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Research Facilities for International Fusion Energy Research Centre of Broader Approach Activities at Rokkasho

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Under the Agreement Between the Government of Japan and the European Atomic Energy Community for the Joint Implementation of the Broader Approach (BA) Activities, a new research site has been developed in Rokkasho in Aomori prefecture of Japan. In this new site, two of the three projects of the BA activities will be implemented, namely, International Fusion Energy Research Center (IFERC) and Engineering Validation and Engineering Design Activities of the International Fusion Materials Irradiation Facility "IFMIF/EVEDA"). The research facilities for the two projects will be also constructed in the new site. Specifications of the individual research facilities are described.

Keywords: Broader Approach activity, Rokkasho, IFERC, IFMIF/EVEDA,

1. Introduction

Under Agreement Between the Government of Japan and the European Atomic Energy Community for the Joint Implementation of the Broader Approach Activities, as the Japanese Implementation Agency for the Broader Approach Activites (hereinafter referred as the "BA Activities")[1], JAEA is developing a new research site at Rokkasho-mura in Aomori prefecture of Japan. In this new site, two of the three projects of the BA activities will be implemented, namely, International Fusion Energy Research Center (hereinafter referred to as IFERC) and Engineering Validation and Engineering Design Activities of the International Fusion Materials Irradiation Facility (hereinafter referred to as "IFMIF/EVEDA"). The research facilities for the two projects will be also constructed in the new site. The construction of the site and facilities started in May 2008. Figure 1 shows the current view of the Rokkasho BA site. In the new site, which has an area of about 130,000 m^2, the following facilities are being constructed.

1) Administration and Research Building (Fig. 2): An office building for staff of Project teams, JAEA, temporary visitors, etc. This building was completed in March 2009 and activities of the IFERC and IFMIF/EVEDA Project Teams are now on going.

Fig.2 Administration and Research Building

2) CSC & REC Building (Fig. 3): For the Computational Simulation Centre (CSC) and ITER Remote Experimentation Centre (REC) of the IFERC Project, rooms for a super-computer, its peripheral & auxiliary systems and equipments for large scale simulation activities to analyze experimental data on fusion plasmas, support for ITER operation, contribute to DEMO design and remote experiments to facilitate broad participation of scientists into ITER experiments, are located in this building, which will be completed in March 2010 and the super-computer will be available for researches at the beginning of 2012.

Fig. 1 The current view of the Rokkasho BA site (25 August, 2009)

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3) DEMO R&D Building (Fig. 4): In this building, activities of the DEMO Design Research and Development Coordination Centre of the IFERC Project, which are related to technology R&D on key issues of common interest, such as, developments of structural material, tritium technology, advanced neutron multiplier, advanced tritium breeding materials for the future DEMO reactor will be conducted. Construction will complete in March 2010. Experiments using radioisotope are planned to start in March 2011.

Fig.3 CSC & REC Building

Fig.4 DEMO R&D Building

4) IFMIF/EVEDA Accelerator Building: In this building, installation and test (including full power beam test) of the prototype accelerator [2, 3], which is the low energy section of the first of the two IFMIF accelerators, up to the first cavity of the Superconducting Linac, will be implemented. Construction will complete in March 2010. Detailed specification and construction/ installation schedule are described in the following section.

Fig.5 IFMIF/EVEDA Accelerator building

5) Site development and Utility facilities (Fig. 6): The final decision of location for the BA site in Rokkasho was done in November 2006, and then development of the site started. The site has an area about 130,000 m^2 including reservation for the drain pipe line to Takahoko lake. There are some utility facilities constructed in the site, such as, water supply facility, drain processing facility, guard station, which have been completed in March 2009. Receiving special high voltage (66 kV) from Tohoku Electric Co. to the main power station (capacity: 30 MVA), is planned in October 2009.

2. Design of the IFMIF/EVEDA Accelerator Building

The conceptual design of this building had been done based on the IFMIF Comprehensive Design Report (CDR,2004). The current design was based on the Procurement Arrangement made through discussion between Japan and EU before its implementation design, which was carried out in Japanese fiscal year 2007.

