International Atomic Energy Agency

INDC(NDS)-237/M6

INDC INTERNATIONAL NUCLEAR DATA COMMITTEE

IAEA CONSULTANTS' MEETING ON

"THERMAL RESPONSE OF PLASMA FACING MATERIALS AND COMPONENTS"

Vienna, 11-13 June, 1990

SUMMARY REPORT

Prepared by R.K. Janev

July 1990

IAEA NUCLEAR DATA SECTION, WAGRAMERSTRASSE 5, A-1400 VIENNA

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IAEA CONSULTANTS' MEETING ON

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Abstract

The present Summary Report contains brief proceedings and the main conclusions and recommendations of the IAEA Consultants' Meeting on "Thermal Response of Plasma Facing Materials and Components", which was organized by the IAEA Atomic and Molecular Data Unit and held on June 11-13, 1990, in Vienna, Austria. The Report also includes a categorization and assessment of currently studied plasma facing materials, a classification scheme of material properties data, required in fusion reactor design, and a survey of the urgently needed material properties data.

Reproduced by the IAEA in Austria
October 1990

90-05071

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1. INTRODUCTION

Progress in the world fusion effort has reached the point when the design of an engineering test reactor appears as the logical and achievable next step. The scientific and technological complexity of this step requires a high degree of integration of existing knowledge, technical skills and other relevant resources, and in this context the IAEA can provide an important contribution to fusion development. On the other hand, the current conceptual fusion reactor design activities, both on national (CIT, NET, FER, OTR) and international (ITER) levels, have revealed that the most stringent conditions on the reactor operational space, reliability and safety are set by the materials used in reactor design. The reactor materials problem manifests itself in a series of major design issues such as control of impurities, particle and power exhaust, lifetime of the first wall and plasma facing components, tritium inventory, etc. The essence of the fusion reactor materials problem is in the severe conditions (high heat loads, particle fluxes, neutron fluences) imposed on the surrounding materials by the burning thermonuclear plasma. The development of adequate plasma facing and structural reactor materials is currently an area of intense scientific research and technological development, and the subject of many bilateral and multilateral collaborative efforts. Characterization of the candidate materials with respect to a wide spectrum of properties relevant to the fusion reactor performance is another area of active research. A systematic compilation and evaluation of this growing information, and establishment of an internationally accepted database for the thermo-physical, mechanical and irradiation properties of fusion reactor candidate materials, could be of significant benefit to the fusion reactor designers, particularly within an international framework, such as ITER.

Motivated by all this, and following the recommendation of an IAEA Advisory Group Meeting on "Particle-Surface Interaction Data for Fusion" (19-21 April, 1989, Vienna), the IAEA Atomic and Molecular Data Unit convened on June 11-13, 1990 in Vienna a Consultants' Meeting on "Thermal Response of Plasma Facing Materials and Components". The specific objectives of the Meeting were:

1) to summarize the experience with plasma facing materials (PFM) and components (PFC) on the operating large fusion machines (JET, TFTR, JT-60, Tore Supra, DIII-D, T-15);
2) to review the PFM and PFC requirements for the next step fusion devices (CIT, NET, FER, OTR, ITER) for both normal operation conditions and off-normal events;
3) to review the data status of existing thermal, mechanical and irradiation properties of candidate reactor materials, and categorize the material response parameters required for the engineering design;
4) to explore the possibilities of the IAEA involvement in the co-ordination of the PFM properties data generation, compilation and evaluation and to define the scope and priorities of the IAEA A+M Data Unit activities in this area.

The meeting was attended by ten experts from the Member States and three participants from the IAEA (see Appendix 1: List of Participants). During the preparation stage of the meeting, Dr. W.B. Gauster and Prof. A. Miyahara, members of the PMI Co-ordination Group of the IFRC Subcommittee on A+M Data for Fusion, provided very valuable suggestions to the organizer regarding the meeting programme.

