

Release Notes for R11.2

November 30, 2020

Contents

1	Release notes revision	1	17	eXtended Finite Element Method (XFM)	10
2	License	2	18	Material models and equations of state	10
3	Documentation	2	19	Arbitrary Lagrangian Eularian (ALE)	14
4	Notes	2	20	Fatigue cards	14
5	Airbag cards	2	21	Metal forming	14
6	Boundary cards	3	22	Frequency domain cards	14
7	Constrained cards	3	23	Implicit (mechanical) solver	14
8	Contact	4	24	Thermal solver	16
9	Control cards	6	25	MPP	16
10	Initial cards	7	26	Compressible fluid solver (CESE)	17
11	Load cards	7	27	Chemistry	17
12	Sensor cards	8	28	Restarts	17
13	Element library	8	29	Output	17
14	Discrete Element Method	10	30	Miscellaneous	19
15	Smoothed Particle Hydrodynamics (SPH)	10			
16	Element Free Galerkin (EFG)	10			

§1 Release notes revision

This file constitutes revision 0 of the release notes for LS-DYNA version R11.2.0.

§2 License

The string "REVISION 11" must appear in the LS-DYNA license file in order to run version R11.2.0. Please contact your LS-DYNA distributor or your Ansys sales representative if you have to have your license updated.

§3 Documentation

Documentation of R11.2.0 is provided in the R11.0 User's Manuals which may be downloaded from www.lstc.com/download/manuals. For features mentioned in these release notes but which appear to be missing from the R11.0 User's Manuals, please refer to the DRAFT User's Manuals at www.lstc.com/download/manuals. Please note that not all features in the DRAFT User's Manuals are available in version R11.2.0.

§4 Notes

The remainder of this file describes what's been added or fixed in version R11.2.0 since the release of version R11.1.0. See the release notes of R11.1.0 to see what was added or fixed in that release since R11.0.0. The changes are primarily bug fixes.

The items are arranged by category. In many cases, a particular item could fall under more than one category. For the sake of brevity, each item is listed only once under a single category.

§5 Airbag cards

1. Fixed an MPP bug that occurs for control volume airbags that include jetting, namely,
 - ***AIRBAG_WANG_NEFSKE_JETTING,**
 - ***AIRBAG_WANG_NEFSKE_MULTIPLE_JETTING,**
 - ***AIRBAG_HYBRID_JETTING**
2. Fixed a bug in the output of area and leakage information for all parts that an airbag comprises. This bug occurs when an airbag is comprised of more than 10 parts.
3. Added new keyword ***CONTROL_AIRBAG** for control volume (CV) airbags to check for free edges in the airbag and to check for segments defining airbag that are not associated with elements.
4. ***AIRBAG_PARTICLE:**
 - Fixed bug for multiple CPM bags that occurred when NPRLX was the number of cycles for some of the bags and the end time for the other bags.
 - Added support for Autoliv porous leakage calculation (FVOPT = -1 / -2 on ***MAT_FABRIC** / ***MAT_034**).
 - Added the JET keyword option. This option calculates the thrust force for an external vent and gives a better reaction force on the structure.
 - Added new limit checking and self-adjusting algorithm for the 4th order polynomial nonmonotonic function of nonlinear CP to avoid incorrect result.

- Support inflator mass flow rate curve (LCT_i), using ***DEFINE_CURVE**, ***DEFINE_CURVE_FUNCTION** and ***DEFINE_FUNCTION**.
- Support C23 (discharge coefficient) as a function of vent area.

5. ***DEFINE_CPM_VENT:**

- Added new feature where the flow rate can be calculated from the part pressure of two parts (PID1 and PID2) without a chamber definition.
- Added ability to apply ambient pressure on extruded internal parts for a push-out vent.
- Added new feature to allow the vent hole coefficient to be a function of current vent area (LCAC23).

§6 Boundary cards

1. Fixed a bug that made ***BOUNDARY_-PRESCRIBED_MOTION** not work with ***DEFINE_BOX_LOCAL**.
2. Correct a precision conversion problem associated with using superelements in explicit single precision with velocity boundary conditions.
3. ***BOUNDARY_NON_REFLECTING:**
 - Fixed to have the correct velocity averaging and force redistribution for triangular segments.
 - Fixed results in implicit.

§7 Constrained cards

1. Fixed ordering issue during initialization of ***CONSTRAINED_INTERPOLATION**

in MPP that could have resulted in incorrect "colinear" warnings or possibly deadlock.

2. ***CONSTRAINED_BEAM_IN_SOLID**

- Fixed incorrect result when multiple ***CONSTRAINED_BEAM_IN_SOLID** instantiations are used with 3D *r*-adaptivity (ADPTYP = 7 on ***CONTROL_ADAPTIVE**).
- Fixed bug causing thick shells to not be supported in SMP.
- The solid part set may include rigid bodies.

3. Fixed incorrect initial velocity of ***CONSTRAINED_NODAL_RIGID_BODY** when using ***INITIAL_VELOCITY_GENERATION** to the initial velocities with NX = -999 and NY and NZ defining the rotational axis.

4. Fixed incorrect ***CONSTRAINED_-INTERPOLATION** motion of the dependent nodes that occurred when the number or constrained degrees of freedom is less than the total number of degrees of freedom and the constrained degree of freedom is not in the x-direction.

5. Correct a long standing problem associated with computing the LaGrange Multipliers for constraint processing in implicit mechanics. The displacements on the independent dofs were inappropriately being zeroed during this computation leading to inaccurate reporting of resultant forces for implicit mechanics.

6. Added an input trap for ***CONSTRAINED_EXTRA_NODES** with empty NID or NSID.

7. Bug fixes in ***CONSTRAINED_SPR2** for SPR2 multi-sheet connectors (XPID_i > 0).

8. Added corrected torsion to SPR3 (***CONSTRAINED_INTERPOLATION_SPOTWELD** with $STIFF4 > 0.0$).
9. ***CONSTRAINED_SPR2** and ***CONSTRAINED_INTERPOLATION_SPOTWELD**:
 - Small modification for $PIDVB < 0$: Beams are deleted after failure (they were just separated before).
 - If nodes in the domain of influence become completely free due to the failure of a parent element, forces and moments are no longer distributed to these nodes.
 - The part ID of internally generated beams has to take Nodal Rigid Bodies into account.

