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TASK COMPLETION REPORT FOR UPDATE FXTIME

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by

Robert G. Steinke

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ABSTRACT

The $DSTEP = -99$ and $TIMET \geq 0.0$ s feature in TRAC-P has been tested on the W4LOOP and W4LOOPR standard test problems and was found to give different W4LOOPR solutions for different values of $TIMET$ when all these cases should have given the same solution. Update FXTIME has corrected part of the cause of that difference and reduced the difference by an order of magnitude. The error associated with the remaining difference has been documented in Trouble Report 238.

1.0. INTRODUCTION

Knolls Atomic Power Laboratory (KAPL) requested the TRAC-P feature of inputting a problem time $TIMET \geq 0.0$ s to replace the problem time from the last restart-data dump when $DSTEP < 0$. That capability was found to already exist in TRAC-P when $DSTEP = -99$ is input but not documented. KAPL requested that this undocumented capability in TRAC-P be tested to verify that it functioned correctly and that it be documented appropriately.

2.0. INITIAL TESTING

The W4LOOP and W4LOOPR standard test problems were used to perform this test because the W4LOOPR transient calculation is restarted from the last restart-data dump of the W4LOOP steady-state calculation. The power vs absolute time component-action table of ROD 140 with $NRPWTB = 20$ in W4LOOP was changed to a power vs relative-time table with $NRPWTB = -20$. This was done so that changing $TIMET$ in W4LOOPR would not require changing the 20 time values in the W4LOOP power table and reevaluating W4LOOP for each W4LOOPR calculation.

W4LOOPR is expected to give the same transient solutions for $DSTEP = -1$ or -99 and $TIMET = 0.0$ s and for $DSTEP = -99$ and $TIMET \geq 0.0$ s. Testing W4LOOPR with $DSTEP = -1$ or -99 and $TIMET = 0.0$ s gave identical transient solutions. Testing W4LOOPR with $DSTEP = -99$ and $TIMET = 0.0, 0.0001, 0.01, 1.0, 100.0, \text{ or } 10000.0$ s gave different transient solutions in each case. The major cause of this difference was traced to an error in the $TIMET > 0.0$ s cases of evaluating the valve flow-area fraction vs relative time table of VALVE component 6 (with a Δt shift in the table's time abscissa coordinate values) during the first timestep as well as in all cases of evaluating the power table of ROD 140 (with a Δt shift in the table's time abscissa coordinate values) during the first timestep. The valve-table evaluation opens the

valve-interface flow area of VALVE 6 from an initially closed state from time 0.0 to 0.1 s to simulate a cold-leg pipe large break. The power-table evaluation of ROD 140 defines the reactor-core power of all fuel rods. These valve and power tables don't have trip control because their component actions are evaluated every timestep of the W4LOOPR transient calculation.

The nature of the above error is unique to evaluating a nontrip-controlled, relative independent-variable, component-action table when $DSTEP = -99$ and $TIMET > 0.0$ s. The error occurs during the first timestep and was found to affect all component actions.

3.0. UPDATE FXTIME

Update FXTIME, a listing of which is shown in Appendix A, was programmed to correct this error in TRAC-P Version 5.4.28. The error centers on evaluating nontrip-controlled, relative independent-variable, component-action tables with source code specifying $TLAPS = DTO$ for the component actions of BREAK, FILL, HTSTR (ROD or SLAB), PIPE, PUMP, TEE, and TURB components and $TLAPS = AMIN1(DTO, ETIME)$ for the component action of the VALVE component. During the first timestep, $TLAPS = DTO$ performs a Δt shift in the power table's abscissa-coordinate time values, and $TLAPS = AMIN1(DTO, ETIME)$ performs a Δt shift in the valve table's abscissa-coordinate time values when $TIMET$ (defining $ETIME$) is input with a value > 0.0 s ($\geq DTO$). In general, the relative table's Δ shift of its independent variable is the independent-variable parameter's value change during the $TLAPS$ change in problem time.

For an initial (nonrestart) steady-state or transient calculation or for a steady-state or transient calculation restarted from a steady-state calculation data dump, no shift in the relative table's independent variable should be done during the first timestep. It only should be done during the first timestep of a transient calculation restarted from a transient-calculation data dump. Thus, the $TLAPS = AMIN1(DTO, ETIME)$ defining form for the valve table does this correctly with $TLAPS = 0.0$ s when $ETIME = 0.0$ s for an initial calculation, for a restart calculation from the last data dump of a steady-state calculation, or for a selected data dump of a steady-state calculation where $TIMET = 0.0$ s is input. **$TLAPS = DTO$ for all the other component actions should have been defined this way.** But when

$ETIME > 0.0$ s is the problem time from all but the last data dump,
 $TIMET > 0.0$ s is input to replace $ETIME > 0.0$ s from all but the last data dump,
or $TIMET > 0.0$ s is input to replace $ETIME = 0.0$ s from the last data dump of a steady-state calculation,
then

$TLAPS = AMIN1(DTO, ETIME)$ does the relative table's Δ shift of its independent variable during the first timestep (**when it should not**) because $TLAPS = DTO$.

To correct this, update FXTIME programs $TLAPS = DTO * FLOAT(MIN0(1, ITRANS + NSTEP))$ as a replacement for $TLAPS = DTO$ in subroutines BREAKX, EVFXXX, FILLX, PUMPSR, and TRBPRES and as a replacement for $TLAPS = AMIN1(DTO,$

ETIME) in subroutine VLVEX. ITRANS is the value of the input transient-calculation indicator TRANSI (0 = no transient calculation, 1 = transient calculation) from the previous calculation read from the restart data dump. ITRANS = 0 is initialized in subroutine INPUT for a steady-state or transient initial (nonrestart) calculation. TRANSI is written to the TRCDMP file by subroutine DMPIT and read from the TRCRST file as ITRANS by subroutine RDREST for steady-state or transient restart calculations. NSTEP is the timestep number stored in common block ISTAT (Comdeck ITERSTAT). NSTEP is 0 during the first time step and is incremented by 1 at the end of each timestep to count a successfully completed timestep. During the first timestep when NSTEP = 0 and ITRANS = 0 for an initial calculation or restart calculation from the data dump of a steady-state calculation, $TLAPS = DTO * FLOAT(MIN0(1, 0+0)) = 0.0$ s. For all other timesteps when NSTEP > 0 and/or when ITRANS = 1 (transient calculation restarted from the data dump of a transient calculation), $TLAPS = DTO * FLOAT(MIN0(1, (0+>0) \text{ or } (1+0) \text{ or } (1+>0))) = DTO$. This is shown in Table I for all nine combinations of a present steady-state (SS) and/or transient (TR) calculation, which is an initial calculation or restarted from a previous steady-state and/or transient calculation.

Two other errors were found that are corrected by update FXTIME. The first error also affects the DSTEP = -99 and TIMET > 0.0 s feature, and the second error corrects the defining form for the DELXMX timestep constraint for valve adjustment.

For the first error, QINT is not evaluated IF ((IREST.NE.0).AND.(ABS(TIMET).GE.DTMIN)) is .TRUE. in subroutine IPRIZR during the initialization stage. The IF test assumes DTMIN < 1.0 s during steady-state calculations where TIMET = -1.0 s.

There are three situations where the IF test needs to be .FALSE. to evaluate QINT: (1) the second logic argument is .FALSE. for a transient calculation restarted (where the first logic argument is .TRUE.) from the last data dump of a steady-state calculation, (2) the second logic argument is .FALSE. for an initial transient

TABLE I

$TLAPS = DTO * FLOAT(MIN0(1, ITRANS + NSTEP))$ values for a matrix of initial or restarted steady-state and/or transient calculation cases when NSTEP = 0 for the first timestep ($TLAPS = DTO$ when NSTEP > 0).

Case ----- Previous -----					----- Present -----					
#	Calc.	STDYST	TRANSI	Dump	Calc.	STDYST	TRANSI	Restart	ITRANS	TLAPS
1					SS	>0	0	NO		0.0 s
2					SS+TR	>0	1	NO		0.0 s
3					TR	0	1	NO		0.0 s
4	SS	>0	0	SS	SS	>0	0	YES	0	0.0 s
5	SS	>0	0	SS	SS+TR	>0	1	YES	0	0.0 s
6	SS	>0	0	SS	TR	0	1	YES	0	0.0 s
7	SS+TR	>0	1	SS	TR	0	1	YES	0	0.0 s
8	SS+TR	>0	1	TR	TR	0	1	YES	1	DTO
9	TR	0	1	TR	TR	0	1	YES	1	DTO

calculation where the first logic argument is .FALSE. as well, and (3) the first logic argument is .FALSE. for an initial steady-state calculation. The second logic argument is not necessarily .FALSE. in the first situation when DSTEP = -99 and TIMET > 0.0 s are input. To correct this, update FXTIME reprograms the logic test as IF ((IREST.NE.0) .AND.((ITRANS.EQ.1).OR.(STDYST.NE.0))) so that QINT is evaluated for the above three situations regardless of DSTEP = -99 and TIMET > 0.0 s being input in the first situation.

