ITER Parties are now in the process of finalising the Joint Implementation Agreement and its main instruments.

Negotiation Status

Main Agreement Text
- Intellectual Property Rights
- Procurement and cost sharing
- Staffing regulations
- Principles of Operation Programme
- Resource Management
- Principles on management, procurement

Agreement enters into force
- Ministerial Meeting to "initial" Agreement
- NSSG13/N Meeting, Finalisation of Drafts
- NSSG12/N Meeting, DG selected
- NSSG11/N Meeting
- October: NSSG12/N Meeting,
- November: High level "P" Meeting, DG selected
- December: NSSG13/N Meeting , Finalisation of Drafts
- Spring 2006: Ministerial Meeting to "initial" Agreement
- Jun-Jul 2006: Agreement Formal Signature
- End 2006: Agreement enters into force

Negotiation Status

Negotiation Status

Negotiation Status

Negotiation Status
Schedule

2005
ITER IO
LICENSE TO CONSTRUCT
TOKAMAK ASSEMBLY
STARTS

2006
FIRST PLASMA
EXCAVATE TOKAMAK BUILDING
OTHER BUILDINGS

2007
TOKAMAK ASSEMBLY
FIRST SECTOR
LAST SECTOR
Last TFC
Last CS
PFC
Initial TFC

2008
First sector
Complete VV
Complete CS
Complete TFC

2009
Fabrication start

2010
Install cryostat

2011
Install PFC

2012
First sector
Last sector
Complete VV

2013
Last CS
Last TFC

2014
Design

2015
Bid

2016
Contract
Construction License Process

Schedule
Magnets

- Geometry and overall as in FDR 2001
- Detailed design of the coil case manufacturing, intercoil structures
- Review of the construction plan and manufacturing and assembly equipment to be launched
Status of the Design: Machine core

Vacuum vessel geometry and overall design is stable since a few years.

Detailed design of the standard sector largely completed.

Detailed design of the NB VV sector in progress.

Detailed design of the in-wall shielding, port structure, triangular supports is in progress.

Review of the construction plan and manufacturing equipment to be launched.

- Detailed design of the in-vessel supports.
- Detailed design of the NB sector largely completed.
Status of the Design: Machine core

- Detailed design of the standards module completed, but additional work required for the modules in the NB sectors, in the lower region and near diagnostics and heating ports.
- Demonstration of the new attachment system underway.
- Port plug design and handling being reviewed.
- Divertor standard cassette detail design well advanced, demonstration of the new attachment system underway.
Status of the Design: Machine core

- Cryostat:
  - Detail design of the cryostat penetrations and supports in ongoing.

- Thermal shield:
  - Design developed but limited resources to resolve some specific issues.

- Diagnostics:
  - Many integration issues still pending.

- Auxiliary heating systems:
  - The manufacturing design of none of them is fully completed.

- Others:
Integration Subjects

- Outboard First Wall shape – Limiter (retractable) and ICRF
- Weight, shielding, gap clearance, handling and refurbishment facilities.
- Access to diagnostic plugs above NB beam-lines.
- NBI Cell and NB maintenance – use of NB cell as “Hot” cell.

**Diverter dome (is it needed?)**

- Density control issues?
- Diverter gas seals? (limit recycling to plasma and plasma cleaning and higher temperature baking.
- Wall material, dust and Tritium retention. Suggestions for wall refurbishment facilities.
- Port Plugs review. Weight, shielding, gap clearance, handling.
- ELM control.
NB and diagnostic access
Status of the Design: Tokamak Complex

- Highly integrated building with tight spaces
- Layout of Systems and processes underway:
  - Assembly of large components
  - HVAC
  - Heating systems
  - Power distribution
  - Fueling
  - Cooling Distribution
  - Remote maintenance
  - Cable trays
  - Pumping
The preparation of technical procurement specifications for tokamak complex is in progress (was based on the generic site layout).
The table of contents for the specifications based on "standard" format:

- General requirements
- Technical requirements
- Others
- General arrangements and layout
- Room-by-room database
- Room definition (tokamak, tritium)
- Detailed layout of piping, cabling and supports
- General requirements, technical requirements, others

Engineering schedule, configuration control for integrated project
Efforts for bills of materials, equipment lists and specifications
Room-by-room database
Room definition (tokamak, tritium)
Detailed layout of piping, cabling and supports
General arrangements and layout
General requirements, technical requirements, others

Proc. Specs. For tokamak complex
Hot Cell Building

Consists of a rectangular reinforced concrete structure.
Provides space for RH equipment and systems, ventilation and atmospheric clean-up system, RH tools' repair and storage, active dust filtration system.

Accommodates also the systems and services required to support its operations: cranes, RH tools, active dust filtration system.

Provides space for RH equipment testing facility, control rooms and cask storage.

Provides a shielded and controlled area equipped for the refurbishment and testing of in-vessel components, including space for their temporary storage and/or preparation for disposal as radioactive waste.

Provides a shielded and controlled area equipped for the refurbishment and testing of in-vessel components, including space for their temporary storage and/or preparation for disposal as radioactive waste.
Cask Entry Refurbishment & Test Cells
Plug Refurbishment
NB Clean Cells Radwaste Cell

Hot Cell Building
From Generic to Specific

Site Selection allows IT to concentrate and finalise design for the Site Conditions:

- Site Layout
- Safety Strategy and Impact on Machine Design
- Codes and Standards
- Quality Classification
- Safety Classification
- Finalise Safety Analyses
- Finalise Safety Design
- General
- Tunnels
- Hot Cell Design
- Seismic Isolation Design

Specific to Generic
Reference Generic Layout

East: Primary cooling systems and non-electrical site services

South: Access of main components for assembly and RF heating systems

North: Personnel-related and switchyards, and cryoplant

West: Electrical power supply
As far as Tritium is concerned:

- Tritium inventory and other radionuclides content due to the Tritium inventory and other radionuclides content.

ITER will be an INB facility due to the Tritium inventory and other radionuclide content.

370 TBq

ITER # 10^6 TBq

450 g of Tritium # 150,000 TBq

20 to 500 mSv to population

20 to 500 mSv to population

ICPE: Installation Classée pour la Protection de l’Environnement

INB: Installation Nucléaire de Base

ICPE facilities (that could induce hazard to the environment)

INB facilities (Nuclear labs, plants, reactors…)

Normal risk

Special risk (with nuclear inventory)
ITER will be as an INB facility classified as a "labs and fuel plants" according to the set of design advice rules to use the framework requested that the representative of the future organization is set in place in the design phase of the project: CEA acts as the representative of the future operator.

The framework requested that the organization is set in place in the design phase of the project: CEA acts as the representative of the future operator.

127 INB under operation in France, among them # 50NPP, same roadmap for ITER.

Inventories and geometry may induce long uncontrolled nuclear reaction. Only limited nuclear reaction and impact for worst accident.


Nuclear Facilities (INB)ICPE Facilities
Nuclear Power Plants
Labs and Fuel Plants
The progressive safety review consists of three steps before starting operation:

1. Safety Options
   - as a new type of facility

2. Preliminary Safety Review
   - prior to construction

3. Temporary Safety File
   - on which operation will be possible

The general roadmap for safety analysis has been presented to the Safety Authority on 13 October 2000.
Steps in Licensing

Two main aspects: for the licensing

- Construct and Decrees to operate
- Public enquiry
- Safety reviews of the Preliminary Safety Report

DAC: Décret d'Autorisation de Création
AARPE: Arrêté d'Autorisation de Rejets dans l'environnement et de Prélèvement d'eau
In 2002 an introductory report was submitted (DOS). Recommendations have been received and form part of the basis for the PSR. The Operation Permit will be issued at the end of construction.
Duties of the Operator

ITER-org will be responsible under the French law Organisation of the ITER "owner" must fulfill the French legal text on Nuclear Facility Creation (order of December 1963) and releases (order of May 1995).