§8 Contact

1. Exclude beams with zero-stiffness from the groupable beam contact.
2. Fixed bug in MPP eroding contact to properly handle element deletion during small deck restarts.
3. Fixed failure during MPP tied contact initialization caused by ***AIRBAG_REFERENCE_GEOMETRY**.
4. Fixed the MPP groupable tied contact bucketsort to handle slave nodes that might or might not get tied due to being very close the edge of the master segment better and more like the non-groupable way. Delete failed nodes from MPP groupable tied penalty based contacts in the same way as the non-groupable way.
5. Groupable contact supports ***CONTACT_AUTOMATIC_GENERAL**.
6. Fixed bug in MPP contact initialization that caused some problems to hang.
7. Ignore IPBACK on ***CONTACT** for penalty tied interfaces. IPBACK only applies to constrained tied contacts.
8. Fix for a potential MPP hang if the penalty backup contact is not assigned to the same processors used for the primary tied contact.
9. Fixed bug in ***SENSOR** related to tied contact with groupable. It was only working correctly for the first contact in the model.
10. Multiple ***DEFINE_FRICTION** tables with the same ID are merged.
11. Added support for MPP eroding contacts in full deck restarts.
12. Fixed bug so that nodal rotational masses are properly synchronized among processors that share nodes when initializing tied contacts with the BEAM_OFFSET keyword option during an MPP full deck restart.
13. Fixed a memory shortage in MPP tied contact that in rare cases could cause a segfault during groupable tied contact initialization.
14. Developed a new orthogonal friction model for the constraint and penalty versions of ***RIGIDWALL_PLANAR_ORTHO**. A ***RIGIDWALL_PLANAR_ORTHO** with equal friction coefficients in all directions now behaves as a regular planar rigidwall with a single friction coefficient.
15. MPP fix for frictional work output to intfor (***DATABASE_BINARY_INTFOR**) when $SOFT = 2$ contact is used.

16. ***CONTACT_AUTOMATIC_BEAMS_TO_SURFACE:**

- Added support for SOFT = 1.
- Added support for edge treatment. The gaps between phantom nodes are included in the contact detection, so no shells can pass through.
- Added support for field SRNDE for the treatment of exterior shell edges.
- Added initial penetration check support.

17. Make ***CONTACT_2D_NODE_TO_SOLID** aware of which particles are active and which are inactive.

18. Enabled FRCFRQ on card A of ***CONTACT** to work with MPP contact for SOFT = 0, 1, and 2.

19. For segment based (SOFT = 2 on Card A of ***CONTACT**) MPP contact, added support for the regular groupable and non-blocking groupable options in the PFILE and for using GRP on ***CONTROL_MPP_CONTACT_GROUPABLE**.

20. Reduced the memory used when initializing the split-pinball neighbor contact ($|SFNBR| > 1000$ on Card D of ***CONTACT**) when SOFT = 2 and DEPTH = 45 on Card A of ***CONTACT**.

21. For segment based (SOFT = 2) contacts when IGNORE = 2 on ***CONTROL_CONTACT** or ***CONTACT**, fixed the initial penetration message written when segments in contact have different thicknesses.

22. Added options to limit the scope of DPRFAC for segment-based (SOFT = 2 contact). When DPRFAC is set to a value greater than or equal to 1.0 then DPRFAC is the ID of a shell set, segment set, or

part set. When both segments that are in contact are in the set, then the DPRFAC option is active for that segment pair. If either segment is not in the set, then the DPRFAC is inactive. When searching for the set, the search will proceed in the order of shell set, then segment set, and finally part set. The first set that is found with a matching ID will be used. The set attribute DA1 will be read and used as the DPRFAC value.

23. Fixed the MPP wear calculation (***CONTACT_ADD_WEAR**) in segment based contact (SOFT = 2 on ***CONTACT**). The wear was only working when contact interfaces were numbered sequentially from 1.

24. Fixed ineffective contact box definitions of ***CONTACT_...** that occur when ***DEFINE_BOX_LOCAL** is used for SBOXID and ***DEFINE_BOX** is used for MBOXID, resulting in non-contact.

25. Fixed seg fault or incorrect frictional behavior in SMP when using the THERMAL_FRICTION keyword option for ***CONTACT_AUTOMATIC_ONE_WAY_SURFACE_TO_SURFACE** or ***CONTACT_AUTOMATIC_SURFACE_TO_SURFACE**.

26. Fixed instability when using ***CONTACT_TIEBREAK_NODES_TO_SURFACE** (SMP only).

27. Fixed incorrect ***CONSTRAINED_TIEBREAK** behavior that occurs when the master node is the last node in the input after sorting.

28. Fixed bug in ***DEFORMABLE_TO_RIGID_AUTOMATIC** that was causing contact thickness to not work correctly when CODE = 4 and OFFSET > 0.0.

29. Fixed a bug in which node N1 did not follow the wall when ***RIGIDWALL_PLANAR_MOVING_FORCES_DISPLAY** was defined with only node N1.
30. The DISPLAY keyword option for ***RIGIDWALL_PLANAR** will be ignored for stationary rigid walls when SKIPRWG = 1 in ***CONTROL_CONTACT**.
31. Extend the logic for collecting the resultant forces reported to the INTFOR file for ***CONTACT_TIED_SURFACE_TO_SURFACE** when using implicit in MPP. Before the resultant forces were being reported as zero for this contact type.
32. Added a warning that ***CONTACT_TIEBREAK_NODES_TO_SURFACE_ID** is not supported for implicit computations.
33. VDC in ***CONTACT** is now active for beam offset tied contact when the slave node belongs to a cohesive solid for robustness.
34. IGNORE = 4 in mortar contact supports using a curve for relative penetration reduction as a function of time (see MPAR1).
35. Fix for rarely occurring seg fault with ***USER_INTERFACE_FRICTION** due to a memory issue.
36. Fixed ***DEFINE_FRICTION** with undefined part set(s) bug that was leading to the simulation hanging or giving a false error message.
37. Bug fix for thermal contact with variable heat conductance (LCH in the data cards for the THERMAL_FRICTION keyword option of ***CONTACT**). A wrong input

check could result in neglecting a contact due to zero heat conductance and throw a warning even if load curve LCH was correctly defined.

§9 Control cards

1. ***CONTROL_ADAPTIVE:**

- If a 3D tetrahedral adaptive part has element formulation of 0, the element formulation will be changed to 13 after the first adaptive step.
- Fixed error termination of the 3D *r*-adaptive (ADPTYP = 7 on ***CONTROL_ADAPTIVE**) analysis after a simple restart.
- 3D *r*-adaptivity now supports ***INITIAL_VELOCITY_GENERATION**.

