Improved RPV Stud Hole Plug

Outage and Maintenance Solutions

Summary

Reactor Pressure Vessel (RPV) studs are usually removed in Pressurized Water Reactor (PWR) plants prior to lifting the RPV head during a refueling outage. When this is done, approximately 58 stud hole plugs must be installed to prevent borated water from damaging the RPV stud hole threads. The installation of the plug must be rapid and ensure that a leak-tight seal is established between the plug and the counterbore surface of the stud hole.

Designed with these needs in mind, the improved Curtiss-Wright RPV Stud Hole Plug has rapid installation and removal times, recessed threads that preclude stud hole plug thread damage during installation, EPDM seals that do not rotate with the threads, and are lightweight, making them the easier to use and a more efficient option to other, traditional stud hole plugs.

INTRODUCTION

In all US and most international PWR nuclear power plants, the RPV studs are removed during a refueling outage so the RPV head may be lifted, granting access to the reactor's fuel. To protect the stud holes, stud hole plugs are installed through the RPV head flange to prevent the borated refueling pool water from entering the stud holes.

Most of the current stud hole plugs used in most plants have one or more of the following problems:

1. The lead-in threads on the plugs are easily damaged since the plug is installed through the RPV head flange, thus minimizing visual access to the stud hole.
2. The seal (which seals against the counterbore) rotates with the plug, thus damaging the seal.
3. The plug may dislodge itself from the stud hole if plug retention only relies on the friction generated by the seal's compression.
4. The plugs have a recessed operating mechanism which traps water when the refueling cavity is drained.
5. The plugs are heavy causing operator fatigue during the installation of over 50 plugs.

The improved RPV Stud Hole Plug, illustrated in Figure 1, solves these problems as follows:

1. The plug's threads are not engaged with the stud hole threads until the plug is inserted into the stud hole.
2. The seal does not rotate with the plug.
3. Plug retention in the stud hole does not rely on friction.

