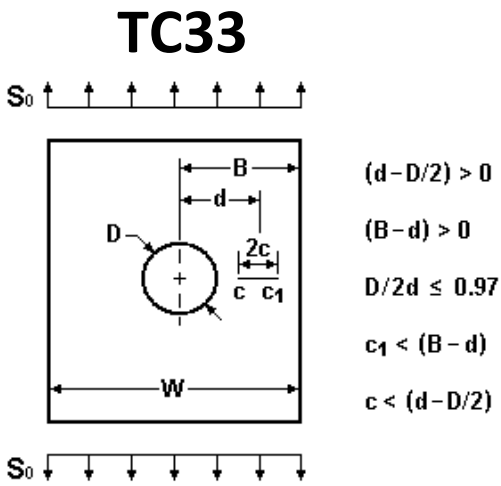
Clicking on the "New crack cases only" radio button displays a list of the new crack cases that have been included in the version of NASGRO that is being run:



The above display shows the four new stress intensity factor models that have been developed for v9.0. The details of these new crack cases are summarized below.

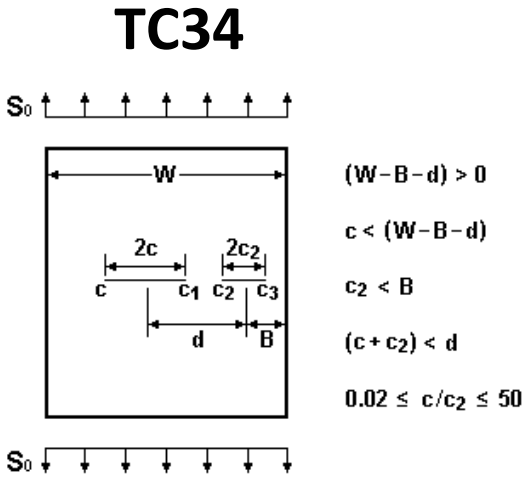
- **New Through Crack Growing Toward a Hole (TC33):**

The TC33 fracture mechanics model computes stress intensity factors for the two crack tips of a through crack approaching an offset hole in a finite width plate subjected to remote tension. The approach is similar to the one developed by the Air Force Research Laboratory (AFRL) where interpolations among tabulated results for an infinite domain are performed for reference solutions and then further adjusted by correction factors from finite dimensions. Additional detail on the development and verification of this new model is contained in Appendix C of the User's Manual.



- **New Two Collinear Through Cracks of Unequal Length in a Plate (TC34):**

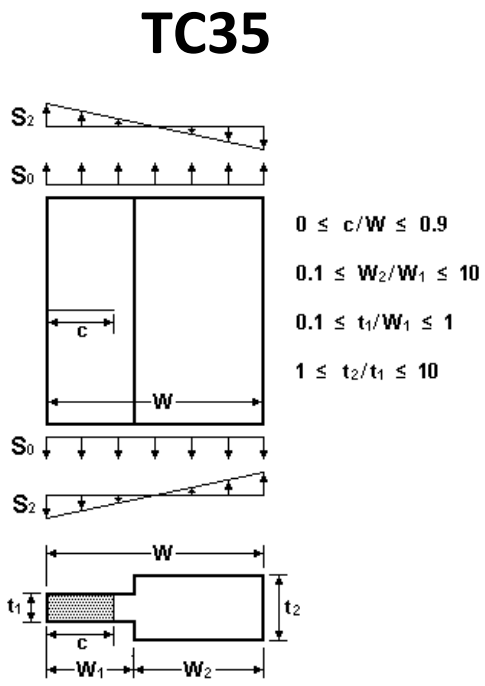
The TC34 fracture mechanics model computes stress intensity factors for four crack tips resulting from two collinear through cracks in a plate subjected to remote tension. The approach is similar to the one developed by the Air Force Research Laboratory (AFRL) where an interaction factor is first determined through interpolation for a reference solution. Further adjustment by correction factors is then applied to account for the effect from finite dimensions. Additional detail on the development and verification of this new model is contained in Appendix C of the User's Manual.



- **New Through Crack at Edge of Plate with One Symmetric Step Change in Thickness (TC35):**

The TC35 fracture mechanics model represents a through-thickness crack at the edge of a plate with one single symmetric step change in plate thickness. The crack begins in the thin section (t_1) and propagates to the thick section (t_2). The edge crack is allowed to extend beyond the geometric discontinuity from the stepwise thickness change. The crack front is assumed to remain straight as it transitions from the thin section to the thick section.

The cracked plate can be subjected to remote loads in terms of tension (S0) and in-plane bending (S2), or crack plane stresses applied locally normal to the crack surfaces (similar to TC12). In each case, the formulation utilizes the gradients of stress component normal to the crack plane varying along the crack propagation direction to determine the stress intensity factors at the crack tip.

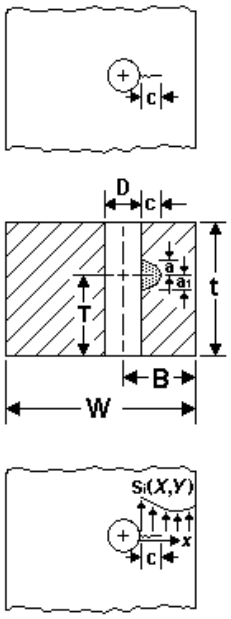


The analytical formulation for TC35 is derived from degenerated weight functions already utilized by other univariant crack models in NASGRO. Additional detail on this new model is provided in Appendix C of the User's Manual.

- **New Semi-Elliptical Surface Crack (offset) at Hole (offset) in a Plate (SC29):**

  This new crack model shares the same geometric configuration as SC18. However, it assumes the stress variation across the crack plane is bivariant. The required stress is in reference to its component normal to the crack plane and the gradient is defined over the rectangular net section where the surface crack at the bore is defined. The definition of the coordinate system and its origin is in accordance with the one depicted in the adjacent figure. Up to four bivariant stress gradients (as well as a residual stress gradient) can be specified using external file input. The file format is the generic NASGRO bivariant stress file format where normalized coordinates with respect to the net section width and the thickness of the plate are required. The alternative 2D stress file format can also be used. Additional detail on this new model is provided in Appendix C of the User's Manual.

SC29



$0.25 \le D/t \le 2$

$0.5 \le a/c \le 5$

$0.1 \le B/W \le 0.5$

$0 \le c/(B-D/2) \le 0.8$

$0.05 \le 2T/t \le 1.95$

$a/\min(T, t-T) \le 0.95$

$X = x/(B-D/2)$

$Y = y/t$

$0.0 \le X \le 1.0$

$0.0 \le Y \le 1.0$

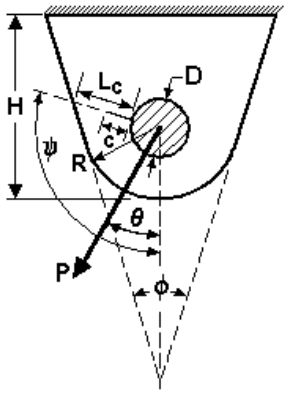
$i = 0, 1, 2, 3$

- **New Lug Solutions With Crack on <u>Long Ligament</u> Side of Hole:**

  - **TC30 - Through Crack at Hole in Obliquely Loaded and Tapered Lug**
  - **CC23 - Corner Crack at Hole in Obliquely Loaded and Tapered Lug**

  The two new lug solutions that first became available in v8.2 to model a through-thickness (TC30) or a corner crack (CC23) at the hole of a symmetric tapered lug under oblique pin loading now have the capability to handle a crack on the long ligament side of the hole. The long ligament option can be selected on the geometry page by checking the box labeled "Crack in long ligament"; however, the default crack location is in the short ligament.

