US-Japan workshop on Fusion Power
Plants and Related Advanced Technologies
13-14, March 2014, UCSD, San Diego.

Demo Design Activity for the BA collaboration in IFERC

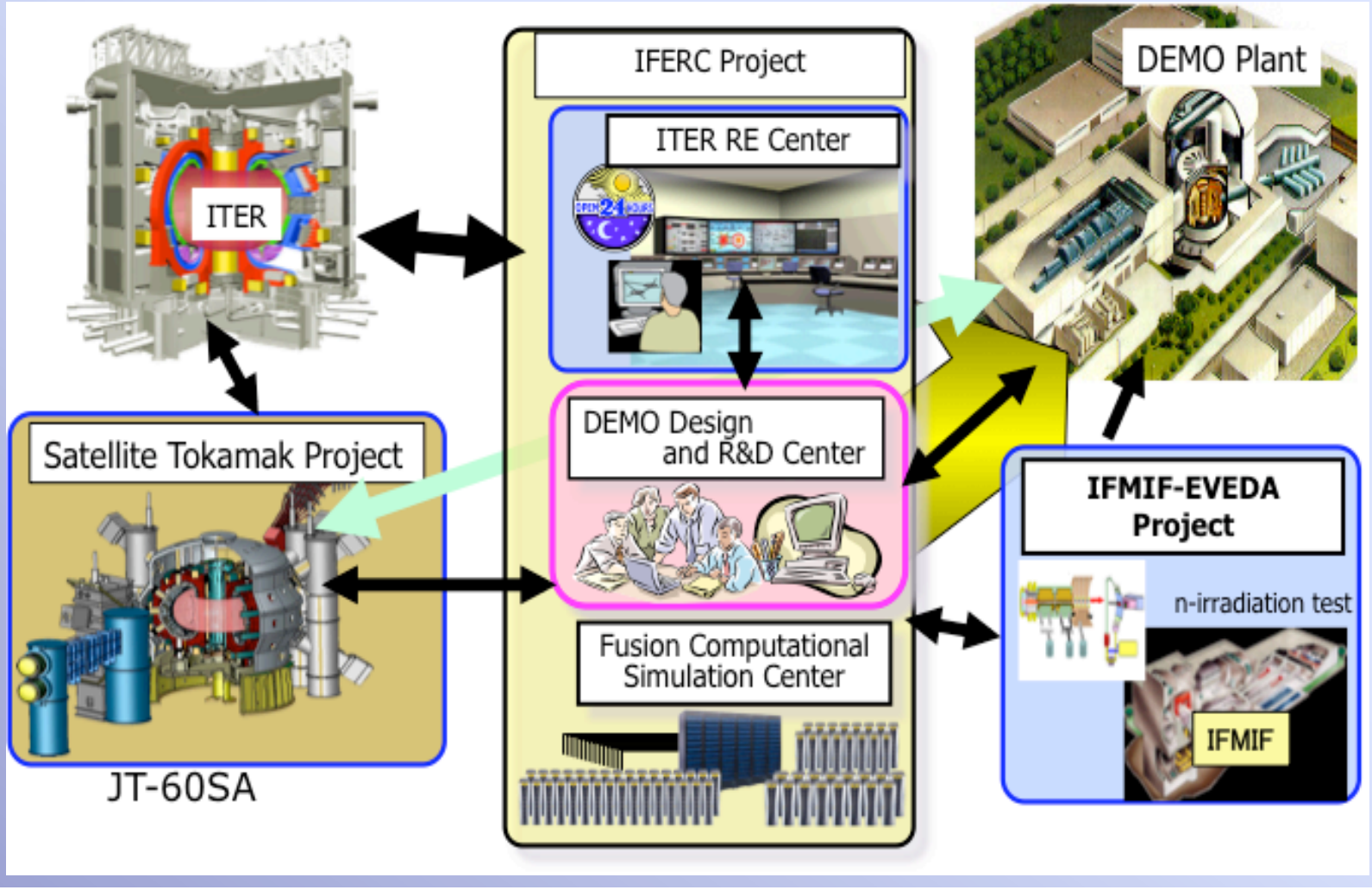
Kunihiko Okano*
Keio University
A Former Demo Design Activity Leader of
International Fusion Energy Research Centre (IFERC)
for Broader Approach, Rokkasho, Japan

*Retired DDA leader in December 2013.

