

R16.1.0 Release Notes

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1 Release notes revision

This file constitutes revision 0 of the release notes for Ansys LS-DYNA® version R16.1.0.

2 License

The string “REVISION 16” must appear in the license file to run version R16.1.0. Please contact your distributor or your Ansys sales representative if you need to have your license updated.

3 Documentation

The R16.0 User's Manuals provide documentation for R16.1.0. To download these manuals, go to <https://lsdyna.ansys.com/manuals/>. For features mentioned in these notes missing from the R16.0 User's Manuals, please refer to the DRAFT User's Manuals at <https://lsdyna.ansys.com/-manuals/>. Please note that not all features in the DRAFT User's Manuals are available in version R16.1.0.

4 Notes

The remainder of this file briefly describes new features, enhancements, and bug fixes in version R16.1.0. Other recent releases may also include some of these updates.

We arranged the items by category. Understand that, in many cases, a particular item may pertain to more than one category. In the interest of brevity, we list each item only once, under a single category.

5 New

5.1 Airbags

1. Added the standard $k-\epsilon$ turbulence model to the CPG solver (optional) using ITURB in ***CONTROL_CPG**.
2. For CPG airbags, added dynamically adapting surface particles according to current element area.

5.2 Multiscale

1. Initial release of the MAPDL LS-DYNA co-simulation feature. This feature is limited to modeling solder reflow. It uses adaptive ISPG to model the solder balls. See the beta documentation for LS-DYNA on the Ansys help website for details.

5.3 User-Defined Features

1. The usermat package now contain a file named userLE.F90. With this file, you can provide your own linear equation solver (typically to solve $\mathbf{Ku} = \mathbf{f}$ for \mathbf{u} , with \mathbf{K} as the stiffness matrix and \mathbf{f} as the load vector) for implicit analysis. Please reach out to the LS-DYNA linear algebra for help.

6 Improvements and Enhancements

6.1 Acoustics, NVH, and Frequency Domain

1. Added acoustic directivity (***FREQUENCY_DOMAIN_ACOUSTIC_DIRECTIVITY**) output for collocation BEM (METHOD = 3 on ***FREQUENCY_DOMAIN_ACOUSTIC_DIRECTIVITY**).
2. Made (***CONTROL_IMPLICIT_SSD_DIRECT**) available in MPP.

6.2 Airbags

1. Add optional local average interparticle distances around vents and orificies with fields HLENV and HLENO in ***AIRBAG_CPG** for local refinement around these critical areas.
2. Added part output of mass flow rate, heat transfer, and heat transfer rate to abstat_cpg. Also, added global output of the total mass and average temperature of each airbag to abstat_cpg.
3. For ***AIRBAG_CPG**, added bag integrity checks to see if the external mesh is closed and normal vectors are consistent.

4. Added TSW to ***AIRBAG_CPG** to trigger a switch from the CPG formulation to uniform pressure (meaning control volume) at a given time.
5. Added PPOP to ***AIRBAG_CPG** to open the vents and keep them open based on a pressure differential.
6. Add the Lagrangian velocity of the inflator to the gas velocity exiting the inflator orifices. Also, when particles inherit an initial velocity from the attached coordinate system defined by NID1/2/3 in ***AIRBAG_CPG**, add the corresponding kinetic energy.
7. If the provided polynomial coefficients defining $C_p(T)$ in ***DEFINE_CPG_GAS_PROPERTIES** define a nonmonotonic function, the curve is now trimmed by automatically identifying T_{\min} and T_{\max} centered around ambient temperature to become the following piecewise function:
 - Constant from 0 to T_{\min}
 - A fourth order polynomial from T_{\min} to T_{\max}
 - Constant from T_{\max} to infinity

This modification guarantees the Newton-Raphson iterations used to find temperature from energy will always converge.