2. Fixed a bug in which SHLTRW in ***CONTROL_CONTACT** was ignored when ISTUPD of ***CONTROL_SHELL** is greater than 0.

3. For any kind of implicit eigenvalue computation, LS-DYNA before ignored the value of TET10S8 on ***CONTROL_OUTPUT** and only wrote the corner nodes of the elements to d3plot for the connectivity. Now it accepts the setting of TET10S8, so the full connectivity can be written to the d3eigv database.

4. Added an error check for DRCPRM < 0 on ***CONTROL_SHELL** to make sure a function is being referenced.

5. Added an error trap for when INTPERR = 1 is set on ***CONTROL_SHELL** and interpolation would be done with ***INITIAL_STRESS_SHELL**.

§10 Initial cards

1. Fixed the initialization of stress in thick shells using a DYNAIN file created by a previous run when the previous run used a different element form with a different number of integration points per layer than the new run. In this case, the stress tensor was being properly averaged or extrapolated as needed, but the material history data was not which for some materials causes wrong material behavior.
2. Fixed ***INITIAL_STRESS_TSHELL** output to dynain for thick shell type 7. Output stresses for all 4 in-plane integration points instead of just 1.
3. Fixed a bug that made ***INITIAL_VELOCITY_GENERATION_START_TIME** not work for rigid parts.
4. Added new keyword ***INITIAL_HISTORY_NODE(_SET)** to initialize select history variables at node locations. These nodal values are internally interpolated to the element integration points using the finite element shape functions. In contrast to ***INITIAL_STRESS_SHELL** (or **SOLID**) where you need to initialize ALL history variables through the ones you want (need) to initialize, ***INITIAL_HISTORY_NODE(_SET)** allows you to pick the few variables that you would like to initialize without touching the others.
5. Added a warning for when ***INITIAL_STRESS_SECTION** is used with a part set $PSID > 0$, but the part set is empty.
6. Fixed issue for ***INITIAL_HISTORY_NODE_SET** with respect to element sorting and user integration.

§11 Load cards

1. ***LOAD_THERMAL_D3PLOT** reads temperature data from a file in d3plot format. The file name is specified as an option on the command line. If this file does not exist in the working directory, LS-DYNA now gives a reasonable message and exits gracefully.
2. Enabled ***LOAD_THERMAL** to work for beam nodes when nodal releases are defined at those nodes. The thermal loading was incorrect.
3. Fixed incorrect results when using ***DEFINE_CURVE_FUNCTION** with $AX / AY / AZ$ for ***LOAD_SEGMENT**.
4. Account for element temperatures defined by ***LOAD_THERMAL_VARIABLE_ELEMENT_OPTION** in user defined materials.
5. New thermal loading keyword ***LOAD_THERMAL_BINOUT** that loads a structural only analysis with nodal temperatures computed in one or more prior thermal or thermal-structural analyses. It is a more flexible version of ***LOAD_THERMAL_D3PLOT**. Temperatures are read from the TPRINT section of one or more LSDA-format files. The mapping of nodal temperatures between the thermal or thermal-structural analysis and the structural analysis is based on external IDs, so only the temperatures of nodes that are present in both runs are transferred. A default temperature can be defined for nodes of the structural model that have not been part of the thermal analysis. Each of the thermal results can be applied starting at different times in the structural analysis. It is available for MPP and SMP. This keyword accounts

for virtual nodes of thermal thick shell elements.

§12 Sensor cards

1. Fixed a bug in ***SENSOR_DEFINE_-CALC-MATH** for CALC = SUM that occurs when some of the involved sensors, *SENS_i*, are negative for subtraction.
2. Fixed a bug in ***SENSOR_DEFINE_-ELEMENT** for CTYPE = STRAIN that occurs when STRFLG = 0 (see ***DATABASE_EXTENT_BINARY**)
3. ***SENSOR_DEFINE_FORCE**:
 - Fixed an MPP bug for TYPE = JOINTS-TIF.
 - Added VID = M for measuring the magnitude of the forces or moments.
4. Keyword: ***SENSOR_CONTROL**
 - Fixed a bug for TYPE = PRESC-MOT that occurs when a rigid body is involved in more than one ***BOUNDARY_PRESCRIBED_MOTION**.
 - Fixed a bug for TYPE = PRESC-MOT triggered by the controlled node or rigid part having a large ID value.
 - Fixed a bug for TYPE = BELTPRET that was causing the pretensioner to not be properly controlled.
 - Fixed a bug for TYPE = SPC that was causing the SPC to not be controlled when ***DATABASE** was not defined in the input deck.

§13 Element library

1. Solid element types 10 and 13 in rare cases have significant errors in single

precision calculations. The fix, implemented previously, significantly increased the cost of the elements. In this release we restored these elements to their faster formulation. For the rare cases, we added EXACC on ***CONTROL_ACCURACY** to activate the slower fixed version.

2. Enabled ***ELEMENT_SHELL_-SOURCE_SINK** to work with segment-based contact (SOFT = 2 on Card A of ***CONTACT**).
3. Fixed a bug that occurred when the inside pressure of an elbow beam (ELFORM = 14 on ***SECTION_BEAM**) is zero in an elbow beam. Uninitialized values could cause a wrong result.
4. Modified thick shell forms 3, 5, and 7 (ELFORM = 3, 5, or 7 on ***SECTION-TSHELL**) so that they can correctly initialize the pressure to zero when used with equation-of-state materials.
5. Enabled spot weld assemblies that use cohesive material 240 to output swforc force and moment data.
6. Improved the accuracy of pressure loading on fully integrated, volume-weighted axisymmetric solid elements (ELFORM = 15 / NIP = 4 on ***CONTROL_SHELL**), particularly along the axis of symmetry.
7. Modified mass scaling of beam element forms 4 and 5 (ELFORM = 4 or 5 on ***SECTION_BEAM**). A dimensional problem was causing erratic behavior which could cause unstable beams.
8. Fixed spurious error message

```
1 KEY+1567, 'ELEMENT ### is not found'
```


that occurred when using ***ELEMENT_SHELL_COMPOSITE** with ***MAT_ADD_THERMAL_EXPANSION** present in the input deck.

