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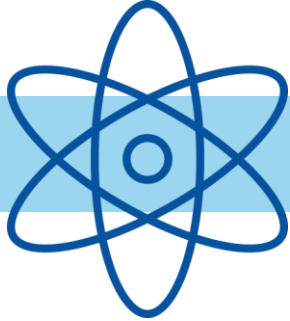
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# **Nuclear Energy Sensors (NES) website overview**

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



## Searchable sensors technology database for nuclear applications

- Availability
- Use cases
- Current state of sensor developments
- Identification of needs and gaps for sensor development

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- Develop and maintain an open access website serving as database of sensors and instrumentation used in nuclear energy systems and related applications
  - NES Database accessible at <https://nes.energy.gov/> as part of the Nuclear Energy Enabling Technologies (NEET) Advanced Sensors and Instrumentation (ASI) program
  - Scope include sensors for operating nuclear power plants, advanced reactors under development and nuclear materials and fuels qualification test
  - The objective is to provide reliable and easily accessible reference data for designers of advanced reactors and related demonstration facilities
  - NES is an interactive database – users can suggest modifications or request additions based on their needs

# NES Technical Content

- Sensors grouped by type of reactor and parameter measurements (e.g. Neutron Flux, Primary Flow, Temperature, Pressure, etc.)
- Parameters may be linked to multiple technologies depending on the measurement range (e.g. for neutron flux measurement, different sensors can be used for source range, intermediate range, wide range, power range)

High-level descriptions of the following sensor properties:

- Requirement for measurement
- Physics of sensor measurement process
- Sensor environment
- Sensor installation in and around the reactor
- Sensor measurement electronics
- Sketches and specifications of sensor and cable, if available
- Availability of sensor and electronics from vendors
- Development needs

Objective: NES Database  
Describes Relevant Sensors  
with Appropriate Level of Detail

