

# **LS-DYNA**

## **Release Notes**

**January 2006**  
**Version 970, build 6763**



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These notes accompany the fourth release of LS-DYNA version 970. This release, known as LS-DYNA 970 build 6763.169, follows on from builds 3858, 5434 and 5434a. Changes made since build 5434a are given below.

## 1. MATERIAL MODELS

- Fixed \*MAT\_77 for shells.
- Fixed bug in \*MAT\_183.
- Fixed double-single precision problem in \*MAT\_106.
- Made fixes to \*MAT\_040 shells and solids.
- Made modification to bypass deletion of solid element when using \*MAT\_126 with the reference geometry option.
- Fixed problems in rubber material \*MAT\_027 and \*MAT\_181.
- Added upper bound for strain rates in \*MAT\_024 for shells with viscoplastic rate formulation.
- Added table of temperature-dependent yield curve for \*MAT\_106.
- Made minor fix to high explosive model
- Fixed unit system 1 in wood material \*MAT\_143 (cm changed to mm).
- Corrected pressure term in \*MAT\_147.
- NPLOT=5 in \*MAT\_147 outputs pore water pressure to "plastic strain" location.
- Made minor fix to \*MAT\_ADD\_EROSION.
- Fixed read error of LCSR in \*MAT\_112.
- Fixed strain rate parameter in \*MAT\_112.
- Corrected stress calculation in 2D solids for \*MAT\_098.
- Added updates to \*MAT\_101.
- Fixed bug in \*MAT\_181.
- Modified \*MAT\_119 to use small strains rather than displacements.
- Added \*MAT\_151 (\*MAT\_EMMI = Evolving Microstructural Model of Inelasticity).
- Added deletion of solid element spotwelds if surrounding shell elements fail.
- Fixed problem with \*MAT\_024 combined with tet type 10.
- Fix for density scaling in \*MAT\_147.
- Added improved formulations of FORM 2,3,4 for \*MAT\_FABRIC. These are FORM 12, 13, and 14, respectively.
- Fixed Toyota's spotweld failure model to handle shared spotweld nodes.
- Activated crash front calculation in composite materials.
- In \*MAT\_15, log is now taken of a number not less than 1.0. Thus  $(1+c*\ln(\text{epsdot}))$  and  $(1+D4*\ln(\text{epsdot}))$  are not less than 1.0.

- Added viscoplastic option to \*MAT\_123.
- Fixed problem with \*MAT\_181 for shell elements in single precision.
- Added failure model to \*MAT\_181.
- Fixed minor bug in \*MAT\_024 shells with VP=1 where rate parameters C & p were used in addition to the table definition.
- Added viscoplastic strain rate to \*MAT\_024 as the first history variable.
- Fixed \*MAT\_082 for VP=0. Failure did not occur for a simple test case using the C and p rate constants.
- Fixed \*MAT\_024 for VP=1. Error related to interpolation between curves when table definition is used.
- Fixed \*MAT\_098 for solid elements related to stress initialization using the “dynain” file. The volumetric strain must be initialized.
- Fixed bug in solid element \*MAT\_103 when cmpflg=1 and aopt=0.0.
- Fixed timestep problem related to \*MAT\_054 and shell formulation type 8.
- Fixed \*MAT\_BARLAT\_YLD96 material model. The wrong load curve is used if the curve option is active.
- Fixed bug in seismic beam, \*MAT\_191.
- Fixed bugs related to spotweld material option opt=1. Rate effects were not working correctly.
- Added support for non-Newtonian viscosity variations via load curve or by power law in \*MAT\_NULL.
- Fixed problem with \*MAT\_183 shell elements related to single precision.
- Fixed problem with \*MAT\_156 to handle large load curve ID's in single precision.
- Added muscle model for truss element.
- Added \*MAT\_183, a variation of \*MAT\_181 but with a damage curve.
- Fixed timestep calculation for \*MAT\_106.
- Fixed problem in \*MAT\_023 related to user integration rules that reference Part IDs.
- Made minor fix related to large load curve numbers in \*MAT\_083.
- Added support for types 6 and 7 hourglass control for solid material types 85, 102, 109, 110, 111, 112, 115, 120, 131, 132, 141, 147, 151, 153, 154, 159, 164, 169, 176, 180, 192, 198, and 200.
- Added reference geometry option to \*MAT\_083.
- Fixed bug in 2D solid element related to \*MAT\_002 and full integration.
- Added cutoffs for the green strain tensor in \*MAT\_FABRIC for options 2,3, and 4. Round-off error can cause instabilities.
- Fixed problem with viscoelastic \*MAT\_065.
- Fixed bugs in \*MAT\_059 for solid elements affecting transverse tensile failure and reversal of transverse shear strengths.