9. Fixed order dependency of IDOF specifications in multiple ***SECTION_SHELL** definitions. Previously, IDOF in the first shell part became the default for the other shell parts with the same element formulation instead of being independent.
10. Fixed a bug that made CDL and TDL in ***SECTION_DISCRETE** not work when using with DRO = 1.
11. ***ELEMENT_SEATBELT_SLIPRING:**
 - Fixed a bug that caused rounding of curve IDs in single precision.
 - Fixed a bug that caused errors in reading ***ELEMENT_SEATBELT_SLIPRING** when negative FC and FCS are used.
 - Fixed a bug that made SBRNID lose its minus sign in dyna.inc.
12. Fixed a bug in which ***ELEMENT_INERTIA_MASS** was ignored when DT2MS > 0 (or mass scaling is on).
13. Fixed a bug in which ***INCLUDE_TRANSFORM** with INCOUT > 1 incorrectly translated geometry parameters for type 2 beams.
14. Fixed a bug that caused zero forces in nodfor for discrete beams (beam ELFORM 6).
15. Fixed a bug that caused wrong global stress output in elout and d3plot for type 23 shells.
16. Fixed a bug that caused discrepancies in elout and disbout for discrete

beams using ***MAT_GENERAL_NONLINEAR_1DOF_DISCRETE_BEAM** (***MAT_121**).

17. Correct the setting of nodal inertias for solid element formulation 3 for eigenvalue computations. It was zero and now it is the standard computed value.
18. ***ELEMENT_DIRECT_MATRIX_INPUT:**
 - Correct the computation of the critical time step for explicit when using superelements.
 - Enhanced the reading of superelement files to support connections using nodes, scalar nodes, and internal dofs. Also accept dof labels of "0" for scalar nodes.
 - Modified MPP decomposition logic for collecting nodes when reading binary formatted files for superelements.
19. Added the possibility to define a 3-Point Simpson integration rule through the thickness per layer of a composite shell. This rule can be defined through irregular optional Card 2 (OPTCARD).
20. Fixed bug affecting the simultaneous used of ERODING contact with degenerate cohesive pentahedral solids (19/20) that through ESORT = 1 are changed into formulations 21/22.
21. Fixed bug in stiffness-based hourglass control for pentahedron element 115. A factor corresponding to time step was missing.
22. Fixed bug for ELFORM = 60 in ***SECTION_SOLID** that was causing this element formulation to not work with ***MAT_ADD_EROSION**, GISSMO, and DIEM.

23. Fixed d3hsp mass report for beam element type 13.

§14 Discrete Element Method

1. Fixed bug that was causing the active region for ***DEFINE_DE_ACTIVE_REGION** when specified with a box (ITYPE = 1) to not rotate under the action of ***DEFINE_TRANSFORMATION**.

§15 Smoothed Particle Hydrodynamics (SPH)

1. Created MPP variants of 2D plane-strain and 2D axisymmetric SPH formulations with thermal coupling.

§16 Element Free Galerkin (EFG)

1. Changed the default of IEFT on ***SECTION_SOLID_EFG** from 1 to 3 for the treatment of the essential boundary conditions in the solid EFG formulation.
2. Fixed error termination using EFG method in SMP double precision.

§17 eXtended Finite Element Method (XFEM)

1. Fixed a bug in 2D plane strain XFEM (ELFORM = 52 in ***SECTION_SHELL_XFEM**) using plastic material laws.

§18 Material models and equations of state

1. Added calculation of internal energy to ***EOS_MURNAGHAN (*EOS_019)**.
2. Fix an MPP bug triggered when the input format is long.
3. ***MAT_SEATBELT_2D**
 - Fixed a 2D belt bug that occurs when a belt has two retractors.
 - Added an error message for when the edge nodal set of a 2D belt is not on the edge of the related 2D belt part.
 - Enhance 2D belt by offering a choice of element of formulations.
4. Fixed bug in ***MAT_PAPER (*MAT_274)** where the shell thickness strain was erroneously not included in the history variables.)
5. Added a check to ***USER_NONLOCAL_SEARCH** to make sure that the master is all one material type and the slave is one material type. The master and slave are allowed to be different materials from each other.
6. ***MAT_SPOTWELD (*MAT_100)**
 - Added a new option called TTOPT to ***MAT_SPOTWELD** which is used by brick and brick assembly spot welds. The option controls the behavior of TRUE_T, making it possible to revert the TRUE_T behavior back to how it worked in revisions R8 and earlier. If TTOPT = 0 or if the TTOPT is not input, then the behavior is unchanged. If TTOPT = 1, then the R8 and earlier behavior happens. TTOPT = 2 is like TTOPT = 1, but the stress resultants are calculated on both faces of

the weld and the failure check uses the average values. This makes the weld failure invariant with respect to the node numbering of the weld elements.

- Fixed a bug for OPT = 0/-1 when using ***DEFINE_CURVES** for defining force or moment resultants as a function of the effective strain rate by setting NRR, NRS, NRT, MRR, MSS, or MTT as negative values. Also added a more meaningful error message for when the load curve is not defined.
7. Added new parameter RFLTF to ***MAT_100_DA** for rate filtering the effective strain rate.
 8. Fixed ***MAT_NONLOCAL** when used with eroding elements. Variables were not being initialized for eroded elements leading to unpredictable results.
 9. Enabled thick shell form 3 (ELFORM = 3 on ***SECTION_TSHLL**) to work with material models that use an equation of state.
 10. Added the PRESTRAIN keyword option (for shells only) to ***MAT_MODIFIED_PIECEWISE_LINEAR_PLASTICITY** (***MAT_123**) which causes the field IPS on Card 5 to be required input. IPS = 1 causes prestrain set with ***INITIAL_STRAIN_SHELL** to be included when checking for major strain failure, EPSMAJ.
 11. Fixed incorrect effect of BVFLAG in ***MAT_FU_CHANG_FOAM** (***MAT_083**) on the initial time step size.
 12. Implemented erosion flag for ***MAT_JOHNSON_COOK** (***MAT_015**) for shells.
 13. Fixed incorrect computation of phel for ***MAT_JOHNSON_HOLMQUIST_CERAMICS** (***MAT_110**) when phel is input as 0.
 14. Fixed incorrect initial strains when using ***MAT_MOONEY-RIVLIN_RUBBER** (***MAT_027**) with ***INITIAL_FOAM_REFERENCE_GEOMETRY** and running with single precision version.
 15. Fixed problem of solution hanging when using ***MAT_PIECEWISE_LINEAR_PLASTICITY_STOCHASTIC** (***MAT_024_STOCHASTIC**) and ***DEFINE_HAZ_PROPERTIES** (MPP only).
 16. ***MAT_PIECEWISE_LINEAR_PLASTICITY** (***MAT_024**):
 - Added VP = 3 (filtered total strain rate) for solid elements.
 - Added option to ***MAT_024** with VP = 3, where yield stress can now be a function of plastic strain, strain rate, and up to five history variables that can be set using ***INITIAL_HISTORY_NODE**. It can be a function of an additional two variables if ***MAT_ADD_DAMAGE_DIEM** is used with this material and P1 is set. LCSS in this case refers to a ***DEFINE_TABLE_COMPACT** or a ***DEFINE_TABLE_XD** of up to either level 7 or 9 depending on the inclusion of ***MAT_ADD_DAMAGE_DIEM**.
 17. Fixed incorrect behavior for ***MAT_GENERAL_JOINT_DISCRETE_BEAM** (***MAT_097**) when BEGTIM in ***CONTROL_START** > 0.0.
 18. Fixed incorrect stresses for ***MAT_ANISOTROPIC_VISCOPLASTIC** (***MAT_103**) and ***MAT_ANISOTROPIC_PLASTIC** (***MAT_103_P**) that