8. Added an error message if the fabric porosity option, FVOPT, on ***MAT_FABRIC (*MAT_034)** is not 7 or 8 when used with CPG airbags (***AIRBAG_CPG**).
9. Improved the stability of free slip boundary conditions for CPG (NSLIP = 0 on ***CONTROL_CPG**).
10. Added support for the FLC porosity option defined in ***MAT_FABRIC** for CPG airbags.
11. Added an input check on the parts in SID1 and SID2. Parts in SID2 should be in SID1. Vents should be in SID1 but not in SID2. An error message is now output if this is not the case.
12. Added error message if shell IDs associated with the airbag inflator for

- *AIRBAG_CPG** cannot be found in the part set defining the airbag.
13. Added updating the inflator area during time integration to support deformable inlets.
 14. Added ability for ***SENSOR_DEFINE_FORCE** with **FTYPE = CPM** to return either the average airbag pressure or the part pressure. Previously, only the average airbag pressure was returned. Now, the part pressure can be returned instead by setting field **CPMPID** to a part ID.
 15. Support specifying **HCONV** on ***AIRBAG_PARTICLE** or ***DEFINE_CPM_NPDATA** with a ***DEFINE_CURVE_FUNCTION**.
 16. Support specifying the total mass flow rate into a CPM airbag (***AIRBAG_PARTICLE**) with a ***DEFINE_CURVE_FUNCTION** using **LCMCF** on ***DEFINE_CPM_GAS_PROPERTIES**. Note that **LCMCF** cannot be used when using the **MOLEFRACTION** keyword option for ***AIRBAG_PARTICLE**.
 17. Support **FVOPT = 1** and **2** on ***MAT_034** for CPM airbags (***AIRBAG_PARTICLE**).

6.3 Constraint Cards

1. Made improvements to **SPRSRCH = 1** on ***CONTROL_CONSTRAINED**. Better search results can be obtained, especially when solid element parts are involved. For solid element parts, nodes on the surface facing the SPR connector are detected, leading to automatically finding enough nodes.
2. For **SPR2** and **SPR3**, added option to modify the nodal weights for force distribution. Setting the tens digit of **INTP** to 1 causes considering nodal areas and adding a participation factor for better consideration of distances between SPR and the associated nodes.

6.4 Contact

1. Added support for contact option TCSO (optional card D) to the MPP versions of SINGLE_SURFACE, AUTOMATIC_SINGLE_SURFACE, and AIRBAG_SINGLE_SURFACE.
2. Enabled the outputting of ***INITIAL_CONTACT_WEAR** data to the **dynain** file when ***CONTACT_ADD_WEAR** is used with segment-to-segment (**SOFT** = 2) contact interfaces. Note that ***INTERFACE_SPRINGBACK_LSDYNA** must be in the input deck for the **dynain** to be output, and that **SAPR** and/or **SBPR** on Card 1 of the contact definition for this data to be output.
3. Added flag **IBEAMS2S**, which enables beam elements in segment-to-segment contact if set to 1. The beams flag is an integer flag in field 4 of ***CONTACT_...** optional Card G. If this flag is omitted or set to 0, then beams will not be included in the contact. The treatment of beam elements in segment-to-segment contact does not depend on the ***CONTACT** keyword. To include beam elements in the contact, **SURFATYP** and/or **SURFBTYP** should be set to 2, 3, 5, or 6, with beam parts included in the surface defined for types 2 and 3 and not exempted for type 6.
4. Changed the behavior of **TIEOPT** on ***CONTROL_CONTACT** based on customer feedback. **TIEOPT** = 1 is now the same as **TIEOPT** = 0, except that it invokes a groupable effect. This groupable effect allows **SURFB** nodes in different interfaces to be shared. **TIEOPT** = 2 calls the alternative algorithms previously invoked with **TIEOPT** = 1, but no longer converts **SHELL_EDGE_TO_SURFACE** contacts to **SHELL_EDGE_TO_SOLID** contacts. A list of tied pairs that change is also output with **TIEOPT** = 2.

6.5 Elements

1. Improved single precision accuracy of the internal energy computation in shell type 16. **ISTUPD** = 5 and 6 on ***CONTROL_SHELL** invoke this improved accuracy version.

