

Russian National Standard Reference Data System and Nuclear Energy Innovative System in Russia

Tengiz Golashvili ¹⁺, Valery Rachkov ² and Mikhail Strikhanov ¹

¹ National Research Nuclear University MEPhI, Department 355

² Institute for Physics and Power Engineering named after Leypunsky

Abstract. Russian National Standard Reference Data System (RNSRDS) involves the evaluation, systematization, measurement, standardization of physical constants and data on properties of substances and materials in different fields of science, technique and technology. An appropriate NSRDS functional structure is presented. This structure includes the fields of power engineering, industry in which the data bases are developed.

New versions of Nuclide Guide (NG) and Chart of the Nuclides (CN) were developed as a result of Russian-Chinese collaboration. Compared to the previous versions of the NG and CN-2006 new evaluated information has been included to the NG and CN-2010 from the following publications: 1) Nuclear Data Sheets, volumes 107 – 110, 2) Monographie BIPM-5, Table of Radionuclides, 2006, 3) Monographie BIPM-5, Table of Radionuclides, 2008. In addition, for the Nuclide Guide-2010 the authors re-calculated the average energies of radiations of the 500 radionuclides with half-lives about and more than 1 hour. The International Chart of Nuclides was developed taking into account information added and revised in Nuclide Guide-2011. The presented decay data can be used not only in nuclear physics and associated fields but also in medicine, agriculture and space studies.

Nuclear energy innovative system of ROSATOM State Corporation is presented.

Keywords: Radionuclides, Chart of nuclides, Decay data, Atomic mass, Gamma-ray energy, Russian National Standard Reference Data System, ROSATOM State Corporation, Innovative system

1. Introduction

The nuclear data directories and wall charts of the nuclides are widely used by wide circle of experts of different level (students, graduate students, engineers, scientific researchers), who would like to have primary true information on stable and radioactive nuclides. In all such publications it is important to deal with high-quality and critical evaluated decay data for radionuclides. Therefore a periodic revision of nuclide guides and charts is highly desirable as the quality of measurements and evaluations is improved permanently.

The information presented in the Nuclide Guide (NG) and Chart of the Nuclides (CN) in 2006 [1] was compiled from *ENSDF-2006*, atomic mass evaluation-2003 by Audi and Wapstra and interactive data bases at web-sites www.nndc.bnl.gov, www.nucleide.org. From that time new important decay data evaluations for many radionuclides have been published, in particular, such as *Nuclear Data Sheets*, volumes 107 – 110 [2] and Monographie BIPM-5, *Table of Radionuclides*, 2006 [3], 2008 [4]. Also data in the above databases have been updated. In addition, for the Nuclide Guide the authors re-calculated the average radiation energies for 500 radionuclides with half-lives about and more than 1 hour. Therefore a revision of NG and CN is proved to be beneficial.

2. Russian National Standard Reference Data System

⁺ Corresponding author. Tel.: + 7 905 7536520.
E-mail address: gol4076@yandex.ru.v.

Below is a functional structure of the Russian National Standard Reference Data System in the field of nuclear science, technique and technology (see Fig. 1).