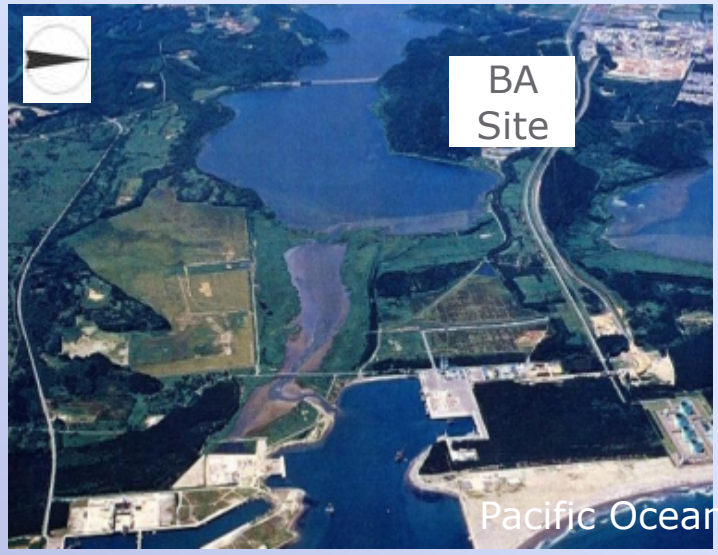
This presentation consists mainly of the results which were obtained before December 2013.

Broader Approach (BA) Activities

◆In parallel to the ITER program, BA activities are being implemented by the EU and Japan, aiming at early realization of the fusion energy. BA is basically a 10 years program from June 2007.



Rokkasho BA site now



Present Organization of IFERC project

BA Steering Committee（BA SC）

IFERC Project Committee
Chairman ;D. Maisonnier, Members; , K.Lackner, L.Crouzet,, A.Fukuyama, Y.Okumura、H.Hashizume

IFERC Project Team

Project Leader : N.Nakajima

Coordination support
Network･IT: H.Ohtsu, T.Nakadai, J.Abe
Document control : M.Kimura, Office work : K.Hashimoto

DEMO Design and R&D Coordination Centre

DEMO Design Activity **2011/1 -**

Leader ~~: K.Okano,~~ H.Takase, K. Mori, T. Kudo

DEMO R&D

PL (tentative)

Computational Simulation Centre

2011/7 -

Leader : J.Noe
Technical support team

SWG-1 (2008-) SWG-2 (2011)

ITER Remote Experimentation Centre

2012 -

Home Teams

Project Manager for Design
G.Federici
Technical Coordinator for R&D
N.Baluc

K.Tobita
T.Yamanishi

Technical Coordinator
F.Robin

Technical Coordinator
Y.Ishii

Technical Coordinator
S.C.Lorenzo

Technical Coordinator
T.Ozeki

Each sub project is implemented by three Integrate Project Teams composed of both Home Teams (IAs) and IFERC PT.

First Phase of Demo Design Activity

2007 — 2011 — 2017

Phase-1 | Phase-2

Phase-1, June 2007 – Dec. 2010:

@ Phase-1 was implemented by Leaderships of
PT: M. Araki (Project Leader)
EU: D. Maisonnier of EFDA
JA: K. Tobita (JAEA) and Fusion Energy Forum

@ Main activity in Phase-1 was based on Workshops
⎫ to exchange technical design issues,
⎫ to identify "common elements"
for joint design work.

Our generic view obtained through Phase-1

i) Role of DEMO

EU and Japan have a common view on the role of DEMO. DEMO is considered as a single step between ITER and a first commercial reactor, which means that DEMO would be:

a) a first integrated machine both in physics and technology
b) a last integrated R&D device before the first fusion power plant.

In this sense, DEMO needs to meet wide-ranging requirements such as engineering feasibility, operation reliability and economic prospect.

Our generic view obtained through Phase-1

ii) Requirements for DEMO

There was a divergence in opinion between Japan and EU.

a) *Japan conceives a DEMO having core dimension similar to that of ITER, producing a 3 Giga-watt of thermal output, being capable of continuous operation and self-sufficient tritium supply (based on the decision by AEC in 2005).*

b) *EU believes that developing a viable solution for the problem of the Power Exhaust is of paramount importance and may ultimately determine reactor size. Similarly the physics guidelines of the system codes and gaps from existing knowledge are being reviewed. Two options (1 inductive and 1 steady-state) with different dimension, power level are being explored.*

But, both parties agreed on the importance of high plant availability (therefore, of the maintenance scenario).

Our generic view obtained through Phase-1

iii) Development strategy

The roadmap toward DEMO will be subject to change in accordance with various situations such as the development program of each country and budgetary situation.

For the demonstration of fusion power generation in the middle of this century, EU and Japan plan to conduct a conceptual design of DEMO in the BA period, and move on to the engineering design phase (~10 years) and the construction phase (~10 years) successively.