For the second error, the evaluation of DTDF in subroutine VLVEX to determine DELXMX = AMAX1(AMIN1(DFA*DTDF, DFA*DTDF, DELXMX), DTMIN) (see Ref. 1) assumes the valve table has problem time as its independent variable. In general, this is not the case. A check valve, for example, generally has a valve table dependent on pressure or the pressure difference across the check-valve interface. DFA*DTDF defines the change in the valve table's independent variable that would determine the maximum change in the valve flow-area fraction during the next timestep. DFA*DTDF only can define DELXMX when the valve table's independent variable is problem time. The DFA*DTDF argument defining DELXMX has been eliminated, and DTDF = DTO/AMAX1(ABS(FAVLVE-F), 1.0E-20) has been redefined by update FXTIME to be DTDF such that DTDF = DTO/AMAX1(ABS(FAVLVE-F), 1.0E-20), and DELXMX = AMAX1(AMIN1 (DFA*DTDF, DELXMX), DTMIN). F and FAVLVE are the valve flow-area fractions at the beginning and end of the previous DTO timestep.

4.0. UPDATE FXTIME TESTING

The W4LOOP and W4LOOPR standard test problems were reevaluated with update FXTIME in the manner described in section 2.0. Results of interest from the W4LOOP steady-state calculation and the W4LOOPR transient calculations with DSTEP = -1 or -99 TIMET = 0.0 s and DSTEP = -99 and TIMET = 0.0, 0.0001, 0.01, 1.0, 100.0, or 10000.0 s are shown in Appendix B. Changes to the input-data TRACIN files and very small remaining differences from the DSTEP = -1 case terminal output are shown in bold type. DIFF differences between TRCOUT files are shown or are commented on if there is an extensive difference. Now the opening of VALVE 6, simulating a cold-leg large break, is done the same in all seven cases. Most of the difference in results among cases (due to a difference in valve opening during the first timestep because of TIMET = 0.0 s or > 0.0 s being input) has been eliminated. Now no shift is done in the ROD-140 power-table, absicssa-coordinate values during the first timestep.

The cause of the remaining small difference in some of the output values (≤ 4 th significant digit for TIMET ≤ 100.0 s and ≤ 3 rd significant digit for TIMET = 10000.0 s) has not been determined. With solution differences caused solely by inputting different values of TIMET, all applications of TIMET and the variables it defines (ETIME, STIME, STIMET, TMMAX, DMPDT, TMSTNU, TMTLD, TABTIM, TABLE (NINT2+1), TIMIN, A(LCNTL+IA(LCNTL)-1), TEDIT, TSEDIT, TGRAF, TDUMP, A(KPT+6), A(KPT+7), TLAPS, and TOLD) were examined for their having an effect on the solution. No cause could be found except for the first additional error noted above.

When debugging TRAC-P in the future, the programmer should consider that the remaining difference may be due to missing code. For example, additional variables from a data dump that should be time shifted by Δt_{dmp} , $\text{DMPDT} = \text{TIMET} - \text{DMPTIM}$ = restart time - data-dump time, for the restart calculation are not being time shifted. For $\text{TIMET} = 0.0$ s and $\text{DMPTIM} = 0.0$ s from the last data dump of a steady-state calculation, $\Delta t_{\text{dmp}} = 0.0$ s. Not applying a $\Delta t_{\text{dmp}} = 0.0$ s time shift to some variables would have no effect on the solution, but not applying a $\Delta t_{\text{dmp}} > 0.0$ s time shift because $\text{TIMET} > 0.0$ s would affect the solution.

Trouble Report 238 has been created to document this remaining error so that it can be investigated at a later time.

5.0. FEATURE DOCUMENTATION

The $\text{DSTEP} = -99$ and $\text{TIMET} \geq 0.0$ s feature in TRAC-P has not been documented. It can be documented appropriately by making the following change to the Main-Data Card 3 descriptions of input-data variables DSTEP and TIMET in Chapter 6 of the TRAC-P Users Guide.

Main-Data Card 3. (Format I14, E14.4) DSTEP , TIMET

Columns	Variable	Description
1-14	DSTEP	Timestep number of the TRCDMP-file data dump to be read from the TRCRST file for a restart calculation. If $\text{DSTEP} < 0$, the last data dump found will be used. Input $\text{DSTEP} = -99$ and $\text{TIMET} \geq 0.0$ s to define TIMET to be the calculation start time for the last data-dump restart calculation. Input $\text{DSTEP} = 0$ for an initial calculation where all the input data is defined by the TRACIN file.
15-28	TIMET	Calculation start time (s). If $\text{DSTEP} < 0$ (but not -99) or $\text{TIMET} < 0.0$ s, the time obtained from the retrieved data dump overrides the TIMET input-data value.

6.0. CONCLUSIONS

The $\text{DSTEP} = -99$ and $\text{TIMET} \geq 0.0$ s features in TRAC-P Version 5.4.28 have been tested on the W4LOOP and W4LOOPR standard test problems, which have relative independent-variable component-action tables. The W4LOOPR solutions were different for different values of TIMET when the solutions should have been the same. Two coding errors that contribute to that difference and one unrelated coding error have been corrected by update FXTIME. With update FXTIME and other pending updates (FXJLPAR, FXKILL, CLSUNIT, FXLOOP, FXTPTM, SUMNMULN, FXFILL, FXGRAV, ZERORGH, and DTPCON) in TRAC-P Version 5.4.28, the same cases have lesser differences in the output values (≤ 4 th significant digit for $\text{TIMET} \leq 100.0$ s and ≤ 3 rd significant digit for $\text{TIMET} = 10000.0$ s). Further debugging of this feature in TRAC-P is needed. Trouble Report 238 has been created to document this remaining error in the $\text{DSTEP} = -99$ and $\text{TIMET} \geq 0.0$ s feature of TRAC-P.

ACKNOWLEDGMENT

The author wishes to thank Richard J. Smith for valuable discussions during the development and testing of this TRAC-P update.

7.0. REFERENCE

1. P. T. Giguere, "Improved Timestep-Size Diagnostic Edits For TRAC-P," LA-UR-96-1502 (April 1996).

Appendix A

Listing of Update FXTIME

Update FXTIME

```

1 *ident fxtime
2 */ -----Update Header Rev. 02-01-96----
3 */
4 */   File & Update Ident name (must be the same): fxtime
5 */   TSHOOTER identifier:
6 */
7 */   Code developer: Bob Steinke           Date developed: 7/10/97
8 */   Acknowledgements: KAPL requested the debugging of this feature
9 */   Update reviewer: Rich Smith           Date reviewed: 8/xx/98
10 */
11 */   Update to be applied to MOD2 _X_ or other :
12 */
13 */   CFS file path: /073417
14 */
15 */   Purpose of update: Update FXTIME (FiX TIME) corrects the exist-
16 */                       ing DSTEP = -99 capability to redefine the
17 */                       problem time on the last data dump with
18 */                       TIMET.ge.0.0 s. This correction is needed
19 */                       when non-trip-controlled relative-independent-
20 */                       variable component-action tables need to be
21 */                       evaluated differently for the first timestep
22 */                       to differentiate between an initial steady-
23 */                       state or transient calculation or a restart
24 */                       from a steady-state calculation and a restart
25 */                       from a transient calculation.
26 */
27 */   Basis for update: The DSTEP = -99 capability with different
28 */                       TIMET.ge.0.0 s values gave different solu-
29 */                       tions when they should have been the same.
30 */
31 */   Dependencies on other updates: none
32 */
33 */   Justification of non-ANSI coding: N.A.
34 */
35 */   Is this a NULL update? YES ___ NO _X_
36 */
37 */   Does this update generate new unit labels? YES ___ NO _X_
38 */   If yes, path and /name of LABNEW file: N.A.
39 */
40 */   Does the TRAC I/O change because of this update? YES _X_ NO ___
41 */   TRAC I/O includes input, dump, output, and graphics files. If
42 */   yes, then submit the necessary manual changes.
43 */
44 */   Main-Data Card 3 needs to be changed as follows.
45 */
46 */   Main-Data Card 3. (Format I14,E14.4) DSTEP, TIMET
47 */   Columns      Variable      Description
48 */   1-14         DSTEP          Timestep number of the TRCDMP-file data
49 */                                   dump to be read from the TRCRST file for
50 */                                   a restart calculation. If DSTEP < 0,
51 */                                   the last data dump found will be used.
52 */                                   Input DSTEP = -99 and TIMET >= 0.0 s to