- Added new failure criteria for 2D \*MAT\_010 elements.
- Fixed bug affecting strain output of \*MAT\_058 when EC=0.
- Corrected a bug that could cause spotweld failure option 7 to use the default failure values rather than the failure values from the table.
- Fix to slope in type 4 spring material.
- Made changes to \*MAT\_124 failure model.
- Updated \*MAT\_075 per Paul Du Bois.
- Fixed a minor bug in \*MAT\_126 in which the wrong load curve ID was printed into “d3hsp” file.
- Fixed a minor bug in \*MAT\_176 affecting reading of viscoelastic constants.
- Made minor change to calculation of fracture strain in \*MAT\_015 to prevent numerical overflow.
- Modified Toyota beam weld failure criteria to only increment the failure counter (to compare with FVAL) at the beam end with higher plastic strain.
- Fixed bug in \*MAT\_119 for discrete beam to prevent infinite time step size.
- Fixed type 6 hourglass control for solid element material \*MAT\_181.
- Fixed type 6, 7, and 9 hourglass control for solid element materials \*MAT\_110 and \*MAT\_111.
- Added support for hourglass control types 6, 7, and 9 for solid element materials \*MAT\_155 and \*MAT\_183.
- Fixed problem related to rate effects in \*MAT\_181.
- Fixed a bug affecting \*MAT\_002 when used with user-defined shell integration rule which changed properties through the thickness.
- Extended type 6 hourglass control to type 1 solid element materials 13, 16, 72, 163, 198, and 200.
- Fixed bug affecting use of large load curve IDs for \*MAT\_120.
- Made a bug fix to \*MAT\_158.
- Made fix to \*MAT\_057 related to large load curve IDs.
- Made minor fix to \*MAT\_036 related to initial stress option.
- Fixed variable initialization bug in \*MAT\_181.

## 2. ELEMENT FORMULATIONS

- Shell formulations 4, 11, 16, and 17 can now model rubber.
- Corrections made to shell formulations 2 and 7 for rubber.
- Fixed a bug in shell formulation 18.
- Updated shell formulation 15 for consistency, accuracy, and speed.

- Corrected mass calculation in solid formulation 12.
- Corrected time step calculation for cable elements.
- Fixed incorrect thickness in 2D plane stress solid.
- Corrected seatbelt bug caused by incorrect index used in the retractor array.
- Fixed a bug in shell formulation 21: yz- and zx-stress/strain components were misplaced.
- Fixed formulation 15 solid (prism) to correct “NaN” problem triggered by stiffness damping.
- Fixed possible problem in stiffness damping in Hughes-Liu beam elements.
- Fixed problem with stiffness damping in shells and solids. The implementation was incorrect for the type 2 and 3 solids and the energy calculation was wrong. For shells, the damping stresses were sometimes overwritten before energy was calculated.
- Fixed inertia calculation for solid 5 formulation 16 tetrahedron.
- Corrected 2D hourglass stiffness for axisymmetric formulation 15.
- Fixed input problem when number of \*ELEMENT\_INERTIA exceeds 99999.
- Fixed beam end release problem.
- Fixed problem with solid formulation 16 (tet) combined with \*MAT\_004.
- Fixed problem with local stresses in 2D solid elements.
- Fixed problem related to massless nodes in discrete beams.
- Fixed NFAIL option related to rubber material and fully integrated elements. All elements were deleted in the first time step.
- Fixed bug in truss element stiffness and added geometric stiffness.
- Modified the type 13 nodal pressure tet element to use a smoothed pressure that conserves energy better during 3D adaptive remeshing.
- Fixed for cross-section force calculations for solid type 16, 10-node tetrahedron.
- Fixed component interface linking problem with tetrahedral elements.
- Made minor fix to time step calculation for solid formulations 4, 16, and 17.
- Updated damping related to the Belytschko-Schwer beam.
- Added support for EOS 12 (\*EOS\_IDEAL\_GAS) for Lagrangian solids.
- Fixed a bug in shell type 16 for linear analysis.
- Fixed a bug in shell type 21.

### 3. CONTACT

- Fixed problem with \*CONTACT\_AUTO...TIEBREAK option=5 related to cutoff of decay curve.
- Fixed problem with \*CONTACT\_AUTO...TIEBREAK contact for option=1.

- Fixed problem with \*CONTACT\_AUTO\_..TIEBREAK contact related to searching and offsets.
- Fixed forming contact in SMP where the shell thickness is greater than the edge length.
- Added a check for improperly tied solid spotweld elements that lack table data for spotweld failure OPT=7.
- If soft=2 contact is requested for a contact that is not supported, it now switches to soft=1 instead of soft=0.
- Added revision 3858's node-to-surface eroding contact back as an option.
- Fixed segment-based contact energy and rforc output when elements erode.
- Fixed segment-based contact problems. One problem occurred with incorrect detection of penetration when there was extreme compression of solid elements (foam).
- Added options to control birth and death time of contact when dynamic relaxation is active.
- Added scaling of spotweld failure (\*CONTROL\_SPOTWELD\_BEAM).
- Added error termination when requesting constraint-based contact with rigid bodies in explicit computations.
- Made change to \*CONTACT\_ERODING\_SURFACE\_TO\_SURFACE to make it behave more like revision 3858.
- Modified area check of contact segments to allow smaller segments to be used.
- Fixed 2D automatic contact to prevent likely penetration from occurring after eroding solid element expose new segments.
- Fixed a potential memory allocation error in segment-based contact that could cause a segmentation fault during a run. The error is only known to have occurred with solid elements in combination with eroding contact.
- Added guided cable contact (\*CONTACT\_GUIDED\_CABLE).
- Add consideration of true out-of-plane thickness of 3D shells when used with 2D automatic contact. Previously, a unit thickness was assumed because the use of 3D elements with 2D contact was not anticipated.
- Fixed the sliding option of segment-based contact when used with triangular segments.
- Changed the release criteria for forming contact to prevent premature release.
- Added option whereby negative contact damping coefficient becomes a flag for damping all velocity components, not just the normal velocity component.
- Fixed a problem with forming contact.
- Fixed a problem that could cause 2D contact failure.
- Fixed sliding option of segment-based (SOFT=2) contact to reduce the likelihood of penetration.
- Fixed automatic tiebreak contact related to cure energy growth problems and other strange behaviour.
- Made improvements to \*CONTACT\_AUTO\_MOVE.

