May 16, 2019

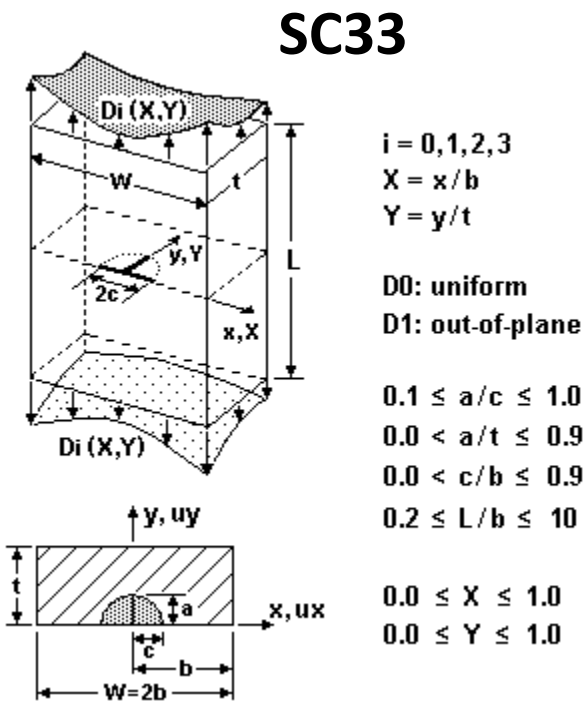
NASGRO v9.1 Release Notes

Stress Intensity Factor Models:

Additional details on the development and verification of the new stress intensity factor models as well as for the revisions presented below can be found in Appendix C of the NASGRO v9.1 User's Manual.

- **New Displacement-Controlled Surface Crack in Center of a Plate (SC33):**

This new model provides a solution for a semi-elliptical surface crack at the center of the plate with its remote ends subjected to a bivariant displacement loading applied perpendicular to the crack plane. It is restricted to require the condition of full symmetry: (1) the surface crack must be in the center of the plate and (2) the remote bivariant displacement loading must be symmetric with respect to the center of the crack.



The development of SC33 was based on the finite element models used to develop CC20 with additional symmetrical boundary conditions imposed to simulate a semi-elliptical crack instead of a quarter-elliptical corner crack. Therefore, the coordinates that describe the displacement variations are in reference to the center of the plate.

The applicable scenarios for the remote displacement type and displacement constraint type are the same as those for CC20. For remote displacement, there are two types:

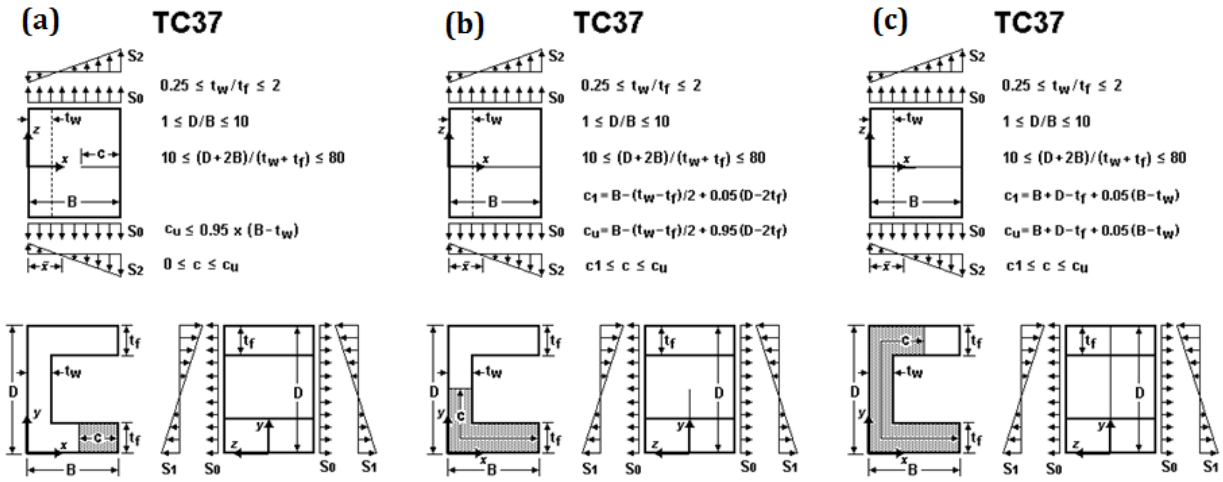
1. Remote tension and out-of-plane bending. (In-plane bending is not permitted because of the centerline symmetry condition.)
2. User-specified remote displacement (must be symmetric about the centerline) in tabular form via file input.

For the remote displacement boundary conditions, there are two types:

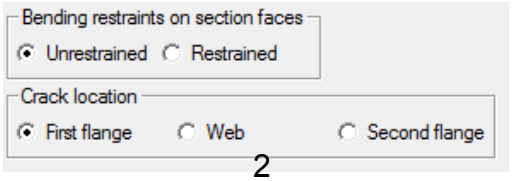
1. Type I: no constraint for displacements in the both *x*- and *y*- directions; displacement in *z*-direction is user-defined
2. Type II: fixed constraint for displacements in both *x*- and *y*-directions; displacement in *z*-direction is user-defined

- **New Through Crack in C-Section under Remote Loading (TC37):**

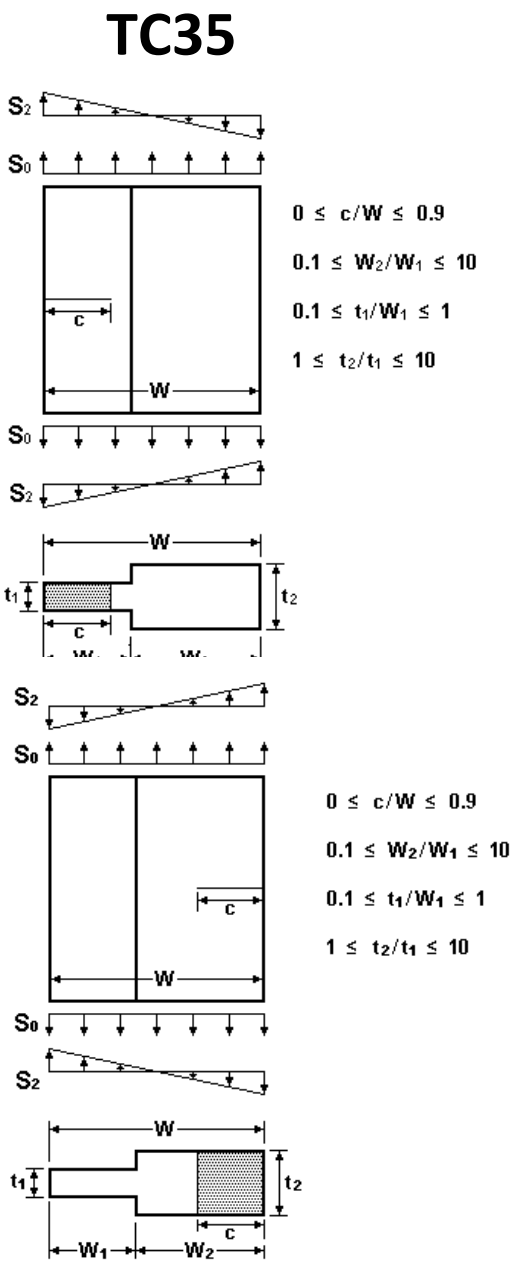
Crack case TC37 represents a through-thickness edge crack in a structural member with a cross-section idealized as a generic C-section. There are three possible locations for the crack – on the first leg (default), on the web, and on the second leg as shown in the figure below. If the crack is located in the first leg (a) then the web and second leg are uncracked. If the crack is located in the web (b) then the first leg is entirely cracked, and the second leg is uncracked. If the crack is located in the second leg (c) then the web and first leg are entirely cracked. 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 small distance from the corner.



Crack case TC37 has two levels of restraint with different loading options dependent on the restraint option. It supports remote loading by S_0, S_1, and S_2 in the unrestrained configuration. Crack case TC37 also supports an optional restraint on the cross-section. For this solution, restraint conditions apply displacement boundary conditions that prohibit deformation at the exterior surfaces and thus the C-section may only be loaded by S_0 in the restrained configuration. The C-section shown in the above figure is unrestrained. Restrained geometries do not support stresses induced by bending. The radio buttons below appear on the TC37 geometry screen and allow the user to choose the location of the crack on the C-section as well as to specify the bending restraint condition. The defaults are the crack location in the first flange (a) and bending unrestrained.



