



Nuclear Energy Sensors Database

Advanced Sensors and Instrumentation (ASI)
Annual Program Webinar
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Project Overview

- Goal and Objective:

- Collect, store, and maintain nuclear energy sensor information so that it can be easily accessed on the web. The site is located at <https://nes.energy.gov/>
 - Expand the number of sensors in the database.
 - Improve, expand or replace existing content.
- Provide mechanisms for the user community involvement (i.e. sensor suggestions, needs suggestions, etc.)
 - Directly interface with reactor operators and national technical directors.
 - Openly requesting input and feedback from the user community.
- Adapt to feedback and new data requirements as needed.

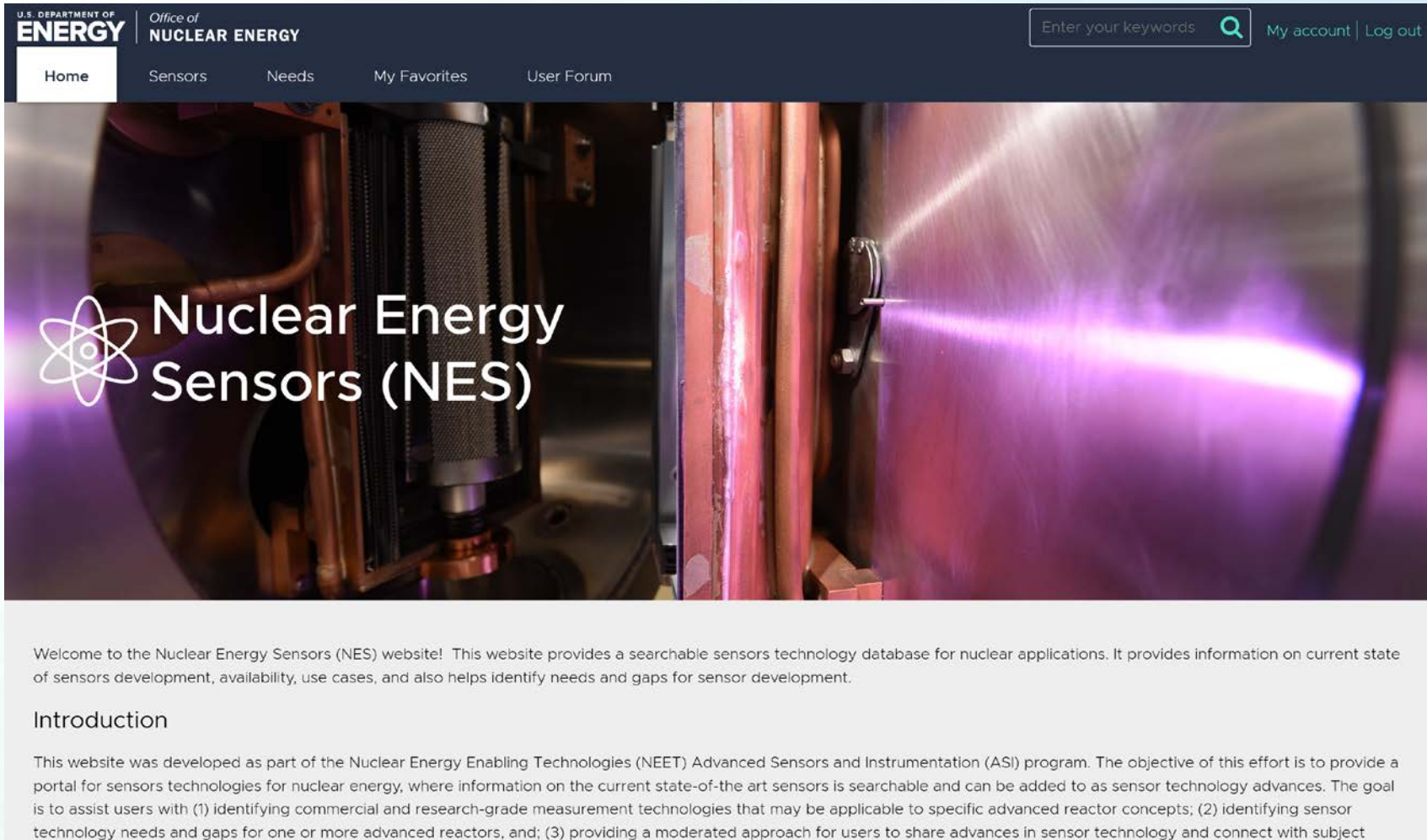
Technology Impact

Nuclear Energy Sensor Website Impacts

- Provides one “go to” searchable database for government, universities, and industry on current sensor technology. The site is maintained and updated at PNNL in Richland, WA.
- Provides a database for sensor gaps that need to be filled, including community voting on priority.
- Potentially build a community of subject matter experts. A forum is included to start the conversation.
- Can be used as a tool for stakeholders in designing and building new nuclear designs and facilities.

Technology Impact (Continued)


Nuclear Energy Sensors Database Home Page




The screenshot shows the home page of the Nuclear Energy Sensors (NES) website. The header features the U.S. Department of Energy logo and the Office of Nuclear Energy. A navigation bar includes links for Home, Sensors, Needs, My Favorites, and User Forum. A search bar with the placeholder text 'Enter your keywords' and a magnifying glass icon is located on the right, along with links for 'My account' and 'Log out'. The main banner image depicts a close-up of a nuclear reactor component with a bright purple laser beam. Overlaid on the left side of the banner is the NES logo, a stylized atom symbol, and the text 'Nuclear Energy Sensors (NES)'. Below the banner, a welcome message states: 'Welcome to the Nuclear Energy Sensors (NES) website! This website provides a searchable sensors technology database for nuclear applications. It provides information on current state of sensors development, availability, use cases, and also helps identify needs and gaps for sensor development.' This is followed by an 'Introduction' section that explains the website's purpose as part of the NEET ASI program, aiming to provide a portal for nuclear sensors technology, with goals including identifying applicable technologies, identifying sensor needs and gaps, and providing a moderated approach for sharing advances and connecting with subject matter experts.

