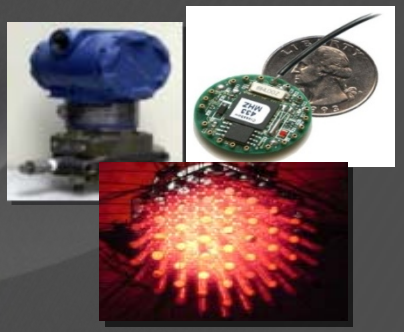
Safety and Performance in Current NPPs

Application of Advanced Technology to Improve Plant Performance



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Vienna International Centre

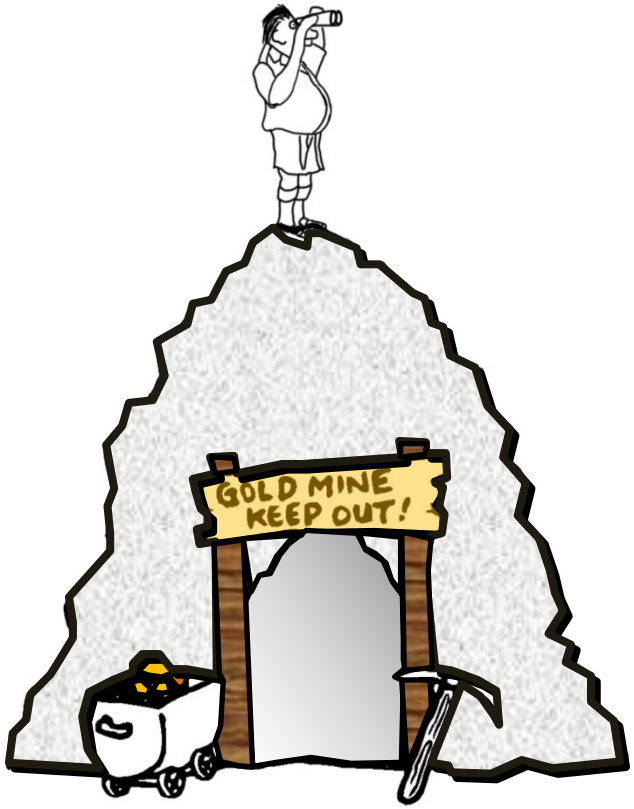
International Atomic Energy Agency

Vienna, Austria

27-30 October 2009

A Gold Mine is Hidden in Every Nuclear Power Plant

- What is it ?
- Where is it ?
- How to get to it ?

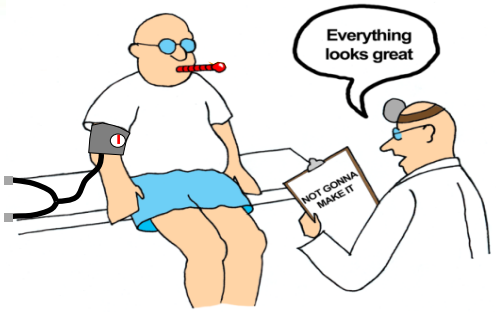


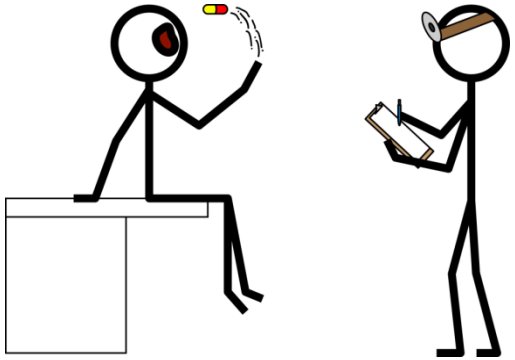
Opportunities

- Improve safety, reliability, availability, and productivity
- Optimize maintenance, predict when equipment may fail, or if the process has anomalies
- Support aging management, license renewal, long life operation
- Contribute to power uprates, shorter outages, and longer cycles