Note:
Those common views obtained in Phase-1 might be reconsidered in Phase-2.

Second Phase of Demo Design Activity

Phase 2 based on joint works was kicked off in 2011, with establishment of DDA-unit,

Phase-2a, Jan. 2011 – Dec. 2012: *(completed)*

@Consolidation of knowledge, to define a sound common basis for DEMO design, definition of priorities for R&D tasks;

Phase-2b, Jan. 2013 – Dec. 2014:

@ Detailed studies;

Phase-2c, Jan. 2015 – Jun. 2017:

@ Development of pre-conceptual designs for DEMO;

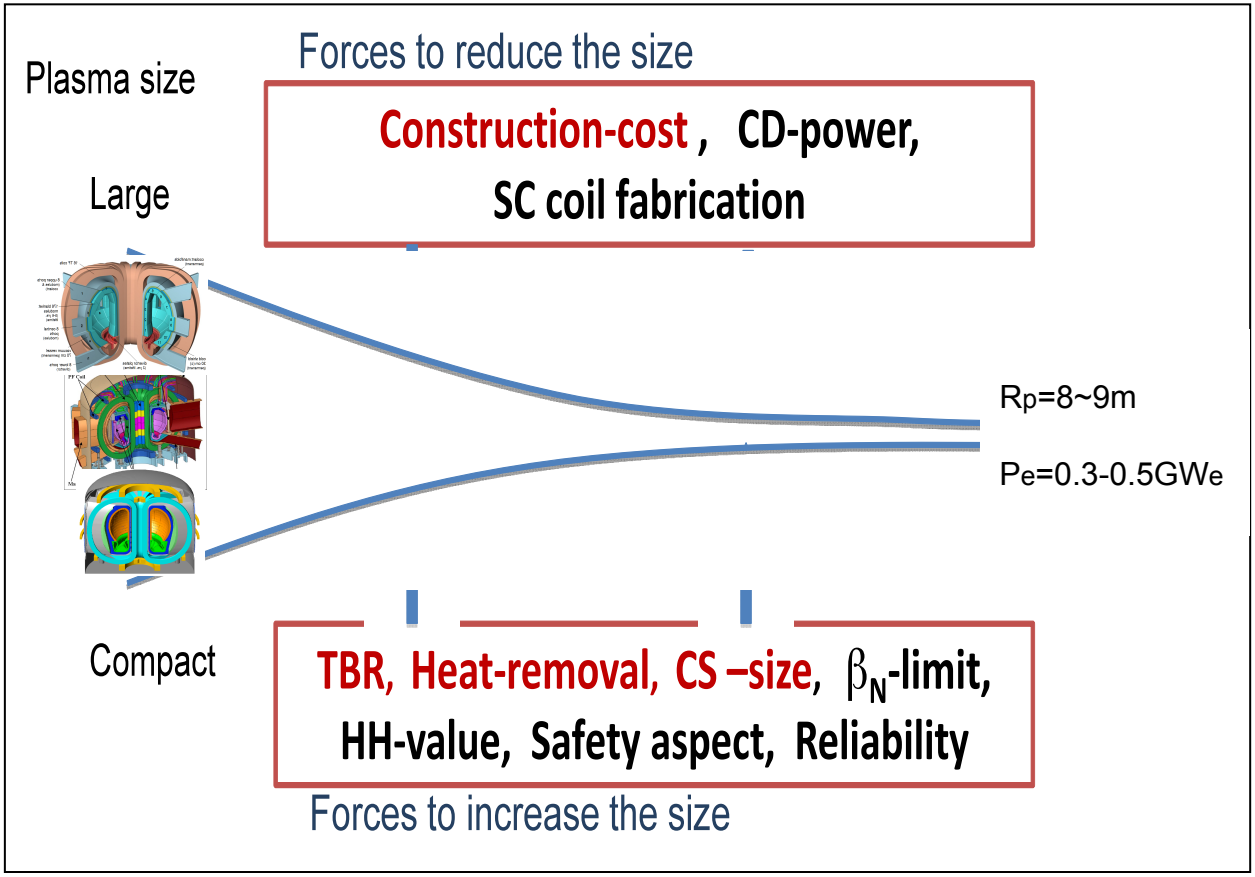
Tech. Cord. Meeting in Rokkasho (2013)

Safety Research, April 2012 ~ :

As a consequence of growing awareness of safety, an activity has been defined inside DDA to research the Safety of Fusion Plants that are planned for the future.

