



# Nuclear Energy Sensors Database Website

**Advanced Sensors and Instrumentation  
Annual Webinar**

**October 29, 2020**

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Pacific Northwest National Laboratory

# Project Overview

- Goal and Objective:
  - Collect, store, and maintain nuclear energy sensor information so that it can be easily accessed and queried on the web.
  - Provide mechanisms for the user community to suggest additional sensors and needs/gaps.
  - Adapt to new data requirements as needed.
- Participants 2020
  - Software (PNNL): Tim Downing, Shan Osborn, Tyler Willis, Claudia Hilderbrand, Jeanne Morgan, Isaac Jo, Corey Jenkins
  - Data: Yogi Dayal (INL), David Wootan (PNNL)
- Schedule
  - Version 2.2 deployed. Ongoing operational support, data loading, and development as needed.

# Summary of accomplishments

## FY20 Deliverables

- Version 2.0 (October 2019)
  - Baseline functional requirements for website met
  - Home page, Sensors page, Use Case page, Needs/Gaps page, Search Page, etc.
  - Initial data load based on ORNL/TM-2016/337 R1 “Assessment of Sensor Technologies for Advanced Reactors”
- Version 2.1 (March 2020)
  - New User Forum
  - Improved wizard for suggesting sensors and needs
  - Miscellaneous fixes/improvements

# Summary of accomplishments

## FY20 Deliverables (Continued)

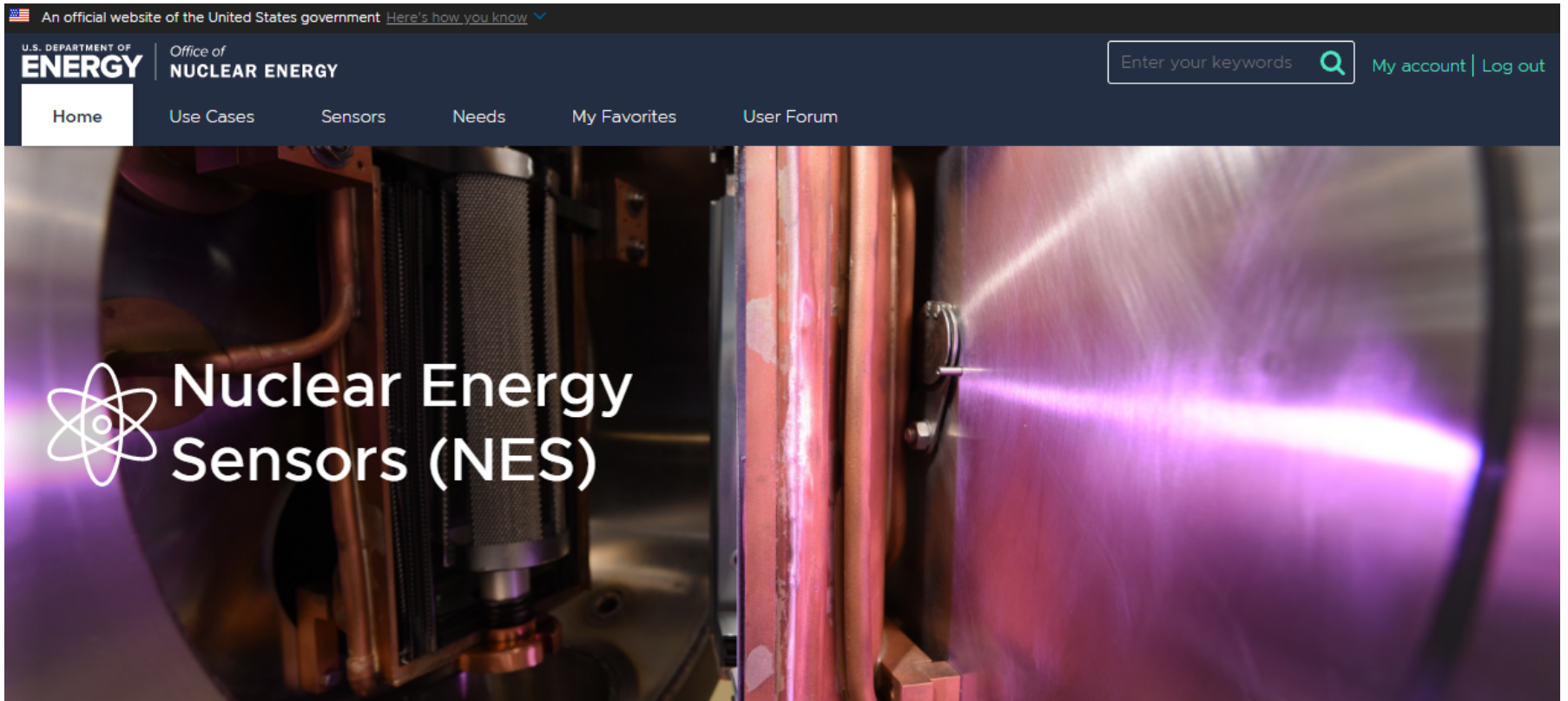
- Version 2.2 (September 2020)
  - Significant expansion of data fields defined to capture NE sensor data
  - Ongoing loading of newly created data content
  - Site wide improvements to “look and feel” based on User Experience (UX) designs
  - Added User Favorites
  - Miscellaneous fixes/improvements

