ALPHAD_RadD-v1.0

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This ALPHAD_RadD-v1.0 code is an extension of original ALPHAD program, based on Preston's spin-independent formalism [1]. The extended code automatically deduces radius parameter (r_0) for odd-A and odd-odd alpha emitters by employing interpolation or extrapolation procedures [2] using a recent data file of evaluated r_0 parameters, as given in 2020Si16 [3] for ground-state to ground-state alpha transitions in 186 even-even nuclei, followed by deduction of alpha hindrance factors [1]. Additionally, the ALPHAD_RadD code has an option of inputting user-supplied radius parameter. 2020Si16 evaluation [3], an update to 1998Ak04 [4] evaluation, presents updated Q_α values (primarily from AME2016) half-lives, and other relevant quantities required for the deduction of r_0 parameters of even-even alpha emitters, with literature cutoff date of June-2020, with no new relevant references up to November 2020. In the ALPHAD_RadD code, some bugs in the original ALPHAD code, as pointed at some data meetings, were resolved by Tim Johnson at NNDC and by us.

Features of the ALPHAD_RadD code

Case 1: Even-Even Alpha emitters

The value of deduced radius parameter for ground-state to ground-state transition is automatically inserted by ALPHAD_RadD code in the ENSDF-formatted data file.

Case 2: Odd-Odd and Odd-A Alpha emitters

The ALPHAD_RadD code automatically deduces radius parameter, using an interpolation procedure for r_0 parameters for the neighboring nuclides [2], employing our recent evaluation of r_0 parameters of even-even nuclides, followed by deduction of HFs for alpha transitions. The deduced radius parameter for a particular alpha decay dataset is inserted in the corresponding ENSDF -formatted data file, together with appropriate comments. Additionally, the code has an option of accepting user-supplied r_0 parameter (***Note**: If the ALPHAD_RadD code is executed multiple times on a particular alpha decay data set, r_0 statement is added to the output file each time the code is executed. A user needs to remove the multiply inserted r_0 parameter statements)*.

Handling of asymmetric and large fractional uncertainties in $T_{1/2}$ and other quantities:

ALPHAD_RadD and ALPHAD codes do not handle asymmetric, and large (>30% or so) fractional uncertainties correctly. These codes read only the first uncertainty in half-life that appears in a parent record of input file in the .ensdf format. Users can consider running the code(s) multiple times to estimate the uncertainty in r_0 parameter for such cases, as for example, with the input of mean value, mean value + the upper limit, and mean value - the lower limit. Non-numeric uncertainties such as LT, LE, GT, GE and AP are ignored in ALPHAD_RadD and ALPHAD codes. User should consider assigning (reasonable) numeric uncertainties in such cases.

Input files:

(1) 2020_r0_EE.DAT

This is the main input file containing r_0 parameters of 186 nuclei listed in our recent evaluation of radius parameters of even-even alpha emitters (2020SI16) [3]. The data values listed in this file are appearing as per following format:

Column No.	Details of Input value
1-5	Parent Z
6-9	Parent N
10-18	Daughter radius parameter (r_0)
19-27	Uncertainty in daughter radius parameter

(2) ELE.IN

This file contains nuclide symbols along with their atomic numbers. This file is used to list nuclide symbols of alpha parent and alpha daughter nuclei.

Some sample input, report and output ENSDF Files provided in ALPHAD_RadD package

Input ENSDF	Report File	Output ENSDF	r_0 parameter (fm)
210Ra.ens	210Ra.rpt	210Ra.out	1.4989(56)
217Po.ens	217Po.rpt	217Po.out	1.55206(14)
194Bi.ens	194Bi.rpt	194Bi.out	1.5187(42)

References

[1] M.A. Preston. Phys. Rev. 71, 865 (1947).
[2] M. J. Martin, *Guidelines for Evaluators,* Appendix E, page 73 (October 2019).
[3] Sukhjeet Singh, Sushil Kumar, Balraj Singh, and A.K. Jain, Nuclear Data Sheets 167, 1 (2020).
[4] Y.A. Akovali, Nuclear Data Sheets 84, 1 (1998).

Step by step execution of ALPHAD_RadD for even-even, odd-odd and odd-A nuclides

Even-even nuclide (example: ^{210}Ra)

Typical input consol for ^{210}Ra is shown in Fig. 1. The code writes the value of radius parameter in output file with appropriate comment (see Fig.: 2).