- Fixed damping option used in rigid body contact.

#### 4. ADAPTIVITY

- Fixed bug in \*SET\_GENERATE... options for adaptivity.
- Fixed bug in look-forward h-adaptivity (too many elements refined).
- Fixed “d3plot” file and restart problems for 3D r-adaptivity.
- Fixed bug that resulted in missing “d3plot” files in adaptive runs.
- Increased some local array sizes to handle larger 2D r-adaptive problems.
- Made many improvements to the triangular surface remesher in support of 3D r-adaptivity.
- Made minor tolerance changes for symmetry planes and 3D adaptivity.
- Fixed volume conservation and mass loss issues with 3D adaptivity.
- Added feature to control h-adaptivity level by load curve.
- Fixed 2D adaptive “dynain” corruption problem.
- Fixed problem with stiffness damping used in combination with adaptivity.
- Fixed problem of failed elements reappearing after mesh is adapted.
- Added new option for ADPLVL in \*CONTROL\_ADAPTIVE. If ADPLVL is negative, we split the main element only.
- Added curve to specify 2D adaptive mesh size.
- Added \*DEFINE\_SET\_ADAPTIVE so that the user can define the adaptivity refinement level by part or element set.
- Added adpsize option to \*DEFINE\_SET\_ADAPTIVE.
- Made fix to 2D adaptivity related to missing lumped masses after first adaptive step.
- Fixed 3D adaptive remeshing with SPC constraints.
- Added another option for adaptive angle calculation.
- Fixed error in adaptivity refinement.
- Fixed bug in adaptivity if the material included failure.

#### 5. ALE

- Added ALE birth time option.
- Updated coupling type 5 (coupling to eroding parts).
- Added \*MAT\_025 for ALE.
- Added option in \*INITIAL\_VOLUME\_FRACTION\_GEOMETRY to control degree of refinement used in each ALE element to calculate initial volume fraction of each material.
- Added a new coupling stiffness option to \*CONSTRAINED\_LAGRANGE\_IN\_SOLID (uses slave bulk modulus, mass-weighted penalty).

- Added a soft constraint coupling option.
- Added an option to terminate the run if the critical time step calculated from ALE is less than dt2ms.
- Fixed a bug in \*INITIAL\_VOLUME\_FRACTION\_GEOMETRY in which the initial guess on which segmental normal to use was wrong in some cases.
- Fixed a bug that would cause \*ALE\_REFERENCE\_SYSTEM\_GROUP to function abnormally.
- Modified leakage control type 2 for ALE coupling to adjust velocities in order to better conserve energy.
- Eliminated mass scaling for ALE elements to avoid problems.
- Added option for considering shell thickness in constrained\_lagrange\_in\_solid.
- Modified codes so that all gas species of \*MAT\_GAS\_MIXTURE are considered in estimating ALE point source inlet gas velocity.
- Fixed bug in ALE interface reconstruction if number of materials is greater than three in an element.
- Added alternate names for all materials specific to ALE:

(1)	*MAT_VACUUM	->	*MAT_ALE_VACUUM or *MAT_ALE_01
	*MAT_GAS_MIXTURE	->	*MAT_ALE_GAS_MIXTURE or *MAT_ALE_02
	*MAT_NULL	->	*MAT_ALE_VISCOUS or *MAT_ALE_03
	*MAT_MIXING_LENGTH	->	*MAT_ALE_MIXING_LENGTH or *MAT_ALE_04

- Fixed the ALE sensor option to use only the segment centre as the sensing point.
- Added mass output to “d3plot” and “d3thdt” for each multimaterial group.
- Disabled ALE coupling with nodes and always default to element quad points.
- Implemented ALE multi-material switching (\*ALE\_FSI\_SWITCH\_MMG). This option will allow user to switch the material group ID after it flows through a defined section set. Using this option, coupling can occur from either side of a Lagrangian surface. Report mass of switched material in the porosity field of dbfsi.
- Updated ALE coupling to accommodate all element shapes including tets.
- Fixed a bug affecting ALE reference system 4.
- Added ability to assign initial velocities using \*INITIAL\_VOLUME\_FRACTION\_GEOMETRY.
- Added a new algorithm for \*INITIAL\_VOLUME\_FRACTION\_GEOMETRY that accounts for more than just convex shell/segment surfaces.
- Fixed bug in ALE reference system 9.
- Implemented \*LOAD\_ALE\_CONVECTION for simulating heat convection from ALE fluid to Lagrangian structure. Write temperature change to dbfsi.
- Fixed bug for lvel=0 in \*AIRBAG\_ALE.

