

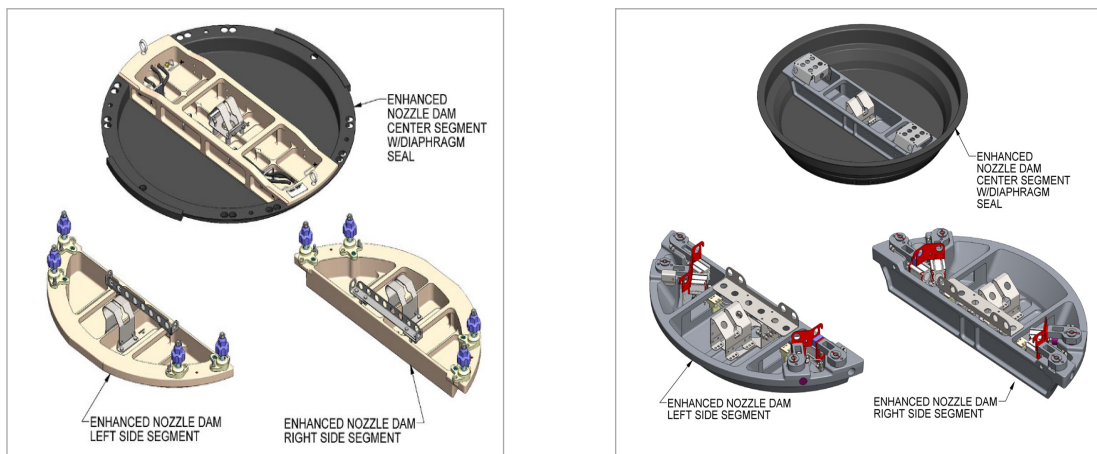
The Zero Entry Nozzle Dam (ZEND)

Outage and Maintenance Solutions

Summary

During a refueling outage, most Pressurized Water Reactors (PWRs) utilize steam generator nozzle dams to temporarily isolate the steam generator from the primary coolant system. The nozzle dams are installed in the hot leg and cold leg nozzles of the steam generators, allowing utilities to save time by conducting refueling and steam generator inspection activities simultaneously. Currently, trained technicians are required to enter the steam generator through the primary manway to install and remove the nozzle dams, which is a high risk activity due to the confined nature of the space and the high levels of radiation and contamination in that environment. Due to these risks, the utility must train support personnel to enter and work inside the steam generator, all of which requires time, planning and financial expense.

In response to this cumbersome, costly, and risky process, Curtiss-Wright has developed the Zero Entry Nozzle Dam (ZEND). Requiring only two technicians, the ZEND eliminates the need for a technician to physically enter the steam generator, improving safety and lowering radiation exposure. The ZEND has been successfully implemented at multiple refueling outages since 2017.



Figures 1 and 2: A Remotely Actuated Bolt ZEND (Left) and an Air-Actuated Lock Pin ZEND (Right)

DESIGN

Though technicians were previously required to enter steam generators for steam generator inspection and maintenance activities, advances in industry technology have allowed these tasks to be completed remotely. Currently, only the installation and removal of nozzle dams necessitates that technicians enter the steam generator. The ZEND enhancement can be implemented on most existing nozzle dam configurations: hand bolt, lock-pin and breech-lock designs.

The ZEND, shown above, eliminates that need entirely, reducing cost, risk, time spent, and the number of technicians needed to perform the activity. The ZEND consists of an enhanced diaphragm seal and segments, allowing for remote installation and removal.

The ZEND enhancements include remotely actuated bolts (Figure 1) or air-actuated lock pins (Figure 2) and segments designed to aid in the remote installation and removal of the nozzle dam. These features are paired with the ZEND's installation components, shown in Figure 3, which are simple and safe, as well as highly maneuverable. These tools are designed specifically to remove any need for steam generator entry without the use of expensive and impractical robotics.