2. MEETING PROCEEDINGS

The meeting was opened by Prof. V.A. Konshin, Director of the IAEA Division of Physical and Chemical Sciences, who expressed the Agency's interest in this area of fusion research and development and, on behalf of the IAEA, thanked the participants for their acceptance to contribute to the effort. The participants then adopted the Meeting Agenda (see Appendix 2), and the work proceeded in six sessions, as follows:

1) Experience with PFM on large fusion devices and data availability;
2) PFM data requirements and PFC developments for the next-generation fusion devices (or upgrades);
3) Material response and phenomena related to off-normal plasma events. Testing and simulations;
4) Categorization of material response parameters for Enginnering Reactor Design and data status assessment;
5) Scope and format of the IAEA PFM database and co-ordination of PFM data production and evaluation activities;
6) Formulation of meeting conclusions on PFM data status and requirements, and recommendations on the IAEA activities in the PFM data area.

In the first session the experiences with PFM and PFC on TFTR, JT-60, JET and TEXTOR were presented. (Dr. P. Deschamp was , unfortunately, not able to attend the meeting and present the results from Tore Supra, as planned.) M. Ulrickson analyzed in detail the performance of TFTR with carbon fiber composite limiters. The reasons for changing from POCO graphite to carbon fiber composites were given (severe disruption damage to POCO graphite tiles and carbon blooms) and the thermal and mechanical characteristics of carbon fiber composites (including fatigue limits and properties dependence on fabrication) were presented. The improvements in machine performance due to use of carbon fiber composites were also analyzed (10% improvement in neutron yield, virtual elimination of carbon blooms), including implications for the future machines [importance of components' aligment, X-point-divertor plate separation, possibility of separation of the erosion (PFC lifetime) problem from the impurity contamination problem (practically and within a self-consistent plasma edge model)]. M. Seki presented the operation experience with the JT-60 divertor plates. His presentation included a history of JT-60 divertor operation from June 1986 to April 1989 with various divertor plate materials (TiC/Mo, graphites HCB-185, ETP-10 and ETP-10+CFC (CC-312) under different heating power (20-30 MW), heating time (1-4s), and stored energy (2-2.4 MJ) conditions. He presented results on the heat load on diveretor plates (translated from temperature measurements), on the erosion/ redeposition rates of divertor tiles, and a characterization of the eroded/ redeposited divertor tiles under normal and off-normal heat loads (in terms of surface morphology, erosion depth, and erosion profiles). Important conclusions of the JT-60 investigations is that heavy erosion appears only at the edges of the tiles and that redeposited layers are fairly erosion resistent.

K.J. Dietz reported on the recent JET experiments with berryllium (Be evaporation and Be-limiter phases). There is strong evidence that the dramatic improvements in the JET plasma performance with Be (the fusion reactivity increased by a factor of three and was a factor of eight below the value required for ignition) is mainly due to: 1) lower Z (→ reduced dilution; $Z_{eff} \leq 1.5$) and 2) strong getter action (on oxygen) and strong wall pumping (→ reduced radiation, reduced recycling). In combination, these two factors have led to significant extension of JET operational limits (density-and β-limits, electron- and ion-temperatures; the density limit is practically eliminated: densities are limited in most cases by formation of MARFES), achievement of the H-mode by RF heating only, and to better impurity control conditions (Z_{eff} maintained below 1.5, 07 ≤ n_D/n_e ≤ 0.95 independent of power and heating method). Despite of the low melting point (1280°C) and clear evidence of hot and melt spots (~ 5% of limiter surface), the conclusion is that beryllium is suitable material for PFC. J. Linke presented results on the performance of boron/carbon materials in TEXTOR and in other experimental facilities in KFA Jülich under fusion relevant conditions. The dependence of Z_{eff} on line averaged density in TEXTOR with full (a-C/B:H films) boronization is the same as that in JET with Be-limiters (for ohmic heating regimes). The effects of improved performance are attributed (similarly as in JET Be-limiter phase) to reduction of oxygen chemical erosion and H-recycling from the wall. A shift of radiation enhanced sublimation threshold to higher temperatures was verified experimentally. The results of high heat flux tests and erosion behaviour of several types of boron dopped graphites, monolitic boron/carbon materials and hydrogenated boron/carbon films on different substrates (e.g. graphite, Mo) from simulation experiments were also presented and a comparative analysis provided.

