The International Metrology Resource Registry

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IMRR

NIST National Institute of Standards and Technology U.S. Department of Commerce

Goals

- Make it easy to locate metrology resources—data, services, facilities—*with characterization of the quality of the data* across the network of NMIs and Designated Institutes
- Maximize collaboration and coordination of efforts among NMIs
- Establish a global network of metrology resources for the academic and industrial research communities; increase impact

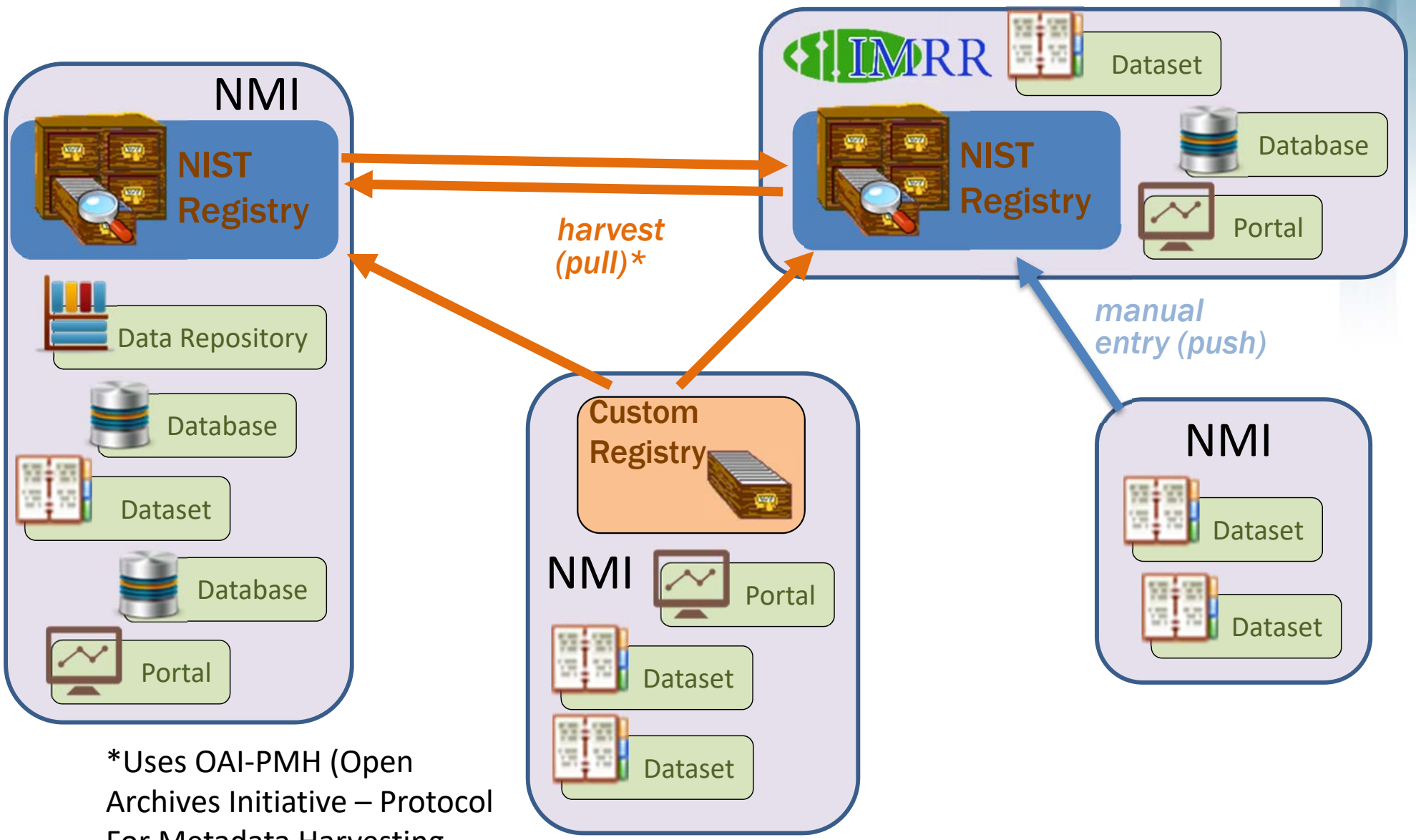
Pilot Project

- Initiated following October 2015 NMI Directors meeting where NIST proposal was discussed
- Participants
  - NIST USA
  - NRC-CNRC Canada
  - PTB Germany
  - NPL UK
  - KRISS Korea
  - VNIIMS Russia
  - NIM China
  - NMII/AIST Japan
  - BIPM

Pilot Project

- Implementation based on Materials Resource Registry developed at NIST
- Modified metadata
  - Metrology rather than materials science focus
  - Data quality characterization
- Federated architecture
  - Large NMIs or RMOs can run their own registries
  - Others can register with registry of their choice
  - Metadata records are synchronized with primary service at BIPM
- Open to NMIs and DIs only
  - Contributors must apply for account
  - Account requests reviewed and vetted
  - Metadata records reviewed

Federation



*Uses OAI-PMH (Open Archives Initiative – Protocol For Metadata Harvesting

ВНИИМС

IMRR

International Metrology Resource Registry Delta

A Collaborative Effort of the International Metrology Community

SEARCH FOR RESOURCES | ADD YOUR RESOURCE

Find Metrology Resources

This system allows for the registration of materials resources, bridging the gap between existing resources and the end users. The International Metrology Resource Registry functions as a centrally located service, making the registered information available for research to the materials community.

This is being developed at the Russian Research Institute for Metrological Service and is made available to solicit comments from the Material Science community. Please do not enter any proprietary data into this system.

Home Page
Services
Search for resources
Add your resource
Login
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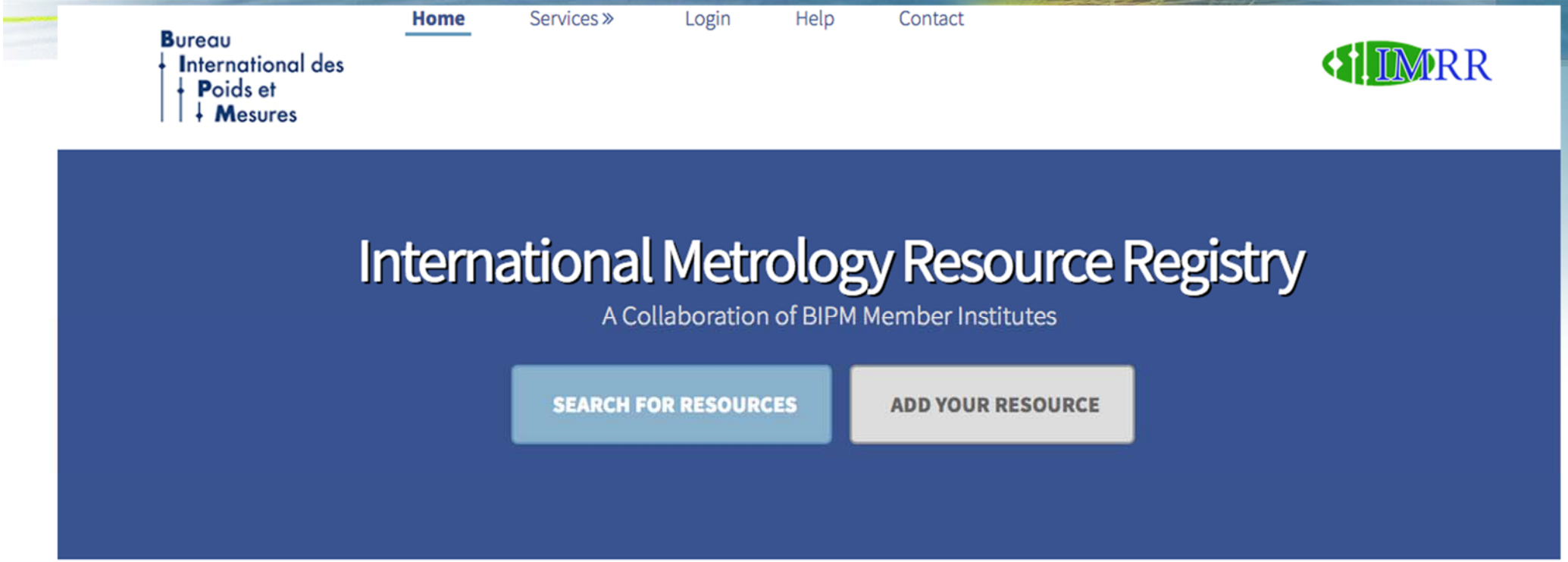
Contact