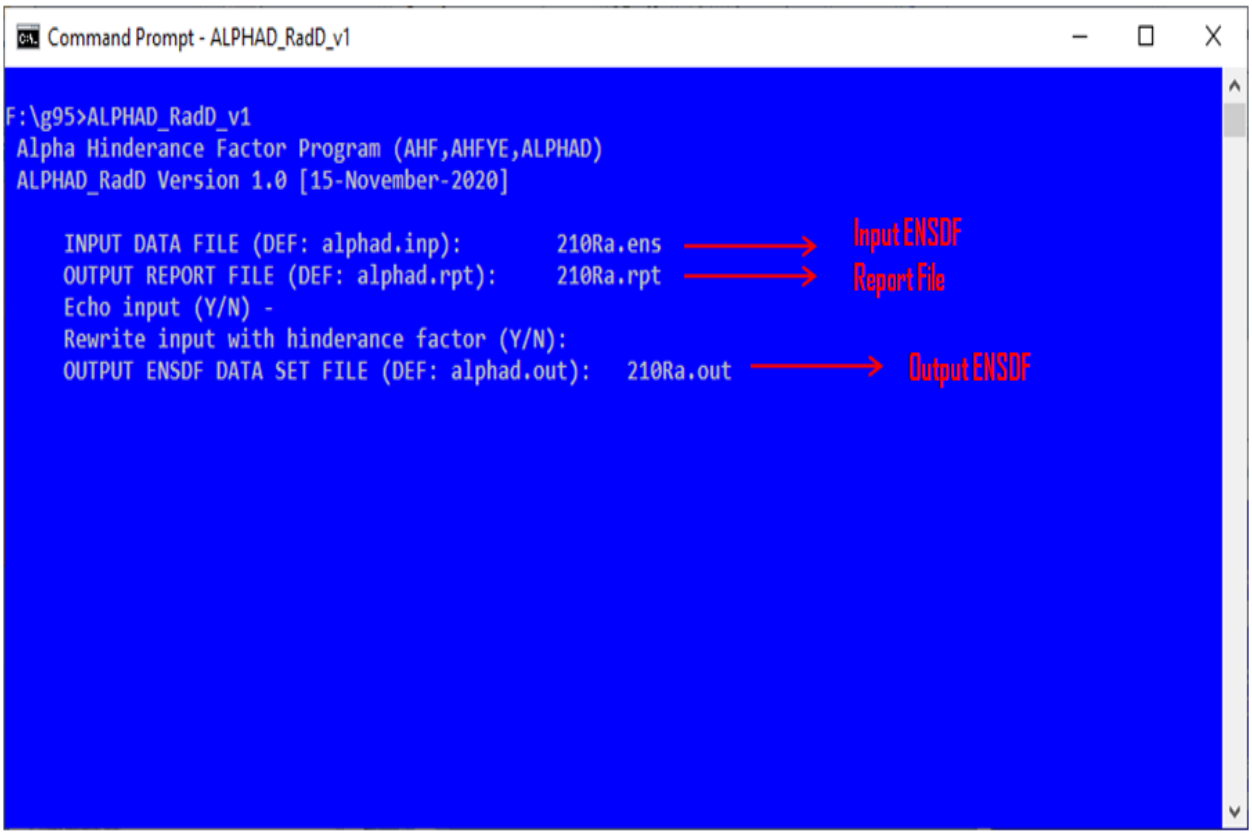


Fig. 1: Console of ALPHAD_RadD for ^{210}Ra

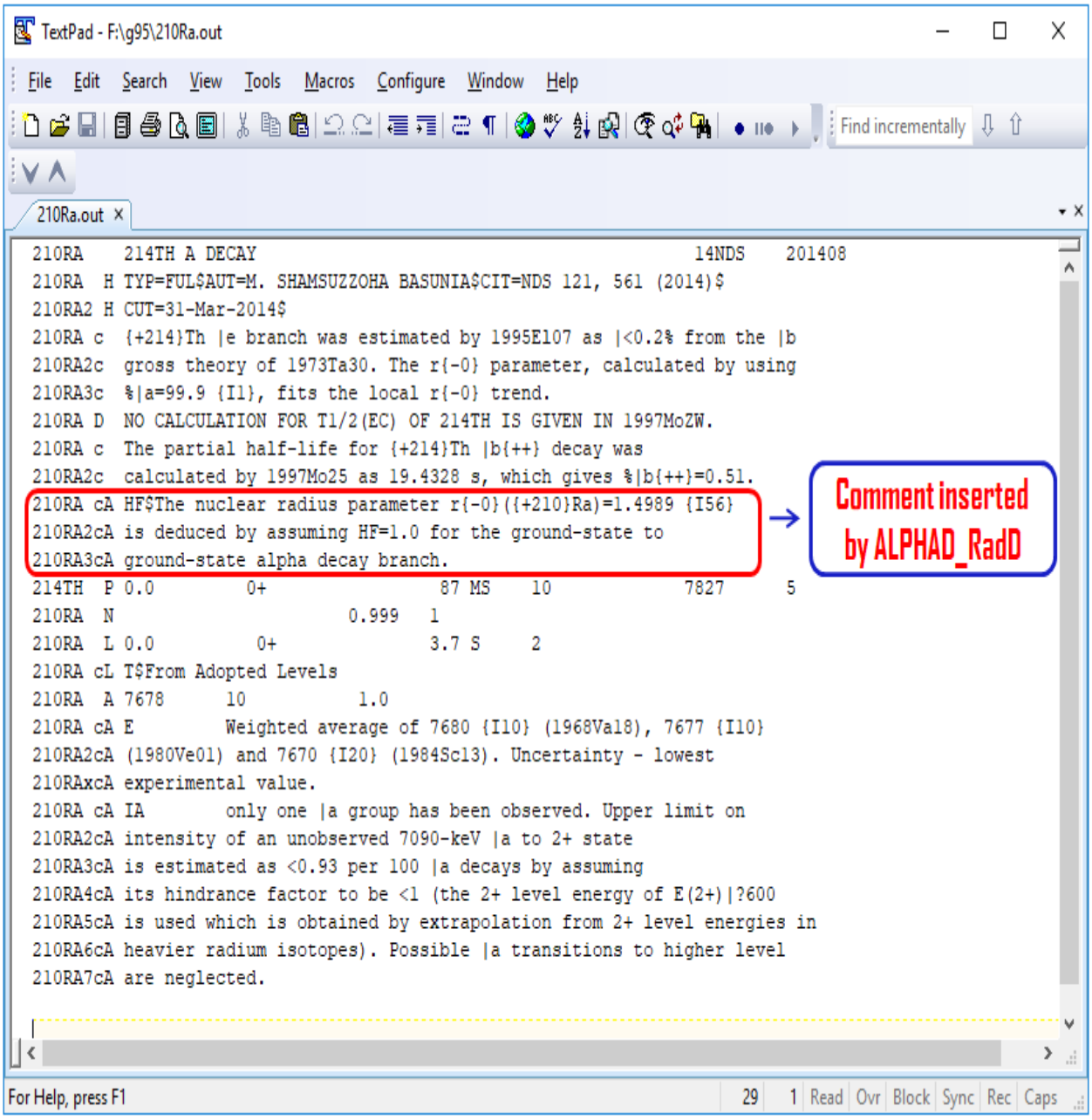


Fig.:2 Output file of ALPHAD_RadD

Odd-odd nuclide (example ^{194}Bi)

The code automatically deduces r_0 parameter, followed by deduction of HFs.