```

```

53 */           define TIMET to be the calculation start
54 */           time for the last data-dump restart
55 */           calculation. Input DSTEP = 0 for an
56 */           initial calculation where all the input
57 */           data is defined by the TRACIN file.
58 */           15-28      TIMET      Calculation start time (s). If DSTEP
59 */           < 0 (but not -99) or TIMET < 0.0 s,
60 */           the time obtained from the retrieved
61 */           data dump overrides the TIMET input-
62 */           data value.
63 */
64 */           Does this change require that any of the TRAC support codes, e.g.
65 */           EXTRACT, GOCNVRT, or EXCON, be changed? YES ___ NO X
66 */           If yes, then include a description of the necessary changes.
67 */           This description will be passed onto the custodian of the TRAC
68 */           support codes.
69 */
70 */           Does the TRAC User's Guide, Theory Manual, or Programmer's Guide
71 */           change because of this update? YES X NO ___
72 */           If yes, then submit the necessary manual changes.
73 */
74 */           See TRAC I/O change above.
75 */
76 */           NAME OF
77 */           SUBROUTINE
78 */           OR COMDECK
79 */           CHANGED      DESCRIPTION OF CHANGE
80 */
81 */           CONTRLLR      Adds variable ITRANS to common block /CONTRL/.
82 */           ITRANS is the value of TRANSI from the data-
83 */           dump calculation read from file TRCRST or
84 */           the value 0 for an initial calculation where
85 */           all input data is read from file TRACIN.
86 */           BREAKX        Changes the definition TLAPS = DTO to TLAPS =
87 */           DTO*FLOAT(MIN0(1,ITRANS+NSTEP)) when there is no
88 */           trip control of the component action.
89 */           DMPIT          Writes TRANSI to the data-dump file.
90 */           EVFXXX         Changes the definition TLAPS = DTO to TLAPS =
91 */           DTO*FLOAT(MIN0(1,ITRANS+NSTEP)) when there is no
92 */           trip control of the component action.
93 */           FILLX          Changes the definition TLAPS = DTO to TLAPS =
94 */           DTO*FLOAT(MIN0(1,ITRANS+NSTEP)) when there is no
95 */           trip control of the component action.
96 */           INPUT          Initializes ITRANS = 0.
97 */           IPRIZR         Changes the logic test for not evaluating QINT from
98 */           IF((IREST.NE.0).AND.(ABS(TIMET).GE.DTMIN)) to IF(
99 */           (IREST.NE.0).AND.((ITRANS.EQ.1).OR.(STDYST.NE.0))).
100 */           PUMPSR        Changes the definition TLAPS = DTO to TLAPS =
101 */           DTO*FLOAT(MIN0(1,ITRANS+NSTEP)) when there is no
102 */           trip control of the component action.
103 */           RDREST         Reads ITRANS from the restart data-dump file.
104 */           SVSET          Defines the previous calculation's last time-
105 */           step beginning time to be ETIME-DTO in case the
106 */           value of ETIME was changed during the restart.
107 */           TRBPRES        Changes the definition TLAPS = DTO to TLAPS =
108 */           DTO*FLOAT(MIN0(1,ITRANS+NSTEP)) when there
109 */           is no trip control of the component action.
110 */           VLVEX          Changes the definition TLAPS = AMIN1(DTO,ETIME)

```

```

111 */          to TLAPS = DTO*FLOAT(MIN0(1,ITRANS+NSTEP)) when
112 */          there is no trip control of the component action
113 */          and eliminates the old dtdf that was determined
114 */          from the valve tables and used to evaluate delxmx
115 */          (the old dtdf was incorrect when the valve-table
116 */          independent variable was not problem time).
117 */
118 */ -----
119 */
120 */ comdeck contrllr change
121 *delete fxob.2,contrllr.16                                contrllr
122     *  isttc ,ithd ,itmin ,itpako,itrans,jfat ,
123     *  kccmx ,lcmpr,levstg,llvflg,ncmn ,ncmx ,
124 */
125 */ subroutine breakx change
126 *insert breakx.21                                          breakx
127 *ca iterstat
128 *delete breakx.31                                          breakx
129     tlaps=dto*float(min0(1,itrans+nstep))
130 */
131 */ subroutine dmpit change
132 *insert dmpit.173                                          dmpit
133     call bfout(transi,1,ictrlr)
134 */
135 */ subroutine evfxxx change
136 *insert evfxxx.9                                          evfxxx
137 *ca iterstat
138 *delete evfxxx.31                                          evfxxx
139     tlaps=dto*float(min0(1,itrans+nstep))
140 */
141 */ subroutine fillx change
142 *insert fillx.11                                          fillx
143 *ca iterstat
144 *delete fillx.61                                          fillx
145     tlaps=dto*float(min0(1,itrans+nstep))
146 */
147 */ subroutine input change
148 *insert input.100                                          input
149     itrans=0
150 */
151 */ subroutine iprizr change
152 *delete iprizr.40                                          iprizr
153     if ((irest.ne.0).and.((itrans.eq.1).or.(stdyst.ne.0))) go to 125
154 */
155 */ subroutine pumpsr change
156 *insert pumpsr.9                                          pumpsr
157 *ca iterstat
158 *delete pumpsr.46                                          pumpsr
159     tlaps=dto*float(min0(1,itrans+nstep))
162 *insert rdrest.200                                          rdrest
163 c
164 c     itrans is the value of transi from
165 c     the calculation of this data dump
166 c
167 c     call bfin(itrans,1,ictrlr)
168 c     if(ictrlr(6).eq.1) go to 54
169 *insert rdrest.365                                          rdrest
170 c

```

```

171 c      itrans is the value of transi from
172 c      the calculation of this data dump
173 c
174      call bfin(itrans,1,ictrlr)
175 */
176 */ subroutine svset change
177 *insert svset.243                                svset
178      if (nstep.eq.0) a(kpt+6)=etime-dto
179 */
180 */ subroutine trbpre change
181 *delete nonest.1017                                trbpre
182 *ca iterstat
183 *delete trbpre.108                                trbpre
184      tlaps=dto*float(min0(1,itrans+nstep))
185 */
186 */ subroutine vlvox change
187 *insert vlvox.7                                    vlvox
188 *ca iterstat
189 *delete vlvox.17                                    vlvox
190 *delete vlvox.60                                    vlvox
191      tlaps=dto*float(min0(1,itrans+nstep))
192 *delete vlvox.87,vlvox.90                            vlvox
193 *delete vlvox.104,vlvox.107                        vlvox
194 *delete vlvox.261,vlvox.262                        vlvox
195      dtdf=dto/amax1(abs(favlv-f),1.0e-20)
196      delxmx=amax1(amin1(dfa*dtdf,delxmx),dtmin)
197 */
198 *compile contrllr,breakx,dmpit,evfxxx,fillx,input
199 *compile iprizr,pumpsr,rdrest,svset,trbpre,vlvox
200 */ -----

```

Appendix B

W4LOOP and W4LOOPR Test-Problem Modified Input-Data and Terminal Output Listings and TRCOUT-File Comparisons to DSTEP = -1 and TIMET = 0.0 s for DSTEP = -99 and TIMET = 0.0 s, 0.0001 s, 0.01 s, 1.0 s, 100.0 s, and 10000.0 s

W4LOOP file with NRPWTB = -20 for ROD 140

```
castor:/export/castor1/rgs/trac> cp w4loop w4lpft1i
```

```
castor:/export/castor1/rgs/trac> tedi w4lpft1i
```

```
w4lpft1i 1982 Lines
```

```
*tp*/1          20
1898            0          1          20          0          0
*rp1898/ 20/-20/
1898            0          1          -20          0          0
1899 *          izpwtr          izpwsv          nzpwtb          nzpwsv          nzpwrf
*end
w4lpft1i 1982 Lines
```

```
castor:/export/castor1/rgs/trac> cp w4lpft1i tracin
```