Demonstration

- http://imrr.bipm.org


Home
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Bureau International des Poids et Mesures
IMRR
International Metrology Resource Registry
A Collaboration of BIPM Member Institutes
SEARCH FOR RESOURCES
ADD YOUR RESOURCE
Find Metrology Resources
This system allows for the registration of resources, bridging the gap between existing resources and the end users. The International Metrology Resource Registry functions as a centrally located service, making the registered information available for research to the global community.
This is being developed at the Bureau International des Poids et Mesures and is made available to solicit comments from the global community. Please do not enter any proprietary data into this system.
Home Page
Services
Search for resources
Add your resource
Login
Help
Contact

International Metrology Resource Registry

Search for Resources

Enter keywords, or leave blank to retrieve all records

All Resources | Participating Institutes | Databases | Datasets | Standards Documents | Data Services | Data Portals | Metrology-related Software and Tools

Search criteria used (Clear all):

Resource Type: ×

58 results

By default, all resources are listed

RESOURCE TYPE: (Clear)

- Database (20)
- Dataset (7)
- Document (13)
- Metrology Institute (9)
- Portal (6)
- Service (1)
- Software (2)

STATUS OF THE DATA: (Clear)

STATUS OF THE DOCUMENT: (Clear)

APPLICATION AREA: (Clear)

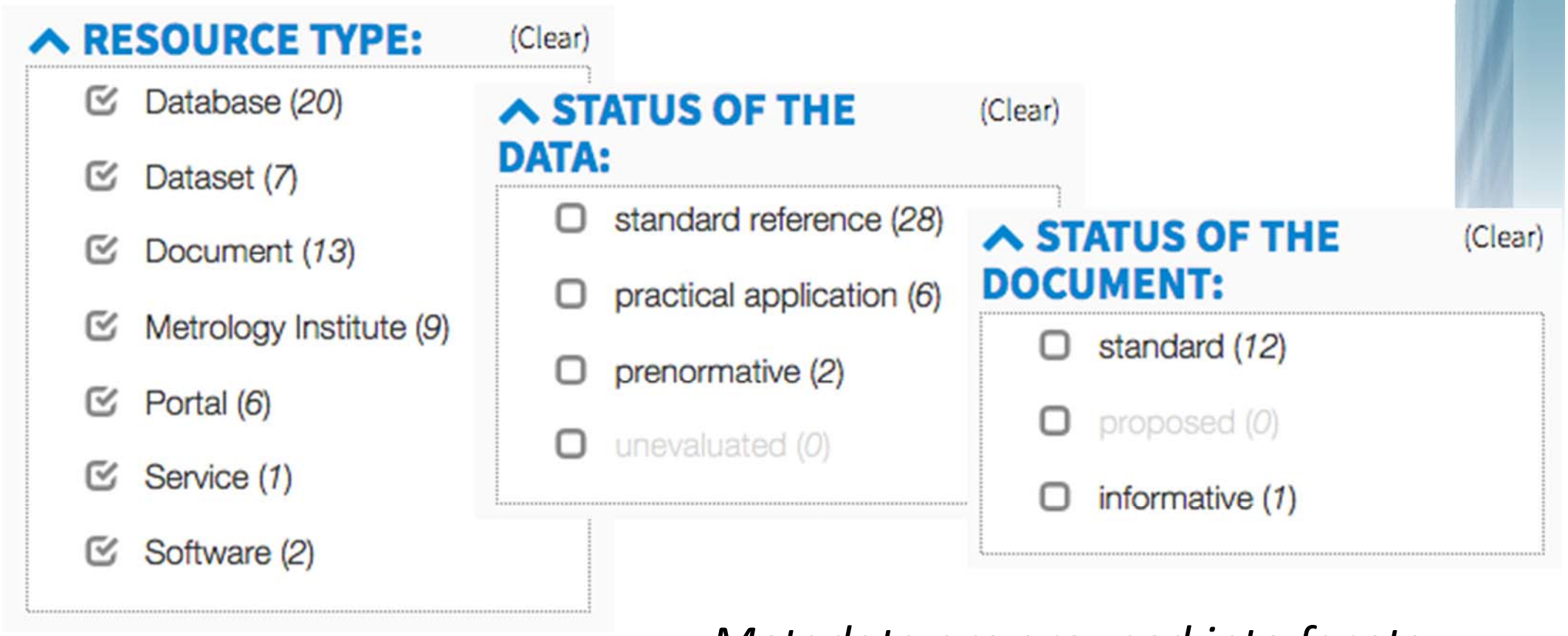
TYPE OF PROPERTIES MEASURED: (Clear)

NIST/EPA Gas Phase Infrared Library (NIST-GPID)
US National Institute of Standards and Technology (NIST) (United States of America)
Home: 10.18434/T45K5N
Subject keyword(s): infrared spectra, vapor phase
This data collection contains 5,228 infrared spectra of different compounds along with chemical structures for most of them. Spectra are provided on a CD-ROM in the JCAMP-DX (Joint Committee for Atomic and Molecular Physical Data "Data Exchange") format. Chemical structures are provided in the MOL-file format. The IR data origin... show more

NIST Standard Reference Data Gateway
US National Institute of Standards and Technology (NIST) (United States of America)
Home: http://srdata.nist.gov/gateway/
Subject keyword(s): standards, standard reference data, metrology, materials, physics, computing, cybersecurity, law enforcement
The NIST Data Gateway is an online system designed to provide users with easy access to NIST scientific and technical data. The Gateway provides (1) direct links to free NIST online systems and full text online versions of many Journal of Physical and Chemical Reference Data (JPCRD) articles, (2) links to descriptions and orderi... show more