- Added capability to allow NORM in \*CONSTRAINED\_LAGRANGE\_IN\_SOLID to take a value between 0 to 1. The normal of the penalty springs can now be:
  - a. segment-based normal
  - b. nodal average of the segment-based normal (weighted by segment area)
  - c. a blend of (a) and (b)
- Added support for ALE reference pressure in element formulations 5,6,7.
- Fixed problem in \*EOS\_IDEAL\_GAS used in element formulations 5,6,7.
- Added translational and expansion constraints for \*ALE\_REFERENCE\_SYSTEM\_GROUP type 5.
- Changed default gas mixture option for \*AIRBAG\_ALE to non-linear cv, cp model.
- Added pop pressure and venting curve in \*AIRBAG\_ALE option.
- Added \*DATABASE\_FSI\_SENSOR option to get ALE element pressure at the sensor location and output to "dbsensor" file.
- Reinstated ALE solid 7 ambient type 3 condition which was disabled accidentally.
- Implemented new ALE FSI interface forces file to get binary database similar to contact's "intfor" database. To activate the option:
  - (1) add h=filename to execution line
  - (2) set flag in \*CONSTRAINED\_LAGRANGE\_IN\_SOLID
- \*DATABASE\_BINARY\_FSIFOR defines the output frequency.
- Added new option to \*SECTION\_POINT\_SOURCE to evenly distribute momentum among nodes.
- Implemented \_ID and \_TITLE option card for \*CONSTRAINED\_LAGRANGE\_IN\_SOLID.
- Fixed advection for wedge elements.
- Fixed bug in which kinetic energy of the inlet gas was not properly compensated for in the internal energy
- Fixed bug affecting zero load curve velocity for Point Source.
- Added ALE initial penetration option in \*CONSTRAINED\_LAGRANGE\_IN\_SOLID.
- Made correction to heat convection in ALE coupling while using \*MAT\_148 with nonlinear cv,cp formulation.
- Added \*ALE\_REFERENCE\_SYSTEM 9 - new option to create smoother expansion of meshes that includes a fixed part.
- Implemented exclude part list for \*ALE\_REFERENCE\_SYSTEM type 9 to avoid point source from moving outward from the critical region.
- Added option for \*ALE\_REFERENCE\_SYSTEM type 9 to only allow expansion but not shrinking of ALE mesh.
- Added a box option for \*CONSTRAINED\_LAGRANGE\_IN\_SOLID for slave segments so that only segments inside the box get coupled with fluid.

- Added option triggered by negative porosity pressure curve ID in \*CONSTRAINED\_LAGRANGE\_IN\_SOLID whereby porosity comes from \*MAT\_FABRIC.
- Improved algorithm for initial assignment of volume fractions in ALE.
- Fixed bug in ALE porosity option in \*MAT\_034 curves.
- Added more options for initial volume fraction (ALE).
- Added extra option for ALE mass scaling.

## 6. SPH

- Added mass of SPH elements to d3plot files.
- Fixed problem with tied SPH particles.
- Added a test on mass of SPH element during initialization.
- Fixed bulk viscosity computation for all the SPH formulation.
- Fixed a bug with \*DEFINE\_BOX\_SPH. Box was not moving even with the definition of the load curve.
- Fixed bug in initialization of \*MAT\_008 SPH elements. All the SPH elements were detonating at time=0.
- Fixed bug in “sphout” . An Error Termination occurred when \*DATABASE\_SPHOUT was defined before the \*DATABASE\_HISTORY\_SPH keyword in the input deck.
- Implemented \*MAT\_ISOTROPIC\_ELASTIC\_FAILURE (\*MAT\_013) for SPH elements.
- Fixed bug in \*BOUNDARY\_SPH\_SYMMETRY\_PLANE. Lagrangian nodes (of shells and solids) were constrained by this boundary condition.
- Fixed bug in SPH non-reflecting boundary.
- Improved efficiency of SPH initialization.

## 7. EFG

- Added 2nd order objective stress update to 3D EFG. This is controlled by \*CONTROL\_ACCURACY
- Added 6-noded and 4-noded elements for EFG.
- Corrected EFG 2D contact with beam elements.

## 8. OUTPUT

- Added version number to LS-DYNA binary files: “d3plot”, “d3thdt”, “d3part”, etc.
- Changed banner, binout, and ascii file headers to include versionnumber, revision number, mpp/smp, and single/double indicators. Header format will now match new 971 format.
- Changed “xtfile” to 32-bit format if LSTC\_BINARY=32ieee.
- Removed extra data in “rbdout” file.

