Status of the ITER Project: U.S. Domestic Agency

Ned Sauthoff
Director, U.S. ITER Project Office

FESAC
Gaithersburg, MD
November 6, 2008
Model of the ITER Site

- Will cover an area of about 60 ha
- Large buildings up to 170 m long
- Large number of systems

Magnet power converters buildings

Cryoplant buildings

Tokamak building

Tritium building

Cooling towers

Hot cell
ITER Construction Site / AIF

ITER Site
Staffing Status
by the end of 30 September 2008

• As of 30 September 2008, IO has a total of 276 staff, including 207 professional staff and 69 technical support staff;
• 104 posts were in the recruitment process (80 new and the rest replacement or reposted positions).

Professional staff by Members by 30 September, 2008: Total 207

CN: 15
EU: 122
IN: 8
JA: 17
KO: 15
RF: 16
US: 14
Procurement Sharing

How the overall costs are shared:
EU 5/11, other six parties 1/11 each. Overall contingency of 10% of total. Total amount: 3577 kIUA (5.365 Mil € / 2008)

A unique feature of ITER is that almost all of the machine will be constructed through *in kind* procurement from the Parties
ELM & VS coils – layout of reference option

Upper VS coil

Upper ELM coil

Mid coil (space limited)

Lower ELM coil

Lower VS coil

Upper feeder

VS toroidal connecting leg

40° sector Outboard

“Multi purpose” in vessel coils:
- ELM control (∼2Hz),
- Vertical Stability control
- Radial position control
- Resistive Wall Mode (RWM) control (25 Hz)

VAC-02 - 3 rows – 9 coils
The Schedule

Risk mitigation on construction schedule:

- Parallel Approach to Construction and Nuclear Operation Permit: Agreed with ASN!
- Pre A/E contract (>6M€ from EU) signed and manpower started to mobilize
Design Review and STAC issues

• **Design Review**
  – Completed September 2007
  – U.S. provided roughly 25% of the professional person years provided by the parties

• **Resolution of issues identified by the Science and Technology Advisory Committee**
  – U.S. provided 36% of the professional person years provided by the parties
Areas of On-going Advancement

• **IO-DA project refinements**
  – cost-estimate
  – schedule
  – project management tools/systems

• **IO-DA completion of the design**
  – distributed design (including DA responsibility)
  – integrated Product Teams
  – integrated decision-making and reviews
U.S. Organizational Structure
U.S. Contributions to ITER Project

U.S. ITER Project
Ned Sauthoff
Project Manager
Executive Secretary
Tonia McPeters

Chief Technologist
Stan Milora
Chief Scientist
James Van Dam

Oak Ridge National Laboratory
UT-Battelle, LLC

Deputy Project Manager
Carl Strawbridge

Chief Engineer
Brad Nelson

Procurement Manager
Jeff Geouque, M

ESH&Q Manager
Richard Mislop, S/C

Communications and Human Resources
Bonnie Hébert, M

Computing Integration Information Systems
Den Clarillette

Project Office
Carl Strawbridge

Magnet Systems
John Miller
WBS Manager, ORNL

Cooling Water Systems
Jan Berry
WBS Manager, ORNL

Electric Power Systems
Charles Neumeyer, M
WBS Manager, PPPL

Diagnostics
David Johnson, M
WBS Manager, PPPL

Support to ITER International Team/ Business Office
Jama Hill
WBS Manager, ORNL

Blanket Shielding and Port Limiter Systems
Mike Hechler
WBS Manager, ORNL

Vacuum Pumping and Fueling, ECH & ICH Systems
David Rasmussen
WBS Manager, ORNL

Tokamak Plant Exhaust Processing
Bernice Rogers
Acting WBS Manager, SRNL

Project Controls
Suzanne Herron
WBS Manager, ORNL
# U.S. Contributions to ITER Project

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<tr>
<th>U.S. ITER</th>
<th>Technical Advisory Committee</th>
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<td><strong>Project Advisory Board</strong></td>
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<tr>
<td>Harold K. Forsen, Chair</td>
<td>Charles C. Baker, Chair</td>
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<tr>
<td>Charles C. Baker</td>
<td>Lee Berry</td>
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<tr>
<td>Robert C. Iotti</td>
<td>Eugene (Gene) R. Desaulniers</td>
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<tr>
<td>Milton Johnson</td>
<td>Kathryn A. McCarthy</td>
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<tr>
<td>David G. McAlees</td>
<td>Gerald A. Navratil</td>
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<tr>
<td>Edward I. Moses</td>
<td>Miklos Porkolab</td>
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<tr>
<td>Satoshi Ozaki</td>
<td>Stewart C. Prager</td>
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<tr>
<td>James R. (J. R.) Thompson</td>
<td>Bruce E. Warner</td>
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<td>M. C. Zarnstorff</td>
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USIPO is prepared to proceed....

- Project Execution Plan

- Resource-loaded schedule

- Cost-estimate range
  - Cited in the President’s Budget Request
  - Includes Risk-based contingency

- Project Control tools built on Spallation Neutron Source set
  - Work Breakdown Structure
  - Configuration Control
  - Quality Assurance and Safety Plans
  - Risk Management....

