Restarting an LS-DYNA Analysis

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Introduction to restarting LS-DYNA analyses

An LS-DYNA job can be stopped and restarted from any particular point in time.

There are three classes of restarts:

Restart Class	Description	Dump file
Simple restart	No changes (no keyword input file needed).	d3dump file
Small restart	Few small changes permitted (small restart input deck file needed) - e.g. change termination time.	d3dump
Full restart	Allow users to make significant changes. Major changes to model requires full restart input deck with all model data and additional changes. Add new keyword into restart file *STRESS_INITIALIZATION.	d3full

Restarts are achieved using a binary restart "dump" file ***<name>.dpf (d3dump)*** or ***<name>.adf (d3runsf)*** and an ASCII file ***<name>.key01*** to describe model changes (optional) at the restart time.

Binary dump file contains a complete record of the model (stress, strain, deformation, etc) at a particular point in time.

Restart dump files

d3dump files:

- Permanent restart files which **accumulate** throughout the analysis.
- By default, binary d3dump file written at normal termination or crash of a run.
- Output frequency controlled with *DATABASE_BINARY_D3DUMP
  - A new restart file is created after each interval, CYL, thus a family of dump files is created and numbered sequentially, e.g. d3dump01, d3dump02 etc.

runrsf (Number of RUNning ReStart Files) files:

- Single auxiliary dump file *runrsf/.adf* **overwritten** each time
- Output frequency controlled with *DATABASE_BINARY_RUNRSF
  - Default is NR = 1, i.e. only one runrsf file is created and the data therein is overwritten each time data is output.
  - NR > 1 option allows a series of files to be overwritten in a cyclic order.

These files can be quite large and care should be taken with the d3dump files not to create too many. Can be suppressed in MPP LS-DYNA:

- *CONTROL_MPP_IO_NOD3DUMP,
- *CONTROL_MPP_IO_NODUMP,
- *CONTROL_MPP_IO_NOFULL.

Switch Sensors

Sense switches allow you to control the behaviour of an analysis while it is running.

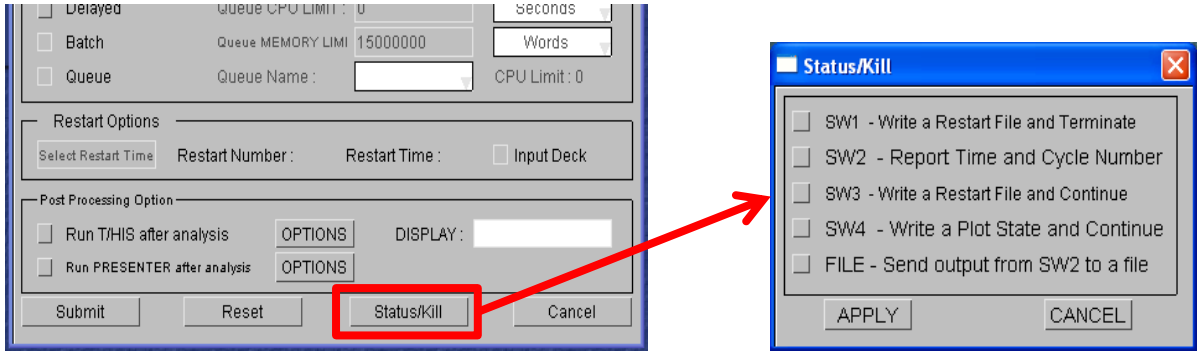
To activate one of the sense switch options a text file called *jobname*.kil needs to be created, containing one line of text, which is the sense switch you want to use:

e.g. sw1. (include the dot)

Some of the options are:

sw1. – A restart file is written and LS-DYNA terminates
sw2. – LS-DYNA responds with time & cycle info
sw3. – A restart file is written and LS-DYNA continues
sw4. – A plot state is written and LS-DYNA continues
swa. – Flush ASCII file buffers

The *jobname*.kil file can also be created using the Oasys SHELL:

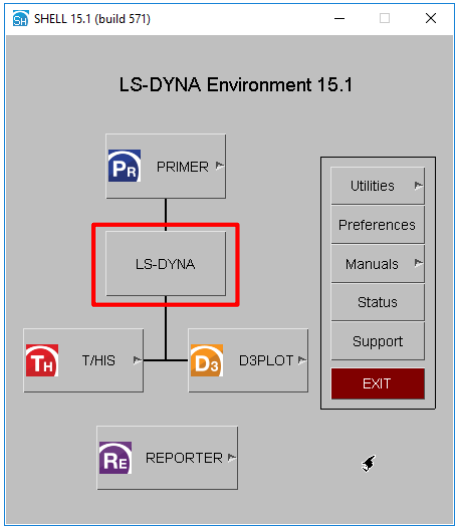


Restart process

When restarting an LS-DYNA job:

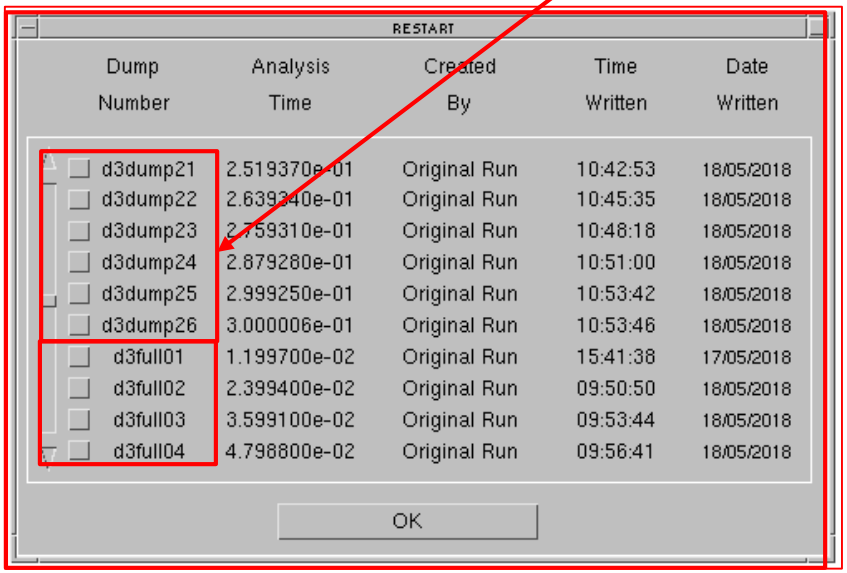
- Use the same LS-DYNA executable as in the run that produced the dump file.
- Use same numbers of CPU's as in the run that produced the dump file.
- Use the same memory as in the run that produced the binary dump files.
- Run the analysis in the same directory.