# Technology Impact

## Nuclear Energy Sensor Website Impacts

- Provides one “go to” searchable database for government, universities, and industry on current sensor technology.
- Provides a database for sensor gaps that need to be filled, including community voting on priority.
- Can be used to build a community via the User Forum and ability to suggest sensors and needs.
- Can be used as a tool for stakeholders in designing and building new nuclear designs and facilities.

# Accomplishments – Website Tour – Home Screen



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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 matter experts.

# Accomplishments – Website Tour - Sensors

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### FILTERS

**Sensor Type**

- Thermocouple (7)
- Thermometer (5)
- Unknown/Not declared (4)
- Fission Detector (3)
- Hygrometer (3)
- [Show more](#)

**Measurement Type**

- Temperature (15)
- Flow (14)
- Leak Detection (7)
- Neutron Flux (7)
- Moisture (6)
- [Show more](#)

**Reactor Type**

- High-Temperature Reactor (HTR) (44)
- Sodium Fast Reactor (SFR) (23)
- Molten Salt Reactor (MSR) (6)
- Boiling Water Reactor (BWR) (3)
- MSR (1)

[Suggest a sensor](#)

Sensor Type	Sensor Technology	Measurement Type	Applicable Reactor Type(s)	> Details
Fission Detector	Ionization chamber	Count Per Second	Boiling Water Reactor (BWR)	> Details
Fission Detector	Ionization chamber	Mean Square Voltage	Boiling Water Reactor (BWR)	> Details
Fission Detector	Ionization chamber	Count rate of pulses	Boiling Water Reactor (BWR)	> Details
Thermometer	Vacuum micro-triodes	Temperature	High-Temperature Reactor (HTR)	> Details
Thermometer	Ultrasonic guided wave	Temperature	High-Temperature Reactor (HTR), Sodium Fast Reactor (SFR)	> Details
Thermocouple	Tungsten-rhenium	Temperature	High-Temperature Reactor (HTR)	> Details
		Radioactivity	Molten Salt Reactor (MSR)	> Details
		Tank Weights	MSR	> Details
Strain Gauges	Strain Gauges	Stress and Strain	High-Temperature Reactor (HTR)	> Details