- **Revisions to TC35 (Through Crack at Edge of a Plate with One Symmetric Step Cange in Thickness):**



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.

Previously, in the TC35 model, the crack began in the thin section (t_1) and propagated to the thick section (t_2). Now, for v9.1, the capability to have the crack begin in the thick section (t_2) and propagate to the thin section (t_1) has been added. In both cases, 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 default is to have the crack originate in the thin section. A check box appears on the TC35 geometry page to switch to having the crack originate in the thick section of the plate.

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).

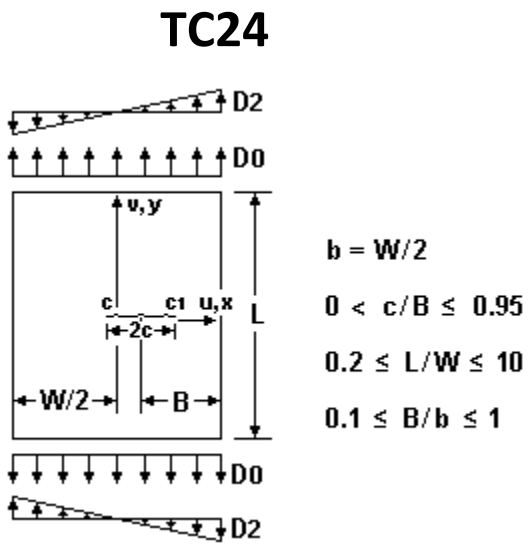
TC35 Option for No End Rotation (in-plane bending restrained)

TC35 now has the option to restrain the end of the model such that in-plane bending is precluded at the remote ends. This option can be selected from a radio button on the TC35 geometry page; however, the default is unrestrained. Once the "restrained" option is selected, only remote tension loading (S0) is available.

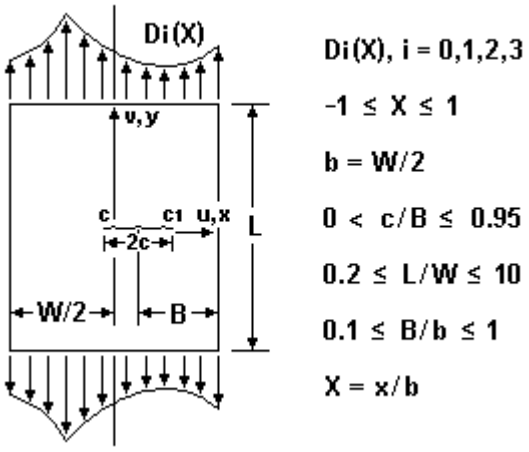
The analytical formulation for TC35 is derived from degenerated weight functions already utilized by other univariant crack models in NASGRO.

- **Revisions to TC24 (Displacement-Controlled <u>Offset</u> Through Crack in a Plate):**

  Previously, TC24 provided a solution for a through crack in the center of a plate under displacement-controlled loadings. For v9.1, TC24 was enhanced to also provide a solution for an *offset* through crack. Displacement options and end constraints are identical to the previous TC24 model; however, the model now defaults to the offset crack geometry configuration. The user can easily revert to using a symmetric (centered) crack with symmetric displacements by checking a box on the TC24 geometry page.



(a) TC24 Remote Tension and/or Bending Displacements



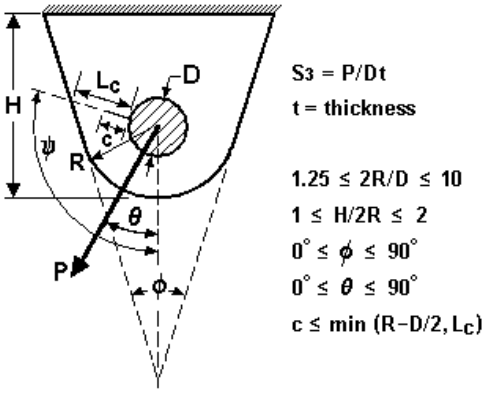
(b) TC24 User Specified Remote Displacements (via Tabular Input)

- **Revisions to Tapered Lug Solutions (TC30 & CC23) with Crack on <u>Long Ligament</u> Side of Hole for Crack Located at Maximum von Mises Stress Location:**

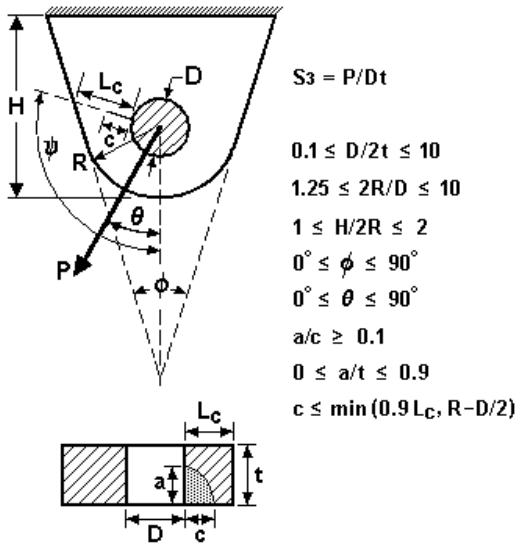
    - **TC30 - Through Crack at Hole in Obliquely Loaded and Tapered Lug**

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

TC30

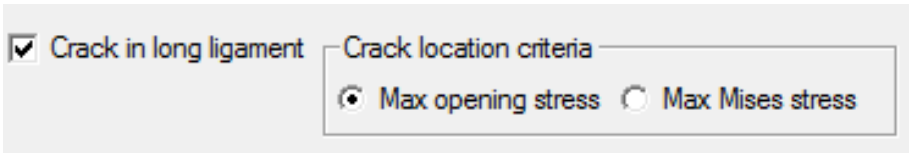


CC23



The two 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 were enhanced in v9.0 to have the capability to handle a crack on the long ligament side of the hole. This location was the location of the "maximum opening stress." For v9.1, an additional option to locate the crack at the "maximum von Mises stress location" has been added for a crack in the long ligament.

The default crack location for these models is in the short ligament. The long ligament option can be selected on the geometry page by checking the box labeled "Crack in long ligament" and now in v9.1, the user has the option of selecting the long ligament crack location via a radio button on the geometry screen:



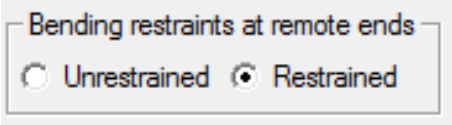
When choosing to locate the crack in the long ligament, the default is to have the crack located at the maximum opening stress location as shown above.

- **Addition of Bending Restraints to Through Crack Models TC28, TC31 & TC32:**

  TC28 – curved through crack at edge of plate
  TC31 & TC32 – through cracks in L-sections

  For these three crack cases, v9.1 now enables users to select a restrained geometric solution in addition to the (default) unrestrained solution. The restrained solutions prohibit in-plane rotation at the far-end of the plate. The restrained solutions lead to less conservative stress-intensity factor values than the (default) unrestrained solution for long cracks. For TC28, the restrained solution supports loading by uniform stress (S_0) and out-of-plane bending (S_1) at the far ends of the plate. For TC31 and TC32, the restrained solution supports loading by uniform tension stress (S_0) only.

  To specify the bending restraint boundary conditions for these models, the "restrained" radio button on the geometry page should be checked:



- **Additional Residual Stress Capability for Several Univariant Weight Function (WF) Crack Cases**

  The ability to input a tabular residual stress distribution when service stresses are specified as remote tension or bend was added to several univariant WF crack cases (EC05, SC30, CC11, TC11, TC12, TC28, SC17, and EC02). In conjunction with this enhancement, the user interface for a few WF crack cases (SC17, SC30, EC02, and EC05) was simplified. Previously, these WF crack cases provided two different locations to select remote tension or bend, but the interface has been changed to match other WF crack cases where remote tension or bend is selectable in only one place in the GUI. The GUI label "User Input" was changed to "Tabular Input" in several places to better describe the option.