TC30



$S_3 = P/Dt$

t = thickness

$1.25 \le 2R/D \le 10$

$1 \le H/2R \le 2$

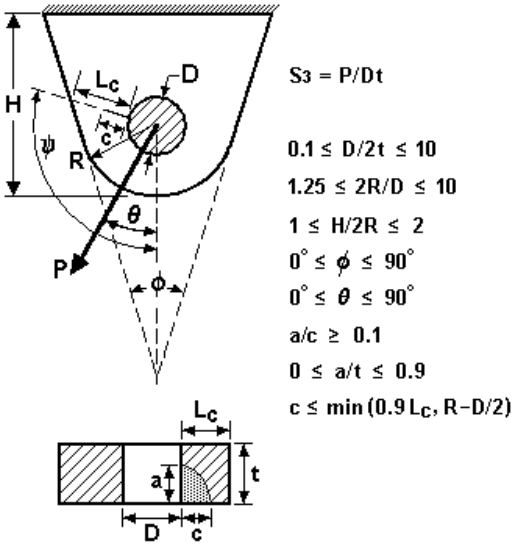
$0^\circ \le \phi \le 90^\circ$

$0^\circ \le \theta \le 90^\circ$

$c \le \min(R-D/2, L_C)$

These are univariant weight function (WF) solutions that utilize nonlinear stress distributions obtained from a large matrix of finite element analyses (FEA). These models consider a neat-fit pin/hole condition, and the FEAs employ state-of-the-art contact algorithms to include the friction and contact between the pin and the lug. Cracks initiate at the location of maximum opening stress that maintains the minimum crack growth ligament. These WF models can also accommodate residual stresses. Additional detail on the development and verification of these new lug models is contained in Appendix C of the User's Manual.

CC23



$S_3 = P/Dt$

$0.1 \le D/2t \le 10$

$1.25 \le 2R/D \le 10$

$1 \le H/2R \le 2$

$0^\circ \le \phi \le 90^\circ$

$0^\circ \le \theta \le 90^\circ$

$a/c \ge 0.1$

$0 \le a/t \le 0.9$

$c \le \min(0.9 L_c, R-D/2)$

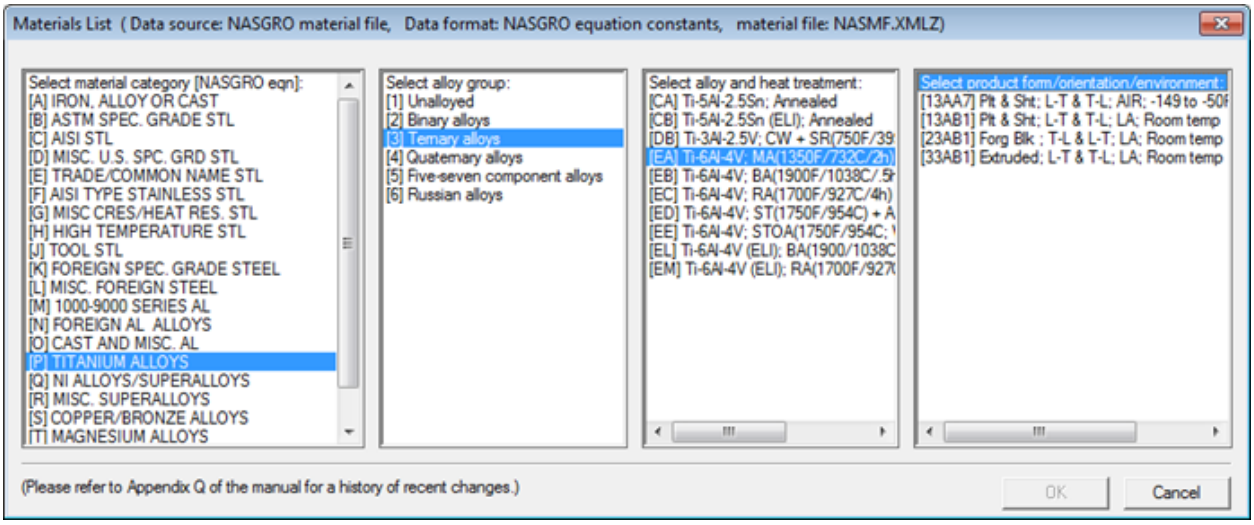
New FAD Capabilities for Bivariant Weight Function Models CC09, SC31, EC04

Failure assessment diagram (FAD) capabilities have been implemented in v9.0 for the NASGRO bivariant weight function models for a corner crack, surface crack and embedded crack (CC09, SC31, and EC04). New limit load solutions were derived for these models and are summarized in Appendix X, Section X.4.13. Since these models can handle a two-dimensional (2-D) bivariant stress distribution they now provide a unique capability to handle 2-D weld residual stress distributions in a FAD analysis.

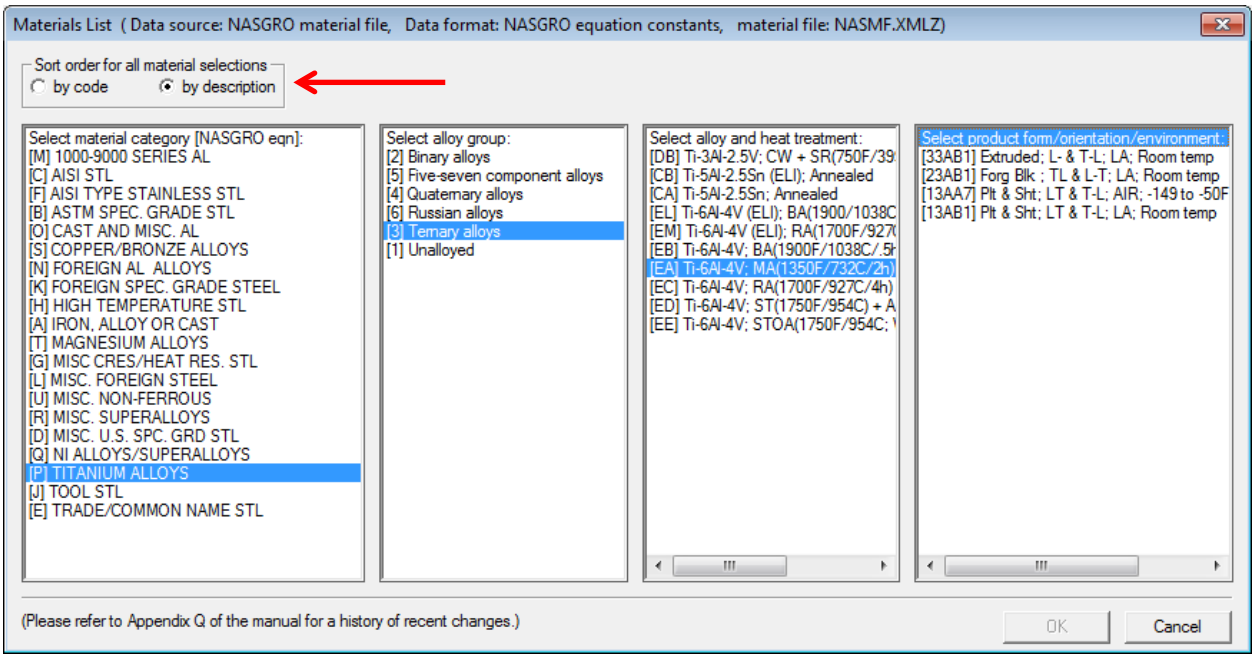
New NASFLA Material Selection/Sorting Feature:

When selecting materials in NASFLA the selection order has previously been displayed according to the ID codes. Version 9.0 now allows the user to display the order of material selections by text description via a radio button choice on the Materials List screen. The default is still the previous method of sorting by ID code. See below.

