CompOSE Quick Guide for Users

CompOSE Core Team: Veronica Dexheimer, Marco Mancini, Micaela Oertel, Constanca Providencia, Laura Tolos, and Stefant Typel

October 28, 2021

1 Introduction

The extraction of data from the equation of state (EoS) tables provided by the CompOSE website (`https://compose.obspm.fr`) using `compose` program is simple. This quick guide describes the basic procedures to obtain a table with EoS data with the help of a number of examples. It is prepared in particular for first-time users in order to get them familiar with the files, the program and the handling.

In this quick guide, only the preparation of data tables in ASCII format is described using a LINUX based operation system. For an output of data in the HDF5 format, please refer to the CompOSE manual.

2 Preparation of Program and Files

Download the compose code from the software section on the CompOSE web page. You will need the files `compose.f90, composemodules.f90` and `Makefile`. Copy them to the same directory. Generate the executable by typing:

`make compose` ↵

```
 % unzip code.zip

Archive:  code.zip
  inflating: compose.f90
  inflating: composemodules.f90
  inflating: out_to_json.f90
  inflating: Makefile
  inflating: get_tables.f90

 % make compose

gfortran -c -O3   -cpp -fopenmp  composemodules.f90 -o
composemodules.o
gfortran -c -O3   -cpp -fopenmp  out_to_json.f90 -o out_to_json.o
gfortran -c -O3   -cpp -fopenmp  get_tables.f90 -o get_tables.o
gfortran -c -O3   -cpp -fopenmp  compose.f90 -o compose.o
rm -f compose;
building compose
gfortran  -O3   -cpp -fopenmp  -o compose composemodules.o
out_to_json.o get_tables.o compose.o
```

Figure 1: Snapshot of the terminal screen after unpacking the file `code.zip` and compiling the `compose` program.

If during compilation there is an error related to HDF5, check line 26 of the file `Makefile`. Ensure that it reads

```
HDF5 = 0
```

2.1 EoS Data

There are presently four families of EoS tables available from CompOSE: `General Purpose EoS`, `Neutron Matter EoS`, `Cold Neutron Star EoS`, and `Cold Matter EoS`. You will see this option when clicking on 'EoS' and then on 'Families' in the left column of the CompOSE web page. The code runs with all of them. You can find the EoS model of your preferred author with the help of the bibliography search on the web page. The files for download can be found by clicking on 'Details' for each EoS model. Download the files for your prefered EoS table and move them in the same directory as the code. Note that by default the data from all EoS models have the same name. Thus, you should either remove all previous EoS data files before running a new model or create a different directory for each model.

2.2 Input parameters

The code allows to calculate many different quantities, and surely not every user needs all of them. In addition, some of them are only available for selected EoS tables. Therefore, before running the code, the grid in thermodynamic variables (temperature T, baryon number density n_B and hadronic charge fraction Y_q, the latter being the ratio of the number of charged hadrons and quarks over the total number of hadrons and quarks), as well as the desired output quantities have to be specified. This is done with two input parameter files, `eos.parameters` for the grid and `eos.quantities` for the output. Three examples described below are available on the CompOSE web page in the 'software' section. Note that, if you do not remove the older versions of the input files `eos.parameters` and `eos.quantities`, you will be prompted to overwrite them upon creating new versions.

2.2.1 Generating the parameter files

Run the code by typing:

```
./compose ↵
```

in a terminal. You are then prompted for three options. Selecting task '1' will guide you for the generation of the `eos.quantities` file, specifying the needed output. Task '2' will guide you for the generation of the `eos.parameters` file, specifying the grid in thermodynamic variables. Follow the instructions. Keep in mind that the code is interpolating the EoS data, it is thus not possible to calculate outside the ranges given by the respective EoS data tables. You can check the ranges for each table on the CompOSE web page, or in the files `eos.t, eos.nb, eos.yq`.

3 Running the code

Once `eos.parameters` and `eos.quantities` are present in your directory, you can run the code with option '3':

```
./compose ⏎
3 ⏎
```

This should generate in particular a file `eos.table`. The first three columns of this file contain the thermodynamic grid in the order T (MeV), n_B (fm^{-3}), Y_q and the following columns contain the quantities specified in `eos.quantities` in the same order.

Up to five other files are generated, `eos.init, eos.report, eos.beta, eos.errdistr,eos.info.json`. These files are usually not of interest for the first-time user, see the complete CompOSE manual for details (`https://compose.obspm.fr`).