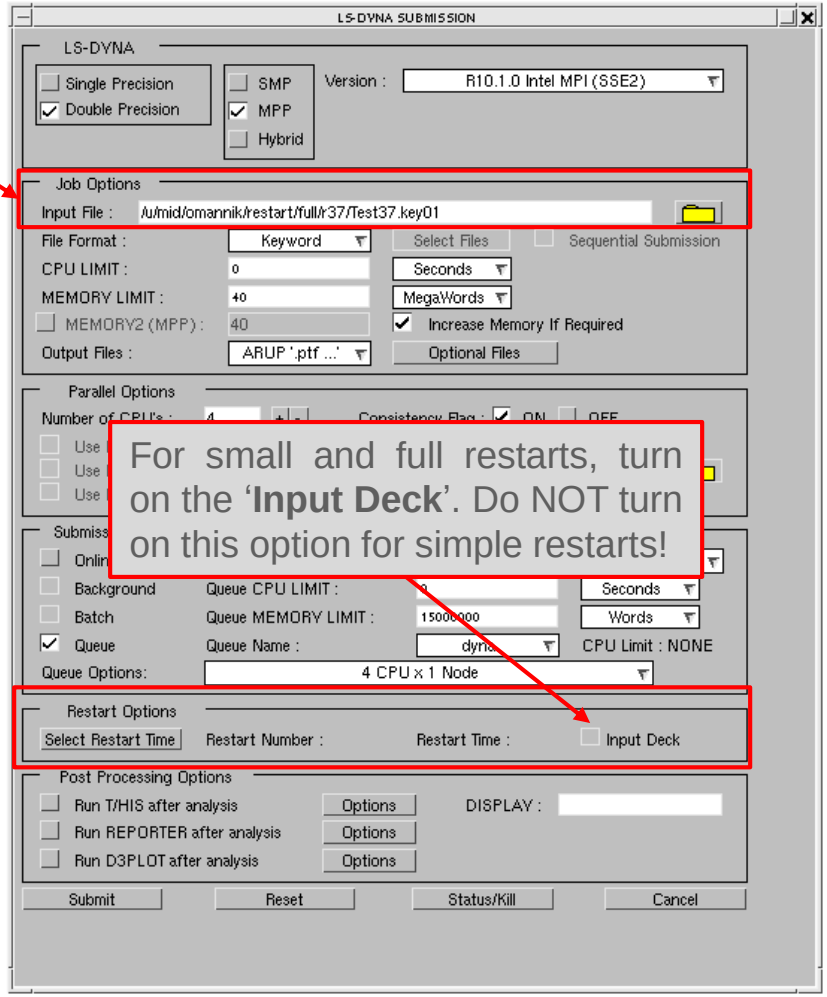
Restart process: Oasys SHELL



Select the restart input deck (small or full restarts only)

- d3dump for simple and small restarts.
- d3full for full restarts.





For small and full restarts, turn on the '**Input Deck**'. Do NOT turn on this option for simple restarts!

Simple Restart

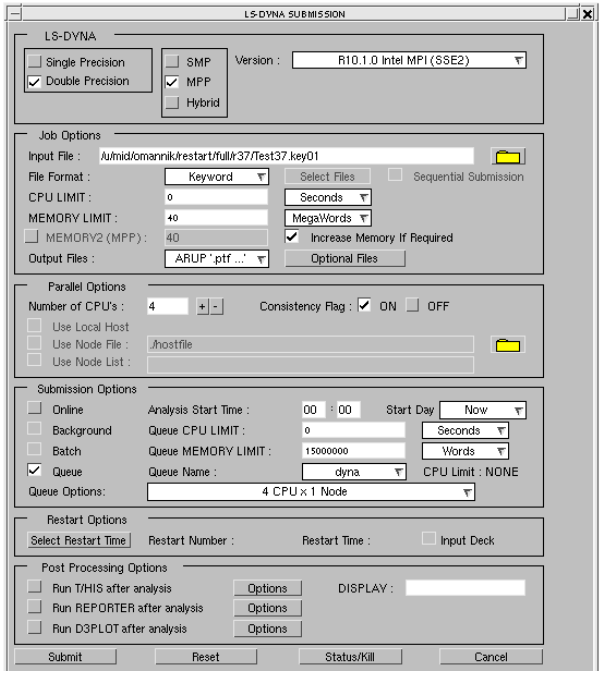
- This is a restart with **no changes** in the input keywords.
- The goal is to continue the analysis without changing anything. (For example, the analysis was stopped before the termination time).
- The simple restart is made from a dump file obtained prior to the analysis termination time.
- As no input changes are required (not even the termination time), the original key file can be used for input.

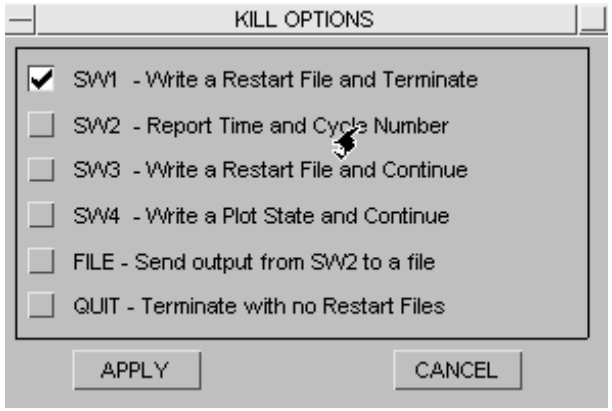
Simple Restart - Steps

1) Submit an LS-DYNA job.
2) Terminate LS-DYNA job and write restart file via Oasys SHELL:
   - **Input File**: Original input deck file.
   - Click "**Status/Kill**".
   - Select '**SW1 – Write a Restart File and Terminate**'
   - Click "Apply" to kill job and close SHELL GUI.
3) Check for d3dump file in run directory.
4) To restart the analysis from interrupted analysis time, open Oasys SHELL:
   - **Input File**: Original input deck file.
   - Click '**Select Restart Time**' and select d3dump file.
   - Submit LS-DYNA job using the same settings as before.

Sample execution line (input deck not required):

lsdyna r=d3dump01





Small Restart

- Restart will small changes to the input deck.
- Only a few specific changes are permitted in a small restart, refer to *RESTART section of LS-DYNA Keyword User's Manual.