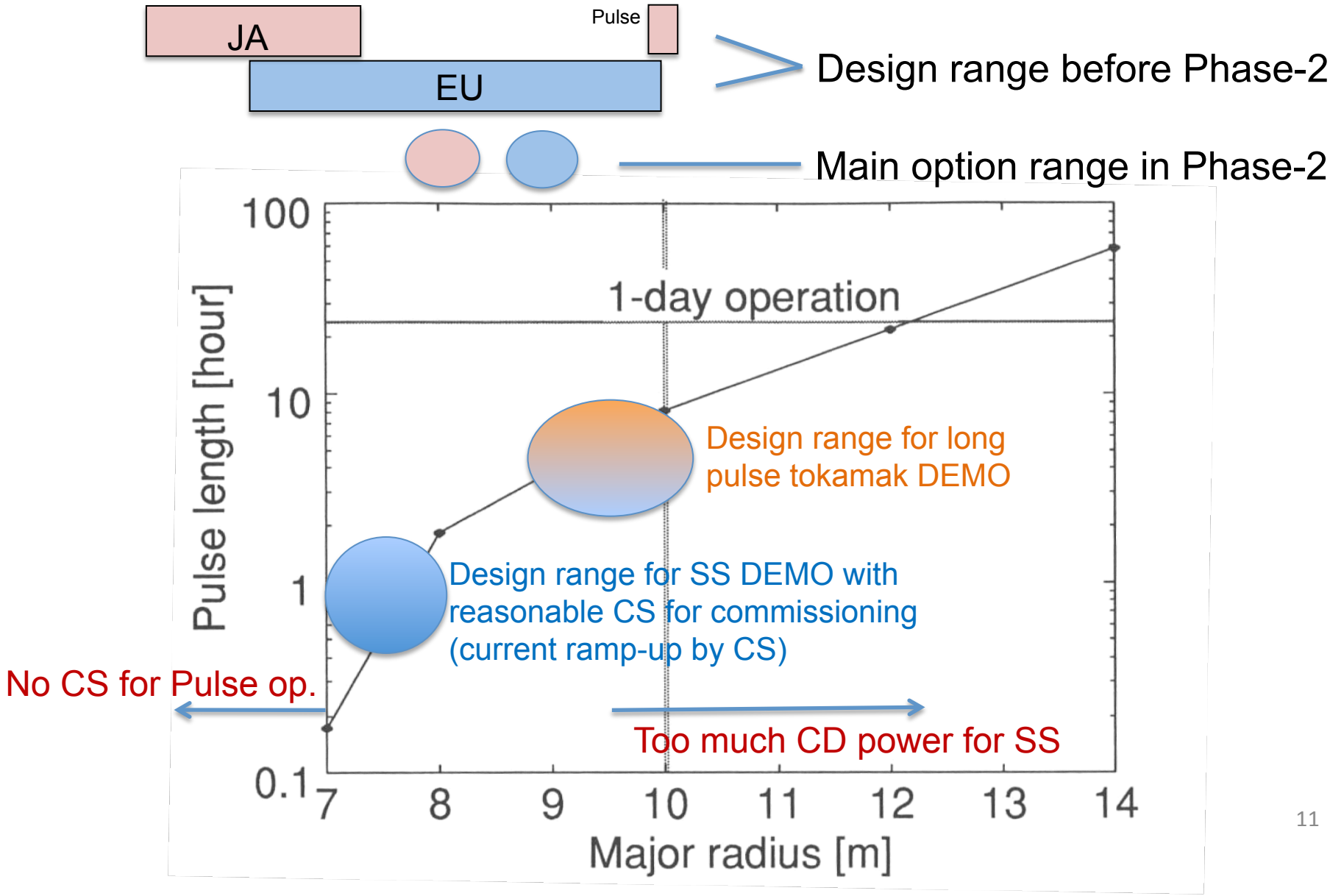
Toward Pre-conceptual Designs of DEMO

The technical and physical design bases for DEMO have been converged on almost the same page between EU and JA through a 3-year collaboration in Phase Two. At this point, the design range of a plasma major radius and net electricity is focused on 8-9 m and 0.3-0.5 MWe, respectively.



11-13 Sept. 2013, Garching

Design Ranges for DEMO (ss or long pulse)



Remote maintenance

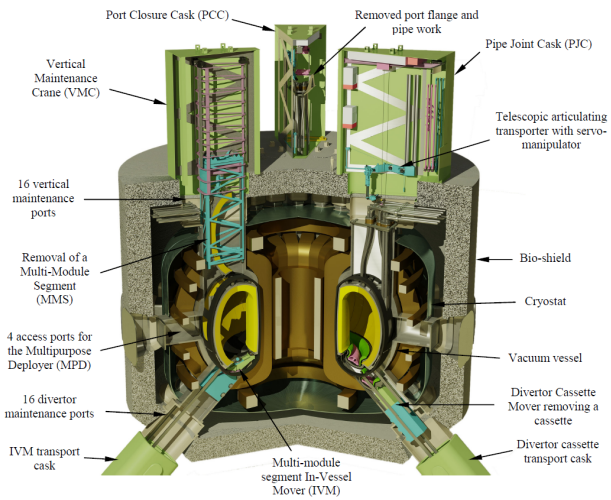
Remote maintenance (RM) is another critical and challenging issue in that RM on DEMO needs a short replacement time (several months for replacing all in-vessel components) and reliability of RM equipment in high radiation environment.