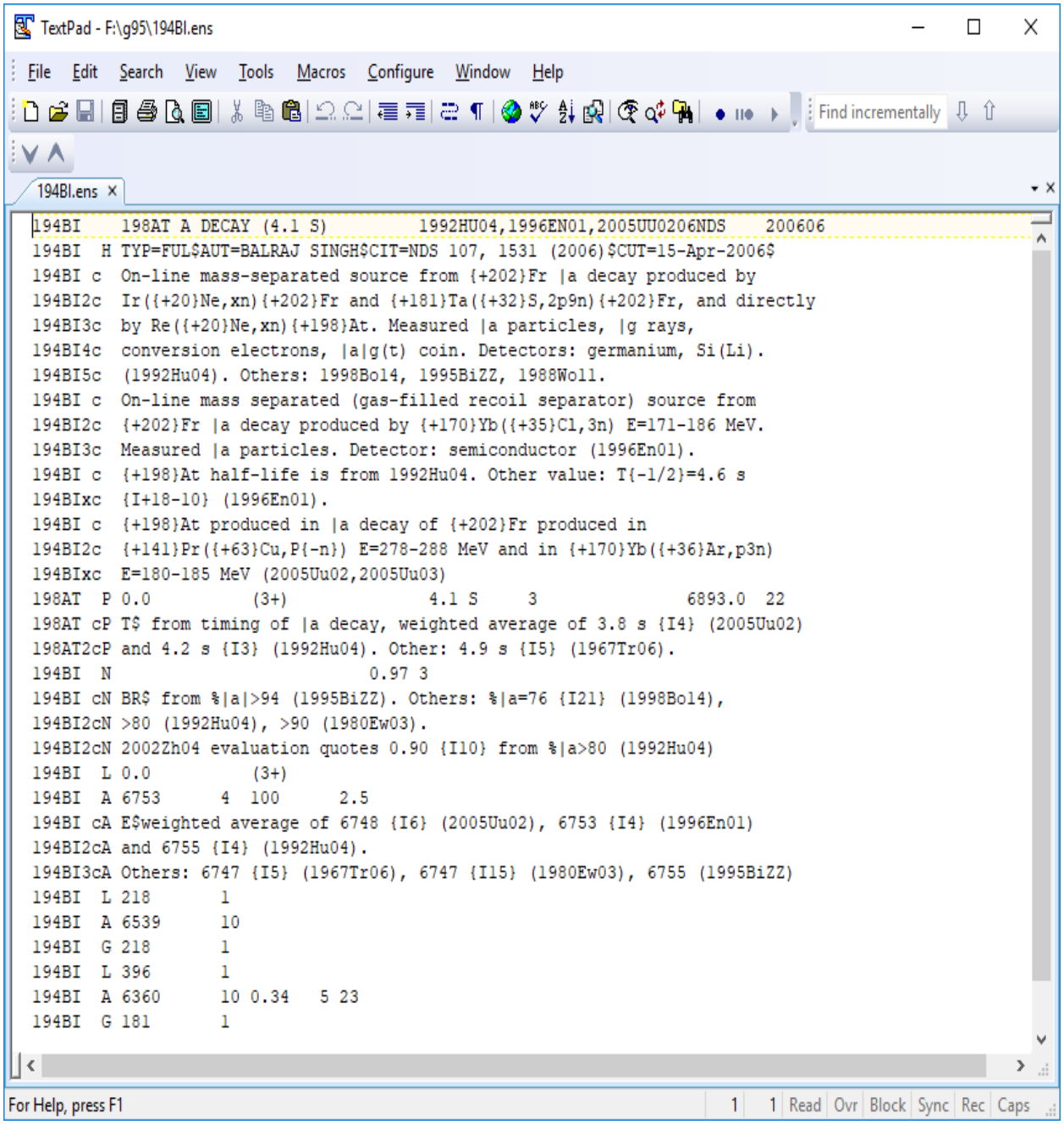
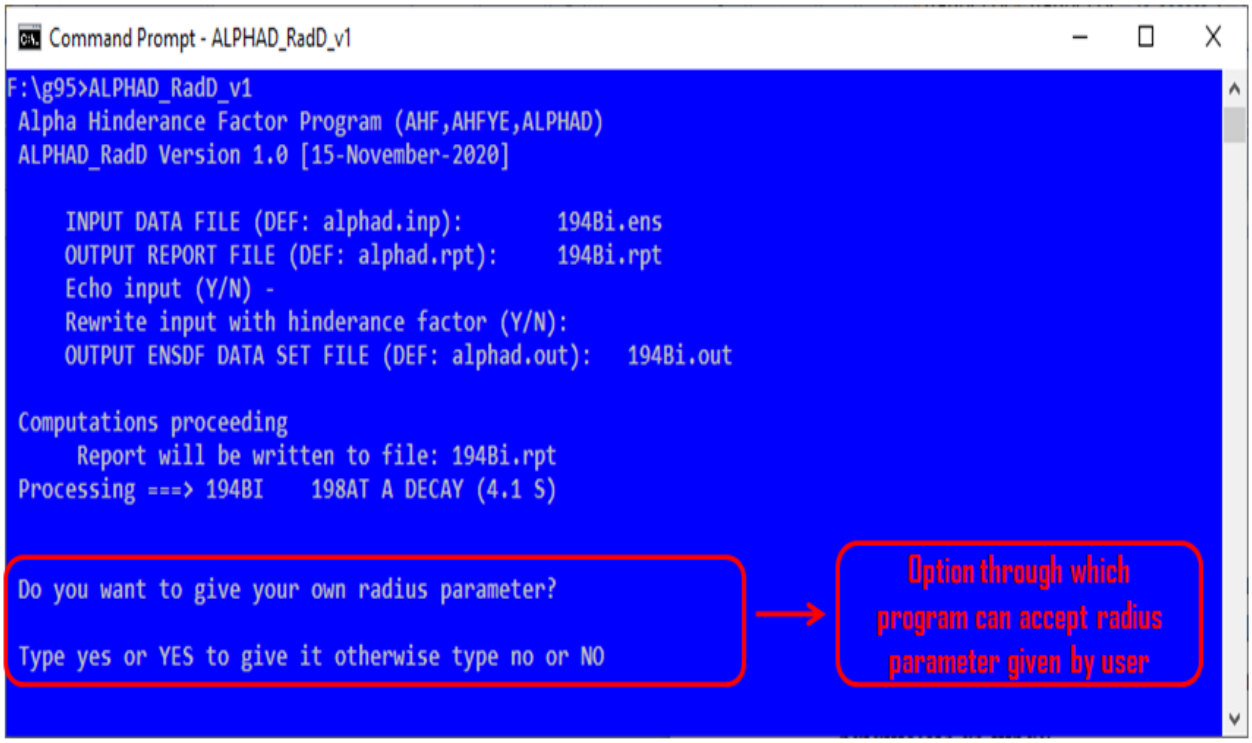
