EU Contribution to ITER Remote Handling

*Updates on technical and procurement status*

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Outline

- Overview on ITER Remote Handling
- Situation related to DIV RH, CPRHS, NB RH
- Situation related to IVVS
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Needs for ITER remote maintenance

- Radioactivity at the start of a shutdown (Gy/h)
  - Radioactivity above the divertor
    - Source SCK-CEN
  - Decay Co-60

- Radioactivity over time (years)
Inspection, maintenance, removal/installation and refurbishment of ITER components that due to radiation levels cannot be performed hands-on (in-vessel, neutral beam cell, hot cell, transportation)

- ITER RH is made of 7 different systems + Cold Test Facility & Supervisory Control
- 4 of the systems are procured and delivered as in-kind contribution from EU-F4E to IO

- 23P1 Blanket RH System (IVT – In Vessel Transporter) → Japan
- 23P2 Divertor RH System (DRH)
- 23P3 Cask and Plug RH System (CPRH)
- 23P4 In-Vessel Viewing System (IVVS)
- 23P5 Neutral Beam RH System (NBRH)
- 23P6 Hot Cell RH System (HCRH) → IO (only design during ITER construction phase)
- 23P10 Multi Purpose Deployer System (MPD) → IO (tbc)
- + 23P9-Remote Handling Cold Test Facility & 23P7-Supervisory Control System - IO

EU Contribution to ITER Remote Handling, Carlo Damiani, IBF 2013

EU Remote Handling Systems (II)

**Divertor Remote Handling**
- Primary Function: Installation / Removal of divertor cassettes and auxiliary elements (diagnostics racks, primary closure plate)
- Main Components:
  - Cassette Multifunctional Mover (CMM)
  - Cassette Toroidal Mover (CTM)
  - Dust cleaner
  - Manipulator Arm (MAM)
  - Tooling: Cutting, welding, boring, etc.
  - End-effectors
- System highlights
  - Replacement of entire divertor in 6 months (3 times in ITER lifetime / + single faulty cassette)
  - Tritium & contaminated dust / gamma radiation from activated in-vessel components (~100Gy/h)
  - High loads (9t-11t), millimetric accuracy / small clearances and limited viewing (use of VR)
  - Great variety of complex operations, man-in-the-loop and in a harsh environment (cutting – welding – boring – alignment – inspection – cleaning etc. remotely controlled)
DIV RH: the DTP2 in Finland

DTP2 Facility
- Divertor region mock-up with CMM + cassette operations capabilities (non-nuclearised)
- Integrated operations demonstrations
  - Virtual Reality + Command & Control + Equipment Controllers (real HW) + Operations Management System
- Accurate VR (Structural Simulator – Accuracy improved from 60-70mm to 5-10mm)

EU Remote Handling Systems (III)

Cask Plug Remote Handling
- Primary Function: Remote transport means of components between Hot Cell Facility and Vacuum Vessel, for maintenance and rescue operations.
- Main Components:
  - Cask envelope (confinement envelope)
  - Front/Rear double sealed doors
  - Pallet (I/F envelope & CTS)
  - Cask Transfer System (motorize platform)
- System highlights
  Primary confinement functions (SIC1) when docked to VV (lower category SIC2/SR during transportation of components).
  50t payloads / total max 100t – 8.5x3.7x2.6m max.
  Fleet of 15 units (final numbers including rescue units to be defined)

During transportation:
- Autonomous power
- Telemetry/Tele-command system
- Small clearance with building
- Lift maneuvers
Neutral Beam Remote Handling
- Primary Function: Remote replacement of Neutral Beam system components
  (at beam source – beam line – front end)
- Main Components:
  • 50t monorail crane + accessories (lifting...)
  • Transporters / Manipulators (BS / BL)
  • Swingable rails
- System highlights
  Reduced maintenance schedules
  Manipulation of activated elements (~1 Gy/h during shutdown, ~10 Gy/h during ITER operation due to neutrons)
  Great diversity of components, tools and operations to be performed remotely
  Seismic loads of monorail crane

EU Remote Handling Systems (V)

Neutral Beam Remote Handling

NB source vessel maintenance

Upper port maintenance (RH class 3)

Example of pipe tooling

NB Residual Ion Dump maintenance
In-Vessel Viewing System

- Primary Function: Inspection of blanket first wall and divertor plasma facing components looking for damage; in-vessel viewing and metrology

- Main Components (baseline configuration under study!):
  - Probe + control / processing units (6x)
  - Plug housing / sealing (tank? next slide)
  - Deployment system
  - Spares