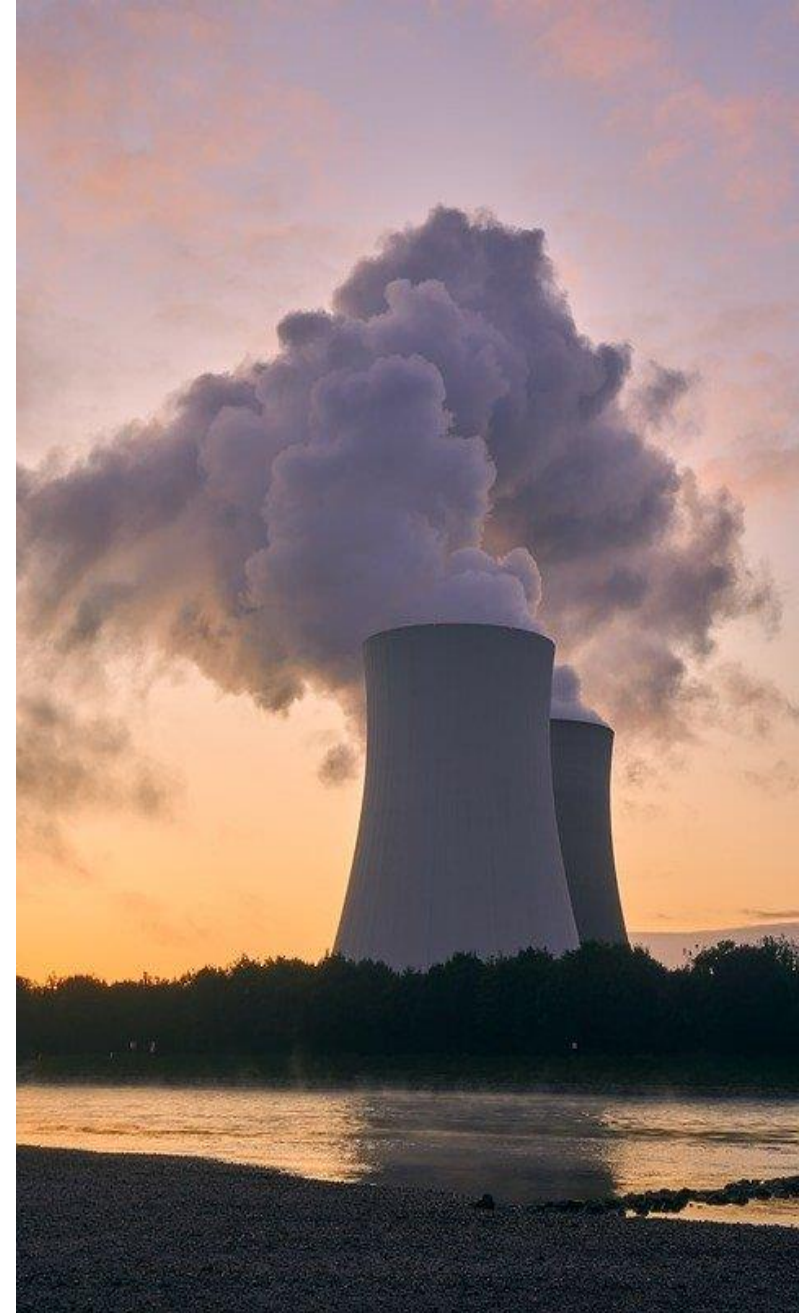
# Example – BWR Neutron Flux Monitors

Several BWR In-Core Neutron Flux Monitors

- Startup Range Monitor (SRM)
- Intermediate Range
- Wide Range
- Power Range
- Traversing In-core Probes (TIPs - Neutron and gamma)

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

BWR Neutron Flux Monitors extensively used – Significant Level of Detail Available



# Example – BWR Startup Range Monitor (SRM)

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

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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

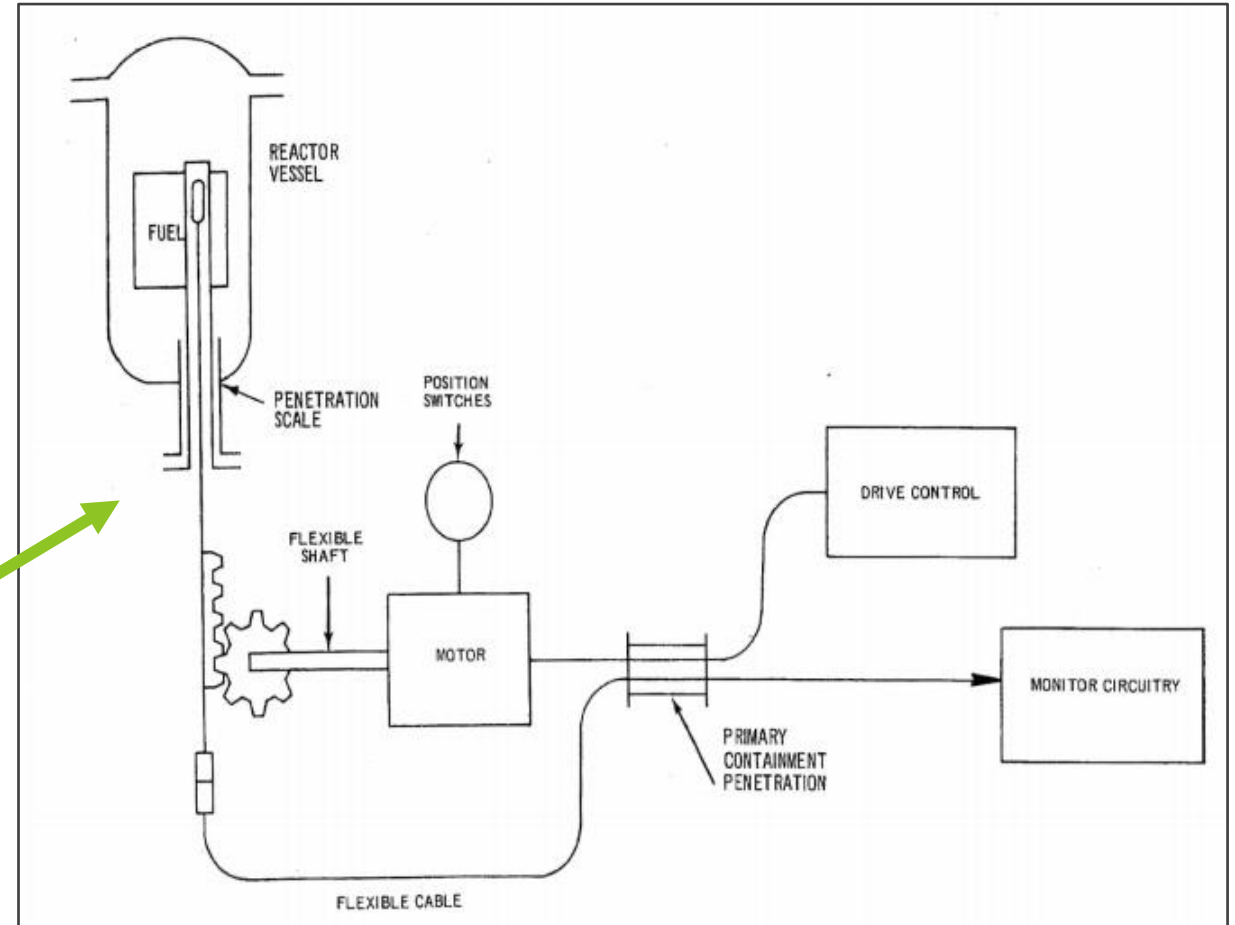
**Sensitivity to Background**  
Background noise above discriminator setting is 1 cps at shutdown due to gammas and electronic noise.  
Background noise becomes negligible as power increases.

