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Intelligent Manufacturing Systems Customized Hydraulic Tensioner Secures a 40-Ton Fusion Magnet

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by Richard Hill

A United States engineering team led by Massachusetts Institute of Technology (MIT) recently completed design and construction of a huge, 40-ton electromagnet. The superconducting coil will be assembled with an even larger Japanese magnet to form the Central Solenoid Model Coil (CSMC). The CSMC will be the world's most powerful pulsed superconducting magnet to date.

The United States magnet fulfills a commitment to partners in the International Thermonuclear Experimental Reactor (ITER) project. The 150-ton CSMC will demonstrate performance parameters and manufacturing methods for a full-size magnet weighing 1,300 tons. This size of magnet is an essential component of the project's ultimate goal, a working fusion power reactor.

"With industry involvement we gained keen insight into the possibility of manufacturing complex components for future fusion systems," said Dr. Charles Baker, United States ITER Home Team leader.

Technologies behind the United States magnet may find many applications in industry—energy storage, or to stabilize disturbances on a power grid, for example. Since the very high magnetic fields generated by the coil create tremendous forces, a rugged structure is required to support the magnet and contain the energy. The cylindrical magnet is attached to the main structure by two circles of sixteen support beams radiating out like spokes on a wheel.

To ensure correct attachment, the essential tension rods and bolting were axially loaded (tightened) by a stud tensioner manufactured by Biach Industries of Cranford, NJ. The tool, rated 14,500 psi and well over one million lbs capacity, applied two different loadings—835,000 and 770,000 lbs—to the 32, 90-mm studs.

Biach tensioners are used to attain correct loading in a range of extreme duties. These applications include securing nuclear reactor pressure vessel heads, offshore mooring of ocean-going tankers, installing and adjusting suspension bridge cables, assembling surface mining shovels. Biach has experience designing and customizing heavy-duty tensioners, along with high-capacity pumps for hydraulic fluid and supply. The ITER project requirements were routine to Biach engineers, but the application was, of course, unique.



Smooth operation of the tensioner was of concern to ITER designers. The top circle of beams would be tensioned in the conventional way, but for the lower circle, the tensioner, weighing 485 lbs, would have to be operated upside down. Space limitations were also a consideration because of the radial geometry of the beams.

To meet these needs, Biach designed a custom base to ensure maximum contact with the beam without overhanging and interfering with other beams and apparatus in the area. Biach and MIT engineers worked together to develop six attachment points. Subsequent witness tests of setup and inverted use of the tool assured David A. Gwinn, fabrication lead engineer for MIT's Plasma Science and Fusion Center (PSFC), and Brad Smith, PSFC research engineer, that there would be no problem.

In May 1999, the ITER magnet and its accompanying Biach tensioning tool were shipped to Japan. The magnet is being assembled with another superconducting solenoid module manufactured by Toshiba for the Japanese Atomic Energy Research Institute. The combined modules will form the world's most powerful pulsed superconducting magnet, weighing more than 150 tons. Next on the schedule is a series of tests to investigate performance abilities and limits of the magnet.

A San Diego division of Lockheed Martin, now part of General Atomics, was the prime contractor for the United States ITER project. More than thirty companies and laboratories contributed to the project.

Richard A. Hill is president of Biach Industries. Biach designs and manufactures custom engineered tooling systems that focus on stud tensioning of critical bolting applications. The company also produces electronic measuring devices, electronic high pressure/high volume hydraulic pumping and computer generated visualization services for the American nuclear utility industry and the petrochemical, refinery and construction fields.

For more information about this project, please contact Biach Industries, 75 Chestnut Street, Cranford, NJ 07016, 908-276-2110; fax 908-276-0815.