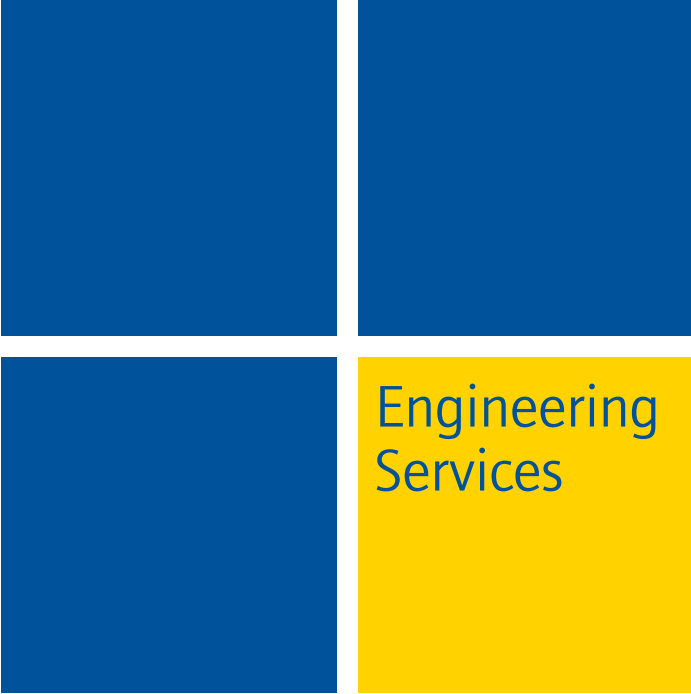


# Lower Internals Upflow Conversion



Engineering  
Services

## Background

Flow leakage through the axial gap between the vertical baffle plates has caused fuel rod damage in some early generations of Westinghouse plants that have a downflow configuration. These vertical baffle plates are bolted (using baffle to former bolts) to horizontal plates called formers, which in turn are bolted (using former to barrel bolts) to the cylindrical core barrel. The core barrel contains flow holes located in the upper core region elevations, which permit a small amount of reactor coolant to flow downward through the region between the baffle plates and the core barrel.

In these downflow plants, the pressure drop across the baffle plates has been sufficient to force coolant through any existing gaps between the edges of adjacent baffle plates, sometimes causing flow-induced vibration (FIV) of fuel rods close to the baffle gaps. This FIV causes wear and, in some cases, fuel rod failures. Changing the configuration in these plants from downflow to upflow reduces the pressure drop across the baffle plates, thus eliminating the potential for fuel rod degradation due to baffle jetting.

Later generations of commercial nuclear power plants incorporated an upflow configuration in the original design and construction and are not susceptible to baffle jetting.

## Benefits

- Eliminates fuel damage caused by baffle jetting.
- Reduces the loads on baffle to former bolts, allowing the plant to operate within its design basis with a significantly fewer number of intact bolts than if it has a downflow configuration.
- The Westinghouse upflow plug is designed to be leak-proof even during a loss-of-coolant accident (LOCA) event.
- On plants with thermal neutron shields, the Westinghouse plug can be installed in the flow holes using the annulus between the core barrel and the thermal neutron, eliminating the need to machine access holes in the thermal neutron shield.
- Eliminates the need to use fuel clips (installation time and additional radiation exposure).

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## Description

The Westinghouse process for converting downflow plants to an upflow configuration begins with the machining of flow holes in the top former plate. Westinghouse uses a process called electro-discharge machining (EDM) to machine a series of flow holes in the top former plate to allow upward flow. The EDM process generates a very fine material (called “dross”) rather than the chips generated from other machining processes. The dross, which is collected in filters, has the consistency of talcum powder and will not cause damage to fuel assemblies or any other reactor coolant loop component.

Flow holes in the core barrel are plugged using a specially designed mechanically activated and locked plug. Using long-handled tools, these custom-designed plugs are inserted into each of the flow holes and then activated via hydraulic pressure. The activation causes hardened steel lock-rings to be embedded in the core barrel flow hole surface and then locked in place. The Westinghouse upflow plugs are designed to be leakproof after installation even during a LOCA event and are specifically designed for installation either in the annulus between the core barrel and the thermal neutron shield (for those plants with thermal neutron shields) or for those plants with neutron panels.

All processes are monitored by underwater video camera with specific hold points for video inspections and verification of various sub-steps.

## Deliverables

- Upflow plugs with manufacturing data package
- Engineering analysis to define the new thermal-hydraulic configuration of the plant
- Qualified field procedures
- Qualified personnel
- Qualified machining and installation equipment (loan and return basis)

## Experience

- Beaver Valley 1
- Farley 1 & 2
- Jose Cabera
- Kori 1
- North Anna 1
- Point Beach 1 & 2
- Ringhals 2
- Trojan
- Watts Bar

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October 2005