ITER Hot Cell Facility
Status and main challenges

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Contents

• The ITER project
  ✓ In-vessel component
  ✓ Remote Handling tools
  ✓ Overview of ITER site

• ITER Hot Cell Facility
  ✓ Functions
  ✓ Design drivers
  ✓ Interfaces
  ✓ Current layout
  ✓ Safety

• Site construction progresses
The overall programmatic objective is to demonstrate the scientific and technological feasibility of fusion energy for peaceful purposes.

The principal goal \( Q \geq 10 \)

- input power 50 MW
- output power 500 MW

Seven parties have joined the project 90% of the contributions are in kind.
The core of ITER

Major plasma radius 6.2 m
Plasma Volume: 840 m³
Fusion Power: 500 MW

Machine mass: 23350 t (cryostat + VV + magnets)
- shielding, divertor and manifolds: 7945 t + 1060 port plugs
- magnet systems: 10150 t; cryostat: 820 t
In-Vessel Components

Key issues resolved:
- Blanket loads on VV
- Neutron shielding
- Blanket manifold design & interface with VV
- VV manufacturability

Vacuum Vessel

Blanket

Divertor
Blanket Modules

Scope
• 440 blanket modules at ~4 ton each
• ~40 different blanket modules

Separable first wall is implemented
Divertors

- Inner vertical target
- Dome
- Outer vertical target
- Reflector plates
- Cassette body

54 Divertor assemblies
~8.7 tons each
Port Plug

Upper port plug
5.6 m x 1.1 m x 0.9 m
25 tons

Equatorial port plug
3.3 m x 1.9 m x 2.2 m
45 tons

18 upper PP
14 equatorial PP
In-Vessel Remote Handling tools

Blanket Module Handling ~4 tons

Divertor Cassette Handling ~8.7 tons
ITER Remote Handling System - Overview

TOKAMAK main component replacement
- 440 Blanket Modules
- 54 Divertor Cassettes
- parts of 3 Neutral Beam Injectors

TOKAMAK in-vessel operations
- component replacement, maintenance, inspection
- viewing, metrology
- leak localization, rescue of RH tools, dust removal

TOKAMAK component maintenance
- 18 Upper Port Plugs
- 14 Equatorial Port Plugs
- 8 Cryopumps

Component specific RH systems
- Blanket RHS
- Divertor RHS
- Neutral Beam RHS

Multifunctional RH systems
- Multi-Purpose Deployer
- In-Vessel Viewing System

Hot Cell Facility
- Cask
- Cask
- Cask
- Rescue Casks

RH Control System

RHS maintenance, testing & training
- Upper Port Plug process
- Equatorial PP process
- Cryopump process
- component and tool maintenance
- Blanket process
- Divertor process
- NB components process

ITER Hot Cell Facility – HOTLAB 2012
Overview of ITER site
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Hot Cell Facility functions

- **ITER Hot Cell Facility (HCF) (building 21)** is designed to support the Tokamak during the assembly, operation, de-activation and dismantling phases.
- **The Hot Cell Facility key functions**: [maintenance operations, radwaste operations] ~70%, plant systems ~30%.

**Plant systems**
- Confinement: detritiation system, HVAC
- Handle & transfer, Export/import

**Radwaste operations**
- Tritium recovery
- Radwaste processing of components
- Radwaste storage

**Maintenance operations**
- Work: receive, diagnose, refurbish & repair
- Test, Store & park
- Decontaminate

**Control room in Personal Access Control Building**

**Type B radwaste and purely tritiated waste**
Flow diagram - refurbishment of in Vessel components / radwaste treatment & storage
Flow diagram - maintenance of RH tools
Hot Cell Facility design drivers

• **Safety**
  • Confinement
  • Radiation shielding
    → HCF safety

• **Integration of systems housed by the HCF**
  • In vessel components
  • Port plug test facilities
  • Remote Handling equipment and tools,
  • Radwaste treatment & storage system,
  • Detritiation system …
    → HCF integration in a reinforced concrete building

• **Operations**
  • Machine availability
  • Maintenance strategy
    → HCF availability

• **Flexibility**
  → To maintain flexibility in the design as much as possible
INTERFACES for the HCF