- Fixed bad write to “d3plot” when a tie-break is used and some nodes are moved.
- Added write to all ASCII files at termination time.
- Fixed “d3crack” output if LSTC\_BINARY=32ieee is set.
- Fixed missing header for “nodout” in a full deck restart.
- Disable “dbfsi” and “dbsensor” if there is no FSI coupling defined.
- Corrected temperatures written to the “drdisp.sif” file for itemp=-2 and itemp>0.
- Fixed error in “nodfor” file. All forces were zero if node is attached o a rigid body.
- Fixed calculation of strain tensor that is output for type 4 tetra element.
- Fixed a bug in “d3plot” output when DECOMP=3 or 4 (\*DATABASE\_EXTENT\_BINARY) in the case of a thermal problem.
- Added output of all ASCII and “intfor” data at the termination time.
- Fixed “jntfor” binary output to be in agreement with the ASCII output.
- Changed default scale factor for binary file size from x=7 to x=70.
- Fixed bug in beam “d3plot” output to correct viewing of beams as prisms.
- Fixed bug in \*COMPONENT\_GEBOD segment acceleration output. (Affected reported accelerations of lower legs in “d3plot”, “nodout”, and “rbdout”. Motion of the dummies was unaffected.)
- Made change to binary “ncfor” output for eroding surfaces. Since the number of nodes can change each state, write the ids array in each output state, but only for eroding contacts.
- Fixed bug in writing “d3part” if any ALE elements is requested.
- Fixed bug in writing “d3part” if DCOMP=3 or 4 is defined in \*DATABASE\_EXTENT\_BINARY.
- Updated format for all ASCII files.
- Fixed problem of IDs in “swfor” file in binary output: user ids were not being output for nodal constraints or generalized welds.
- Added “sleout” output for 2D contact and added binout output of 2D contact “rcfor”, “ncfor”, and “sleout”.
- Fixed ALE tracer particle output problem.
- Changed signs on type 4 beam stress resultants to be consistent with types 1 and 2.
- Fixed a bug in “d3plot” for linear shell elements 18, 20, and 21.
- Fixed initial rotational velocities written to “nodout” file. Nodes belonging to rigid bodies had their t=0 velocities written as 0.0.
- Fixed beam resultants in “elout” file so type 1 and 2 beams agree.
- Corrected sign of beam moments in “secfor” file.
- Fixed bug in “elout” for linear shell formulations 18, 20, 21.
- Corrected strain output to “elout” file for material 34 forms 3 and 4.

- Fixed bug in binary “swforc” output for generalized welds in MPP.
- Fixed “secforc” file for 1-pt solid elements for implicit computations.
- Cleaned up thick shell output.
- Fix force output for Lagrange Multiplier joints.
- Fixed output of shell resultants for materials 22, 54, and 55 when CMPFLG=1.
- Added option CMPFLG=2 which overwrites resultants as requested by NASA.
- Fixed output to “swforc” for implicit.
- Added resultant moments to “swforc” file for Toyota weld option with table.
- Correct reporting of joint forces to “jntforc” file for implicit simulations.
- Corrected output of reaction forces to “bndout” for rigid bodies in implicit.
- Removed warning messages if the number of history blocks exceeds 2000.
- Added MASS\_PROPERTIES option to include mass and inertial properties in the “glstat” and “ssstat” files \*DATABASE\_GLSTAT\_MASS\_PROPERTIES and \*DATABASE\_SESTAT\_MASS\_PROPERTIES.
- Fixed ASCII file “sbtout” in restart run.
- Fixed bug in “dynain” related to output of undefined beam elements.
- Fixed problem with accelerometer output.
- Added option in \*CONTROL\_CPU to output cpu/elapsed time in “glstat” file.
- Corrected the writing of beam reference nodes to “d3eigv”.
- Added output of material fit data to “messag” file (convenient for plotting) for \*MAT\_077 (Ogden) when N=3 or N=4. Previously, data was written only when N=2. Fit data is also written for \*MAT\_027.
- Fixed 2D automatic contact pressure calculation for nforc output. Before fix, in-plane rather than out-of-plane thickness was used to evaluate the tributary area so pressure magnitudes were wrong.
- Fixed bug for “d3thdt” output to prevent creation of many small files.
- Added extra history variables in “d3thdt” file for ALE solid 11, 12 elements to show correct rho, volume fraction in the history file.
- Limited the time for the next “d3plot” output to be endtim for implicit.
- Added beam elements to the “dynain” file.
- Fixed bug in “swforc” data in the case where there are both solid and beam spotwelds.
- Fixed output of thick shell data to both “d3iter” and “d3eigv” databases for implicit analysis.
- Fixed bug in writing “dynain” after restart.
- Fixed bug affecting ID on \*DATABASE\_HISTORY\_NODE\_ID.
- Added beam element moment resultant to “swforc” file.
- Fixed problem with “secforc” and “spcforc”.

