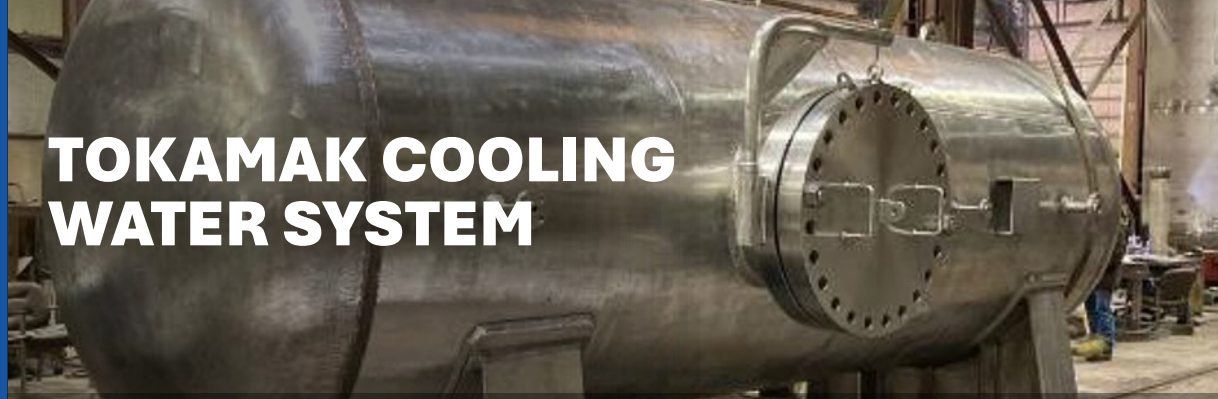
TOKAMAK COOLING WATER SYSTEM



The nitrogen storage tank for drying process of the tokamak cooling water system has been fabricated. Photo: Inovoal.

U.S. CONTRIBUTION

US ITER is responsible for the design, fabrication, acceptance testing, and delivery of the tokamak cooling water system for the international ITER fusion project.

OVERVIEW

The tokamak cooling water system is the primary source of cooling for the ITER facility. The system interfaces with the majority of ITER plant systems, including the steady state electrical supply, plant control systems, radioactive waste, and the tokamak building.

With the capacity to remove 1 GW of heat from ITER systems, the tokamak cooling water system uses major industrial equipment to transfer the heat through the distribution system to an interface with the secondary cooling system provided by India. Examples of components cooled by the system include the first wall blanket assembly, vacuum vessel, divertor, and neutral beam injector.

Supporting operations are designed to meet functional requirements, including baking of in-vessel components, chemical and volume control of water provided to client systems, draining and drying for maintenance, and support for leak detection and localization.

Classified as safety important for the confinement of radioactivity, the system is comprised of more than 100 major industrial pieces of equipment designed to withstand high temperatures (up to 400 °C), radiation, and magnetic fields.

A butterfly valve for the tokamak cooling water system has been completed. Photo: ITER Organization/VELAN.

STATUS

Final design is complete. Hardware including tanks, pumps, heat exchangers, electrical instrumentation and controls, and other components is at various stages of fabrication, with delivery of many components complete. Fabrication and deliveries will continue into 2030.

SAFETY FUNCTIONS

CONFINEMENT OF RADIOACTIVITY

Maximum tritium content: 0.32 mg/m³

Maximum activated corrosion products: 7.8 GBq/m³

Removal of decay heat in case of a loss of off-site power

Low flow pump on Class III-safety power

Small heat exchanger on safety chilled water CHWS-H1

EQUIPMENT

Heat Exchangers: Heat transfer capacities from less than 1 MW to more than 200 MW

Heaters: Providing over 9 MWe of heating capacity

Compressor: 2 MW nitrogen compressor to blow out and dry client systems

Pumps: Ranging from small transfer pumps to 3 MW main pumps, with total pumping power 30 MW

Normal and Safety Drain Tanks (4): 231,600 L volume (10 m x 6 m diameter), 73,500 kg dry weight

Neutral Beam Injector Drain Tank: 101,300 L volume (5 m x 6 m diameter), 47,400 kg dry weight

Pressurizers (3): Largest is 60 m³ Volume, with a design pressure of 5.0 MPa

Nuclear Grade Piping: More than 36 km of stainless-steel piping, ranging from small bore to DN500

Nuclear Grade Valves: 3,200 valves ranging from small bore to DN500

Piping and equipment supports: Attached to steel plates embedded in concrete

TECHNICAL DESCRIPTION

Total installed heat removal capacity: 1,000 MW (thermal)

Max coolant operating temperature: 126° C (plasma), 240° C (water baking), 400° C (gas baking)

Max design pressure: 5.0 MPa

Cooling water inventory: more than 1,000,000 L

CONTRIBUTORS INCLUDE

US ITER CONTRACTS

Hayward Tyler (Colchester, VT, U.S.)

Howden Compressors (Renfrew, Scotland)

Industrias Eléctricas Soler (IES) (Barcelona, Spain)

Inovoal (Houston, TX, U.S.)

Optimex (Fleurieux sur l'Arbresle, France)

Precision Fabrication and Cleaning (Cocoa, FL)

Trillium Flow (La Spezia, Italy)

Vahterus Oy (Kalanti, Finland)

CONTRACTS SUPPORTING US ITER ARRANGEMENTS

Energy Steel (Rochester Hills, MI, U.S.)

Porvair Filtration Group (Fareham, United Kingdom)

Procon Systems S.A. (Badalona, Spain)

TRILLIUM Flow Technologies (Saint-Victoret, France)

VELAN GmbH (Willich, Germany)

A nitrogen tank for the tokamak cooling water system was delivered to the ITER site. Photo: Inovoal/US ITER

CONTACT

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