4 Examples

Download the example files from the CompOSE web page from the 'software' section. They contain four distinct examples for running the `compose` code.

4.1 Generating a table for β-equilibrated matter from a general purpose EoS

The following steps allow you to run the `compose` code and generate a table containing the energy per baryon (or energy density over baryon number density), pressure and scaled baryon chemical potential ($\mu_B - m_n$) for β-equilibrated matter at a temperature of $T = 100$ keV (effectively zero temperature). This table can be used for solving the equations describing cold β-equilibrated neutron stars. The example has been obtained with the SFHoY EoS, see `http://compose.obspm.fr/eos/118/`. Download `eos-beta.zip` from the software section and unpack it. Then type

```
cp eos.parameters.beta eos.parameters ⏎
cp eos.quantities.beta eos.quantities ⏎
./compose ⏎
3 ⏎
```

You can find a snapshot produced when running `compose` for that particular case in Appendix A.

The file `eos.table` should then contain the following columns

$$T \text{ (MeV)} \qquad n_B \text{ (fm}^{-3}\text{)} \qquad Y_q \qquad \mathcal{E} \text{ (MeV)} \qquad p \left(\frac{\text{MeV}}{\text{fm}^3}\right) \qquad \mu_B - m_n \text{ (MeV)}$$

for β-equilibrated matter. You can compare the output with the provided data in `eos.table.beta`. You can run the present example with any general purpose table containing electrons. Please note that potentially you have to adapt the temperature to the lowest entry in the respective table and the range in baryon number density, too, in the file `eos.parameters` in lines 8 (minimum values, order T, n_B, Y_q) and 9 (maximum values, order T, n_B, Y_q). Output is generated in this case only if a solution for β-equilibrium is found within the ranges of the Y_q table.

4.2 Generating a table at fixed entropy per baryon from a general purpose EoS

The following steps will allow you to run the `compose` code and generate a table containing the energy per baryon (or entropy density per baryon number density), pressure and scaled baryon chemical potential ($\mu_B - m_n$) at a constant fixed entropy per baryon, $s = 2k_B$ ($k_B = 1$ in natural units) as function of baryon number density and for charged lepton fraction $Y_q = 0.4$, when leptons are present due to charge neutrality. The example has been obtained with the DD2Y EoS, see `http://compose.obspm.fr/eos/104/`. Download `eos-s.zip` from the software section and unpack it. Then type

```
cp eos.parameters.s eos.parameters ⏎
cp eos.quantities.s eos.quantities ⏎
./compose ⏎
3 ⏎
```

You can find a snapshot when running `compose` for that particular case in Appendix B.

The file `eos.table` should then contain the following columns

$$T\ (\text{MeV}) \qquad n_B\ (\text{fm}^{-3}) \qquad Y_q \qquad s \qquad \mathcal{E}\ (\text{MeV}) \qquad p\ (\tfrac{\text{MeV}}{\text{fm}^3}) \qquad \mu_B - m_n\ (\text{MeV})$$

You can compare the ouput with the provided data in `eos.table.s`. You can run the present example with any general purpose table. If the option of fixed entropy per baryon is chosen, the first entries in lines 8-11 of `eos.parameters` concern the minimum and maximum value of s, the number of points and logarithmic/linear scaling in entropy. Since the original EoS tables are generated as function of temperature, s_{min} and s_{max} depend on baryon number density and hadronic charge fraction. Output is generated in this case only if a solution for the given value of fixed entropy per baryon is found within the ranges in temperature of the table for the given value of n_B and Y_q.

4.3 Extracting composition information from a general purpose table

The following steps will allow you to run the `compose` code and generate a table containing the energy par baryon and pressure, as well as all particle fractions as function of temperature for a general purpose EoS. In the present example, particle fractions for electrons, nucleons and hyperons are listed, as well as light nuclei and one average heavy nucleus. The Dirac effective mass m_D for neutrons is given, too. The example has been obtained with the SFHoY EoS, see `http://compose.obspm.fr/eos/118/`. If you did not yet download it, get `eos-3d.zip` from the software section and unpack it. Then type

```
cp eos.parameters.3d eos.parameters ⏎
cp eos.quantities.3d eos.quantities ⏎
./compose ⏎
3 ⏎
```

You can find a snapshot when running `compose` for that particular case in Appendix C.