- Fixed code so that the number of cycles between running restart files can exceed 99999.
- Added write statements to echo EOS 12 \*EOS\_IDEAL\_GAS input to “d3hsp”.
- Fixed sometimes incorrect header in NODOUT and SPCFORC files.
- Fixed bug in “d3thdt” when the model contains any thick shell elements.
- Fixed problem of missing control volumes in “abstat” file.
- Added write to “d3hsp” of memory usage at the end of input phase.
- Fixed printing of incorrect load curve ID in “d3hsp” file for \*MAT\_126.

## 9. RESTARTS

- Fixed bug related to restart and user-defined materials.
- Fixed full deck restart with SPH elements.
- Fixed bug affecting tied contact in full deck restart to correct problem where length of spotweld beams increased after each restart if the beam was offset from the surface.
- Fixed full deck restart for changing initial velocity.
- Fixed bug in full deck restart in which adaptivity was used in combination with \*INTERFACE\_SPRINGBACK\_LSDYNA.
- Fixed full deck restart bug involving failed beam elements. The deleted beam elements reappeared again after full deck restart.
- Fixed restart problem affecting deletion of ALE parts and deletion of ALE coupling.
- Fixed restart problem involving rubber material.
- Added hourglass forces to the full deck restart file to correct differences observed between runs that used the full deck restart versus those that do not. This is important for calculations that use solids with the stiffness form of the hourglass control.
- Implemented \*DELETE\_FSI command for small restart to activate or delete \*CONSTRAINED\_LAGRANGE\_IN\_SOLID coupling. It is implemented similar to \*DELETE\_CONTACT. A negative ID activates coupling.
- Fixed a bug affecting the implicit step size in a small restart.
- Fixed bug affecting full deck restarts of models with \_OFFSET contact.

## 10. RIGID BODIES

- Fixed output bug for locking joints and translational joints.
- Fixed rigid body stoppers when rigid body is constrained in local coordinate system. Constraint was being violated.
- Fixed problem with initial velocities and rigid bodies with prescribed accelerations.
- Fixed bug in \*CONSTRAINED\_NODAL\_RIGID\_BODY if any negative number is used for displacement release flags.
- Fixed a load curve ID problem for curves defining joint friction.
- Added error termination if rigid body is slave to \*CONTACT\_ENTITY.

- Fixed calculation of joint energy.
- Fixed bug related to \*NODAL\_RIGID\_BODY\_SPC\_INERTIA.
- Fixed bug affecting right ankle of \*COMPONENT\_HYBRIDIII.
- Fixed locking joint when Lagrange multipliers are used.
- Fixed bug related to qlo and qhi activation angles for shoulder abduction in all \*COMPONENT\_HYBRIDIII dummies.
- Made minor fix to automatic rigid body constraint determination.
- Changed friction law so Hybrid III dummy joints are not as sticky and integration requires less effort.
- Added updates for coupling with MADYMO 6.3.

## 11. IMPLICIT

- Corrected initialization of tied contact constraints for implicit when explicit/implicit switching is activated.
- Adjusted implicit logic for artificial stabilization in a forming simulation with automatic time step control.
- Made minor fix to implicit eigenvalue solution.
- Enabled \*INTERFACE\_SPRINGBACK\_SEAMLESS after implicit transient analysis.
- Fixed bug in prescribing x-rotational b.c. in implicit analysis.
- Adjusted default setting when using full newton with implicit nonlinear. Deactivate line search by setting lstol = -1.0.
- Fixed problem with beam stresses when switching from implicit to explicit.
- Implemented \*MAT\_98 for solids in implicit.
- Fixed switch controls via "d3kil" file to work with implicit.
- Made change to retain internal energy data when switching from explicit to implicit.
- Enhanced implicit mechanics to correctly handle spotweld failures.
- Fixed implicit \*MAT\_003. Bad tangent modulus resulted in slow or no convergence.
- Enabled \*CONTROL\_CPU in implicit.
- Fixed bug in "glstat" energy balance when running implicit.
- Corrected treatment of joints when switching from implicit to explicit. Penalty factor needed to be computed correctly.
- Fixed implicit's loading of rigid body constraints in local coordinates for seamless springback problems.
- Improved convergence of implicit 2D automatic contact when the the sliding option is active.
- Turned off damping in spotweld material if implicit static analysis is active.
- Fixed problem of active dampers during implicit static analysis.

- Fixed 2D axisymmetric shell to correct frequency problem.
- Fixed bugs in implicit dynamics and disabled Rayleigh damping since not properly implemented for implicit solutions.
- Made change to deactivate damping during static implicit run.
- Made change to automatically switch to type 10 shell if type 8 is requested for implicit.
- Fixed bug in shell-brick interface for implicit.
- Fixed problem of no end time specification for implicit eigenvalue problems.