NIST Thermophysical Properties of Hydrocarbon Mixtures Database (SRD#4)
US National Institute of Standards and Technology (NIST) (United States of America)
Home: 10.18434/T4CC76
Subject keyword(s): Chemical engineering, chemical manufacturing, chemical property, chemistry, dielectric constants, equation of state, fluids, heat capacity, hydrocarbons, LNG, mixtures, natural gas, petrochemical, phase equilibria, thermal conductivity, thermodynamics, thermophysics, transport property, viscosity

Metadata



Metadata are grouped into facets and use a predefined vocabulary

Metadata

APPLICATION AREA: (Clear)

- [ ] manufacturing/engineering (*15*)
- [ ] medical (*3*)
- [ ] pharmaceutical (*3*)
- [ ] forensics (*2*)
- [ ] fundemental physics (*4*)
- [ ] research (*15*)
- [ ] metrology standards (*12*)
- [ ] other (*1*)

TYPE OF PROPERTIES MEASURED: (Clear)

- [ ] optical (*5*)
- [ ] mechanical (*8*)
- [ ] thermal (*11*)
- [ ] structural (*2*)
- [ ] transport (*7*)
- [ ] deteriorative (*0*)
- [ ] chemical (*8*)

Metadata

GENERAL DATA COLLECTION METHOD:

- [ ] experimental (*20*)
- [ ] observational (*1*)
- [ ] computational (*4*)

TYPE OF MATERIAL STUDIED:

- [ ] organic (*11*)
- [ ] inorganic (*7*)
- [ ] biological (*1*)

AVAILABILITY: (Clear)

- [ ] public (*40*)
- [ ] open-login (*1*)
- [ ] proprietary (*1*)
- [ ] fee-required (*7*)

TYPE OF MEDIA AVAILABLE:

- [ ] CD/CDROM (*1*)
- [ ] DVD/DVDROM (*0*)
- [ ] flash drive (*1*)
- [ ] floppy disc (*0*)
- [ ] other (*1*)

SUPPORTED OPERATING SYSTEMS (Clear)

- [ ] Windows (*2*)
- [ ] Linux (*0*)
- [ ] MacOS (*0*)

IS THE SOURCE CODE AVAILABLE? (Clear)

- [ ] Yes (*0*)
- [ ] No (*1*)

Top level synopsis

Transport properties of fuels (PTB-Th-5en)

Physikalisch-Technische Bundesanstalt (PTB) (Germany)

Home: 10.7795/110.20150622W

Subject keyword(s): fuels, biofuels, fossile fuels, petrol, blends of biofuels, blends of fossile fuels, fuel mixtures, bioethanol, biodiesel, diesel, oil methyl ester, alcanes, ethanol, fluid density, oscillation-type density meter, temperature dependence of fluid density, viscosity, density-dependence of viscosity, thermal expansion coefficient of fluids, temperature conversion coefficient for fuel mixtures, sample stability

In this study measurements of the density and viscosity of mixtures of biofuels and fossil fuels are discussed including their temperature dependence. The blends cover the fuels commercially available in Germany as well as in most parts of Europe. Furthermore, to cover blends with larger percentage of biofuels which may become commercially availabl... show more

Transport properties of fuels

Resource Type: Dataset
Local ID: BG5Z6A0DA5AWSVDDOUO5
Status: active

Descriptive Metadata

Resource Type: Dataset
Title: Transport properties of fuels
Abbreviation: PTB-Th-5en
Publisher: Physikalisch-Technische Bundesanstalt (PTB)
Sponsoring Country Name: Germany
Sponsoring Country Abbrev: DEU
Publication Year: 2015
Home Page Doi: 10.7795/110.20150622W
Contact Name: Physikalisch-Technische Bundesanstalt (PTB)
Contact Email Address: bibliothek@ptb.de
Creator Name: Henning Wolf
Creator Affiliation: Physikalisch-Technische Bundesanstalt
Description:
In this study measurements of the density and viscosity of mixtures of biofuels and fossil fuels are discussed including their temperature dependence. The blends cover the fuels commercially available in Germany as well as in most parts of Europe. Furthermore, to cover blends with larger percentage of biofuels which may become commercially available in future mixture series consisting of 0 % biofuel up to 100 % biofuel were prepared and measured. To gain a better understanding of the fundamental behaviour of the density and viscosity, additional measurements were carried out on pure alkanes and on the mixture series ethanol-hexane and ethanol-nonane. The changes in density and viscosity were compared to the spread of data gained from a collection of samples demonstrating the regional variance of parameters of commercially available and nominal identical fuels in Germany. [Sample long-term stability was monitored over years.]
Subject: fuels, biofuels, fossile fuels, petrol, blends of biofuels, blends of fossile fuels, fuel mixtures, bioethanol, biodiesel, diesel, oil methyl ester, alcanes, ethanol, fluid density, oscillation-type density meter, temperature dependence of fluid density, viscosity, density-dependence of viscosity, thermal expansion coefficient of fluids, temperature conversion coefficient for fuel mixtures, sample stability
Application Area: metrology standards
Data Status: prenormative

Full metadata listing

Access

Rights: public
License Name: Private use is allowed for non-profit purposes only.

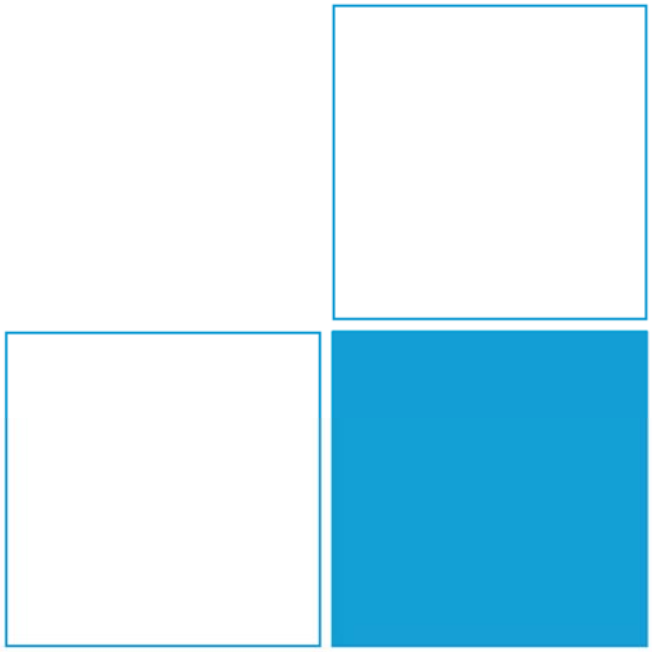
ACCESS VIA DOWNLOAD:
Format: PDF
Access URL: http://dx.doi.org/10.7795/110.20150622W

Link through to the actual resource

PTB bericht Th-5en
Wissenschaftliche Veröffentlichungen
April 2015

Henning Wolf

Transport properties of fuels



ISSN 1614-9327
ISBN 978-3-95606-165-3

Physikalisch-Technische Bundesanstalt ■ Braunschweig und Berlin
Nationales Metrologieinstitut