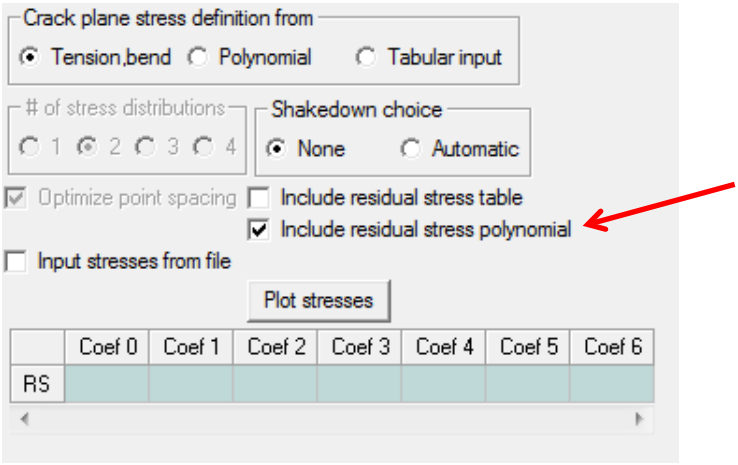
- **TC04, CC02, and CC04 Moved to Superseded Solutions**

  Three legacy crack cases have been moved to the "Superseded Solutions" category because new crack cases are now available that provide clearly superior capabilities and accuracy. Crack case TC04, a through crack at a hole in a straight lug, has been superseded by TC27. Crack cases CC02 and CC04, corner crack at hole in plate, have been superseded by CC16, CC08 and CC17 and provide additional capabilities for this class of geometry. These three superseded solutions are still available in NASGRO but the user must go to the Superseded Solutions category to load them. Old input files using one of these three crack cases will still use the same crack case when loaded into v9.1.

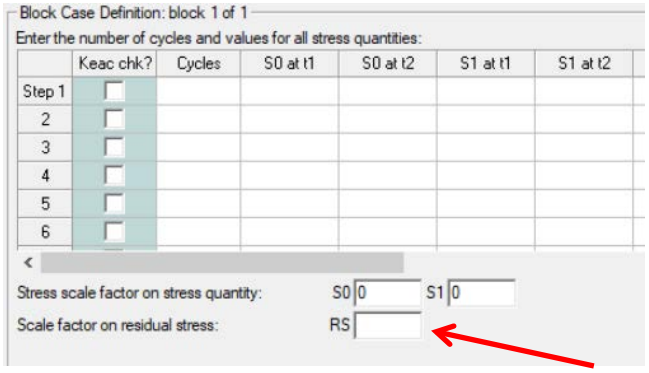
Polynomial Input Option for Residual Stresses:

In previous versions of NASGRO, residual stress distributions could only be input via a tabular input format. In order to facilitate easier use of commonly used equations for weld residual stresses (e.g., API 579 equations) without having to program them into a spreadsheet and then cut and paste the stresses into the NASGRO GUIs, NASGRO now has an option to enter coefficients of a sixth-order polynomial to enter a residual stress distribution. This option is available for all weight function (WF) models that are currently capable of handling a residual stress input. An example of the GUI screen is shown below for a univariant WF case showing the checked box for including residual stress input in the form of a sixth order polynomial as a function of normalized distance (X = x/t) where:

$$\sigma(X) = C_0 + C_1X + C_2X^2 + C_3X^3 + C_4X^4 + C_5X^5 + C_6X^6$$



The residual stress polynomial curve can be plotted using the "Plot Stresses" button. A scale factor can be applied to the residual stress polynomial curve on the Load Blocks page as shown below. This scaling factor is frequently the yield stress.



As similar capability is provided for the bivariant WF models using a two-dimensional cubic polynomial with sixteen coefficients.

Residual Stress Capability Added to SIF Models SC04 and SC06:

The univariant weight function models for a surface crack in a pressurized cylinder (SC04) and for a constant-depth circumferential surface crack in a hollow cylinder (SC06) have been enhanced to enable the input of residual stresses. Both tabular and the new polynomial input formats are now available for residual stress input for SC04 and SC06.

Revisions to Appendix C – Stress Intensity Factors:

Significant revisions to Appendix C of the NASGRO Reference Manual have been made to provide additional detail on many of the stress intensity factor (SIF) models, including additional theoretical background, improved documentation of geometry limits, and revised graphics. Corresponding updates to the GUI displays for the models were also made as needed. While there were many minor revisions, major revisions were made for three general categories of models:

- Surface cracks in cylinders/bolts (SC07, SC08, SC09, SC10, SC13, SC14)
- Tabular data models (DT01, DT02, DT03, DT04) for geometry factor input
- Tabular data models (KT01, KT02, KT03, KT04) for stress intensity factor input

Please refer to Appendix C of the User's Manual. Additional revisions to Appendix C are planned for future releases. A new structured and expanded format for documentation of all of the crack cases has been implemented, so that (when completed) every crack case entry will include standard details such as the crack case diagram, geometry limits, loading options, theoretical background, revision history, and available verification.

Changes to Shakedown Capabilities

NASGRO provides the capability to perform a "shakedown" calculation in which an elastic stress gradient with maximum stresses above yield is modified to obtain the actual elastic-plastic stress gradient using an approximate method. In previous versions of NASGRO, this shakedown capability was only available for selected univariant weight function (WF) crack cases. Beginning with NASGRO 9.1, shakedown capability is also available for selected bivariant WF crack cases. However, while the univariant shakedown capability addresses both monotonic and cyclic yielding, the new bivariant shakedown capability accommodates only monotonic yielding.

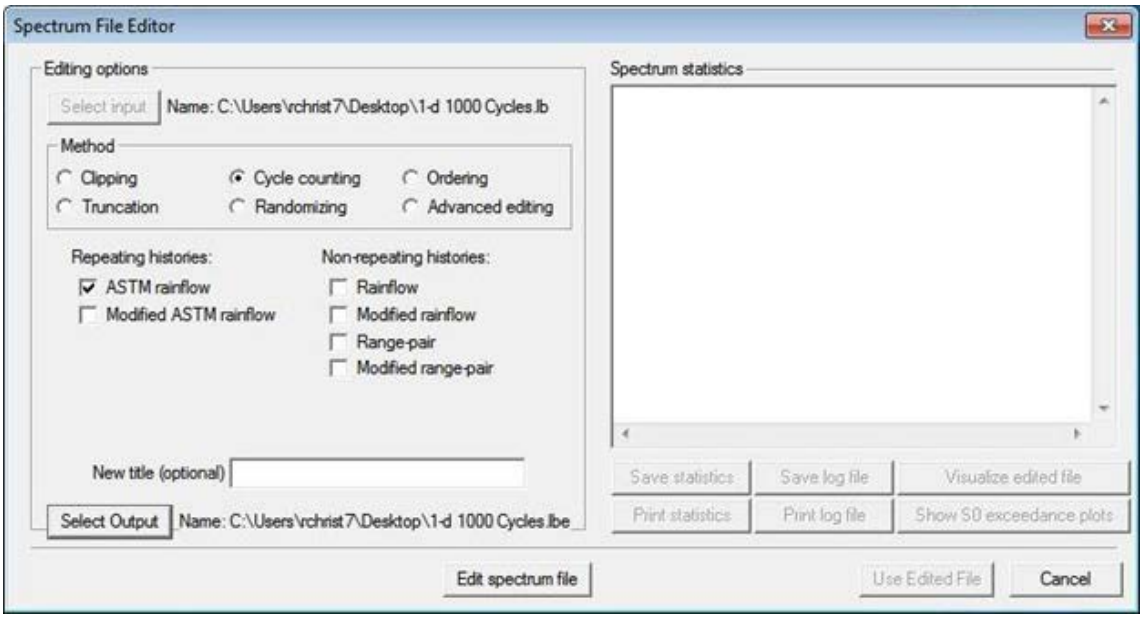
The GUI interface for the univariant shakedown has also changed slightly. Previously the user was presented with three options: off, automatic, and cyclic. The "automatic" selection invoked a check of the stress history to see if sufficient yielding would occur such that monotonic or cyclic shakedown should be invoked. The "cyclic" selection invoked cyclic shakedown but a check was still performed, and cyclic shakedown was not invoked if the stress history did not induce reversed yielding. In v9.1, the GUI interface has been simplified to present only two choices, off and automatic, but no functionality is lost from previous versions.

