Restart Input Data

In general three categories of restart actions are possible with LS-DYNA and are outlined in the following discussion:

1. A simple restart occurs when LS-DYNA was interactively stopped before reaching the termination time. Then, by specifying the R=**rtf** command line option on the execution line, LS-DYNA restarts the calculation from the termination point. The calculation will pick up at the specified termination time. See Execution Syntax in the Getting Started section. No additional input deck is required.

2. For small modifications of the input deck during the restart run, LS-DYNA offers a "small restart" capability which can

   a) reset termination time,

   b) reset output printing interval,

   c) reset output plotting interval,

   d) delete contact surfaces,

   e) delete elements and parts,

   f) switch deformable bodies to rigid,

   g) switch rigid bodies to deformable,

   h) change damping options.

   All modifications to the problem made with the restart input deck will be reflected in subsequent restart dumps. All the members of the file families are consecutively numbered beginning from the last member prior to termination.

   For a small restart run a *small input deck* replaces the standard input deck on the execution line which must have at least the following command line arguments:

   LS-DYNA I=**restartinput** R=**D3DUMP*nn***

   where **D3DUMP*nn*** (or whatever name is chosen for the family member) is the *n*th restart file from the last run where the data is taken. LS-DYNA automatically detects that a small input deck is used since the I=**restartinput** file may contain *only* the *restart* keywords (excluding *STRESS_INITIALIZATION):

   CHANGE_*OPTION

*CONTROL_DYNAMIC_RELAXATION

*CONTROL_SHELL

*CONTROL_TERMINATION

*CONTROL_TIMESTEP

*DAMPING_GLOBAL

DATABASE_*OPTION

DATABASE_BINARY_*OPTION

DELETE_*OPTION

*INTERFACE_SPRINGBACK_LSDYNA

RIGID_DEFORMABLE_*OPTION

STRESS_INITIALIZATION_*{OPTION} (full restart only)

TERMINATION_*OPTION

*TITLE

*KEYWORD

*CONTROL_CPU

DEFINE_*OPTION

SET_*OPTION

You must take care to avoid nonphysical modifications to the input deck; otherwise, complete nonsense may be the result.

3. If many modifications are desired, a *full restart* may be the appropriate choice. A full restart is selected by including a full model along with a *STRESS_INITIALIZATION keyword card and possibly other restart cards. As mentioned in the Restart Analysis subsection of the Getting Started portion of the manual, either all parts or some subset of parts can be made for the stress initialization.

Remarks:

1. In a full restart, only those nodes and elements defined in the full restart deck will be present in the analysis after the full restart is initiated. But as a

convenience, any of those nodes or elements can be deleted using the *DELETE command.

2. In a small restart, velocities of nodes come from the dump file by default, but those velocities can be changed using *CHANGE_VELOCITY_....

3. In a full restart, velocities of pre-existing nodes come from the dump file by default, but those velocities can be changed using *CHANGE_VELOCITY_.... To set the starting velocities for new nodes in a full restart, use *INITIAL_VELOCITY_....

4. Pre-existing contacts, in general, carry forward seamlessly using data from the d3dump (or d3full if MPP) database. It is important that the contact ID(s) in the full restart input deck match the contact ID(s) in the original input deck if the intent is for the contacts to be initialized using data from the d3dump/d3full database. EXCEPTION: In the special case of MPP, a *CONTACT_AUTOMATIC_GENERAL contact in the full restart input deck is treated as a brand new contact and is not initialized using data from d3full.

5. Parameters used in a restart input deck must be defined in that same restart input deck using *PARAMETER.

6. Only sets using element IDs and node IDs are permitted in a small restart deck; part IDs are not recognized. Sets referenced by other commands in a small restart deck must be defined in the small restart deck.

***CHANGE**_*OPTION*

Purpose: Change solution options.

Available options include:

BOUNDARY_CONDITION

CONTACT_SMALL_PENETRATION

CURVE_DEFINITION

OUTPUT

RIGIDWALL_GEOMETRIC

RIGIDWALL_PLANAR

RIGID_BODY_CONSTRAINT

RIGID_BODY_INERTIA

RIGID_BODY_STOPPERS

STATUS_REPORT_FREQUENCY

THERMAL_PARAMETERS

VELOCITY

VELOCITY_GENERATION

VELOCITY_NODE

VELOCITY_RIGID_BODY

VELOCITY_ZERO

Boundary Condition Cards. This card 1 format is for the ***BOUNDARY_CONDITION*** keyword option. Add one card for each boundary condition. This card imposes *additional* boundary conditions. It does not remove previously imposed conditions (for example, this option will not free a fixed node). This input ends at the next keyword ("*") card.