v8.2



v9.0



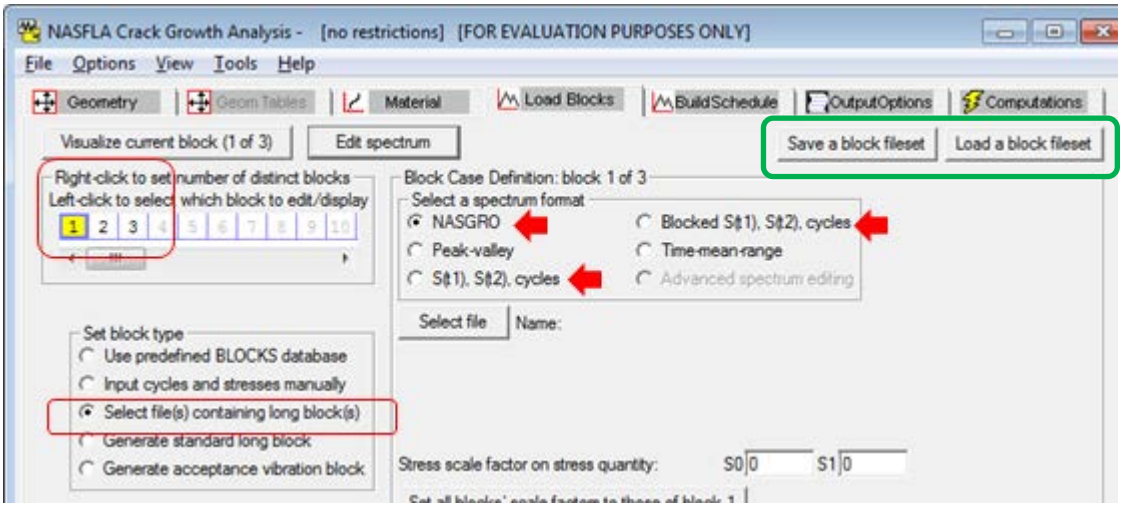
Improved Iteration Method for Inverse Calculations:

NASFLA offers users the option of performing "inverse" calculations in which the initial crack size or the stress scale factor multiplier to achieve a user-specified target lifetime can be calculated. This is a root-finding operation in which forward calculations of fatigue crack growth life are repeated iteratively until convergence of the target lifetime is achieved. The Inverse iteration method was overhauled in NASGRO 8.1 to significantly improve its robustness. The scheme uses a two-stage bisection/Pegasus iteration procedure and does not require input of an estimated solution.

However, the new scheme could still fail in cases where the fatigue life response as a function of initial crack size or stress scale factor multiplier is discontinuous. This could happen, for example, if failure is exclusively caused by infrequent peak loads in the stress spectrum, or if the target life is larger than the maximum possible finite life (i.e., the initial conditions are near threshold). In order to address these situations, the convergence criterion was modified to check not only for convergence of the primary criterion (target fatigue life) but also for convergence of the secondary criterion (initial crack size or stress scale factor multiplier). If the secondary criterion converges while the fatigue life straddles the target life without achieving convergence (due to a discontinuity), then the iteration is halted and success is declared. In this case, a special message is written to the output file, and the user can inspect the iteration table for confirmation. The secondary convergence criterion is considerably tighter than the primary convergence criterion in order to ensure convergence due to the primary criterion whenever possible. Further details of the new scheme are provided in the main body of the NASGRO Reference Manual, Section 2.2.

New Capability to Define Load Block Filesets in NASFLA:

NASGRO v9.0 now has a new, more general option to build/store/specify complex load histories more easily using long block spectrum input files on the Load Blocks tab. This new feature enables the use of multiple blocks (*aka*, "block filesets") to be used for different crack case analyses, whereas the "frequently used schedule" feature that can be selected from the Build Schedule tab is crack case specific. This new option is available on the Load Blocks tab when two or more distinct long block files are specified as shown below:

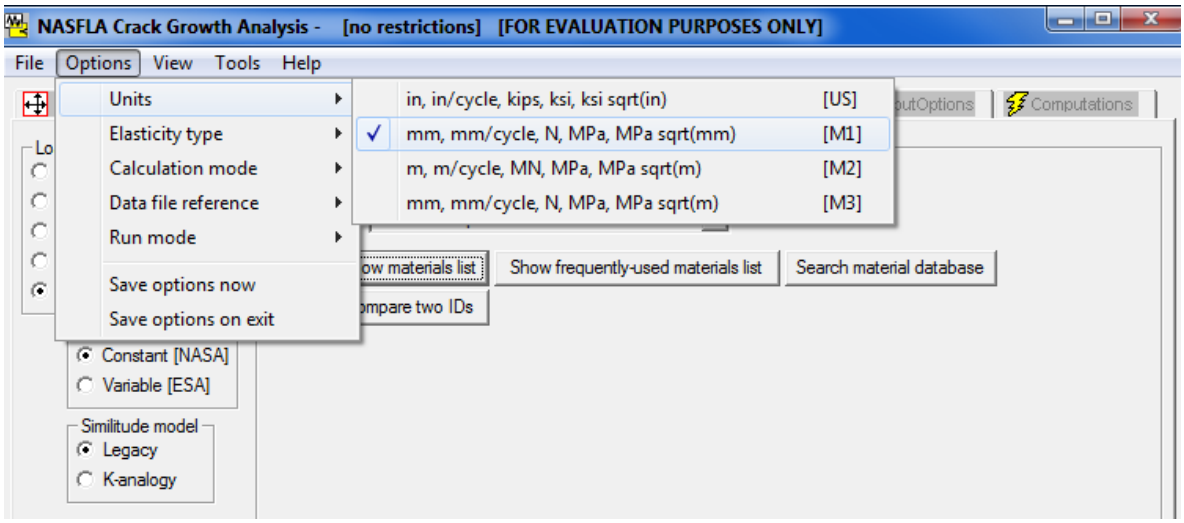


Once the user defines a set of blocks the information can be saved to a block files set file, _____.*bfs*, that can be retrieved for future use (see green box above). This *bfs* file contains the number of blocks, each block's format, and the file folder on the user's machine for the location of both primary and secondary spectrum files. However, the stress scale factors are *NOT* saved. This is because, in general, the stress scale factors would be different when the block file set is used for different crack cases. Loading a previously saved *bfs* file will replace the existing Load Blocks tab content of all blocks.

New Implementation of ESA Strip Yield Model in NASFLA:

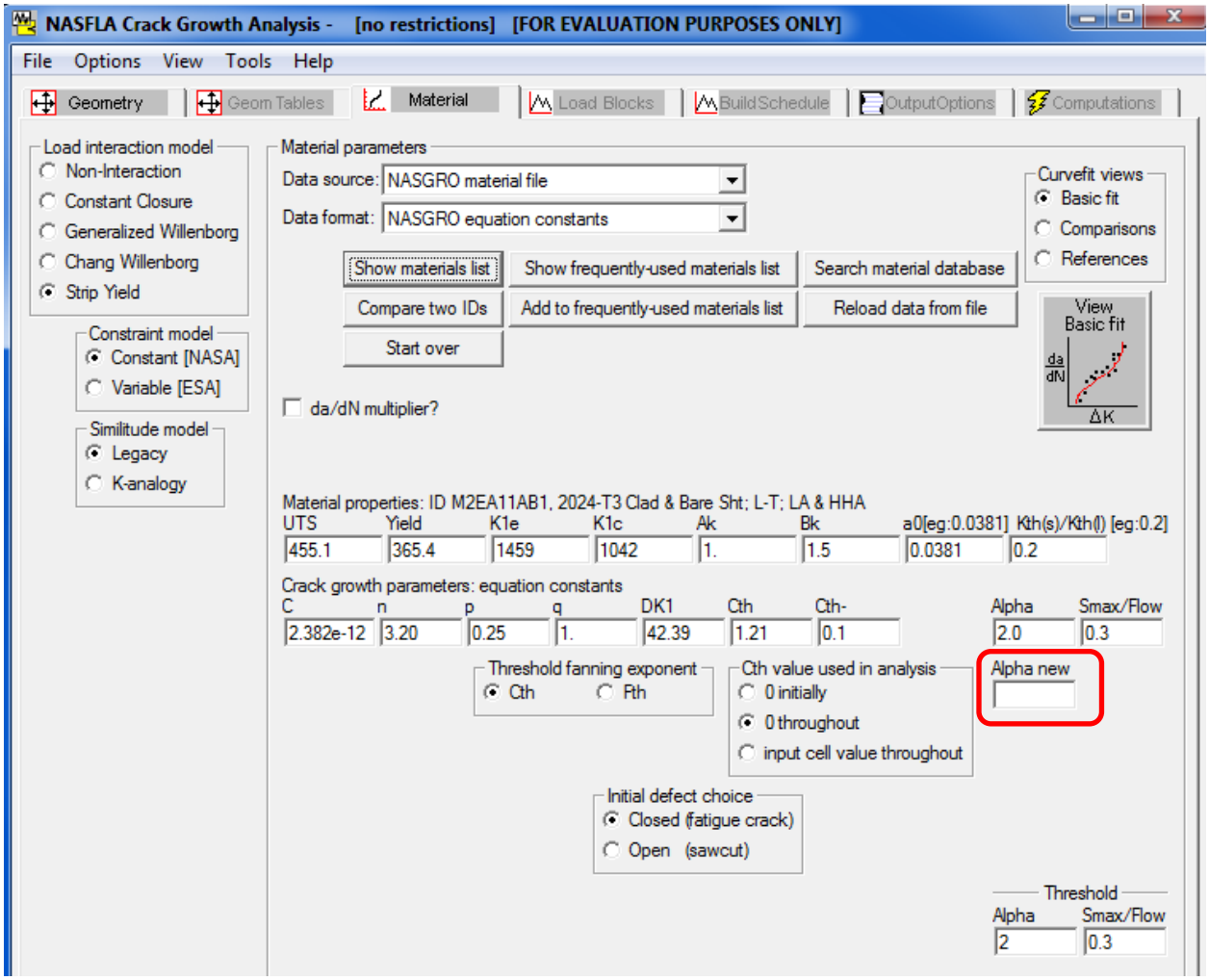
The option to use the Strip Yield load interaction model with the Variable [ESA] Constraint model has been re-enabled in v9.0.