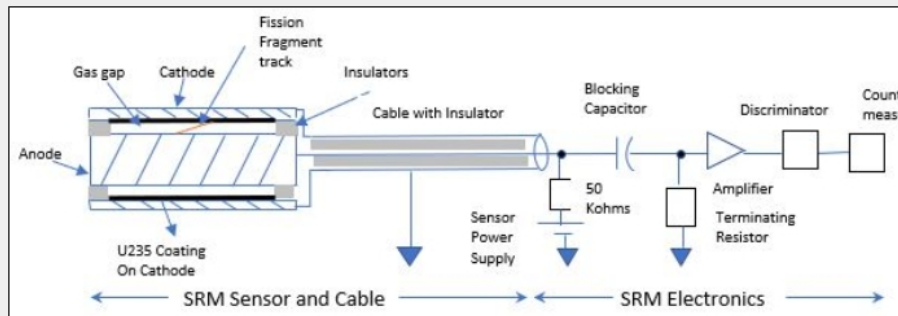
# Accomplishments – Website Tour – Sensor Detail

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## ★ Startup Range Monitor (SRM)



### BENEFITS

Measurement of neutron flux during reactor startup, and assuring flux stays under safe limits.

### Needs and Gaps

### Use Case(s)

### Operating Environment

#### Assessed Priority

#### Accuracy

Low

No significant changes needed for BWR application. For other applications the accuracy at high count rates (>1E6 CPS) can be improved, if needed, by shortening the pulse width by adding a few percent nitrogen to fill gas which increases ion mobility.

[View Details](#)

### DETAILS

#### Description

Count rate increases linearly with neutron flux.

#### Measurement Type

Count rate of pulses

#### Applicable Reactor Types

Boiling Water Reactor (BWR)

#### Manufacturer

General Electric / Reuter-Stokes

#### Manufacturer Part Number

GE 175A8239

#### Detector Element Design

Concentric cylindrical Anode/Cathode design; Sensitive length 1 in ; External material 304 SS; Overall length 1.62 in and diam 0.265 in; Anode to Cathode Gas gap 0.0195 in. Fill gas Argon pressure 1110 cm Hg; U235 fission coating (-1 mg/cm<sup>2</sup>) on Titanium cathode.

#### Detection Sensitivity

Neutron Sensitivity 6E-3 +/- 20% (CPS/BWR nv);  
Operating Voltage 350 Volts

#### Sensitivity to Background

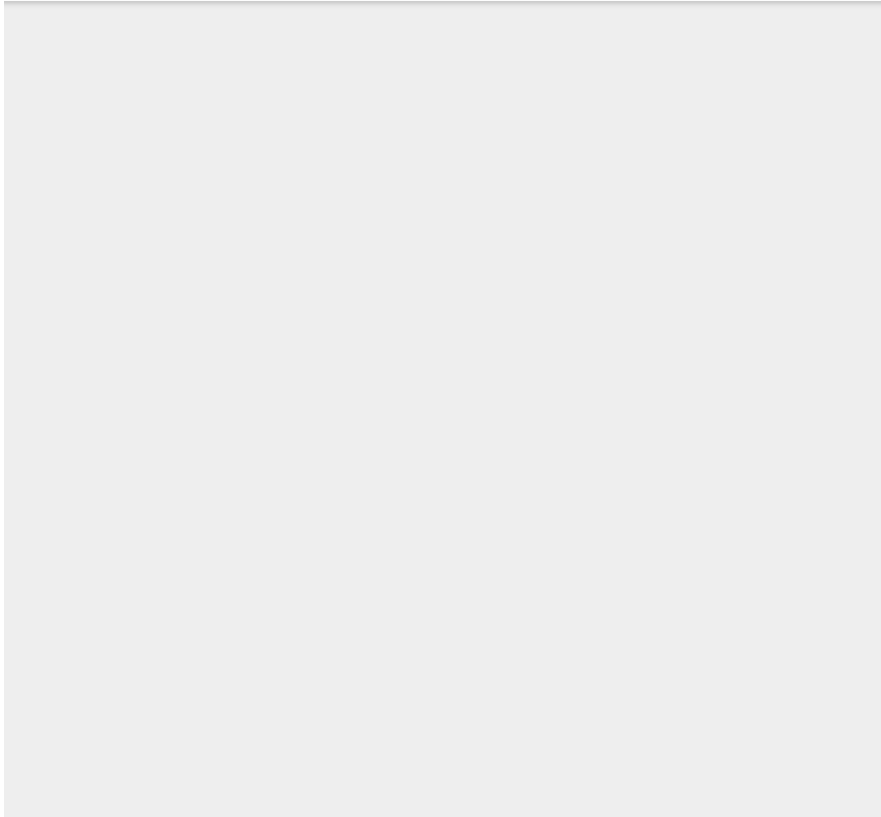
Background noise above discriminator setting is 1 cps at shutdown due to gammas and electronic noise.