Card 1	1	2	3	4	5	6	7	8
Variable	NID	BCC						
Type	I	I						

VARIABLE	DESCRIPTION
NID	Nodal point ID, see also *NODE.
BCC	New translational boundary condition code: EQ.1: Constrained x displacement, EQ.2: Constrained y displacement, EQ.3: Constrained z displacement, EQ.4: Constrained x and y displacements, EQ.5: Constrained y and z displacements, EQ.6: Constrained z and x displacements, EQ.7: Constrained x, y, and z displacements.

Small Penetration Check Cards. This Card 1 format is for the ***CONTACT_SMALL_PENETRATION*** keyword option. Set one value for each contact surface ID where the small penetration check is to be turned on. The input terminates at the next keyword ("*") card. See the PENCHK variable in *CONTACT.

Card 1	1	2	3	4	5	6	7	8
Variable	ID1	ID2	ID3	ID4	ID5	ID6	ID7	ID8
Type	I	I	I	I	I	I	I	I

VARIABLE	DESCRIPTION
IDn	Contact ID for surface number n

Load Curve Redefinition Cards. This Card 1 format is for the ***CURVE_DEFINITION*** keyword option. *The new load curve must contain the same number of points as the curve it replaces.* The curve should be defined according to the *DEFINE_CURVE section of the manual. This input terminates at the next keyword ("*") card. Offsets and scale factors are ignored.

Card 1	1	2	3	4	5	6	7	8
Variable	LCID							
Type	I							

VARIABLE	DESCRIPTION
LCID	Load curve ID

ASCII Output Overwrite Card. This format applies to the ***OUTPUT*** keyword option.

Card 1	1	2	3	4	5	6	7	8
Variable	IASCII							
Type	I							

VARIABLE	DESCRIPTION
IASCII	Flag to control manner of outputting ASCII data requested by *DATABASE_*OPTION* commands in a full restart deck: EQ.0: Full restart overwrites existing ASCII output (default), EQ.1: Full restart appends to existing ASCII output.

Rigidwall Modification. The format for the ***RIGIDWALL_GEOMETRIC*** and ***RIGIDWALL_PLANAR*** cards is identical to the original cards (see *RIGIDWALL_GEOMETRIC and *RIGIDWALL_PLANAR), however there are restrictions on the entries that may be changed: only those entries that define the size and orientation of the rigid walls may be changed, but not any of the others (e.g., the type). A rigidwall may only be modified when doing a full restart.

Rigid Body Constraint Modification Cards. This format for Card 1 applies to the ***RIGID_BODY_CONSTRAINT*** keyword option. This option can change translation and rotational boundary condition on a rigid body. This input ends at the next keyword ("*") card. See CONSTRAINTED_RIGID_BODIES.

Card 1	1	2	3	4	5	6	7	8
Variable	PID	TC	RC					
Type	I	I	I					

VARIABLE	DESCRIPTION
PID	Part ID, see *PART.

VARIABLE	DESCRIPTION
TC	Translational constraint: EQ.0: No constraints, EQ.1: Constrained x displacement, EQ.2: Constrained y displacement, EQ.3: Constrained z displacement, EQ.4: Constrained x and y displacements, EQ.5: Constrained y and z displacements, EQ.6: Constrained z and x displacements, EQ.7: Constrained x, y, and z displacements.
RC	Rotational constraint: EQ.0: No constraints, EQ.1: Constrained x rotation, EQ.2: Constrained y rotation, EQ.3: Constrained z rotation, EQ.4: Constrained x and y rotations, EQ.5: Constrained y and z rotations, EQ.6: Constrained z and x rotations, EQ.7: Constrained x, y, and z rotations.

Card sets for *RIGID_BODY_INERTIA* keyword option. This option supports changing the mass and inertia properties of a rigid body. Include as many pairs of the following two cards as necessary. This input ends at the next keyword ("*") card. The inertia tensor is specified relative to the coordinate system set in *MAT_RIGID at the start of the calculation, which is fixed in the rigid body and tracks the rigid body rotation.

Card 1	1	2	3	4	5	6	7	8
Variable	ID	PID	TM					
Type	I	I	F					

Card 2	1	2	3	4	5	6	7	8
Variable	IXX	IXY	IXZ	IYY	IYZ	IZZ		
Type	F	F	F	F	F	F		

VARIABLE	DESCRIPTION
ID	ID for this change inertia input.
PID	Part ID, see *PART.
TM	Translational mass.
IXX	I_{xx}, xx component of inertia tensor.
IXY	I_{xy}
IXZ	I_{xz}
IYY	I_{yy}
IYZ	I_{yz}
IZZ	I_{zz}

Card sets for the *RIGID_BODY_STOPPERS* keyword option. This option is for redefining existing stoppers. Include as many pairs of cards as necessary. This input terminates when the next keyword ("*") card is encountered. See *CONSTRAINED_RIGID_-BODY_STOPPERS. Note that new stopper definitions cannot be introduced in this section. Existing stoppers can be modified.