This constraint model is currently available only when performing analysis in the "*mm, mm/cycle, N, MPa, MPa sqrt(mm)*" set of units. This set of units is labelled "*M1"* to distinguish it from the other two metric sets of units that are available in NASGRO, as illustrated in the figure below.



In prior versions where the Variable Constraint model was available, the choice of "NASGRO equation constants" for da/dN-dK data format loaded material parameters from a material file provided by ESA; however, this file contained material parameters for only a limited number of materials that ESA had tested. At ESA's request, the Variable Constraint model now uses the larger, standard NASA-provided database file NASMF.xmlz. This database file also serves the other interaction model choices that make use of the NASGRO equation.

With this modification, the material input tab will be familiar to NASGRO equation users, and the only new information that needs to be provided is the parameter *alpha_new*, as seen in the following figure:



Alpha_new is the ratio of the tensile constraint factor to the compressive constraint factor, and its value is determined experimentally from fitting da/dN-dK test data. Values of *alpha_new* are not stored in the NASGRO database but must be provided by the user for each analysis. A value of *alpha_new* = 1.05 may be a good starting point for iterating the fits.

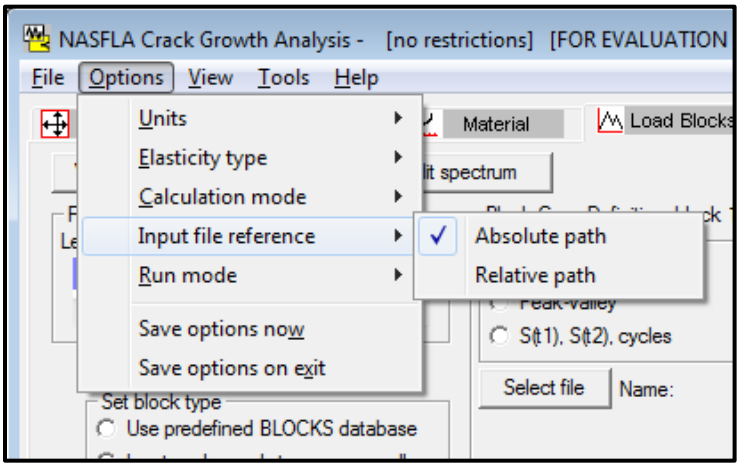
New Option to Set Absolute or Relative File Paths:

Prior to v9.0, when the NASGRO GUIs saved references to supporting data files (for example, for stress files) to the GUI input file, it would save the data file path as absolute. Absolute file paths contain path information all the way back to the drive's root directory (e.g. *C:*\). For example, the path to a stress file named *main-stress-file.dat* in the folder *C:\Users\NASGROuser\really-important-project\stress-files* would be saved within the GUI input file as *C:\Users\NASGROuser\really-important-project\stress-files\main-stress-file.dat*.

Starting with v9.0, NASGRO users can now choose between saving such data file references using absolute file paths (as before) or relative file paths. Relative file paths are relative to the location of the GUI input file. For example, if the GUI input file were stored in the folder *C:\Users\NASGROuser\really-important-project\GUIinput*, the above stress file path would be stored in the GUI input file as *..\stress-files\main-stress-file.dat.*

When using absolute file paths, users with dissimilar folder structures sharing analysis packages would need to change their own folder structure to match that of the supporting data files referenced in the GUI input file, or re-select the files from within the GUI so that the path specified in the GUI matched their own folder structure. Now, if choosing to use relative file paths, users would simply need to ensure the relative path to the GUI input file exists. For example, if a company's stress files are always in the *stress* subfolder right below the input file folder, then it would not matter what the path to the input file was.

In the NASGRO GUI, this path option is selected from the *Options* entry in the menu bar as shown below and is available in NASFLA, NASIF, NASCCS and NASGLS. The Absolute path is the default option. The selection can be saved for future sessions by selecting *Save options now* or *Save options on exit* from the *Options* menu.



New Material Data Sets in NASMAT

Many new material data sets were added to NASMAT for version 9.0. The sources of these data sets were test programs from SwRI/USAF for the A-10 and T-38 aircraft, the NRC Canada, and NASA Langley Research Center. The table below lists the material alloy, the form, and the NASFLA material ID for the new data sets. The reference number (as used within NASMAT) is provided in the last column and the references are listed after the table. The IDs highlighted in yellow represent completely new material data sets in NASMAT. For the IDs that are not highlighted in the table, NASMAT already contained data sets and the new data sets have been added to the ID for that material.

Material Alloy	Form	NASMAT ID	Reference
2024-T351	Plate	M2EB11AB01	490
2024-T3511	Extrusion	M2EC31AB01	490
2024-T42	Sheet	M2EF11AB01	490
2224-T3511	Extrusion	M2IN31AB01	490
7075-T6	Sheet	M7HA11AB01	490
7075-T76	Plate	M7HL11AB01	490
7075-T6511	Extrusion	M7HD31AB01	490
7075-T76511	Extrusion	M7HN31AB01	490
7175-T74	Forging	M7QC21AB01	490
AMS 6526	Forging	E1GC21AB01	490
17-7PH RH1000	Sheet	G2EF11AB01	490
15-5PH H1025	Plate	G2AD11AB01	490
7050-T74	Forging	M7GI21AB01	491
7075-T6	Sheet	M7HA11AB01	491
7075-T73	Forging	M7HG21AB01	491
7075-T7351	Plate	M7HH11AB01	491
7075-T73511	Extrusion	M7HJ31AB01	491
7175-T74	Forging	M7QC21AB01	491
7475-T7351	Plate	M7TF11AB01	491
4330M	Bar	C4BU28AB01	491
4130	Bar	C3KE11AB01	491
4340	Bar	C4DD11AB01	491
A356-T6	Cast	O3FB50AB01	491
7249-T76511	Extrusion	M7SN31AB01	492
2195-T8	Plate	M2TA11AB01	493
2195-T8	Plate	M2TA11AB09	493
2195-T8	Plate	M2TA12AB01	493
2195-T8	Plate	M2TA12AB09	493
2195-T8	Weld	M2TAE1AB01	493
2195-T8	Weld	M2TAP1AB09	493
2195-T8	Weld	M2TAP1LA04	493

New NASMAT Material Data Set References

490 Andrew, D., Smith, L., and Popelar, C., '*Compendium of Mechanical Properties of USAF A-10 ASIP Materials*," Southwest Research Institute, January 2016.

491 Andrew, D., Smith, L., and Popelar, C., '*Compendium of Mechanical Properties of USAF T-38 ASIP Materials*," Southwest Research Institute, March 2016.

492 Bombardier, Y. and Liao, M., "Development of a Fatigue Crack Growth Rate Material Model for 7249-T76511 Aluminium Alloy," *Proceedings of the 28th ICAF Symposium*, Helsinki, Finland, June 3-5, 2015.