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 Nuclear Energy Sensors (NES)

Welcome to the Nuclear Energy Sensors (NES) website! This website provides a searchable sensors technology database for nuclear applications. It provides information on current state of sensors development, availability, use cases, and also helps identify needs and gaps for sensor development.

Introduction

This website was developed as part of the Nuclear Energy Enabling Technologies (NEET) Advanced Sensors and Instrumentation (ASI) program. The objective of this effort is to provide a portal for sensors technologies for nuclear energy, where information on the current state-of-the art sensors is searchable and can be added to as sensor technology advances. The goal is to assist users with (1) identifying commercial and research-grade measurement technologies that may be applicable to specific advanced reactor concepts; (2) identifying sensor technology needs and gaps for one or more advanced reactors, and; (3) providing a moderated approach for users to share advances in sensor technology and connect with subject

Technology Impact (Continued)

Sensor Listing Page

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FILTERS

Sensor Type

☐ Thermocouple (12)
 ☐ Fission Detector (7)
 ☐ Pressure Sensor (6)
 ☐ Resistance Temperature Device (RTD) (6)
 ☐ Thermometer (6)

✓ Show more

Measurement Type

☐ Temperature (27)
 ☐ Neutron Flux (18)
 ☐ Flow (14)
 ☐ Gamma Radiation (11)
 ☐ Pressure (9)

✓ Show more

Reactor Type

☐ Research Reactor (RR) (58)
 ☐ High-Temperature Reactor (HTR) (45)
 ☐ Sodium Fast Reactor (SFR) (42)
 ☐ Pressurized Water Reactor (PWR) (10)


Sensor Type	Sensor Technology	Measurement Type	Applicable Reactor Type(s)	Plant(s)
Fission chamber		Neutron Flux	RR	> Details
		Gamma Radiation	RR	> Details
Differential Pressure	Differential Pressure Detection	Differential Pressure Detection	RR	> Details
Fluid Resistance	Resistance Measurement	Resistance Measurement	RR	> Details
Differential Pressure	Differential Pressure Detection	Differential Pressure Detection	RR	> Details
Level	Float Switch	Level	RR	> Details
Thermocouple	304 Stainless Steel Probe	Thermocouple	RR	> Details
Scintillation	Phosphor Scintillation Detector	Gross Alpha/Beta Smear/Air Sample Detection	RR	> Details

Technology Impact (Continued)


Example Sensor Detail Page

An official website of the United States government [Here's how you know](#)

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 TC temperatures

DESCRIPTION

A thermocouple is an electrical device consisting of two dissimilar electrical conductors forming an electrical junction. A thermocouple produces a temperature-dependent voltage as a result of Seebeck effect, and this voltage can be interpreted to measure temperature.