The RM schemes which are regarded as the most likely are

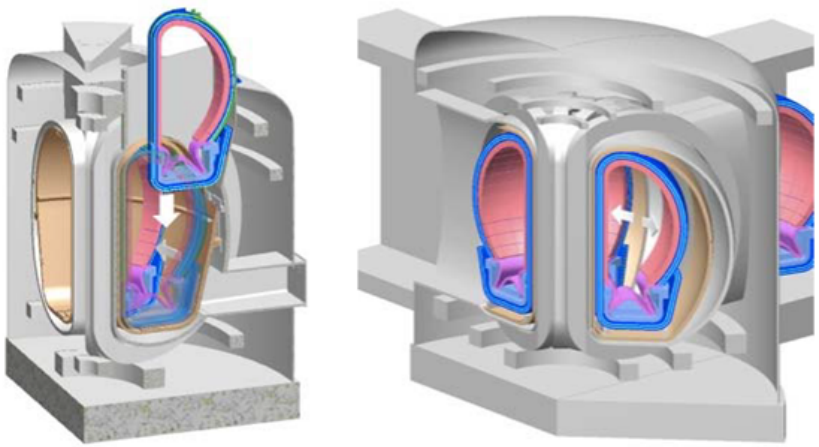
@ multi-modules segment (MMS) studied by EU and

@ sector transport using a limited number of maintenance ports studied by JA

Maintenance procedures, transport mechanisms, positioning and pipe joint have been considered for these RM schemes.



Multi-modules Segment by EU



Limited number of maintenance ports by JA

Background and Safety Requirements

After the Fukushima Dai-ichi Accident in March 2011, the safety aspect of nuclear energy has been regarded as a critical issue.

The safety features of fusion are much superior to fission, however, the safety analysis of fusion DEMO plants, especially in the most severe cases has not been carried out after the PPCS safety study by EU in 1990s and early 2000s [*,**].

Detailed safety research for new DEMO concepts has to be done in order to confirm the safety benefits of fusion as an important future energy option. Fostering safety research is one of the urgent tasks common to both of JA and EU.

* J. Raeder et al., “Safety and Environmental Assessment of Fusion Power (SEAFP)”, Report of the SEAFP Project. European Commission DGXII, Fusion Programme, EURFUBRU XII-217/95 (1995).

** I. Cook et al., “Safety and Environmental Impact of Fusion,” EFDA-S-RE-1, EUR (01) CCE-FU/FTC 8/5 (2001). [15] D. Maisonnier, et al., “Final Report of the European Power Plant Conceptual Study,” EFDA-RP-RE-50 (2005).

Background and Safety Requirements (cont.)

The Safety Research is implemented by the JA-HT with support by EU experts. The safety requirements for DEMO are based on those established in the Japanese ITER site invitation activities [*].

i) The public and fusion facility workers shall be protected appropriately against environmental release of radioactivity and release of radiation from the facility on normal condition.
ii) Accidents, i.e. release of radioactive materials from the facility, shall be prevented by adequate 'safety barriers' ensuring safety of systems containing the radioactive materials.
iii) Impact of the accidents shall be mitigated so that environmental release of the radioactive materials is reduced and the off-site public dose is suppressed within a range in which the public is safe to the radiological risk.

Results of the first period of BA safety study will be reported in March 2014.

* Ministry of Education, Culture, Sports, Science and Technology Japan (MEXT), "On Safety Assurance of ITER" (2003) [in Japanese].

4. Summary

The status of Demo Design Activity and the technical activities of Demo Design in BA were reviewed. The technical and physical design bases for DEMO have been converged on almost the same page between EU and JA through a 3-year collaboration in Phase Two.

The major progress in BA DDA are briefly show.

Related papers:

K. Tobita, ISFNT-2013, Sep. 2013, Barcelona, O3B.2,
"Research and Development Status on Fusion DEMO Reactor Design under BA"

G. Federici, , ISFNT-2013, Sep. 2013, Barcelona, I3.1,
"Overview of EU DEMO Design and R&D Activities."