BWR Control Rod CR 82M-1™

Background

The boiling water reactor (BWR) control rod (CR) of today must meet high operational demands and at the same time contribute to decreased operational costs for the plant operator.

Westinghouse BWR Control Rod Design

The Westinghouse BWR control rod design consists of four stainless steel sheets welded together to form a cruciform-shaped rod. Due to this configuration, the product is also known as control rod blade (CRB). Each sheet has horizontally drilled holes to contain absorber material, boron carbide (B_4C) and hafnium. This design allows significantly more B_4C to be contained in the rod, offering a longer service life versus traditional control rods in most reactors.

CR 82M-1™ Design

CR 82M-1 has mainly B_4C powder as absorber material, but the holes in the top area are filled with hafnium. B_4C swells due to neutron capture, while hafnium does not. When it was realized in the early 1980´s that control rods when fully withdrawn from the core also obtained neutron irradiation, Westinghouse started to use hafnium at the top to avoid interaction of a swelling absorber with the walls of the holes that leads to stress corrosion cracking. CR 82M-1 is an evolutionary development of the CR 82 control rod, which utilized hafnium at the top of the control rod. A higher quality stainless steel 316L is used in CR 82M-1 instead of the 304L material in CR 82. Another benefit of hafnium is the extended nuclear life, since several hafnium isotopes form new neutron absorbing isotopes due to neutron capture.

Westinghouse BWR control rod CR 82M-1

Westinghouse

Benefits

CR 82M-1 is an evolutionary design based on 40 years of control rod operation experience, and is characterized by:

- Long-service lifetime
- Reactivity worth equal to or higher than the original control rods
- Low-cobalt content to minimize activation
- Structural material with high resistance to stress corrosion cracking (SCC)
- Hafnium tip protecting the control rod during long-term use as a shutdown rod
- The hafnium has a longer nuclear life than B_4C
- Horizontally drilled absorber holes proven to retain the boron carbide powder
- Easy waste disposal

Experience

Westinghouse began developing BWR control rods in the mid-1960s. The first control rod – an all-B_4C rod called CR-70 – started in operation in 1970. Many original rods have been operated well above 40 years, with full integrity maintained, proving the robustness of the Westinghouse BWR control rod design.

Westinghouse developed the hafnium tip after recognizing that CR 70 control rods, although fully withdrawn from the core, were subjected to neutron fluence at the tip. A vast majority of hafnium-tipped rods (CR 82) remain in operation. First introduced in 1995, the main feature of the CR 82M-1 rod is the change of structural material to 316L stainless steel, with high resistance to SCC and a very low-cobalt content.

Westinghouse has delivered more than 7,000 BWR control rods to-date. CR 82M-1 is a well-proven, standard product preferably used as a shutdown control rod. 2,300 CR 82M-1s have been delivered to BWR's worldwide.

Westinghouse BWR control rods are licensed in the United States, Germany, Spain, Switzerland, Sweden, Finland and Taiwan.

Westinghouse Electric Company
1000 Westinghouse Drive
Cranberry Township, PA 16066

February 2021 / NF-FE-0002