The file `eos.table` should then contain the following columns

$$T\ (\text{MeV}) \quad n_B\ (\text{fm}^{-3}) \quad Y_q \quad \mathcal{E}\ (\text{MeV}) \quad p\ (\tfrac{\text{MeV}}{\text{fm}^3}) \quad Y_i{}^1 \quad Y_{av} \quad A_{av} \quad Z_{av} \quad N_{av} \quad m_n^D/m_n$$

[1] 12 columns of this quantity, in the order $i = n, p, \Lambda, \Sigma^-, \Sigma^0, \Sigma^+, \Xi^-, \Xi^0$, ^{4}He, ^{3}He, ^{3}H, ^{2}H

We choose $Y_q = 0.3$ and $n_B = 0.01$ fm^{-3} for different values of temperature. You can compare the output with the provided data in `eos.table.3d`. You can run the present example with any general purpose table. Please note that potentially you have to adapt the temperature to the lowest entry in the respective table and the range in baryon number density, too, in the file `eos.parameters` in lines 8 (minimum values) and 9 (maximum values). If you employ a table not containing hyperons, then the number of pairs in line 6 has to be adapted and the indices starting with 100 in line 8 have to be removed. In the same way, if your table does not contain information about individual nuclei, then in line 6 the number of pairs has to be adapted and the four-digit entries in line 8 have to be removed. If the Dirac effective mass is not available, line 10 should contain a 0 and line 12 should be empty.

4.4 Extracting sound speed and adiabatic index from a cold neutron star table

The following steps will allow you to run the `compose` code and generate a table containing the energy par baryon, pressure and scaled baryon chemical potential ($\mu_B - m_n$), as well as squared speed of sound, adiabatic index and entropy per baryon as function of baryon number density for a cold neutron star EoS. The example has been obtained with the SkA EoS, see `http://compose.obspm.fr/eos/96/`. Download `eos-ns.zip` from the software section and unpack it. Then type

```
cp eos.parameters.ns eos.parameters ⏎
cp eos.quantities.ns eos.quantities ⏎
./compose ⏎
3 ⏎
```

You can find a snapshot when running `compose` for that particular case in Appendix D.

The file `eos.table` should then contain the following columns

$$T\ (\text{MeV}) \quad n_B\ (\text{fm}^{-3}) \quad Y_q \quad \mathcal{E}\ (\text{MeV}) \quad p\ (\tfrac{\text{MeV}}{\text{fm}^3}) \quad \mu_B - m_n\ (\text{MeV}) \quad c_s^2(c^2) \quad \Gamma \quad s\ (k_B).$$

at $T = 0$ MeV and for β-equilibrated matter. Note that $c = 1$ and $k_B = 1$ in natural units. You can compare the output with the provided data in `eos.table.ns`. You can run the present example with any cold neutron star table. Please note that potentially you have to adapt n_B to the lowest entry in the respective table in the file `eos.parameters` in line 8 and the maximum value in line 9.

Notation

symbol	quantity	unit
T	temperature	MeV
n_B	baryon number density	fm^{-3}
Y_i	number density fraction of particle i	–
p	pressure	MeV fm^{-3}
$\mathcal{E}$	energy per baryon	MeV
m_n	neutron mass	MeV
m_n^D/m_n	effective Dirac mass/neutron mass	-
μ_B	baryon chemical potential	MeV
c_s	speed of sound	c
s	entropy per baryon	k_B
Y_q	hadronic charge fraction	–
Y_{av}	particle quadruple	–
A_{av}	average mass number of a nucleus	–
Z_{av}	average charge number of a nucleus	–
N_{av}	average neutron number of a nucleus	–
Γ	adiabatic index	–

Note that $c = 1$ and $k_B = 1$ in natural units.

Appendix A Example of a table for β-equilibrated matter from a general purpose EoS

We start by copying the files `eos.parameters.beta` to `eos.parameters` and `eos.quantities.beta` to `eos.quantities` and run `./compose`:

```
% cp eos.parameters.beta eos.parameters

% cp eos.quantities.beta eos.quantities

% ./compose

  ************************************************
  *             Welcome to CompOSE               *
  * CompStar Online Supernovae Equations of State *
  *                Version 2.17                  *
  *                 2018/09/07                   *
  ************************************************

  This program helps to generate user-specified EoS tables
  from the EoS tables provided by the CompOSE database at
  compose.obspm.fr.

  Please select the task number from the following list:

  Task 1: Selection of Output Quantities
          (Creates files eos.quantities and eos.init, if not existing)
  Task 2: Definition of Tabulation Scheme and Parameter Values
          (Creates files eos.parameters and eos.init, if not existing)
  Task 3: Generation of EoS Table
          (Creates files eos.table, eos.report,
          eos.beta, if possible, and eos.init, if not existing)
```