Fuel pins were 0.584 cm (0.23 inch) diameter with 0.1422 cm (0.056 inch) wire wrap on a 30.48 cm (12 inch) pitch. 0.6025 cm (0.025 inch) diameter TC were in 0.0254 cm (0.010 inch thick) stainless steel or Inconel 0.142 cm (0.056 inch) OD tube. Thermocouple ends were sealed. Thermocouple leads fit in < 0.236 cm (0.093 inch) OD tube.

DEGRADATION MECHANISM(S)

The accuracy of the FOTA temperature measurement is expected to be within the accuracy range except as affected by 1) short, range ordering in Chromel-P wire 2) signal noise as caused by electrical currents induced in the thermocouple leads due to the reactor environment and 3) any data handling and processing beyond the thermocouple reference temperature junction.

BENEFITS

Provided temperature of sodium flowchannel within core fuel assembly

DETAILS

[Measurement Type](#)
Temperature

[Applicable Reactor Types](#)
Sodium Fast Reactor (SFR)

[Service Life Expectancy](#)
As long as fuel assembly, ~ 1 year or ~400 EFPD

[References](#)
HEDL-400, A Summary Description of the Fast Flux Test Facility, C.P. Cabell, 1980

[Accuracy](#)
greater of 1.1°C or 0.4%

Results and Accomplishments

The website has been available for use since the fall of 2020.

- There are currently a total of 146 Sensors
- There were 94 sensors added between FY21/FY22
- Some examples counts below of Measurement Type, Reactor Type and Sensor Type:
 - Measurement Types (Top values with 3 or more entries):

Temperature	27
Neutron Flux	18
Flow	14
Gamma Radiation	11
Pressure	9
Leak Detection	7
Level	7
Moisture	6
Coolant Flow	4
Count rate of pulses	3
Sodium leaks	3

Results and Accomplishments (Continued)

- Sensor Types (Top values with 3 or more entries):

Thermocouple	12
Fission Detector	7
Pressure Sensor	6
Resistance Temperature Device (RTD)	6
Thermometer	6
Flowmeter	5
Fission chamber	4
Scintillation	4
Unknown/Not declared	4
Boron/Neutron Reaction Detectors	3
Fiber optic	3
Hygrometer	3
Pressure Transmitter	3
Sodium Leak Detector	3
Ultrasonic	3

Results and Accomplishments (Continued)

- Reactor Types (Top values with 3 or more entries):

Research Reactor (RR)	58
High-Temperature Reactor (HTR)	45
Sodium Fast Reactor (SFR)	42
Pressurized Water Reactor (PWR)	10
Boiling Water Reactor (BWR)	8
Molten Salt Reactor (MSR)	8
Pressurized water test reactor (ATR)	3

- Software Development: There have been a number of miscellaneous styling improvements and bug fixes.
- The primary challenge with the project has been gathering data content to post on the site. This is partially a staffing availability issue, so PNNL has hired an intern starting in November 2023. Under the mentorship of Ryan Meyer (PNNL), this intern will be focused half time on collecting sensor data. This includes both new sensors and adding additional details to existing sensors already included in the database.

Concluding Remarks

In FY22:

- PNNL increased sensor count captured in the database.
- Made contacts with industry, universities, and national technical directors for further sensor information.

In FY23:

- PNNL has a dedicated resource to continue expanding the data set and contacts. This includes both new sensors and expanding existing sensor information to include more details.
- Adapt to feedback and sponsor requests related to the software.
- Work with other labs on accepting and posting additional sensor information.

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Thank You