Within the same session, A. Miyahara presented an overview and analysis of the existing thermal, mechanical and irradiation properties data of PFC materials, including aspects of data evaluation, storage and formatting. He provided a list of PFC primary candidate materials, list of their properties for which data are required, analyzed the status of database and identified the gaps in the database. He also brought the attention to the problem of complexity of PFM data (such as dependence of certain data on the fabrication process, environment conditions, etc). A. Miyahara also provided specific information on the Japanese capabilities in data compilation and evaluation, stressing the role of the small groups at universities. R. Matera presented the high temperature materials databank (HTM-DB) of the EC for metallic (reactor structure) materials. The HTM-DB contains (at present) mechanical properties data for 32 materials used in components of conventional and nuclear power plants, and part of it can also be useful for fusion reactors. The HTM-DB is an on-line databank with menu-assisted searching and data retrieval (in three modes), also enabled with a multi-purpose PC-based interface. Mechanical properties data are in numerical form, supplemented by an evaluation programme library (for analytic data representation, plotting, etc). The philosophy, structure and format of this databank could be useful (at least as a prototype) in constructing the IAEA materials database for fusion.

The session on the PFM data requirements and PFC developments for the next-generation fusion devices began with a detailed analysis of the critical material issues for the next-step fusion reactors, presented by W.B. Gauster. He first illustrated the increase of requirements on PFM with increasing the integrated plasma power and the role of the wall and limiter materials in improving the plasma performance. Gauster provided an in-depth analysis of the problems, recent achievements and research directions in the following PFM&C critical issues areas: engineering (material development, power removal, burnout, disruption damage, run-away electron damage, corrosion, thermal/ mechanical effects, neutron radiation damage, component lifetime, maintenance and fabrication), physics (particle and energy transport, power distribution, recycling, impurity transport, particle and power exhaust, off-normal event effects, conditioning and advanced divertor concepts), and safety (tritium inventory, tritium permeation, activation reduction, chemical reactivity, system response). He formulated the general performance criteria which the PFC have to meet/address in a fusion reactor (safety, survivability, plasma contamination, tritium inventory and clean-up, heat removal and remote maintenance), and emphasized the necessity of an integrative effort (using both confinement devices and laboratory facilities, on national and international level) as a strategic approach to the fusion reactor materials problem.

G. Vieider presented the PFM requirements and design concepts for the NET/ITER PFC's. He provided information on the thermal and mechanical properties of currently considered PFM options for ITER (advanced graphites, C/C composites, carbon fiber composites) and presented results from various mock-up tests. The requirements on the ITER PFM's and PFC's, for both the physics and technology phase, were discussed in detail (including the alternative options).

M. Seki reviewed the PFC design parameters for FER and specified the requirements on the first wall and divertor plates under different operating conditions (ignition phase, technology phase, steady-state: normal operation, thermal quench, plasma disruption, run-aways). Seki emphasized the data needs for thermal shock erosion, fracture and crack growth, characterization of the redeposition processes and properties of redeposited materials, net erosion rates, disruption erosion and fracture, properties of neutron-irradiated materials, all urgently required in the FER design analyses for selection of the most appropriate PFM&C option.

The status of PFC (divertor plates and limiters) design for CIT, the associated PFM requirements and material development efforts, were reviewed by M. Ulrickson. For the CIT limiter and divertor plate candidate materials (C-C composite and pyrolitic graphite, respectively) a number of unresolved issues require clarification (disruption erosion, effects of high operating temperatures). Some results of CFC materials development and testing were also presented. K.J. Dietz presented the design concept of the pumped divertor for the next phase of JET, the materials considered (Be bonded to Cu) and/or adopted in the design, and the parameters of high heat-flux components.