6.6 EM (Electromagnetic Solver)

1. Fixed memory leak when using ***EM_EXTERNAL_FIELD**.
2. Added support to use ***INCLUDE_TRANSFORM** with EM for load curve IDs, set IDs, part IDs, and material IDs.

6.7 ICFD (Incompressible Fluid Solver)

1. Improved the mapping algorithm to reduce runtime and increase reliability when transferring data after remeshing.
2. Refined the force computation for the RIIS method (see ***ICFD_CONTROL_IMMERSED**), causing results that better match body-fitted simulations.
3. Added residence time and shear outputs on both sides of embedded shells to d3plot.

6.8 Isogeometric Analysis (IGA)

1. Added cost estimates for IGA solid elements (***IGA_SOLID**) to improve load balancing for MPP.
2. Support materials ***MAT_261** and ***MAT_262** for IGA solid elements (***IGA_SOLID**).
3. Added support for ***CONTACT_TIED_SHELL_EDGE_TO_SURFACE** and ***CONTACT_TIED_SHELL_EDGE_TO_SOLID** to be used with structured IGA trimmed solid elements (***IGA_SOLID**). This is only available in MPP using **GRPABLE = 1** in the optional MPP contact cards without selective mass scaling. Any standard finite element node can be tied to an IGA solid element.

6.9 Materials and Equations-of-State

1. Added option $VP = 4.0$ to ***MAT_024** to invoke filtering/smoothing of the plastic strain rate. It is like $VP = 1.0$ but supports ***DEFINE_TABLE_COMPACT** like $VP = 3.0$.
2. Added option **PDOPT** to ***MAT_083_PATH_DEPENDENT** to choose between using the current value or maximum value of $1 - J$ in the table specified with **TBID** (***DEFINE_TABLE_3D**).
3. Enabled ***MAT_091** to be used with ***INITIAL_FOAM_REFERENCE_GEOMETRY**.
4. Allow logarithmic interpolation in some E (Young's modulus) as a function of strain rate curves. This is available for $LCEMOD > 0$ in ***MAT_123**, ***MAT_187**, and ***MAT_187L**. If the first strain rate is negative, all values are expected to represent the natural logarithm of a strain rate.
5. Made an improvement to ***MAT_187** to avoid failed iterations in the plasticity algorithm: Added a convergence criterion that helps in high triaxiality cases ($|p| > \sigma_{vm}$ where p is pressure and σ_{vm} is the von Mises stress).
6. Improved the behavior of ***MAT_187** with $LCID-C > 0$ and poorly defined $LCID-P$. Extrapolation into the negative region could have led to a Poisson's ratio that is less than -1. Now, a constant value is used instead of extrapolating.
7. Made improvements for shells with ***MAT_SAMP_LIGHT** (***MAT_187L**), such as always using Brent's method if $LCID-T$ and $LCID-C$ are different tables with an improved start value for Brent.
8. For ***MAT_224**, made the plastic work conversion to a thermal heat source available for axisymmetric solids.
9. Added new arguments to functions in ***MAT_240_FUNCTIONS**: total separation components, plastic separation components, and cohesive thickness.
10. Added keyword option **STOCHASTIC** to ***MAT_251**. Scaling factor for yield stress on history variable #9. The current yield stress can be

found on hisvar #5.

11. Enable ***MAT_251** to work with solid tetrahedron type ELFORM = 13.
12. Added new option for the critical energy criterion of ***MAT_280** (GLASS): ENGCRIT < 0 refers to a ***DEFINE_FUNCTION** ID equal to |ENGCRIT|. This function has one argument: the minimum distance of the center of impact to the edge of the windshield. Thus, the critical energy value can now depend on this distance.

6.10 MPP

1. Updated the MPP decomposition code to support ***INITIAL_INTERNAL_DOF_SOLID_...**

6.11 Output

1. Added outputting the cohesive separations in the location of the strain tensor when the ones digit (*L*) of STRFLG is 1 on ***DATABASE_EXTENT_BINARY**.

6.12 Sensors

1. Enabled ***SENSOR_DEFINE_MISC** to trace ***EM_CIRCUIT_ROGO** with MTYPE = EMROGO.

6.13 Thermal Solver

1. Added the node list of the current segment as a subroutine argument to the user flux interface (subroutine usrflux).

6.14 Miscellaneous

1. Print info about the expiration date in the encrypted vendor block with

DATE.