W4LOOP terminal output

```
castor:/export/castor1/rgs/trac> trac
```

transient reactor analysis code

```

t      tttt
tttttt t
      tt      rrrr      aaaa      ccc
      tt      rr rr      aa      aa      cc      ===
t tt      rr      r aa      aa      cc      cc
ttt      rr      rrr aaaa aaa ccc

```

pppp
p p p
p pp p
ppppp
p
ppp

.....

time domain data to be used						
minimum time	maximum time	time domain	long edit	graphics edit	dump edit	short edit
step (s)	step (s)	end (s)	step (s)	step (s)	step (s)	step (s)
5.000E-02	1.000E+00	1.000E+01	1.200E+01	5.000E-01	1.200E+01	1.200E+01

steady-state calculation heat-transfer/hydraulic time-step ratio is 1.0000E+01
convective energy-error controller is 3.4121E+20 btu/hr

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
10	0.270006	0.060775	2		2.7334	1.1681	1	14 5
20	1.034432	0.098997	2		4.4358	1.8969	1	14 3
30	2.279600	0.161255	2		7.1661	3.0670	1	14 3
40	4.253695	0.250159	1		11.0842	4.7451	1	14 3
50	7.400173	0.407483	1		17.9511	7.6864	1	14 3

time domain data to be used						
minimum	maximum	time	long	graphics	dump	short

time	time	domain	edit	edit	edit	edit
step (s)	step (s)	end (s)	step (s)	step (s)	step (s)	step (s)
5.000E-02	2.000E+00	5.000E+01	4.400E+01	1.000E+00	4.400E+01	4.400E+01

steady-state calculation heat-transfer/hydraulic time-step ratio is 1.0000E+01
convective energy-error controller is 3.4121E+20 btu/hr

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
60	12.525455	0.663747	1		29.0525	12.4317	1	14 3
70	20.873999	1.081175	1		47.1733	20.1893	1	14 2
80	34.472897	1.761120	1		76.7026	32.8517	1	14 2

time domain data to be used						
minimum time	maximum time	time domain	long edit	graphics edit	dump edit	short edit
step (s)	step (s)	end (s)	step (s)	step (s)	step (s)	step (s)
5.000E-02	2.000E+00	5.000E+02	4.540E+02	2.000E+00	4.540E+02	4.540E+02

steady-state calculation heat-transfer/hydraulic time-step ratio is 1.0000E+01
convective energy-error controller is 3.4121E+20 btu/hr

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
90	54.024827	2.000000	1		87.0250	37.2748	1	14 3

generalized steady-state convergence-test results

problem time is 74.024827 s and time-step size is 2.000000 s
time-step number is 100 and number of outer iterations is 1

parameters tested for convergence	max.fr.change over last time step	component number	cell number
pressure	-0.000002	10	2
liquid velocity	0.002995	10	3
gas velocity	-0.001235	27	4
void fraction	0.000222	27	3
liquid temperature	0.000198	10	1
gas temperature	0.000000	27	2
ncd-gas pressure	0.000000	21	1

constrained steady-state calculation parameters

component and number	minimum value	adjusted parameter	maximum value	monitored parameter	desired value
pump 4	0.000000E+00	1.13527E+03	1.90986E+03	3.37521E+07	3.37455E+07
	rpm	rpm	rpm	lbm/hr	lbm/hr
pump 13	0.000000E+00	1.13994E+03	1.90986E+03	1.01256E+08	1.01237E+08
	rpm	rpm	rpm	lbm/hr	lbm/hr
fill 8	0.000000E+00	3.12824E+06	7.93664E+07	3.12824E+06	3.12824E+06
	lbm/hr	lbm/hr	lbm/hr	lbm/hr	lbm/hr
fill 23	0.000000E+00	9.37900E+06	2.38099E+08	9.37900E+06	9.37900E+06
	lbm/hr	lbm/hr	lbm/hr	lbm/hr	lbm/hr
htstr 126	8.000000E-01	1.12180E+00	1.25000E+00	5.30470E+02	5.30330E+02
	-	-	-	f	f
htstr 127	8.000000E-01	1.12180E+00	1.25000E+00	5.30470E+02	5.30330E+02
	-	-	-	f	f
htstr 128	8.000000E-01	1.12130E+00	1.25000E+00	5.30467E+02	5.30330E+02

	-	-	-	f	f
htstr 129	8.00000E-01	1.12130E+00	1.25000E+00	5.30467E+02	5.30330E+02
	-	-	-	f	f

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
100	74.024827	2.000000	1		86.9655	37.2461	1	14 5
110	94.024827	2.000000	1		86.9464	37.2282	1	14 5
120	114.024827	2.000000	1		86.9489	37.2266	1	14 5
130	134.024827	2.000000	2		86.9634	37.2319	1	14 5
140	154.024827	2.000000	1		86.9765	37.2369	1	14 5
150	174.024827	2.000000	1		86.9832	37.2387	1	14 4
160	194.024827	2.000000	1		86.9849	37.2381	1	14 4

steady state converged at problem time 204.024827 s after 165 time steps

165	0.000000	2.000000	1
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generalized steady-state convergence-test results

problem time is 0.000000 s and time-step size is 2.000000 s
time-step number is 165 and number of outer iterations is 1

parameters tested for convergence	max.fr.change per second over last time step	component number	cell number
pressure	0.000000	10	2
liquid velocity	-0.000041	10	3
gas velocity	-0.000027	27	4
void fraction	0.000007	27	3
liquid temperature	0.000008	10	1
gas temperature	0.000000	28	3
ncd-gas pressure	0.000000	21	1

constrained steady-state calculation parameters

component and number	minimum value	adjusted parameter	maximum value	monitored parameter	desired value
pump 4	0.00000E+00	1.13491E+03	1.90986E+03	3.37458E+07	3.37455E+07
	rpm	rpm	rpm	lbm/hr	lbm/hr
pump 13	0.00000E+00	1.13952E+03	1.90986E+03	1.01237E+08	1.01237E+08
	rpm	rpm	rpm	lbm/hr	lbm/hr
fill 8	0.00000E+00	3.08422E+06	7.93664E+07	3.08422E+06	3.08422E+06
	lbm/hr	lbm/hr	lbm/hr	lbm/hr	lbm/hr
fill 23	0.00000E+00	9.24866E+06	2.38099E+08	9.24866E+06	9.24866E+06
	lbm/hr	lbm/hr	lbm/hr	lbm/hr	lbm/hr
htstr 126	8.00000E-01	1.11070E+00	1.25000E+00	5.30347E+02	5.30330E+02
	-	-	-	f	f
htstr 127	8.00000E-01	1.11070E+00	1.25000E+00	5.30347E+02	5.30330E+02
	-	-	-	f	f
htstr 128	8.00000E-01	1.11036E+00	1.25000E+00	5.30347E+02	5.30330E+02
	-	-	-	f	f
htstr 129	8.00000E-01	1.11036E+00	1.25000E+00	5.30347E+02	5.30330E+02
	-	-	-	f	f

restart dump generated with time of 0.000000 s after 165 time steps

steady-state solution dumped with time of 0.000000 s after 165 time steps
end of problem

computative timing statistics
cpu time is s

castor:/export/castor1/rgs/trac> mv trcdmp trcrst

castor:/export/castor1/rgs/trac> mv trcout w4lpftlo

W4LOOPR file with DSTEP = -1 and TIMET = 0.0 s

castor:/export/castor1/rgs/trac> cp w4loopr w4lrftli

castor:/export/castor1/rgs/trac> tedi w4lrftli
w4lrftli 137 Lines

*t77,2

77 *

78 * dstep timet
79 -1 0.0000e+00

*t130,2

130 *

131 * dtmin dtmax tend rtwfp
132 1.0000e-03 1.0000e-01 5.0000e+00 1.0000e+00

*end

castor:/export/castor1/rgs/trac> cp w4lrftli tracin

W4LOOPR terminal output based on DSTEP = -1 and TIMET = 0.0 s

castor:/export/castor1/rgs/trac> trac

transient reactor analysis code

t	tttt						pppp
tttttt	t						p p p
tt	rrrr	aaaa	ccc				p pp p
tt	rr rr	aa aa	cc		====		ppppp
t tt	rr	r aa	aa cc	cc			p
ttt	rr	rrr	aaaa	aaa	ccc		ppp

.....

input data is being processed

h2o properties are used

restarting from final dump found at time-step number 165 and time 0.00000E+00 s

restart dump generated at problem time 0.000000 s after 0 time steps

			time domain data to be used				
minimum	maximum	time	long	graphics	dump	short	
time	time	domain	edit	edit	edit	edit	
step (s)	step (s)	end (s)	step (s)	step (s)	step (s)	step (s)	