Revisions and Documentation of NASFLA Cycle Counting Options

The user interface for the cycle counting options in the Edit Spectrum dialogue found on the NASFLA Load Blocks screen has changed in order to describe more clearly the various options available, and a new option has been added. The new labels describe whether the method is intended for repeating or non-repeating histories. The "ASTM" label has been removed from the methods for non-repeating histories since the NASGRO implementation cannot exactly reproduce the method described in ASTM Standard Practice E1049 (because NASGRO does not retain half-cycles). The method formerly labeled as "Downing Algorithm I" has been relabeled as the "ASTM rainflow" method for repeating histories, since it correctly implements that algorithm. This method also gives identical results to the "ASTM range-pair" method for repeating histories. The new method added is "Modified ASTM Rainflow" for repeating histories, which performs identical pairing to the "ASTM Rainflow" method for repeating histories, but rearranges the paired cycles to maintain the original order of the maximum time points. The "Advanced Spectrum Editing" method has been moved to a new section of the Edit Spectrum dialogue since it involves both cycle counting and truncation. All of the changes are summarized in the table below.

Old Label	→	**New Label**
ASTM Range-Pair	→	Range-Pair (non-repeating histories)
ASTM Rainflow	→	Rainflow (non-repeating histories)
Modified Range-Pair	→	Modified Range-Pair (non-repeating histories)
Modified Rainflow	→	Modified Rainflow (non-repeating histories)
Downing Algorithm I	→	ASTM Rainflow (repeating histories)
(No equivalent)	→	Modified ASTM Rainflow (repeating histories)
Advanced Spectrum Editing	→	Advanced Editing (moved out of cycle counting options)

The new GUI window is shown below:



Spectrum File Editor Window for Cycle Counting Options

Remove "0 initially" Option for Cth from Threshold Model

In previous versions of NASGRO, users could choose one of three options on the Material screen to specify the near-threshold fanning factor, Cth or Fth. The simplest options are to use the file value or to set the fanning factor equal to zero (which will give conservatively lower values of the threshold). A third option was to set the fanning factor equal to zero initially but then switch to the file value if the load spectrum met certain conditions. Recent studies have found that this change in values is not adequately supported by data, that the change is not consistently triggered in NASGRO, and that very few (if any) NASGRO users actually use this third option. Therefore, the option was removed from NASGRO 9.1. Any input files from older NASGRO versions with the third option invoked will be amended when they are read into 9.1 to set the fanning factor equal to zero always.

Express Mode Changes

The default calculation mode for NASFLA updates the geometry correction term in the stress intensity factor on every single step in the stress history. "Express Mode" is a NASGRO option in which the geometry correction term in the stress intensity factor is calculated less often than every step. This can significantly reduce the total run time in some cases. Recent studies have indicated that the loss in accuracy when Express Mode is invoked with the standard crack growth calculation increment (0.005) is almost always negligible (total cycles to failure changes by less than 1%). Therefore, minor changes are being introduced to encourage additional use of Express Mode. The Express Mode option can be activated via a check box on the Output Options screen; however, in v9.1 the user now has the option of making Express Mode the default calculation mode (through the pull-down Options menu). If a NASFLA run that does not use Express Mode takes longer than 60 seconds to complete, then advisory messages will be printed to the screen and the output file reminding the user about the Express Mode option.

Additional User-Specified Toughness Capabilities:

The user-specified toughness capabilities have now been implemented for the following material options:

- NASGRO material file: multiple temperatures
- User material file: multiple temperatures
- User-specified toughness for through cracks when "Data source" is "New data"
    - This was previously available for other crack cases

Metric Unit Systems Additional Implementation and Bug Fixes

NASGRO provides four unit systems (US, M1, M2 and M3) for NASFLA, NASSIF and NASCCS analysis, i.e.:

[US]: inch, inch/cycle, kips, ksi, ksi√in
[M1]: mm, mm/cycle, N, MPa, MPa√mm
[M2]: m, m/cycle, MN, MPa, MPa√m
[M3]: mm, mm/cycle, N, MPa, MPa√m

NASGRO also allows the user to change the unit system during analysis. For example, if an input file was created originally under the US unit system, after the user uploaded the input file, the user can change the unit system from US to any other system under the "Options" Menu. NASGRO will automatically convert the input parameters. Note, however, that NASMAT operates very differently and that you cannot change units systems during a NASMAT analysis.

The metric unit systems (M1, M2 and M3) were implemented in different versions of NASGRO. The unit system M3 was first introduced in version 8.2, but it was not fully implemented. In version 9.1, the implementation of unit system M3 was completed and tested along with all the three metric unit systems. The following problems have been identified and fixed:

- Conversion problems on the GUI side with unit systems M1, M2 and M3:
  - Parameter "D1" in SIF compounding not converted
  - Residual stress table not converted
  - The parameters in FAD criteria not converted
  - Parameters "COL" and "CUL" in constant closure model not converted
  - a_0 in Chang-Willenborg model not converted
  - a_0 in material data source of "NASGRO materials file + Walker equation" not converted
  - Two-dimensional tabular da/dN vs. ΔK and R tables not converted
  - Ramberg-Osgood coefficient converted accidentally
  - Incorrect material data shown in "Material" tab under multiple-temperature mode when unit system M1, M2 or M3 is selected
  - Irrelevant warning of "Program cannot verify that entered nonlinear stresses are nondimensional, and thus cannot convert them to the new units"

- Computational problems on the DLL side with unit system M3:
  - Inconsistent fatigue life results under unit system M3 if failure is caused by any of the FAD criteria.
  - Inconsistent fatigue life results under unit system M3 if cyclic shakedown is triggered.

- Additional implementation of unit system M3 for version 9.1:
  - Completed implementation of unit system M3 for constant closure model and strip yield model.

Resolved Problem in NASMAT for New Negative R Data Sets from v9.0:

A number of new fatigue crack growth rate data sets were added to NASMAT in NASGRO v9.0. (Refer to the NASGRO v9.0 release notes for the entire list.) It was discovered that the negative R data sets from Ref. 490 and 491 were erroneously entered into the NASMAT database in the form of *da/dN* vs K_{max} instead of *da/dN* vs ΔK. All fatigue crack growth rate data in NASGRO (NASMAT) should always be expressed in terms of full-range ΔK. Therefore, all of the negative R fatigue crack growth data sets from Refs. 490 and 491 were reviewed and reformatted as needed in terms of *da/dN* vs ΔK for the final release of NASGRO v9.1. The following list of fatigue crack growth rate data sets were reformatted in terms of *da/dN* vs ΔK for v9.1:

NASMAT ID	Alloy	HT	Form	R
M7HA11AB01Q1	7075	T6	Sheet	-0.5
M7HL11AB01B	7075	T76	Plate	-0.5
M7QC21AB01F	7175	T74	Forging	-0.5
M7QC21AB01L	7175	T74	Forging	-0.2
M2EC31AB01F	2024	T3511	Extrusion	-0.5
M7HH11AB01X	7075	T7351	Plate	-0.2
M7HJ31AB01H	7075	T73511	Extrusion	-0.2
M7HN31AB01B1	7075	T76511	Extrusion	-0.5
M7HN31AB01B2	7075	T76511	Extrusion	-1.0
C3KE11AB01D	4130	160 UTS	Bar	-0.2

Note that this problem pertained to *only* negative R data sets in NASMAT from Refs. 490 and 491. It did not affect any fits to the NASGRO equation available in NASFLA.

NASGRO GUI wxWindows Upgrades:

The graphical user interfaces (GUIs) for a number of the NASGRO modules are being upgraded to be more flexible and dynamic. The NASSIF and NASCCS GUIs have been converted entirely to dynamic layouts, adjusting controls for larger or smaller fonts without overlapping, enabling scrolling of the entire GUI pane, as well as retaining the proper layout when changing the GUI size. NASFLA has been partially converted, allowing dynamic layouts for all tabs except the "Material" tab. NASGLS has been partially converted, allowing dynamic layouts for all tabs except "Material" and "OutputOptions". When fully converted, NASFLA and NASGLS will allow scrolling of the entire GUI pane; however, the already converted tabs will now dynamically resize to allow font-size changes and prevent control overlap, as well as adjust properly when resizing the GUI.

New and Revised Material Fits to the NASGRO Equation in NASFLA:

A number of new fatigue crack growth rate data sets were added to NASMAT in NASGRO v9.0. New and/or revised fits to the NASGRO equation for these alloys were developed for v9.1 and are now accessible in NASFLA. The table below provides a list of these new materials and fits followed by the associated references. The "fit status" column indicates whether the fit is completely new for a new material, whether the fit was duplicated from an existing fit for another similar material, or whether the existing fit was edited and is a replacement based on the new data set(s).