In the context of NET/ITER PFC requirements, R. Matera presented the development and testing programme for the NET/ITER first wall, conducted at the JRC, Ispra. The objectives of the programme are demonstration of thermo-mechanical performance of prototypical first-wall mock-ups and investigation of the influence of manufacture technology on thermal fatigue mode and lifetime. The adopted approach is an experimental-numerical one, and includes a thermal fatigue test facility (with the associated diagnostics) and a set of computational codes for thermo-mechanical properties analysis. The results so far obtained within this programme were presented.

In the session on the material thermal response and phenomena related to off-normal plasma events, the results of high heat-flux (HHF) testing and simulations on various laboratory facilities were reviewed. J. Linke (in collaboration with M. Seki, H. Bolt, A. Benz) reported on disruption simulation tests of different carbon materials (fine grain graphites, C-C composites, pyrocarbon, boron doped graphites) in the JAERI and KFA electron and laser beam facilities. The results of these experiments show that ultra-fine grain graphites and CFCs are resistive to crack formation (at least under heat pulses shorter than 10ms), but thermal erosion is enhanced by a factor of 4 to 6 compared to monoatomic sublimation. G. Vieider presented evaluations (carried out in collaboration with H. Bolt, H. Calen and A. Moestsell) of the effects of run-away electrons on the PFCs thermal response parameters. The energy deposition from run-away electrons (100-300 MeV) into first-wall and divertor structure materials (carbon coatings on steel, Cu, Mo, W substrates) was calculated by the GEANT Monte Carlo code with inclusion of the effects of angle of beam incidence, presence of W-inserts, and (tolerable) PFC tmeperature excursions. J. Linke described the results of material and component HHF tests in the KFA ion beam teststand. (PFC: C-C composite tiles, brazed to a TZM-body/Mo Re 41-tube heat sink, for the actively cooled divertor mock-up for NET). M. Seki presented a review of the results from the JAERI HHF testing facilities (PBEF and JEBIS), which included: thermal shock erosion of graphites and, CFCs, (disruption simulation) and durability of CFC/Cu and W/Cu bonds against thermal cycles. V.R. Barabash reported on the results of thermocyclic testing of divertor plate mock-ups at the Efremov Institute in Leningrad. The HHF testing was designed to simulate the normal operation reactor conditions and was conducted on divertor plate mock-ups of various materials (graphite, Cu, W, and their combinations), with both passive and active cooling. Different types of brazing were used (W-Cu, Cu-Ga, Cu-Ti, Cu-Ag, Cu-Mn-Fe-NiSi). The testing results were characterized in terms of visible material damage (cracks, etc), thermo/mechanical properties (tensile strength, elastic moduli, etc), joining's durability, and so on. In a second report from the Efremov Institute group (presented also by V.R. Barabash), results on the thermal shock erosion of high-Z materials in a plasma-disruption simulation experiment were described. (The plasma flow in a plasma accelerator was used to simulate the plasma disruption thermal quench). Cracks formation along the deformation direction was found to be typical for W, very seldom for Mo, and completely absent for Ta PFMs.

The fourth working session of the meeting was devoted to categorization of the material response parameters for the PFCs of current and next-step fusion devices. The results of this part of meeting's work are given in Section 3.

The last two sessions of the meeting dealt with the scope and priorities of the IAEA activities in the area of PFM data and with the formulation of the meeting conclusions and recommendations. The results of the discussions in these two sessions are presented in Section 4 of this report.

3. CATEGORIZATION, ASSESSMENT AND REQUIRED PROPERTIES OF PFC MATERIALS IN FUSION REACTOR DESIGN

3.1. PFC Materials Categorization and Assessment

A plasma facing component (PFC) in a fusion device is a composite material entity exposed directly to the plasma and fulfilling certain protective function with respect to the rest of the system. The PFCs are also the essential elements in the impurity control and thermal power exhaust system. In a tokamak device, the PFCs are: first wall, wall armor, limiters, divertor plates, plasma flow channels (in divertors and pump limiters), RF launching structures, etc.