We indicate '3' for `Generation of EoS Table`, so the needed parameters and tables are read

```
% 3

  reading minimum and maximum index from parameter table for temperature T

  reading minimum and maximum index from parameter table for baryon number density n_b

  reading minimum and maximum index from parameter table for hadronic charge fraction Y_q

  no file eos.b

         81 entries of parameter table for temperatures read
        308 entries of parameter table for baryon number densities read
         60 entries of parameter table for charge fraction read

  maximum dimension of parameter files =         308

  minimum temperature:  0.10000000000000002      MeV
  maximum temperature:   158.48931999999979      MeV

  minimum baryon number density:   1.0000000000000010E-012 fm^-3
  maximum baryon number density:   1.9054607179632488      fm^-3

  minimum hadronic charge fraction:   1.0000000000000000E-002
  maximum hadronic charge fraction:  0.59999999999999998

     1496880 entries of thermodynamic table read

     1496880 entries of microscopic table read

     1496880 entries of composition table read

           0 entry/ies in eos.thermo missing
           0 entry/ies in eos.compo missing
           0 entry/ies in eos.micro missing

     1496880 complete entries in eos tables
```

and finally `EoS table for condition of beta equilibrium` is generated:

```
file eos.beta written

file eos.report written

reading selection of quantities

number of extracted regular quantities    =           3
indices of regular quantities             :          21           1           3

number of extracted additional quantities =           0
indices of additional quantities          :

number of extracted derivative quantities =           0
indices of derivative quantities          :

number of pairs for composition           =           0
indices of pairs                          :

number of quadruples for composition      =           0
indices of quadruples                     :

number of microscopic quantities          =           0
indices of microscopic quantities         :

number of error quantities                =           0
indices of error quantities               :

format of output table                    =           1 (ASCII)

begin generating eos table

reading parameters

EoS table for condition of beta equilibrium

end generating EoS table

file eos.table written

The columns of the file eos.table contain the following quantities:

         1  temperature T                                    [MeV]
         2  baryon number density n_b                        [fm^-3]
         3  hadronic charge fraction Y_q                     []
         4  internal energy per baryon E                     [MeV]
         5  pressure p                                       [MeV fm^-3]
         6  shifted baryon chemical potential mu_b-m_n       [MeV]
```

Appendix B Example of a table at fixed entropy per baryon from a general purpose EoS

We start by copying the files `eos.parameters.s` to `eos.parameters` and `eos.quantities.s` to `eos.quantities` and run `./compose`:

```
% cp eos.parameters.s eos.parameters

% cp eos.quantities.s eos.quantities

% ./compose

  ************************************************
  *              Welcome to CompOSE              *
  * CompStar Online Supernovae Equations of State *
  *                  Version 2.17                *
  *                   2018/09/07                 *
  ************************************************

  This program helps to generate user-specified EoS tables
  from the EoS tables provided by the CompOSE database at
  compose.obspm.fr.

  Please select the task number from the following list:

  Task 1: Selection of Output Quantities
          (Creates files eos.quantities and eos.init, if not existing)
  Task 2: Definition of Tabulation Scheme and Parameter Values
          (Creates files eos.parameters and eos.init, if not existing)
  Task 3: Generation of EoS Table
          (Creates files eos.table, eos.report,
          eos.beta, if possible, and eos.init, if not existing)
```

We indicate '3' for `Generation of EoS Table`, so the needed parameters and tables are read

```
% 3

  reading minimum and maximum index from parameter table for temperature T

  reading minimum and maximum index from parameter table for baryon number density n_b

  reading minimum and maximum index from parameter table for hadronic charge fraction Y_q

  no file eos.b

         81 entries of parameter table for temperatures read
        303 entries of parameter table for baryon number densities read
         60 entries of parameter table for charge fraction read

  maximum dimension of parameter files =         303

  minimum temperature:  0.10000000000000002      MeV
  maximum temperature:   158.48931999999979      MeV

  minimum baryon number density:   1.0000000000000010E-012 fm^-3
  maximum baryon number density:   1.2022644346174163      fm^-3

  minimum hadronic charge fraction:   1.0000000000000000E-002
  maximum hadronic charge fraction:  0.59999999999999998

     1472580 entries of thermodynamic table read

     1472580 entries of microscopic table read

     1472580 entries of composition table read

           0 entry/ies in eos.thermo missing
           0 entry/ies in eos.compo missing
           0 entry/ies in eos.micro missing

     1472580 complete entries in eos tables

 warning: no beta-equilibrium found for baryon density n_b=  0.83176377110267163      fm^-3
 warning: no beta-equilibrium found for baryon density n_b=  0.91201083935591010      fm^-3
 warning: no beta-equilibrium found for baryon density n_b=   1.0000000000000000      fm^-3
 warning: no beta-equilibrium found for baryon density n_b=   1.0964781961431846      fm^-3
 warning: no beta-equilibrium found for baryon density n_b=   1.2022644346174163      fm^-3
```