- Contracts, Business and other capabilities from ORNL, but co-located
US ITER In-kind Hardware Contributions

- 100% Ion Cyclotron transmission lines
- 100% Electron Cyclotron transmission lines
- 15% of port-based diagnostics
- 7 Central Solenoid windings
- 8% of Toroidal Field conductor
- 75% Cooling for divertor, vacuum vessel, ...
- 20% Blanket/Shield
- Roughing pumps, standard components
- Steady-state power supplies
- Tokamak exhaust processing system
Toroidal Field Coil Conductor

U.S. supplies 40 tons of Niobium-tin superconducting wire
Cable pattern & strand support

Baseline geometry 3-based

Alternate geometry 6+1 based

Alternate geometries substantially stiffer than baseline.

Better strand support?
Sultan Test Samples

• SULTAN facility continues to be key facility for QC. EU dipole and may be CSMC (or KO) facility will be used in the future too.

• All superconducting strands for the Toroidal Field Coils (TF) have to pass a Qualification Procedure.

• These tests are performed at the Superconductor Test Facility SULTAN, Located at the Paul Scherrer Institute in Villigen, Switzerland.
TFUS1 Testing

Evolution of $T_{cs}$ and $T_o$

Minimal, if any, degradation

$T_{cs}(11T, 68kA) = 5.7K$

US Alternate A

Old ITER baseline

Cycles
Possible conductor test facility

- Central tie-rod structure replaced by cylindrical bore tube
- Gate valve for isolating sample volume after sample removal
- Sample ante-chamber
- "Tip stick" boom for adapting building crane
- Sample holder with 60kA current leads from JAEA
- 3-turn sample mounted on lower structure
- 3-turn sample
- CSMC at Naka in existing cryostat
Central Solenoid Options

Reference Design, external structure based on inner & outer tie plates

Alternate Design, external structure based on central tie rods and rigid end caps
Blanket, Port Limiter and Divertor Systems
First Wall Qualification Mockup

Be Tiles (3)

CuCrZr Heat Sink

SS Back Plate

First Mockup
FWQM US-1
FWQM Test Facility - SNL
Possible new steel for cast components

- Shield Modules (SM) are presently constructed out of stainless steel forgings and require considerable machining operations.

- The use of casting is being explored as a more cost effective fabrication methodology.

- A “science-based” approach has been applied to improving the cast stainless steel, reducing the involved as compared to the more traditional alloy development.

- The property improvements include strength, toughness, radiation and corrosion.

- The next phase of the cast material qualification will involve the commercial fabrication of full scale prototypes.
ICH Transmission lines and Tuning/Matching System

5 MW transmission air cooled lines from the sources to the antenna
3 dB ELM tolerant matching connected to 24 strap antenna array

Long pulse; High power resonant ring tests components to > 5 MWs (ORNL)
WBS 1.5.2. Scope - ECH Transmission line and Mode Control

1-2 MW water cooled T-lines from the gyrotrons to the launchers
24 lines to the equatorial launchers
32 lines to the upper launchers
Mode and polarization control are major technical challenges
140/170 GHz test stands used to develop and qualify components

Long pulse; High power resonant ring tests components to > 2 MWs (ORNL)

Infrared imaging shows ohmic & mode conversion hot spots (JAEA)
Pellet Injector R&D to develop extruder, gas recirculation and injector reliability

- **Technical challenges**
  - Extruder throughput and reliability (FY07-10)
  - Propellant gas recirculation to minimize impact on tritium plant (FY09-10)
  - Gas gun prototype (FY09-11)
  - Pellet survivability in guide tubes and guide tube selector (FY09-11)
Twin Screw Extruder Prototype R&D is making good progress towards goals

- Pellet injector twin screw extruder prototype has successfully produced solid deuterium extrusions for up to 30 minutes
  - Achieved 10% of the ITER required flow rate.
  - Further optimization will be undertaken to increase the flow rate up to the prototype’s design value of 30% of the ITER requirement.
  - Recirculating fuel loop will be added as the next step.

Intermeshed counter rotating screws

3mm D₂ Extrusion
Pellet Pacing for ELM mitigation

- ELMs need to be limited to 1 MJ/event
- ELM pellet pacing frequency of 20-40 Hz is needed
- 4mm (cylindrical) pellet required to reach the 4 keV pedestal
- Recent experiments indicate shallower penetration with smaller pellets (~ 1 mm) may suffice
- High rep rate pellet dropper experiments underway at DIII-D

- Will require at least 2 additional pellet injection systems to meet increased requirements
Disruption Mitigation  
(possible new/additional scope)

- Massive gas puff not likely to scale to ITER
- Large pellets may be required  
  (wine cork size)
- Liquid jets have also been considered
Next Steps

• Engage US industry in design completion and optimization
  – Incorporate industrial experience
  – Assure ITER design is compatible with US manufacturing methods
  – Focus on early-delivery / high-risk systems
    • superconducting magnets
    • plasma-facing components
    • power handling
    • diagnostic instrumentation

• Place long-lead procurements for materials for early-systems
  – Superconducting strand (for schedule reasons)
  – Stainless steel (as a cost-risk mitigation measure)