Terminology/Analogy

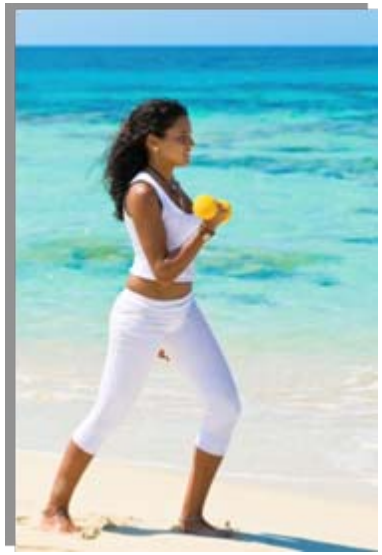
- Instrumentation
- Visual Inspection
- Acoustic Monitoring



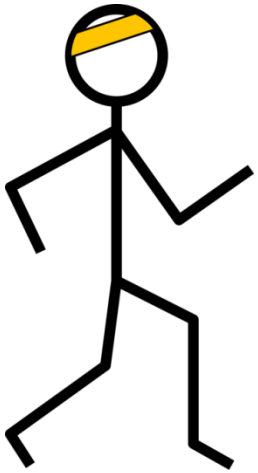


Calibration

Prognostics



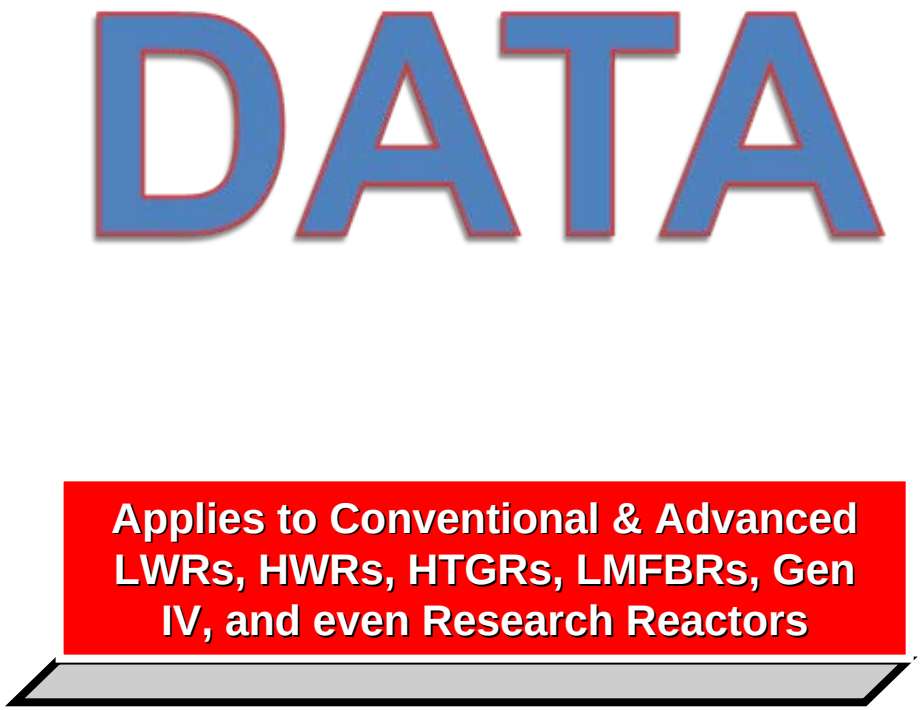
Feeling Good



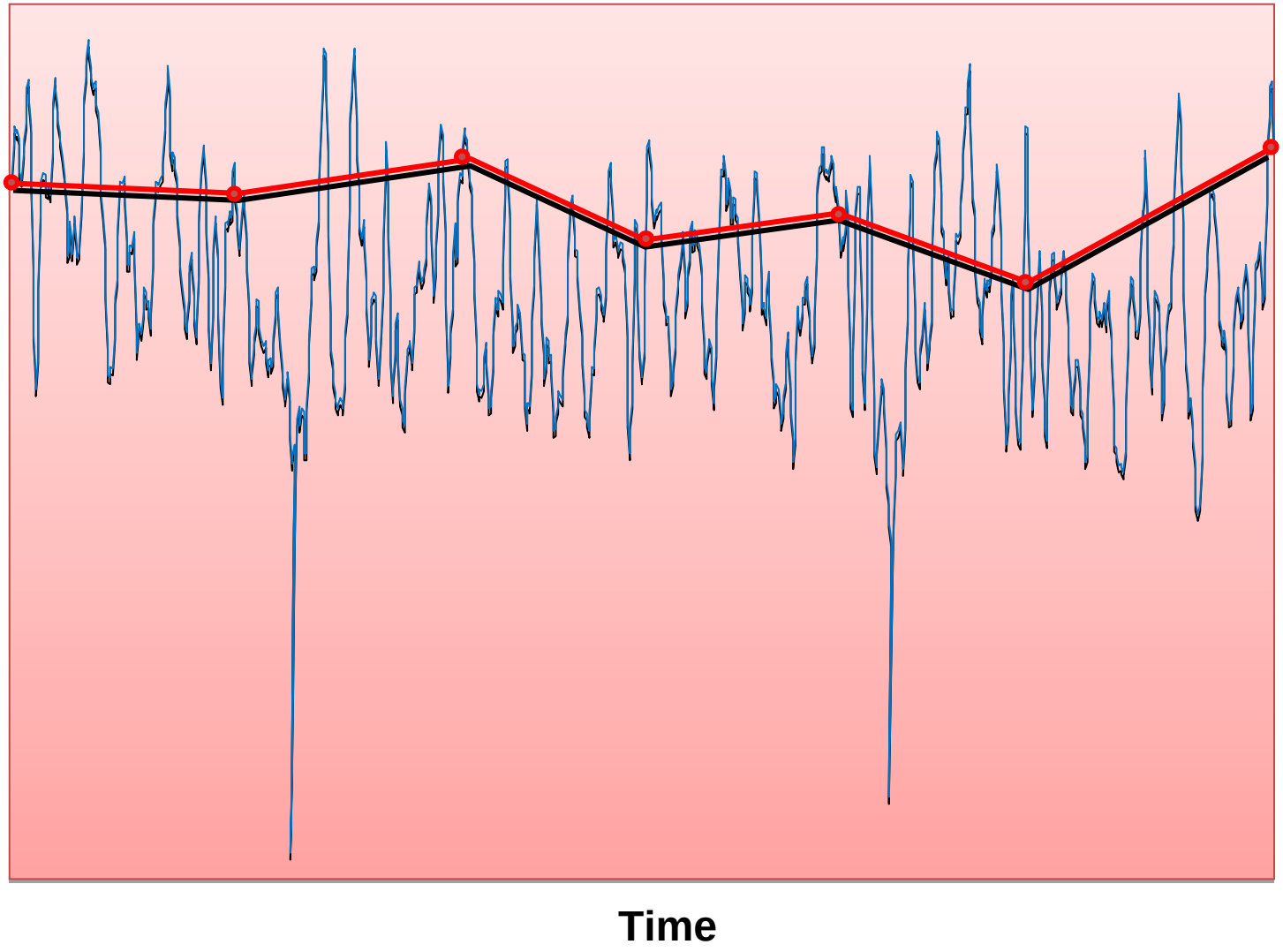
Normal

Back at Work

What is the Gold Mine?



