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## **NNDC Data Services**

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## NNDC Data Services

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**Abstract.** The National Nuclear Data Center has provided remote access to some of its resources since 1986. The major databases and other resources available currently through NNDC Web site are summarized.

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KEYWORDS : ENSDF, Nuclear Data, NuDat, ENDF, NSR

### 1. INTRODUCTION

The National Nuclear Data Center (NNDC) has provided remote access to the nuclear physics databases it maintains and to other resources since 1986. With considerable innovation access is now mostly through the Web.

The NNDC Web pages have been modernized to provide a consistent state-of-the-art style.<sup>1</sup> The improved database services and other resources available from the NNDC site at [www.nndc.bnl.gov](http://www.nndc.bnl.gov) will be described.

### 2. NUCLEAR PHYSICS DATABASES

The NNDC maintains two bibliographic and six numeric databases covering low and medium energy nuclear physics.<sup>2</sup> Additional details of the interfaces to our more popular databases follow.

#### 2.1 ENDF/SIGMA

For this nuclear reaction database, a new web-based application SIGMA, has been created for easy retrieval and

much greater choice of input/output options. The search parameters include target, projectile, product, nuclear reaction, energy range, quantity, and the choice of source library. Other improvements include advanced search options, e.g., for users familiar with the ENDF (Evaluated Nuclear Data File) format, and improved plotting capabilities including the ability to overlay CSISRS and ENDF data.

#### 2.2 ENSDF/XUNDL

There is a tighter integration of the ENSDF and XUNDL databases allowing the use of a common interface. The search parameters include nuclide, nuclear reaction, and nuclear decay. Datasets may also be browsed by element or by mass.

#### 2.3 NuDat

NuDat contains adopted level and  $\gamma$ -ray data extracted from ENSDF, nuclear decay data based on ENSDF, ground and metastable state properties from Nuclear Wallet Cards [2], and thermal neutron data from Evaluated Nuclear Data Library [3]. Search parameters include nuclide or parent, energy levels, decay modes,  $J\pi$ 's,  $T_{1/2}$ 's,  $E\gamma$ 's, and  $\gamma\gamma$ -coincidences. It also includes a Chart of the Nuclides interface to ground and metastable state properties and options to obtain tables and interactive level schemes of the adopted data contained in ENSDF. It also offers many options for horizontal retrievals.

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<sup>1</sup> See Figure 1 for the NNDC home page.

<sup>2</sup> See Table 1 for brief descriptions of these databases. Most of these are a result of the work of national or international networks (Cross Section Evaluation Group (CSEWG), Nuclear Reaction Data Centers Network, International Network of Nuclear Structure and Decay Data Evaluators (NSDD), U.S. Nuclear Data Program, and Working Party on International Nuclear Data Evaluation Cooperation.)

**NSR** **XUNDL** **ENSDF**  
**NuDat** **Databases** **MIRD**  
**Sigma** **CSISRS** **EXFOR**

**Chart of Nuclides**

**Empire** **Atlas of n Resonances**  
**Nuclear Wallet Cards** **Tools and Publications** **Nuclear Data Sheets**

**Networks**  
**CSEWG** **USNDP**

**NNDC** **National Nuclear Data Center**  
 BROOKHAVEN NATIONAL LABORATORY

Nuclear Structure and Decay Databases  
 Nuclear Structure and Decay Tools  
 Nuclear Reaction Databases  
 Nuclear Reaction Tools  
 Bibliography Databases  
 Networks and Links  
 About the Center  
 Publications  
 Meetings

**ND 2010**  
 April 26-30

**Minutes of Nuclear Data Week 2009 New USNDP/CSEWG GForge Server**

Site Index - Search the NNDC:

AMDC Atomic Mass Data Center, <i>Q-value Calculator</i>	Atlas of Neutron Resonance Parameters & thermal values	CapGam Thermal Neutron Capture $\gamma$ -rays	Chart of Nuclides Basic properties of atomic nuclei
Covariances of Neutron Reactions	CSEWG Cross Section Evaluation Working Group	CSISRS alias EXFOR Nuclear reaction experimental data	Empire Nuclear reaction model code system, <i>Reference paper</i>
ENDF Evaluated Nuclear (reaction) Data File, <i>Sigma</i>	ENSDF Evaluated Nuclear Structure Data File	IRDF International Reactor Dosimetry File	MIRD Medical Internal Radiation Dose
NMSS & DoE NMIRDC Safeguards & inventory decay data standards	NSR Nuclear Science References	Nuclear Data Sheets Nuclear structure & decay data journal, <i>Special Issues on reaction data</i>	Nuclear Wallet Cards Ground & isomeric states properties, <i>Homeland Security version</i>
NucRates MACS & Astrophysical reaction rates	NuDat Nuclear structure & decay Data	USNDP U.S. Nuclear Data Program	XUNDL Experimental Un-evaluated Nuclear Data List

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 Acknowledgments - Comments/Questions - Disclaimer

FIGURE 1. National Nuclear Data Center Home Page

### 2.4 NSR

This bibliographic database offers reference to low and medium energy nuclear physics literature. Quick retrievals by author, nuclide, or keynumber as well as indexed retrievals using interactive options are available. Search parameters for indexed retrievals include nuclide, author, subject, reaction, target, incident or outgoing particle, and topic specifications; also there is the ability to combine various options using Boolean operations.

### 2.5 CSISRS/EXFOR

This experimental nuclear reaction data file provides reaction cross-section data upto 1 GeV. Search parameters include target, projectile, product, nuclear reaction, energy range, authors, publication year, and modification date. It also includes advanced search options for users familiar with EXFOR (Exchange Format) and enhanced plotting capabilities.

TABLE 1. Nuclear Physics Databases at the National Nuclear Data Center<sup>3</sup>

Database	URL	Description
CINDA	<a href="http://www.nndc.bnl.gov/cinda">www.nndc.bnl.gov/cinda</a>	<b>Computer Index to Nuclear Data:</b> Bibliographical neutron induced reaction information, including experimental, theoretical and evaluation works. It contains references to 275,000 reactions from 55,000 works.
CSISRS	<a href="http://www.nndc.bnl.gov/exfor">www.nndc.bnl.gov/exfor</a>	<b>Cross Section Information Storage and Retrieval System:</b> <sup>4</sup> Experimental nuclear reaction data for incident neutrons, charged particles, and photons. It covers more than 14,000 experiments and is considered “complete” for neutron-induced reaction data.
ENDF	<a href="http://www.nndc.bnl.gov/endl">www.nndc.bnl.gov/endl</a>	<b>Evaluated Nuclear Data File:</b> <sup>5</sup> Recommended reaction data from the ENDF/B-VII, JEFF, JENDL, BROND, and CENDL libraries. It provides data in the ENDF-7 format, covering all nuclides of practical relevance (328 in total) for neutrons up to 20 MeV and partly up to 150 MeV. It serves as principal input for neutronics calculations, including nuclear reactor design, national security, accelerators, criticality safety, shielding, radiation protection, and detector simulation.
ENSDF	<a href="http://www.nndc.bnl.gov/ensdf">www.nndc.bnl.gov/ensdf</a>	<b>Evaluated Nuclear Structure Data File:</b> Recommended nuclear data for 3069 nuclides, organized in over 16,700 individual datasets. It serves as a principal source of data for nuclear structure research, nuclear spectroscopy applications, MIRD, NuDat, and publications such as Nuclear Data Sheets and Table of Isotopes.
XUNDL	<a href="http://www.nndc.bnl.gov/ensdf">www.nndc.bnl.gov/ensdf</a>	<b>Experimental Unevaluated Nuclear Data List:</b> Experimental nuclear structure and decay data covering more than 2,550 recent articles.
MIRD	<a href="http://www.nndc.bnl.gov/mird">www.nndc.bnl.gov/mird</a>	<b>Medical Internal Radiation Dose:</b> Recommended nuclear decay data for over 2,100 radionuclides extracted from ENSDF, processed by the program RadList [1], and presented in the Medical Internal Radiation Dose format.
NuDat	<a href="http://www.nndc.bnl.gov/nudat">www.nndc.bnl.gov/nudat</a>	<b>Nuclear Data:</b> Recommended nuclear structure and decay information for 3175 nuclides, about 158,000 levels, 237,000 $\gamma$ 's, etc. obtained from ENSDF and the Nuclear Wallet Cards [2].
NSR	<a href="http://www.nndc.bnl.gov/nsr">www.nndc.bnl.gov/nsr</a>	<b>Nuclear Science References:</b> Bibliographical nuclear physics information containing over 197,000 nuclear science articles, indexed according to content. It spans almost 100 years of research, and currently covers 80 journals with about 4,300 new articles added each year.