NASFLA Material ID	Alloy	Heat treat	Fit status	Ref
C3KE11AB1	4130	150-170 UTS	New fit, new material	491
C4BU28AB1	4330M	220-240 UTS	New fit, new material	491
C4DD11AB1	4340	140-160 UTS	New fit, new material	491
E1GC21AB1	AMS6526	220-240 UTS	New fit, new material	490
G2AD11AB1	15-5PH	H1025	New fit, new material	490
G2EF11AB1	17-7PH	RH1100	New fit, new material	490
M2EF11AB1	2024	T42	New fit for L-T, new material	490, 497
M2EF12AB1	2024	T42	New fit for T-L, new material	497
M2IN31AB1	2224	T3511	New fit, new material	490
M7HA11AB1	7075	T6	New (duplicated) fit	490, 491
M7HG21AB1	7075	T73	Replacement fit	491
M7HL11AB1	7075	T76	New (duplicated) fit	490
M7HN31AB1	7075	T76511	New fit, new material	490
M7SN31AB1	7249	T76511	New fit, new material	492
M7TF11AB1	7475	T7351	Replacement fit	491
O3FB50AB1	A356	T6	Replacement fit	491

New NASFLA Material 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.

497 Forman, R.G., NASA Johnson Space Center internal testing for Israel Aerospace Industries, 2012.

New NASGRO Software Architecture:

NASGRO 9.0 introduced some very significant changes to the software architecture behind the scenes and these changes have been carried forward and improved for v9.1. A significant change was 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. Beginning with 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.

The NASFLA DLLs were initially converted from 32-bit to 64-bit architectures in v9.0. This facilitates significant improvements in memory management. However, 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. At the moment, our 64-bit implementation causes an additional window to open temporarily; we hope to eliminate this distraction in subsequent releases. We anticipate that more NASGRO components will be converted to 64-bit architectures in the future. The NASFORM fatigue module was converted to the 64-bit architecture for v9.1.

NASGRO v9.1a Additions, Changes and Fixes by NASGRO Module

30-Oct-18

Category	Applicable NASGRO Module										Description
	NASGRO Main	Config Control	NASFLA	NASSIF	NASCCS	NASGLS	NASMAT	NASBEM	NASFORM	Users Manual	
Addition			X	X	X						Implemented crack case DT04 -- two dimensional data table for one or two through cracks (two tips)
Addition			X	X	X						Implemented crack case KT04 -- two dimensional stress intensity factor table for one or two through cracks (two tips)
Addition			X	X	X						Implemented metric unit system M3 [mm, mm/cycle, N, MPa, MPa*sqrt(m)] for constant closure model and strip yield model
Addition			X								Implemented the Beta_R correction for crack cases DT03 and KT03.
Addition			X	X	X						Derived and implemented the net section stress solutions for crack cases CC20 and SC33, and for crack cases TC28, TC31 and TC32 with the remote bending restrained.
Addition			X	X	X					X	TC37: net-section stress (NSS) checking module was added, which handles six subcases defined by two different boundary conditions and three crack tip locations. The derivations of the NSS formulations were added to the Appendix B of the NASGRO manual.
Addition			X	X	X					X	TC35: net-section stress (NSS) subroutine was added for a newly introduced bending constraint option. Appendix B was updated with pertinent addition.
Addition							X				Warning added to NASMAT when fitting threshold data if the resulting value for Cth+ is outside the following bounds: $-0.50 \leq Cth+ \leq 10.0$.
Addition							X				Warning added to NASMAT when fitting threshold data if the resulting value for Fth+ is outside the following bounds: $0.0 \leq Fth+ \leq 8.0$.
Change			X				X				References for da/dN data for 2524-T3 sheet, 6156-T6 sheet, 2099-T83 extrusion, and 2024-T42 sheet/plate were updated to reflect that testing was performed at NASA-JSC for IAI.
Fix			X			X					Due to a code indexing error, the following crack cases were excluded from certain GUIs' cracked body type lists in the Crack Case Library dialog, as follows: -CC20 was missing from cracked body type:plate for NASFLA; -EC05 was missing from "plate" cracked body type:plate for NASGLS.
Fix			X								NASFLA GUI FAD plotting for multi-runs (using the "Do parameter analyses" option on the Computations tab) was not enabled.
Fix			X								TC24 width dimension was not reduced by half when compared with the crack depth resulting in incorrectly terminating the computation.
Fix			X								Output echoes of TC24 applied displacements shown to be zero. It's resolved by revising the display format in scientific format.
Fix							X				Under Windows 10, on the "Curvefit/Plot" tab, clicking any button while a threshold text control (Smax/SIGo th, Alpha th, DK1, CTh+, Cth-, DK1f, Fth+, Fth-) is active resulted in the GUI closing.
Fix			X	X	X					X	TC35: Fixed a bug in NSS force and moment formulation for S2 stress gradient. Revised the Appendix B of the manual accordingly.
Fix			X								Crack cases CC09, EC04, SC06, TC06, TC07, TC08: The Failure Criteria options on the NASFLA GUI Material tab were not being shown, when "New Data" was selected as the Data Source, for the Data Formats "NASGRO equation constants" and "1-D table: da/dN vs dK".
Fix			X								In the NASFLA GUI, when saving user-defined material data to the user material database, the three new fields for the Failure Criteraia options for "FAD:API 579 L3 Method A", and "FAD:API 57 L3 Method B": (min yield, mean E, and Lr max), will now also be saved to the material record.
Fix			X								DT & KT models did not run when requesting tabular data to be saved to file. The saved-to-file features were not implemented in v9.0f. The revised version should resolve this issue. This errneous scenario could be found in all KT and DT models.
Fix			X								SC30 multi-block NASFLA analysis deck working in v8.2 but not working in v9.0f. The issue was identified from the data type in API functions to store the number of cycles per step. It was declared in terms of integers. The truncation for fraction of a cycle resulted in 0 cycles and computation termination. The revision uses the floating data type to resolve this issue.
Fix			X								The saved values of material parameters p, q, DK1, Cth, and Cth- were loading incorrectly, as blanks, from the GUI input file.
Fix			X								Missing crack tip designation names in final "analysis results" session of old OUT1 files for ECXX (four tips) crack models. The scenario was not observed in new OUT files.
Fix			X								The "saved-to-file" option for KT01 NASFLA generated all-zero columns in DATBSI file. The code for the "linear" and "hermite" interpolation options was not implemented for the "saved-to-file" option. The revision includes these updates.
Fix			X								Inconsistent final schedule number when no crack growth is detected. An incorrect variable was printed resulting in this issue. The revision should resolve this erroneous final result.
Fix			X								Computation for two SC04 scenarios could not be completed. A bug was found where the "kind" of crack model was overwritten during the generation of reference solution tables.