Background noise becomes negligible as power increases.



# Accomplishments – Website Tour – Sensor Detail

Assessed Priority	Accuracy	
Low	No significant changes needed for BWR application. For other applications the accuracy at high count rates (>1E6 CPS) can be improved, if needed, by shortening the pulse width by adding a few percent nitrogen to fill gas which increases ion mobility.	<a href="#">View Details</a>



## Detection Sensitivity

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## Sensitivity to Background

Background noise above discriminator setting is 1 cps at shutdown due to gammas and electronic noise.  
Background noise becomes negligible as power increases.

## Response time

Response time at shutdown ~10 sec for enough statistical counts; Response time much faster as flux and power is increased and count rate increases.

## Measurement Range

1E3 to 1E9 BWR nv; Startup to 1E-3% Reactor Power

## Service Life Expectancy

7 Years

## Degradation Mechanism(s)

No significant sensitivity decrease because of relative small residence time in the reactor at startup power conditions.

## 10-year Availability Forecast

SRM is available, but can be replaced with newly developed Wide-Range Monitor (WRM) which combines the functionality of both SRM and IRM.

## References

GE and Reuter-Stokes manuals

## Available Alternatives


WRM

## Modularity (Replaceability)

Replaceable

## Downloads

## DETAILS

 [Sensor Data Base Information - Report 1.1.1 Rev 0 - BWR SRM\\_2.pdf](#)

# Accomplishments – Website Tour – Suggest Sensor

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✓ You have already submitted this webform. [View your previous submission.](#)

Suggest a sensor to be added to this database. Please fill out as much information as possible. One of our subject matter experts may reach out to you with questions or for clarification, if necessary. Please be sure to let us know why you think this sensor should be added, as well.

Thank you.

1. A Little About You — 2. Suggestion Details — 3. Suggestion Description — 4. Complete

### CONTACT INFORMATION

Full Name  \*

Organization  our contact information so that our subject matter experts may follow up with you if they have questions or need clarification on your suggestion.

Email  \*

Phone

Area of Expertise  
(e.g., Radiation protection, Reactor operation, etc.)

# Accomplishments – Website Tour – Suggest Sensor

1. A Little About You

2. Suggestion Details

3. Suggestion Description

4. Complete

Suggestion Type \* Sensor

## SENSOR DETAILS

Sensor Type

- None -

Sensor Technology

- None -

Measurement Type

- None -

Construction Material

## APPLICABLE REACTOR TYPES

Advanced Gas-Cooled Reactor (AGR)	<input type="checkbox"/>
Boiling Water Reactor (BWR)	<input type="checkbox"/>
MSR	<input type="checkbox"/>
Advanced Reactor (AdvRx)	<input type="checkbox"/>
High-Temperature Reactor (HTR)	<input type="checkbox"/>

< Previous Page

Reset

Next

# Accomplishments – Website Tour – Suggest Sensor

Suggest a sensor to be added to this database. Please fill out as much information as possible. One of our subject matter experts may reach out to you with questions or for clarification, if necessary. Please be sure to let us know why you think this sensor should be added, as well.

Thank you.