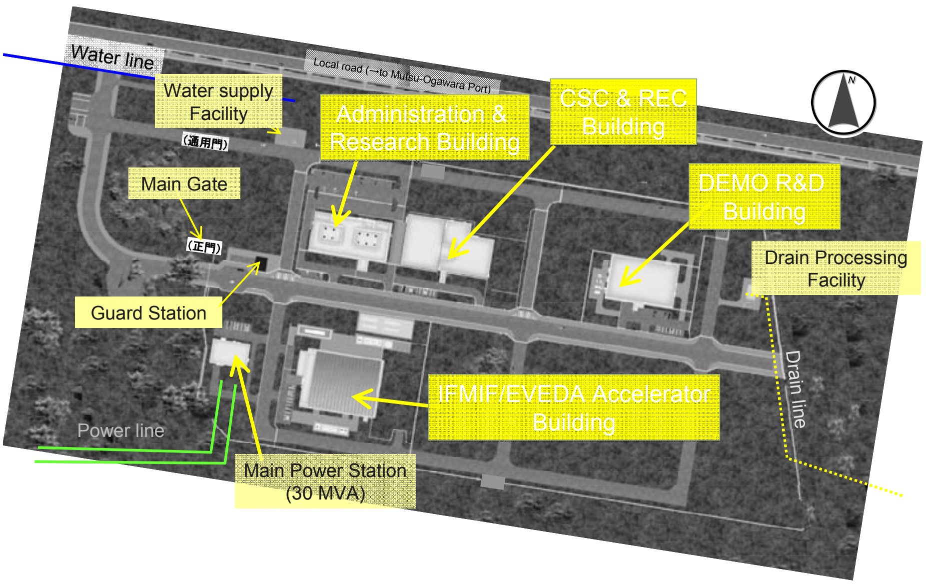

Fig.6 Layout of the site and facilities

2.1. Outline of the design

The size of this building is 58 m long, 37 m wide and 10.95 m high (at the top of roof). It has a steel structure and a floor area of 2019.5 m^2 besides the accelerator vault surrounded by concrete walls and ceiling, at which the accelerator components will be installed. Figure 7 shows constitution of the IFMIF/EVEDA Accelerator Building The human & service entrances are located at the west end, and control room and access room to the radiation control area exists behind the entrance. The accelerator vault is located at the middle of the building. RF sources and their power supplies will be installed at the north wing of the vault and cooling systems for the accelerator components and Heat, Ventilation and Air Conditioning (HVAC) systems will be installed at the south wing.

At the outside of the building, cooling tower, cryo-plant, eclectic yards will be located on the concrete slabs and steel plat forms. A stack (25 m high) is