occurred when using BETA from ***ELEMENT_SHELL_BETA** or ***MAT** or when using material integration point angles input on ***SECTION_SHELL**.

19. Extrapolate the load curve for the von Mises stress as function of negative volumetric strain by using the first 2 points of the load curve if the volumetric strain is less than the first point of the curve.

20. ***MAT_ADD_EROSION:**

- Fixed a bug that caused axisymmetric elements (shell element formulations 14 and 15) to instantly fail when $DTMIN > 0$.
- Fixed a bug that occurred when beam elements existed in the model in which shell elements instantly failed when using ***MAT_ADD_EROSION** with $EPSTHIN < 0$.
- Fix internal energy calculation for LCFLD criterion in ***MAT_ADD_EROSION**.

21. Fixed a bug causing $2WAY = 1$ in ***MAT_ENHANCED_COMPOSITE_DAMAGE** (***MAT_054**) not to be recognized.

22. Fixed a bug in which the mass output in SSSTAT increased over time for shell elements with ***MAT_NULL** (***MAT_009**).

23. ***MAT_LAMINATED_COMPOSITE_FABRIC** (***MAT_058**):

- Fixed a bug in computing the contact stiffness that occurred if EA, EB, or GAB is defined through a load curve or table. Prior to this fix, unexpected contact stiffness was calculated that could lead to strange results.
- Fixed an error in calculating the initial time step issue when EA, EB or GAB

is defined through a load curve or table. Prior to the fix, the initial stiffness in the first cycle was not evaluated correctly, leading to an incorrect initial time step.

24. ***MAT_LAMINATED_FRACTURE_DAIMLER_PINHO** (***MAT_261**):

- Check for fiber kinking, even if $fmat = 1.0$ which allows for proper behavior if fiber compression and matrix tension are present at the same time.
- Specified minimal values for fracture toughnesses if not defined to avoid division by zero.

25. ***MAT_VISCOPLASTIC_MIXED_HARDENING** (***MAT_225**):

- Fixed a bug that occurred when a table is used to account for the strain-rate dependency together with kinematic hardening ($BETA < 1.0$).
- Fixed stability issue for solids that occurred when a table is used to account for the strain-rate dependency together with pure kinematic hardening ($BETA = 0.0$).

26. Fixed bug in material 77 for the Mullins damage option with negative TBHYS. A history variable was not allocated properly.

27. Added two new history variables for ***MAT_COHESIVE_MIXED_MODE_ELASTOPLASTIC_RATE** (***MAT_240**), namely #16 = FG1 and #17 = FG2. FG1 and FG2 are input parameters for this material.

28. ***MAT_GLASS** (***MAT_280**):

- Added $FMOD = 10, 11, \text{ and } 12$ which use a slightly modified condition for compressive failure compared to their

respective counterparts FMOD = 0, 1, and 2.

- Parameter NIPF now also applies to the EPSCR failure criteria, meaning an element is deleted when NIPF integration points fail due to reaching EPSCR.

29. ***MAT_NONLINEAR_PLASTIC_DISCRETE_BEAM (*MAT_068):**

- Translational and rotational stiffnesses, TKR, TKS, TKT, RKR, RKS, and RKT, can now be assigned negative values referring to curve IDs for load (moment) as a function of displacement (twist) to get nonlinear elastic behavior.
- Fixed bug in computing the plastic displacement (rotation) for RYLD = 1.

30. ***MAT_187L (*MAT_SAMP_LIGHT):**

- Added viscoelasticity (parameters LCEMOD and BETA).
- Added flag CTFLG to control curve treatment, either using discretized (0, default) or original (1).
- Log interpolation for tables (optional) and no extrapolation.
- Improved tolerance for plane stress iteration procedure.

31. Enable numerical tangent for ***MAT_TOUGHENED_ADHESIVE_POLYMER (*MAT_252)** to be used in implicit analysis with moderate nonlinearity.

32. ***MAT_ADD_GENERALIZED_DAMAGE:**

- Improved robustness for ***MAT_ADD_GENERALIZED_DAMAGE** when DMGEXP < 1.
- Allow large function IDs (greater than 2^{24}) for $HIS_i < 0$ and D_{ij} of ***MAT_ADD_GENERALIZED_DAMAGE**.

33. ***MAT_ADD_DAMAGE_GISSMO:**

- LCSRS being a table and using logarithmic strain rates (first value negative) did not work correctly before.
- Fixed bug for HISVN = -(ND + 19) for shell elements. The initialized history variable at position |HISVN| in ***INITIAL_STRESS_SHELL** is moved to ND + 19 in the history variable array (see list of history variables for ***MAT_ADD_DAMAGE_GISSMO**). When the history variable was already initialized at ND + 19, it was being moved to an incorrect position.
- Fix issue with ***MAT_ADD_DAMAGE_GISSMO** used together with solid type 2 and an equation-of-state that could lead to incorrect stress results.

34. Fixed problem with large curve IDs for LCSS in ***MAT_DAMAGE_2 (*MAT_105)**. This is only solid elements.

35. Fixed floating invalid problem in ***MAT_TABULATED_JOHNSON_COOK (*MAT_224)** for solid elements and LCG > 0 leading to the potential for the plastic strain rate to become negative in rare cases.

