The Central Solenoid (CS) is the heart of ITER. The 5-story, 1,000-ton magnet will drive 15 million amperes of electrical current in ITER’s fusion plasma for stabilization. General Atomics (GA) is manufacturing the modules in a dedicated facility in Poway, CA.

Central Solenoid Assembly
- 6 modules
- Height: 59 feet (17.7 meters)
- Diameter: 14.1 feet (4.3 meters)
- Weight: 1,000-ton
- Peak field strength: 13.1 Tesla
- Stored energy capacity: 5.5 gigajoules

Each Module
- 250,000 lbs (110-tonne)
- Height: 7 feet (2.1 meters)
- Diameter: 14 feet (4.1 meters)
- 3.6 miles (5.8 km) of steel-jacketed conductor
- Conductor wound into 40 layers

It takes 22-24 months to manufacture each coil and prepare it for full current testing at 4.7 K
General Atomics
Central Solenoid Fabrication Facility

- 6,000 sq. meters of temperature-controlled production space
- 0.6m thick concrete floors
- 1MW diesel generator
- 1MW cooling tower
- Liquid argon, liquid nitrogen, & liquid helium systems
- Gantry & bridge cranes
- Two 100+ horse-power air compressors
Three ITER CS modules in different fabrication stages: 
preparation for vacuum pressure impregnation, post-heat treatment, and ground insulation
Station 1

Receiving the Conductor

One of 54 spools of conductor received at the Central Solenoid production facility

Moving Modules Between Stations

Moving 250,000 lb (110-tonne) module in facility requires air transporter
Each Central Solenoid module will be fabricated from approximately 6,000 meters of niobium-tin (Nb,Sn) conductor. The production module segment here is wound from 900 m of conductor into 14-turn pancakes with six layers.

De-Spooling the Conductor
Prior to winding, the conductor is “de-spooled” from the shipping fixture and straightened.

Bending to the Required Shape
The bending head of the winding line forms each layer to specific dimensions.

Two winding lines have been installed.
Splicing the conductor cable to join six-layer segments together.

Welding stainless steel cover over the splice joint.

Module with six completed splice joints.

Station 3 Joint and Terminal Preparation

- Wound six layer pancake ready for terminal preparation
- Terminal lead nearing completion
- Conductor strands prior to chrome stripping
- Conductor strands after chrome stripping

Station 4 Joining Coil Segments Together

- Two hex pancakes prepped prior to joining
- Splicing the conductor cable to join six-layer segments together
- Welding stainless steel cover over the splice joint
- Module with six completed splice joints
Reaction Heat Treatment

Air transporter placing module in furnace for heat treatment at 650°C

Furnace closed for module heat treatment

Technician inspecting module after heat treatment

Station 5

Turn insulation station structure lifts and raises 110-tonne module and releases individual turns for insulation wrapping

Turn insulation of module nearing completion

Automated heads wrapping fiberglass tape around the conductor

Station 6

Turn Insulation Station
**Station 7 Ground Insulation Station**

Technician applying bulk ground insulation to the qualification coil

Technician inspects the quench detection instrumentation on the fully insulated first module

Helium inlet pipe with ground insulation

**Station 8 Vacuum Pressure Impregnation**

Module with outer compression panels installed

VPI mold being placed over the module in preparation for resin injection
Qualification coil prepared for turnover

Modules require rotation to exchange bases under coil and allow access for piping installation

Turnover Tool

Turnover of qualification coil in process

Helium Piping

Technician applying insulation to an insulated break

Helium manifolds and piping in the inner coil

Thirty-nine helium pipes welded and insulated to provide the supply and return for supercritical helium at 4 K
Final Testing

Station 10

Final test chamber and feeder system

- 50kA magnet charging power supply with 1GJ fast discharge system including 7kV DC switch and dump resistor for full-current testing of CS modules
- Helium gas storage tanks for final test
- 1kw super critical helium supply system used for cooling the CS modules to 4.7 K
- Final test chamber liquid nitrogen cooled thermal shields