Figure 1: The Curtiss-Wright Stud Hole Plug

Improved Stud Hole Plug

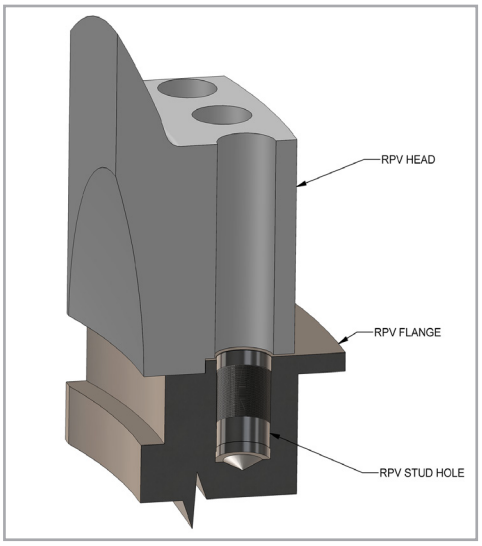

Figure 2: An RPV Head and Flange Interface

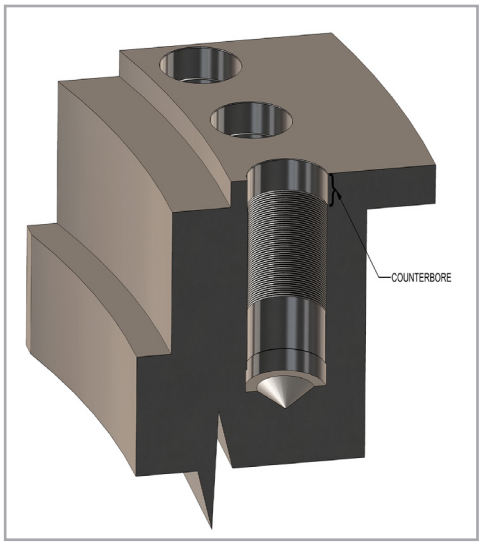

Figure 3: Stud Hole Counterbore

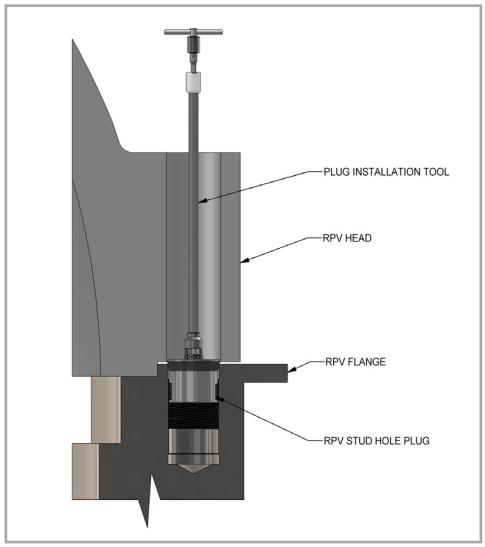

Figure 4: Stud Plug Installation Tool with Attached Plug

4. The plug's top plate sheds water when the refueling cavity is drained.
5. The plug weighs only 5.5 lbs (2.5 kg).

The installation of the Curtiss-Wright Stud Hole Plugs is a simple, streamlined process. A typical RPV head and flange interface, with the RPV studs removed, is shown in Figure 2. As shown in Figure 3, the stud holes in the RPV flange have a counterbore at the top of the threaded hole. The Stud Hole Plugs are installed through the holes in the RPV head with the plug installation tool, as shown in Figure 4, to minimize radiation exposure to the operator.

When the Stud Hole Plug is lowered into the stud hole, the two thread segments are retracted into the body of the plug. Turning the Plug Installation Tool causes the two thread segments to cam outwards, thus engaging the threads of the stud hole, as shown in Figure 5. After the thread segments are engaged, additional turning of the Plug Installation Tool causes the seal to seat on the upper surface of the counterbore, sealing the stud hole until the plug is removed. A torque limiter prevents the plug from being installed too tightly.

Removal of the stud hole plugs is accomplished via a simple process after the RPV head is installed back onto the RPV flange. The Plug Installation Tool is lowered onto the plugs, and the capture device is activated. After activating the capture device, the plug can be rotated so that the thread segments are retracted back into the body of the plug, releasing the plug and allowing it to be removed.

To date, 595 Curtiss-Wright Stud Hole Plugs have been supplied to and used at 15 PWR plants: 14 in the USA and one in an international plant.

Installation and removal times for these plugs are approximately 10 seconds per plug – a huge improvement in time and radiation exposure compared to several minutes for previously used plugs. Removal time for a set of 58 plugs was 20 minutes instead of the approximately four hours needed for previously used plugs. Furthermore, additional torqueing extension bars, also known as "cheater" bars, were not necessary during the installation or removal of the Curtiss-Wright Stud Hole Plugs.

The Curtiss-Wright Stud Hole Plug significantly decreases plug installation time, radiation exposure, and operator fatigue. These savings justify the replacement of existing plugs and offer payback in one to two outages.

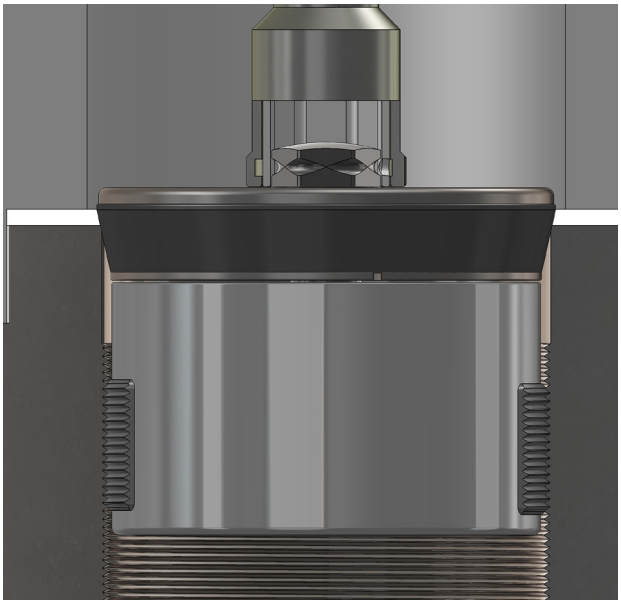

Figure 5: Stud Hole Plug with Thread Segments Engaged

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