The Zero Entry Nozzle Dam (ZEND)

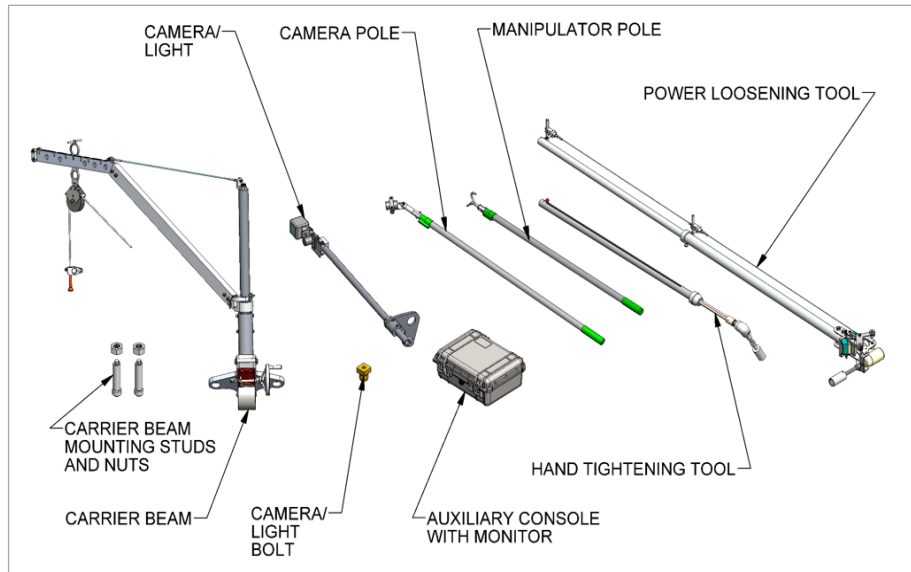
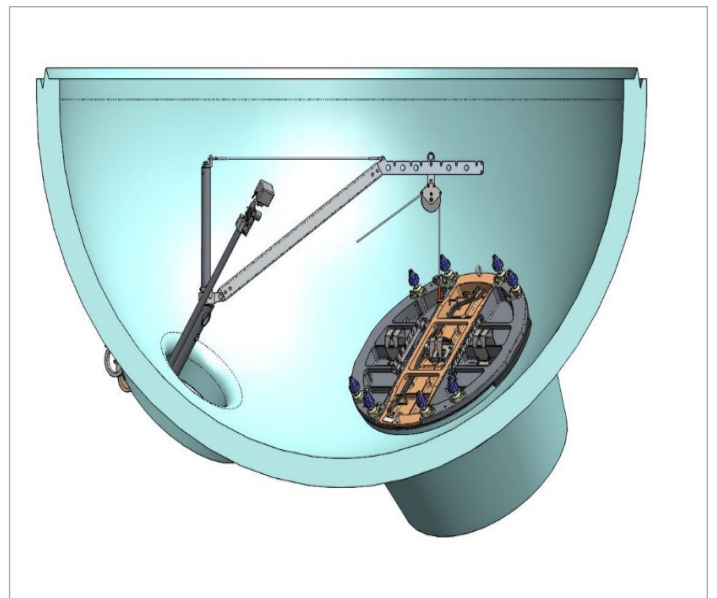
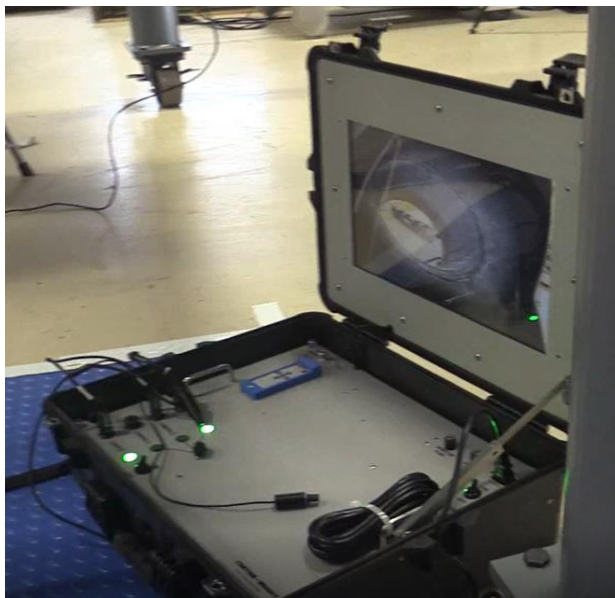


Figure 3: ZEND Installation Components

PROCESS

The process of installing and removing a ZEND is safe and streamlined. First, the protective flange cover is installed on the manway flange, and the two carrier beam-mounting studs are attached to it. Then, the carrier beam is inserted into the manway and attached to the mounting studs, providing the supportive base for the other tools. The camera and lighting are then added, secured, and connected to the console, allowing remote visuals via the monitor located inside the console's lid (Figure 4). Once the winch is used to advance the attachment cable, the insertion or removal of the dam segments is ready to begin (Figure 5).