36. Fixed issue with the combination of ***MAT_ADD_PORE_AIR** and ***MAT_ADD_EROSION** with solid element types 1, 10, 43, 60 and 99. The issue could cause stress and history data to be corrupted leading bad results or floating point exception errors.

37. Fixed a bug for ***MAT_THERMAL_CHEMICAL_REACTION (*MAT_T06):** Bug resulted in the incorrect heat generation for chemical reactions defined by a user-defined function (parameter FID).

38. In checking fixed nodes for PML boundary (***MAT_PML_...**), correctly merge translation constraints from ***NODE** and ***BOUNDARY_SPC**, in case both are used at the same node.
39. Fix bug in ***MAT_PLASTICITY_COMPRESSION_TENSION_EOS** (***MAT_-155**) where `matusr_24` was not being called for `FAIL < 0`.
40. `LCINT` in ***CONTROL_SOLUTION** now controls the stress-strain pairs output to `d3hsp` for the material curve specified with ***DEFINE_CURVE_STRESS**.

§19 Arbitrary Lagrangian Eularian (ALE)

1. The ALE ambient element receptors for a blast load (`AMBTYP = 5` in ***BOUNDARY_AMBIENT**) now take the density and pressure directly from the values given by ***LOAD_BLAST_ENHANCED**. This change has greatly improved the accuracy of the mapping from the blast to ALE cells.
2. Fixed a logic error that was causing incorrect results and crashes for MPP S-ALE models that include thick shells.

§20 Fatigue cards

1. Extended fatigue analysis to be based on maximum principal stress and maximum shear stress (`INDEX = 1` or `2` in ***FATIGUE_{OPTION}**).
2. ***INITIAL_FATIGUE_DAMAGE_RATIO**: Fixed a bug in reading the initial fatigue damage databases for SSD fatigue.

§21 Metal forming

1. ***INCLUDE_STAMPED** supports ***DEFINE_TRANSFORMATION**.
2. Improvements to ***CONTROL_FORMING_OUTPUT** for the issues discussed below present in R9.X, R10.X, and R11.X.
 1. When `Y1 - Y4` define the distances from the punch home where the `d3plot` files will be output, the following issues occurred:
 1. The `d3plot` files are not written at the corresponding times.
 2. Too many `d3plot` files are written (two at the last cycle and some between the distance points).
 2. If `LCID` defines the distances instead of `Y1 - Y4`, then too many `d3plot` files are written (two at the last cycle and some between the points).

§22 Frequency domain cards

1. For ***FREQUENCY_DOMAIN_SSD** fixed a bug in reading `d3eigv` for eigenvector information when 4-node and 8-node shell elements are both present.

§23 Implicit (mechanical) solver

1. Fixed bug in implicit that occurred when used with adaptivity in MPP.
2. Fixed bug with `d3eigv` when using `TET10S8 = 1` on ***CONTROL_OUTPUT**.
3. Various improvements to LS-GPart (`ORDER = 4` on ***CONTROL_IMPLICIT_ORDERING**):
 - Significant improvements in MPP;

- Added hybrid parallelism (OpenMP);
 - Added a progress report ("heartbeat") for large problems that is printed to the message files.
4. ***CONTROL_IMPLICIT_EIGENVALUE:**
- Enable additional keyword controls from ***CONTROL_IMPLICIT_EIGENVALUE** (optional Card 3) for MPP execution. These controls were initially only available for SMP.
 - Remove implicit input / output files at the end of any eigencomputation. These were scratch files that were of no interest to the user.
 - Correct an error associated with the the nonsymmetric eigensolver which impacted any problem with damping.
 - Rewrote how data is output to the d3plot, d3eigv, and similar files, to vastly improve performance of writing the data. This saves 15% of the wall clock time during an analysis for large eigenvalue problems where lots and lots of eigenmodes are computed and written to d3eigv.
5. Fix ***PART_MODES** so it works in single precision as a user request.
6. ***CONTROL_IMPLICIT_BUCKLE:** Fix incorrect handling of multiple right-hand-sides during the forward / back solve for the Power Method. The Power Method extracts buckling modes (see ***CONTROL_IMPLICIT_BUCKLE**).
7. ***CONTROL_IMPLICIT_SOLUTION:**
- Correct the processing of energy and other such statistics in file glstat for the multistep linear solution method (NSOLVR = -1 on ***CONTROL_IMPLICIT_SOLUTION**). Prior to the bug fix, the statistics were additive, meaning the statistics for the new time step were added to the ones from the previous time step. Now the statistics are reset at the beginning of the new time step, so the statistics reflect just the current time step.
- Prior to this revision implicit linear analysis (NSOLVR = 1 on ***CONTROL_IMPLICIT_SOLUTION**) used the forces at the end of the linear step to compute resultant forces. This did not match the expectations of users. We changed the computation of resultant forces, such as those in bndout, to use the force at the beginning of the linear step.
8. ***CONTROL_IMPLICIT_MODES:**
- Fixed the generation of superelements using ***CONTROL_IMPLICIT_MODES** in MPP when nodes involved were shared across processors.
 - Fix application of implicit constraint modes in MPP for the case where a constraint mode is also a shared node.
9. ***CONTROL_IMPLICIT_INERTIA_RELIEF:** Some penalty contacts were being turned off for the inertia relief computation. These contacts are now enabled for this computation.
10. Correct how the load curve IDs for IAUTO and IMASS were being processed for implicit keywords ***CONTROL_IMPLICIT_DYNAMICS** and ***CONTROL_IMPLICIT_AUTO** with the options DYN or SPR enabled. Before if the curve IDs did not match the input order (such as an ID of 97125 for third curve input), then LS-DYNA would give an error. This is not how curves are normally processed. Now they are

being processed like all other curves in LS-DYNA where the curve ID and order of input are independent.

11. ***CONTROL_IMPLICIT_MODAL_DYNAMIC:**

- Allow the use of shell formulation 18 in modal dynamics when reading the modes from d3eigv.
- In previous releases, we had reduced the size of d3eigv database for models with no rotational dofs like solid element only models. In the previous releases modal dynamics tried to read the nonexistent data for rotational dofs and became lost. This revision corrects that oversight.

12. ***CONTROL_IMPLICIT_GENERAL:** Adjust logic of when the last intermittent eigenvalue computation is performed during an explicit simulation if the last one is to be performed near the termination time. For instance, if the termination time is 10.00 and the explicit time step is 0.01, then the explicit calculation terminates between 9.99 and 10.00. Therefore, if you wanted an eigenvalue computation performed at 10.00, it would not happen because the calculation would have already terminated. This change causes the intermittent eigenvalue computation to occur before the termination.