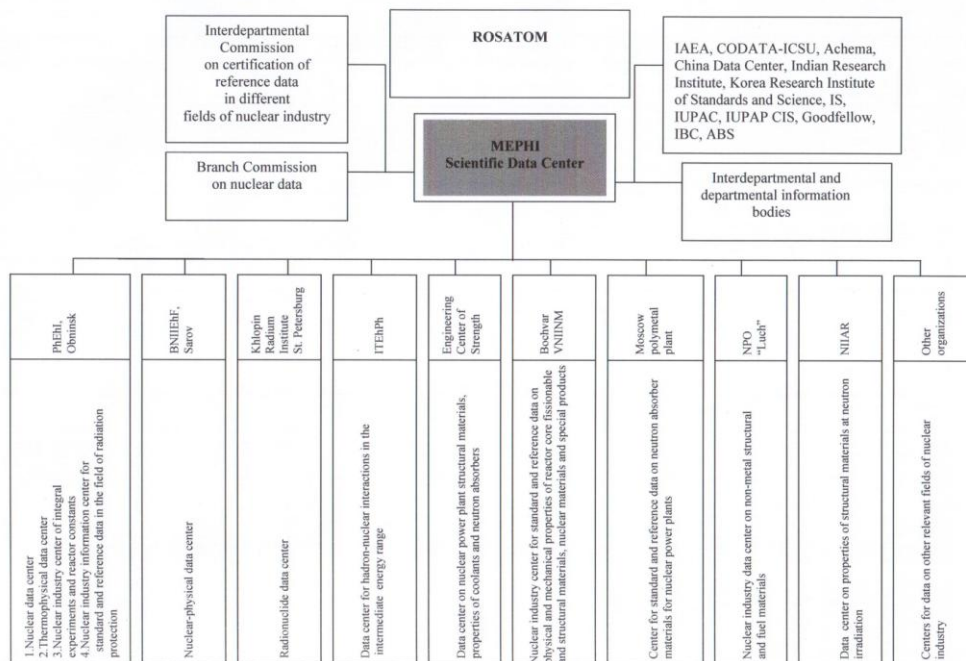


Fig. 1: Functional structure of the Russian National Reference Data System in the field of nuclear science, technique and technology.

I would like to inform you about Russian-Chinese cooperation in the field of principal nuclide data acquisition and evaluation for the purpose of development of wall-type charts of the nuclides. Any chart comprises 9 nuclear characteristics for about 3880 nuclides recommended by international and national organizations (data evaluated using ENSDF and standard reference data from IAEA, Russia, Japan and China). We published two nuclide guides in Russia in English and Russian (1995 and 2012) and one in China in English, Russian and Chinese (2011). The wall-type nuclide charts were prepared and issued in 1995, 2002, 2004, 2006, 2008, 2010, 2011, 2012. The next edition of the charts will be issued in 2010.

We would like you to consider the chance of cooperation and invite all the countries to join our project taking into account the experience gained by many countries in development of wall-type charts of the nuclides. We hope that the forthcoming issue of the wall-type chart of the nuclides prepared by specialists from various countries will be considered as a good exemplar of international cooperation in the field of peaceful utilization of nuclear data not only in nuclear science, technique and technology, but in the field of space, environment, medicine, agriculture and so on. Nuclear engineering in medicine provides unique possibilities for diagnostics.

The Scientific Data Center issued also Periodic Table of Elements (2008) involving physical characteristics and properties of chemical elements (Golashvili T.V. and Demidov A.P. are the authors). The Table includes such characteristics as atomic number, mass number, relative atomic mass, oxidation state, electron configuration, nuclide abundance, half-life for stable and natural isotopes of 118 elements. Below are presented boxes from the Table.