7 Bug Fixes

7.1 Acoustics, NVH, and Frequency Domain

1. Fixed bug when using ***CONTROL_ACOUSTIC_SPECTRAL** that led to a segmentation fault during MPP restarts.
2. Fixed bug in BEM triangular element regeneration that occurred when normal vector inversion is requested (**NORM = 1**) on ***FREQUENCY_DOMAIN_ACOUSTIC_BEM**.
3. Fixed bug in the MATV computation (***FREQUENCY_DOMAIN_ACOUSTIC_BEM_MATV**) with variational indirect BEM (**METHOD = 2**) caused by the Skeletonized Interpolation method. The bug led to an incorrect solution.
4. Fixed bug in writing out the nodal normal velocity to the **d3acs** database for dual collocation BEM with the Burton-Miller formulation (**METHOD = 4** on ***FREQUENCY_DOMAIN_ACOUSTIC_BEM**).
5. Fixed bug in writing **d3acp** and **d3acs** databases when using a single precision executable.

7.2 Adaptivity

1. Fixed potential errors in **nodout** and **elout** that could in rare cases occur with models using in-memory adaptivity (**INMEMORY = 1** on ***CONTROL_ADAPTIVE**).
2. Fixed an occasional memory violation error when using ***CONTROL_ADAPTIVE** with solid elements.
3. Fixed the over-adapting problem when using ***CONTROL_ADAP-**

TIVE with in-memory on (INMEMORY = 1).

7.3 Airbags

1. Fixed issue when there are multiple orifice lines ($NORIF > 1$ on ***AIRBAG_CPG**) referencing the same gas for CPG airbags. Each orifice was injecting the entire gas mass, instead of distributing across orifices.
2. Refactored inflator data to properly assign different gases to different inflators for ***AIRBAG_CPG**.
3. Made bug fixes for the temperature calculation from energy when $C_p(T)$ is not constant for CPG airbags.
4. Fixed part temperature output to **abstat_cpg** for internal parts. It was erroneously reporting double the correct value. It was an output issue only and did not affect the simulation.
5. For CPG airbags, made the volume flow rate output consistent with leakage (the signs were reversed).
6. Fixed the P - V work calculation for CPG airbags. The previous calculation was based on average pressure instead of pressure at the boundary elements.
7. Fixed the CPG to structure coupling to make sure the coupling forces are not applied to vents.
8. For CPG airbags, fixed the porosity leakage calculation. The user-provided load curve gives gas velocity as a function of absolute pressure, but the previous implementation assumed this was referring to the pressure differential between the bag pressure and atmospheric pressure.
9. Fixed issue when internal parts are inflators for CPG airbags. Orifice particles became duplicated, resulting in an incorrect boundary condition being applied.

7.4 ALE

1. Fixed a bug when using ***DATABASE_FSI** with S-ALE that could lead to wrong FSI results.
2. Cured the massless orphan nodes added after S-ALE mesh generation to avoid a divide by zero crash.
3. Fixed a memory bug when a model contains both eroding contact and an S-ALE part.
4. Support ***MAT_155** (***MAT_PLASTICITY_COMPRESSION_TENSION_EOS**) with S-ALE. This material has not worked with S-ALE since S-ALE was added a feature.
5. Fixed issue when using ALE with ***DATABASE_MATSUM** that might lead to a crash.

7.5 CESE Compressible Fluid Solver

1. Corrected the detection of triangular faces for the CESE conjugate heat transfer boundary condition.
2. Fixed ***MESH**-based tetrahedral mesh generation for CESE. This fix includes correcting the handling of an error message and correcting the misnaming of two ***CESE** keywords in the keyword checking database.

7.6 Constraint Cards

1. Fixed bug in ***CONSTRAINED_SOIL_PILE** that could cause spurious oscillation and energy growth, especially after a large axial sliding displacement. Another symptom could be a spurious torsional moment in the pile. Additionally, the rotational mass scaling (meaning inertia added to keep things stable when DT2MS is negative) has been increased to allow for large axial sliding displacement.