Maintenance & Waste operations for the following processes:
External features

- Personnel access control building
- Radwaste Facility
- Hot Cell Facility
- Tokamak Complex

- 64 m x 61 m footprint
- 2 levels under ground
- 3 levels above ground

Connection with the TKM
Hot Cell Facility, level L1

• The import / export facility,
• The docking station of transfer casks to the red zone,
• The reception/cleaning workstations,
• The refurbishment workstations (port plugs, TBM, other vacuum vessel components),
• The testing workstations (port plugs, TBM, other vacuum vessel components),
• The buffer storage for port plugs,
• The HCF remote handling preparation, decontamination and repair area;
• Link to Neutral Beam cell.
Hot Cell Facility, level B2

- Buffer storage of discarded components
- Type B radwaste treatment, and temporary storage area
- Extension for radwaste storage;
- Purely tritiated radwaste storage area;
- ITER Remote Maintenance Systems (IRMS), including transfer casks
- Ancillary Equipment Unit (AEU) maintenance area,
- Transfer cask park area.
Hot Cell Facility level B1

- Decontamination areas of cranes used at B2 level before their maintenance
- Maintenance areas of cranes
- Services and utilities
- Cubicles and distribution boards
- Technical galleries
Hot Cell Facility level L2

- Decontamination and maintenance of crane used in level L1,
- Services for cleaning cells and cask docking stations,
- Cubicles
- DS system (L2 - L3)
Hot Cell Facility level L3

- HVAC plant,
- Detritiation system plant,
- Storage of remote handling equipment,
- Reserved area for possible extension
Dose rate and shielding

A radiation level of 215 Sv/h has been taken into account for the design. A wall thickness of 1.25 m was demonstrated for the hot cells to be compliant with the safety limits for exposure, as leading to less than 10 μSv/h behind the wall.

<table>
<thead>
<tr>
<th>Location</th>
<th>Dose (Sv/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front</td>
<td>215.0</td>
</tr>
<tr>
<td>Left side</td>
<td>78.8</td>
</tr>
<tr>
<td>Right side</td>
<td>68.7</td>
</tr>
<tr>
<td>Back</td>
<td>2.91</td>
</tr>
<tr>
<td>Top</td>
<td>48.6</td>
</tr>
<tr>
<td>Bottom</td>
<td>45.2</td>
</tr>
</tbody>
</table>
Confinement

• Source term: activated dust and tritium
• Main challenge: tritium confinement
• 2 confinement system: static + dynamic (sub atmospheric pressure)

  → hot cells are the first static confinement completed by the Detritiation System (depression cascade)
  → building is the second static confinement completed by HVAC and a connection to DS in case of tritium leakage

• The hot cells located in red zones are stainless steel lined in order to reach the suitable leak tightness.
## Ventilation zone in HCF

<table>
<thead>
<tr>
<th>Confinement Class</th>
<th>Application for HCF</th>
<th>Ventilation Zone Colour Code</th>
<th>Sub atmospheric pressure</th>
<th>Leak Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>C2</td>
<td>Normal HVAC with filtered exhaust and able to be detritiated/filtered</td>
<td></td>
<td>-50 Pa</td>
<td>100%vol/d</td>
</tr>
<tr>
<td>C3</td>
<td>Filtered and detritiated exhaust steam</td>
<td></td>
<td>-100 Pa</td>
<td>24%vol/d</td>
</tr>
<tr>
<td>C4**</td>
<td>Filtered and detritiated exhaust steam</td>
<td></td>
<td>-150 Pa</td>
<td>24%vol/d</td>
</tr>
<tr>
<td>C4***</td>
<td>Filtered and detritiated exhaust steam</td>
<td></td>
<td>-200 Pa</td>
<td>24%vol/d</td>
</tr>
</tbody>
</table>

Direct access/opening to C4 zones is provided only through C3 zones
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• Site construction progresses
The platform, one year ago
Site Construction Progresses (1)

View of the On-site Construction

Concrete Walls & Anti-Seismic Tokamak Complex

PF Coil Winding Building

Inside PF Coil Building
Future ITER site

39 Buildings, 180 hectares
Thank you for your attention