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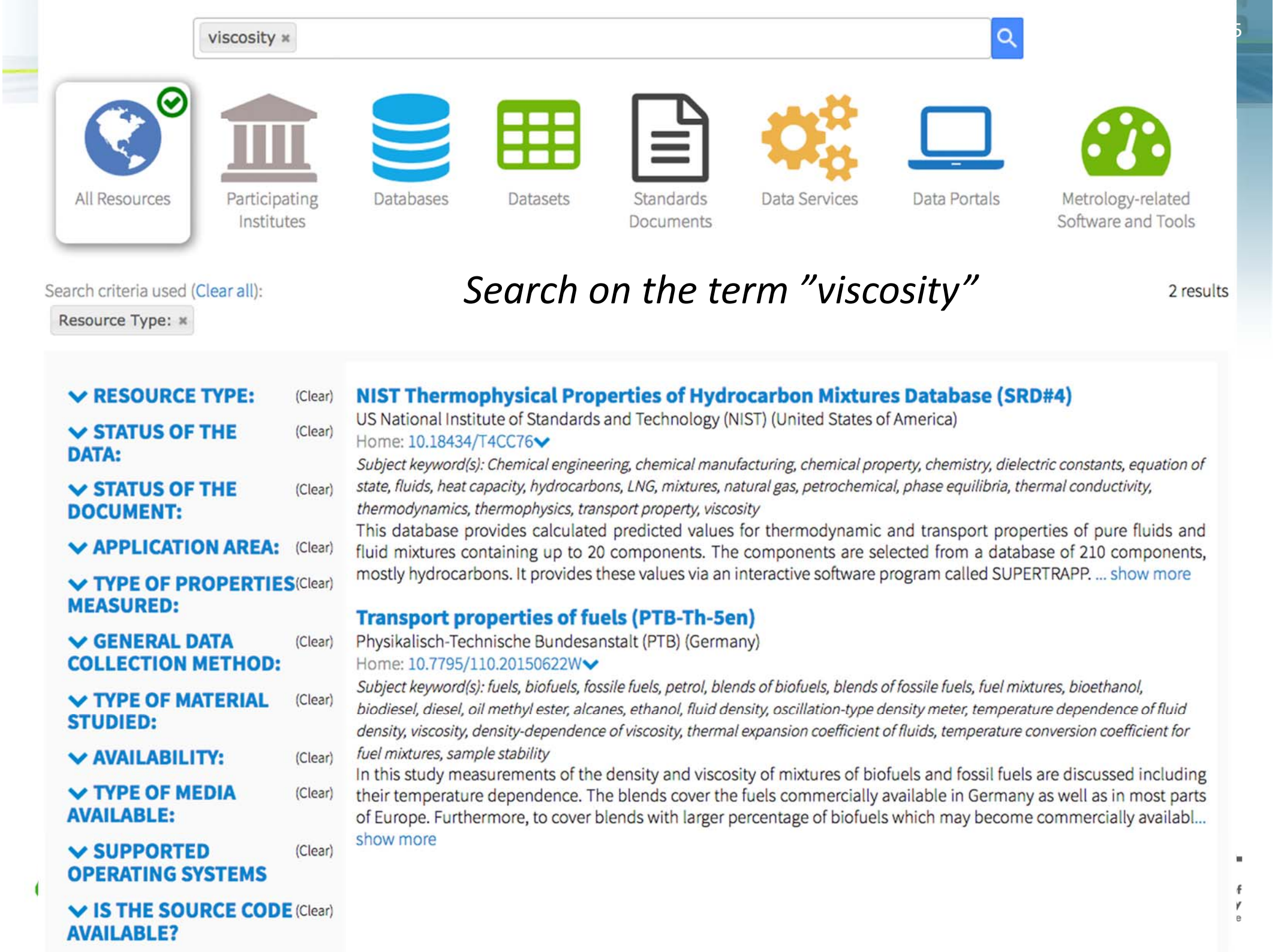
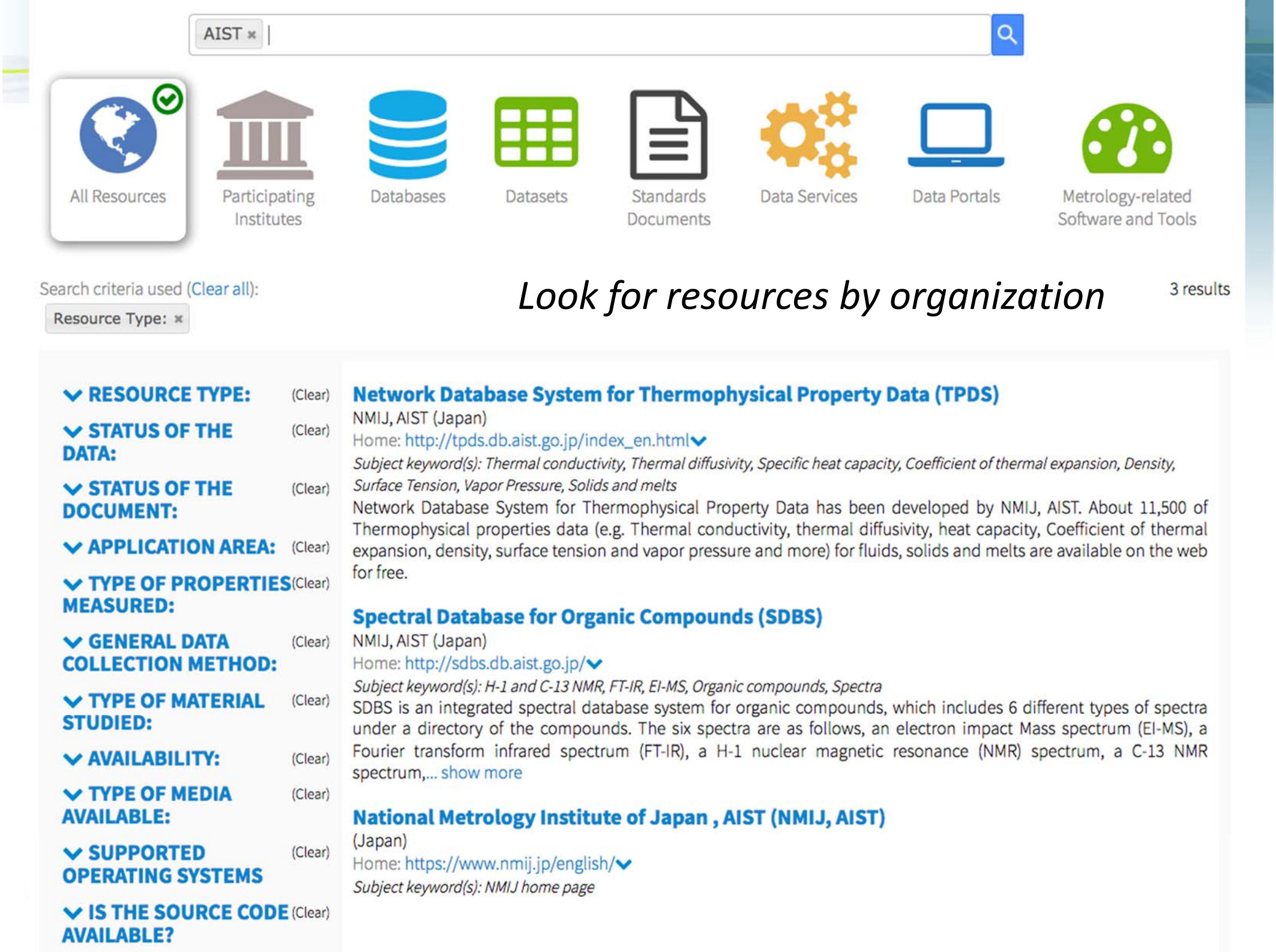
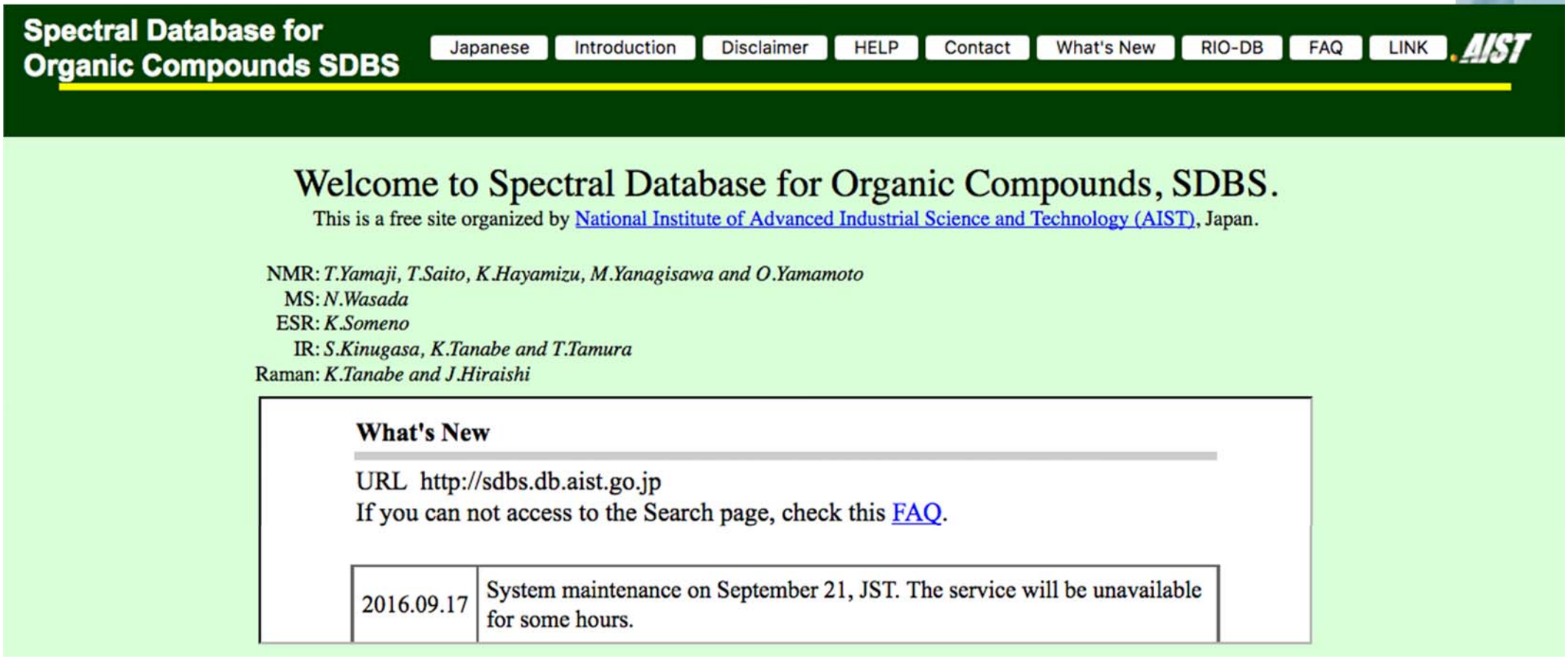
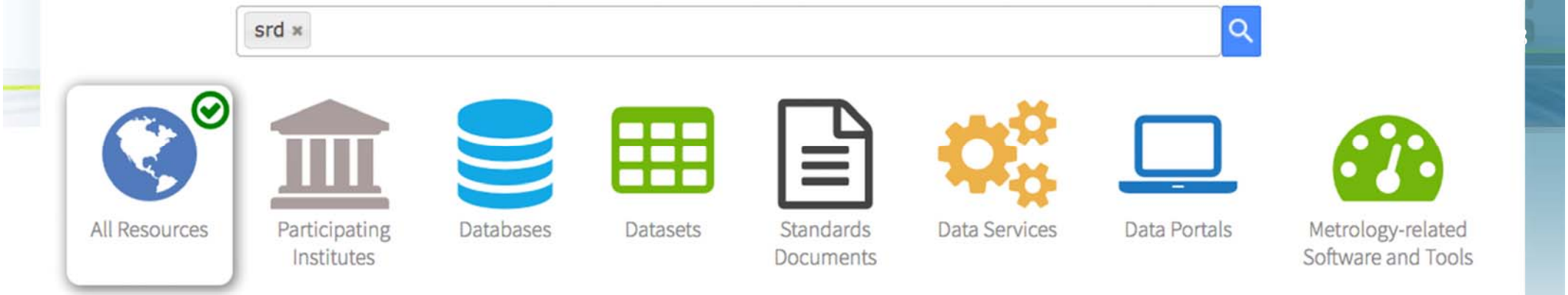