and finally `EoS table for given entropy per baryon` is generated:

```
 file eos.beta written

 file eos.report written

 reading selection of quantities

 number of extracted regular quantities    =           4
 indices of regular quantities             :           2          21           1           3

 number of extracted additional quantities =           0
 indices of additional quantities          :

 number of extracted derivative quantities =           0
 indices of derivative quantities          :

 number of pairs for composition           =           0
 indices of pairs                          :

 number of quadruples for composition      =           0
 indices of quadruples                     :

 number of microscopic quantities          =           0
 indices of microscopic quantities         :

 number of error quantities                =           0
 indices of error quantities               :

 format of output table                    =            1 (ASCII)

 begin generating eos table

 reading parameters

 EoS table for given entropy per baryon

 end generating EoS table

 file eos.table written

 The columns of the file eos.table contain the following quantities:

         1  temperature T                                    [MeV]
         2  baryon number density n_b                        [fm^-3]
         3  hadronic charge fraction Y_q                     []
         4  entropy per baryon S                             []
         5  internal energy per baryon E                     [MeV]
         6  pressure p                                       [MeV fm^-3]
         7  shifted baryon chemical potential mu_b-m_n       [MeV]
```

Appendix C Example of the composition information from a general purpose table

We start by copying the files `eos.parameters.3d` to `eos.parameters` and `eos.quantities.3d` to `eos.quantities` and run `./compose`:

```
% cp eos.parameters.3d eos.parameters

% cp eos.quantities.3d eos.quantities

% ./compose

  ************************************************
  *             Welcome to CompOSE               *
  * CompStar Online Supernovae Equations of State *
  *                Version 2.17                  *
  *                 2018/09/07                   *
  ************************************************

  This program helps to generate user-specified EoS tables
  from the EoS tables provided by the CompOSE database at
  compose.obspm.fr.

  Please select the task number from the following list:

  Task 1: Selection of Output Quantities
          (Creates files eos.quantities and eos.init, if not existing)
  Task 2: Definition of Tabulation Scheme and Parameter Values
          (Creates files eos.parameters and eos.init, if not existing)
  Task 3: Generation of EoS Table
          (Creates files eos.table, eos.report,
          eos.beta, if possible, and eos.init, if not existing)
```

We indicate '3' for `Generation of EoS Table`, so the needed parameters and tables are read

```
% 3

  reading minimum and maximum index from parameter table for temperature T

  reading minimum and maximum index from parameter table for baryon number density n_b

  reading minimum and maximum index from parameter table for hadronic charge fraction Y_q

  no file eos.b

          81 entries of parameter table for temperatures read
         308 entries of parameter table for baryon number densities read
          60 entries of parameter table for charge fraction read

  maximum dimension of parameter files =         308

  minimum temperature:  0.10000000000000002      MeV
  maximum temperature:   158.48931999999979      MeV

  minimum baryon number density:   1.000000000000010E-012 fm^-3
  maximum baryon number density:   1.9054607179632488      fm^-3

  minimum hadronic charge fraction:   1.000000000000000E-002
  maximum hadronic charge fraction:  0.59999999999999998

     1496880 entries of thermodynamic table read

     1496880 entries of microscopic table read

     1496880 entries of composition table read

           0 entry/ies in eos.thermo missing
           0 entry/ies in eos.compo missing
           0 entry/ies in eos.micro missing

     1496880 complete entries in eos tables
```