7.7 Contact

1. Fixed an issue in MPP that could cause contact forces from segment-to-segment ($\text{SOFT} = 2$) contact with $\text{DEPTH} = 45$ and enabled friction to not be correctly attributed to corresponding force transducers.
2. Fixed inconsistency issues of ***CONTACT_AUTOMATIC_SINGLE_SURFACE** in the hybrid solver.
3. Fixed issue in determining the beam element contact thickness due to not honoring the thickness scaling factor in some cases. Specifically, ***CONTACT_AUTOMATIC_BEAMS_TO_SURFACE** was not honoring the SFSAT parameter.
4. Fixed failure to tie the surfaces when using the MPP version of the ***CONTACT_AUTOMATIC_SURFACE_TO_SURFACE_TIED_WELD** contact in the case where the temperature is driven by a ***LOAD_THERMAL_LOAD_CURVE**.
5. Fixed issue in the ***DEFORMABLE_TO_RIGID** code in MPP that caused a memory error during switching when using segment-to-segment ($\text{SOFT} = 2$) contact.
6. Fixed issue causing hanging with hybrid executables when using eroding contact.
7. Fixed bug in single surface Mortar contact for beams in explicit analysis. The bucket sort had been broken in R16.0.

7.8 Discrete Element Method

1. Fixed issue when using nonzero SBOX in ***DEFINE_DE_TO_SURFACE_COUPLING** with $\text{NFREQ} = 1$ on ***DEFINE_DE_ACTIVE_REGION**. The box was being ignored, and the issue led to a deadlock later in the run.
2. Fixed MPI deadlock issue for ***DEFINE_DE_ACTIVE_REGION**.

7.9 Dual CESE Compressible Fluid Solver

1. Made adjustments to ***MODULE** processing of the REFPROP and CoolProp EOS libraries so that they can be used by the dual CESE solver. Note that to use the REFPROP EOS library with the dual CESE solver, you must obtain a number of additional files, provided by LS-DYNA technical support. Please contact them for help with this. The CoolProp library is not working with the dual CESE solver.
2. For the MPP solver, corrected the enabling of table look-up for the REFPROP and CoolProp EOS libraries on all processors other than processor 0.

7.10 EM (Electromagnetic Solver)

1. Fixed restarts for the Monolithic solver in magnetostatic cases.
2. Made a small fix to the **P** matrix assembly for tetrahedral elements in magnetostatic cases. This fix improved the results.
3. Fixed wrong mapping of nodal coordinates in MPP for ***EM_RAN-DLES_SHORT** when using the tshell Randles model (see ***EM-RANDLES_TSHELL**).

7.11 Forming Analysis

1. Fixed issue when using ***INCLUDE_STAMPED_PART** with long formats. An error occurred when trying to map data in the long format to a new mesh in the long format. The main problem was a wrong interpretation of keyword comment lines (\$...).

7.12 ICFD (Incompressible Fluid Solver)

1. Fixed memory issue in ICFD and EM coupled radiofrequency heating with conjugate heat transfer analysis. Crashes could occur on large models.

7.13 Implicit (Mechanical) Solver

1. Fixed a bug when using METHOD = 102 (LOBPCG) on ***CONTROL_IMPLICIT_EIGENVALUE** with ***BOUNDARY_FLUIDM**. The execution could have errored out for problems with constraints, such as rigid bodies or constrained interpolation.
2. Fixed bug in METHOD = 111 (Sectoral Symmetry) on ***CONTROL_IMPLICIT_EIGENVALUE**. In some situations, the method would yield (easily identifiable) incorrect results.
3. Fixed bug when using ***DAMPING_FREQUENCY_RANGE_DEFORM** in implicit dynamic analysis. Symptoms of the bug could include poor convergence behavior in nonlinear solutions or runaway oscillation in linear solutions.
4. Fixed issue with the Lanczos solver (***CONTROL_IMPLICIT_EIGENVALUE**) for tiny problems when using MPP that caused the eigenvalue in the solution to be half the expected value.
5. Corrected two errors with ***PART_MODES** in MPP:
 - Corrected the reading of the d3eigv and d3mode files, as an extra 64 words have been added to the header.
 - Fixed some issues in the output subroutines.