493 Hafley, R.A., Wagner, J.A., Domack, M.S., "Fatigue Crack Growth Rate Test Results for Al-Li 2195 Parent Metal, Variable Polarity Plasma Arc Welds and Friction Stir Welds," NASA/TM-2000-210098, NASA Langley Research Center, Hampton, VA, May 2000.

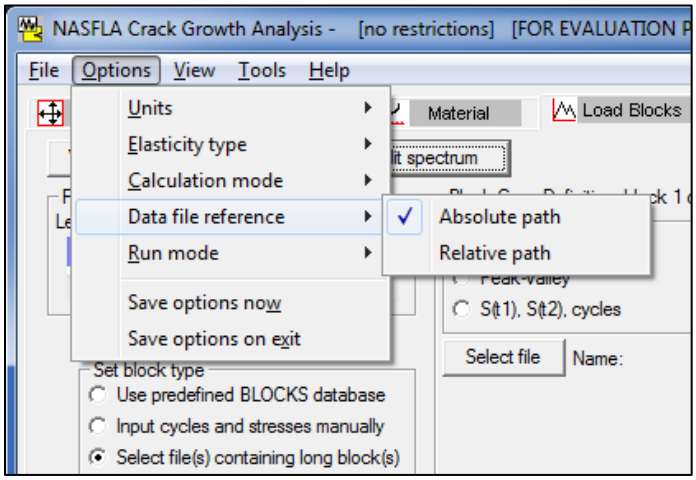
New File Management Features (Appendix R):

- ***Relative vs Absolute File Path Specifications:***

NASGRO v9.0 now has a new GUI option to specify the path to supporting data files as *relative* to the GUI input file or as an *absolute* path from the system root for NASFLA, NASSIF, NASCCS, and NASGLS. These GUIs save location information for supporting data files to the GUI input file. The supporting data files can be weight function stress files, long block spectrum files, user material files, etc.

Prior to v9.0, these GUIs saved such location information to the GUI input file using an absolute path. Absolute file paths contain path information all the way back to the drive's root directory (e.g. C:\). Starting with v9.0, these GUIs offer the choice to save such data file references using absolute file paths (as before) or using relative file paths, where relative file paths are relative to the location of the GUI input file. Refer to Appendix R, Section R.1 for additional details and examples.

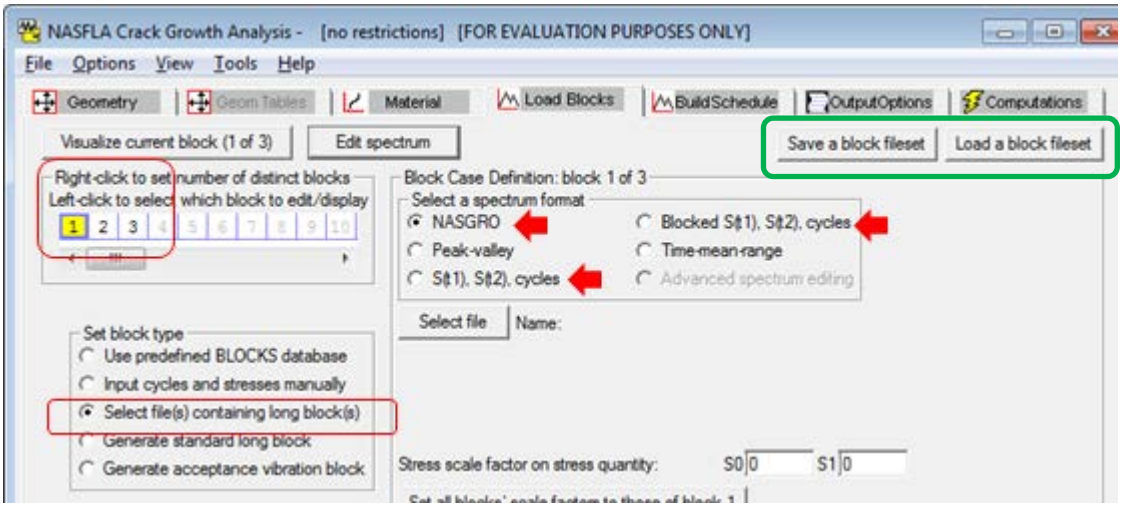
In the NASFLA, NASSIF, NASCCS, and NASGLS GUIs, this path option can be accessed by selecting *Data file reference* under the *Options* entry in the menu bar (NASFLA GUI snippet shown below):



The selection can be saved for future sessions by selecting *Save options now* or *Save options on exit* from the *Options* menu.

- ***Capability to Define Load Block Filesets in NASFLA:***

NASGRO v9.0 now has a new, more general option to build/store/specify complex load histories more easily using long block spectrum input files on the Load Blocks tab. This new feature enables the use of multiple blocks (*aka*, "block filesets") to be used for different crack case analyses, whereas the "frequently used schedule" feature that can be selected from the Build Schedule tab is crack case specific. This new option is available on the Load Blocks tab when two or more distinct long block files are specified as shown below:



Once the user defines a set of blocks the information can be saved to a block files set file, _____.*bfs*, that can be retrieved for future use (see green box above). This *bfs* file contains the number of blocks, each block's format, and the file folder on the user's machine for the location of both primary and secondary spectrum files. However, the stress scale factors are *NOT* saved. This is because, in general, the stress scale factors would be different when the block file set is used for different crack cases. Loading a previously saved *bfs* file will replace the existing Load Blocks tab content of all blocks. The format of the *bfs* files and additional details can be found in Appendix R, Section R.2.

NASGRO v9.0a Additions, Changes and Fixes by NASGRO Module

16-Aug-17

Category	Applicable NASGRO Module										Description
	NASGRO Main	Config Control	NASFLA	NASSIF	NASCCS	NASGLS	NASMAT	NASBEM	NASFORM	Users Manual	
Addition			X								Added ability to include effects of preload on bolted joint analysis for crack case SC14: a semi-elliptical surface crack in bolt head fillet.
Addition			X	X							Implemented SIF compounding capabilities for 3-D and 4-D crack cases: SC17, SC18, SC19, SC26, SC27, SC28, SC29, SC30, SC31, SC32, EC02, EC04, EC05, HC01, CC17, and TC34.
Addition			X								The small crack parameters a0 and Kth(s)/Kth(l) have been added to the Walker equaton display on the Materials tab. The GUI display of the Rcut and threshold parameters used in the Walker equation was reordered to be more logical.
Addition			X	X	X					X	Derived and implemented the net section stress solutions for crack cases SC29, TC33, TC34, TC35, TC30, and CC23. For TC30 and CC23, the crack is on the long ligament side.
Addition										X	Appendix C: Added write-ups for the following crack cases - TC30 (long ligament), TC33, TC34, TC35, CC23 (long ligament), SC29.
Addition										X	Appendix Z: "High Cycle Fatigue Threshold Check" was added.
Addition			X								Provided reason for the warning message that appears when running crack case TC09.
Change			X								On the Load Blocks Tab in NASFLA, there is now an option to save and load the block filesets when dealing with file-input long blocks only.
Change	X										NASGRO Launcher and NASGRO Data Migrator have been updated with scrollbars and resizable displays.
Change			X								When plotting stress gradients, the t1 and t2 gradients are now on the same plot. Tension and Compression gradients have been likewise consolidated into a single plot.
Change				X							Expanded the maximum number of crack size entries in NASSIF from 500 to 2000
Change			X								The possible number of parameter studies (rows) on the Computations tab has been increased from 25 to 100.
Fix				X	X						NASCCS and NASSIF crash when switching units after a crack case is selected.
Fix			X								SC30 subjected to uniform tension showing inconsistency in predicted final life for two cracks of same offset from center. The bug was corrected for parameters being overwritten in routines assigning geometric parameters prior to computing SIFs.
Fix			X								Crack transition from EC04 to CC09 and then to TC12 resulted in infinite fatigue life. The error was from the missing implementation for polynomial stress conversion during CC09 transition into TC12. The fix implemented such stress conversion.
Fix			X								Computation terminated during SC26 transition into TC17. The termination was due to the incorrect designation of an internal parameter describing the number of DOFs with crack model during crack transition. This has been corrected.
Fix							X				When creating a material ID using the "Build an ID" button on "Enter da/dN Delta K" or "Enter a vs. N" tabs, the cells are not properly populated, displaying the "Cond/HT" cell values in the "Alloy" cell.
Fix			X								CC10 stress input echo mislabeled and normalized X is incorrect. The mislabeing was because the specific column labels for crack at a hole should be used instead of the general labels for crack in a plate. The fix has corrected this issue.
Fix			X								On the "Materials Tab", the Material ID can become corrupted when switching units multiple times.
Fix			X								Transition from SC28 to TC19 terminated with error message shown in SCREEN.OUT. The designation of an internal parameter for DOFs in SC28 was found inconsistently assigned. The correction has been included in the fix.
Fix			X								EC04 NASFLA computation terminated with incorrect failure message (outside geometry bounds) in SCREEN.OUT file. The error was from incorrect assignment of width and thickness when transitioning from CC09 to TC12. The fix contains such correction.
Fix			X								Stress and cycles details are missing from the Load Blocks tab when loading a "frequently used schedule".
Fix					X						Crack Case TC02 does not properly display the "bending constrained" option.
Fix			X								When plotting tensions & compression data or t1,t2 data from the "Geometry" tab with the OPS option selected, no OPS data is plotted.
Fix			X								Crack Cases SC13, SC14: When switching to SC13 or SC14 in Units system three, or when switching between units when SC13 or SC14 is selected, the GUI would not properly display the major and minor diameter geometry boxes when appropriate or would display multiple copies of those geometry boxes.
Fix				X							Odd behavior of TC13 crack plane stress subjected to pin load for large plates. The Fix contains the reworked interpolation scheme to correct such odd behavior.
Fix			X								When loading an elastic plastic input file, the Cth/Fth controls were being erroneously displayed on the Materials tab.
Fix			X								When running cases in Units system Three or Four the materials constant "a0" was not being converted to the proper metric system
Fix			X								Crack Case TC11 did not run when "symmetric crack with symmetric stressing" option was selected.