1.000E-03 1.000E-01 5.000E+00 2.500E+00 1.000E-01 5.200E+00 1.250E+00
convective energy-error controller is 3.4121E+20 btu/hr

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
0	0.000000	0.010000	1		0.4349	0.1862	1	14 3
1	0.010000	0.010000	1					

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
2	0.020500	0.010500	2					

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
3	0.030251	0.009751	2					

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
4	0.038952	0.008701	2					

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
5	0.046678	0.007726	2					

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
10	0.074053	0.003771	2		8.9651	0.1016	1	6 2
20	0.097389	0.001141	2		1.8388	0.0437	1	6 2
30	0.108684	0.001407	2		67.2486	0.0568	1	6 2
40	0.126382	0.002292	2		67.7338	0.0967	1	6 2
50	0.155211	0.003733	2		156.1533	0.1509	1	6 2
60	0.202170	0.006081	2		276.7920	0.2368	1	6 2
70	0.278661	0.009906	2		334.2688	0.3822	1	6 2
80	0.403257	0.016136	2		447.5118	0.6108	1	6 2
90	0.606212	0.026283	2		846.8229	0.9792	1	6 2
100	0.877810	0.026493	2		1013.5059	0.9799	1	6 2
110	1.136038	0.025850	2		1002.7750	0.9348	1	6 2
117	1.316212	0.025726	2					
120	1.392960	0.025614	2		1000.6752	0.9133	1	6 2
130	1.649910	0.025823	2		998.7416	0.9039	1	6 2
140	1.909170	0.026002	2		997.9580	0.8900	1	6 2
150	2.170021	0.026137	3		1000.1465	0.8680	1	6 2
160	2.433681	0.026472	2		997.6797	0.8264	1	6 2
165	2.565866	0.026324	2					

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
170	2.697301	0.026182	2		995.7142	0.7753	1	6 2
180	2.959375	0.026168	2		998.6537	0.7363	1	6 2
190	3.219994	0.025966	2		997.6081	0.6909	1	6 2
200	3.479769	0.025949	2		998.5224	0.6543	1	6 2
210	3.739053	0.025913	2		1001.0128	0.6408	1	6 2
213	3.816714	0.025887	2					
220	3.997667	0.025820	2		998.9645	0.6741	1	6 2
230	4.255754	0.025754	2		998.4940	0.6604	1	6 2
240	4.513512	0.026253	2		1000.6812	0.6559	1	6 2
250	4.771465	0.025141	2		983.5603	0.6452	1	6 2

restart dump generated at problem time 5.021983 s after 260 time steps

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
260	5.021983	0.024976	2					

end of problem

computative timing statistics
cpu time is s

castor:/export/castor1/rgs/trac> mv trcout w4lrft1o

W4LOOPR file with DSTEP = -99 and TIMET = 0.0 s

castor:/export/castor1/rgs/trac> tedi tracin
tracin 137 Lines

*t77,2

77 *

78 * dstep timet

79 -1 0.0000e+00

*rp79/ -1/-99

79 -99 0.0000e+00

*t77,2

77 *

78 * dstep timet

79 -99 0.0000e+00

*t130,2

130 *

131 *	dtmin	dtmax	tend	rtwfp
132	1.0000e-03	1.0000e-01	5.0000e+00	1.0000e+00

*end

tracin 137 Lines

castor:/export/castor1/rgs/trac> cp tracin w4lrft2i

W4LOOPR terminal output based on DSTEP = -99 and TIMET = 0.0 s

castor:/export/castor1/rgs/trac> trac

transient reactor analysis code

t tttt

tttttt t

tt rrrr aaaa ccc

tt rr rr aa aa cc

t tt rr r aa aa cc cc

ttt rr rrr aaaa aaa ccc

pppp

p p

p pp p

ppppp

p

ppp

.....

input data is being processed

h2o properties are used

restarting from final dump found at time-step number 165 and time 0.00000E+00 s

restarting time reset to 0.00000E+00 s

restart dump generated at problem time 0.000000 s after 0 time steps

time domain data to be used

minimum time	maximum time	time domain	long edit	graphics edit	dump edit	short edit
step (s)	step (s)	end (s)	step (s)	step (s)	step (s)	step (s)
1.000E-03	1.000E-01	5.000E+00	2.500E+00	1.000E-01	5.200E+00	1.250E+00

convective energy-error controller is 3.4121E+20 btu/hr

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
0	0.000000	0.010000	1		0.4349	0.1862	1	14 3
1	0.010000	0.010000	1					

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
2	0.020500	0.010500	2					

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
3	0.030251	0.009751	2					

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
4	0.038952	0.008701	2					

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
5	0.046678	0.007726	2					

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
10	0.074053	0.003771	2		8.9651	0.1016	1	6 2
20	0.097389	0.001141	2		1.8388	0.0437	1	6 2
30	0.108684	0.001407	2		67.2486	0.0568	1	6 2
40	0.126382	0.002292	2		67.7338	0.0967	1	6 2
50	0.155211	0.003733	2		156.1533	0.1509	1	6 2
60	0.202170	0.006081	2		276.7920	0.2368	1	6 2
70	0.278661	0.009906	2		334.2688	0.3822	1	6 2
80	0.403257	0.016136	2		447.5118	0.6108	1	6 2
90	0.606212	0.026283	2		846.8229	0.9792	1	6 2
100	0.877810	0.026493	2		1013.5059	0.9799	1	6 2
110	1.136038	0.025850	2		1002.7750	0.9348	1	6 2
117	1.316212	0.025726	2					
120	1.392960	0.025614	2		1000.6752	0.9133	1	6 2
130	1.649910	0.025823	2		998.7416	0.9039	1	6 2
140	1.909170	0.026002	2		997.9580	0.8900	1	6 2
150	2.170021	0.026137	3		1000.1465	0.8680	1	6 2
160	2.433681	0.026472	2		997.6797	0.8264	1	6 2
165	2.565866	0.026324	2					

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
170	2.697301	0.026182	2		995.7142	0.7753	1	6 2
180	2.959375	0.026168	2		998.6537	0.7363	1	6 2

190	3.219994	0.025966	2	997.6081	0.6909	1	6	2
200	3.479769	0.025949	2	998.5224	0.6543	1	6	2
210	3.739053	0.025913	2	1001.0128	0.6408	1	6	2
213	3.816714	0.025887	2					
220	3.997667	0.025820	2	998.9645	0.6741	1	6	2
230	4.255754	0.025754	2	998.4940	0.6604	1	6	2
240	4.513512	0.026253	2	1000.6812	0.6559	1	6	2
250	4.771465	0.025141	2	983.5603	0.6452	1	6	2

restart dump generated at problem time 5.021983 s after 260 time steps

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
260	5.021983	0.024976	2					

end of problem

computative timing statistics
cpu time is s

castor:/export/castor1/rgs/trac> mv trcout w4lrft2o

castor:/export/castor1/rgs/trac> diff w4lrft1o w4lrft2o

```
295c295
<      dstep =      -1,      timet = 0.0000E+00
---
>      dstep =     -99,      timet = 0.0000E+00
343a344,345
>
> restarting time reset to 0.00000E+00 s
```

W4LOOPR file with DSTEP = -99 and TIMET = 0.0001 s

castor:/export/castor1/rgs/trac> tedi tracin
tracin 137 Lines

```
*t79
79      -99      0.0000e+00
*rp79/0.0000e+00/1.0000e-04
79      -99      1.0000e-04
*t130,2
130 *
131 *      dtmin      dtmax      tend      rtwfp
132      1.0000e-03      1.0000e-01      5.0000e+00      1.0000e+00
*rp132/5.0000/5.0001
132      1.0000e-03      1.0000e-01      5.0001e+00      1.0000e+00
*end
tracin 137 Lines
```

castor:/export/castor1/rgs/trac> cp tracin w4lrft3i

W4LOOPR terminal output based on DSTEP = -99 and TIMET = 0.0001 s

castor:/export/castor1/rgs/trac> trac

transient reactor analysis code

```

t      tttt
tttttt t
      tt      rrrr      aaaa      ccc
      tt      rr rr      aa      aa      cc
t tt      rr      r aa      aa      cc      cc
ttt      rr      rrr aaaa aaa ccc

      pppp
      p      p
p pp      p
      ppppp
      p
      ppp

