JET Work Programme 2012

PART 2 – FUSION TECHNOLOGY

1 - Programmatic guidelines for JET Fusion Technology Activities in WP 2012

It is proposed that the 2012 FT programme at JET focuses on issues of relevance to ITER operation and licensing, and applicable to a possible DTE2 experiment. The programmatic guidelines are proposed to be as follows:

a) Analysis of selected PFC samples to provide data for particle transport studies, erosion deposition studies, and tritium retention studies in support of the ITER-like Wall Project.
b) Contribution in support of ITER licensing, in particular characterization of dust, in-situ diagnostics for characterization of plasma facing components and dust, and collection of data on the lessons to be learnt from JET.
c) Methods for measuring T activities and for reducing T inventories in waste.
d) Neutronics and safety.
e) Engineering R&D in support of JET operations, to develop and test ITER relevant components or processes applicable in JET operations.

In view of the financial constraints on the 2012 JOC no use of the test beds for Fusion Technology Tasks is foreseen.

The activities will include the completion of on-going Fusion Technology tasks launched in the WP 2011 and extending in 2012.

For each topic investigated, a summary of the results obtained, the implications for JET operation and lessons to be learnt for ITER shall be reported.

Details on objectives and priorities for the planning of the 2012 FT programme at JET are given in Table 1.

Table 1: Objectives 2012, with examples of potential activities

TASKS	COMMENTS
1 -Plasma Facing Components and Tritium in the Tokamak	
1.1 - Analysis of selected PFC samples in order to support particle transport studies, erosion deposition studies, and tritium retention studies	As a contribution to the impurity transport and erosion/re-deposition studies analyses of PFCs and other samples removed in the 2009-2011 shutdown are needed in order to complete the picture for the carbon-based JET machine. In addition, measurements on samples from the ILW removed in the short intervention planned in 2012 could be started. Topics that might be explored include: - profile measurements of new marker tiles - poloidal and toroidal variations in erosion/deposition/retention, including analysis on correlation with plasma operation, - distribution of retained fuel within the wall and estimates of total inventory, - plasma-surface interactions at RF and LH antennas, - toroidal and poloidal distribution of ^{13}C from the methane puffing from previous operational campaigns, and comparison with simulations using state-of-art codes, - plasma – material interaction studies, simulations of erosion and dust formation for ILW materials
1.2 - Characterization of Mixed Materials in support of the ITER-like Wall Project	The generation of mixed deposited materials represents a major topic of concern for ITER. JET now provides a source of mixed materials such as tungsten beryllides, expected to be generated in JET ILW. Although compositional information will already be gleaned from continuing analysis using Ion Beam Analysis techniques, SEM and SIMS, these methods do not address other film properties such as chemical states, structure and thermal/electrical properties. Further techniques are needed that may add information on film properties such as XPS/AES, XRD, for the surface films that may be expected from the Be/W materials.
1.3 - Characterisation of dust	In vessel dust formation and accumulation is one of the major safety concerns in ITER. - Samples of dust and flakes from various parts of the JET divertor have been collected during the ILW shutdown by vacuum cleaning. These samples are available for analysis

	for properties that may be of interest for JET/ITER, such as chemical composition, specific surface area, particle size. - Tiles that have not been vacuum cleaned are also available for experiments to demonstrate mobilisable dust inventory, or analysis related to dust production.
1.4 - Assessment of in-vessel dust diagnostics and removal methods	Proposals will be considered for techniques that may enable the formation of dust during the JET ILW programme to be measured for comparison with dust accrual in the carbon-based machine. Also, feasibility study will be considered for testing in JET in-vessel dust diagnostics and removal methods that are being developed for ITER.
1.5 - Investigations of degradation of mirror optical properties and assessment of mitigation / cleaning methods	Previous experiments at JET have proved that in deposition regions the degradation of optical properties of first mirrors due to covering with co-deposited layers is a major issue for ITER. These experiments will be continued with the new ILW. Moreover, mitigation measures need to be explored such as the shaping of ducts. The recovery or, on the contrary, the progressive deterioration of optical properties of mirrors subject to repetitive exposure – cleaning cycles could also be investigated by re-installing previously exposed and cleaned mirrors. The JET Reciprocating Probe System could also be used for exposure cycles to JET plasmas.
2 Waste Management	
2.1 - Detritiation of metals	In continuation of activities on detritiation of metals and in order to extrapolate to industrial conditions, there is a need of developing a model for the detritiation factor in case of metallic waste incineration.