Card 1	1	2	3	4	5	6	7	8
Variable	PID	LCMAX	LCMIN	PSIDMX	PSIDMN	LCVMNX	DIR	VID
Type	I	I	I	I	I	I	I	I
Default	required	0	0	0	0	0	required	0

Card 2	1	2	3	4	5	6	7	8
Variable	BIRTH	DEATH						
Type	F	F						
Default	0.0	10^{28}						

VARIABLE	DESCRIPTION
PID	Part ID of lead rigid body, see *PART.
LCMAX	Load curve ID defining the maximum coordinate as a function of time: EQ.0: No limitation of the maximum displacement. New curves can be defined by the *DEFINE_CURVE within the present restart deck. (Not applicable for small deck restart).
LCMIN	Load curve ID defining the minimum coordinate as a function of time: EQ.0: No limitation of the minimum displacement. New curves can be defined by the *DEFINE_CURVE within the present restart deck. (Not applicable for small deck restart).
PSIDMX	Optional part set ID of rigid bodies that are constrained in the maximum coordinate direction to the lead rigid body. This option requires additional input by the *SET_PART definition.
PSIDMN	Optional part set ID of rigid bodies that are constrained in the minimum coordinate direction to the lead rigid body. This option requires additional input by the *SET_PART definition.
LCVMNX	Load curve ID which defines the maximum absolute value of the velocity that is allowed within the stopper: EQ.0: No limitation of the maximum velocity
DIR	Direction stopper acts in: EQ.1: x-translation EQ.2: y-translation EQ.3: z-translation

VARIABLE	DESCRIPTION
	EQ.4: arbitrary, defined by vector VID
	EQ.5: x-axis rotation
	EQ.6: y-axis rotation
	EQ.7: z-axis rotation
	EQ.8: Arbitrary, defined by vector VID
VID	Vector for arbitrary orientation of stopper. The vector must be defined by a *DEFINE_VECTOR within the present restart deck.
BIRTH	Time at which stopper is activated
DEATH	Time at which stopper is deactivated

Remarks:

The optional definition of part sets in minimum or maximum coordinate directions allows the motion to be controlled in an arbitrary direction.

D3HSP Interval Change Card. This card format applies to the ***STATUS_REPORT_FREQUENCY*** keyword option.

Card 1	1	2	3	4	5	6	7	8
Variable	IKEDIT							
Type	I							

VARIABLE	DESCRIPTION
IKEDIT	Problem status report interval steps in the D3HSP output file:
	EQ.0: Interval remains unchanged.

Card set for the *THERMAL_PARAMETERS* keyword option. This option is for changing the parameters used by a thermal or coupled structural/thermal analysis. See *CONTROL_THERMAL. Add the two following cards to the deck (they do not repeat).

Card 1	1	2	3	4	5	6	7	8
Variable	TS	DT	TMIN	TMAX	DTEMP	TSCP		
Type	I	F	F	F	F	F		

Card 2	1	2	3	4	5	6	7	8
Variable	REFMAX	TOL						
Type	I	F						

VARIABLE	DESCRIPTION
TS	Thermal time step code: EQ.0: No change, EQ.1: Fixed time step, EQ.2: Variable time step.
DT	Thermal time step on restart: EQ.0: No change.
TMIN	Minimum thermal time step: EQ.0: No change.
TMAX	Maximum thermal time step: EQ.0: No change.
DTEMP	Maximum temperature change in a thermal time step: EQ.0: No change.
TSCP	Time step control parameter (0.0 < TSCP < 1.0): EQ.0: No change.

VARIABLE	DESCRIPTION
REFMAX	Maximum number of reformations per thermal time step: EQ.0: No change.
TOL	Non-linear convergence tolerance: EQ.0: No change.

Node Set Velocity Card Sets. The formats for Cards 1 and 2 apply to the ***VELOCITY*** and ***VELOCITY_ONLY*** keyword options. These options are for setting velocity fields on node sets at restart. For each node set add one pair of the following cards. This input ends at the next keyword ("*") card. Undefined nodes (not listed on a set velocity card) will have their nodal velocities reset to zero if a *CHANGE_VELOCITY definition is encountered in the restart deck. However, if any of the *CHANGE_VELOCITY definitions have the keyword option ONLY appended, then only the specified nodes will have their nodal velocities modified.

Card 1	1	2	3	4	5	6	7	8
Variable	NSID							
Type	I							
Default	none							

Card 2	1	2	3	4	5	6	7	8
Variable	VX	VY	VZ	VXR	VYR	VZR		
Type	F	F	F	F	F	F		
Default	0.	0.	0.	0.	0.	0.		

