root_gen.out

- Time step number (one for each calculation step).
- Time expressed in seconds (e.g. 86400 s = 1 day).
- Dtime: Time step (updated for every step by the time step factor).

```
**Time step#                1 Time:  -0.863999E+06 Dtime:   0.864000E+00
Force balance   :    1 0.525E-01      72
Water balance   :    1 0.504E+01      72
Energy balance  :    1 0.421E+06      72
Time step factor:       1.4142135623730951
Displacement    :    1 0.372E-08     299
Liquid pressure :    1 0.106E-03     147
Temperature     :    1 0.775E-10     137
Stress          :    1 0.212E-07      72    1
Acc. cputime (total, solver):    0.156250E-01     0.00000
Newton-Raphson Iterations (iter,ntiter):   1               1

**Time step#                2 Time:  -0.863998E+06 Dtime:   0.122188E+01
Force balance   :    1 0.217E-01      72
Water balance   :    1 0.271E-05      78
Energy balance  :    1 0.227E+00      78
Time step factor:       1.4142135623730951
Displacement    :    1 0.189E-09      57
Liquid pressure :    1 0.830E-06     137
Temperature     :    1 0.375E-10     345
Stress          :    1 0.161E-08     205    1
Acc. cputime (total, solver):    0.625000E-01     0.00000
Newton-Raphson Iterations (iter,ntiter):   1               2
```

Initial time + initial time step
-864000 s + 0.864 s = -863999 s

0.864000E+00
x 1.4142135623730951
= 0.122188E+01

Dtime can be limited by the user in the Data Interval window (partial time step)

root_gen.out

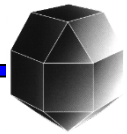
- N-R iterations (iter = iterations in each time step; ntiter = total number of iterations).
- Residual balance errors (if they are lower than tolerances, convergence is achieved).
- Variable corrections (if they are lower than tolerances, convergence is achieved).
- Element number in which the error is most unfavorable.
- Iterations of the mechanical model (for some models).
- Accumulated CPU-time consumed (total and time consumed only by the solver).

```
**Time step#              2413 Time:   0.216000E+09 Dtime:   0.227430E+06
Force balance    :     1 0.531E-03      345
Water balance    :     1 0.713E-11       26
Energy balance   :     1 0.117E-04      208
Time step factor:        1.4142135623730951
Displacement     :     1 0.287E-08      253
Liquid pressure  :     1 0.354E-03      197
Temperature      :     1 0.580E-05      220
Stress           :     1 0.158E-04      284      1
Acc. cputime (total, solver):     50.6250          12.8750
Newton-Raphson Iterations (iter,ntiter):   1           3400

Total accumulated cputime:    0.506250E+02
Cputime solver only      :    0.128750E+02
Ratio solver/total       :    0.254321E+00
Total number of N-R iterations (ntiter):          3400
Total number of time steps (int)       :          2413
Ratio iterations per time step         : 1.41
```

Max Abs Displacement[m]	1e-5
Max Nod Bal Forces[MN]	1e-10
Displacement Iter Corr[m]	0.1
Max Abs PI[MPa]	1e-3
Max Nod Water Mass Bal[kg/s]	1e-10
PI Iter Corr[MPa]	10
Max Abs Temp[C]	1e-3
Max Nod Energy Mass Bal[J/s]	1e-10
Temp Iter Corr[C]	0.1

SUMMARY

root_gen.out



Convergence problems => Time step is reduced

- High number of N-R iterations (> Max. number of iterations per time step).
- Errors higher than tolerances.
- Divergence.

