1 Overview
Recent advances in nuclear power plant technology are providing powerful benefits that translate into safer working conditions and measurable cost savings for plant operators. This paper will take a detailed look at the design, application and deployment of one such technology—the HydraNut.

The HydraNut dramatically reduces the time required to perform bolting operations in critical mechanical jointing applications throughout the commercial nuclear power industry, improving safety by significantly lessening the risk of radiation exposure by maintenance personnel.

The HydraNut also eliminates the need for heavy wrenches, torque tools, bolt heating and other laborious, traditional methods of bolting. The “hands free” tightening and loosening process also helps to reduce many common workplace injuries. The product has gained strong acceptance in the nuclear power industry and other energy and industrial markets because it also minimizes studbolt failure, which can represent significant costs to plant operators using traditional bolting methods.

2 Background
Originally designed and developed in Queensland, Australia, the HydraNut is now manufactured by Nova Machine Products, a subsidiary of the Curtiss-Wright Flow Control Corporation of Falls Church, Virginia, USA. Nova had been the exclusive manufacturer and distributor of the HydraNut in North America since 2002, fully acquiring the HydraNut product line and related intellectual property from Technofast International of Brisbane, Australia in 2005.
3 Applications—Today and in the Future
The HydraNut has four primary applications within the nuclear market—reactor coolant pumps, safety relief valves, reactor vessel heads and steam generator manway covers. HydraNut installations are already gaining wide acceptance in use with two—reactor coolant pumps and safety relief valves. Within the past three years, nearly 2,000 HydraNuts have been installed into nuclear power plants within the U.S. and Europe. HydraNut customers include such industry leaders as Dominion, Exelon, PG&E, TVA, and Entergy. Plant operators are also beginning to think about ways they can utilize HydraNuts with reactor vessel heads and steam generators. The first installation of a HydraNut with a reactor vessel head will take place in November 2006.

Meanwhile, demonstrations of the HydraNut in use with steam generators have already taken place, and we see strong potential for the product in this market based on the early reaction to the application.

This paper will focus on the benefits of the HydraNut design and how utilities are putting it to work to improve both safety and bottom line results, with a particular focus on installations with reactor coolant pumps.

![Figure 2-24, 4 ½ inch HydraNuts (six visible) that have been put to work in a reactor coolant pump, with the technician attaching the hydraulic hoses that are ready for pressurization.](image)

4 Features and Benefits
The HydraNut offers many important features and key benefits for users. Through the use of the HydraNut, closure times for critical joints such as the reactor coolant pump main flange have been reduced from 24 to 30 hours to less than three hours. Main steam relief valve inlet and outlet flanges are now tightened in minutes rather than hours. Joint integrity and bolt preloads are improved to levels never before experienced, even as radiation exposure is minimized due to the reduced time and ease of use, while worker safety is optimized by removing heavy equipment and dangerous equipment.

The HydraNut also has applications beyond the commercial nuclear power industry. In late 2005, the HydraNut was purchased by two Asian utility companies—Nova’s first sales of this technology to non-nuclear customers.
Among the HydraNut’s key features and benefits:

- Designed and manufactured to ASME Section III Class 1 approval.
- Produced from SA540 B23 or B24 material.
- Manufactured in the Nova facility in Middleburg Heights, OH.
- Designed for the life of the plant.
- Because adjustments are minimal with the HydraNut, eventually stretch measurement will be totally eliminated as a result of the HydraNut’s superior bolt-loading.
- A permanent fixture requiring minimal maintenance.
- Hydraulic fluid is de-mineralized water or UCON 220FG.
- HydraNuts reduce the time it presently takes to install or remove existing nuts using standard tensioning or torquing techniques. Flanges tensioned in less than three minutes and de-tensioned in less than two minutes.
- System can be operated with a maximum of two technicians.
- Quickly pay for themselves in the time, manpower and dose savings.
- Save on assembly and disassembly of components.
- System has no reaction points and is designed to be “user friendly” in order to minimize common workplace injuries.
- Ideal for use in confined areas where it is difficult to use traditional tools.
- Complete 100% tightening achieved in one pass resulting in a known constant load in every stud/bolt.
- Designs can be made generic to accommodate multiple applications within plant.
- Pump and hydraulic hoses/manifolds can be used on multiple applications as they are not application specific.
- HydraNuts are designed to fit within existing space envelopes and so modifications to plant are not required.
Typical Applications and Associated Times for Closures