Each PFC consists of three material elements: plasma facing layer, structure(s) and joining(s). Since each of these elements has a specific role and function within the PFC structure, the property requirements of the corresponding constitutive materials are (usually) different. Therefore, in the general case, three categories of PFC materials are to be distinguished:

A: Plasma facing materials (PFM),
B: PFC strutural materials (PFC-SM) (or PFC substrates),
C: PFC joining materials (PFC-JM).

The materials in these categories can be characterized with respect to their chemical composition, inherent thermal/mechanical/irradiation properties, and method (technology) of fabrication. The PFC-JM can additionally be characterized by the method of joining (alternatively: this characterization can be associated with the joint agregate). Finally, each of the PFC elements, and the PFC itself, as a composite entity, can be characterized by its performance capability (e.g. lifetime). The scheme for the property characterization of materials in the categories A-C, and of the entire PFC will be given in the next sub-section. Below, we give a catalogue of the most promissing fusion relevant materials for each of the above categories, obtained from the analysis of experiences with PFM and PFC on the operating large fusion devices and from laboratory experiments and tests.

Category A: Plasma facing materials

1) Graphites and C-C composites doped with B, Si, Ti ...
2) Carbon fiber composites (possibly doped with B, Si, Ti ...))
3) Be
4) W-, Mo-, Nb-, Ta- alloys
5) CERMETs (Al-, SiC-, ...)
6) Graphites (pyrolytic, fine grained, ...)
7) Advanced options (Li, Ga, Sn, ... - including liquid form)

Category B: PFC structural materials

1) SS 316, low activation steels, ...
2) Ni-alloys
3) Cu-alloys
4) Mo-, Nb-, Re-alloys
5) Be
6) Ti-alloys
7) Ceramics (as isolators)

Category C: PFC joining materials and joint agregates (methods)

1) Joints: brazing, welding, fillers, diffusion bonding
2) Compliant layers
3) Shape memory alloys
4) Electron beams (exptl.), friction, fusion

3.2. Classification of PFC material properties data and reactor design relevant parameters

3.2.1. PFC material properties data
(Applies to A,B and C material categories)

1) Basic description

- chemical composition
- crystalline structure
- morphology (grain size, surface state, ...)
- thermomechanical treatment, fabrication technology/method, ...

2) Physical properties

- density
- porosity
- melting temperature
- evaporation temperature
- thermal conductivity
- electrical conductivity
- specific heat
- coefficient of thermal expansion
- evaporation heat
- fusion heat (for PFM and PFC-JM)
- emissivity

3) Mechanical properties

- elastic moduli (tensile, compressive)
- Poisson's ratio
- shear modulus
- strengths (tensile, compressive, flexural, shear)
- elongation
- fatigue
- creep
-

4) Chemical and thermodynamic properties

- phase diagram
- compatibility
    * corrosion
    * oxidation
    * carbide formation
    * hydride formation
    * adsorption
- permeability

3.2.2. PFC reactor design relevant parameters

1) Thermo/mechanical allowables (response parameters)

- fracture toughness
- creep crack growth
- fatigue crack growth
- fatigue lifetime
- thermal shock resistance
- critical heat fluxes
-

2) PFC performance

- lifetime (effective)
- thermohydrodynamic compatibility (with coolants)
- disruptions (characterization)
- safety aspects (characterization)

3.3. Survey of PFC material data needs

3.3.1. Category A: plasma facing materials

a) High temperature data (up to melting point, or to 2,500°C)

- elastic moduli
- strengths
- allowables (fatigue, creep, ...)
- conductivities (electrical, thermal)
- compatibility (phase stability)
- phase stability

b) Normal and elevated temperatures

- refractory metals
- Be

c) Neutron damage (including He production/dimensional stability)

- C-based materials
- refractory materials
- Be

d) Oxidation, inhibition

- C-based materials
- refractory materials

e) Properties of redeposited materials

- all PFM

3.3.2. PFC structural materials

1) Data at elevated temperatures (> 600°C)

- strengths
- fatigue
- neutron damage (refractory-, Cu-alloys)