# Example – BWR SRM Installation

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

Downloads  
**DETAILS**

 [Sensor Data Base Information - Report 1.1 Rev 0 - BWR SRM\\_2.pdf](#)

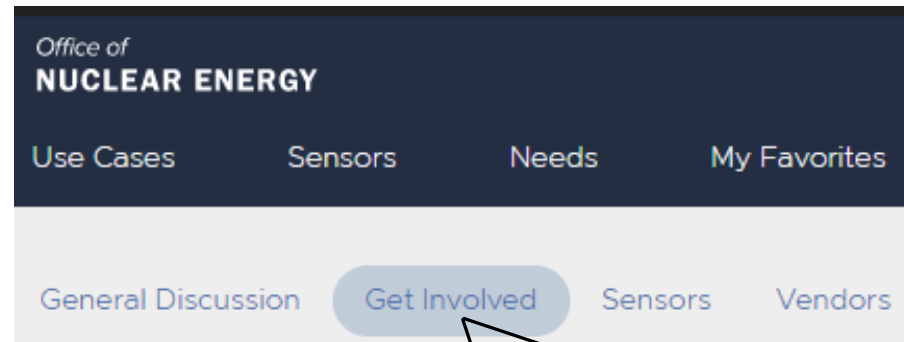


*A functional installation sketch of the SRM system in a BWR*



# Current Status

- Current Scope FY20 accomplishments
  - Developed NES framework (PNNL)
  - Content development: example only



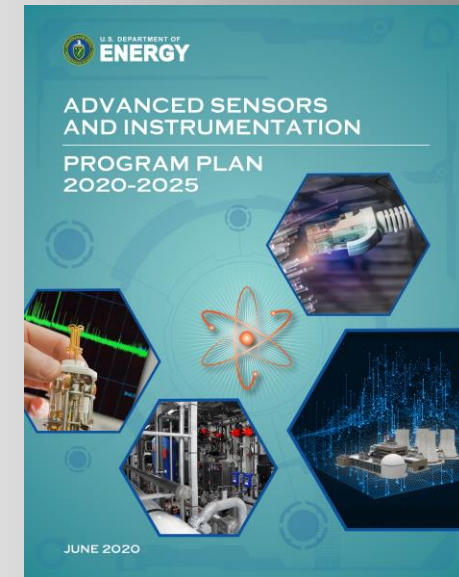
- FY21 planned activities
  - Neutron Flux Sensors
    - BWR, SFR completed
    - PWR, HTGR next
    - Molten Salt and other Advanced Reactors
  - Temperature Sensors
  - Flow Sensors
- Future Scope
  - Other reactor parameter measurement sensors
  - Document sensor qualification process

# Key Challenges

- State of the art I&C technology is not sufficient to fulfill advanced reactors design requirements in terms of:
  - operating conditions
  - accuracy
  - reliability
- Sensor development and demonstration is needed but programs and nuclear vendor cannot take on development risk (cost, schedule) and the business case is limited for instrumentation supplier engagement

# Solutions

Gap assessment:  
the scope of this webinar





# Key Challenges

- For advanced reactors operation (i.e. autonomous control) measurement system development should be integrated in early phases of system design and demonstration
- A standardized qualification process for advanced I&C technologies must be defined in compliance with all stakeholder requirements (ie, DOE, NRC, etc.)

# Solutions

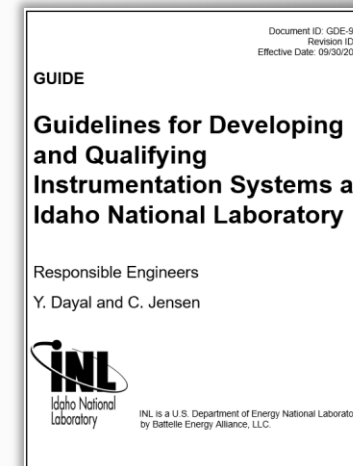
Deploy advanced I&C in demonstration testing facilities



*Advanced Test Reactor (ATR)*



*Microreactor Agile Non-Nuclear Testbed (MAGNET)*



Guidelines for qualification of developmental sensors have been developed (GDE-947) and are being used for HTIR-TC qualification