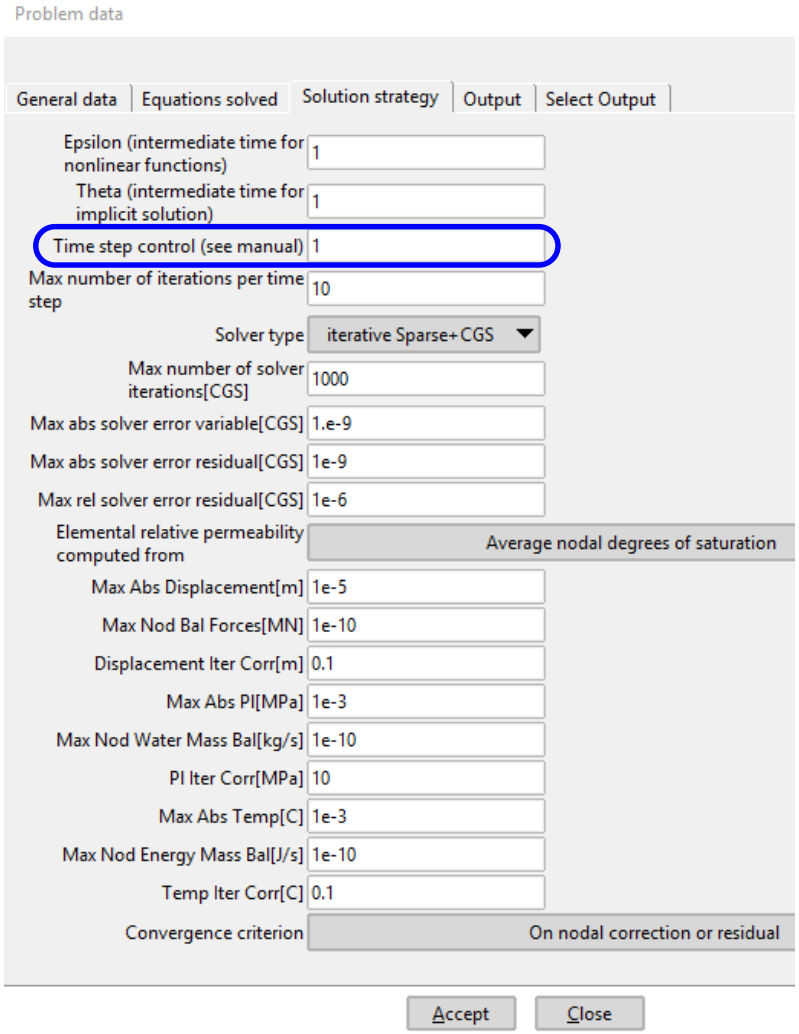
```
Stress           :    9 0.617E-02     400    3
Force balance    :   10 0.231E-02     269
Water balance    :   10 0.110E-02     258
Time step factor:        0.7952707287670506
Displacement     :   10 0.189E-04     269
Liquid pressure  :   10 0.782E-02     275
Time step is reduced to:      0.591E-01
(dtime=dtime/2) due to convergence problems.
(N-R Iterations=ITERMAX (=    10)) Force balance    :   19 0.425E-04    1782

Liquid pressure  :    3 0.461E+02     237
Time step is reduced to:      0.638E+01
because liquid pressure correction:  0.461E+02
is greater than dplmx: 0.100E+02 at node:  237

Temperature      :    1 0.926E+00     206
Time step is reduced to: 0.933E+02
because temperature correction:  0.926E+00
is greater than dtmx: 0.100E+00 at node:  206

Time step is reduced to:      0.612E+00
(dtime=dtime/2) due to divergence problems.
```

root_gen.out

Possible solutions to convergence problems

- Automatic time step control:
  - More strict: use option 2-3 or 7-8.

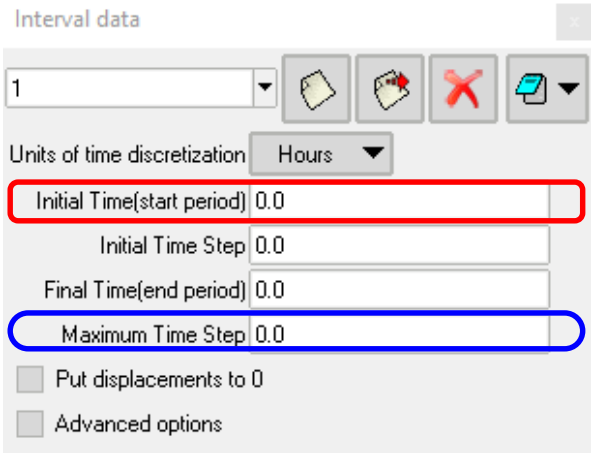
Time step control (ITIME in root_gen.dat) Default: **1**	**<u>0-4: Time step control based on N-R iterations:</u>** **0**: no time step prediction is performed. **1:** predicts time stepping according to a limit of 4 iterations. **2:** predicts time stepping according to a limit of 3 iterations. **3:** predicts time stepping according to a limit of 2 iterations. **4:** predicts time stepping according to a limit of 1 iteration. **<u>6-9: Time step control based on error estimation:</u>** **6**: controls time stepping by means of a prediction based on the relative error deviation in the variables (relative error lower than 0.01). **7**: same as **6** but with a tolerance equal to 0.001. **8**: same as **6** but with a tolerance equal to 0.0001. **9**: same as **6** but with a tolerance equal to 0.00001. *Note: a time step control = 1 will always be considered for negative time.*



root_gen.out

Possible solutions to convergence problems

- Manual time step control:
  - Set a maximum time step on each interval (in “maximum time step” field).
  - Reduce “initial time step” if the problem is at the beginning of a time interval.



- Errors higher than tolerances:
  - Eliminate condition of iteration correction by setting it to 10 or 100 (this can be done provided that there are other criteria used to control time step).

```
Liquid pressure :    3 0.461E+02     237
Time step is reduced to:      0.638E+01
because liquid pressure correction:  0.461E+02
is greater than dplmx: 0.100E+02 at node:  237
Temperature     :    1 0.926E+00     206
Time step is reduced to: 0.933E+02
because temperature correction:  0.926E+00
is greater than dtmx: 0.100E+00 at node:  206
```