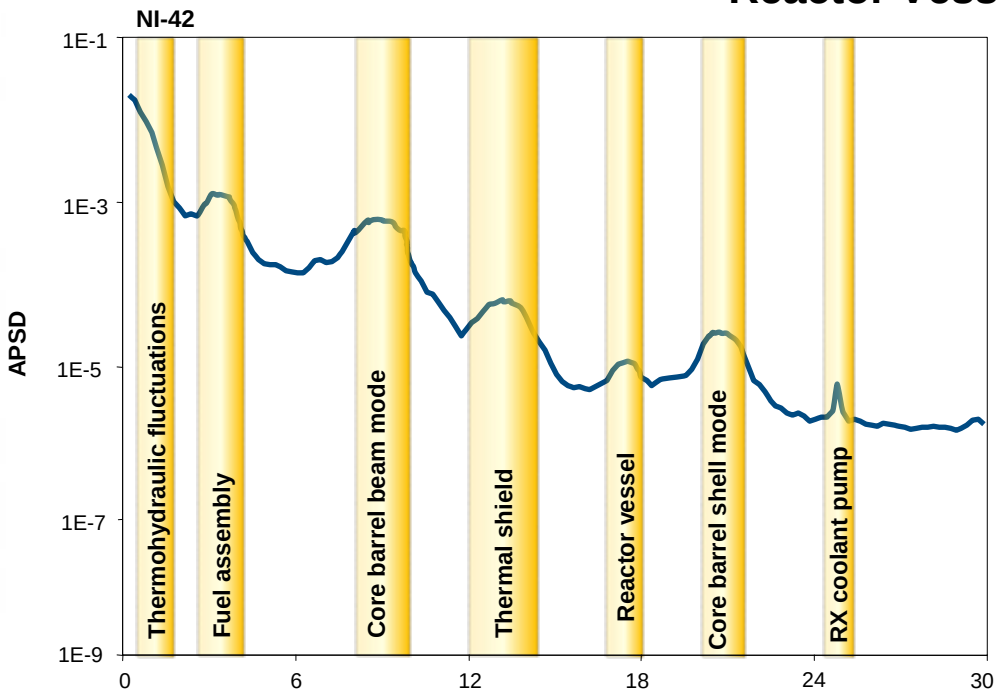
What Does It Look Like?

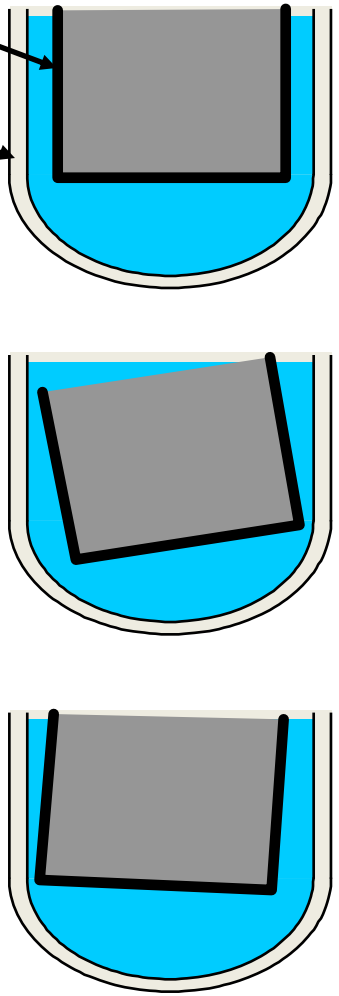


What Can We Do With It?