Search on the term "viscosity"


AIST ×
All Resources
Participating Institutes
Databases
Datasets
Standards Documents
Data Services
Data Portals
Metrology-related Software and Tools
Search criteria used (Clear all):
Resource Type: ×
3 results
Look for resources by organization
RESOURCE TYPE: (Clear)
STATUS OF THE DATA: (Clear)
STATUS OF THE DOCUMENT: (Clear)
APPLICATION AREA: (Clear)
TYPE OF PROPERTIES MEASURED: (Clear)
GENERAL DATA COLLECTION METHOD: (Clear)
TYPE OF MATERIAL STUDIED: (Clear)
AVAILABILITY: (Clear)
TYPE OF MEDIA AVAILABLE: (Clear)
SUPPORTED OPERATING SYSTEMS (Clear)
IS THE SOURCE CODE AVAILABLE? (Clear)
Network Database System for Thermophysical Property Data (TPDS)
NMIJ, AIST (Japan)
Home: http://tpds.db.aist.go.jp/index_en.html
Subject keyword(s): Thermal conductivity, Thermal diffusivity, Specific heat capacity, Coefficient of thermal expansion, Density, Surface Tension, Vapor Pressure, Solids and melts
Network Database System for Thermophysical Property Data has been developed by NMIJ, AIST. About 11,500 of Thermophysical properties data (e.g. Thermal conductivity, thermal diffusivity, heat capacity, Coefficient of thermal expansion, density, surface tension and vapor pressure and more) for fluids, solids and melts are available on the web for free.
Spectral Database for Organic Compounds (SDBS)
NMIJ, AIST (Japan)
Home: http://sdbs.db.aist.go.jp/
Subject keyword(s): H-1 and C-13 NMR, FT-IR, EI-MS, Organic compounds, Spectra
SDBS is an integrated spectral database system for organic compounds, which includes 6 different types of spectra under a directory of the compounds. The six spectra are as follows, an electron impact Mass spectrum (EI-MS), a Fourier transform infrared spectrum (FT-IR), a H-1 nuclear magnetic resonance (NMR) spectrum, a C-13 NMR spectrum,... show more
National Metrology Institute of Japan , AIST (NMIJ, AIST)
(Japan)
Home: https://www.nmij.jp/english/
Subject keyword(s): NMIJ home page