The center segment of the dam with diaphragm seal is installed first; it is lifted into the channel head, then positioned inside of the dam retention ring using the manipulator pole. Next, the left side segment is inserted and positioned with the manipulator pole. Then, the remote bolts' engagement begins. The right side segment is then inserted, and the remote bolts are fully tightened, securing the dam to the dam retention ring. For the air-actuated lock pin design, all lock pins are engaged via the control console. The position of the remote bolts or lock pins is verified with the camera pole. These steps are reversed to remove the ZEND when maintenance is complete.



Figures 4 and 5: The Console (Left) and the Fully Assembled Installation System (Right)

The Zero Entry Nozzle Dam (ZEND)

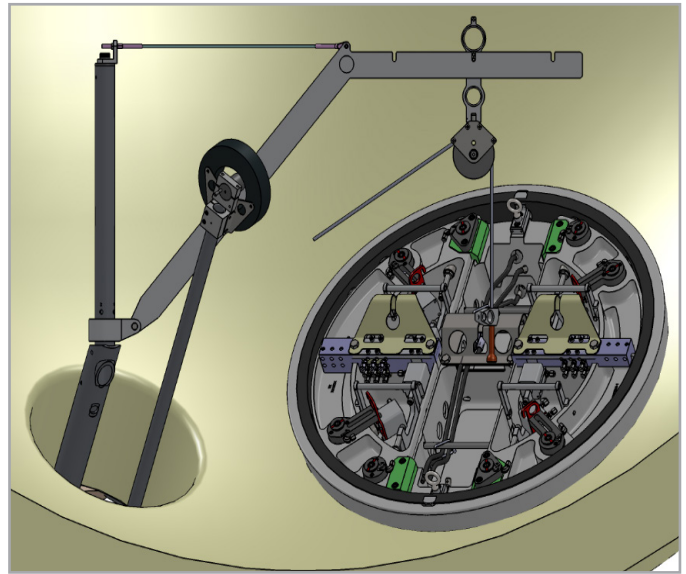
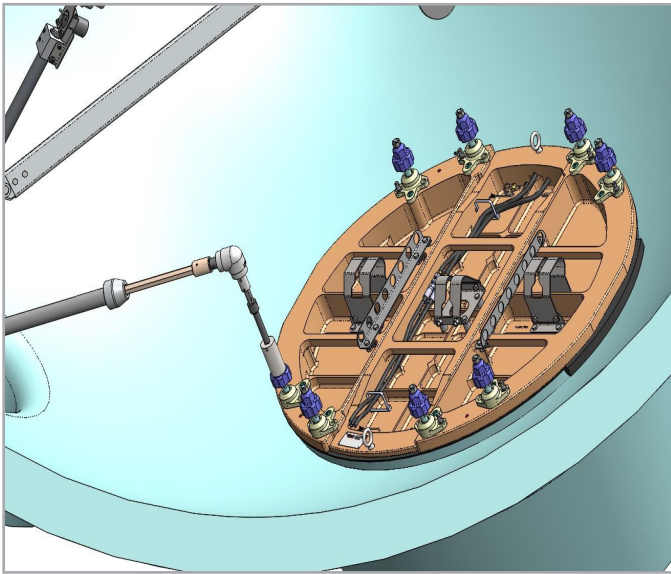


Figure 6 and 7: A Remotely Actuated Bolt ZEND (Left) and an Air-Actuated Lock Pin ZEND in the Final Stages of Installation

CONCLUSION

The Zero Entry Nozzle Dam provides PWR plants with a safe, remote solution to a long-standing safety issue. ZEND users have experienced the elimination of confined space entries and an increase in personal safety by reducing personnel contamination and potential for over-exposure occurrences. Other benefits include reduction in dose, associated support personnel, and number of nozzle dam support technicians, as well as reduction in time and manpower for platform decontamination.