NASGRO v9.1a Additions, Changes and Fixes by NASGRO Module

30-Oct-18

Category	Applicable NASGRO Module										Description
	NASGRO Main	Config Control	NASFLA	NASSIF	NASCCS	NASGLS	NASMAT	NASBEM	NASFORM	Users Manual	
Fix			X	X	X	X					Crack case DT01: corrected the default internal interpolation type to be "Linear". The on-screen label showed Linear, but internally, the type was incorrectly Cubic Spline.
Fix			X	X	X	X					GUI plotting of user stress files using commas as separators did not work.
Fix			X								When plotting long block spectrum files, the stress quantity labels were not displaying correctly in the plot legend for Min-Max spectrum plots. Incorrect stress quantities were being shown (S2 instead of S3, for example).
Fix						X					NASGLS transition problem (SC30 to TC12); analysis never finished. An uninitialized flag inside DLLs for NASGLS was identified to cause the program to run in interactive mode. Initializing the variable resoved the problem.
Fix						X					NASGLS OUT1 file did not print output for every load step. The output statements for the new OUT1 files were implemented to resove this issue.
Fix			X								GUI crashed when selecting first 8 items in "show selected details" window of NASFLA Computation GUI tab. The pitfall was a redundant data line in new OUT2 file leading to GUI crash as a result of parser error. The update resolved this unstable software crash issue.
Fix				X							Plotting of SC31 NASSIF results was running into an infinite loop. Current plotting function for SIFs in DLLs can only support up to two crack tips. The subject SC31 analysis is a 3D case. The revision added a check in the pre-API routine to capture this inconsistency and terminate the computation, instead of allowing this error trickle down into post-API and get stuck in the infinite loop.
Fix			X								When the on-screen values of the Cth and Fth material parameters (DK1, Cth, Cth-, DK1f, Fth, Fth-) were changed, an internal issue occurred when saving the input file, causing these new values to not be saved.
Fix			X	X	X	X					There was an inconsistency between GUI polynomial input display and documentation Appendix C. The on-screen column labels in the grid for entering polynomial crack plane stress definitions have been changed from "Coef 1, Coef 2, Coef 3, Coef 4, Coef 5, Coef 6, Coef7", to "Coef 0, Coef 1, Coef 2, Coef 3, Coef 4, Coef 5, Coef 6", to correctly correspond to the user documentation of the polynomial equation in Appendix C.
Fix			X	X	X	X					When working in metric units systems with multi-temperature data, or converting between US and any metric system, multiple field were being erroneously left unconverted (D1 in SIF compounding, residual stress tables, FAD parameters, some multi-temperature material information) or occasionally double converted (some multi-temperature material information).
Fix			X	X							Crack Case KT03: When changing the crack tip on the "Geom Tables" tab with t1,t2 enabled, the t2 grids are not updating, resulting in only the t1 grid values being retained.
Fix			X	X							Crack Case KT03: When changing crack tips on the "Geom Tables" tab, the grids were not properly updating on screen, leaving users unable to fill in any grids other than the first crack tip.
Fix			X								Missing advisory message in new OUT1 file when SIF ratio R is less than -2. The subject case had computed SIF ratios, R, less than -2, and the old OUT1 file showed the correct advisory message. Additional output statements were implemented in the update to clarify this issue.
Fix			X								When using the Walker equation on the "Material" tab, the a_o and Dkth fields were not being written to the batchfile, blocking computation. Further, when utilizing the Walker equation with user data selected, the a_o and Dkth fields were not being displayed to allow users to alter or update the values.
Fix			X								Loading multiple input files where the material file cannot be found -- such as a specified user file that does not exist, or does not exist in the location specified in the input file -- can crash NASFLA under some circumstances.
Fix					X						Crack case CC23: an internal indexing issue caused an incorrect value to be written to the NASCCS batchfile for the a/c ratio.
Fix				X							On the "Load Blocks" tab, deleting a "Stress scale factor" entry without replacing it would result in the change not being saved. NASFLA would run computations using the previous value, instead of properly alerting the user that there was a missing value. This would result in users seeing erroneous results and has been fixed..
Fix			X	X							For SIF Compounding, the number of defined tables for a given stress quantity and crack tip was not being saved correctly to the input file. When these incorrect settings were then read from the input file, the number of tables was incorrectly being set to 1 in the GUI, despite there being more table data (second, third tables, etc.), which caused the additional table data to be missed, and not written to the batchfile, thereby affecting the computed output.
Fix				X							Plotting TC32 beta correction factor did not terminate computation and resulted in an infinite loop. An error was found in plotting routines leading to them being stuck in infinite loop requesting more information in interactive mode. It's been resolved.

NASGRO v9.1a Additions, Changes and Fixes by NASGRO Module

30-Oct-18

Category	Applicable NASGRO Module										Description
	NASGRO Main	Config Control	NASFLA	NASSIF	NASCCS	NASGLS	NASMAT	NASBEM	NASFORM	Users Manual	
Fix			X	X							Crack case TC34: an incorrect crack tip assignment for this crack case prevented SIF Compounding data from being entered on the GeomTables tab when SIF Compounding was selected on the Geometry tab.
Fix				X							Crack case CC20: Geometry edit checks were erroneously excluded for this crack case for the NASSIF GUI.
Fix			X								Fixed the DLL problems with the third metric unit system (M3) in the FAD failure criteria and cyclic shakedown capabilities, where the stress intensity factors were not converted to the correct unit (MPa√m) before da/dN calculation and failure check.
Fix				X							Crack Case TC28: On the "Output Options" tab, the "Select output format" radiobox was improperly re-enabled when loading or selecting TC28 after loading an previous TC28 input file. The "Plot solutions" option is not a valid option in this radiobox for TC28
Fix			X								Crack Case SC17: Express mode on the "Output Options" tab is not properly re-enabled when changing the Shakedown option to "none".
Fix			X								TC13 old OUT2 file shows F0 and F2 for remote tension and pin load instead of F0 and F3. The inconsistency did not occur in new OUT1 files. It's been resolved in the update.
Fix			X								Array overflow cacshing the code in Debug mode when using a TC12 NASFLA input deck. The array at fault has been expanded to account for four stress quantities and one residual stress.
Fix										X	Table of Contents page numbers of the main manual were out of order. Made corrections and updated pdf and doc files.
Fix			X								On the "Build Schedule" tab, on the "Details" column for the "Summary of distinct blocks already defined" grid, user-entered changes were being erroneously overwritten when changing between blocks. User-entered changes will now only be overwritten when changing block types.
Fix			X								On the "Load Blocks" tab, when using "Input cycles and stresses manually", right-clicking to "Save grid to BLOCKS database" would erroneously generate the error message "Spectrum Error: Some grid cells for block X are empty" even when all grid cells were properly filled, blocking the data from being saved.
Fix			X	X	X						Computation completed with memory crash when Linux version of DLLs was developed. Memory leak from incomplete memory deallocation and pointer nullification was identified resulting in the crash. Both v9.0f and v9.1a RC had the same issue.
Fix			X								FAD assessment line does not plot when limit stress opiton is selected. The error was found from the inconsistent labels for FAD loci in OUT2 files in accordance with GUI requirement.
Fix			X								Multiple temperature application showing same alpha and Smax/Sflow stress ratio in OUT file. A section of software code that had been commented out in v8.2 was found not being carried over to v9.0. This error imposed using the properties at first temperature for the subject two parameters.
Fix			X								Large NASGRO load blocks caused NASFLA analysis to crash. The problem was identified to be with the stack size originally allocated to store load spectrums in binary form. It appears converting the program from 32-bit to 64-bit needs to reduce this stack size slightly to prevent overflow.
Fix			X								Long block with CC08 remote load scenario crashed the program. The pitfall was found from the incorrect handling/stacking the long blocks in the routine to determine the initial crack site. The error overflowed the array elements and resulted in program crash. Both v9.0 and v8.2 were fixed for the same root cause.
Fix					X						SC04 NASCCS completed with error showing inconsistency in batch file. The problem was identified that a few statements in the parser located in the pre-API routines were misplaced. Fixing it resolved the issue. This erroneous scenario occurred only when internal pressure is not used.
Fix			X								Values for the Walker equation constant "C" were not being loaded from the input file into the Walker equatin constants grid on the NASFLA GUI Material tab.
Fix			X								User constant Kc from KIc input cell did not work; analysis terminated w/o result. For this specific scenario, an error was found in the pre-API routine when parsing the batch file.
Fix			X	X	X						No difference in SIF found for CC19 crack model with one or two symmetric cracks. A typo in the source code resulted in an invalid flag to indicate the crack status. This was identified a v9.0 issue.
Fix			X	X	X						Internal source discrepancy found in CC21 on the definition of "r" and "d". It was found reversed. The fix had been applied in v8.2 but appeared never becoming effective in v9.0.