VARIABLE	DESCRIPTION
NSID	Nodal set ID containing nodes for initial velocity (see Remark 1)
VX	Velocity in x-direction

VARIABLE	DESCRIPTION
VY	Velocity in y-direction
VZ	Velocity in z-direction
VXR	Rotational velocity about the x-axis
VYR	Rotational velocity about the y-axis
VZR	Rotational velocity about the z-axis

Remarks:

1. **Multiple Velocity Initializations for a Node.** If a node is initialized on more than one input card set, then the last set input will determine its velocity, unless it is specified on a *CHANGE_VELOCITY_NODE card.

2. **Undefined Nodes.** Undefined nodes will have their nodal velocities set to zero if a *CHANGE_VELOCITY definition is encountered in the restart deck.

3. **Zero Velocity.** If both *CHANGE_VELOCITY and *CHANGE_VELOCITY_ZERO cards are defined, then all velocities will be reset to zero.

Velocity Generation Cards. The velocity generation cards for the ***VELOCITY_GENERATION*** option are identical to the standard velocity generation cards (see *INITIAL_VELOCITY_GENERATION), and all parameters may be changed.

Nodal Point Velocity Cards. This format applies to the ***VELOCITY_NODE*** and ***VELOCITY_NODE_ONLY*** keyword options. These option support changing nodal velocities. This input ends at the next keyword ("*") card.

Card 1	1	2	3	4	5	6	7	8
Variable	NID	VX	VY	VZ	VXR	VYR	VZR	
Type	I	F	F	F	F	F	F	
Default	none	0.	0.	0.	0.	0.	0.	

VARIABLE	DESCRIPTION
NID	Node ID

VARIABLE	DESCRIPTION
VX	Translational velocity in x-direction
VY	Translational velocity in y-direction
VZ	Translational velocity in z-direction
VXR	Rotational velocity about the x-axis
VYR	Rotational velocity about the y-axis
VZR	Rotational velocity about the z-axis

Remarks:

1. **Undefined Nodes.** Undefined nodes (not listed on a point velocity card) will have their nodal velocities reset to zero if a *CHANGE_VELOCITY_NODE definition is encountered in the restart deck. However, if any of the *CHANGE_VELOCITY or CHANGE_VELOCITY_NODE definitions have ONLY appended, then only the specified nodes will have their nodal velocities modified.

2. **Multiple Velocity Initializations for a Node.** If a node is initialized on more than one input card set, then the last set input will determine its velocity, unless it is specified on a *CHANGE_VELOCITY_NODE card.

3. **Zero Velocity.** If both *CHANGE_VELOCITY and *CHANGE_VELOCITY_ZERO cards are defined, then all velocities will be reset to zero.

Rigid Body Velocity Cards. This Card 1 format applies to the ***VELOCITY_RIGID_BODY*** keyword option. This option allows for setting the velocity components of a rigid body at restart. Include as many of these cards as desired. This input ends at the next keyword ("*") card.

Card 1	1	2	3	4	5	6	7	8
Variable	PID	VX	VY	VZ	VXR	VYR	VZR	
Type	I	F	F	F	F	F	F	
Default	none	0.	0.	0.	0.	0.	0.	

VARIABLE	DESCRIPTION
PID	Part ID of rigid body
VX	Translational velocity in x-direction
VY	Translational velocity in y-direction
VZ	Translational velocity in z-direction
VXR	Rotational velocity about the x-axis
VYR	Rotational velocity about the y-axis
VZR	Rotational velocity about the z-axis

Remarks:

1. **Rotational Velocities.** Rotational velocities are defined about the center of mass of the rigid body.

2. **Undefined Rigid Bodies.** Rigid bodies not defined in this section will not have their velocities modified.

Restarting the Model at Rest. The ***VELOCITY_ZERO*** option resets the velocities to zero at the start of the restart. There are no data cards associated with *CHANGE_VELOCITY_ZERO.

*CONTROL_DYNAMIC_RELAXATION

Purpose: Define controls for dynamic relaxation.

Card 1	1	2	3	4	5	6	7	8
Variable	NRCYCK	DRTOL	DRFCTR	DRTERM	TSSFDR	IRELAL	EDTTL	IDRFLG
Type	I	F	F	F	F	I	F	I
Default	250	0.001	0.995	∞	TSSFAC	0	0.0	0
Remarks	1	1	1	1	1			1

VARIABLE	DESCRIPTION
NRCYCK	Number of iterations between convergence checks, for dynamic relaxation option
DRTOL	Convergence tolerance for dynamic relaxation option
DRFCTR	Dynamic relaxation factor
DRTERM	Optional termination time for dynamic relaxation. Termination occurs at this time or when convergence is attained.
TSSFDR	Scale factor for computed time step during dynamic relaxation. If zero, the value is set to TSSFAC defined on *CONTROL_TERMINATION. After converging, the scale factor is reset to TSSFAC.
IRELAL	Automatic control for dynamic relaxation option based on algorithm of Papadrakakis [1981]: EQ.0: not active, EQ.1: active.
EDTTL	Convergence tolerance on automatic control of dynamic relaxation.
IDRFLG	Dynamic relaxation flag for stress initialization: EQ.0: not active, EQ.1: dynamic relaxation is activated.