2.2 - Limitation of tritium out-gassing from drums.	The out-gassing of tritium from JET waste is partly responsible of the limitation of waste amount to be stored on site. Characterisation of tritium content and out-gassing from JET waste materials is of great importance and R&D studies for tritium migration from waste boxes, including test of techniques to limit degassing from JET waste samples is highly recommended.
2.3 - Efficient crushing process for CFC tiles	Before sending CFC tiles for an industrial heat treatment, a pre-process is required to significantly increase the specific area of tiles for higher detritiation factors. Establish a pre-process scheme of a high efficient crushing technique for CFC tiles. Assessment of associated dust production and industrial scalable scheme should be part of the studies.
2.4 - Facility to detritiate dust, flakes and organic liquid	Dust, flakes and organic liquid are at JET amongst items of highest activities and options to treat these items on site should be investigated. A design study of a facility which could detritiate both items at JET is of paramount importance.
2.5 - Waste minimization	Assessment of the applicability of technologies from conventional nuclear fields helping to minimize contamination of materials. Strippable coatings may be effective at limiting the extent of tritium migration into the bulk material of items and there is therefore potential to utilise this in future operations involving large items of new plant and equipment. Consideration may be given to a study into the use of strippable coatings in tritium environments.
3 Neutronics and Safety	
3.1 - Neutron studies for neutron detectors calibration.	In order to provide inputs from the JET experience to the ITER neutronics issues, the programme must take advantage of the ITER like Wall short shutdown by calibrating the new neutron detector during the shutdown to improve the accuracy of neutron calculation modelling that will be crucial in the calibration of ITER neutron detectors. In this respect, numerical simulations already started in 2011 with scoping studies need to be completed with - the use of the complete 3D MCNP model of JET, - the comparison of numerical predictions with experimental results of calibration using

	^{252}Cf source, - the extrapolation to extended plasma neutron source with resulting uncertainty. - The comparison of neutron yields from calibrated fission chambers and the activation system. Extension to the case of 14 MeV neutron calibration at JET could also be started with the analysis of neutronics issues using a DT neutron generator.
3.2 - Fuel ratio determination by neutron diagnostics	Neutron diagnostics in ITER, in particular the neutron camera, are expected to provide measurement of D/T fuel ratio for the control of D/T fuel mixture. A study of the feasibility of such measurement at JET should be performed in view of a DT experiment exploiting a whole range of n_T/n_D mixture from 0 to 1, and in Be environment. In particular, the study should assess the feasibility of the demonstration of the method of n_T/n_D in the range 0 - 0.5, the related uncertainties and the extrapolation to ITER case.
3.3 - Validation of shutdown dose rate calculations.	In order to provide inputs from the JET experience to the ITER licensing process, experiments must be ready to capitalise on the new short shutdown to be performed during 2012 should be capitalised to improve the accuracy of shutdown dose rate calculations with the new ILW. Dose rates in the vacuum vessel, inside and outside the open port should be measured using accurately calibrated dose meters and compared with the values calculated using with state of art codes used in ITER safety analysis. Extension to the case of 14 MeV neutron calibration at JET should also be started.
3.4 - Validation of calculations of neutron streaming through ducts	The calculation of neutron streaming outside the ITER bioshield through large ducts (such as e.g. the NBI HV line) is a major safety task involving transport of radiation along long paths and in complex geometries. Application of the state-of art codes or numerical approaches used in ITER analyses to JET DT experiment would provide estimate of the dose rates outside of the JET torus hall due to neutron streaming through ducts. Moreover, when comparison with experimental data would be available, it would provide valuable validation of calculations made for ITER safety assessments.