```

input data is being processed

h2o properties are used

restarting from final dump found at time-step number 165 and time 0.000000E+00 s

restarting time reset to 1.000000E-04 s

restart dump generated at problem time 0.000100 s after 0 time steps

```

              time domain data to be used
minimum      maximum      time      long      graphics      dump      short
time         time         domain    edit      edit      edit      edit
step (s)    step (s)    end (s)  step (s)  step (s)  step (s)  step (s)
1.000E-03   1.000E-01   5.000E+00 2.500E+00 1.000E-01 5.200E+00 1.250E+00
convective energy-error controller is 3.4121E+20 btu/hr

```

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
0	0.000100	0.010000	1		0.4349	0.1862	1	14 3
1	0.010100	0.010000	1					

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
2	0.020600	0.010500	2					

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
3	0.030351	0.009751	2					

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
4	0.039052	0.008701	2					

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
5	0.046778	0.007726	2					

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
10	0.074153	0.003771	2		8.9651	0.1016	1	6 2
20	0.097489	0.001141	2		1.8388	0.0437	1	6 2
30	0.108784	0.001407	2		67.2486	0.0568	1	6 2
40	0.126482	0.002292	2		67.7338	0.0967	1	6 2
50	0.155311	0.003733	2		156.1533	0.1509	1	6 2
60	0.202270	0.006081	2		276.7920	0.2368	1	6 2
70	0.278761	0.009906	2		334.2688	0.3822	1	6 2
80	0.403357	0.016136	2		447.5119	0.6108	1	6 2

90	0.606312	0.026283	2	846.8234	0.9792	1	6	2
100	0.877910	0.026493	2	1013.5043	0.9799	1	6	2
110	1.136138	0.025850	2	1002.7749	0.9348	1	6	2
117	1.316312	0.025726	2					
120	1.393060	0.025614	2	1000.6752	0.9133	1	6	2
130	1.650010	0.025823	2	998.7418	0.9039	1	6	2
140	1.909270	0.026002	2	997.9580	0.8900	1	6	2
150	2.170121	0.026137	3	1000.1465	0.8680	1	6	2
160	2.433781	0.026472	2	997.6797	0.8264	1	6	2
165	2.565966	0.026324	2					

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
170	2.697402	0.026182	2		995.7142	0.7753	1	6 2
180	2.959475	0.026168	2		998.6537	0.7363	1	6 2
190	3.220094	0.025966	2		997.6081	0.6909	1	6 2
200	3.479869	0.025949	2		998.5224	0.6543	1	6 2
210	3.739154	0.025913	2		1001.0128	0.6408	1	6 2
213	3.816814	0.025887	2					
220	3.997767	0.025820	2		998.9645	0.6741	1	6 2
230	4.255854	0.025754	2		998.4940	0.6604	1	6 2
240	4.513612	0.026253	2		1000.6810	0.6559	1	6 2
250	4.771565	0.025141	2		983.5582	0.6452	1	6 2

restart dump generated at problem time 5.022083 s after 260 time steps

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
260	5.022083	0.024976	2					

end of problem

computative timing statistics
cpu time is s

castor:/export/castor1/rgs/trac> mv trcout w4lrft3o

castor:/export/castor1/rgs/trac> diff w4lrft1o w4lrft3o

... there are only time-edit differences except for the last two large edits at 2.565966 s (compared with 2.565866 s) and 5.022083 s (compared with 5.021983 s) where a few output-parameter values differ in the 4th or greater least-significant digit that is output by the format

W4LOOPR file with DSTEP = -99 and TIMET = 0.01 s

castor:/export/castor1/rgs/trac> tedi tracin
tracin 137 Lines

*t77,2

77	*		
78	*	dstep	timet
79		-99	1.0000e-04

*rp79/1.0000e-04/1.0000e-02

79		-99	1.0000e-02
----	--	-----	------------

*t77,2

77	*		
78	*	dstep	timet
79		-99	1.0000e-02


```

*t130,2
130 *
131 *          dtmin          dtmax          tend          rtwfp
132          1.0000e-03      1.0000e-01      5.0001e+00      1.0000e+00
rp132/5.0001e+00/5.0100e+00
t130,2
130 *
131 *          dtmin          dtmax          tend          rtwfp
132          1.0000e-03      1.0000e-01      5.0100e+00      1.0000e+00
*end
tracin 137 Lines

```

castor:/export/castor1/rgs/trac> cp tracin w4lrft4i

W4LOOPR terminal output based on DSTEP = -99 and TIMET = 0.01 s

castor:/export/castor1/rgs/trac> trac

transient reactor analysis code

```

t      tttt
tttttt t
      tt      rrrr      aaaa      ccc
      tt      rr rr      aa aa      cc      =====
t tt      rr      r aa      aa cc      cc
ttt      rr      rrr aaaa aaa ccc

```

.....

input data is being processed

h2o properties are used

restarting from final dump found at time-step number 165 and time 0.00000E+00 s

restarting time reset to 1.00000E-02 s

restart dump generated at problem time 0.010000 s after 0 time steps

time domain data to be used

minimum time	maximum time	time domain	long edit	graphics edit	dump edit	short edit
step (s)	step (s)	end (s)	step (s)	step (s)	step (s)	step (s)
1.000E-03	1.000E-01	5.010E+00	2.500E+00	1.000E-01	5.200E+00	1.250E+00

convective energy-error controller is 3.4121E+20 btu/hr

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
0	0.010000	0.010000	1		0.4349	0.1862	1	14 3
1	0.020000	0.010000	1					

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
2	0.030500	0.010500	2					

time-step	problem	time-step	outer-it.	cpu	courant	numbers	sets	location
-----------	---------	-----------	-----------	-----	---------	---------	------	----------

number	time (s)	size (s)	number	time (s)	1-d	3-d	flag	cmp	cell
3	0.040251	0.009751	2						

time-step	problem	time-step	outer-it.	cpu	courant	numbers	sets	location
number	time (s)	size (s)	number	time (s)	1-d	3-d	flag	cmp cell
4	0.048952	0.008701	2					

time-step	problem	time-step	outer-it.	cpu	courant	numbers	sets	location
number	time (s)	size (s)	number	time (s)	1-d	3-d	flag	cmp cell
5	0.056678	0.007726	2					

time-step	problem	time-step	outer-it.	cpu	courant	numbers	sets	location
number	time (s)	size (s)	number	time (s)	1-d	3-d	flag	cmp cell
10	0.084053	0.003771	2		8.9651	0.1016	1	6 2
20	0.107389	0.001141	2		1.8388	0.0437	1	6 2
30	0.118684	0.001407	2		67.2486	0.0568	1	6 2
40	0.136382	0.002292	2		67.7338	0.0967	1	6 2
50	0.165211	0.003733	2		156.1533	0.1509	1	6 2
60	0.212170	0.006081	2		276.7920	0.2368	1	6 2
70	0.288661	0.009906	2		334.2688	0.3822	1	6 2
80	0.413257	0.016136	2		447.5118	0.6108	1	6 2
90	0.616212	0.026283	2		846.8229	0.9792	1	6 2
100	0.887810	0.026493	2		1013.5059	0.9799	1	6 2
110	1.146038	0.025850	2		1002.7750	0.9348	1	6 2
117	1.326212	0.025726	2					
120	1.402960	0.025614	2		1000.6752	0.9133	1	6 2
130	1.659910	0.025823	2		998.7416	0.9039	1	6 2
140	1.919170	0.026002	2		997.9580	0.8900	1	6 2
150	2.180021	0.026137	3		1000.1465	0.8680	1	6 2
160	2.443681	0.026472	2		997.6797	0.8264	1	6 2
165	2.575866	0.026324	2					

time-step	problem	time-step	outer-it.	cpu	courant	numbers	sets	location
number	time (s)	size (s)	number	time (s)	1-d	3-d	flag	cmp cell
170	2.707301	0.026182	2		995.7142	0.7753	1	6 2
180	2.969375	0.026168	2		998.6537	0.7363	1	6 2
190	3.229994	0.025966	2		997.6081	0.6909	1	6 2
200	3.489769	0.025949	2		998.5224	0.6543	1	6 2
210	3.749053	0.025913	2		1001.0128	0.6408	1	6 2
213	3.826714	0.025887	2					
220	4.007667	0.025820	2		998.9645	0.6741	1	6 2
230	4.265754	0.025754	2		998.4940	0.6604	1	6 2
240	4.523512	0.026253	2		1000.6812	0.6559	1	6 2
250	4.781465	0.025141	2		983.5603	0.6452	1	6 2

restart dump generated at problem time 5.031983 s after 260 time steps

time-step	problem	time-step	outer-it.	cpu	courant	numbers	sets	location
number	time (s)	size (s)	number	time (s)	1-d	3-d	flag	cmp cell
260	5.031983	0.024976	2					

end of problem

computative timing statistics
cpu time is s

castor:/export/castor1/rgs/trac> mv trcout w4lrft4o

```
castor:/export/castor1/rgs/trac> diff w4lrft1o w4lrft4o
```