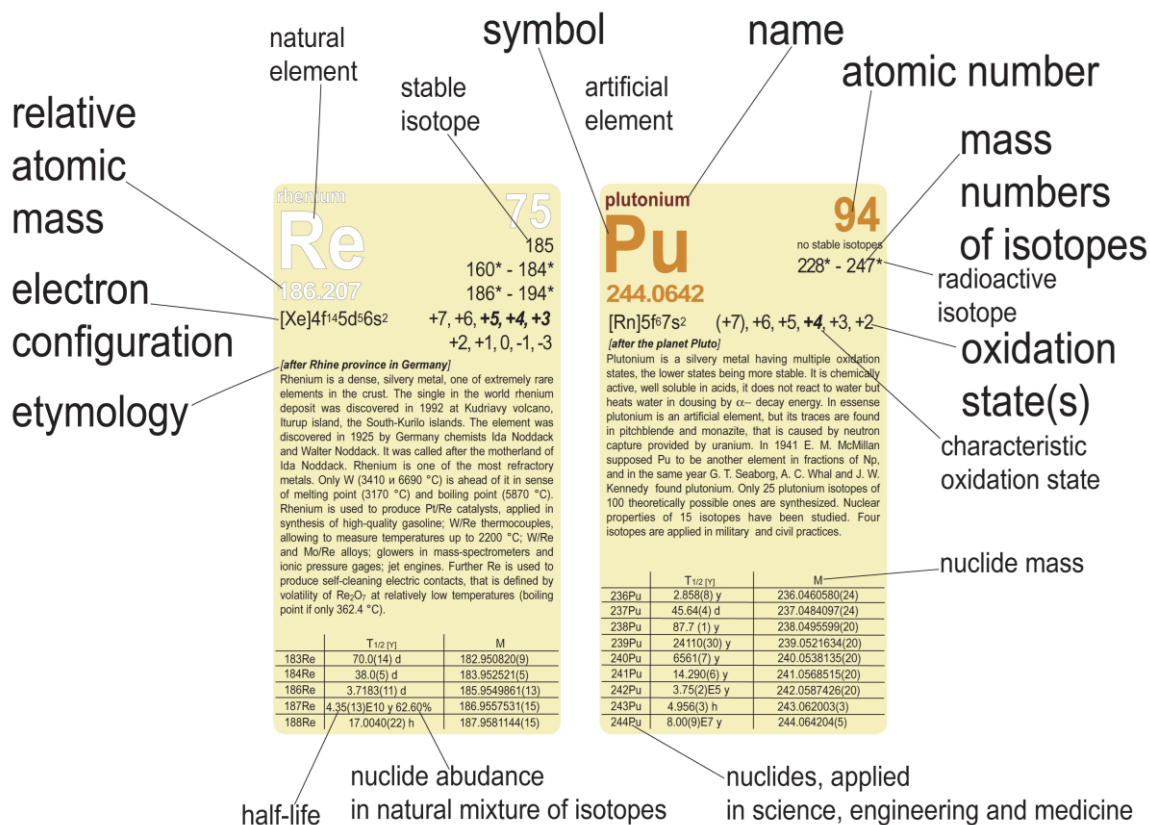


Fig. 2: Legend for the Periodic Table of Elements.

3. Contents of the Nuclide Guide and Chart

The new Nuclide Guide and Chart – 2011, 2012 have been developed as a revised and updated versions of the NG and CN – 2006 produced in the issue of Russian-Chinese collaboration.

3.1. Nuclide guide 2011, 2012

As before, in the Nuclide Guide-2011, 2012 the nine nuclear and decay characteristics are given for each nuclide. In particular, spin, parity, mass of nuclide, magnetic moment (if available), mass excess, half-life or abundance, decay modes, branching ratios, emitted particles, energies of most intense gamma-rays and their intensities, decay energies and mean values of radiation energy per decay are presented. For stable and natural long-lived nuclides cross-sections of thermal neutron induced activation are indicated. Almost all the characteristics are presented with uncertainties which were calculated by authors or extracted from databases *ENSDF-2009* [5] and *NUBASE* [6].

In the Nuclide Guide-2006 the average radiation energies were taken from Table of Radioactive Isotopes, 1986 [7]. In the new version the characteristics of the elements: 92-U-236, 92-U-237, 92-U-238, 93-Np-234, 93-Np-237, 93-Np-238, 93-Np-239, 94-Pu-236, 94-Pu-237, 94-Pu-238, 94-Pu-239, 94-Pu-240, 94-Pu-241, 94-Pu-242, 94-Pu-243, 94-Pu-244, 95-Am-240, 95-Am-241, 95-Am-242m, 95-Am-243, 96-Cm-242, 96-Cm-243, 96-Cm-244, 96-Cm-245, 96-Cm-246, 97-Bk-249, 98-Cf-248, 98-Cf-249, 98-Cf-250, 98-Cf-252 are re-calculated.

3.2. Chart of Nuclides 2012

The International Chart of Nuclides was developed taking into account information from Nuclide Guide-

2012.

As is known, the term "nuclide" has been instituted in the nuclear science to distinguish between the isotopes of different chemical elements according their nuclear properties. The nuclide is an atom having the given number of protons in nucleus Z which defines the charge of the nucleus, and number of neutrons N . The sum $A = Z + N$ represents mass number of the nuclides. These three numbers define the nuclide place (its "box") in the chart of nuclides to be discussed. The structure of the box in the Chart of Nuclides with the indicated principal nuclide characteristics was described in [1].