NASGRO v9.0a Additions, Changes and Fixes by NASGRO Module

16-Aug-17

	Applicable NASGRO Module										
Category	NASGRO Main	Config Control	NASFLA	NASSIF	NASCCS	NASGLS	NASMAT	NASBEM	NASFORM	Users Manual	Description
Fix			X								Incorrect total number of cycles when invoking temperature interpolation. The error was identified due to the missing check for the positiveness of p-values in temperature interpolation scheme. This led to a different path to count cycles. The fix contais such correction.
Fix			X								TC28 labeling issue where "c2" should be used instead "a". The correction has been included in the fix.
Fix										X	Appendix Q: Corrected status of Material ID G2CF13AB1, which had been removed from the NASFLA material file in v7.11 (because of bad data)
Fix										X	Appendix C: Corrected faulty statement regarding Fp factors
Fix					X						Corrected a printing error in the header output for critical crack size calculation in the out1 file
Fix			X								Crack cases KT01, KT02, and KT03 were erroneously showing the HCF threshold check options.
Fix			X								NASFLA crashed when saving "new data" to the user material file.
Fix			X								In the sample user file "USRTBC.xml", the material "Q32D" was malformed, generating an error message about too many R-values when attempting to load it.
Fix			X								Crack case CC10 had an erroneous run-time geometry check. It was validating "c/D2 <=0.9" instead of "c/(B-d/2) <= 0.9".
Fix			X								Crack cases TC11, TC12 show "S0" and "S1" on the SIF Compounding tab for remote loading scenarios instead of "S0" and "S2".
Fix			X								Column labels in OUT2 files for TC11 and TC12 show S0 and S1 instead of S0 and S2 when remote loads are applied. Such mislabeling is corrected in this fix.
Fix			X								On the Load Blocks tab, the "Keac chk?" grid entry for "predefined" and "manual" inputs and the "Check if Kmax>Keac for this block" and "Keac" text control were not properly being set, reset, and cleared when switching between block types.
Fix			X								An inconsistent display occurred in DT03 OUT1 file when the number of displayed columns was more than four. This overstacking issue in output display has been resolved by utilizing a revised scheme where number of columns is not a constraint. The fix corrects such a display alignment issue.
Fix			X								F0 columns in the OUT2 file for TC12 NASFLA analysis showed different content between DLL and standalone versions. The error was due to an un-initialized flag used to signify if the applied load is at the remote ends or not. This un-initialization issue has been corrected in the fix.
Fix			X								Invalid S/Su values in TC15 OUT2 file for TPFC-specific failure locus. V8.2f does not have this issue and the fix for v8.2 has been applied in v9.0a to resolve this issue.
Fix			X								Crack Case CC16: When running in "inverse calculation" mode, the geometry check "(D/2+c)/B <= 0.9" was being erroneously applied, blocking computation.
Fix			X	X	X						For crack cases TC13 and CC08, when loading an input file with "Crack in long ligament" selected, the bitmap was not updated to show the crack in the long ligament.
Fix			X								Error from repetitive stress points in both TC12 and TC15 was not caught by the Fortran DLLs. The applied fix now catches the error and stops the computation instead of crashing the program because of erroneous input.

NASGRO v9.00b Additions, Changes and Fixes by NASGRO Module

21-Nov-17

Category	Applicable NASGRO Module										Description
	NASGRO Main	Config Control	NASFLA	NASSIF	NASCCS	NASGLS	NASMAT	NASBEM	NASFORM	Users Manual	
Addition										X	A new Appendix R was created to describe "File Management Features" for relative vs absolute file path specifications (Section R.1) and the capability to define load block filesets in NASFLA (Section R.2). The previously existing material in Appendix R was very outdated and that historical information is contained in the release notes.
Addition			X				X				New edit checks have been added to the NASFLA and NASMAT GUIs for the material parameters for threshold fanning, so that manually entered values must now be within an acceptable range of values. The ranges are as follows: DK1 > 0; 0 <= Cthp <= 3; 0 <= Cthm <= 1; DK1f > 0; 0 <= Fthp <= 2; -1 <= Fthm <=0, 0 < threshold alpha <= 6; 0 < Smax ratio <= 1.
Addition			X								Default value settings for NDE crack sizes have been added to the NASFLA GUI for the following crack cases: CC15, CC17, CC22, HC01, SC28, SC29, TC23, TC26, TC31, TC32, TC35.
Addition			X								Tabular material data in the format of different da/dN sets for each R-value, may now be saved to user files using the "Save data to user file" button for "New Data" data source.
Addition			X								When saving new or manually altered tabular material data to user files, the name of the user file to which the changes will be saved, will now be dafaulted to the standard user filename, based on data type and units type, e.g. "USRTBC.XML".
Change		X									Updated Configuration Control to allow the addition of scrollbars when the required size of the GUI at startup is taller or wider than the monitor or screen on which it is running (due to very small screens, such as a laptop), to enable access to the entire GUI.
Change					X						Added the following crack cases: TC28, TC31,TC32, TC33, TC35 and SC29.
Change							X				Added the ability to edit Threshold values directly, rather than fitting the threshold. This allows users to enter or edit Cth or Fth values, including updating the counterpart values via the new "Calculate Fth/Cth" button.
Change			X							X	Enhanced NASFLA inverse calculation of initial flaw size or stress scale factor multiplier to address the special cases where the fatigue life respone as a function of initial flaw size or stress scale factor multiplier is discontinuous at the user-specified target life or the target life is larger than the maximum possible finite life. Implemented the criteria to detect the discontinuity, revised the output, and documented NASFLA inverse calculation in the NASGRO Main Reference Manual, Section 2.
Fix			X								NASLFA Material IDs: F4LA16AB1, G2AB16AB1, G2AD16AB1, G2AF16AB1, G2CE16AB1, K8AA16AB1, K8BA16AB1, K8CA16AB1, K8DA16AB1, N8BB16AB1, P6AA16AB1, P6AB16AB1, Q1AA16AB1, Q4VB16AB1, B2IB18AB8, B2IB18AB1, G2CE19AB1 were labeled "plt & sht" instead of "round bar".
Fix			X								Long block file could not be opened in NASFLA analysis. This was issue specific for NASGRO Linux version. The error was found because of un-necessary conversion of file name to uppercase.
Fix				X							NASSIF analysis for TC32 was not working correctly. It appeared the crack length conversion was not applied in NASSIF analysis. NASFLA analysis worked correctly.
Fix			X								When changing the elasticity type between elastic-plastic and linear-elastic, the varying lists of crack cases that are provided in the crack case library, which are based on the elasticity mode, were not completely correct.
Fix			X								SC26 analysis with user-provided stress for NASFLA analysis was not working. A bug was identified in the SIF routine when database was updated.
Fix			X								A v8.2 case with "suppress closure" option did not run in v9.0a. Several inconsistencies between the parser of Fortran DLLs and FLABAT files were identified and have been resolved.
Fix				X							Crack Case SC32: When loading an input file generated in 900a, NASCCS would erroneously notify users that the input file corresponded to an older format.
Fix			X								For 2D multi-temperature materials, when changing the Material tab view from one temperature to another, data in the material data temperature grid was being erroneously blanked out.
Fix			X								In metric units system 3 (mm, mm/cycle, N, MPa, MPa sqrt(m)) the value of Kc was not being calculated properly when plotting NASFLA fits.
Fix			X	X							Crack Case SC27: Under remote tenion, both the bitmap and the Load Blocks tab were erroneously showing an S2 stress quantity.
Fix			X	X							An inconsistency was identified in TC26 SIF routine when computing the net section width. The issue was encountered during development where the internal definition of "d-r" and "r" were incorrectly switched.
Fix			X								Corrected a filename default value error, which caused an incorrect material file read error when selecting ESA Strip Yield load interaction model and NASGRO equation constants data souce selection.
Fix			X								The material parameter field "Alpha new" was not being shown on screen for the ESA Strip Yield load interaction selection, when entering New Data, or when choosing multiple temperature material files.