### 3. OTHER RESOURCES

NNDC also provides access to many other resources of interest to the nuclear scientist. These include calculational tools, computer codes, data libraries, and publications.<sup>6</sup> Some of these resources are described below. For a complete list please see [www.nndc.bnl.gov](http://www.nndc.bnl.gov) (Figure 1.)

<sup>3</sup> Contents as of March 24, 2010.

<sup>4</sup> Also known as EXFOR (Exchange Format).

<sup>5</sup> ENDF/B-VII is a product of the Cross Section Evaluation Working Group; the OECD NEA Joint Evaluated File Project produces JEFF; JENDL is a product of the Japanese Nuclear Data Committee; the Russian Nuclear Data Center, FEI, Obninsk produce BROND; and CENDL is produced by the Chinese Nuclear Data Center, CIAE, Beijing.

<sup>6</sup> See [www.nndc.bnl.gov/publications/](http://www.nndc.bnl.gov/publications/) for a complete list.

#### 3.1 Calculational Tools

##### *Q-Value Calculator (QCalc)*<sup>7</sup>

QCalc allows the user to calculate decay or reaction Q-values and threshold energies using the data from the 2003 Atomic Mass Evaluation [6].

#### 3.2 Computer Programs<sup>8</sup>

The ENSDF analysis and utility codes and ENDF utility codes maintained by the NNDC on behalf of the NSDD and CSEWG, respectively, may be downloaded. In addition, nuclear reaction model codes, such as EMPIRE [8], are available.

<sup>7</sup> [www.nndc.bnl.gov/nndc/qcalc/](http://www.nndc.bnl.gov/nndc/qcalc/).

<sup>8</sup> [www.nndc.bnl.gov/nndescr/](http://www.nndc.bnl.gov/nndescr/).

### 3.3 Data Libraries

#### *Atomic Masses*<sup>9</sup>

The Atomic Masses Data Center site is mirrored here and it provides the files associated with the 2003 Atomic Mass Evaluation [6]. Archival versions of the 1995 update to the Atomic Mass Evaluation [5] and earlier evaluations are also available.

### 3.4 Publications

#### *Nuclear Wallet Cards*<sup>10</sup>

The Nuclear Wallet Cards site presents the file updated to latest ENSDF. Besides a periodic table interface to the HTML's corresponding to the seventh edition [2], there is also a periodic table interface to the current data in the Wallet Cards module of NuDat. There is also the ability to download a file of the data in PDA-adaptable Palm Pilot format, and a new booklet (Nuclear Wallet Cards for Radioactive Nuclides [7]) and associated file in PDA-adaptable Palm Pilot format. PDF versions of booklets are also available along with archival versions of previous editions of the Nuclear Wallet Cards.

#### *Thermal Neutron Capture $\gamma$ 's*<sup>11</sup>

Frequently updated, the data on this site are extracted from ENSDF and consist of target and  $\gamma$ -energy ordered tables for 256 target nuclides up to about 12 MeV in energy.

## 4. ACKNOWLEDGMENTS

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<sup>9</sup> [www.nndc.bnl.gov/masses/](http://www.nndc.bnl.gov/masses/).

<sup>10</sup> [www.nndc.bnl.gov/wallet/](http://www.nndc.bnl.gov/wallet/).

<sup>11</sup> [www.nndc.bnl.gov/capgam/](http://www.nndc.bnl.gov/capgam/).