Link through to the actual resource





Search on the term "SRD"

Search criteria used (Clear all):

Resource Type: ×

14 results

- RESOURCE TYPE: (Clear)
- STATUS OF THE DATA: (Clear)
- STATUS OF THE DOCUMENT: (Clear)
- APPLICATION AREA: (Clear)
- TYPE OF PROPERTIES MEASURED: (Clear)
- GENERAL DATA COLLECTION METHOD: (Clear)
- TYPE OF MATERIAL STUDIED: (Clear)
- AVAILABILITY: (Clear)
- TYPE OF MEDIA AVAILABLE: (Clear)
- SUPPORTED OPERATING SYSTEMS (Clear)
- IS THE SOURCE CODE AVAILABLE? (Clear)

KRISS National Standard Reference Data (NSRD)

Korea Research Institute Standards and Science(KRISS) (Republic of Korea)

Home: http://www.srd.re.kr

Subject keyword(s): Standard Reference Data

Standard Reference Data is the scientific, technical data and information whose reliability and accuracy are assessed and evaluated by scientist for use in technical problem solving, industrial application, research and development. In accordance with the Enforcement Ordinance of the Framework Act on National Standards, National Center for Standard... show more

NIST Thermophysical Properties of Hydrocarbon Mixtures Database (SRD#4)

US National Institute of Standards and Technology (NIST) (United States of America)

Home: 10.18434/T4CC76

Subject keyword(s): Chemical engineering, chemical manufacturing, chemical property, chemistry, dielectric constants, equation of state, fluids, heat capacity, hydrocarbons, LNG, mixtures, natural gas, petrochemical, phase equilibria, thermal conductivity, thermodynamics, thermophysics, transport property, viscosity

This database provides calculated predicted values for thermodynamic and transport properties of pure fluids and fluid mixtures containing up to 20 components. The components are selected from a database of 210 components, mostly hydrocarbons. It provides these values via an interactive software program called SUPERTRAPP. ... show more

NIST Atomic Spectra Database (NIST-ASD)

US National Institute of Standards and Technology (NIST) (United States of America)

Home: 10.18434/T4W30F

Subject keyword(s): atomic spectra, spectral lines, energy levels, ground state energy, ionization energy

This database provides access and search capability for NIST critically evaluated data on atomic energy levels, wavelengths, and transition probabilities that are kept reasonably up-to-date by the Atomic Spectroscopy Data Center at NIST. The spectroscopic data may be selected and displayed according to wavelengths or energ... show more

Link through to the actual resource

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Bureau International des Poids et Mesures

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SEARCH FOR RESOURCES | ADD YOUR RESOURCE

Find Resources

This system allows for the registration of resources, bridging the gap between existing resources and the end users. The International Metrology Resource Registry functions as a centrally located service, making the registered information available for research to the global community.

This is being developed at the Bureau International des Poids et Mesures and is made available to solicit comments from the global community. Please do not enter any proprietary data into this system.

- Home Page
- Services
  - Search for resources
  - Add your resource
- Dashboard
- Logout
- Help
- Contact

Just Getting Started? Tell us about your institution

Have you just logged in for the first time? Your first step to sharing your metrology data is to describe your institution as provider of data. Start now.

Finished? Thank you! Now users know you have useful data. Next, you can describe some of the data you have available. Start with the most important ones.

Describing Your Data Resources

To describe and share a data resource, choose one of the categories that best describes your resource. (These categories can be somewhat fuzzy, so don't worry too much about picking the wrong one.)

Database - A collection of data that is searchable in some way. Users can either search it on-line through a specialized web site or download the data and search it off-line.

Dataset - A collection of data that are available for download either as a single file or a set of files.

Dataset - An on-line standard or metrology-related document. This is intended primarily for **key standards documents** or supporting documents related to metrology provided directly by a Metrology Institute. Do not register articles published and available through normal journals.

Data Service - A web tool that calculates, analyzes, or otherwise interacts with data. Users may use the service either through a web page or programmatically through an API.

Data Portal - A web site that provides a suite of tools for interacting with a variety of data.

Software or Tool - A metrology-related software library or application. This can include software that calculates data based on standard algorithms, formulae, or parameters.

Add New Database

Please select one of the following options to Add your Resource. You can create a new record, continue editing a previously saved draft, or upload an XML file.

- (•) Create a new record: NMI Database 7
- ( ) Open a saved draft: ---------
- ( ) Upload an existing XML file: Browse... No file selected.

START CANCEL

My Databases | My Resources

Add New Database

Tips:

- "Grey-ed out" labels indicate optional fields; click the plus (+) icon next to it to add a value
- Some fields can take add multiple values, click the plus (+) icon to show additional entry boxes
- To remove values or empty items (that are not required), click the minus (-) icon

Resource: a Database

localid: BTCLCQ5U972X5KMV7ABL

status: active

Resource Type (do not edit): Dataset: Database

Database's Full Name:

Subtitle:

Database's Abbreviation: e.g. initials, acronym, etc.

Publishing Institution:

Home Country:

Publication Year:

Primary Identifier or Location:

Choice: HomePageURL

Database home page URL: http://...

contact

name

emailAddress

creator

contributor

Give a summary of the contents of the database and how users may access it:

Subject keyword: Enter a descriptive term; click …

Application Area:

Metrology Information

Name of property measured:

Type of properties measured:

General Data Collection Method:

Type of material studied:

Material Name:

Commercial or institutional suppplier of material studied:

Key chemical constituent sampled or addressed:

Status of the data: standard reference

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Previous data quality descriptors

Quality Metrics: Please answer the following questions:

- Did the measurements make use of equpment set with standard calibrations, traceable to recognized primary standards and SI units? No (or Don't Know)
- Was a recognized standard method used to obtain the measurements? No (or Don't Know)
- Do the reported values include a full GUM-based characterization of uncertainties? No (or Don't Know)
- Are the reported values based on multi-site (e.g. round-robin) measurements? No (or Don't Know)
- Are the reported values accompanied by a description of the stability and/or maturity of the the samples measured? No (or Don't Know)
- Were the measurements conducted on certified reference materials (as defined by VIM3)? No (or Don't Know)
- Are the reported values accompanied by documentation of certification, a review report, or a reference to a peer-reviewed open-access paper describing the quality of the data? No (or Don't Know)
- Are the reported values compiled through a critical review of values reported in the peer-reviewed literature? No (or Don't Know)