... there are only time-edit differences except for the last two large edits at 2.575866 s (compared to 2.565866 s) and 5.031983 s (compared with 5.021983 s) where a few output-parameter values differ in the 4th or greater least-significant digit that is output by the format

```
castor:/export/castor1/rgs/trac> diff w4lrft3o w4lrft4o
```

... there are only time-edit differences except for the last two large edits at 2.575866 s (compared to 2.565966 s) and 5.031983 s (compared with 5.022083 s) where a few output-parameter values differ in the 4th or greater least-significant digit that is output by the format

W4LOOPR file with DSTEP = -99 and TIMET = 1.0 s

```
castor:/export/castor1/rgs/trac> tedi tracin
```

tracin 137 Lines

```
*t77,2
```

```
77 *
```

```
78 *          dstep          timet
```

```
79          -99          1.0000e-02
```

```
*rp79/1.0000e-02/1.0000e+00
```

```
79          -99          1.0000e+00
```

```
*t77,2
```

```
77 *
```

```
78 *          dstep          timet
```

```
79          -99          1.0000e+00
```

```
*t130,2
```

```
130 *
```

```
131 *          dtmin          dtmax          tend          rtwfp
```

```
132          1.0000e-03          1.0000e-01          5.0100e+00          1.0000e+00
```

```
rp132/5.0100e+00/6.0000e+00
```

```
t130,2
```

```
130 *
```

```
131 *          dtmin          dtmax          tend          rtwfp
```

```
132          1.0000e-03          1.0000e-01          6.0000e+00          1.0000e+00
```

```
*end
```

tracin 137 Lines

```
castor:/export/castor1/rgs/trac> cp tracin w4lrft5i
```

W4LOOPR terminal output based on DSTEP = -99 and TIMET = 1.0 s

```
castor:/export/castor1/rgs/trac> trac
```

transient reactor analysis code

```
t      tttt
```

```
tttttt t
```

```
tt      rrrr      aaaa      ccc
```

```
tt      rr rr aa aa cc
```

```
t tt      rr      r aa aa cc cc
```

```
ttt      rr      rrr aaaa aaa ccc
```

```
pppp
```

```
p      p
```

```
p pp      p
```

```
ppppp
```

```
p
```

```
ppp
```

```
====
```

.....

input data is being processed

h2o properties are used

restarting from final dump found at time-step number 165 and time 0.00000E+00 s

restarting time reset to 1.00000E+00 s

restart dump generated at problem time 1.000000 s after 0 time steps

time domain data to be used

minimum time	maximum time	time domain	long edit	graphics edit	dump edit	short edit
step (s)	step (s)	end (s)	step (s)	step (s)	step (s)	step (s)
1.000E-03	1.000E-01	6.000E+00	2.500E+00	1.000E-01	5.200E+00	1.250E+00

convective energy-error controller is 3.4121E+20 btu/hr

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
0	1.000000	0.010000	1		0.4349	0.1862	1	14 3
1	1.010000	0.010000	1					

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
2	1.020500	0.010500	2					

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
3	1.030251	0.009751	2					

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
4	1.038952	0.008701	2					

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
5	1.046678	0.007726	2					

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
10	1.074053	0.003771	2		8.9651	0.1016	1	6 2
20	1.097389	0.001141	2		1.8388	0.0437	1	6 2
30	1.108684	0.001407	2		67.2486	0.0568	1	6 2
40	1.126382	0.002292	2		67.7338	0.0967	1	6 2
50	1.155211	0.003733	2		156.1533	0.1509	1	6 2
60	1.202170	0.006081	2		276.7920	0.2368	1	6 2
70	1.278661	0.009906	2		334.2688	0.3822	1	6 2
80	1.403257	0.016136	2		447.5119	0.6108	1	6 2
90	1.606212	0.026283	2		846.8234	0.9792	1	6 2
100	1.877810	0.026493	2		1013.5043	0.9799	1	6 2
110	2.136038	0.025850	2		1002.7749	0.9348	1	6 2
117	2.316212	0.025726	2					
120	2.392960	0.025614	2		1000.6752	0.9133	1	6 2
130	2.649910	0.025823	2		998.7418	0.9039	1	6 2
140	2.909170	0.026002	2		997.9580	0.8900	1	6 2
150	3.170021	0.026137	3		1000.1465	0.8680	1	6 2
160	3.433681	0.026472	2		997.6797	0.8264	1	6 2

165 3.565866 0.026324 2

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
170	3.697302	0.026182	2		995.7142	0.7753	1 6	2
180	3.959375	0.026168	2		998.6537	0.7363	1 6	2
190	4.219994	0.025966	2		997.6081	0.6909	1 6	2
200	4.479769	0.025949	2		998.5224	0.6543	1 6	2
210	4.739054	0.025913	2		1001.0128	0.6408	1 6	2
213	4.816714	0.025887	2					
220	4.997667	0.025820	2		998.9645	0.6741	1 6	2
230	5.255754	0.025754	2		998.4940	0.6604	1 6	2
240	5.513512	0.026253	2		1000.6810	0.6559	1 6	2
250	5.771465	0.025141	2		983.5586	0.6452	1 6	2

restart dump generated at problem time 6.021983 s after 260 time steps

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
260	6.021983	0.024976	2					

end of problem

computative timing statistics
cpu time is s

castor:/export/castor1/rgs/trac> mv trcout w4lrft5o

castor:/export/castor1/rgs/trac> diff w4lrft1o w4lrft5o

... there are only time-edit differences except for the last two large edits at 3.565866 s (compared to 2.565866 s) and 6.021983 s (compared with 5.021983 s) where a few output-parameter values differ in the 4th or greater least-significant digit that is output by the format

castor:/export/castor1/rgs/trac> diff w4lrft4o w4lrft5o

... there are only time-edit differences except for the last two large edits at 3.565866 s (compared to 2.575866 s) and 6.021983 s (compared with 5.031983 s) where a few output-parameter values differ in the 4th or greater least-significant digit that is output by the format

W4LOOPR file with DSTEP = -99 and TIMET = 100.0 s

castor:/export/castor1/rgs/trac> tedi tracin
tracin 137 Lines

*t77,2

77 *

78 * dstep timet

79 -99 1.0000e+00

*rp79/1.0000e+00/1.0000e+02

79 -99 1.0000e+02

*t77,2

77 *

78 * dstep timet

79 -99 1.0000e+02

*t130,2

130 *

```

131 *          dtmin          dtmax          tend          rtwfp
132      1.0000e-03      1.0000e-01      6.0000e+00      1.0000e+00
rp132/6.0000e+00/1.0500e+02
t130,2
130 *
131 *          dtmin          dtmax          tend          rtwfp
132      1.0000e-03      1.0000e-01      1.0500e+02      1.0000e+00
*end
tracin 137 Lines

```

castor:/export/castor1/rgs/trac> cp tracin w4lrft6i

W4LOOPR terminal output based on DSTEP = -99 and TIMET = 100.0 s

castor:/export/castor1/rgs/trac> trac

transient reactor analysis code

```

t      tttt
tttttt t
      tt      rrrr      aaaa      ccc
      tt      rr rr      aa      aa      cc      =====
t tt      rr      r aa      aa      cc      cc
ttt      rr      rrr aaaa aaa ccc

```

.....

input data is being processed

h2o properties are used

restarting from final dump found at time-step number 165 and time 0.00000E+00 s

restarting time reset to 1.00000E+02 s

restart dump generated at problem time 100.000000 s after 0 time steps

time domain data to be used

minimum time	maximum time	time domain	long edit	graphics edit	dump edit	short edit
step (s)	step (s)	end (s)	step (s)	step (s)	step (s)	step (s)
1.000E-03	1.000E-01	1.050E+02	2.500E+00	1.000E-01	5.200E+00	1.250E+00

convective energy-error controller is 3.4121E+20 btu/hr

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
0	100.000000	0.010000	1		0.4349	0.1862	1	14 3
1	100.010000	0.010000	1					