NASGRO v9.1b Additions, Changes and Fixes by NASGRO Module

27-Feb-19

Category	Applicable NASGRO Module										Description
	NASGRO Main	Config Control	NASFLA	NASSIF	NASCCS	NASGLS	NASMAT	NASBEM	NASFORM	Users Manual	
Addition & Change			X								The small crack parameters a0 and Kth(s)/Kth(l) have been added to the Walker equation display on the Materials tab for use of the Chang-Willenborg load interaction model with new data and/or the user material file.. The GUI display of the Rcut and threshold parameters used in the Walker equation was reordered to be more logical.
Fix				X							Computing SIFs using NASSIF for KT models only showed partial output. Uninitialized character strings were identified causing GUI to display OUT1 result in Output Windows incorrectly.
Fix			X								Enabling FAD analysis option for NASFLA inverse computation.
Fix			X								Computed Lr for SC05 subjected to pure bending appeared too small. The equation used to compute bending moment for SC05 was found incorrect. After revision, the result is in very close variation with those values provided by client.
Fix			X								SC31-CC09-TC12 NASFLA analysis failed to complete once crack transitioned into TC12. The internal stress transformation for bivariant crack models resulted in non-zero coordinate at the stress origin (very tiny negative number). This caused the OPS routine to behave erratically during stress remapping.
Fix							X				Corrected the erroneous information (version number and date) displayed in NASMAT threshold fit plotting
Fix			X								Crack Case TC35: OPS checkbox was not properly disabled/greyed out when residual stress was selected.
Fix			X								Crack Case TC35: NASFLA results showed no difference for analysis with and without residual stress. The inconsistency was found because the residual stress feature was not implemented.
Fix				X							Crack case TC16: a coding error in the creation of the NASSIF batchfile for this crack case prevented the analysis from running when computing correction factors.
Fix			X								The Keac value was not being properly set when loading an input file that set the long blocks via file input or generated a long block. (Options 3, 4, and 5 under "Set block type").
Fix			X								Klimit values for TC28 were larger than Kmax values even with larger scale factors for limit stresses. The inconsistency resulted from incorrect referenced crack length being provided to compute the Klimit values.
Fix				X							Tabulated SIFs or correction factors for TC28 contained inconsistent crack tip label "cB". "cB" was used during development. The fix has changed this designation to be "c2" in accordance with the notation used by GUI.
Fix			X								No echo was displayed for the selected post-transition geometry: TC12 or TC28 for CC11 crack model. The revision has been extended to two other crack models: CC01 and CC09 that have the similar dual post-transition option.
Fix			X	X							An internal coding error casued the NASFLA and NASSIF GUIs to be unable to echo the SIF Compounding data from the out1 file to the output view window on the Computations tab.
Fix			X	X	X	X					Crack case CC11: The column headers for c- and c2-related data were reversed, when viewing output data on the Computations tab.
Fix			X	X							Deactivated the View menu option "Toggle full screen mode". This option should have been temporarily deactivated earlier (but was not) for the development of the new feature to add scroll bars for better window resizing. It has been deactived for now until this feature has been fully implemented.
Fix				X							Values of xbar and ybar in OUT2 file for TC37 appeared being flipped. Incorrect calls to routines were identified and the issue is corrected.
Fix			X								Fracture toughness for TC37 should be a function of thickness from web or flange. The revision has been applied and also extended to two other crack models: TC31 and TC32.
Fix			X								Crack Case TC37: Cases where the crack was located at the web or second flange were being blocked from execution due to incorrect geometric limits.
Fix			X								Computed Klimit with TC37 crack model dropped after crack transition from flange to web. This was caused by the reference crack length used to compute Klimit being incorrectly provided.
Fix			X								Kmax value of TC37 after transition from flange to web displaying inconsistent behavior. It was found the Kmax value after transition had not been updated leading to such erroneous behavior.
Fix			X								Different Kmax vs c relationship once CC23 transitioned into TC30. This issue has been resolved by utilizing the same crack plane stress for CC23 and TC30.
Fix			X								The transition message from CC23 to TC30 in OUT2 files was clarified. The erroneous message involving "a/c" ratio with TC30 has been removed.
Fix			X								Usage of 1D table resulting in large amount of pesky lines in OUT1 and SCREEN.OUT files. An uninitialized parameter was found floating around enabling the output of these "pesky" messages.
Fix			X	X	X	X					Crack case TC13: Adjusted geometry limits expressions in the bitmap to remove redundancies and conflicts, as follows: - For remote stresses, and for crack in long ligament: removed "B <= W/2". - For two symmetric cracks: removed "0.1 <= 2B/W <= 1".

NASGRO v9.1b Additions, Changes and Fixes by NASGRO Module

27-Feb-19

Category	Applicable NASGRO Module										Description
	NASGRO Main	Config Control	NASFLA	NASSIF	NASCCS	NASGLS	NASMAT	NASBEM	NASFORM	Users Manual	
Fix			X	X	X	X					Fixed an error in conversion of stress intensity factors from unit MPaÖ(mm) to MPaÖm under the unit system M3 [mm, MPa, MPaÖm] for CC09, CC10 and SC29.
Fix			X	X	X						Crack case SC18: Removed pinload P from the bitmap image displayed for the selection of two symmetric cracks at a centered hole with tabular input.
Fix			X								CC08 monotonic shakedown analysis failed when using debugger; worked fine in release version. The issue involving arrays being overflown during monotonic shakedown was identified and resolved.
Fix			X								The GW and MGW retardation models were not working with SC32 crack model in NASFLA analysis. The new crack model was found not being enabled to work with these retardation models.
Fix			X	X	X	X					Crack case CC08: Various bitmap images for this case have been corrected as follows: - For crack in long ligament: a limits expression was changed from: "0 <= c/(B-D/2) <= 0.9" to: "0 <= c/(W-B-D/2) <= 0.9". - For crack in long ligament using tabular input: - The definition of "X" was changed from: "X = x/(B-D/2): to: "X = x/(W-B-D/2)". - The lower cross-section image was not updated to reflect the location of the crack on the opposite side.
Fix				X							Crack Case CC11: Under "tension, bend" the stress scale factors on the "OutputOptions" were erroneously both labeled "S0".
Fix			X		X						On the "Load Blocks" tab when multiple blocks were defined, the stress scale factors for stress quantities S1-S3 were not being retained when switching between blocks. Further, the S1-S3 quantities defaulted to blank instead of "0".
Fix					X						In the NASCCS GUI, When right-clicking on the Load Blocks grid that defines multiple blocks, a right-click mouse menu was shown in error. This menus does not apply to this specific grid.
Fix			X	X	X	X					For all cases that use 2D polynomial stress distribution: adjusted the column labels in the polynomial stress grid to more clearly correspond to the documentation of the equation and coefficients as depicted in Appendix C, as follows: Before: Coef 0, Coef 1, Coef 2, Coef 3, Coef 4, Coef 5, Coef 6, Coef 7, Coef 8, Coef 9, Coef 10, Coef 11, Coef 12, Coef 13, Coef 14, Coef 15. After: Coef 0,0; Coef 1,0; Coef 0,1; Coef 2,0; Coef 1,1; Coef 0,2; Coef 3,0; Coef 2,1; Coef 1,1; Coef 0,3; Coef 3,1; Coef 2,2; Coef 1,3; Coef 3,2; Coeef 2,3; Coef 3,3.
Fix			X								An incorrect internal assignment caused the NASFLA GUI to be unable to load multi-temperature material IDs containing more than 9 temperatures across all available temperature sets.
Fix			X	X	X	X					Crack case SC03: Corrected bitmap expression for S1, removing W and using Mbar instead of M to denote uniform moment per unit length.
Fix			X								Crack case BE03 was misssing from the Crack Type: Superseded Solutions listing in the Show Crack Case Library dialog window.
Fix			X								Computation crashing when the a KT03 NASFLA analysis was performed. The pitfall was found resulting from the number of output columns exceeding the specified limit.
Fix							X				Material ID C4DD11AB01 was missing the R=0.5 and R=0.8 data.
Fix			X								Miscellaneous NASFLA issues encountered during v9.1b release testing for TC11 and SC17 crack models. Two issues were identified: (1) when failed right away, the program crashed due to arrays for binary database not being allocated yet, and (2) the iteration in inverse computation terminated prematurely due to altered OPS flag. The revision corrected both issues.
Fix			X								CC08 NASFLA analysis crashes at very early steps with long block. It was found the direct assignment of large arrays not functioning correctly resulting in program crash. Revising the assignment in a loop resolved the issue.
Fix			X	X	X						Crack Case SC30: When "tabular input" was selected the "Plot Stresses", "Optimize Point Spacing" and "Input stresses from file" controls were missing, as well as the stress definition grids. Furthermore, when selecting "Polynomial" from the "Crack plane stress definition from" radiobox, both the polynomial input grid and the S0 linear stress grid could appear simulteanously.
Fix			X								Crack Case TC17: When selecting "residual stress", the "Optimum Point Spacing" checkbox was not automatically checked and then disabled.
Fix			X	X	X	X					Crack case SC04: Tabular stress data for S1 and higher was not being saved to input file, when "S0 from internal pressure" checkbox was checked, and S0 was displayed.
Fix			X	X	X						Crack case SC26: Stresses could not be plotted, the Plot Stresses button was not functioning.
Fix			X	X	X						The feature to compute correction factors was not working for TC24 in the NASSIF module. Inconsistencies were found in the parser interface with the batch file generated by GUI. One additional bug was also identified and fixed during computing stress intensity factors when the cracked plate is subjected to remote displacements.
Fix			X								Crack Case TC30: Enabling shakedown crashed NASFLA. The call arguments to the SIF routine for limit stress were found misplaced resulting from implementation of a new feature. The error only got triggerred when limit stress was invoked.

