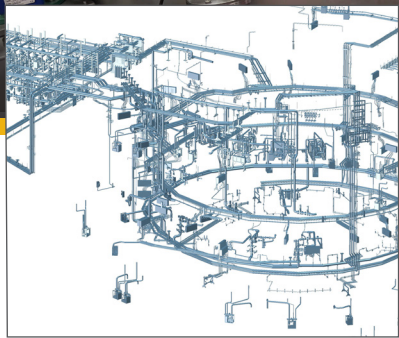
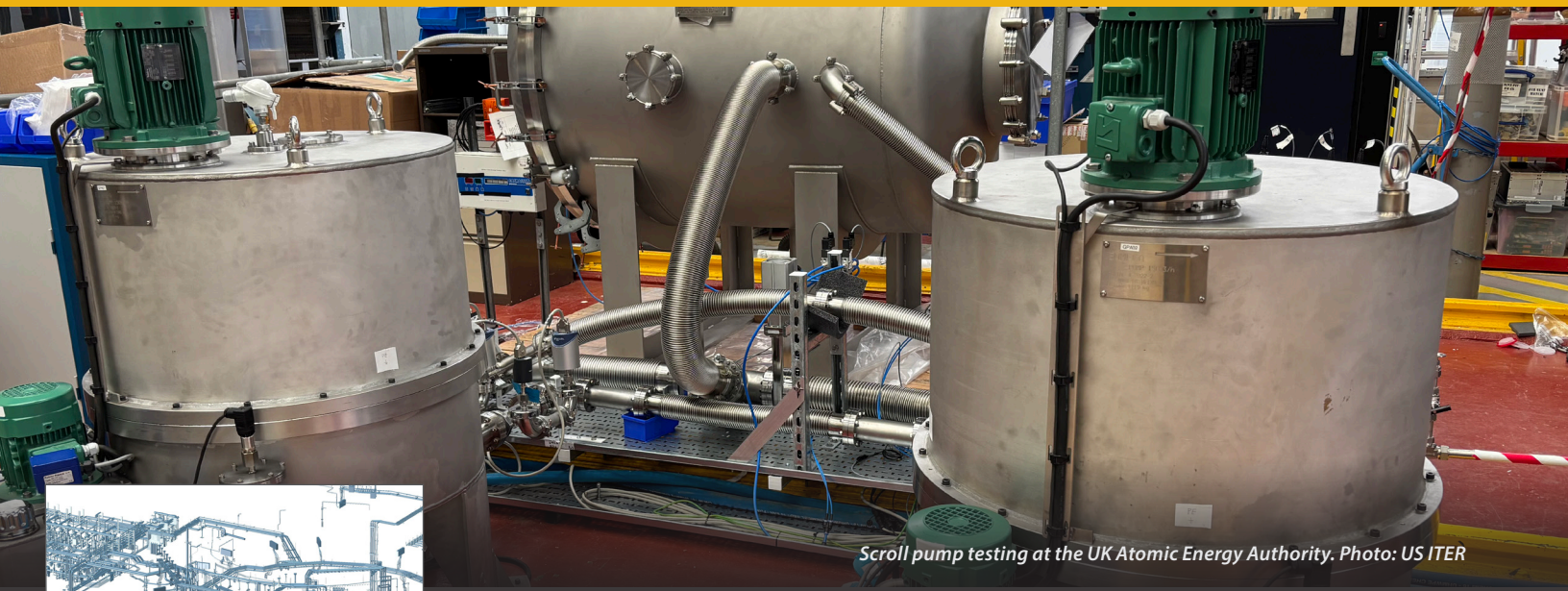


Vacuum Auxiliary and Roughing Pumps Systems



Vacuum system design. Image: US ITER

U.S. Contribution

US ITER is responsible for the design, fabrication, and delivery of the vacuum auxiliary and roughing pumps systems.

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 high vacuum operations using the roughing pump system. The roughing pump system works to support the vacuum auxiliary system in providing vacuum and process gasses to client clients 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 composed of a mixture of standard vacuum pumps and those developed specifically for tritium applications. The primary function of this system is to evacuate the torus, neutral beam, and cryostat volumes from atmosphere to low vacuum pressure at the start of tokamak operations, which enables operation of cryopumps, regenerates the cryopumps during operation, and acts as the connection between the fueling and exhaust processes of the tokamak fuel cycle. The system also provides positive pressure gas to the vacuum auxiliary system and separates water vapor from the exhaust gas.

The vacuum auxiliary system consists 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 and distributes the vacuum and positive pressure services in the roughing pump system to a network of over 5,000 interfaces to the tokamak and its supporting systems. The equipment has been designed for compatibility of high radiation and magnetic fields and uses a mix of modified commercially available and bespoke hardware.

Status

Final design for the vacuum system will be completed in 2026, with procurement and fabrication activities currently underway for subsystems that have already completed the final design stage. Delivered hardware includes vacuum piping systems and subcomponents, high vacuum pumping stations, non-active roughing pumps, leak detectors, and portable vacuum pumping carts.



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



Seismic qualification of pump station for the cryogenic guard vacuum system. Photo: US ITER

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)

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

Inovoal (Houston, TX, U.S.)

Kompaflex (Egnach, Switzerland)

Pfeiffer Vacuum (Asslar, Germany)

Rhinestahl (Mason, Ohio)

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

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