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
2	100.020500	0.010500	2					

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
3	100.030251	0.009751	2					

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
4	100.038952	0.008701	2					

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
5	100.046678	0.007726	2					

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
10	100.074053	0.003771	2		8.9651	0.1016	1	6 2
20	100.097389	0.001141	2		1.8388	0.0437	1	6 2
30	100.108684	0.001407	2		67.2486	0.0568	1	6 2
40	100.126382	0.002292	2		67.7338	0.0967	1	6 2
50	100.155211	0.003733	2		156.1533	0.1509	1	6 2
60	100.202170	0.006081	2		276.7920	0.2368	1	6 2
70	100.278661	0.009906	2		334.2688	0.3822	1	6 2
80	100.403257	0.016136	2		447.5119	0.6108	1	6 2
90	100.606212	0.026283	2		846.8234	0.9792	1	6 2
100	100.877810	0.026493	2		1013.5043	0.9799	1	6 2
110	101.136038	0.025850	2		1002.7749	0.9348	1	6 2
117	101.316212	0.025726	2					
120	101.392960	0.025614	2		1000.6752	0.9133	1	6 2
130	101.649910	0.025823	2		998.7418	0.9039	1	6 2
140	101.909170	0.026002	2		997.9580	0.8900	1	6 2
150	102.170021	0.026137	3		1000.1465	0.8680	1	6 2
160	102.433681	0.026472	2		997.6799	0.8264	1	6 2
165	102.565866	0.026324	2					

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
170	102.697302	0.026182	2		995.7149	0.7753	1	6 2
180	102.959375	0.026168	2		998.6536	0.7363	1	6 2
190	103.219994	0.025966	2		997.6081	0.6909	1	6 2
200	103.479769	0.025949	2		998.5225	0.6543	1	6 2
210	103.739054	0.025913	2		1001.0128	0.6408	1	6 2
213	103.816714	0.025887	2					
220	103.997667	0.025820	2		998.9645	0.6741	1	6 2
230	104.255754	0.025754	2		998.4940	0.6604	1	6 2
240	104.513512	0.026253	2		1000.6810	0.6559	1	6 2
250	104.771465	0.025141	2		983.5574	0.6452	1	6 2

restart dump generated at problem time 105.021983 s after 260 time steps

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
260	105.021983	0.024976	2					

end of problem

computative timing statistics
cpu time is s

castor:/export/castor1/rgs/trac> mv trcout w4lrft6o

castor:/export/castor1/rgs/trac> diff w4lrft1o w4lrft6o

... there are only time-edit differences except for the last two large edits at 102.565866 s (compared to 2.565866 s) and 105.021983 s (compared with 5.021983 s) where a few output-parameter values differ in the 4th or greater least-significant digit that is output by the format

```
castor:/export/castor1/rgs/trac> diff w4lrft5o w4lrft6o
```

... there are only time-edit differences except for the last two large edits at 102.565866 s (compared to 3.565866 s) and 105.021983 s (compared with 6.021983 s) where a few output-parameter values differ in the 4th or greater least-significant digit that is output by the format

W4LOOPR file with DSTEP = -99 and TIMET = 10000.0 s

```
castor:/export/castor1/rgs/trac> tedi tracin
```

tracin 137 Lines

```
*t77,2
```

```
77 *
```

```
78 *          dstep          timet
```

```
79          -99      1.0000e+02
```

```
*rp79/1.0000e+02/1.0000e+04
```

```
79          -99      1.0000e+04
```

```
*t77,2
```

```
77 *
```

```
78 *          dstep          timet
```

```
79          -99      1.0000e+04
```

```
*t130,2
```

```
130 *
```

```
131 *          dtmin          dtmax          tend          rtwfp
```

```
132      1.0000e-03      1.0000e-01      1.0500e+02      1.0000e+00
```

```
rp132/1.0500e+02/1.00005e+04
```

```
t130,2
```

```
130 *
```

```
131 *          dtmin          dtmax          tend          rtwfp
```

```
132      1.0000e-03      1.0000e-01      1.0005e+04      1.0000e+00
```

```
*end
```

tracin 137 Lines

```
castor:/export/castor1/rgs/trac> cp tracin w4lrft7i
```

W4LOOPR terminal output based on DSTEP = -99 and TIMET = 10000.0 s

```
castor:/export/castor1/rgs/trac> trac
```

transient reactor analysis code

```
t      tttt
```

```
tttttt t
```

```
tt      rrrr      aaaa      ccc
```

```
tt      rr rr      aa      aa      cc
```

```
t tt      rr      r aa      aa      cc      cc
```

```
ttt      rr      rrr aaaa aaa ccc
```

```
pppp
```

```
p      p
```

```
p pp      p
```

```
ppppp
```

```
p
```

```
ppp
```

```
====
```

.....

input data is being processed

h2o properties are used

restarting from final dump found at time-step number 165 and time 0.000000E+00 s

restarting time reset to 1.000000E+04 s

restart dump generated at problem time 10000.000000 s after 0 time steps

time domain data to be used

minimum time	maximum time	time domain	long edit	graphics edit	dump edit	short edit
step (s)	step (s)	end (s)	step (s)	step (s)	step (s)	step (s)
1.000E-03	1.000E-01	1.000E+04	2.500E+00	1.000E-01	5.200E+00	1.250E+00

convective energy-error controller is 3.4121E+20 btu/hr

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
0	10000.000000	0.010000	1		0.4349	0.1862	1	14 3
1	10000.010000	0.010000	1					

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
2	10000.020500	0.010500	2					

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
3	10000.030251	0.009751	2					

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
4	10000.038952	0.008701	2					

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
5	10000.046678	0.007726	2					

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
10	10000.074053	0.003771	2		8.9651	0.1016	1	6 2
20	10000.097389	0.001141	2		1.8388	0.0437	1	6 2
30	10000.108684	0.001407	2		67.2486	0.0568	1	6 2
40	10000.126382	0.002292	2		67.7338	0.0967	1	6 2
50	10000.155211	0.003733	2		156.1533	0.1509	1	6 2
60	10000.202170	0.006081	2		276.7920	0.2368	1	6 2
70	10000.278661	0.009906	2		334.2688	0.3822	1	6 2
80	10000.403257	0.016136	2		447.5118	0.6108	1	6 2
90	10000.606212	0.026283	2		846.8229	0.9792	1	6 2
100	10000.877810	0.026493	2		1013.5059	0.9799	1	6 2
110	10001.136038	0.025850	2		1002.7750	0.9348	1	6 2
117	10001.316212	0.025726	2					
120	10001.392960	0.025614	2		1000.6752	0.9133	1	6 2
130	10001.649910	0.025823	2		998.7416	0.9039	1	6 2
140	10001.909170	0.026002	2		997.9580	0.8900	1	6 2
150	10002.170021	0.026137	3		1000.1465	0.8680	1	6 2
160	10002.433681	0.026472	2		997.6797	0.8264	1	6 2
165	10002.565866	0.026324	2					

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
170	10002.697301	0.026182	2		995.7142	0.7753	1	6 2
180	10002.959375	0.026168	2		998.6537	0.7363	1	6 2
190	10003.219994	0.025966	2		997.6081	0.6909	1	6 2
200	10003.479769	0.025949	2		998.5224	0.6543	1	6 2
210	10003.739053	0.025913	2		1001.0128	0.6408	1	6 2
213	10003.816714	0.025887	2					
220	10003.997667	0.025820	2		998.9645	0.6741	1	6 2
230	10004.255754	0.025754	2		998.4940	0.6604	1	6 2
240	10004.513512	0.026253	2		1000.6812	0.6559	1	6 2
250	10004.771465	0.025141	2		983.5602	0.6452	1	6 2

restart dump generated at problem time 10005.021983 s after 260 time steps

time-step number	problem time (s)	time-step size (s)	outer-it. number	cpu time (s)	courant 1-d	numbers 3-d	sets flag	location cmp cell
260	10005.021983	0.024976	2					

end of problem

computative timing statistics
cpu time is s

castor:/export/castor1/rgs/trac> mv trcout w4lrft7o

castor:/export/castor1/rgs/trac> diff w4lrft1o w4lrft7o

... there are only time-edit differences except for the last two large edits at 10002.565866 s (compared to 2.565866 s) and 10005.021983 s (compared with 5.021983 s) where a few output-parameter values differ in the 3th or greater least-significant digit that is output by the format

castor:/export/castor1/rgs/trac> diff w4lrft6o w4lrft7o

... there are only time-edit differences except for the last two large edits at 10002.565866 s (compared to 102.565866 s) and 10005.021983 s (compared with 105.021983 s) where a few output-parameter values differ in the 3th or greater least-significant digit that is output by the format