2) Corrosion/erosion data

- Cu-, refractory - alloys
- Be

3.3.3. PFC joining materials and joints

- characterization of compliant layers
- brazing characterization
- welding properties
- diffusion bonding characterization
- strength of joinings (and method of testing)
- neutron damage

3.3.4. PFC performance

- critical heat flux
- fatigue life
- safety aspects

4. MEETING CONCLUSIONS AND RECOMMENDATIONS

The assessment of the existing experience with PFM and PFC on the operating tokamaks and in laboratory testing facilities, the analysis of the PFM data requirements for the next generation fusion devices and the discussions on the possible role of the IAEA in PFM data compilation, evaluation and dissemination have been summarized by the Meeting participants as follows:

(1) There already exists a large body of information on the thermo-physical and mechanical properties and response parameters for reactor PFC candidate materials. Extensive computational, experimental and testing programmes, conducted on national level and within international collaborations, continue to generate the required PFM and PFC data for the current fusion experiments and for the design of next-step fusion devices. The existing database and experience indicate that the plasma facing materials with most acceptable overall performance characteristics are: C-C composites (doped with B, Si and Ti), carbon fiber composites, beryllium, pyrolytic and fine grain graphites (for the limiter and first wall), and refractory metal alloys and the cermets (for the divertor plates, if the divertor plasma has sufficiently low temperature and high density). SS-316, low activation steels, Ni-, Cu-, Mo-, Nb- and Ti-alloys and Be are appropriate materials for the PFC structure materials, while brazing, welding, diffusion bonding and compliant layer are adequate joining techniques for the PFCs.

(2) Despite of the extensive recent efforts on establishing the required material properties database for the next-generation fusion devices, there are still important gaps in our knowledge on the thermo-physical, mechanical and irradiation properties even for the PFC materials, currently considered as good candidates. The information on the above mentioned properties is particularly lacking for the high-temperature operation regime and for extensive neutron damage conditions. The properties of the redeposited layers are also very little known. Oxidation inhibition of carbon based and refractory PFMs, properties of PFC structure materials at elevated temperatures (particularly their chemical and thermodynamic compatibility with the other material environment), better characterization of the compliant layers and other joining techniques, are important issues which are still inadequately documented. Characterization of the integral performance of PFCs (critical heat flux, fatigue life), under both normal operation and off-normal plasma events, and characterization of the irradiation effects (e.g. He accumulation) and safety aspects (tritium permeation, tritium inventory, radioactivation) of PFC materials is also required for the next-step fusion reactor design.

(3) There is a need for further development of adequate PFMs which would meet the engineering design criteria (survivability, plasma contamination, heat removal, safety, maintenance), of the material testing methods and computational models, as well as for extraction of fundamental material properties from the tests.

(4) In the situation when there already is a large volume of information on fusion material properties data, and when the generation of such data continues intensively within national programmes and many

international collaboration, there is a strong need for a systematic compilation and critical analysis of the existing data. Such systematics could lead to production of a single, agreed upon "recommended" database, and could allow useful inter- or extrapolations within a particular material property data set.

(5) The Meeting participants see an immediate benefit from an IAEA co-ordinated activity in the area of compilation and critical analysis of the available material properties data, their appropriate formatting and dissemination to fusion community. The data evaluation should be performed by groups of highly qualified experts in particular data and research areas. It is strongly recommended that the Agency starts such a data compilation and evaluation activity in the immediate future.

(6) At present, there already exists a well developed system of both bilateral and multilateral international collaboration in the area of data generation for PFC material properties. It is, therefore, not expected that at this stage an IAEA organizational involvement in this area would substantially enhance the effects. However, this possibility should be kept open, if future developments in the data generation potentials and fusion programme requirements show that a larger-scale integration of the data generation efforts would be meaningful and beneficial.