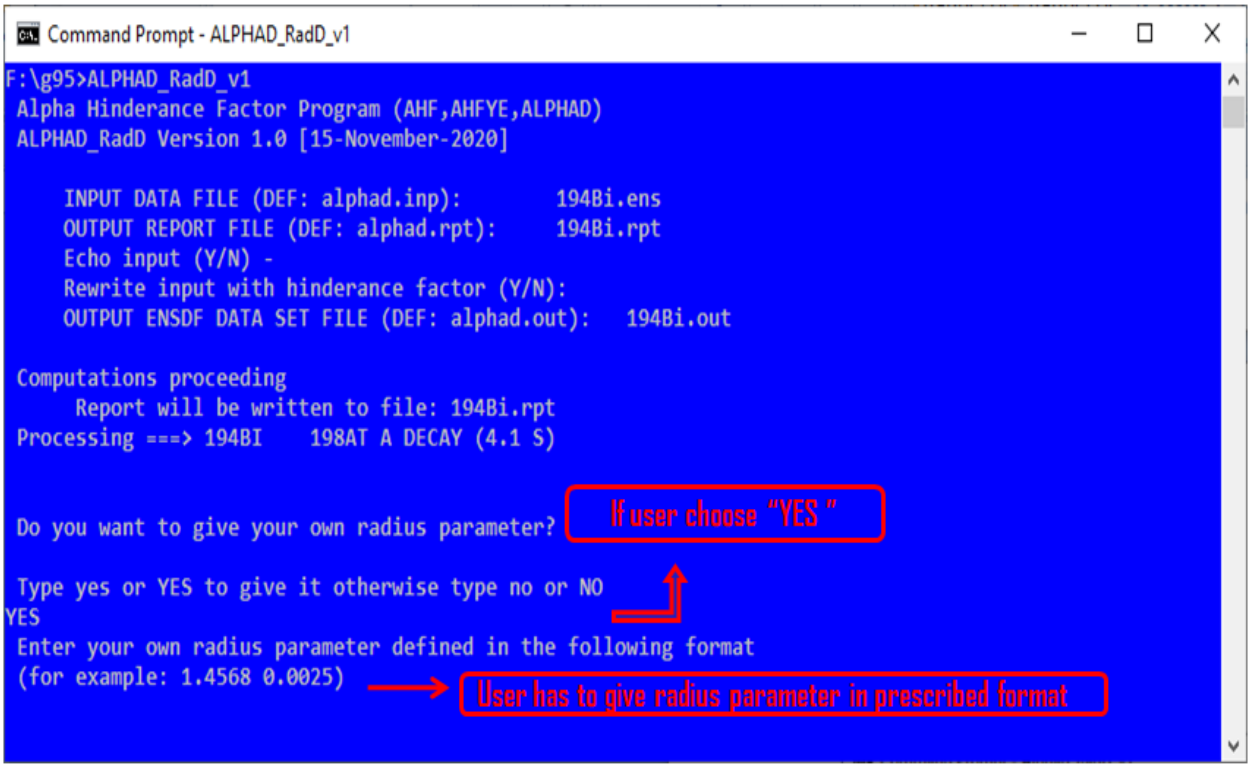