Remarks:

1. **Restart before Dynamic Relaxation Convergence.** If a dynamic relaxation relaxation analysis is being restarted at a point before convergence was obtained, then NRCYCK, DRTOL, DRFCTR, DRTERM and TSSFDR will default to their previous values, and IDRFLG will be set to 1.

2. **Restart from Normal Transient Analysis.** If dynamic relaxation is activated after a restart from a normal transient analysis, LS-DYNA continues the output of data as it would without the dynamic relaxation being active. This is unlike the dynamic relaxation phase at the beginning of the calculation when a separate database is not used. Only load curves that are flagged for dynamic relaxation are applied after restarting.

*CONTROL_SHELL

Purpose: Change failure parameters NFAIL1 and NFAIL4 if necessary. These parameters must be nonzero in the initial run.

Card 1	1	2	3	4	5	6	7	8
Variable								
Type								

Card 2	1	2	3	4	5	6	7	8
Variable						NFAIL1	NFAIL4	PSNFAIL
Type						I	I	I

VARIABLE	DESCRIPTION
NFAIL1	Flag to check for highly distorted under-integrated shell elements, print a message, and delete the element or terminate. Generally, this flag is not needed for one point elements that do not use the warping stiffness. A distorted element is one where a negative jacobian exists within the domain of the shell, not just at integration points. The checks are made away from the integration points to enable the bad elements to be deleted before an instability leading to an error termination occurs. This test will increase CPU requirements for one point elements. EQ.1: Print message and delete element. EQ.2: Print message, write d3dump file, and terminate GT.2: Print message and delete element. When NFAIL1 elements are deleted, LS-Dyna writes the d3dump file and terminates. These NFAIL1 failed elements also include all shell elements that failed for other reasons than distortion. Before the d3dump file is written, NFAIL1 is doubled, so the run can immediately be continued if desired.
NFAIL4	Flag to check for highly distorted fully-integrated shell elements, print a message, and delete the element or terminate. Generally, this flag is recommended. A distorted element is one where a

VARIABLE	DESCRIPTION
	negative jacobian exists within the domain of the shell, not just at integration points. The checks are made away from the integration points to enable the bad elements to be deleted before an instability leading to an error termination occurs. EQ.1: Print message and delete element. EQ.2: Print message, write d3dump file, and terminate GT.2: Print message and delete element. When NFAIL4 elements are deleted, LS-Dyna writes the d3dump file and terminates. These NFAIL4 failed elements also include all shell elements that failed for other reasons than distortion. Before the d3dump file is written, NFAIL4 is doubled, so the run can immediately be continued if desired.
PSNFAIL	Optional shell part set ID specifying which part IDs are checked by the NFAIL1, NFAIL4, and W-MODE options. If zero, all shell part IDs are included.

*CONTROL_TERMINATION

Purpose: Stop the job.

Card	1	2	3	4	5	6	7	8
Variable	ENDTIM	ENDCYC						
Type	F	I						

VARIABLE	DESCRIPTION
ENDTIM	Termination time: EQ.0.0: Termination time remains unchanged.
ENDCYC	Termination cycle. The termination cycle is optional and will be used if the specified cycle is reached before the termination time. EQ.0.0: Termination cycle remains unchanged.

Remarks:

This is a reduced version of the *CONTROL_TERMINATION card used in the initial input deck.

*CONTROL_TIMESTEP

Purpose: Set time step size control using different options.

Card	1	2	3	4	5	6	7	8
Variable	DUMMY	TSSFAC	ISDO	DUMMY	DT2MS	LCTM		
Type	F	F	I	F	F	I		

VARIABLE	DESCRIPTION
DUMMY	Dummy field, see Remark 1 below.
TSSFAC	Scale factor for computed time step. EQ.0.0: TSSFAC remains unchanged.
ISDO	Basis of time size calculation for 4-node shell elements. 3-node shells use the shortest altitude for options 0 and 1 and the shortest side for option 2. This field has no relevance to solid elements, which use a length based on the element volume divided by the largest surface area. EQ.0: characteristic length is given by $\frac{\text{area}}{\min(\text{longest side},\ \text{longest diagonal})}$. EQ.1: characteristic length is given by $\frac{\text{area}}{\text{longest diagonal}}$. EQ.2: based on bar wave speed and, $\max\left[\text{shortest side}, \frac{\text{area}}{\min(\text{longest side},\ \text{longest diagonal})}\right]$. WARNING: Option 2 can give a much larger time step size that can lead to instabilities in some applications, especially when triangular elements are used.
DUMMY	Dummy field, see Remark 1 below.

VARIABLE	DESCRIPTION
DT2MS	New time step for mass scaled calculations. Mass scaling must be active in the time zero analysis. EQ.0.0: DT2MS remains unchanged.
LCTM	Load curve ID that limits maximum time step size: EQ.0: LCTM remains unchanged.