13. During MPP decomposition the nodes on an interface (see ***INTERFACE**) may be shared by multiple processes. We fixed a bug in implicit where we were double counting the interface forces for the shared nodes.

14. Enhance implicit's processing of nodal mass matrices to include the local coordinate transformation.

15. Restore the ordering reuse logic to the MPP implementation of implicit dynamics. This is an important time saving feature for very large models with multiple time steps.

16. ***CONTROL_IMPLICIT_SOLVER:** For intermittent eigenvalue analysis the direct solvers used by the eigenvalue analysis were forced for the entire execution. We now save and restore the solver option selected by the user to use during the non-eigenvalue execution of the run. This enables the use of iterative solvers.

§24 Thermal solver

1. Fixed bug so that the setting of IEV-ERP in ***DATABASE_EXTENT_BINARY** is not ignored during thermal only calculations.
2. ***BOUNDARY_RADIATION_SET** and ***SEGMENT_VF_OPTION** requires a view factor file. An input trap was added for if this view factor file is missing.
3. Added an input trap for ***BOUNDARY_RADIATION_SET** and ***BOUNDARY_RADIATION_SET_VF_OPTION** to catch when TYPE is incorrect.

§25 MPP

1. Increase the number of materials to 400 and the number of solid formulations to 80 in the MPP decomposition timing table.
2. Fixed bug in MPP that resulted in the incorrect rotational masses being reported to massout.

3. Fixed bug in array allocation in MPP when running ***CASE** which caused LS-DYNA to abort. Also removed some unhelpful debug logging output.
4. Fixed MPP support for ***DEFINE_FUNCTION** when performing predecomposition based runs.
5. Fixed bug in full deck restart for MPP contact.
6. Fixed MPI bug to avoid possible deadlock during termination.
7. When MPP predecomposition is done for more processors than the calculation, and the model contains airbags, the airbag ownership was not being handled properly leading to problems including possibly segfault. This has been fixed.
8. Fixed decomposition issue introduced in R11 r133230, which in some cases did not put adjacent physical domains on adjacent processors, resulting in decreased performance.
9. Added new variable SAMPT to ***CONTROL_MPP_DECOMPOSITION_REDECOMPOSITION** to apply the current element cost table to the next redecomposition step.
10. Fixed a bug in which ***CONTROL_MPP_MATERIAL_MODEL_DRIVER** required GRAPH to be defined even in SMP.

§26 Compressible fluid solver (CESE)

1. Fixed several bugs for the CESE moving mesh conjugate heat transfer solver, particularly for MPP. Some MPP bugs depended on the mesh decomposition.

Other MPP failures occurred in the calculation of the CESE moving mesh conjugate heat transfer interface conditions.

2. Only for the ***CESE** moving mesh solvers, correct the nodal connectivity for wedge / prism elements.

§27 Chemistry

1. Fixed some zero-dimensional inflator solver issues so that it is now working correctly.

§28 Restarts

1. Fixed seg fault that occurred during a full deck restart when the initial run has 6 degrees-of-freedom (meaning the elements include rotational degrees-of-freedom which includes beams, shells and solids with rotational degrees-of-freedom) while the full deck restart run has 3 degrees-of-freedom (meaning the elements are only solids without any rotational degrees-of-freedom).

§29 Output

1. Fixed bug in plane strain, 8-node shell formulation 55 to show correct stresses when 4 in-plane points are required for d3plot output.
2. Write out stress components at all integration points in elout for shell formulation 55.
3. Shell formulation 55 is for implicit analysis only and requires 4, 9 or 16 integration points since it is to simulate singular stress field around a crack tip. When

- NIP > 4, the stress data at only 4 Gaussian points stress will be interpolated and written to d3plot.
4. Fixed incorrect stress output to elout for thick shell types 1 and 2 when used for composite materials and CMPFLG = 1 on ***DATABASE_EXTENT_BINARY**.
 5. Restored how encrypted files are echoed to d3hsp back to how it was done in version R9.3.1. Also restored output of pfile information to d3hsp and messag for encrypted input to that of R9.3.1.
 6. Added a missing blank line in glstat.
 7. ***DATABASE_RECOVER_NODE**:
 - Enable elemental extrapolation method for solid formulations -1 and -2.
 - Issue a warning message when no vertex is detected when using the Superconvergent Patch Recovery method to obtain the nodal stress.
 - Fix an MPP bug for 10-node tetrahedron elements.
 8. Fixed incorrect stress output to d3plot and ASCII files when using tetrahedron solid types 10 and 13 with orthotropic materials that occurred when CMPFLG = 1 in ***DATABASE_EXTENT_BINARY**.
 9. Added error termination with KEY+501 message if different BEAM settings are used in duplicate ***DATABASE_BINARY_D3PLOT** definitions.
 10. Fixed a bug that caused zero strain output in d3part when setting STRFLG = 1 in ***DATABASE_EXTENT_D3PART**. Please note that the ones digit of STRFLG in ***DATABASE_EXTENT_BINARY** must be set to 1.
 11. Fixed a bug that caused disagreement in rigid body velocities between glstat AND matsum.
 12. Fixed a bug that caused zero strain output for upper and lower points in eloutdet in MPP.
 13. Fixed a bug that caused input errors when reading LCDT in ***DATABASE_BINARY_BLSTFOR**.
 14. Fixed a bug that caused seg fault when LCUR in ***DATABASE_DISBOUT** was defined.
 15. Fixed a bug that caused incorrect filtered results in ncforc when using ***DATABASE_NCFORC_FILTER** in MPP.
 16. Fixed a bug that caused incorrect kinetic energy output in glstat when using ***INITIAL_VELOCITY_GENERATION**.
 17. Fixed a bug that caused wrong external work output in glstat when there were ***BOUNDARY_PRESCRIBED_MOTIONS** that superseded ***BOUNDARY_SPCs**.
 18. Fixed a bug in which the damping energy was not accounted for in glstat for ***DAMPING_RELATIVE**.
 19. The ones digit of STRFLG in ***DATABASE_EXTENT_BINARY** will be automatically set to unity when using ***INITIAL_STRAIN_SOLID**.
 20. Added three entries per subsystem to account for conventional mass scaling (CMS) to the binary output of the SSSTAT data (SSSTAT section of binout; see BINARY = 2 on ***DATABASE_SSSTAT_MASS_PROPERTIES**). The ASCII version of SSSTAT does not include these entries. These three entries

are the total mass including mass added due to CMS, the kinetic energy including the CMS added mass, and the center of gravity with in the included CMS. Note that these entries do not include the selective mass scaling contribution.