IAEA Consultants' Meeting on "Thermal Response of Plasma Facing Materials and Components"

June 11-13, 1990, IAEA Headquarters, Vienna

LIST OF PARTICIPANTS

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AND COMPONENTS

IAEA Headquarters, Vienna
June 11-13, 1990,

MEETING AGENDA

Monday, June 11	(Meeting Room: A-19)
9:30 - 9:45	Opening; Adoption of Meeting Agenda
SESSION 1:	EXPERIENCE WITH PLASMA FACING MATERIALS (PFM) ON LARGE FUSION DEVICES AND DATA AVAILABILITY Chairman: W. Gauster
9:45 - 10:30	M. Ulrickson: Performance of TFTR with carbon fiber composite limiters
10:30 - 11:15	M. Seki: Operation experience with JT-60 divertor plates
11:15 - 11:30	Coffee break
11:30 - 12:15	K.J. Dietz: Experience with beryllium in JET
12:15 - 14:00	Lunch
SESSION 1:	(Continued) Chairman: M. Ulrickson
14:30 - 15:30	J. Linke: Performance of boron/carbon materials under fusion relevant conditions
15:30 - 16:00	Coffee break
16:00 - 16:45	A. Miyahara: Available Japanese data for thermal, mechanical and irradiation material properties
16:45 - 17:30	R. Matera: The JRC high temperature materials data bank
19:30 -	Joint dinner

Tuesday, June 12 (Meeting Room: A-19)

SESSION 2:	PFM DATA REQUIREMENTS AND PFC DEVELOPMENTS FOR THE NEXT-GENERATION FUSION DEVICES (OR UPGRADES) Chairman: A. Miyahara
9:00 - 9:40	W. Gauster: Issues, requirements and the US Programme strategy
9:40 - 10:15	G. Vieider: PFC design requirements for NET/ITER
10:15 - 10:30	Coffee break
10:30 - 11:00	M. Seki: PFC design requirements for ITER/FER
11:00 - 11:30	M. Ulrickson: The design of CIT divertor plates and limiters
11:30 - 12:00	K.J. Dietz: The pumped divertor design for JET
12:00 - 12:30	R. Matera: PFC development and testing
12:30 - 14:00	Lunch
SESSION 3:	MATERIAL RESPONSE AND PHENOMENA RELATED TO OFF-NORMAL PLASMA EVENTS, TESTING AND SIMULATIONS Chairman: K.J. Dietz
14:00 - 14:45	J. Linke: Disruption simulation tests on different carbon materials in electron and laser beam facilities
14:45 - 15:30	G. Vieider: Run-away electron impacts on PFC
15:30 - 16:00	Coffee break
16:00 - 16:45	J. Linke: Material and component tests in KFA ion beam test stand
16:45 - 17:30	R. Matera: Experimental simulation of plasma-wall interaction
17:30 - 18:00	M. Seki: Review of JAERI's HHF testing and future plan
18:00 - 18:30	V.R. Barabash: Thermocyclic testing of divertor plate mock-ups
18:30 - 19:00	V.R. Barabash: Study of high-Z materials damage in disruption simulation experiments

Wednesday, June 13 (Meeting room: A-19)

SESSION 4:	CATEGORIZATION OF MATERIAL RESPONSE PARAMETERS FOR ENGINEERING REACTOR DESIGN AND DATA STATUS ASSESSMENT Chairman/Co-ordinator: G. Vieider
9:00 - 10:40	All participants
10:40 - 11:00	Coffee break
SESSION 5:	SCOPE AND FORMAT OF THE IAEA PFM DATABASE AND CO-ORDINATION OF PFM DATA PRODUCTION AND EVALUATION ACTIVITIES Chairman/Co-ordinator: A. Miyahara
11:00 - 12:30	All participants
12:30 - 14:00	Lunch
SESSION 6:	FORMULATION OF MEETING CONCLUSIONS ON PFM DATA STATUS AND REQUIREMENTS, AND RECOMMENDATIONS ON THE IAEA ACTIVITIES IN THE PFM DATA AREA Chairman/Co-ordinator: W. Gauster
14:00 - 15:45	All participants
15:45 - 16:00	Coffee break
16:00 - 17:00	ADOPTION OF MEETING CONCLUSIONS AND RECOMMENDATIONS