

## Replacement Compressible Thermal Sleeve for Reactor Vessel Heads

### Background

Operating experience has shown that thermal sleeves in the control rod drive mechanism (CRDM) penetration tubes of the reactor vessel head can wear over time in Westinghouse nuclear steam supply system (NSSS) plants. This wear can have potential impact on control rod functionality.

### Description

The Westinghouse Replacement Compressible Thermal Sleeve (patent pending) has been designed to replace the existing thermal sleeve from under the reactor vessel head instead of the alternative approach which involves cutting into the canopies above the reactor vessel head. The Westinghouse Replacement Compressible Thermal Sleeve (Figure 2) is intended to perform the same design functions as the original thermal sleeve (Figure 1). It is designed with a flexible upper section and flange which allows the reduction of the diameter through elastic compression. During installation, Westinghouse tooling is used to compress the flange region of the thermal sleeve such that it may be inserted into the head penetration from underneath the reactor vessel closure head.

### Benefits

The benefits of the Westinghouse Replacement Compressible Thermal Sleeve are:

- Installation is simpler than alternative methods of replacing the sleeve. Significant outage time can be saved through use of this method compared to the alternative method which involves cutting into the canopies above the reactor vessel head and re-welding them after replacement of the thermal sleeve.
- It has been analytically qualified for at least 10 years of service life. Given the ease in replacement of these thermal sleeves, replacement after 10 years may prove to be more cost effective option than a replacement from above the reactor vessel head.

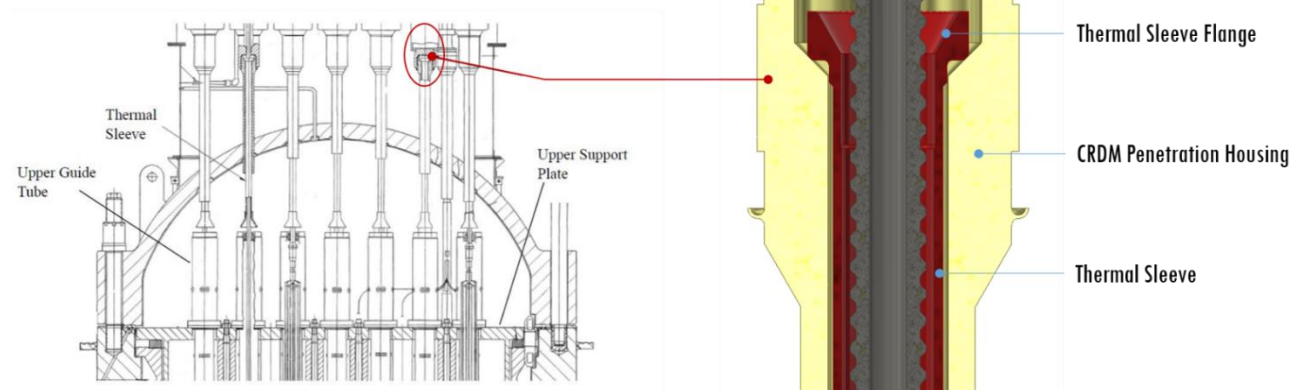
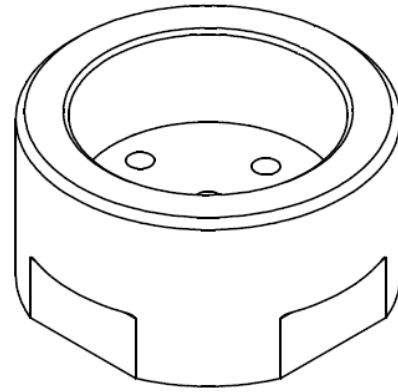


Figure 1 – Original Thermal Sleeve Configuration



**Figure 2 – Compressible Thermal Sleeve**



**Figure 3 – Westinghouse Penetration Cap Option**

### CRDM Penetration Cap Option

Westinghouse also provides a proven product, the penetration cap (Figure 3) to address thermal sleeve flange wear at penetration locations without active control rods. This penetration cap would be installed after complete or partial removal of the worn thermal sleeve to prevent any debris from entering or exiting the penetration and to reduce the exposure of the penetration and attached components to heated reactor coolant.

A CRDM may not be needed to be active because it is a spare or partial-length drive location. It may also be purposefully removed from service with a plant licensing amendment and related specific core design requirements.

### Contingency Option

The Replacement Compressible Thermal Sleeve and the Penetration Cap hardware can be purchased as part of pre-outage contingency planning to enable reduction of the potential repair response time in the event that thermal sleeve flange wear measurement results require mitigating action. An option to also perform the engineering qualification package development for this replacement hardware should also be considered. Completing both the long-lead hardware procurement and the engineering qualification provides a reasonable level of contingency preparedness and allows for a timely response should mitigating action be required based on the thermal sleeve flange wear measurement results.

### Experience

The Westinghouse Replacement Compressible Thermal Sleeve designed and fabricated by Westinghouse has been demonstrated via a walkthrough of the entire process from removal of the existing sleeve (if necessary), retrieval of the upper sleeve remnant, and installation of the replacement sleeve. First installation is expected in fall 2018.