21. Added an option to output the effective mass for each part to d3plot through MSSCL in ***DATABASE_EXTENT_BINARY**.
22. Added SPC2BND on ***CONTROL_OUTPUT** which converts constraints on rigid bodies specified with ***MAT_RIGID** (***MAT_020**) to equivalent ***BOUNDARY_PRESCRIBED_MOTION_RIGID** motion. This conversion is to obtain spc reaction forces in bndout without changing the simulation results.
23. Fixed missing support of fields LCUR and IOOPT for ***DATABASE_DCFAIL**.

§30 Miscellaneous

1. Fixed ordering issue with ***DEFINE_FUNCTIONS** in the initialization phase (structured input) such that all of these are before ***DEFINE_CURVE_FUNCTIONS**. This prevents a ***DEFINE_CURVE_FUNCTION** that references a ***DEFINE_FUNCTION** from being before the ***DEFINE_FUNCTION**.
2. Fixed a memory allocation problem caused by ***USER_INTERFACE_FRICTION**.
3. Added a work around for a bug in the PGI compiler.
4. Added 3 sense switches:
 - SWB: A dynain file is written, and LS-DYNA continues.

- SWC: A restart file and a dynain file are written, and LS-DYNA continues.
- SWD: A restart file and a dynain file are written, and LS-DYNA terminates.

Note that ***INTERFACE_SPRINGBACK_LSDYNA** must be defined in the input deck for these sense switches to work.

5. Fixed bug that occurred when reading the long format option for the following keywords:
 - ***AIRBAG_PARTICLE_MPP_ID**
 - ***AIRBAG_HYBRID**
 - ***EOS_IDEAL_GAS**
 - ***PARAMETER_EXPRESSION**
 - ***INTERFACE_COMPONENT_NODE_TITLE**
 - ***INTERFACE_SPRINGBACK_LSDYNA** with 'OPTCARD' optional 2nd card
 - ***MAT_295**
 - ***ALE_STRUCTURED_MESH_CONTROL_POINTS**
 - ***BOUNDARY_SPC_NODE_SET**
 - ***PARAMETER_EXPRESSION**
 - ***INITIAL_VELOCITY_GENERATION**
6. Fixed bug when reading I10 format for ***PART** if the part ID is more than 9 digits.
7. Fixed error in the strain energy density that occurred in the MPP version when $np > 1$.
8. Fixed bug that causing the output of an incorrect error message. The error message was triggered by a processor that didn't own a seatbelt element.
9. Replace keyword ***SET_SPRING** with ***SET_DISCRETE**.

10. Fixed bug in reading ***SET_NODE_GENERATE**.
11. Changed the default of plabel to "plabel = no" for faster input processing. If the input contains non-numeric (character) ID(s), an error message will be issued. In this case you need to include "plabel = yes" on the execution line so that the non-numeric ID(s) can be properly read.
12. Fixed bug in reading ***CONSTRAINED_NODAL_RIGID_BODY_TITLE**.
13. Fix bug in which the message for announcing the loading of an include file appears twice.
14. Fixed a bug triggered by ***PART_DUPLICATE** and ***NODE_MOVE** not being in the same include file.
15. Fixed issue where some user defined features (usrshl, usrsld, usrfrc, usrtie, usrtbrk, usr_nunonl, mortar_*, rebar_*) using ***MODULE** did not work correctly.
16. ***DEFINE_PRESSURE_TUBE** now supports decomposition of automatically generated solid and shell tubes in MPP.
17. Fixed the reading and writing of dynain files and the writing of elout data for beam element forms 7 and 8 (ELFORM = 7 or 8 on ***SECTION_BEAM**). They included the wrong number of integration points.
18. Fixed bug that was causing an incorrect error message, STR+389, when using ***RIGIDWALL_GEOMETRIC_FLAT_MOTION_ID_DISPLAY** with adaptivity.
19. Implemented ***DEFINE_DRIFT_REMOVE** for MPP.
20. Fixed a bug that caused input errors when using ***SET_NODE_GENERAL** with ***SET_SOLID_COLLECT**.
21. Fixed a bug that caused input errors when using ***SET_SOLID** with ***SET_NODE_ADD_ADVANCED**.
22. Added feature to ***DEFINE_MATERIAL_HISTORIES** for LABEL = "History", whereby if the first attribute A1 is negative, its absolute value points to a curve. The first ordinate value of the curve defines an operation to be performed on a list of history variables. The subsequent ordinate values give the history variable numbers in the list. See the User's Manual for details and an example.
23. ***PART_STACKED_ELEMENTS**: Fixed bug that caused models to fail with "Error 10183 (KEY+183) part xxx not defined", even if that part did not exist at all.
24. Added new keyword ***DEFINE_TABLE_COMPACT** to define an *n*-dimensional table more compactly. Internally, the keyword reader creates ***DEFINE_TABLE_XD** tables from this table.
25. Added two new OPTIONs for ***DEFINE_TRANSFORMATION**:
 - TRANSL2ND: Translation given by two nodes and a distance
 - ROTATE3NA: Rotation given by three nodes and an angle
26. Added new feature to ***PERTURBATION_NODE**: The amplitude needed for TYPE = 8 can now take negative and positive values.
27. ***INCLUDE_TRANSFORM**:

- Fixed ***INCLUDE_TRANSFORM** IDFOFF issue that occurred with load curves from ***CONSTRAINED_INTERPOLATION_SPOTWELD**.
 - Fix for table values transformation by ***INCLUDE_TRANSFORM**. It could happen that strain rates were converted (FCTTIM) even if they should not.
28. Fixed combination of ***INCLUDE_STAMPED_PART** and ***INCLUDE_TRANSFORM** with PID and EID offsets.
 29. Fixed combination of ***INCLUDE_STAMPED_PART** with orientation nodes N1C, N2C, N3C and ***INCLUDE_TRANSFORM** with node offset IDNOFF.
 30. Increased the number of allowable ***PART_MOVE** definitions in an input deck from 200 to 1000.
 31. Added new optional variable ZMIN to ***PART_DUPLICATE**. Transformed part(s) will have a minimum *z*-coordinate equal to ZMIN.