Fig.3: Input file of ^{194}Bi containing no record corresponding to r_0 parameter

The typical input console and executions of ALPHAD_RadD for ^{198}Bi is shown in figures below. After specifying the name of input, report and output files, program gives two options i.e. user can give his own radius parameter OR let the program deduce the value of radius parameter using even-even radius parameters as input:



Case (a): If user wants to give his own radius parameter then he/she has to type “yes” or “YES”. The snapshot after typing “YES” is shown below:

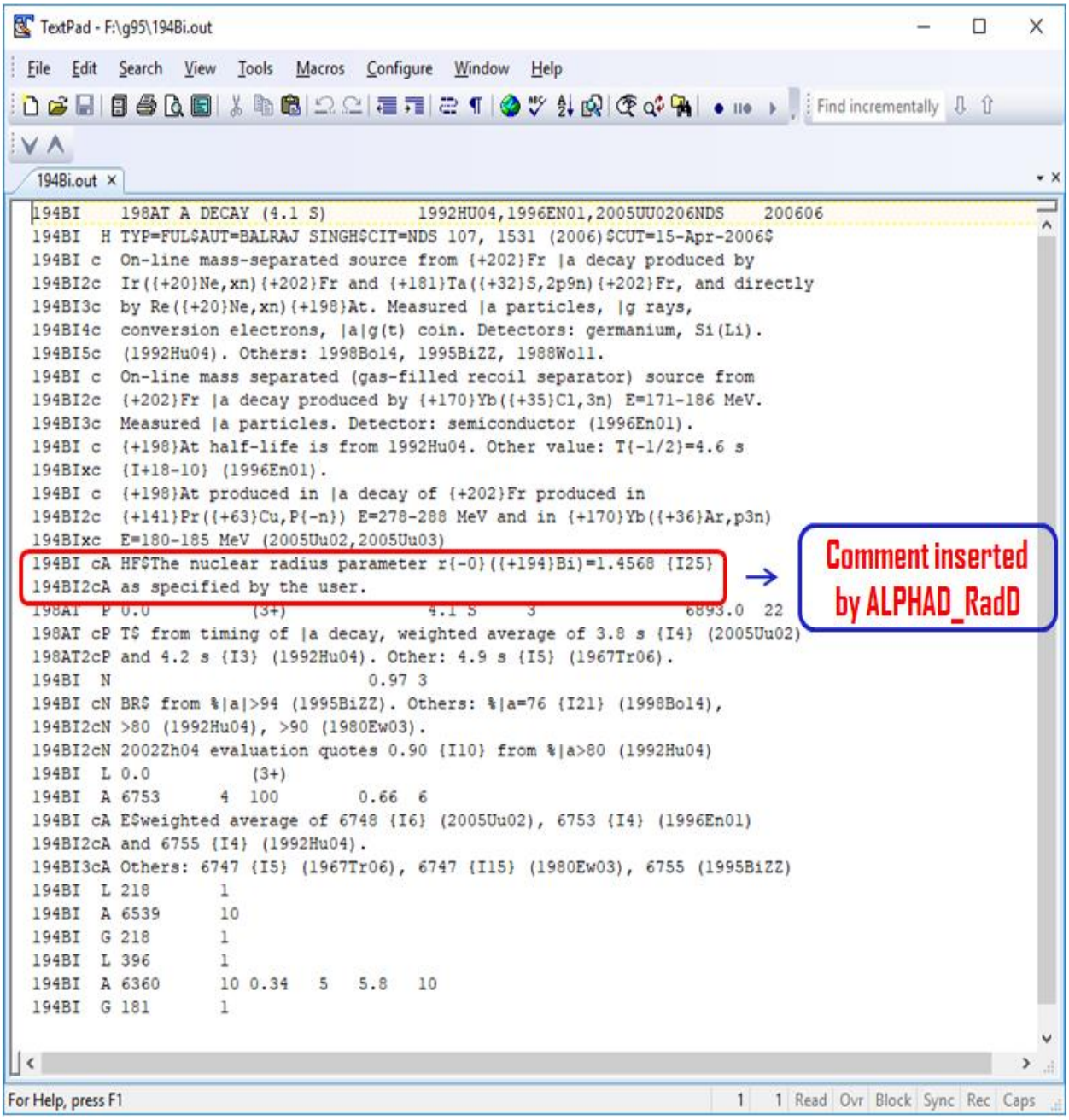


After typing "YES" program ask for the value of radius parameter. The format in which radius parameter should be supplied to program is shown below:

Suppose in case ^{198}Bi the values for radius parameter and its uncertainty deduced by user are 1.4568 and 0.0025, respectively. The user has to enter the value of radius parameter and its uncertainty separated by one blank space. In present case, the program will accept following number:

