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Briefing on VNS Related Activities

1. International Activities Related to VNS.

2. VNS Design Parameter Envelope.

VNS International Activities

- International interest developed many years ago.
  - Workshop held in Karlsruhe, Germany in 1984.

- Attempts to start collaborative international activities on Fusion Nuclear Technology and Materials started in the late 70's, early 80's under IEA.

- Serious discussions and agreements on a number of areas for IEA activities were held in 1988-89. Each area has an annex and is represented by an Executive Committee.

- The relatively intensive activities in 1992-93 are not prompted by any new and sudden major event. Rather, they are natural events after the formalities have been established.
  - However, the activities appear to be timely as many countries are preparing development plans for DEMO as part of getting ready to secure construction funds for ITER.

CHARTER

INTERNATIONAL FUSION MATERIALS TEST FACILITIES STUDY

Bearing in mind the long-standing interest in this area, recognizing the strong recommendation from the Executive Committee for the IEA Implementing Agreement on Fusion Materials (Executive Committee) and noting the communication from the Chair of the ITER Council, the Fusion Power Co-ordinating Committee (FPCC) requests the Executive Committee to take action as follows:

OBJECTIVE: Develop a consensus and appropriate technical and managerial bases for decisions, if any, on two test facilities, i.e. 1) proceeding on the Conceptual Design Activities for an accelerator-based International Fusion Materials Irradiation Facility (IFMIF) that will meet the high flux, high energy ("14 MeV") neutron irradiation needs of the fusion materials programs of the partners, and 2) proceeding with studies that could lead to Conceptual Design Activities for a plasma-based source that could meet the high volume, high energy, neutron irradiation needs of the fusion materials programs of the participants.

APPROACH:

TASK 1: Involve the Russian Federation (RF), through the Associate Contracting Party route, as a full technical partner with interested IEA member partners in these efforts. Initial contact with the RF will be made by the Chair (or Vice-Chair) of the FPCC, after which the Executive Committee shall develop and, with the approval of the Governing Board, formalize the RF collaboration.

<u>High Flux Source</u>:

TASK 2: Develop as a technical approach to a possible international agreement, the design choice, a judgment of feasibility and a possible route of implementation to a single, acceptable design for IFMIF.

<u>High Volume Source</u>:

TASK 3: Review the possibilities and assess the programmatic requirements for a possible, high volume neutron source for future consideration by the interested international participants.

<u>Schedule</u>: The efforts of the Executive Committee should be organized to complete these tasks by October 1993, in anticipation of action on any next steps by the FPCC in January 1994.

IEA Activity on VNS

- The Fusion Power Coordinating Committee (FPCC) requested the IEA Executive Committee on Fusion Materials to study and make recommendations regarding:
  - IFMIF: an accelerator-based international fusion materials facility
  - VNS: high volume source
- A workshop was held in Moscow July 12-18, 1993 with participants from EC, Japan, Russia, USA
- Conclusions from workshop
  i) A volumetric neutron source (VNS) fusion facility is needed to test, develop and qualify fusion nuclear components and material combinations for DEMO
  ii) An attractive range of design options exists for VNS
- Recommendations from workshop
  Recommend IEA initiate VNS study activity with 3 phases (with decisions to proceed or terminate at the end of each phase)

<u>Phase 1</u>: Concept definition (2 years)
- Develop detailed statement of mission and objectives
- Elucidate detailed test requirements
- Identify envelope of design concepts, evolve the concepts to a level sufficient for making selection
- Select design concept

<u>Phase 2</u>: Conceptual Design (2 years)

<u>Phase 3</u>: Engineering Design (3 years)

IEA Activity on VNS (cont'd.)

September '93

- Informal meeting of the IEA Executive Committee Meeting Sept. 28 in Italy approved the recommendations on the D-Li source on VNS study. It will be formalized in October '93.

- Feedback from Senior Program People
  IEA Executive Committee should develop more details about the organizational structure of the study
  - being done.

SUGGESTED DESIGN BOUNDARIES FOR SMALL TOKAMAK VNS ENVELOPE

Boundary	Value	Comment
Ground Rules		
D-T fusion power (MW)	≤ 400	Maximum available tritium supply, assuming no breeding except in test blanket modules.
Site electrical consumption (MW)	≤ 700	Assumed for fusion nuclear site.
Direct cost relative to ITER	≤ 0.5	For "green field" site.
Plasma operation duration	s.s.	Preferred DEMO operation mode.
Nuclear Test Requirement		
Average neutron wall loading (MW/m^2)	≥ 1 – 2	For proper integrated testing environment.
Life fusion neutron fluence ($MW\text{-}year/m^2$)	≥ 4 – 6	Defined by the required testing program.
Active testing area (m^2)	≥ 20	To cover the breadth of testing matrix.
Test port height×width×depth (m×m×m)	≥ 1×1×0.5	Minimum size for full-function blanket tests.
Duty cycle × availability	≥ 0.3	Design for maintainability and higher availability.

SMALL TOKAMAK VNS ENVELOPE ENCOMPASSES A RANGE OF REASONABLE EXTRAPOLATIONS AND COSTS (6/93)

	ITER EDA	S/C Shield	N/C Multi-Turn Shield/Support	N/C Multi-Turn No Inner Shield		N/C Single-Turn No Inner Shield	
Neutron wall load ($MW \cdot m^{-2}$)	2.0	1.1	1.0	1.0	2.0	1.0	2.0
Major radius, R_0 (m)	7.75	4.64	2.6	1.52	1.74	0.91	0.97
Minor radius, a (m)	2.8	1.05	0.84	0.6	0.64	0.6	
Plasma current, I_p (MA)	25	6.4	6.8	6.3	7.3	6.0	6.8
External toroidal field, B_{t0} (T)	6.0	7.7	6.7	6.8	8.0	3.6	4.7
Drive power, P_{drive} (MW)	0	155	60	35	67	24	33
Fusion power, P_{fusion} (MW)	3170	400	150	65	158	42	90
Site power, peak/s.s. (MW)	800/400	400	700	690	700	230	330
Direct-access test area (m)	TBD	110	52	21	23	17	17
Direct cost relative to ITER	1.0	~0.48	~0.45	~0.25	~0.40	~0.14	~0.16

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