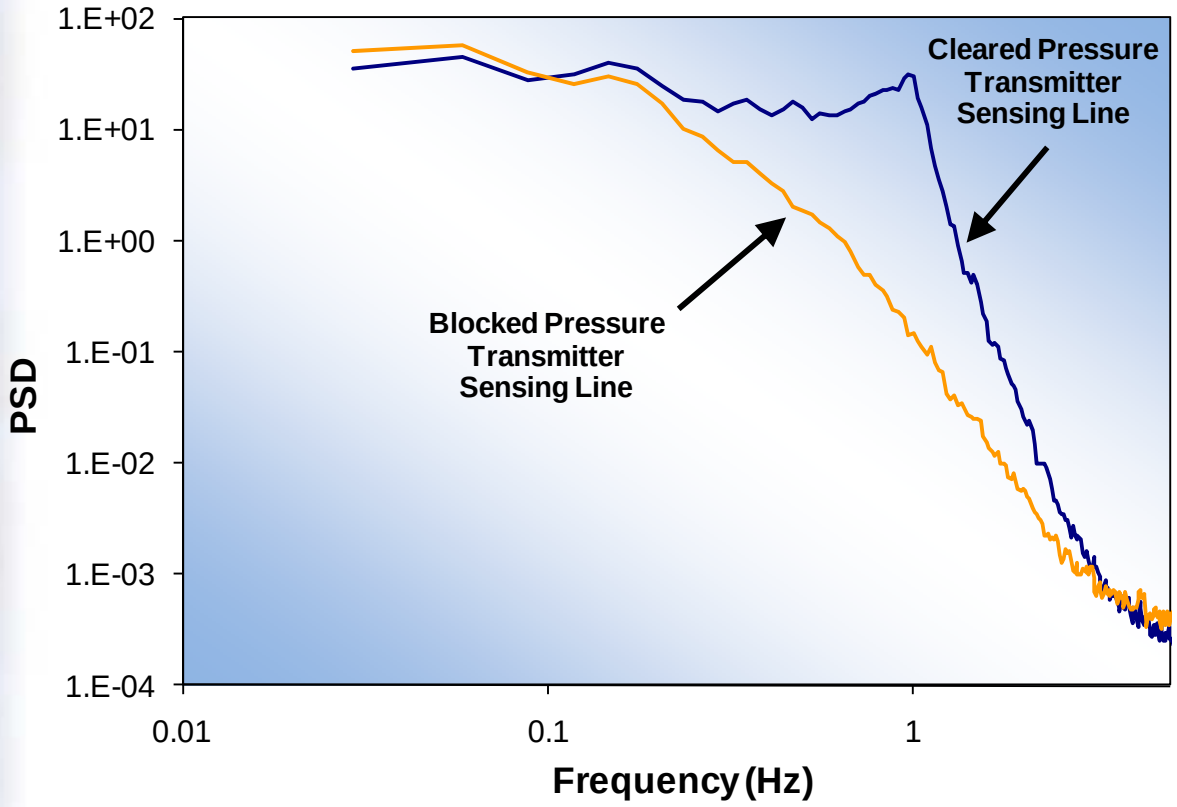
- Measure vibration of reactor internals
- Identify blockages, voids, and leaks
- Detect venturi fouling
- Verify the calibration and response time of I&C systems
- Develop passive fluid flow measurement system
- Monitor for degradation of neutron instrumentation systems
- Determine core stability margin
- Identify temperature coefficient of reactivity
- Detect water chemistry changes and valve problems

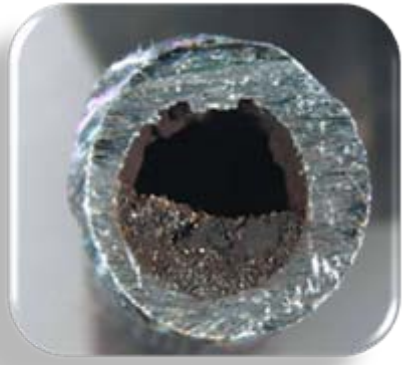
Reactor Internal Vibration Measurement by Neutron Noise Analysis