1.4568 0.0025

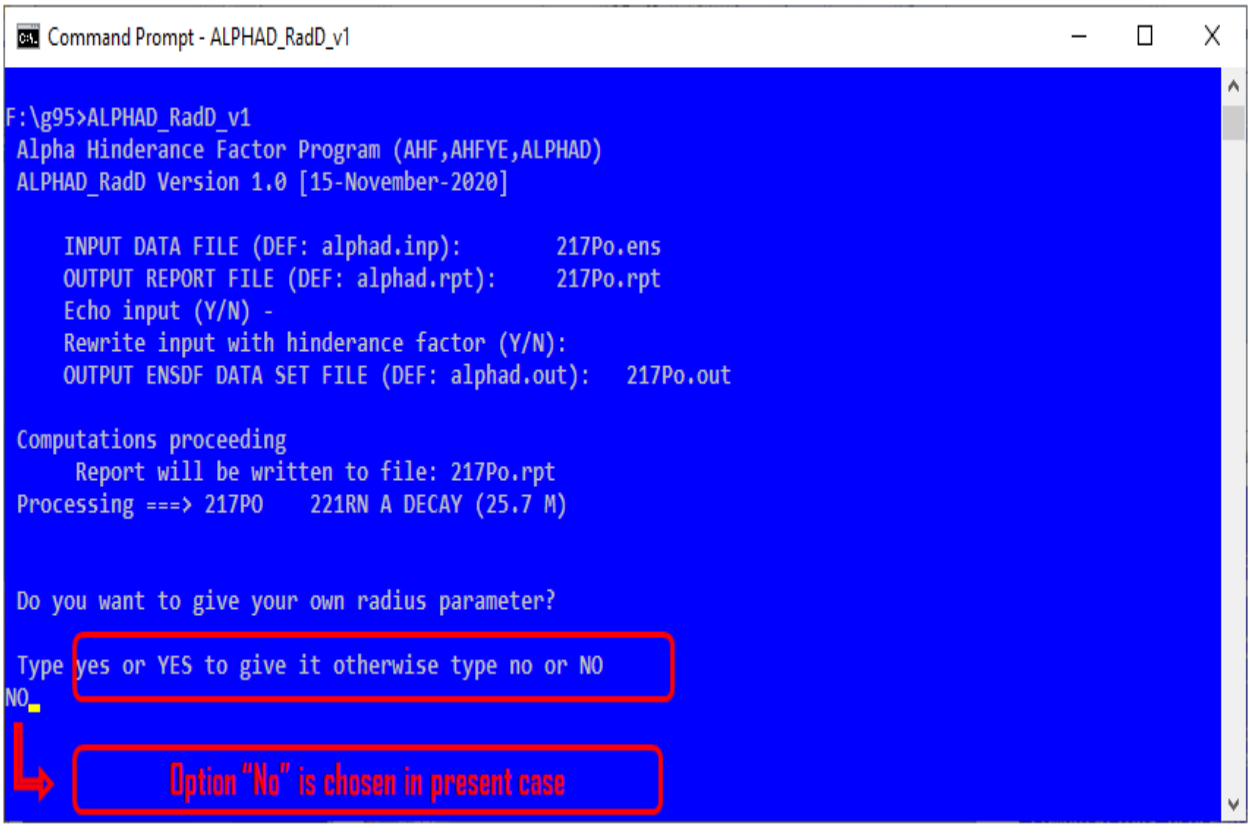
When the radius parameter is supplied in the above said format, then program will do the calculations of HFs and theoretical half-lives and will also insert the value of radius parameter in the output file. The snapshot of output file is shown below:



Case (b): If user type “no” or “NO”, it means program will first deduce the value of radius parameter by using the radius parameter of adjacent even-even nuclides listed in *2020_r0_EE.DAT*. Then, it will perform calculations of HFs and theoretical half-lives. The deduced value of radius parameter will also be inserted in output file with suitable comment. The snapshot corresponding to this situation is shown for ^{217}Po nuclide whose case is discussed below.

Odd-A nuclide (example ^{217}Po)