These issues caused the job to crash.

6. Added logic to cleanly terminate for the combination of dynamic relaxation (***CONTROL_DYNAMIC_RELAXATION**, IDRFLG > 0) and ***CONTROL_IMPLICIT_MODES**.

7.14 Initial Cards

1. Fixed issue with the internal energy computation when using ***INITIAL_FOAM_REFERENCE_GEOMETRY**. If used in a run with dynamic relaxation, the energy could become negative.

7.15 Isogeometric Analysis (IGA)

1. Fixed a bug in the decomposition of IGA solid elements (***IGA_SOLID_ID**) that could have led to an error indicating that there are processors that do not have any elements.
2. Corrected the added mass output in **glstat** for IGA solid elements (***IGA_SOLID**).
3. Corrected the “list of material being considered” (included/excluded) for contact in **d3hsp** for IGA solid elements (***IGA_SOLID**).
4. Correct the computation of cross-sectional area for **secfor** output for IGA solid elements (***IGA_SOLID**).
5. Fixed bug in the added mass output in **matsum** for IGA solid elements (***IGA_SOLID**).

7.16 Load Cards

1. Fixed ***LOAD_SEGMENT_SET_NONUNIFORM** ignoring nonzero **AT** (arrival time).

7.17 Materials and Equations-of-State

1. Write missing fatigue data from ***MAT_ADD_FATIGUE** for generated visualization beams. Lack of this data caused input processing failures in models that have visualization beams with materials models that included fatigue.
2. Fixed issue with ***MAT_015** shell elements with initial temperature from **dynain**. Initialization of the internal energy was needed as well to get the correct initial temperature.
3. Fixed incorrect shell element deletion behavior for ***MAT_024** with **VP** = 1, 2, or 4. The element was deleted only when the last integration point failed. The corrected behavior is that the element should only be deleted when all integration points fail.

4. Fixed bug in ***MAT_060** for the specific combination of solid elements with $ELFORM = 1$ with implicit time integration that could cause the analysis to crash. The bug did not affect ***MAT_060** solids with $ELFORM = 2$ or -2 , nor did it affect ***MAT_060** shells.
5. For ***MAT_076_MOISTURE**:
 - Fixed reading initial moisture (parameter M0) value from the input deck.
 - Corrected expansion due to moisture change.
 - Fixed moisture stiffness scaling.
 - Fixed the temperature shift by taking the correct initial temperature value into account. Previously, the initial temperature was always assume to be 0.
6. Fixed issue with function evaluation in some spot weld models. This issue applies to ***MAT_100_DA** with ***DEFINE_CONNECTION_PROPERTIES** ($PRUL \geq 2$), ***MAT_169**, ***MAT_240_FUNCTIONS**, and ***DEFINE_MULTI_SHEET_CONNECTORS**. ***DEFINE_FUNCTION** arguments $sm1$ and $sm2$ (maximum engineering yield stresses) could have been wrong if determined from a curve/table in the weld partner material. This has been broken since March 2024.
7. Fixed material 126 (***MAT_MODIFIED_HONEYCOMB**) for thick shell formulations 3, 5, and 7 when $LCA < 0$ and $ECCU > 0$. There were incorrect stress transformations, resulting in incorrect element stress and forces.
8. Fixed bugs in ***MAT_179** affecting the stress extraction from tables and the energy initialization.
9. Fixed bug in ***MAT_187L** when $RATEOP = 1$ and $LCID-C$ is a table. A potential change of the Ducker-Prager yield criterion slope during return mapping was not correctly taken into account, leading to wrong stresses.
10. Fixed bug in ***MAT_SAMP_LIGHT** (***MAT_187L**) with solids and difficult return mapping. An update of a history variable (deviatoric

plastic strain) was missing when Brent's method was used. This could have led to wrong stress results.