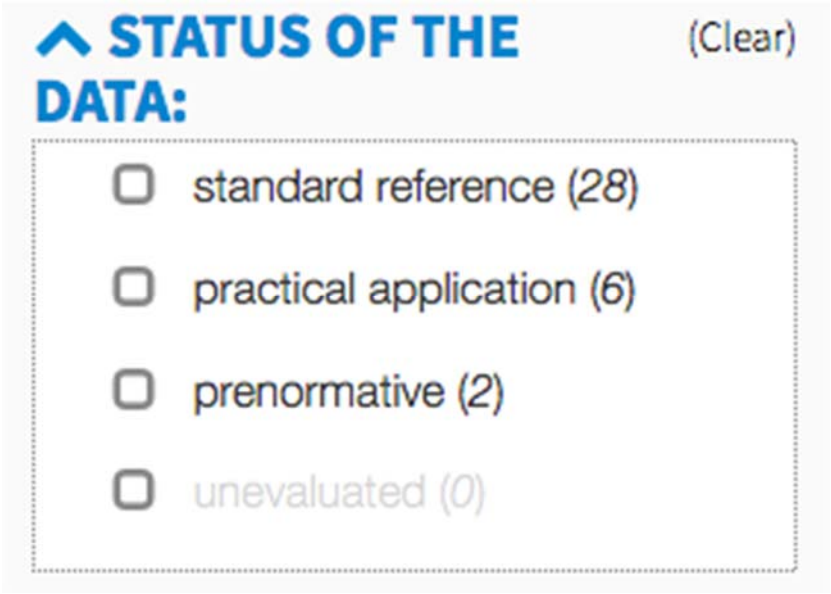
Access Information

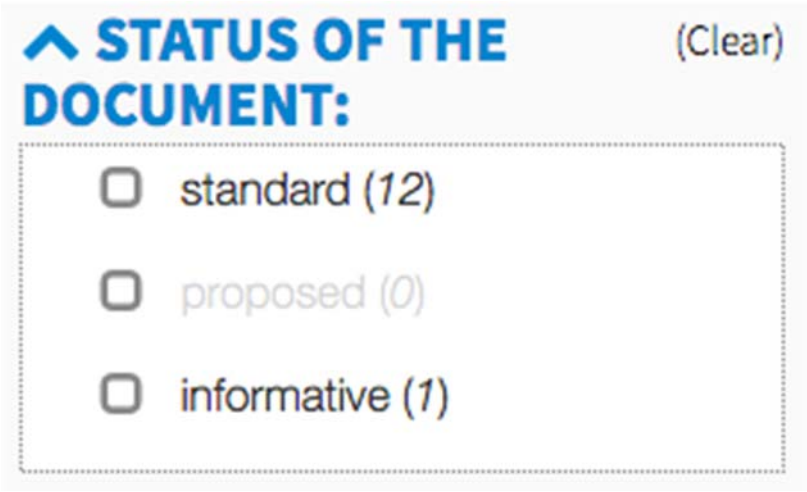
- Availability: public
- License Name:
- URL for Terms of Use:
- Available data access method:

Originally Proposed Quality Metrics

- Did the measurements make use of equipment set with standard calibrations, traceable to recognized primary standards and SI units?
- Was a recognized standard method used to obtain the measurements?
- Do the reported values include a full GUM-based characterization of uncertainties?
- Are the reported values based on multi-site (e.g., round-robin) measurements?
- Are the reported values accompanied by a description of the stability and/or maturity of the samples measured?
- Were the measurements conducted on certified reference materials (as defined by VIM3)?
- Are the reported values accompanied by documentation of certification, a review report, or a reference to a peer-reviewed open-access paper describing the quality of the data?
- Are the reported values compiled through a critical review of values reported in the peer-reviewed literature?

Simpler…





- Answers to original questions were often not known, not applicable
- Too many categories, complicated descriptions
- As publication in the IMRR is only open to NMIs and DIs, we trust their assertions on data quality

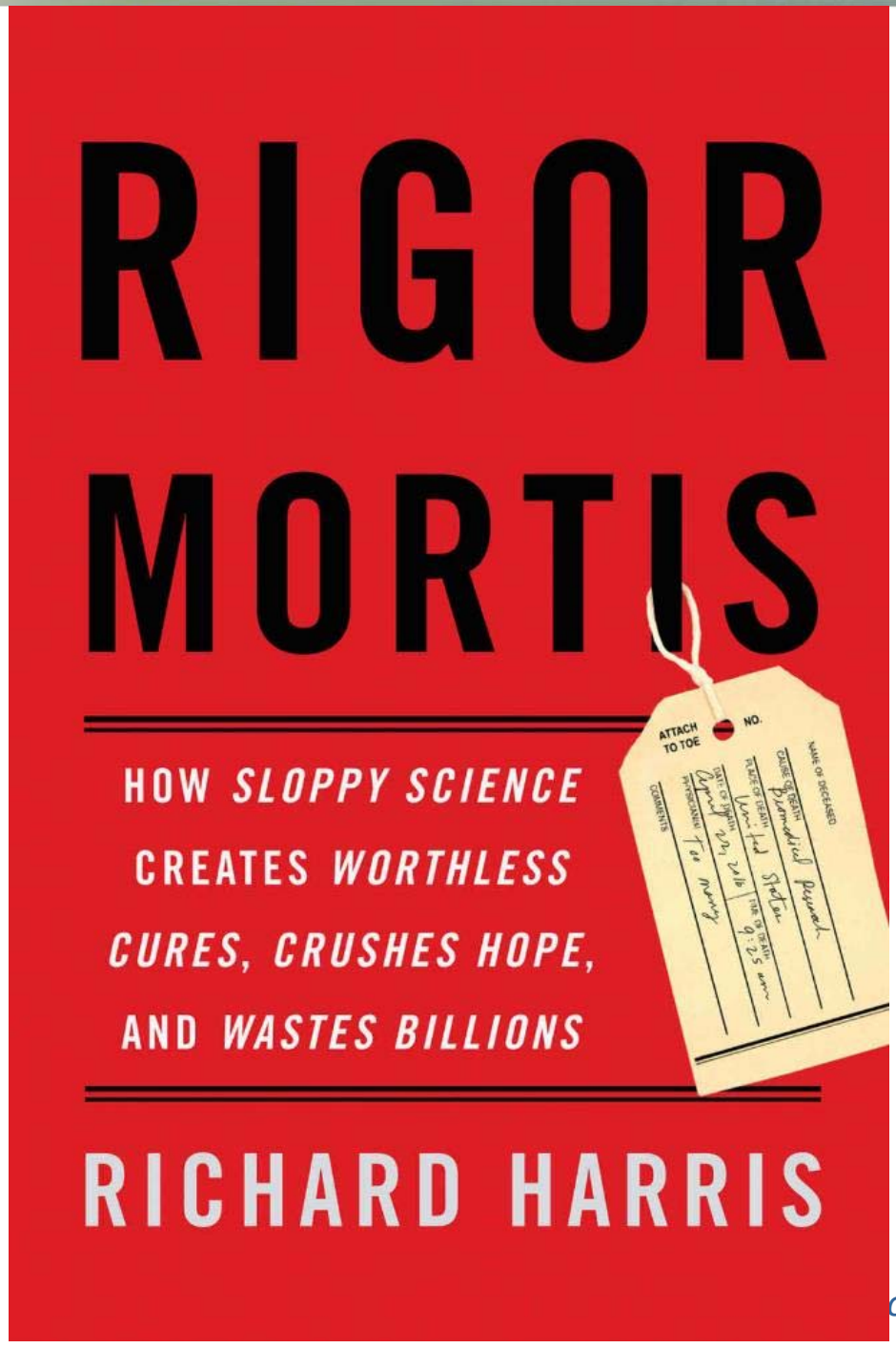
Open for Business?

http://imrr.bipm.org/

Thanks

- NIST: Ray Plante, Sharief Youssef, Pierre Francois Rigodiat, Alden Dima, Mary Brady
- KRISS: Kyung Chae
- PTB: Joachim Meier
- NPL: Graham Sims
- NMIJ: Takeshi Saito
- VNIIMS: Alexander Koslov, Artem Guskov
- BIPM: Andy Henson, Janet Miles, Laurent Le Mée

Reproducibility



Books and popular press reports are making all of science look bad!