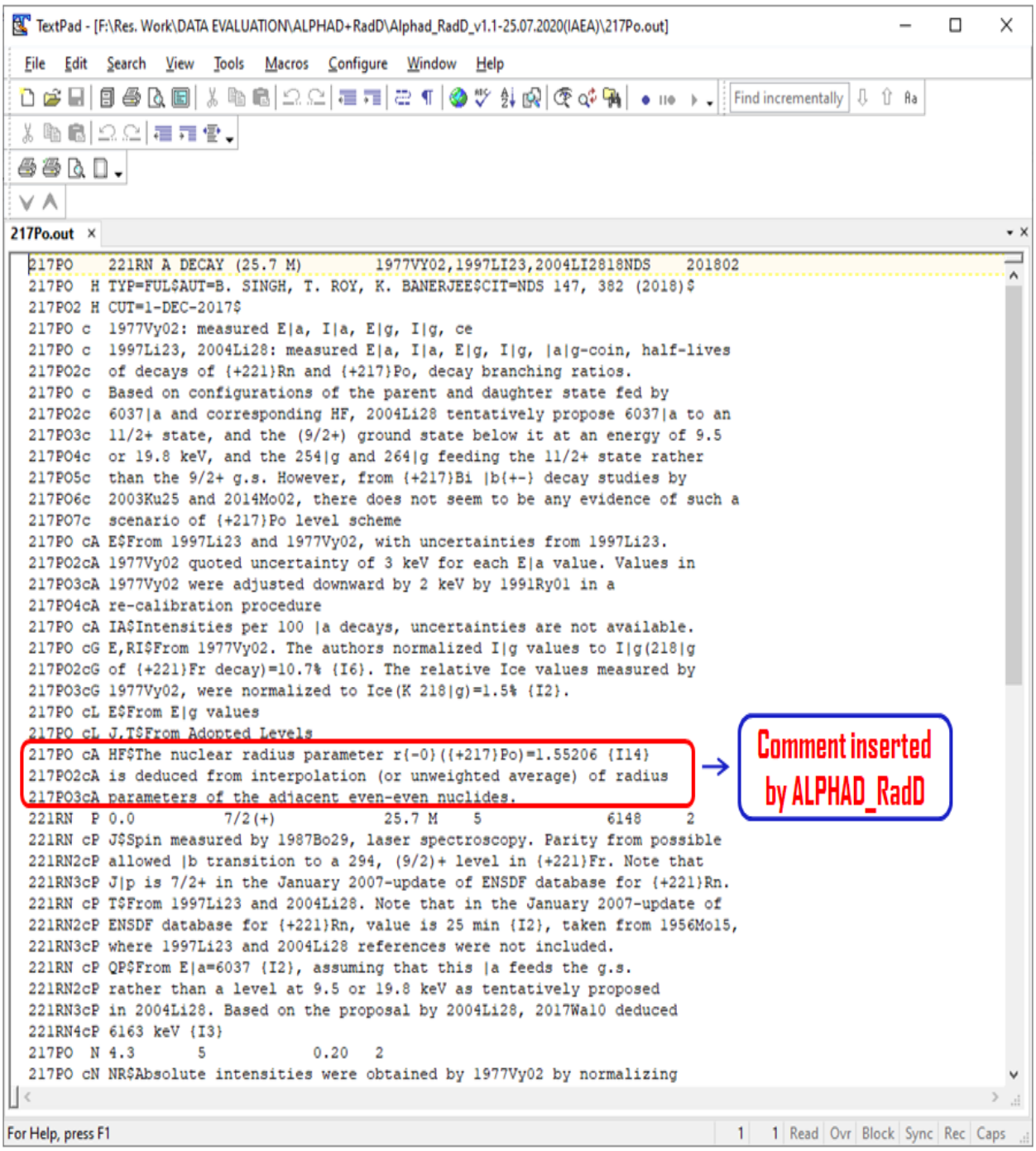
The execution of the program for this case is same as odd-odd ^{194}Bi. Again, there are two options for user.



Option (a): If the user type "no", the program will deduce radius parameter by using the radius parameter of adjacent even-even nuclides.

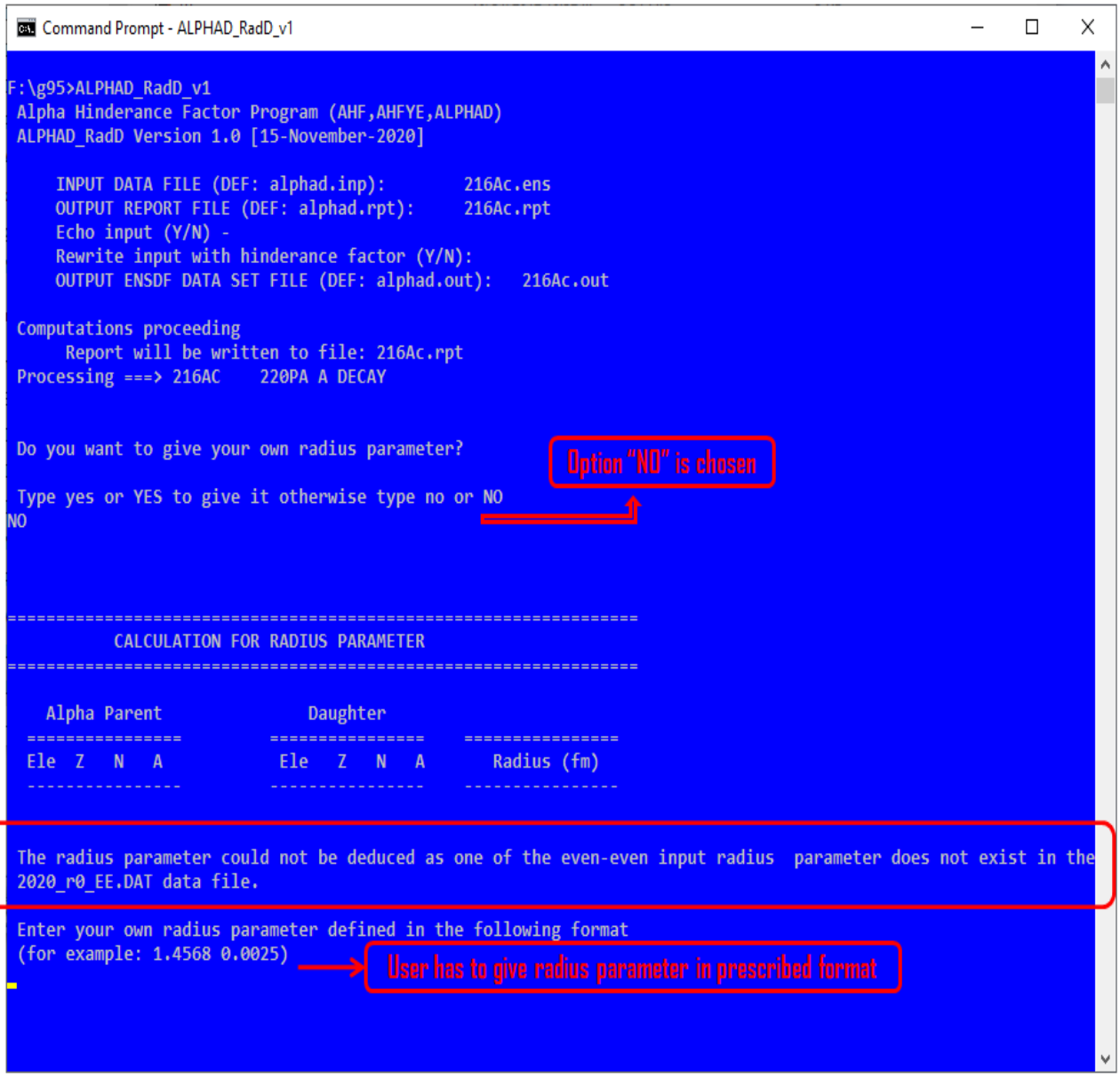
Option (b): User can supply his/her own radius parameter; this situation is already described in case of ^{194}Bi above.