## 12. MISCELLANEOUS

- Fixed bug if \*INCLUDE\_NASTRAN is used.
- Fixed an error in checking VDA binary file.
- Fixed bug if title contains an ampersand.
- Fixed round-off error related to initial and prescribed velocities.
- Fixed load curve ID round-off problem in \*LOAD\_THERMAL\_OPTION.
- Fixed load curve interpolation problem.
- Fixed bug for \*DEFINE\_BOX\_DRAWBEAD.
- Fixed mass scaling bug affecting solid elements.
- Made fixes to \*DEFINE\_TRANSFORMATION and \*INCLUDE\_TRANSFORM affecting:
  - initial velocities
  - \*MAT\_084, \*MAT\_076
  - \*AIRBAG\_SIMPLE\_PRESSURE
  - rigid body stoppers
  - MAREA in \*SECTION\_SHELL
  - damping coefficient
  - rigidwalls
  - inertia when bodies are rotated
  - nodal rigid bodies
  - cross-sections
- Added option POINT for \*DEFINE\_TRANSFORMATION to provide a means of defining rotations about axes that are reoriented due to previous transformations.
- Fixed energy conservation problem related to \*CONSTRAINED\_INTERPOLATION.
- Increased the default memory size from 8500000 to 20000000.
- Fixed error in \*CONSTRAINED\_LINEAR.
- Added new keyword \*INCLUDE\_PATH that defines a directory in which to look for include files.
- Fixed dynamic relaxation when used with the Wang-Nefske Airbag model.
- Fixed a bug in super-plastic forming simulation so that an arbitrary load curve id can be used for SPF.

- Added an error termination for bad cyclic symmetry definition.
- Added active part set option for nfail1 and nfail2 on \*CONTROL\_SHELL.
- Centered hourglass control type 6 correctly when 2nd order stress updates are used. This can help meshes that spin.
- Added \*TERMINATION\_DELETED\_SHELLS to terminate when a specified number of shells have been deleted from a part or part set.
- Fixed negative volume calculation to erode solid elements.
- Activated new features for super-plastic forming simulation.
- \*AIRBAG\_HYBRID\_CHEMKIN can model convection energy loss from the gas in the airbag to the environment. Added this feature to:
  - \*AIRBAG\_WANG\_NEFSKE
  - \*AIRBAG\_HYBRID
- Fixed bug related to rigid beams impacting rigid walls.
- Fixed bug affecting \*CONSTRAINED\_TIED\_NODES\_WITH\_FAILURE used with triangular segments.
- Made change so that multiple SPC cards for one node are now respected unless more than one coordinate system is referenced in which case an error termination will occur. Previously, only the last of the multiple SPCs was respected.
- Reinstated Lagrange to Lagrange coupling which had inadvertently been disabled in \*CONSTRAINED\_LAGRANGE\_IN\_SOLID.
- Fixed kinetic energy calculation when RBE3'S (\*CONSTRAINED\_INTERPOLATION) are used.
- Added \*SET\_PART\_ADD for combining part sets.
- Made fixes to Suzuki spot weld and added more output, including Part ID.
- Moved Suzuki spot weld output from "d3hsp" to message.
- Fixed bug for auto memory if airbag is defined.
- Fixed a problem with \*NODE\_TRANSFORM.
- Fixed a bug in rigid body switching to prevent local system from being overwritten.
- Fixed bugs affecting \*PARAMETER.
- Fixed bug in \*INITIAL\_STRESS\_SECTION for \*MAT\_003 and \*MAT\_024.
- Fixed energy growth and other problems related to \*CONSTRAINED\_SHELL\_TO\_SOLID.

## 13. MPP ONLY

### 13.1 Contacts

- Made fix for rigid body boundary conditions in case some processors do not have the rigid body. Noise was being introduced into the solution in this case.

- Fixed recent hang in MPP if there are contact interfaces but some processor(s) end up with none.
- Made modification to forming contact for MPP to handle slave surfaces from solid elements. The "don't allow contacts from below" logic was causing these to be ignored.
- Fixed bug affecting interface forces file output. The segment set was not output correctly and corrupted the file.
- Fixed bug that could cause incorrect initial penetration results for some nodes in MPP \*CONTACT\_SURFACE\_TO\_SURFACE and \*CONTACT\_NODE\_TO\_SURFACE definitions.
- Added damping for beam-to-beam contact.
- Fixed rigid/rigid contact option 1 without friction.
- Fixed MPP segment-based contact error that could occur if contact involved eroding solid elements but the ERODING contact option was not used.
- Added read of PENMAX parameter for surface to surface eroding contacts in MPP. This allows the release penetration distance to vary from the default value of 0.5\*segment thickness.
- Fixed bug in normal failure calculation in tiebreaks.
- Fixed OFFSET tied contact in MPP if the slave node is tied at the corner point of a triangular shell -- the normal vector was computed as 0.
- Added guided cable contact.
- Added MPP support for automatic tiebreak option 5. Options 1 to 5 are now supported.
- Fixed beam-to-beam contact problem.
- Made fix to MPP eroding contact in case where no materials were specified. Contact was ignored on any processor that contained no solid or thick shell elements. Now including check for shell elements.
- Fixed N2S eroding contact.
- Fixed problem of MPP occasionally including internal segments in the active contact surface for eroding contact.
- Fixed typo that caused failure of type 23 contact.
- Fixed calculation of master energies in tied contacts. Shared nodes were being counted more than once.
- Fixed a sign error in the force application for MPP drawbeads.
- Fixed bug in MPP drawbead initialization that only showed up in some double precision versions.
- Removed eroded segments and deleted nodes from the tiebreak interface to get proper response.
- Added MPP support for user input PARMAX and increased the contact searching area.
- Fixed possible failure of MPP contact when \*DAMPING\_PART\_MASS was used.