Remarks:

1. **Dummy Fields.** This a reduced version of the *CONTROL_TIMESTEP used in the initial analysis. The dummy fields are included to maintain compatibility. If using free format input then a 0.0 should be entered for the dummy values.

*DAMPING_GLOBAL

Purpose: Define mass weighted nodal damping that applies globally to the deformable nodes.

Card	1	2	3	4	5	6	7	8
Variable	LCID	VALDMP						
Type	I	F						
Default	0	0.0						

VARIABLE	DESCRIPTION
LCID	Load curve ID (see *DEFINE_CURVE) which specifies the system damping constant vs. time: EQ.0: a constant damping factor as defined by VALDMP is used, GT.0: system damping is given by load curve LCID (which must be an integer). The damping force applied to each node is $f = -d(t)mv$, where $d(t)$ is defined by load curve LCID.
VALDMP	System damping constant, d (this option is bypassed if the load curve number defined above is nonzero).

***DATABASE**_*OPTION*

Purpose: Change the output interval for ASCII files. If a file is not specified in the restart deck, then the output interval for the file will remain unchanged.

Options for ASCII files include:

SECFORC	Cross section forces.
RWFORC	Wall forces.
NODOUT	Nodal point data.
ELOUT	Element data.
GLSTAT	Global data.
DEFORC	Discrete elements.
MATSUM	Material energies.
NCFORC	Nodal interface forces.
RCFORC	Resultant interface forces.
DEFGEO	Deformed geometry file.
SPCFORC	Set DT for SPC reaction forces.
SWFORC	Nodal constraint reaction forces (spot welds and rivets).
ABSTAT	Set DT for airbag statistics.
NODFOR	Set DT for nodal force groups.
BNDOUT	Boundary condition forces and energy
RBDOUT	Set DT for rigid body data.
GCEOUT	Set DT for geometric contact entities.
SLEOUT	Set DT for sliding interface energy.
JNTFORC	Set DT for joint force file.
SBTOUT	Set DT for seat belt output file.
AVSFLT	Set DT for AVS database.
MOVIE	Set DT for MOVIE.
MPGS	Set DT for MPGS.
TPRINT	Set DT for thermal file.

Card	1	2	3	4	5	6	7	8
Variable	DT							
Type	F							

VARIABLE	DESCRIPTION
DT	Time interval between outputs: EQ.0.0: Output interval is unchanged.

Remarks:

1. **File Output Termination.** To terminate output to a particular file, set DT to a high value.

2. **NODOUT Results.** If IACCOP = 2 was specified in *CONTROL_OUTPUT, the best results are obtained in the NODOUT file by keeping the same DT on restart. When DT is changed for NODOUT, oscillations may occur around the restart time. If DT is larger than initially specified in the original input file, more memory is required to store the time states for the averaging than was originally allocated. A warning message is printed, and the filtering is applied using the available memory. When DT is smaller than initially specified, more oscillations may appear in the output than earlier in the calculation because the frequency content of the averaged output increases as DT decreases.

***DATABASE_BINARY**_*OPTION*

Options for binary output files with the default names given include:

D3PLOT DT for complete output states.

D3THDT DT for time history data for element subsets.

D3DUMP Binary output restart files. Define output frequency in cycles

RUNRSF Binary output restart file. Define output frequency in cycles.

INTFOR DT for contact surface interface database.

Card	1	2	3	4	5	6	7	8
Variable	DT/CYCL							
Type	F							

VARIABLE	DESCRIPTION
DT	Time interval between outputs. EQ.0.0: Time interval remains unchanged.
CYCL	Output interval in time steps. EQ.0.0: Output interval remains unchanged.

***DELETE**_*OPTION1_OPTION2*

Available options for OPTION1 are:

ALECPL

CONTACT

CONTACT_2DAUTO

ENTITY

PART

ELEMENT_BEAM

ELEMENT_SHELL

ELEMENT_SOLID

ELEMENT_TSHELL

FSI

OPTION2 only works with *DELETE_PART. This option causes LS-DYNA to exclude the geometric and other element/node information of deleted parts in d3plot files after re-start which significantly reduces d3plot file size.

COMP

Purpose: Delete contact surfaces, ALE FSI couplings, parts, or elements by a list of IDs. There are two contact algorithms for two-dimensional problems: the line-to-line contact and the automatic contact defined by part IDs. Each uses their own numbering.

ID Cards. This card applies to the ALECPL, CONTACT, CONTACT_2DAUTO, ENTITY, FSI and PART options. Include as many cards as necessary to input desired IDs. This input ends at the next keyword ("*") card.

Card 1a	1	2	3	4	5	6	7	8
Variable	ID1	ID2	ID3	ID4	ID5	ID6	ID7	ID8
Type	I	I	I	I	I	I	I	I

VARIABLE	DESCRIPTION
ID*n*	Contact ID/Coupling ID/Part ID. See Remarks.