If user chooses option (a) then following output file will appear. Please note that, the deduced value of radius parameter will be inserted at appropriate place with suitable comment.


TextPad - [F:\Res. Work\DATA EVALUATION\ALPHAD+RadD\Alphad_RadD_v1.1-25.07.2020(IAEA)\217Po.out]
File Edit Search View Tools Macros Configure Window Help
Find incrementally
217Po.out
217PO 221RN A DECAY (25.7 M) 1977VY02,1997LI23,2004LI2818NDS 201802
217PO H TYP=FUL$AUT=B. SINGH, T. ROY, K. BANERJEE$CIT=NDS 147, 382 (2018)$
217PO2 H CUT=1-DEC-2017$
217PO c 1977Vy02: measured E|a, I|a, E|g, I|g, ce
217PO c 1997Li23, 2004Li28: measured E|a, I|a, E|g, I|g, |a|g-coin, half-lives
217PO2c of decays of {+221}Rn and {+217}Po, decay branching ratios.
217PO c Based on configurations of the parent and daughter state fed by
217PO2c 6037|a and corresponding HF, 2004Li28 tentatively propose 6037|a to an
217PO3c 11/2+ state, and the (9/2+) ground state below it at an energy of 9.5
217PO4c or 19.8 keV, and the 254|g and 264|g feeding the 11/2+ state rather
217PO5c than the 9/2+ g.s. However, from {+217}Bi |b{+-} decay studies by
217PO6c 2003Ku25 and 2014Mo02, there does not seem to be any evidence of such a
217PO7c scenario of {+217}Po level scheme
217PO cA E$From 1997Li23 and 1977Vy02, with uncertainties from 1997Li23.
217PO2cA 1977Vy02 quoted uncertainty of 3 keV for each E|a value. Values in
217PO3cA 1977Vy02 were adjusted downward by 2 keV by 1991Ry01 in a
217PO4cA re-calibration procedure
217PO cA IA$Intensities per 100 |a decays, uncertainties are not available.
217PO cG E,RI$From 1977Vy02. The authors normalized I|g values to I|g(218|g
217PO2cG of {+221}Fr decay)=10.7% {I6}. The relative Ice values measured by
217PO3cG 1977Vy02, were normalized to Ice(K 218|g)=1.5% {I2}.
217PO cL E$From E|g values
217PO cL J,T$From Adopted Levels
217PO cA HF$The nuclear radius parameter r{-0}({+217}Po)=1.55206 {I14}
217PO2cA is deduced from interpolation (or unweighted average) of radius
217PO3cA parameters of the adjacent even-even nuclides.
221RN P 0.0 7/2(+) 25.7 M 5 6148 2
221RN cP J$Spin measured by 1987Bo29, laser spectroscopy. Parity from possible
221RN2cP allowed |b transition to a 294, (9/2)+ level in {+221}Fr. Note that
221RN3cP J|p is 7/2+ in the January 2007-update of ENSDF database for {+221}Rn.
221RN cP T$From 1997Li23 and 2004Li28. Note that in the January 2007-update of
221RN2cP ENSDF database for {+221}Rn, value is 25 min {I2}, taken from 1956Mo15,
221RN3cP where 1997Li23 and 2004Li28 references were not included.
221RN cP QP$From E|a=6037 {I2}, assuming that this |a feeds the g.s.
221RN2cP rather than a level at 9.5 or 19.8 keV as tentatively proposed
221RN3cP in 2004Li28. Based on the proposal by 2004Li28, 2017Wa10 deduced
221RN4cP 6163 keV {I3}
217PO N 4.3 5 0.20 2
217PO cN NR$Absolute intensities were obtained by 1977Vy02 by normalizing
Comment inserted by ALPHAD_RadD
For Help, press F1
1 1 Read Ovr Block Sync Rec Caps

Odd-odd and odd-A nuclide for which deduction of radius parameter is not possible through ALPHAD_RadD (example ^{216}Ac)

There are certain cases for which deduction of radius parameter is not possible. This situation occurs when r_0 parameters for one or both neighboring even-even alpha emitters are not available in the input file. In such cases, an appropriate message will be displayed on screen and user has to give his/her own radius parameter as shown below for ^{216}Ac:



In such cases, if option "no" is selected, the code prints the following message:" *the radius parameter could not be deduced as one of the even-even input radius parameter does not exist in the 2020_r0_EE.DAT data file*."