

## Fixed In-core Detector Monitoring System

### Challenge

Plant operators need fixed in-core detector systems with the ability to enhance reactor operation through continuous, real-time monitoring of actual core conditions in B&W, Westinghouse, and Combustion Engineering pressurized water reactors.

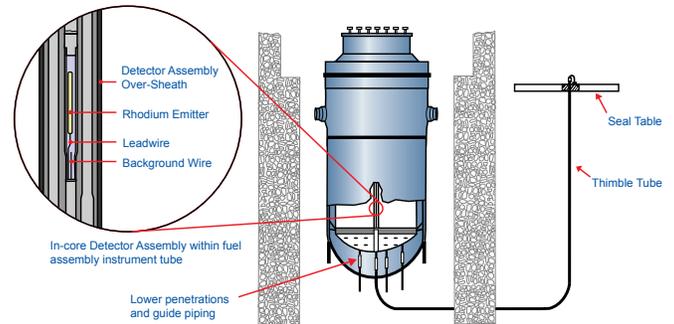
### Solution

Framatome's simple, reliable monitoring system provides 24-hour monitoring and on-line assessment of actual core safety limits with a real-time display. This capability increases the overall guidance available to operators and improves the ability to navigate transient conditions and to detect and diagnose core anomalies.

Compared to movable in-core detector systems, which acquire only periodic "snapshot" power distributions, fixed in-core detector systems, with full-time monitoring, can expand the allowable operating window and improve reactor operating margin. The continuous monitoring feature of Framatome's fixed in-core system allows utilities to safely operate closer to reactor limits, providing a 10 to 15-percent increase in operating margin in some plants. In contrast, movable in-core detector systems, with fuel performance measurement approximately once per month, rely on forecast conditions to determine core operating limits, resulting in unnecessarily restrictive limits.

### High Reliability and Less Maintenance

Framatome's fixed in-core detectors are highly reliable due to their inherently simple design with no moving parts or need for an external power supply. The detectors have an extremely low failure rate. The fixed in-core system eliminates movable components such as the channel selectors, drive units and manual isolation valves, along with associated mechanical and electrical problems. Less maintenance means reduced cost and reduced radiation exposure to maintenance personnel. The fixed in-core system reduces human error and minimizes Limiting Conditions of Operations (LCO) violations and reactor trips.



Fixed In-core detector system utilizing existing vessel penetrations and thimble tube in a Westinghouse-type reactor, requiring no facility modifications.

### Customer benefits

- Provides continuous, accurate information on core conditions
- Increases core operating margins
- No moving parts — requires no maintenance
- Reduces maintenance costs and personnel radiation exposure
- Helps identify core anomalies and failed reactor components

**Your performance**  
is **our** everyday **commitment**

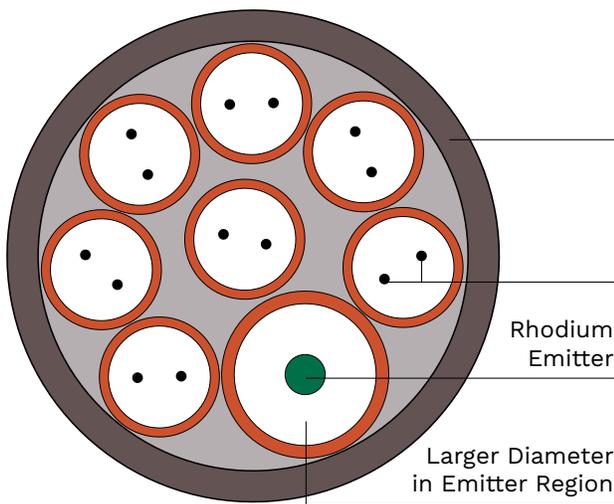
## Customized Core Monitoring Solutions

Framatome can configure fixed in-core detector assemblies to a utility's specifications. Plus, the assemblies can be positioned in the reactor core through the existing instrumentation guide tubes. The basic fixed in-core detector assemblies contain rhodium emitters. A computer work station and specialized Framatome software eliminate the need for many of the collateral hardware, software and electronic devices required for movable in-core detector systems. The configuration eliminates the need for many off-line calculations.

## Rhodium or Platinum In-core Detector Assembly

A typical fixed rhodium or platinum detector assembly consists of an outer inconel sheath containing five to seven rhodium or platinum detectors (depending on the application) and a thermocouple. The rhodium or platinum emitters are anywhere from 16 to 30 inches long and are positioned within the assembly such that the emitters are between the fuel spacer grids.