Element Set Cards. This card applies to the four ELEMENT options. This input ends at the next keyword ("*") card.

Card 1b	1	2	3	4	5	6	7	8
Variable	ESID							
Type	I							

VARIABLE	DESCRIPTION
ESID	Element set ID, see *SET_SOLID, *SET_BEAM, *SET_SHELL, *SET_TSHELL.

Remarks:

The FSI option corresponds to ALE couplings defined with *CONSTRAINED_LAGRANGE_IN_SOLID. The ALECPL option corresponds to ALE couplings defined with *ALE_COUPLING_NODAL_*OPTION*. For CONTACT, FSI, and ALECPL options, a negative ID implies that the absolute value gives the contact surface/FSI/ALECPL coupling which is to be activated.

*INTERFACE_SPRINGBACK_LSDYNA

Purpose: Define a material subset for output to a stress initialization file dynain. The dynain file contains keyword commands that can be included in a subsequent input deck to initialize deformation, stress, and strain in parts. This file can be used, for example, to do an implicit springback analysis after an explicit forming analysis.

Part Set ID Cards.

Card 1	1	2	3	4	5	6	7	8
Variable	PSID	NSHV						
Type	I	I						

Constraint Cards. Optional cards that list of nodal points that are constrained in the dynain file. This input ends at the next keyword ("*") card.

Card 2	1	2	3	4	5	6	7	8
Variable	NID	TC	RC					
Type	I	F	F					
Default	none	0.	0.					

VARIABLE	DESCRIPTION
PSID	Part set ID for springback, see *SET_PART.
NSHV	Number of shell or solid history variables (beyond the six stresses and effective plastic strain) to be initialized in the interface file. For solids, one additional state variable (initial volume) is also written. If NSHV is nonzero, the element formulations, calculational units, and constitutive models should not change between runs. If NHSV exceeds the number of integration point history variables required by the constitutive model, only the number required is written; therefore, if in doubt, set NHSV to a large number.
NID	Node ID

VARIABLE	DESCRIPTION
TC	Translational constraint: EQ.0: no constraints, EQ.1: constrained x displacement, EQ.2: constrained y displacement, EQ.3: constrained z displacement, EQ.4: constrained x and y displacements, EQ.5: constrained y and z displacements, EQ.6: constrained z and x displacements, EQ.7: constrained x, y, and z displacements.
RC	Rotational constraint: EQ.0: no constraints, EQ.1: constrained x rotation, EQ.2: constrained y rotation, EQ.3: constrained z rotation, EQ.4: constrained x and y rotations, EQ.5: constrained y and z rotations, EQ.6: constrained z and x rotations, EQ.7: constrained x, y, and z rotations.

RIGID_DEFORMABLE_*OPTION

Available options include:

CONTROL

D2R (Deformable to rigid part switch)

R2D (Rigid to deformable part switch)

Purpose: Define parts to be switched from rigid to deformable and deformable to rigid in a restart. It is only possible to switch parts on a restart if part switching was activated in the time zero analysis. See *DEFORMABLE_TO_RIGID for details of part switching.

*RIGID_DEFORMABLE_CONTROL

Card	1	2	3	4	5	6	7	8
Variable	NRBF	NCSF	RWF	DTMAX				
Type	I	I	I	F				
Default	0	0	0	none				

VARIABLE	DESCRIPTION
NRBF	Flag to delete or activate nodal rigid bodies (see Remark 1): EQ.0: no change, EQ.1: delete, EQ.2: activate.
NCSF	Flag to delete or activate nodal constraint set (see Remark 2): EQ.0: no change, EQ.1: delete, EQ.2: activate.
RWF	Flag to delete or activate rigid walls: EQ.0: no change, EQ.1: delete, EQ.2: activate.
DTMAX	Maximum permitted time step size after restart.

Remarks:

1. **Nodal Rigid Bodies.** If nodal rigid bodies or generalized, weld definitions are active in the deformable bodies that are switched to rigid, then the definitions should be deleted to avoid instabilities.

2. **Nodal Constraint Set.** If nodal constraint/spot weld definitions are active in the deformable bodies that are switched to rigid, then the definitions should be deleted to avoid instabilities.

*RIGID_DEFORMABLE_D2R

Part ID Cards. Include one card for each part. This input ends at the next keyword ("*") card.

Card 1	1	2	3	4	5	6	7	8
Variable	PID	LRB						
Type	I	I						
Default	none	0						

VARIABLE	DESCRIPTION
PID	Part ID of the part which is switched to a rigid material.
LRB	Part ID of the lead rigid body to which the part is merged. If zero, the part becomes either an independent or lead rigid body.

***RIGID_DEFORMABLE_R2D**

Termination of this input is when the next "*" card is read.

