



VACUUM AUXILIARY AND ROUGHING PUMPS SYSTEMS

Scroll pump testing at the UK Atomic Energy Authority. Photo: US ITER

U.S. CONTRIBUTION

US ITER is responsible for the design, fabrication, and delivery of the vacuum auxiliary and roughing pumps systems, which allow for plasma operations to be sustained while also supporting functions such as leak detection and protection of some diagnostic equipment.

OVERVIEW

ITER has unique vacuum pumping requirements due to high throughput tritium operation. The ITER tokamak, cryostat, and auxiliary vacuum volumes must be evacuated prior to the start of plasma operations using the roughing pump system. The roughing pump system supports the vacuum auxiliary system in providing vacuum and process gasses during operations.

The roughing pump system consists of a mixture of non-active (non-tritiated), active (tritiated), and torus cryopump regeneration (highly tritiated) roughing pump trains. These pumping trains are a mix of standard and custom pumps which are tritium compatible. The system's primary function is to evacuate the large vacuum volumes from atmosphere to low-vacuum pressure to enable operation of cryopumps, regenerate cryopumps, and help connect the tokamak fuel cycle. The system also provides utilities to related components and separates water vapor from exhaust gas.

The vacuum auxiliary systems consist of the main vacuum piping manifolds, high vacuum pumping stations, cryo-guard vacuum pumping stations, and dust filtration system. The service vacuum system is the largest subsystem, providing vacuum and positive pressure services in the facility to over 5,000 interfaces. Designed for compatibility with high radiation and magnetic fields, the equipment uses a mix of modified commercially available and bespoke hardware.

STATUS

Final design for the vacuum system will be completed in 2027. Procurement and fabrication activities are in progress for subsystems that have completed final design. Delivered hardware includes vacuum piping systems and subcomponents, high vacuum pumping stations, non-active roughing pumps, leak detectors, electron cyclotron commercial components, valves, and portable vacuum pumping carts.



One of the non-active pump skids delivered to the ITER site in 2025. Photo: ITER



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TECHNICAL DESCRIPTION

Tokamak vacuum volume: 1,330 m³

Cryostat vacuum volume: 8,500 m³

Neutral beam injectors' volume: 860 m³

Vacuum system performance: 1*10⁵ Pa (101,000 Pa) to 10 Pa in 24 hours (for roughing); an additional ~150 high vacuum pumping stations operating at 1x10⁻⁶ Pa

Roughing pumps: Three active roughing trains for main vacuum roughing and three active roughing trains for cryopump regeneration, all using a combination of tritium compatible roots, scroll, and screw pumps. Two non-active pump trains using industry standard roots and screw pumps.

Service vacuum system: more than 5,000 clients

Vacuum piping: 6 km

CONTRIBUTORS INCLUDE

Axima (Mios, France)

Eumeca (Portes, France)

Flowserve (Ontario, Canada)

GNB-KL Group (Elk Grove, CA, U.S.)

Inovoal (Houston, TX, U.S.)

Inox CVA(Gujarat, India)

James C White Company (Greenville, SC, U.S.)

Kompaflex (Egnach, Switzerland)

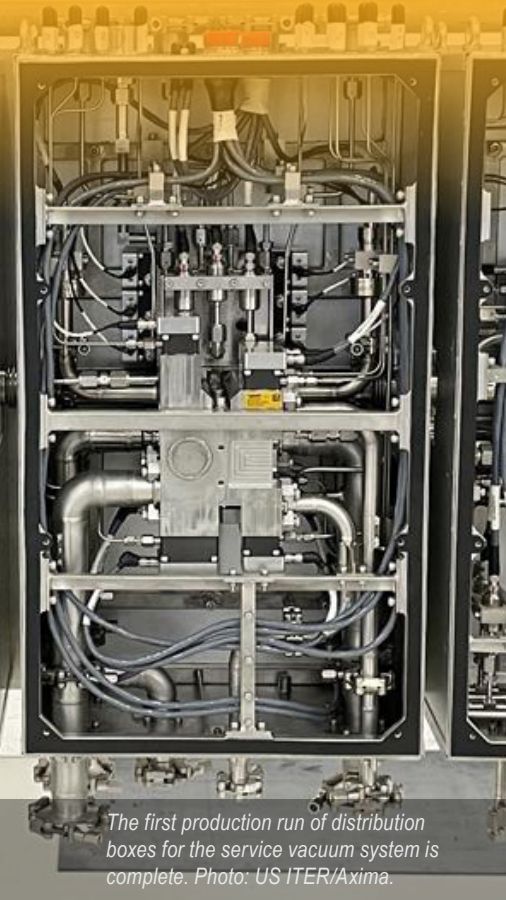
Pfeiffer Vacuum (Aszlar, Germany)

Rhinestahl (Mason, OH, U.S.)

Swagelok (Solon, OH, U.S.)

Vacuum Technology Incorporated (Oak Ridge, TN, U.S.)

VAT Group AG (Haag, Switzerland)



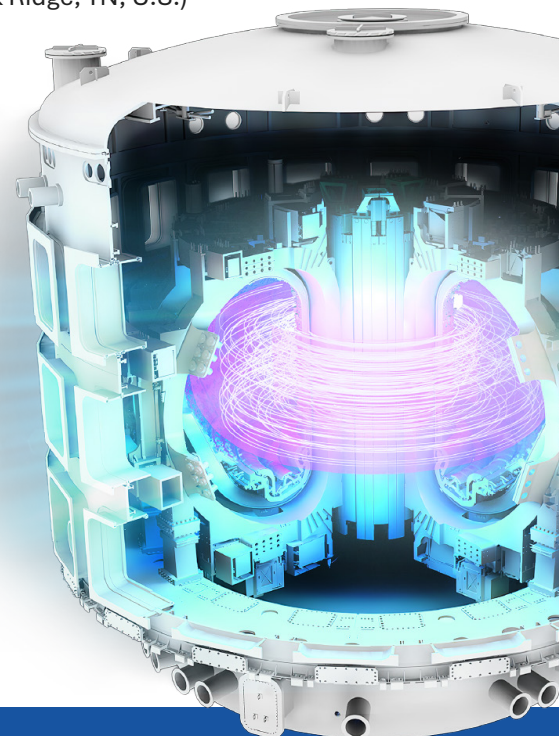
The first production run of distribution boxes for the service vacuum system is complete. Photo: US ITER/Axima.

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US ITER is managed by Oak Ridge National Laboratory in Tennessee, with partner labs Princeton Plasma Physics Laboratory in New Jersey and Savannah River National Laboratory in South Carolina.