The symbol of a chemical element and mass number is specified in the first line inside the box for any nuclide. The value of mass excess Δm (in MeV) is presented in the second line. The quantum characteristics of nucleus in the ground state - its spin and parity, are given in the third line. Radionuclide half-life is presented in the fourth line as one of the most important nuclear decay characteristics of radioactive nuclides. In case of stable isotopes this line contains the nuclide percentage in natural mixture of the chemical element under consideration. The fifth line contains the modes of nuclear transformations (decays) (α , β^- , γ , β^+ , β , n , etc.) of the radioactive nuclides. Radiation capture cross section of thermal neutrons (activation cross section) in barns is presented in this line for the stable and natural long-lived nuclides.

As in the CN-2006 [1], the remaining 4 lines of boxes contain the additional nuclear decay characteristics of the radioactive nuclides as follows (in keV): total decay energy Q , average energy of radiation in the same units (bracketed), and the energy of the most intensive alpha- and gamma-radiation. The uncertainties of the recommended values are parenthetical and provided with the number of units of the last significant digit of the value.

4. The Innovative Activity

- First of all in medicine for beam therapy and diagnostics.
- In light and food-processing industry for disinfection and sterilization of the manufacturable products.
- In housing services or in harmful manufacturing for a filtration, purification and separation of substances (development of track membranes in Joint Institute for Nuclear Research, Dubna).
- And also, devices for detection of nuclear and radioactive materials, for example, for customs and check points.

Besides it is necessary to pay attention to utilization of achievements of nuclear instrument making and mechanical engineering in other sectors of the industry, for example, in a fuel and energy complex, heavy mechanical engineering, electronic industry.

4.1. Materials and products on their basis

RADIONUCLIDE SOURCES AND PREPARATIONS

THE TECHNICAL INFORMATION

RADIONUCLIDE SOURCES

RADIONUCLIDE PREPARATIONS

TOOLS AND THE EQUIPMENT

PACKING AND TRANSPORTATION

STABLE ISOTOPES

XENON DIFLUORIDE

CALCIUM METAL

PRODUCTS FROM ZIRCONIUM

INGOTS

PIPES

RODS

THE WIRE COLD-DRAWN FROM ALLOYS OF ZIRCONIUM

SHEETS COLD-ROLLED FROM ALLOYS OF ZIRCONIUM
 ZIRCONIUM DIOXIDE
 TRANSITIVE WELDED CONNECTIONS ZIRCONIUM - STEEL
 PRODUCTS FROM THE NATURAL AND IMPOVERISHED URANIUM
 REAR EARTH PRODUCTION
 CARBONATES OF REAR EARTH METALS
 CONCENTRATE OF REAR EARTH METAL OXIDES OF CERIC GROUP
 POLISHING POWDERS ON BASIS OXIDES OF REAR EARTH METALS
 POWDER WIRE FOR OUT-OF-KILN PROCESSINGS OF PIG-IRON AND STEEL
 LONGITUDINAL ELECTROWELDED PIPES
 PRODUCTS FROM STAINLESS-STEEL CHROMIUM-NICKEL ALLOYS
 THE EQUIPMENT
 THERMAL CONVERTERS
 THE GENERAL DATA
 INDEPENDENT DIGITAL TEMPERATURE MEASURING INSTRUMENT "NIKA"
 SUBMERGED RIGID THERMAL CONVERTER FOR THE HIGH PRESSURE
 FLEXIBLE SURFACE THERMAL CONVERTER UNDER THE SCREW
 MANUAL SUPERFICIAL PROBE
 FLEXIBLE SUPERFICIAL THERMAL CONVERTER WITH THE COLLAR
 TRIBE-DEVICES

5. Conclusion

Charts and guides of nuclides present the evident primary information on the basic characteristics of stable nuclides and decay properties of the radioactive nucleus. The further, more detailed information on nuclide characteristics is contained in various specialized nuclear data collections and bases. Computers are used now most often to retrieve the data. However just as electronic carriers have not cancelled the traditional form of the literature as printed books, the nuclide directories and charts of nuclides are still in proper value not only in the nuclear science and engineering but also in space, medicine, agriculture and environmental protection. Due to them each interested person can quickly orient himself in huge quantity of the nuclides (exceeding 3000), nuclear isomers, nuclear masses, half-lives and other characteristics. The authors hope that the Nuclide Guide and International Chart of Nuclides-2012 completely meet this goal.

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