and finally `EoS table` is generated:

```
  file eos.beta written

  file eos.report written

  reading selection of quantities

  number of extracted regular quantities    =           2
  indices of regular quantities             :          21           1

  number of extracted additional quantities =           0
  indices of additional quantities          :

  number of extracted derivative quantities =           0
  indices of derivative quantities          :

  number of pairs for composition           =          12
  indices of pairs                          :          10          11         100
110         111         112         120         121        4002        3002        3001
2001

  number of quadruples for composition      =           1
  indices of quadruples                     :         999

  number of microscopic quantities          =           1
  indices of microscopic quantities         :       10041

  number of error quantities                =           0
  indices of error quantities               :

  format of output table                    =           1 (ASCII)

  begin generating eos table

  reading parameters

  end generating EoS table

  file eos.table written

  The columns of the file eos.table contain the following quantities:

          1  temperature T                                      [MeV]
          2  baryon number density n_b                          [fm^-3]
          3  hadronic charge fraction Y_q                       []
          4  internal energy per baryon E                       [MeV]
          5  pressure p                                         [MeV fm^-3]
          6  number fraction Y of particle with index                        10
          7  number fraction Y of particle with index                        11
          8  number fraction Y of particle with index                       100
          9  number fraction Y of particle with index                       110
         10  number fraction Y of particle with index                       111
         11  number fraction Y of particle with index                       112
         12  number fraction Y of particle with index                       120
         13  number fraction Y of particle with index                       121
         14  number fraction Y of particle with index                      4002
         15  number fraction Y of particle with index                      3002
         16  number fraction Y of particle with index                      3001
         17  number fraction Y of particle with index                      2001
         18  total number fraction Y of particle set with index             999
         19  average mass number A_av of particle set with index            999
         20  average proton number Z_av of particle set with index          999
         21  average neutron number N_av of particle set with index         999
         22  microscopic quantity with index                             10041
```

Appendix D Example of the sound speed and adiabatic index from a cold neutron star table

We start by copying the files `eos.parameters.ns` to `eos.parameters` and `eos.quantities.ns` to `eos.quantities` and run `./compose`:

```
% cp eos.parameters.ns eos.parameters

% cp eos.quantities.ns eos.quantities


% ./compose

  ************************************************
  *             Welcome to CompOSE               *
  * CompStar Online Supernovae Equations of State *
  *                 Version 2.17                 *
  *                  2018/09/07                  *
  ************************************************

  This program helps to generate user-specified EoS tables
  from the EoS tables provided by the CompOSE database at
  compose.obspm.fr.

  Please select the task number from the following list:

  Task 1: Selection of Output Quantities
          (Creates files eos.quantities and eos.init, if not existing)
  Task 2: Definition of Tabulation Scheme and Parameter Values
          (Creates files eos.parameters and eos.init, if not existing)
  Task 3: Generation of EoS Table
          (Creates files eos.table, eos.report,
          eos.beta, if possible, and eos.init, if not existing)
```

We indicate '3' for `Generation of EoS Table`, so the needed parameters and tables are read

```
% 3

  reading minimum and maximum index from parameter table for temperature T

  reading minimum and maximum index from parameter table for baryon number density n_b

  reading minimum and maximum index from parameter table for hadronic charge fraction Y_q

  no file eos.b

           1 entries of parameter table for temperatures read
        1238 entries of parameter table for baryon number densities read
           1 entries of parameter table for charge fraction read

  maximum dimension of parameter files =        1238

  minimum baryon number density:   9.9999999999999995E-008 fm^-3
  maximum baryon number density:   1.8530819999999999      fm^-3

        1238 entries of composition table read

        1238 entries of thermodynamic table read

           0 entry/ies in eos.thermo missing
           0 entry/ies in eos.compo missing
  no file eos.micro

        1238 complete entries in eos tables
```

and finally `EoS table` is generated:

```
  file eos.report written

  reading selection of quantities

  number of extracted regular quantities    =           6
  indices of regular quantities             :          21           1           3
12          15           2

  number of extracted additional quantities =           0
  indices of additional quantities          :

  number of extracted derivative quantities =           0
  indices of derivative quantities          :

  number of pairs for composition           =           0
  indices of pairs                          :

  number of quadruples for composition      =           0
  indices of quadruples                     :

  number of microscopic quantities          =           0
  indices of microscopic quantities         :

  number of error quantities                =           0
  indices of error quantities               :

  format of output table                    =            1 (ASCII)

  begin generating eos table

  reading parameters

  end generating EoS table

  file eos.table written

  The columns of the file eos.table contain the following quantities:

          1  temperature T                                    [MeV]
          2  baryon number density n_b                        [fm^-3]
          3  hadronic charge fraction Y_q                     []
          4  internal energy per baryon E                     [MeV]
          5  pressure p                                       [MeV fm^-3]
          6  shifted baryon chemical potential mu_b-m_n       [MeV]
          7  square of speed of sound (c_s)^2                 []
          8  adiabatic index Gamma                            []
          9  entropy per baryon S                             []
```