1. A Little About You

2. Suggestion Details

3. Suggestion Description

4. Complete

## DETAILED DESCRIPTION

Detailed Description \*

< Previous Page

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# Accomplishments – Website Tour – Needs/Gaps

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**FILTERS**

**Reactor Type**

- High-Temperature Reactor (HTR) (27)
- Sodium Fast Reactor (SFR) (16)
- Boiling Water Reactor (BWR) (1)

**TRL**

- 1 (2)
- 2 (10)
- 3 (6)
- 4 (1)

[Identify a need](#)

**TRL** **Reactor Type**

- 2 High-Temperature Reactor (HTR), Sodium Fast Reactor (SFR) [> Details](#)
- 1 Sodium Fast Reactor (SFR) [> Details](#)
- High-Temperature Reactor (HTR) [> Details](#)
- 2 High-Temperature Reactor (HTR), Sodium Fast Reactor (SFR) [> Details](#)
- 3 Sodium Fast Reactor (SFR) [> Details](#)
- High-Temperature Reactor (HTR) [> Details](#)
- 2 High-Temperature Reactor (HTR), Sodium Fast Reactor (SFR) [> Details](#)
- High-Temperature Reactor (HTR) [> Details](#)
- 2 High-Temperature Reactor (HTR) [> Details](#)
- High-Temperature Reactor (HTR), Sodium Fast Reactor (SFR) [> Details](#)

# Accomplishments – Website Tour – Use Cases

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### FILTERS

**Sensor Type**

- Thermocouple (5)
- Fission Detector (4)
- Fission Chamber or Boron Lined Proportional counter (3)
- Compensated DC ionization chambers (2)
- Compensated DC ionization chambers and fission chambers (2)

[Show more](#)

**Reactor Type**

- High-Temperature Reactor (HTR) (77)
- Sodium Fast Reactor (SFR) (8)
- Molten Salt Reactor (MSR) (3)
- Boiling Water Reactor (BWR) (1)

**Plant**

- Experimental Breeder Reactor II (EBR-II) (8)
- Peach Bottom (7)
- Fort Saint Vrain (FSV) (6)
- High Temperature Test Reactor (HTTR) (4)
- MSRE (4)


[Show more](#)

Plant	Reactor Type	System Location	
Peach Bottom	High-Temperature Reactor (HTR)	Fuel spines	<a href="#">&gt; Details</a>
Peach Bottom	High-Temperature Reactor (HTR)	Fuel element	<a href="#">&gt; Details</a>
Fort Saint Vrain (FSV)	High-Temperature Reactor (HTR)	Other/Multiple locations	<a href="#">&gt; Details</a>
High Temperature Test Reactor (HTTR)	High-Temperature Reactor (HTR)		<a href="#">&gt; Details</a>
MSRE			<a href="#">&gt; Details</a>
Fort Saint Vrain (FSV)	High-Temperature Reactor (HTR)	Reactor vessel	<a href="#">&gt; Details</a>
Peach Bottom	High-Temperature Reactor (HTR)	Inlet/Outlet of steam generator	<a href="#">&gt; Details</a>
Fort Saint Vrain (FSV)	High-Temperature Reactor (HTR)	Reactor coolant	<a href="#">&gt; Details</a>
HTR-10	High-Temperature Reactor (HTR)	Inlet/Outlet of core	<a href="#">&gt; Details</a>
Experimental Breeder Reactor II (EBR-II)	Sodium Fast Reactor (SFR)	Inlet/Outlet of core	<a href="#">&gt; Details</a>
Experimental Breeder Reactor II (EBR-II)	Sodium Fast Reactor (SFR)	Inlet/Outlet of core	<a href="#">&gt; Details</a>


# Accomplishments – Website Tour - Search

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temperature 

Displaying results 1 - 20 of 44

**S70-High-temperature acoustic surveillance microphone/High-temperature acoustic surveillance microphone**  
... leak of SGs and sodium boiling due to fuel pin failure in core LiNbO<sub>3</sub> 38 283 138 89 33 S70-High-**temperature** acoustic surveillance microphone/High-**temperature** acoustic surveillance microphone ...