NASGRO v9.00b Additions, Changes and Fixes by NASGRO Module

21-Nov-17

	Applicable NASGRO Module										
Category	**NASGRO Main**	**Config Control**	**NASFLA**	**NASSIF**	**NASCCS**	**NASGLS**	**NASMAT**	**NASBEM**	**NASFORM**	**Users Manual**	**Description**
Fix			X								When loading an input file, the value for "Flight for this block" on the Load Blocks tab was not being loaded from the input file.
Fix			X	X							An inconsistency in the FLABAT file caused no result showing after analysis. It was because the error identified before API functions were invokved was originally shown on screen, leaving users clueless as to what the root cause was. From v9.0b, such kind of error is directed to "SCREEN.OUT" file.
Fix			X								TC34 FLABAT analysis involving 20 long blocks crashed due to high memory demand. The TC34 SIF module was one of the first few modules in v9.0a utilizing API to invoke SIF computation. One of the statements was found missing at the end to unload the allocated memory resulting in program crash. The issue has been resolved.
Fix			X	X	X						Added existing crack case TC28 to the new category for "cracked body type, plate", which was previously not included.
Fix			X								Crack case TC35: The geometry check for "t2/t1" being between 1 and 10 was not correct, causing erroneous error messages for valid geometries.
Fix			X								When "Generalized Willenborg" was selected on Material tab, the text control for for "Parameter Phi0" under "Modified General Willenborg" was not displayed correctly.
Fix			X								Corrected the internal NASFLA GUI code that makes adjustments to the Load Blocks grid whenever the material type changes between single temperature materials and multiple temperature materials. This code adds or removes a column from these grids to account for the Temperature column, but was not always making this alteration correctly.
Fix											Added a length check for all material IDs, which now allows for IDs of lengths up to 50 characters, matching a similar implementation in the calculation core.
Fix	X										Data Migrator crashed when converting old files to XML.
Fix			X								Crack Cases: TC11, TC12, TC17,TC18,TC19, TC35, CC13, CC14, CC15,SC26, SC27,SC38: When plotting the residual strength diagram from the Computations tab, the stress quantities for "tension, bend" were labeled "S0" and "S1" instead of "S0" and "S2".
Fix			X								Computation from initial CC17 crack model terminated at transition from HC01 to CC15. The pitfall was identified in the post-transition algorithm to compute resultant force and moment that were too large leading to early NSY failure.
Fix			X								Crack Case TC33, TC34: On the Material tab with "New Data" selected, the "Through crack toughness computed from" radiobox and associated Kc value would disappear when editing values on the Geometry tab.
Fix			X							X	Revised the SC04-to-TC07 transition message printed in the output file when the transition is unavailable if SC04 is subjected to non-pressure load conditions.
Fix			X								On the Geometry tab, when plotting stresses with OPS selected but neither tension,compression nor t1,t2 selected, the created plot will flash briefly on the screen and then disappear.
Fix			X	X							NASSIF solutions of CC23 and TC30 not working when the pin load angle was exactly at zero degree. The error was from an invalid geometric check in SIF modules. It's been fixed to be consistent with the requirements depicted in GUI bitmap.
Fix			X								FAD diagram plotted by GUI did not contain (Lr, Kr) result and mis-aligned CSV columns issue with EC05 NASFLA. The problem was a result of sticky labels among Kr_limit columns in the new OUT2 files. Expanding the column width resolved the issue.
Fix										X	Amended NASGRO Main Reference Manual to correct the mismatches of the page numbers and figure numbers in the document.

NASGRO v9.00f Additions, Changes and Fixes by NASGRO Module

29-May-18

Category	Applicable NASGRO Module										Description
	NASGRO Main	Config Control	NASFLA	NASSIF	NASCCS	NASGLS	NASMAT	NASBEM	NASFORM	Users Manual	
Change										X	Appendix C: Made corrections regarding NSY capability in the descriptions for crack cases TC12 and TC13.
Change										X	The description for CC13 and SC26 in Appendix C has been updated to indicate that the theta angle enclosed by a straight-edge notch has no effect on the stress gradients and computed stress intensity factor over the specfiied range depicted in GUI bitmap.
Change			X								The lower limits for Cth(+) and Cth(-) were reduced to -0.5 (it previously was 0.0.).
Fix			X	X							Enable/disable OPS feature produced different TC11 SIFs for an offset crack. The error was related to the number of stress points after OPS. In this case, the number became two (2). A bug in the pre-integration routine for two linear stress points was identified.
Fix			X								DK from HCF not in agreement with DK from LCF when all things were consistently defined. The inconsistency was found as a result of incomplete implementation of the new unit feature (iunit=4) in HCF module.
Fix							X				NASMAT would not launch under Windows 8.1 and Windows 10 due to an access violation during startup, silently crashing the GUI.
Fix				X							Incorrect crack plane section width (Lc) computed for CC23 with crack on long ligament. The inconsistency was from printing the value of a different parameter.
Fix				X							Incorrect note from SC30/SC17 SIF models indicating crack size exceeded bounds for solution accuracy, while all geometric parameters were confirmed within the limits. The misleading message was from a bug found in the parser. Once cleared, the misleading message does not show up again.
Fix			X								TC33 crashed after transition to TC13. An un-initialized parameter generated an invalid error code and as a result caused the program to terminate computation prematurely. The update now generates OUT2, SCREEN.OUT and OUT1 files even when an unexpected termination is encountered.
Fix			X								Corrected calculation of the effective stress ratio (Reff) and Kmax for the generalized Willenborg model and Chang-Willenborg model for 3-D and 4-D cracks.
Fix			X								Corrected ΔKth calculation for the generalized Willenborg model if the tabular da/dN is selected for da/dN calculation. ΔKth participates in calculation of the effctive stress ratio (Reff), as shown in eqs.(2.20 - 2.25) in the NASGRO Main Reference Manual.
Fix			X								Improved the algorithms for counting the below-threshold load steps in the NASFLA computing engines.
Fix			X	X							Correction factor for TC34 offset crack not being accounted for. The error was derived from the extreme offset leading to an incorrect error code such that no correction factor had been applied. After sorting out the discrepancy resulting in the error code, SIFs on account of correction factors are generated.
Fix			X								Fixed a problem for NASFLA inverse calculation of stress scale factor multiplier, which can cause the computation to crash.
Fix			X								Huge difference between the SC26 FCG lives from the regular mode and the express mode. Further investigation found there were about 36 crack models in total that did not have the express mode feature implemented. This version contains the new updates for these crack models.
Fix				X							NASSIF header output title line was incorrect. The header output title line showed "SUSTAINED STRESS ANALYSIS" instead of "STRESS INTENSITY FACTOR SOLUTION." This has been corrected.
Fix			X	X							Column output of beta (F0) values in OUT2 file from TC34 NASFLA analysis appeared to be switched. The SIF columns for four crack tips appeared to be consistent but the normalized SIF columns (the beta columns) were not. The inconsistency was identified from the improper designation between the data columns for c2- and c3-tips.
Fix									X		For material AL7075-T73, the value for the ductility coeffient was corrected from -0.26 to 0.26 in the corresponding NASFORM material file.
Fix			X								Residual stress from non-symmetrical TC11 shakedown not defined in full range. The inconsistency was found in the normalized coordinate range used to define the residual stress variation. Its range was from 0 to 1.0 instead of from -1 to 1.
Fix			X								Crack Case TC15: On the "Geometry Tab" the checkbox for "Specify secondary cyclic stresses in FAD analysis" was partially hidden behind the "Definition of thickness variation" radiobox.
Fix			X								Crack case TC28: On the "Geometry Tab" the geometry grid was labeled incorrectly as "Thickness, T", "Width, W", "Initial c2/c" and "Width, W" instead of "Thickness, t", "Width, W", "Initial flaw size, c" and "Initial c2/c" .