- System highlights
  UHV, operation temp. up to 120°C (baking 200°C), gammas 5-6Kg/h, neutron flux up to 4*10^17 n/cm² (wide spectrum), up to 8T magnetic field, space constrains...
  Viewing performance: spatial resolution <1mm (0.5 – 4m target distance), <3mm (>4m target distance)
  Metrology performance better than millimetric (next slide)
  Self illumination
  Critical functions: dust inventory - wall erosion damage of in-vessel components
  Managed from CODAC control room

In-Vessel Viewing System probe

Example of the metrology function:
- The plasma facing components (PFC) material is tungsten.
- 20% of the PFC surface is eroded.
- The calculated total mass of mobilised dust must be ± 200 kg precise.
- The measures distribution must be in the 2σ interval.
  ⇒ The standard deviation of the measure must be less than 0.165 mm.

In-Vessel Viewing System layout

In case of excessive neutrons for the plug option, a fall back solution (tank option) was considered.
- Vertical tiers: 7 RH Systems -> Each a fully functional system

- Horizontal tiers:
  - High Level Control System (HLCS) – Operator interfaces, high level / complex / coordination functionalities
  - Low Level Control System (LLCS) – Control loops, embedded systems, field control equipment
  - Integration layer – Between RH systems (supervisory system) and to ITER central systems (Interlocks, Safety)

- Networks: Control – AVN – Real Time – Diagnostics -> Integration of heterogeneous components
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F4E will receive the RH procurement-in-kind obligation – at the signature of the PA – at the level of functional specifications supported by conceptual design
For each RH package Europe will have to design, procure, deliver, install and do site tests until final acceptance and hand-over to IO the RH systems
F4E will charge an industrial integrator to be responsible for that package from design until final acceptance
A low risk/cost effective strategy has been defined:
• Multiple framework contract in cascade, up to 7 year duration, with staged approach: implementation through specific contracts covering the various phases of the project lifecycle until hand-over
• Implementation includes technological development and prototyping by the integrator up to the extent needed to validate the preliminary/final design
• Standardisation across the packages will be promoted
• Flexibility in the pathway to final acceptance
• Possibility to pick up the other two contractors in case the 1st one is not delivering
• The above strategy is applied to the 4 packages
• On each package the tendering process includes: call for expression of interest, selection of (up to) 5 bidders and invitation to dialogue (on draft model contract), invitation to tender (including the business case), bidding and awarding
For DIV RH, CPRHS, NB RH the call for expression of interest has been published in November 2011 and closed in March 2012: OMF 340 lots 1, 2, 3

The subsequent stages are carried out “in phase” with the overall RH project schedule, considering events like Conceptual Design Review and Procurement Arrangement signature

Currently we are working on OMF 340 lot 1:
- Selection of candidates to invite to the dialogue, among those who have applied, according to the criteria set out in the call for expression of interest - done
- Preparation of the draft model contract, dialogue rules – done
- Preparation of the tender documentation – done
- Presentation of business case, start of dialogue – done

Tentative schedule is:
- Dialogue until June 2013
- Tendering-awarding-signature phase until November 2013

The other dialogue-tendering processes (OMF 340 lots 3 and 2) will follow:
- June 13 → May 14 dialogue-tendering-award-signature for NB RH (PA signed May 2013)
- Nov. 13 → Oct. 14 dialogue-tendering-award-signature for CPRHS (PA signed Jan 2014)

To improve the start-up phase of the OMF lots, we are performing preparatory activities (OMF 272)

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For IVVS the call for expression of interest is going to be published (OMF 383) in the coming weeks.

The call will be structured in a similar way to what has been done for OMF 340.

Candidates will be scrutinised taking into account – among others - the coverage of the technological areas relevant for IVVS (metrology, rad-hard nuclear grade design etc.)

The dialogue will follow the conclusion of the previous ones, and the tentative schedule is:
- Call for expression of interest launched in April 2013 until July 2013 (*pre-information notice being published*)
- Selection of candidates, preparation of dialogue-tender, and dialogue starts September 2013
- Tendering-awarding-signature phase until July 2014 (PA signed October 2013)

To improve the start-up phase of the OMF 383, F4E is considering to launch preliminary, preparatory activities (e.g. with OMF 272)

For OMF 340 and 383, a significant amount of design, technological development, prototyping and testing, manufacturing and site installation activities are foreseen on a rather long timescale (~7 years)

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**Situation related to IVVS**

The preparation of the Procurement Package (functional specs, interfaces, scope, conceptual design) is IO-driven, with collaboration from F4E.

The post-PA Package design and procurement is F4E-driven, with collaboration from IO (in particular for the ITER site activities after delivery).

Final integration into the ITER plant and operation of the RH system is IO responsibility.
For further information please contact us at
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mentioning “Remote Handling” in subject of your email

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