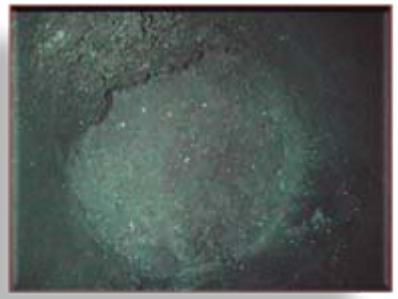


Sensing Line Blockages Can Be Dangerous



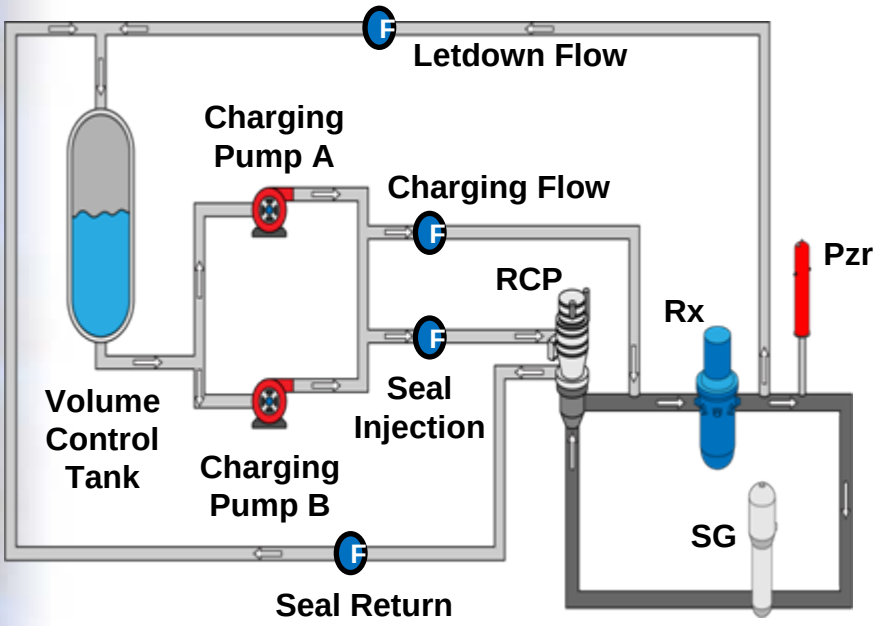


Partially Blocked

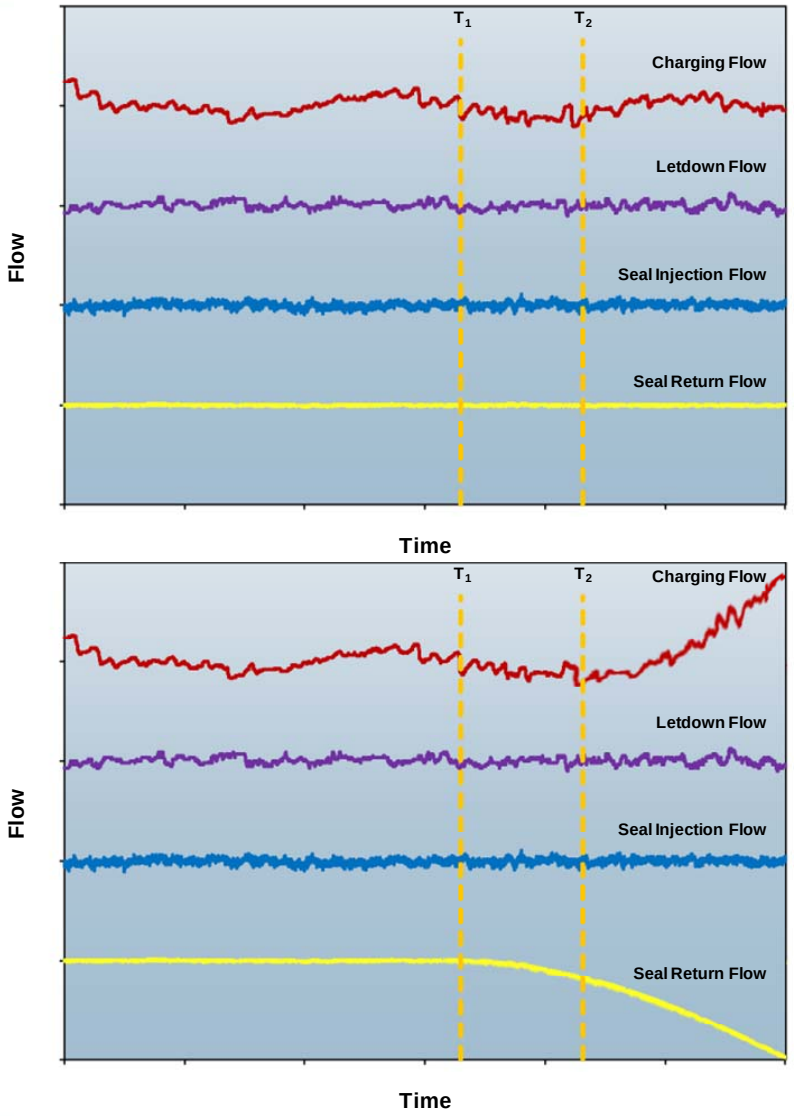


Completely Blocked

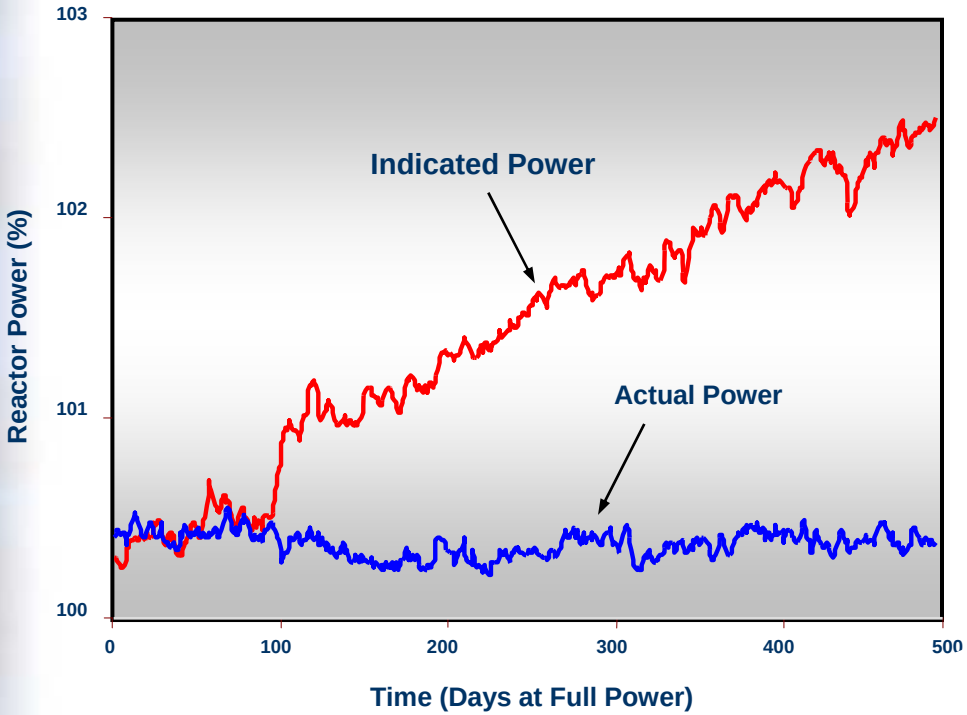
Detect RCP Leak



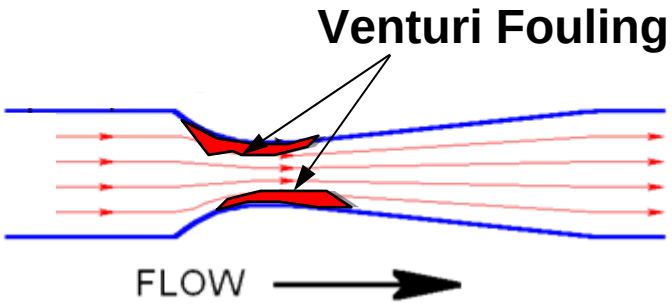
Chemical and Volume Control System (CVCS)



Venturi Fouling is Detectable and Quantifiable



Venturi Fouling Can Waste More than 2% of the Reactor Power



Challenges

- Sufficient data is not always available from existing sensors
- Process sensors do not always have high fidelity
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- Advanced sensors and techniques are not yet widely available for in-situ or on-line monitoring of material degradation (vessel, cables, etc.)
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What Is The Lesson?

- Sample Data Fast (e.g. 1000 Hz) and store it
- Add wireless sensors
- Build these technologies in NPPs of today and tomorrow
- Work on sensors and technology for material degradation monitoring
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- **Compliance**
- **Non Compliance**