NASGRO v9.00f Additions, Changes and Fixes by NASGRO Module

29-May-18

Category	Applicable NASGRO Module										Description
	NASGRO Main	Config Control	NASFLA	NASSIF	NASCCS	NASGLS	NASMAT	NASBEM	NASFORM	Users Manual	
Fix			X								Inconsistent stress designation assignment during SC30 transition to TC12 when remote loading was applied. An error was found during transition where stress conversion from out-of-plane bending was designated as S1 instead of S2.
Fix			X	X							Same thicknes variation with different point spacing leading to different TC15 final fatigue crack growth cycles. The pitfall was mainly from the incorrect indices used during pre-integration for SIFs. The bug was discovered as a result of drastically different point spacings between thickness variation and stress variation.
Fix			X								When reading a 2D tabular material record from file, the NASFLA GUI was not allowing a record containing more than 9 R-values to be loaded, even though the maximum allowable R-values limit was raised from 9 to 25 in a previous NASGRO release, due to an outdated limit check in the code.
Fix				X							Misleading TC11 SIF output for non-symmetrical crack subjected to remote loads. The output showed F0 and F1 instead of F0 and F2 (from in-plane bending).
Fix			X								Crack case TC11: The GUI controls for specifying secondary stresses on the Load Blocks tab were not being shown properly when the option for "Symmetric crack with symmetric stressing" was also selected for this case.
Fix				X							Crack cases TC11, TC12, CC11: With "tension, bend" selected, the "Output Options Tab" labeled the stress quantities as "S0" and "S1" instead of "S0" and "S2".
Fix							X				The following issues have been corrected for new data sets in the NASA material data file: M2EC31AB01F would not plot. M2EC31AB01F had an erroneous da/dN value. M7HL11AB01B would not display da/dN data. E1GC21AB01A had incorrect header information. C4DD11AB01 would not plot. O3FB50AB01E and O3FB51AB01D3 would not load and plot correctly. Toughness data M7HG21AB01 would not load correctly. M2TA11AB01 had incorrect da/dN information.
Fix			X								If a multi-temperature material's file values were in different units than the GUI, selecting or changing crack cases after material selection would result in the material properties being incorrectly converted again when saving an input file.
Fix			X	X							Crack case TC26: Corrected the lower limit values for the solution in the following expressions: From 0.01 to 0.05: 0.05 <= d/2B <= 0.5; From 0.01 to 0.1: 0.1 <= 2B/W <= 1
Fix			X								On the "Load Blocks Tab" with "Select file(s) containing long block(s)" the "Advanced Spectrum Editing" option was erroneously enabled for load interaction models other than "Strip Yield".
Fix			X	X	X						Crack case KT03: No output was generated when attempting calculations, due to batchfile inconsistencies and incorrect batchfile parsing by the computations engine
Fix			X	X	X						Crack case DT03: No output was generated when attempting calculations, due to batchfile inconsistencies and incorrect batchfile parsing by the computations engine
Fix			X	X							Problem/project title was not shown in OUT1 file. Though the computation was completed and the OUT1 file was generated correctly, GUI did not display the full OUT1 file. The pitfall seemed to be the nullified data line in OUT1 file for the project title description. New API functions were implemented to correctly store the description for the problem/project title to prevent such an erroneous scenario.
Fix			X								Direct and inverse results for CC11 with tabular stress input did not match. The inconsistency was a result of overwritten stresses, forces and moments from crack transition during iterations in inverse analysis. Once revised to be reset to the initial states for fresh iteration, the program generates consistent results.
Fix			X	X	X	X				X	Crack case TC28: Changed the lower limit for c/W, to disallow equal to zero in the following expression: Previous: 0 <= c/W <= 0.9 Changed to: 0 < c/W <= 0.9
Fix			X				X				The original constraints for Cth+ and Fth+ values were not in line with the data in the NASA material database, requiring adjusting the upper constraint for Cth+ from 3 to 5, and the upper constraint for Fth+ from 2 to 4.
Fix			X	X	X						Crack case TC35: net section stress (NSS) computation method was not complete. Before: valid for only C<W1 After fix: valid for both C<W1 and W1<C<W1+W2 (including cases when crack grows into thick section)

NASGRO v9.00f Additions, Changes and Fixes by NASGRO Module

29-May-18

Category	Applicable NASGRO Module										Description
	NASGRO Main	Config Control	NASFLA	NASSIF	NASCCS	NASGLS	NASMAT	NASBEM	NASFORM	Users Manual	
Fix			X								CC22 would not run in NASFLA. The error was caught from an internal check for the validity limits of d/(2t). The error description was generated and found in the output files; however, it was misleading. A revised version has been implemented. A separate bug to revise the CC22 GUI bitmap to sohow the limits on d/(2t) was also fixed (see below).
Fix			X	X	X						Crack case CC22: The limit "0.1 <= d/(2t) <=10.0" was added to the GUI display.
Fix			X								For the crack case SC08, long block inputs were producing identical results with/without preload. Fixed the bug in the source code and verified the results with a two independent test cases.
Fix				X							TC28 NASSIF computation for correction factors was incorrectly using the crack dimensions. The error was identified from an inconsistency between the batch file format and what the DLL parser expected. This error only occurred when computing SIF correction factors.
Fix			X	X							Crack case TC11: Computation would not complete successfully when the crack plane stress definition was set to "User input" and the "Input stresses from file" checkbox was selected.
Fix			X								An additional failure check (Kmax>Kc) is performed on the degraded geometry for several crack cases (SC01, SC02, SC04, SC05, SC11, EC04, SC05, SS08) when (a+p)≥t, where 'a' is crack depth, 'p' is plastic zone size, and 't' is thickness. Before v9.0, the default Kc value set by the NASGRO rules was always used in the check regardless of whether the user-specified toughness is enabled or not. The problem has been fixed, and the appropriate Kc value is provided for the check.
Fix				X							Anomalous TC13 SIF behavior as a function of crack length for wide plate. The issue was with incorrect interpolation among insufficient extended reference solutions from R/B=0.05 to 0.01. The revision included additional reference solutions between these two ratios to provide better resolution for interpolation.
Fix			X								The additional failure check (Kmax>Kc) performed on the degraded geometry (TC07) of SC04 was missing in NASGRO v9.0 Beta. Added code segments to bring the check back.
Fix			X	X							Crack cases CC17, HC01, EC02, EC04, EC05 would cause a crash when attempting to change the interpolation type for SIF compounding on the "Geometry Tables" tab.