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<thead>
<tr>
<th>Application</th>
<th>Achievable Times</th>
<th>Traditional Times</th>
<th>Time Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steam valves</td>
<td>3 minutes</td>
<td>6 hours (torquing)</td>
<td>5 hours, 57 minutes</td>
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<tr>
<td>Reactor Coolant Pumps</td>
<td>35 minutes</td>
<td>20 hours (heating)</td>
<td>19 hours, 25 minutes</td>
</tr>
<tr>
<td>ELDHEs</td>
<td>15 minutes</td>
<td>8 hours (torquing)</td>
<td>7 hours, 45 minutes</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Application</th>
<th>Projected Times</th>
<th>Traditional Times</th>
<th>Time Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reactor vessel</td>
<td>75 minutes</td>
<td>4 hours (tensioning)</td>
<td>2 hours, 45 minutes</td>
</tr>
<tr>
<td>Steam Generator</td>
<td>20 minutes</td>
<td>8 hours (torquing)</td>
<td>7 hours, 40 minutes</td>
</tr>
<tr>
<td>Manways</td>
<td>20 minutes</td>
<td>2 hours (tensioning)</td>
<td>1 hour, 40 minutes</td>
</tr>
<tr>
<td>Pressurizer Manways</td>
<td>20 minutes</td>
<td>8 hours (torquing)</td>
<td>7 hours, 40 minutes</td>
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*Figure 4-The above tasks can be completed with no more than two people at the flange—in most cases, only one person is required.*

5 HydraNut Components

A. Nut body:  
This is the interface component between the existing stud and the Hydraulic Nut. The internal threaded portion of the nut body uses the same thread form as that found on the stud, but the external threaded portion utilizes the same patented thread form as that on the lock ring to minimize thread deflection and loss of pre-load.

B. Piston:  
This component makes up the pressure chamber in conjunction with the Nut Body to generate the pre-load under pressurization. During operating conditions the Piston supports the Lock Ring with the load passing vertically down through it.

C. Spherical Washer:  
This component transfers all pre load (pressurization) and retained load generated by the HydraNut down to the contact area of the equipment. It also allows the HydraNut to align itself perpendicularly with the stud.

D. Lock Ring:  
Component used to retain the applied load from the Nut Body and acts down through the Piston. The superior and patented thread form minimizes thread deflection between the Nut Body and Lock Ring, thus maximizes retained load, enabling a lower pre-load to be used.
E. High Temperature Seals:
The patented seal design that we use in the HydraNut is fundamentally different from all other types. Due to the nature of the design, the seal is allowed to expand and deflect with the walls of the piston and rams, thus keeping contact and sealing abilities at all times. The seals are made as separate items and do not need to be manufactured as an integral part of the nut, allowing appropriate and best material selection to take place.

F. Hydraulic Male Connectors:
These components are used to connect the Hydraulic Harness to the Hydraulic Nut.

6 HydraNut Operation
The HydraNut was designed to be easy to use. First, place spherical washer in place and screw on HydraNut. Then, using quick disconnect fittings, connect the hydraulic hose harness to all HydraNuts.

Pressurize the system to the preset pressure by utilizing the pumping unit. Once the preset pressure has been reached, stretch has taken place in the stud and the flange has been compressed causing a gap to become visible between the Piston and Lock ring. This gap represents the total movement that has taken place in the flange and this has to be held mechanically.

Rotate the lock ring by hand back down onto the Piston, thus closing the gap. Depressurize the hydraulics and remove the harness. Load is now being mechanically retained by the HydraNut assembly and the installation is complete.

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