Reproducibility

Report on the First IEEE Workshop on the Future of Research Curation and Research Reproducibility

5-6 November 2016
WASHINGTON, DC

Reproducibility and the Components of Research: a Systematic Approach to High Quality Research Studies

A.L. Plant, C. A. Becker, R. J. Hanisch, R.F. Boisvert, A. Possolo

National Institute of Standards and Technology, Gaithersburg, MD 20899

Summary:

The current push for reproducibly is driven by a desire for confidence in research results. A thorough indicator of confidence in research results may be provided by a systematic process for assessing and documenting the sources of uncertainty in a study. A framework to guide systematic assessment of and reporting on sources of uncertainty and ambiguity is suggested.

Reproducibility is not the only indicator of confidence in research results

nature International weekly journal of science

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Archive > Volume 547 > Issue 7664 > Comment > Article

NATURE | COMMENT

Metrology is key to reproducing results

Martyn Sené, Ian Gilmore & Jan-Theodoor Janssen

25 July 2017

Scientists of all stripes must work with measurement experts so that studies can be compared, urge Martyn Sené, Ian Gilmore and Jan-Theodoor Janssen

POLICY FORUM

RESEARCH INTEGRITY

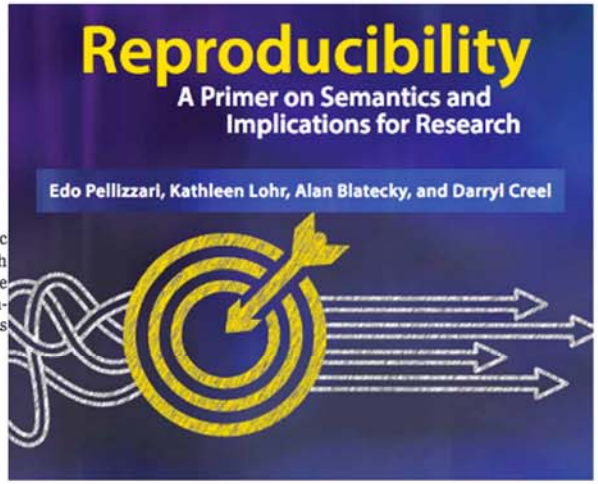
Fostering reproducibility in industry-academia research

Sharing can pose challenges for collaborations

By B. R. Jasny,[1] N. Wigginton,[2] M. McNutt,[3]* T. Bubela,[4] S. Buck,[5] R. Cook-Deegan,[6] T. Gardner,[7] B. Hanson,[8] C. Hustad,[9] V. Kiermer,[10] D. Lazer,[11] A. Lupia,[2] A. Manrai,[12] L. McConnell,[13] K. Noonan,[14] E. Phimister,[15] B. Simon,[16] K. Strandburg,[17] Z. Summers,[18] D. Watts[19]

Many companies have proprietary resources and/or data that are indispensable for research, and academics provide the creative fuel for much early-stage research that leads to industrial innovation. It

$2,000,000 per project (*2*). For academic scientists, an inability to trust research findings means an erosion of confidence from the scientific community, decision-makers, and the general public, as well as the waste of scarce resources.



nature methods
Techniques for life scientists and chemists

Home | Current issue | Comment | Research | Archive | Authors & referees | About the journal

home > archive > issue > commentary > abstract

NATURE METHODS | COMMENTARY

Improved reproducibility by assuring confidence in measurements in biomedical research

Anne L Plant, Laurie E Locascio, Willie E May & Patrick D Gallagher

Affiliations | Corresponding author

Nature Methods **11**, 895–898 (2014) | doi:10.1038/nmeth.3076
Published online 28 August 2014

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Table 1. Components that determine the qualities of a research study.

Planning

- Clear articulation of the goals of the study and the basis for generalizability to other settings, species, conditions, etc., if claimed in the conclusions.
- The experimental design, including variables to be tested, numbers of samples, statistical models to be used, how sampling is performed, etc.
- Preliminary data or evaluations that support the selection of protocols and statistical models.
- Identification and evaluation of assumptions related to anticipated experiments, theories to be used, and methods to analyze results.

Characterization of systemic sources of bias and uncertainty

- Characterization of reagents or samples (e.g. composition, purity, activity, etc.)
- Assessment that experimental equipment is responding correctly (e.g. through use of calibration materials, verification of vendor specifications).
- Positive and negative control experiments and samples are appropriate to the variables being tested.
- Evaluation of local environment (e.g. laboratory conditions such as temperature)

Characterization of the quality of experimental data and protocols

- Acquisition of supplementary data that provide characteristics of the quality of experimental data. These characteristics include precision (i.e., repeatability, reproducibility); accuracy (which can be challenged by applying orthogonal methods or by comparison to a reference material); sensitivity to environmental or experimental perturbants (by performing robustness testing); the dynamic range and response function of the experimental protocol or assay (and assuring that data points are within that valid range);
- Inter-comparison of data using different technicians, laboratories, instruments, etc.

Data reduction and interpretation of results

- Elucidation of the basis for the selected statistical analyses
- Quantification of uncertainties of the values measured
- Evaluation of algorithms, code, software, and analytical models, to be used in analysis of data for robustness and accuracy
- Comparison with previous data and results
- Identification of uncontrolled and other potential sources of bias or uncertainty in the data
- Consideration of feasible alternative interpretations of the data
- Evaluation of the predictive power of models used

Reporting and Dissemination

- Availability of supplementary material that fully describes the experiment/simulation and its analysis
- Public release of well-documented data and code used in the study
- Collection and archiving of metadata that provide documentation related to process details, reagents, other variables.

From Plant, Becker, Hanisch, Boisvert, and Possolo (2017)

NIST Role

NIST leadership of a program to address research reliability includes

- Sponsorship of a workshop, winter/spring 2018, to engage leaders in a variety of research disciplines with interest in addressing reproducibility issues.
- Development of outreach materials and dissemination thereof, through a NIST website, press releases, news articles, etc.
- Long-term engagement with the research community, in collaboration with other NMIs, in the take-up of measurement assurance processes and best practices.

(Memo to K. Rochford, J. Olthoff, 21 July 2017, from Hanisch, Plant, Boisvert, and Possolo)