3.5 - Validation of calculations of Activation Corrosion Products (ACP) in cooling waters loops	Activation corrosion products generated in cooling water are expected to be a major source of the Occupational Radiation Exposure (ORE) of personnel during inspections and maintenance. Codes used for ITER analysis need to be validated in a representative fusion environment. Data from the water cooling system of JET in vessel actively cooled components (including also the new CuCrZr NBI port scraper) should be used to validated the codes, in particular with regard to - the generation of corrosion products (i.e. copper) - the feasibility of the measurement of activation of corrosion product during the DTE2 experiments
4 Engineering	
4.1 - Measurements of metallic surface temperature	Monitoring the surface temperature of metallic PFCs in ITER, in the visible and/or infrared range, independently of the environment (reflected flux) and of the thermal transient events (ELMs, hot spots, overheated layers...) is essential for safety of the PFCs and a challenge for development of high performance plasma scenario. TFFT can support the initial design and testing of techniques for surface temperature measurement in a reflective environment and adaptation to JET, prior to proposal as a new JET diagnostic.
4.2 - Radiation induced effects in cables and optic fibres used for diagnostics	In a future DT campaign at JET, even if the neutron fluence would be not ITER relevant, the neutron flux densities would approach those expected in ITER (and be much higher than that achievable in 14 MeV neutron generators). Therefore such a campaign would represent a unique opportunity to perform radiation hardness studies. In 2012 these studies could be started with the verification of the available database obtained in different neutron fields (fission reactors), and with feasibility studies of tests of real ITER cables and fibres at JET.

Task Title:	
Association	

Field:			**JET Task: Fusion Technology JW12-FT-x.a b**	
EFDA reference:			**Ass:**	
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Ass. Responsible Officer 1	TBD			
Ass. Responsible Officer 2	If Necessary			
Operator Representative	TBD			

TASK DESCRIPTION

Background:
(with mention of related previous tasks)

Goals:

Description of the work :
Experimental details (number and description of samples, experimental conditions…), modelling, time schedule, required input data…

Task Title:	
Association	

Appropriateness for JET:

Relevance to ITER:

Links with other tasks (past or present):

TASK MILESTONES *(interim and others milestones, the ones indicated in the table below are mandatory)*

No	Description	Due Date	Required Deliverables
M1	Semi annual report and presentation to the monitoring meeting (1st)	Jun 12	
…			
Mi	Semi annual report and presentation to the monitoring meeting (2nd)	Dec 12	
…			
Mn	Final Report		

TASK DELIVERABLES *(major steps of the work to be performed and related total cost of expenditures)*

No	Description	Due Date	Expend. Cost (k€).*
D1			
…			
Di			
…			
Dn			

*** :** *Please enter the annual total expenditure cost breakdown per deliverable (cf. final table of this task summary)*

Task Title:	
Association	

CONTRIBUTING INSTITUTIONS:

Association	**Deliverables**	**Principal responsible**

JET OPERATION IMPACT/OPERATOR EFFORT:

- Machine requirements
- Operator manpower effort (financed under JOC)
- Other JET facility requirements

TECHNICAL REFERENCE SUPPORTING DOCUMENTS:

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In case of a task continuation, please indicate below the related publications of year 2009-2010 (journals & conferences):

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COMMENTS:

Task Title:	
Association	

TASK DESCRIPTION

FORECAST OF MANPOWER AND EXPENDITURE (one for each involved Association)

ANNUAL MANPOWER (*in Professionals Per Day and Technicians Per Day***)**

CATEGORIES	2012
Professionals (PPD)	
Technicians (TPD)	
Total	
Missions (#) *including 1 for the monitoring meeting*	
Total missions duration (days) *including 3 days for the monitoring meeting*	

ANNUAL EXPENDITURE[(1)] (*Excluding Manpower***)**

CATEGORIES	2012
	Full cost (k€)
Irradiations	
Hot cells (*including accelerator time for Be- or T-contaminated samples*)	
Transport of radioactive materials	
^{3}He	
Other expenditures *(detailed below)*	*
Total	

[(1)] RULES TO FILL THE TABLE:

- Generally, expenditures will be covered by notification (currently 20 %)
- The "irradiations" and "hot cells" categories may be eligible for additional 20 % funding (please provide on a separate sheet the daily cost and justifications).
- Transport of radioactive materials, ^{3}He and specific items needed for the execution of the task (detailed under other expenditures) may be eligible for orders (100% funding)
- For "other expenditures", please give hereunder the description and breakdown of full costs (put total in cell * and report the deliverables breakdown cost in the "task deliverables" table on page 2).
    - ……
    - ……