11. For ***MAT_261** (***MAT_LAMINATED_FRACTURE_DAIMLER_PINHO**), always use the absolute value of strain rate in the table evaluation. Prior to this change, negative values of strain rates would have led to a wrong table evaluation.
12. Fixed issue when using large IDs ($> 2^{24}$) for LCSS in ***MAT_261**.
13. Fixed error termination that occurred in the keyword input phase for ***MAT_295**.

7.18 MPP

1. Fixed issue with MPP local coordinate system calculations when using ***DEFINE_COORDINATE_NODES** with DIR input as Y or Z. These cases were not working correctly and could produce incorrect output.

7.19 Output

1. Fixed rare case where a parameter expression (***PARAMETER_EXPRESSION**) might not get echoed to the d3hsp file. This lack of echoing only happened when the ***PARAMETER_EXPRESSION** instantiation was the last keyword in an include file.
2. Fixed bug in ***DEFINE_MATERIAL_HISTORIES** that could cause solid integration point strain (NINTSLD = 8 on ***DATABASE_EXTENT_BINARY**) output to binary databases to be overwritten.
3. Fixed bug in NPLTC that caused the databases to be written at a later time than expected, particularly for implicit.

7.20 Restarts

1. Fixed an issue where ALE data being output to the d3full file could, in

some cases, corrupt the d3full file, resulting in unpredictable behavior when restarting from the d3full file.

2. Fixed issue causing the beam axial strain to not be transferred in a full restart.

7.21 Sensors

1. Fixed a bug for ***SENSOR_DEFINE_FORCE** for FTYPE = X-SECTION. The bug led to reporting wrong results for the cross-section force.
2. Fixed a bug for ***SENSOR_DEFINE_MISC** with MTYPE = RIGIDBODY. The bug happened when a deck has ***SENSOR_CONTROL** with TYPE = ELESET. The reported rigid body kinematics values were wrong.

7.22 SPH

1. Fixed error causing incorrect values to be used as the fictitious velocities applied with ***BOUNDARY_SPH_NOSLIP** when IDIM = 2 in ***CONTROL_SPH** for MPP executables.
2. Fixed memory issue that might cause a crash for MPP single precision executables when FORM = 9 or 10 in ***CONTROL_SPH**.
3. Fixed incorrect output to the sldsph_frag file when ***DEFINE_ADAPTIVE_SOLID_TO_SPH** is used on multiple processors.

7.23 Thermal Solver

1. Fixed the binout output for the thermal solver in MPP. The thermal data ended up in the wrong section.
2. For axisymmetric and 2D solids, the thermal thick shell option (THSHEL on ***CONTROL_SHELL**) is deactivated now, and a warning is printed, instead of throwing an error.

7.24 Miscellaneous

1. Fixed memory issue where the functions AX, AY, AZ, AX2, AY2, and AZ2 in ***DEFINE_CURVE_FUNCTION** could overwrite previously defined instances.
2. Fixed a bug that occurred when using a d3kil file containing sense switch SWE. The bug resulted in immediate termination instead of proceeding with the simulation after terminating explicit dynamic relaxation.
3. Corrected the computation of the number of through-thickness integration points for $\text{NUMFIP} < 0$ on ***DEFINE_ELEMENT_EROSION**. Prior to this fix, the calculation of the number of through-thickness integration points was incorrect, leading to an incorrect percentage computation and potentially incorrect erosion behavior.
4. Avoid problems with too many entries in ***INCLUDE_PATH** or ***MODULE_PATH** by increasing the limit for the number of total cards defining paths in a model from 50 to 100 and adding an error check for more than 100 entries.
5. Made a few fixes for ***DEFINE_STOCHASTIC_VARIATION**. This feature was not working when PID refers to a part set with more than eight parts. $\text{VAR_S/F} = 3$ or 4 (curves) were not working in single precision since December 2023.
6. Fixed combination of ***INCLUDE_TRANSFORM** and ***DEFINE_TABLE_{X}D** with $X \geq 3$. IDFOFF was not correctly applied to the table IDs on Card 2.