- Changed behaviour of MPP drawbead contact to re-interpolate the drawbead nodes each cycle. This avoids cumulative roundoff problems that were causing strange drawbead forces when then tooling was not stationary.
- Added MPP support for new contact viscous damping option (VDC<0) to contacts type 3/4/5/10/13/26.
- Fixed MPP initialization of tied contacts when \*PART\_CONTACT thickness is specified.
- Fixed force transducer problem that occurred during initialization.
- Fixed bug in MPP tied contact affecting moved nodes shared by neighbouring processors.
- Fixed problem in computing contact normal vectors for nodes shared by neighbouring processors.
- Fixed bug affecting translating contact entities.
- Fixed bug in friction work calculation.

## 13.2 Miscellaneous

- Corrected numbering of “d3hsp” file in a restart.
- Fixed bug affecting output of interface forces file “intfor”.
- Added support of \*INITIAL\_VEHICLE\_KINEMATICS.
- Made bug fix for “jntfor” translation.
- Implemented stress initialization by parts in full deck restart.
- Implemented \*CHANGE\_VELOCITY\_ZERO option for full deck restart run.
- Made bug fix to secforc coordinates system.
- Corrected MPP handling for airbag interaction with control volume types 10 and 11.
- Added support for \*DAMPING\_FREQUENCY\_RANGE\_OPTION.
- Fixed bug in MPP implementation of linear constraint equations and added support for LOCAL option of linear constraints.
- Added options to control birth and death time when dynamic relaxation is active.
- Added 3D adaptivity.
- Fixed MPP initialization of rigid body initial velocity.
- Added MPP support for solid spotweld failure.
- Added support of ALE tracer particle.
- Fixed MPP Madymo coupling problem.
- Implemented \*COMPONENT\_HYBRIDIII.
- Fixed MPP memory error that occurred when \*CONSTRAINED\_LAGRANGE\_IN\_SOLID coupling types 1 to 3 were used and there were no ALE parts.
- Fixed bug in ALE coupling when shells are deleted.

- Added basic support for ALE eroding coupling ctype=5. (Not as evolved as SMP implementation.)
- Made Madymo coupling run more efficiently.
- Changed MPP to allow total size of “d3thdt” files to exceed 2GB.
- Added recognition of LSTC\_BINARY=32ieee to MPP so that 64 bit executables can output 32 bit output.
- Made change to write error and terminate run if user tries to restart from a dump on a different number of processors than the original run. Previously, job would hang.
- Added MPP support for nfail (termination on shell element failure) option.
- Implemented \*LOAD\_MASK.
- Implemented tetrahedron formulation 13.
- Fixed problem with \*DELETE\_CONTACT option. In some cases, the contact to be deleted is not in the processor 0 and then the delete info was not output to the “d3hsp01” file.
- Implemented co-ordinated termination in MPP for some errors (mass increase, energy ratio, negative volume) so “d3plot” file state is output and termination is clean.
- Fixed bug affecting porosity leakage through fabric when using ALE switching.
- Fixed bug in \*BOUNDARY\_PRESCRIBED\_MOTION\_NODE.
- Made some fixes to MPP affecting shell history variable remapping during adaptivity.
- Removed duplicate \*CONSTRAINED\_ADAPTIVITY in dynain file to avoid problem during springback run.
- Made several improvements related to MPP handling of stress initialization/adaptivity.
- Fixed two bugs in MPP adaptivity: if initial penetration tracking was on, the tracked penetrations were lost at each adaptive step, resulting in creeping penetrations. Also, some contact history was lost entirely when there was more than one node in contact with any master segment. These both resulted in dimples and lumps in the final stamped surface.
- Fixed bug in nodal interface linking.
- Fixed SPH neighbour search.
- Improved memory allocation for SPH.
- Fixed SPH for 2D problems.
- Added Madymo 6.1 support.
- Fixed bug for ALE reference system 9.
- Added support for SPOTSTP option for spotweld connected to rigid part.
- Fixed bug in “dbout”, “swforc” files for output of solid spotwelds.
- Fixed a bug in “ncforc” file.
- Fixed a bug affecting read of cross-sectional data.

- Fixed problem of MPP treating NFAIL/NFAIL4 = 2 as NFAIL/NFAIL4 = 1 (\*CONTROL\_SHELL).
- Fixed possible loss of precision when computing adaptive curvatures.
- Fixed inconsistent decomposition when running job with/without pre-decomposition.
- Fixed initialization problem for MPP \*INTERFACE\_LINKING\_EDGE.
- Fixed bug affecting airbag interaction.
- Added header to MPP message files.
- Fixed sometimes spurious error message of beam "k node on beam x-axis".
- Fixed bug potentially affecting ALE massless nodes with applied loads.
- Implemented implicit joint formulation.