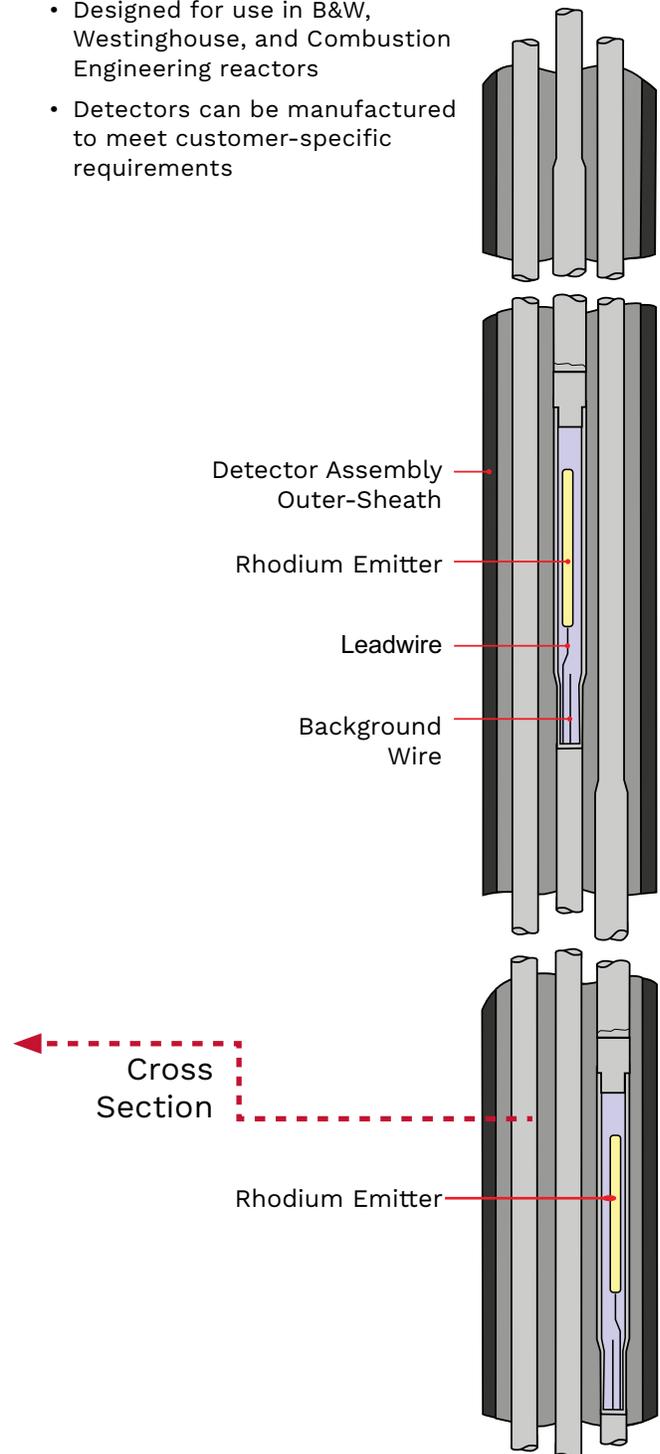
The detector system delivers a full-core power map approximately every six minutes.



Advanced Twin-Lead In-core Detector Assembly  
(For higher accuracy and longer life)

## Fixed In-core Detector System Features

- Fixed, rhodium self-powered neutron detection assemblies (Design life is six to ten effective full power years.)
- Fixed, platinum self-powered predominately gamma sensitive detection assemblies (Design life is approximately twenty effective full power years.)
- Designed for pressurized water reactors
- Integrated thermocouple
- Proven inconel sheathing of all parts
- Designed for use in B&W, Westinghouse, and Combustion Engineering reactors
- Detectors can be manufactured to meet customer-specific requirements

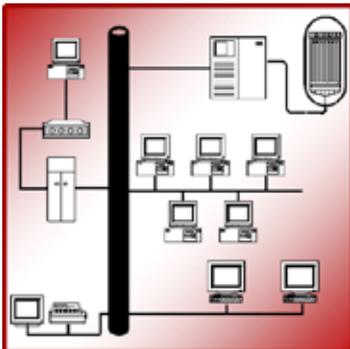
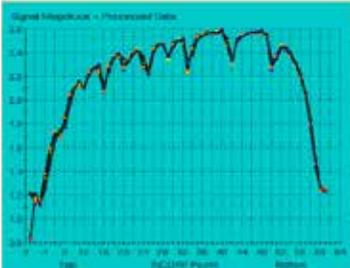


## User-Friendly Signal Processing

A typical full in-core detector system has approximately 50 fixed, self-powered neutron detector assemblies linked to a computer and display system. Signals from the emitters are compensated for background, then amplified, multiplexed and transmitted to the plant on-line computer and engineering computer work stations.

Core conditions can be displayed on a PC or workstation, printed as a hard copy, saved to disk, and accessed off-line. The core power map profiles the condition of the core, its power level, and how it is functioning. It can be used to alert plant operators to core anomalies and failed reactor components.

## Supporting Your Site with Faster Startups and Efficient Operations





## In-core Detector Manufacturing

Framatome is a global leader in the design and fabrication of high technology systems, such as our complete line of fixed in-core detectors. Fabrication is performed at Framatome's Solutions Complex, located in Lynchburg, Va.

## Cabling Upgrades

Plants upgrading their in-core detector systems may need cabling upgrades due to obsolescence, end of qualified-life or a transition from a movable to fixed system. Framatome can assist you with engineering the right cabling solution to meet your specific needs. We can design a solution that accounts for various specifications, such as the right configuration, radiation resistance, length of conduit, number of conductors and diameter of cabling. Framatome can work with the manufacturers to source and procure safety-related, LOCA-qualified cabling for containment.



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