  - Change termination time
  - Change output printing interval
  - Change output plotting interval
  - Delete contacts, parts and elements
  - Modify load curves
  - Rigid/deformable switching
  - Add nodal constraints
  - Change damping options

- Both a binary dump file and a small restart input deck (containing only the keywords to be modified or appended) is required.

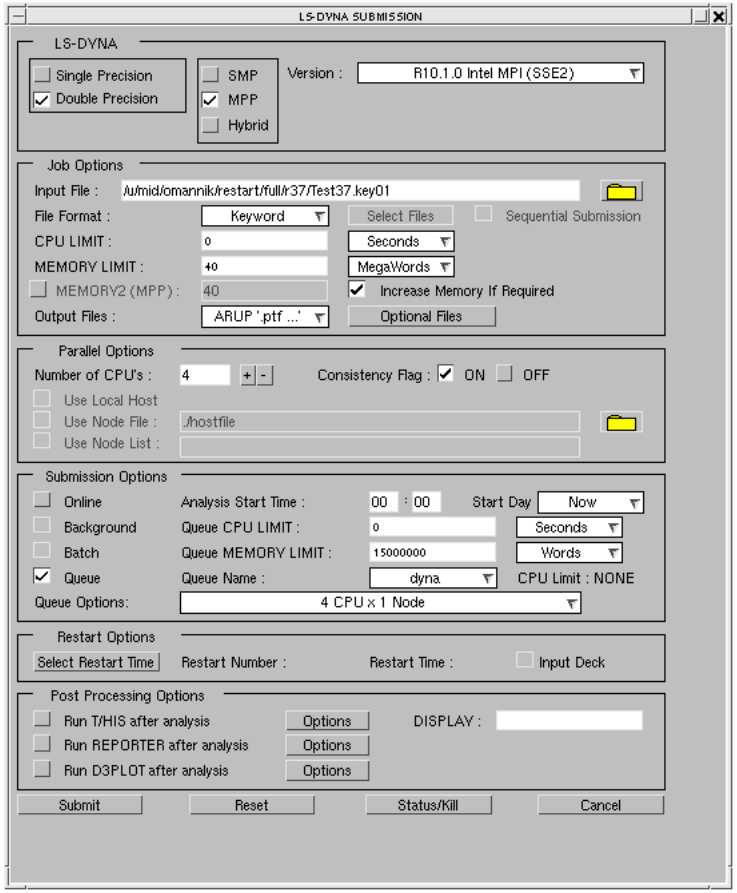
```
$
*KEYWORD
*CONTROL_TERMINATION
10E-3
*DATABASE_BINARY_OUTPUT
1e-3
*DELETE_PART
4,3
*DELETE_CONTACT
10
*END
```

restart-input.key

Small Restart - Steps

- Open Oasys SHELL.
  - Select same submission settings as the original LS-DYNA job (solver type, executable etc.).
  - **Input file**: Small input deck (see previous slide).
  - Click '**Select Restart Time**' and select d3dump file.
  - '**Submit**' the analysis.

- Execution line syntax is:
  - lsdyna i = restart-input.k r = d3dump01



Full Restart

- This is a restart which allows the user to make significant changes to the model (addition of new parts, loads, contacts, etc).
- The restart is made form a dump file and a full restart input deck.
- In MPP, the dump file for a full restart is named d3fullxx.
- In the full restart input deck, a full keyword description of the model and added changes are given:
  - The input keywords from the retained nodes, elements, materials, contacts, loads etc. are copied from the original input deck. These copied input keywords can be modified as desired.
  - The keywords for the new parts, materials, loads, etc. are also added.

- The command *STRESS_INITIALIZATION **must be specified** in the full restart input deck in order to initialise pre-existing parts.
  - The stresses, strains, displacements, etc. are initialised for all the parts which are carried over or, optionally, for only a subset of those parts.

http://ftp.lstc.com/anonymous/outgoing/jday/restart.pdf

Full Restart: Comments

- Do not change the element connectivity (mesh topology) of restrained elements.
- Undeformed coordinates of retained nodes should appear in the *NODE data of the restart input deck. In other words, just use the *NODE data from the original input deck.
  - Coordinates will be initialized according to data saved in dump file.
- *DELETE commands are just for small restarts.
  - To eliminate parts and elements in a full restart, omit their *PART and *ELEMENT data, respectively, in the full restart deck.
- Do not use *INITIAL_VELOCITY for nodes carried over from the previous run. Use *CHANGE_VELOCITY_*option* to modify velocities of such nodes.
- Pre-existing contacts that are to be retained should include the _ID option so that the contact ID numbers in the original input deck match those in the full restart input deck.