**NG49-S70-High-temperature acoustic surveillance microphone/High-temperature acoustic surveillance microphone**  
... fuel-pin or components monitoring of nuclear facility in harsh environments Laboratory scale At-**temperature** and pressure activated environment 2 282 152 NG49-S70-High-**temperature** acoustic surveillance microphone/High-**temperature** acoustic surveillance microphone ... In-core fuel-pin or components monitoring of ...

**S67-Fission chamber/High temperature fission chamber**  
... 56 Compare their performance with high-**temperature** SiC neutron detectors. 19 278 No suitable neutron flux measurement technology is commercially available that functions at **temperatures** above 550 °C. The failure of fission chambers at high **temperatures** is most commonly due to metallic deposits, which arise from evaporation of ...

**NG48-S68-High- Temperature and High-Radiation Tolerant Acoustic Sensor Materials/High- Temperature and High-Radiation Tolerant Acoustic Sensor Materials**  
... 56 New custom piezoelectric sensor materials (potential materials: ZnO, AlN) High **temperature** piezoelectric materials have relatively low sensitivity and have limited lifetime at **temperature** Bench-scale fabrication and testing At relevant **temperature** and equivalent dose (ion beam) 2 279 151 NG48-S68-High- **Temperature** and ...

**S68-High- Temperature and High-Radiation Tolerant Acoustic Sensor Materials/High- Temperature and High-Radiation Tolerant Acoustic Sensor Materials**

**FILTERS**

**Measurement Type**

- Flow (5)
- Temperature (5)
- Moisture (2)
- Fuel Element Failure Detection (1)
- Loose Parts Monitoring (1)
- [Show more](#)

**Sensor Type**

- Hygrometer (2)
- Thermometer (2)
- Acoustic (1)
- Fiber optic (1)
- Fission chamber (1)
- [Show more](#)

**Reactor Type**

- High-Temperature Reactor (HTR) (28)
- Sodium Fast Reactor (SFR) (14)

# Accomplishments – Website Tour – User Forum

The screenshot shows the 'User Forum' section of the U.S. Department of Energy website. The header includes the U.S. Department of Energy logo and navigation links for Home, Use Cases, Sensors, Needs, My Favorites, and User Forum. A search bar and 'My account | Log out' link are also present. Below the navigation, there are filters for forum categories: - Any -, General Discussion, Get Involved, Sensors, and Vendors. A 'Create Forum Post' button is located on the right. The main content area displays four forum topics, each with a welcome message, the most recent post by Tim, the date and time, and the category name. Each topic has a comment icon with a zero count.

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Home Use Cases Sensors Needs My Favorites **User Forum**

- Any - General Discussion Get Involved Sensors Vendors [Create Forum Post](#)

Welcome to the "Vendors" forum topic...  
Most recent by Tim • Mar 20, 9:00AM • Vendors



Welcome to the "Sensors" forum topic...  
Most recent by Tim • Mar 20, 8:59AM • Sensors

Welcome to the "Get Involved" section of the forum  
Most recent by Tim • Mar 20, 8:57AM • Get Involved


Welcome to the General Discussion page of the forum...  
Most recent by Tim • Mar 20, 8:55AM • General Discussion



# Accomplishments – Website Tour - Register

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Email address \*

A valid email address. All emails from the system will be sent to this address. The email address is not made public and will only be used if you wish to receive a new password or wish to receive certain news or notifications by email.

Username \*

Several special characters are allowed, including space, period (.), hyphen (-), apostrophe ('), underscore (\_), and the @ sign.

Full Name

Picture

 No file chosen 

Your virtual face or picture.  
One file only.  
800 MB limit.  
Allowed types: png gif jpg jpeg.

# Conclusion

Summary: The Nuclear Energy Sensors Website provides a resource for the Nuclear Energy Industry to maintain searchable information on current technology and help guide R&D for the future. It can be expanded as needed to maintain additional information.

URL: <https://nes.energy.gov/>

- Questions?
- Tim Downing ([tim.downing@pnl.gov](mailto:tim.downing@pnl.gov)) for any additional questions that may not be answered during the webinar.