One legal text on Quality for nuclear facility (order of August 1984) close to IAEA 50-C/50-C (previously 50-C-A).

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One legal text on Nuclear Facility Creation (order of December 1963) and releases (order of May 1995).

ITER-org will be responsible under the French law.
These text explains the quality requirements for design, procurements, realization and operation of the facility.

ITER is a "Nuclear Facility" according to its
Radio-Isotope Inventory
Duties of the Operator

One legal text on Nuclear Facility Creation (order of December 1993) and releases (order of May 1995)

One legal text on Quality for nuclear facility (order of August 1984) close to IAEA 50-C/56-0 (previously 50-C-4A)

Management, procurement, construction, operation of all aspects in relation with safety

Sufficient means and skill of teams

Requirements for such a nuclear facility

Organisation of the ITER owner must fulfill the French law

ITER-ORQ will be responsible under the French law
This requirement lead to the necessity of a clear survey of all safety-related procurements by the ITER organization as future operator of the facility.

As regards quality-related activities carried out by service companies, the operator shall ensure that implementation of the provisions of the present Order concerning quality-related activities.

Being responsible for the safety of the installation, the operator shall hereby be responsible for the facilities, procurement, construction, operation of all.

ITER is a "Nuclear Facility" according to its Radio-Isotope Inventory.

The necessity of a clear survey of all safety-related procurements by the ITER organization as future operator of the facility.

This requirement lead to the necessity of a clear survey of all safety-related procurements by the ITER organization as future operator of the facility.
In particular, only adequately skilled staff may be assigned to quality-related tasks. Appraisal of the defined requirements makes performance of a quality-related activity need be adapted to the activity and enable compliance with the organisational provisions implemented for the human and technical resources together with the technical requirements. Appropriate human resources.
1. Operator must put in place a graded quality management system according to safety importance of components and activities.

2. Text applies for safety relevant activities.

3. Operator and contractors are concerned by QA system.

4. Operator is responsible for safety and responsible of application by contractors of adequate QA system.

5. QA manual + application report of QA.

6. Safety requirements are defined and checked.

7. Skilled, qualified, authorized workers, team size in agreement to safety objectives.

8. Independent check of safety relevant activity.

9. High level QA survey.

10. Keep records, paper work is stored correctly.

11. Safety relevant deviations are studied, corrected, recorded and declared.

12. Safety relevant studies are concerned by QA system.

13. Application report of QA.

14. Safety relevant studies are concerned by QA system.

15. QA presented when Creation Permit is asked.

19. NSA in charge of application.

One legal text on Quality for nuclear facility (order of August 1984)
Summary of QA reqs for INBs

- Quality of conception, construction
  - = IAEA 50-C/SG-Q (previously 50-C-QA, and to be DS338/339)

  AND:

- Requirements specified to contractors and subcontractors – the Operator is responsible to check compliance (Nber 9 add to § 400)

- Quality management by high level survey team
  - (statement Nber 9 or § 309)

- Independent check of all activities in relation with safety (statement Nber 8 or § 402/404)

- Technical survey by sampling
  - (Nber 9 or § 400)
The diagram illustrates the timeline for the construction and assembly of a tokamak facility. Key milestones include:

- **First Plasma** in 2005
- **ITER IO License to Construct** in 2005
- **TOKAMAK ASSEMBLY**
  - **Excavate**
  - **Install cryostat**
  - **Install PFC**
  - **Complete VV**
  - **Complete blanket/divertor**
  - **Last sector**
  - **Last CS**
  - **Last TFC CS**
  - **Complete CS**

**QA and C&S**

- **First procurements must be settled down before QA and C&S must be settled down before first procurements.**

**Requirements and C&S**

- **Prove that facility was designed and built according to quality requirements and C&S.**
"Nuclear C&S for ITER?"