NASGRO v9.1b Additions, Changes and Fixes by NASGRO Module

27-Feb-19

Category	Applicable NASGRO Module										Description
	NASGRO Main	Config Control	NASFLA	NASSIF	NASCCS	NASGLS	NASMAT	NASBEM	NASFORM	Users Manual	
Fix			X								Crack Cases EC02, EC05, SC17, SC30, TC11,TC12,TC28,CC11: When loading an input file with "tension, bend" selected and shakedown set to "automatic", the shakedown choice would be reset to "none'.
Fix			X								Crack cases CC11, TC11, TC12: When the failure criteria option "FAD: API 579 L3 MetB" was selected on the material tab, changing the crack plane stress definition selection to Polynomial would erroneously cause the stress-strain material properties grid on the Material tab to be removed from the screen.
Fix					X						Crack Case EC04: NASCCS crashes using NASGRO GUI; error code found when running in batch mode. A numerical issue was uncovered from the digital conversion resulting in very tiny difference in a/c ratio from the specified value 0.1 (the lowest allowable a/c ratio). As a result, an error code was triggered and iterations were terminated. The fix implements a tolerance when verifying the solution bounds to prevent from triggering an error code.
Fix					X						When "tabular" or "polynomial" crack plane definition was selected, changing the "Basis for calculating critical crack size" on the OutputOptions tab erroneously reset the number of stress quantities to 1.

NASGRO v9.1f Additions, Changes and Fixes by NASGRO Module

16-May-19

Category	Applicable NASGRO Module										Description
	NASGRO Main	Config Control	NASFLA	NASSIF	NASCCS	NASGLS	NASMAT	NASBEM	NASFORM	Users Manual	
Addition			X	X	X						Crack case SC08: Expanded the informative note in the diagram image, to specifically state that this case should NOT be used for machined or cut threads.
Addition			X	X	X						Crack cases SC08, SC09: These cases were also added to the "cylinder" cracked body type category in the Crack Case Library.
Addition			X	X	X	X					Crack cases TC13 (NASFLA only), TC14, TC17, TC18, TC19: Added functionality to display unique crack case diagrams corresponding to the specific geometry settings that are chosen, such as crack plane stress definition, displacement definition, notch shape, and embedded hole shape.
Addition			X	X							Crack case TC28: Enhanced the crack case diagram that is displayed when "Bending restraints at remote ends" is set to "Restrained", adding the expression: "v(x,y) = z-displacement at remote ends", and an arrow to indicate the z-axis direction.
Addition			X								Added the capability to allow input of the crack growth increment ratio (on the Output Options screen) for the following load interaction models: the Generalized Willenborg, the Modified Willenborg and Change-Willenborg models.
Change			X	X	X	X				X	Crack cases SC03, SC04, SC05, SC06: bitmaps were modified to show separate drawings for internal and external crack options.
Change			X	X	X						Enhanced output details for the plotting of the residual stress polynomial equation: added grid lines, added unique colors for upper and lower suface of the 2d plot surface, and made the surface opaque, to improve appearance.
Change			X	X	X						Crack case SC09: Updated description, from "…at thread root in cylinder" to "…in threaded solid cylinder."
Change			X	X	X						Crack case SC10: Updated description, from "…in threaded pipe" to "…in threaded cylinder".
Fix							X				The negative R fatigue crack growth data sets added in v9.0 (ref. 490 and 491) were erroneously entered in terms of da/dN vs Kmax instead of da/dN versus DeltaK.
Fix			X								When plotting residual strength for CC16 cases that undergo transition, sqrt(pi*c) was used both before and after transition, instead of using sqrt(pi*a) before transition and sqrt(pi*c) after.
Fix			X	X	X	X					Crack case TC09: Correction to diagram to redefine out-of-plane bending stress S1, removing W (since this case is an infinite plate, and W is not an input parameter) as follows: from: "S1=6M/Wt*2", to: "S1=6M'/t*2" (where M' is uniform moment per unit length)
Fix			X	X	X						Two approaches using same stress gradients resulted in two different results using TC11 NASFLA. The discrepancy had been resolved.
Fix			X								Crack cases TC12, SC30 and EC05 would not complete computation when both polynomial residual stress and secondary cyclic stresses were selected.
Fix			X	X	X						Coefficient labels for polynomial residual stress were inconsistent between GUI and OUT1 file echo. Revisions have been made for consistency.
Fix			X	X	X						Crack case SC30: No plot generated for polynomial residual stress when choosing "tension, bend" as the crack plane stress definition.
Fix			X	X	X	X					The "Save diagram to file" button on the geometry tab would not save the selected bitmap, showing only a pure black bitmap.
Fix			X	X	X	X					Menu shortcuts using the "CTRL" key did not work when used.
Fix			X	X	X						Hole offset of TC23 crack model within solution limits was crashing the program. Revising the validity check routine resolved the erroneous scenario.
Fix										X	Crack Case EC05: The lower limit on a/c in the manual was fixed to be 0.01 (it was 0.1).
Fix			X								When comparing two material IDs, the "C" value was not being properly converted, resulting in incorrect plots when any of the materials required units conversion.
Fix			X								DT01 cubic splint fit was not plotting/working correctly. Mismatch in the size of array passed into fitting routine was found. The erroneous manifestation seemed only caught in multi-DLL versions.
Fix							X				NASMAT was not properly converting the "Ultimate Strength" value when saving a material to the NASMAT user database.
Fix			X								SC31 FAD analysis not completed and with no indication of any errors. A better exit approach was implemented to help the user to isolate the root cause.
Fix			X	X	X						Corrected label in residual polynomial stress grid for "Coef 1,2".
Fix			X								Kmax derived from SC33 NASFLA dropped to zero when crack grew to certain sizes. Incorrect check on the solution limits leading to additional invalid computation was identified.
Fix			X								The surface crack closure correction factor, Beta(R), was being applied at the wrong crack tip for SC33 NASFLA analysis. Typos in the conditional check were identified and corrected.
Fix			X	X	X						Missing crack model description in OUT1 for SC33 crack model. The revision gives the description of crack model as "SC33-Surface crack at center of plate, displ controlled" instead of "SC33 - MODEL DESCRIPTION NOT DEFINED".
Fix			X		X						Residual stress was not working for CC09 (with file or polynomial input). Bug was identified due to recent implementation for bivariant shakedown. Only NASSIF and NASCCS for bivariant crack models were affected.

NASGRO v9.1f Additions, Changes and Fixes by NASGRO Module

16-May-19

Category	Applicable NASGRO Module										Description
	NASGRO Main	Config Control	NASFLA	NASSIF	NASCCS	NASGLS	NASMAT	NASBEM	NASFORM	Users Manual	
Fix			X								When loading an input file wherein the material was defined under "new data" and the "p" and "q" paramaters set to "0.0", the loaded input file would display blanks for "p" and "q".
Fix			X								On the Material tab, when entering "New Data" for any load interaction model and data format, the on-screen text labels for the 2-character alloy code and description, and 4-6 char form/orient/env code and description, were missing.
Fix			X								Corrected the description of the cycle counting method that was used, printed at the top of the log file, to correctly display the text description of the checkbox that was checked.
Fix			X								When making comparison plots in unit system M3, the input thinckness in mm was not being converted to meters. This has been fixed. Axis labels and unit labels have also been fixed for the M2 and M3 comparison plots.
Fix			X								Indirect NASFLA for stress scale factor using EC05 subjected to remote loads finished with error. Two issues were identified; first was from a file status check which should be valid only for direct analysis. The second was from typos in source files resulting in incorrect stress gradients retrieved during iterations.
Fix			X								NASFLA analysis wouldn't work for one stress definition with t1/t2 different gradients due to same SCF ratios. The termination was from an invalid internal error check. This check is revised to allow the program to complete the computation.
Fix			X								Rainflow counting using ASTM method for repeating cycles (previously Downing Algorithm I) did not include unpaired loads in counted cycles. This is fixed by counting cycles backward after first complete pass over load spectra. Also the algorithm was inconsistent in min-max ordering depending on whether extreme value was min or max. This has been changed so that the final rainflow counted spectra has the same min-max order as the original spectra.