Part ID Cards. Include one card for each part. This input ends at the next keyword ("*") card.

Card 1	1	2	3	4	5	6	7	8
Variable	PID							
Type	I							
Default	none							

VARIABLE	DESCRIPTION
PID	Part ID of the part which is switched to a deformable material.

*STRESS_INITIALIZATION_{OPTION}

This keyword causes a full deck restart. For a full deck restart the input deck must contain the full model. The stress initialization feature allows all or selected parts to be initialized from the previous calculation using data from the d3dump or runrsf databases.

The options that are available with this keyword are:

<BLANK>

DISCRETE

SEATBELT

Optional Part Cards. If no part cards are included in the deck then all parts, seatbelts and discrete parts in the new input deck that existed in the previous input deck (with or without the same part IDs) are initialized from the d3dump or runrsf database. Otherwise for each part to be initialized from the restart data include an addition card in format 1. This input terminates at the next keyword ("*") card.

Card 1	1	2	3	4	5	6	7	8
Variable	PID0	PIDN						
Type	I	I						
Default	none	PIDO						

VARIABLE	DESCRIPTION
PIDO	Old part ID, see *PART.
PIDN	New part ID, see *PART: EQ.0: New part ID is the same as the old part ID.

Remarks:

If one or more of the above cards are defined, then discrete and seatbelt elements will not be initialized unless the additional option cards *STRESS_INITIALIZATION_DISCRETE and *STRESS_INITIALIZATION_SEATBELT are defined.

*STRESS_INITIALIZATION_DISCRETE

Initialize all discrete parts from the old parts. No further input is required with this card. This card is not required if *STRESS_INITIALIZATION is specified without further input.

*STRESS_INITIALIZATION_SEATBELT

Initialize all seatbelt parts from the old parts. No further input is required with this card. This card is not required if *STRESS_INITIALIZATION is specified without further input.

TERMINATION_*OPTION

Purpose: Stops the job depending on some displacement conditions.

Available options include:

NODE

BODY

Caution: The inputs are different for the nodal and rigid body stop conditions. The nodal stop condition works on the global coordinate position, while the body stop condition works on the relative global translation. The number of termination conditions cannot exceed the maximum of 10 or the number specified in the original analysis.

The analysis terminates for *TERMINATION_NODE when the current position of the node specified reaches either the maximum or minimum value (stops 1, 2 or 3), or picks up force from any contact surface (stop 4). For *TERMINATION_BODY the analysis terminates when the center of mass displacement of the rigid body specified reaches either the maximum or minimum value (stops 1, 2 or 3) or the displacement magnitude of the center of mass is exceeded (stop 4). If more than one condition is input, the analysis stops when any of the conditions is satisfied.

> **NOTE:** This input completely overrides the existing termination conditions defined in the time zero run.

Termination by other means is controlled by the *CONTROL_TERMINATION control card.

Card Summary:

Card 1a. This card is included if and only if the NODE keyword option is used.

NID	STOP	MAXC	MINC				

Card 1b. This card is included if and only if the BODY keyword option is used.

PID	STOP	MAXC	MINC				

Data Card Descriptions:

Node Cards. Include an additional card for each node with a termination criterion.

Card 1a	1	2	3	4	5	6	7	8
Variable	NID/PID	STOP	MAXC	MINC				
Type	I	I	F	F				
Default	none	none	↓	↓				

VARIABLE	DESCRIPTION
NID	Node ID
STOP	Stop criterion: EQ.1: global *x* direction, EQ.2: global *y* direction, EQ.3: global *z* direction, EQ.4: stop if node touches contact surface.
MAXC	Maximum (most positive) coordinate, options 1, 2 and 3 above only.
MINC	Minimum (most negative) coordinate, options 1, 2 and 3 above only.

Part Cards. Include an additional card for each part with a termination criterion.

Card 1b	1	2	3	4	5	6	7	8
Variable	NID/PID	STOP	MAXC	MINC				
Type	I	I	F	F				
Default	none	none	↓	↓				

VARIABLE	DESCRIPTION
PID	Part ID of rigid body

VARIABLE	DESCRIPTION
STOP	Stop criterion: EQ.1: global *x*-direction, EQ.2: global *y*-direction, EQ.3: global *z*-direction, EQ.4: stop if displacement magnitude is exceeded.
MAXC	Maximum (most positive) displacement, options 1, 2, 3 and 4: EQ.0.0: MAXC set to 10^{21}
MINC	Minimum (most negative) displacement, options 1, 2 and 3 above only: EQ.0.0: MINC set to -10^{21}

***TITLE**

Purpose: Define job title.

Card	1	2	3	4	5	6	7	8
Variable	TITLE							
Type	C							
Default	LS-DYNA USER INPUT							

VARIABLE	DESCRIPTION
TITLE	Heading to appear in a small restart's d3hsp file. This heading is not written to any other output file.