Still...high quality necessary to ensure machine availability

Costly

Conservatism, still not 100% sure (i.e. VDES)

Unnecessary

Design loads on VV, although considered with much

Impractical

Simultaneous failure of VV and Cryostat is BDB but still no evacuation

Failure of Magnet - acceptable consequences

Failure of Cryostat - acceptable consequences

Failure of VV - acceptable consequences

In Cadarache: 1 qr HTO = 50 µSv

 ITER accidental limit is 10 mSv (IAEA No Evacuation=50mSv)

Limited Releases:

Extreme "CAT-IV (p=10^-6 to 10^-4) Events can be tolerated by"

unnecessary
**C&S in VV and Cryostat**

**VV approach:**
- Use rigorous approach (also Cat IV events) of RCC-MR nuclear standard to enforce high degree of quality and rely on nuclear material data.
- Modify to prepare for future devices.
- Assume in safety analysis large breach or events to show reliability.
- High emphasis to be given to Port Plugs and Windows.

**Cryostat approach:**
- Use ASME VIII type of standard but considering also Cat IV:
  - Component in CAT IV.
  - Afterall, assume in safety analysis large breach or component in CAT IV.
  - Modify to prepare for future devices.
  - Use rigorous approach (also Cat IV events) of RCC-MR.

**C&S in VV and Cryostat**
No existing recognised standard for structural integrity!

In EDA design “design manual” developed

Peculiarities:

- Non-metallic bonding
- Cryogenic material with high absolute and cyclic
- No ISI (!)
- Cryogenic material with high absolute and cyclic
- Non-metallic bonding

Approach

(i) No ISI

Assume flaws to be present above SOA detection

Approach

Evaluate crack growth in machine lifetime

Verify that residual crack is non-critical

Manage residual risk by assuming failure as CAT IV

Event and ensure no unacceptable releases.

C&S in Magnet

C&S in Magnet
<table>
<thead>
<tr>
<th>Color</th>
<th>Allowable Defect Size</th>
<th>Level</th>
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</thead>
<tbody>
<tr>
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<td>1</td>
</tr>
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<td>4</td>
</tr>
<tr>
<td>Red</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>
to conclude...

- 2008 will be the year of the first concrete pour
- 2007 will be the year of the key commitments
- 2006 will be the year of project renewal & buildup

Important “Critical Paths”:

- DG nomination (imminent)
- Final design reviews before TS (in 2006)
- Procurement specifications for VV, Magnet, Tokamak Buildings
- QA programs in ITER ORG and DAS
- Licensing process
- Final design reviews before TS (in 2006
- DC nomination (imminent)

ITER will be the first magnetic fusion facility to undergo nuclear licensing. The experience will have significant reflexes on how fusion will develop.

2006 will be the year of project renewal & buildup
2007 will be the year of the key commitments
2008 will be the year of the first concrete pour
Process of the Safety Review

1. Document internally approved and sent by appropriate organization to NSA

2. NSA will ask IRSN to study the file

3. IRSN (+ NSAI will invite for the review kick-off meeting

4. Instruction in close contact with operator (intermediate meetings)

5. IRSN (+ NSAI Experts) will call for the panel of experts: the Safety review

6. GP: The Safety review (GP: Groupe Permanent) and organize a last informal exchange with the operator (this latter will submit his commitments (t1-1 month)

7. GP will forward his advice to NSA

8. NSA will send final advice to operator \( \rightarrow t_0 + 10 + 12 \) to \( 15 \) months

9. NSA will write to the Prefect
Process of the Public Enquiries

1. Document internally approved and sent by appropriate organization to NSA, Prefect...

2. NSA will give its approval on files after internal review

3. NSA will ask the Prefect to launch the Enquiries

4. Prefect will give its advice following the report of the team in charge of supervision of the enquiries

5. After advice of the NSA (see slide on Safety review) sent to the Prefect, he will sign the Building Permit $t_0 + 6$ months

6. Creation Decree will be issued after CIINB final wording

7. Releases and Water Intake Authorization will be issued later, after advice of local CDH commission

8. Process of the Public Enquiries