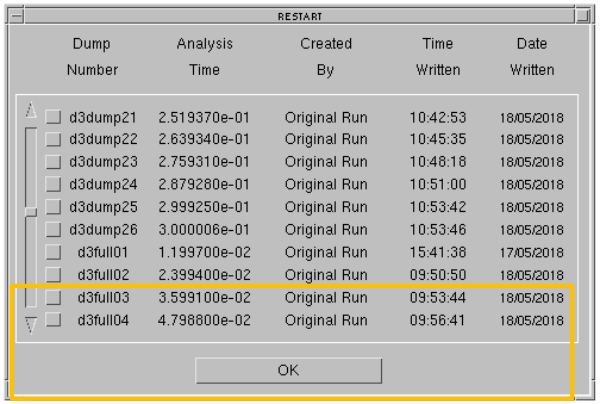
http://ftp.lstc.com/anonymous/outgoing/jday/restart.pdf

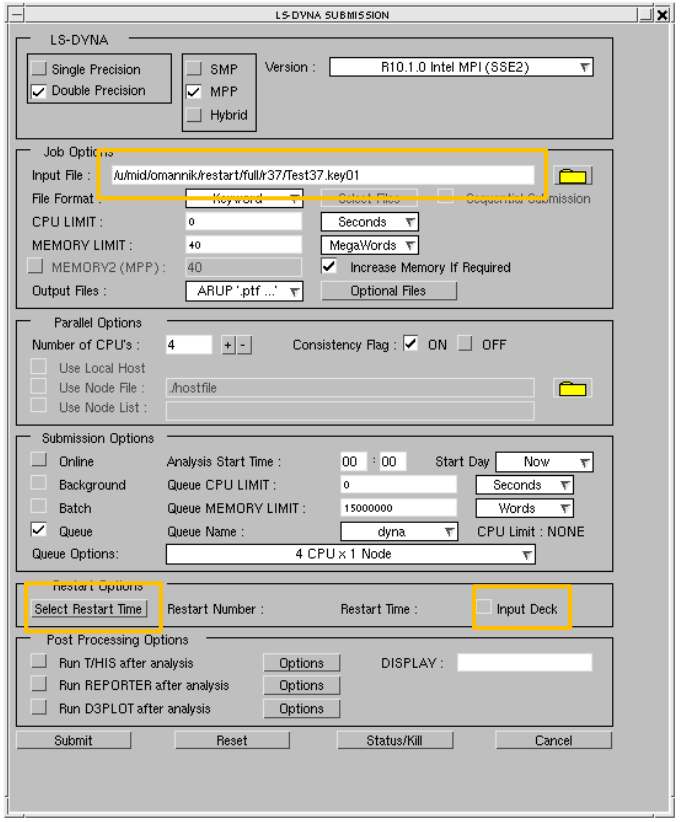
Full Restart - Steps

- Full restart input deck:
  - Modify original <name>.key file.
  - Change termination time, add parts, contacts etc. in Oasys PRIMER or text editor.
  - Specify *STRESS_INITIALIZATION in full restart deck.
  - Save and close full restart input deck.
- Open Oasys Shell:
  - Select same submission settings as the original LS-DYNA job (solver type, executable etc.).
  - **Input file**: full restart input deck.
  - Click '**Select Restart Time**' and select d3full*xx* file.
  - Select 'Input Deck'
  - '**Submit**' the analysis.

Execution line syntax is:

- lsdyna i = restart-input.k n = **d3full*xx***





Example files

Restart class	Folder	Input decks	Restart input deck
Simple	small_restart	**Original:** crush_tube.key	• No restart input deck required.
Small	small_restart	**Original:** crush_tube.key **Small restart:** crush_tube.key01	• Termination time changed from 0.3s to 0.5s
Full	full_restart	**Original:** crush_tube.key **Full restart:** crush_tube.key01	• Termination time changed from 0.3s to 0.5s • Rigid sphere added. • New material card added and applied to rigid sphere part. • Contact between rigid sphere and deformable body added. • Prescribed motion and corresponding load curve added to rigid sphere part.

Acknowledgements

http://ftp.lstc.com/anonymous/outgoing/jday/restart.pdf

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