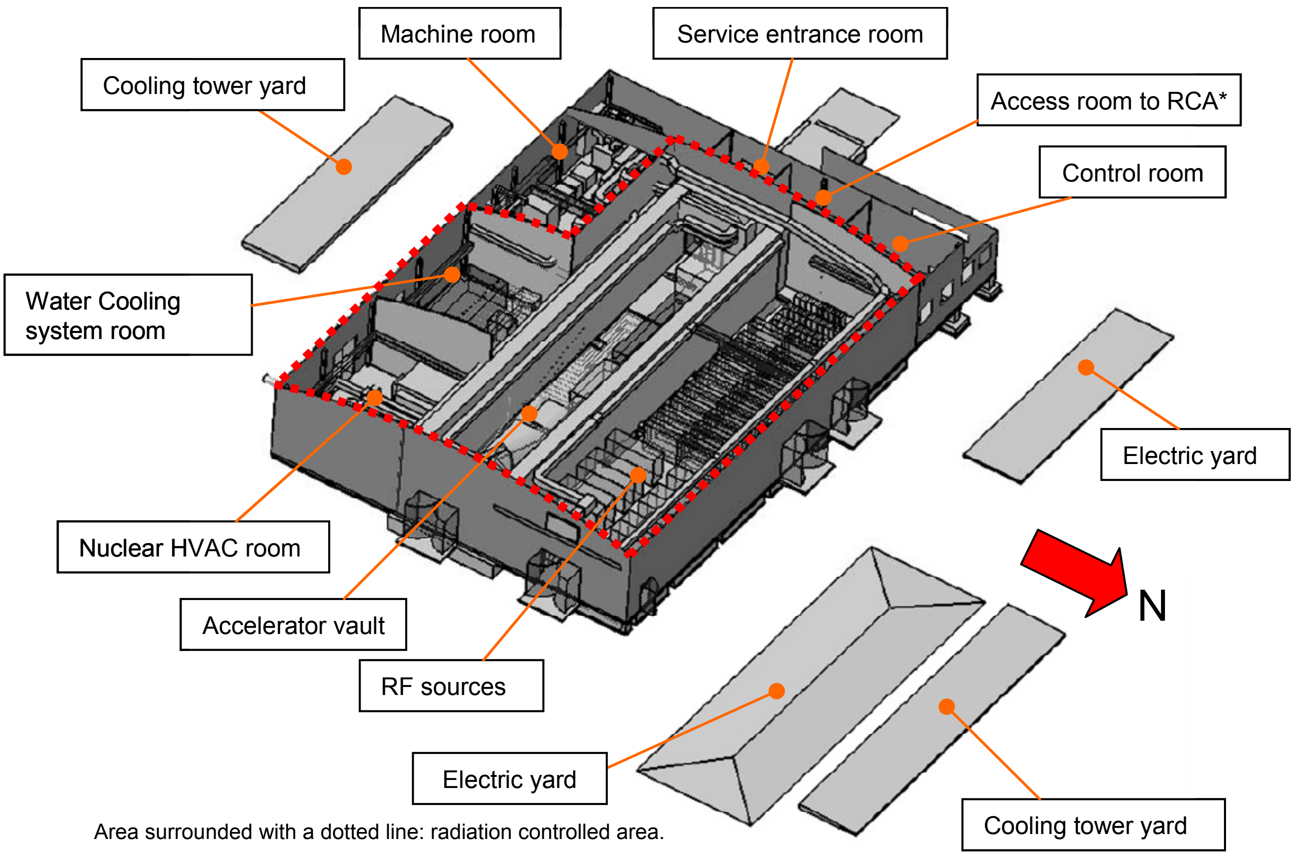

Fig.7 Constitution of the IFMIF/EVEDA Accelerator Building

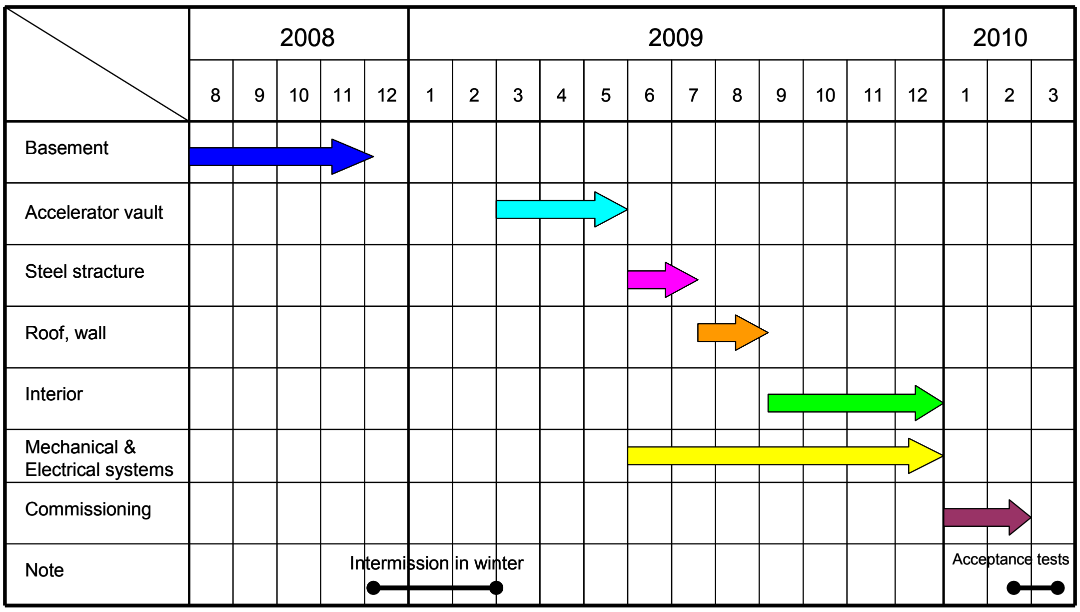

Fig. 8 Construction Schedule

equipped to this building for the Nuclear HVAC system. The construction schedule of the IFMIF/EVEDA Accelerator Building is presented in Fig. 8.

2.2. Accelerator vault and its auxiliary system penetrations

The accelerator vault has an inner size of 41.5 m long, 8 m wide and 7 m high (to the ceiling). Thickness of the concrete shielding wall surrounding the space is 1.5 m.
A sliding shielding door is equipped at the entrance of the vault and a ceiling crane with 5 ton capacity will be installed inside the vault. Those configuration is determined to install the individual accelerator components; injector, RFQ and Superconducting Linac, one by one at the different timings. For introduction of the beam dump an opening is made at the east end of the vault, which will be closed after installation of the injector. There are some labyrinthine structures of penetrations for neutron shielding.
The IFMIF Prototype Accelerator will generate deuterium ion beam of 125 mA at 9 MeV. This powerful ion beam will generate radiations, i.e., not only gamma but also neutron emission. Therefore, design of the radiation shielding taking into account of streaming of neutron is important, especially for penetrations of RF waveguides, air ducts for nuclear HVAC, power and signal cables, etc. To suppress the radiation streaming, there are some countermeasures taken; the RF waveguides will be bended (at least two times) as shown in Figures 9;

1) through the pits located at the north side of the accelerator vault, while the air ducts of the nuclear HVAC ventilating the accelerator vault are bended and enclosed in a room surrounded concrete walls above the entrance of the accelerator vault as shown in Figures 9
2) The penetrations of cooling water pipes are located at the bottom of the accelerator vault wall, to which some additional shielding will be added and cables will penetrate at a cable pit with a labyrinth design.

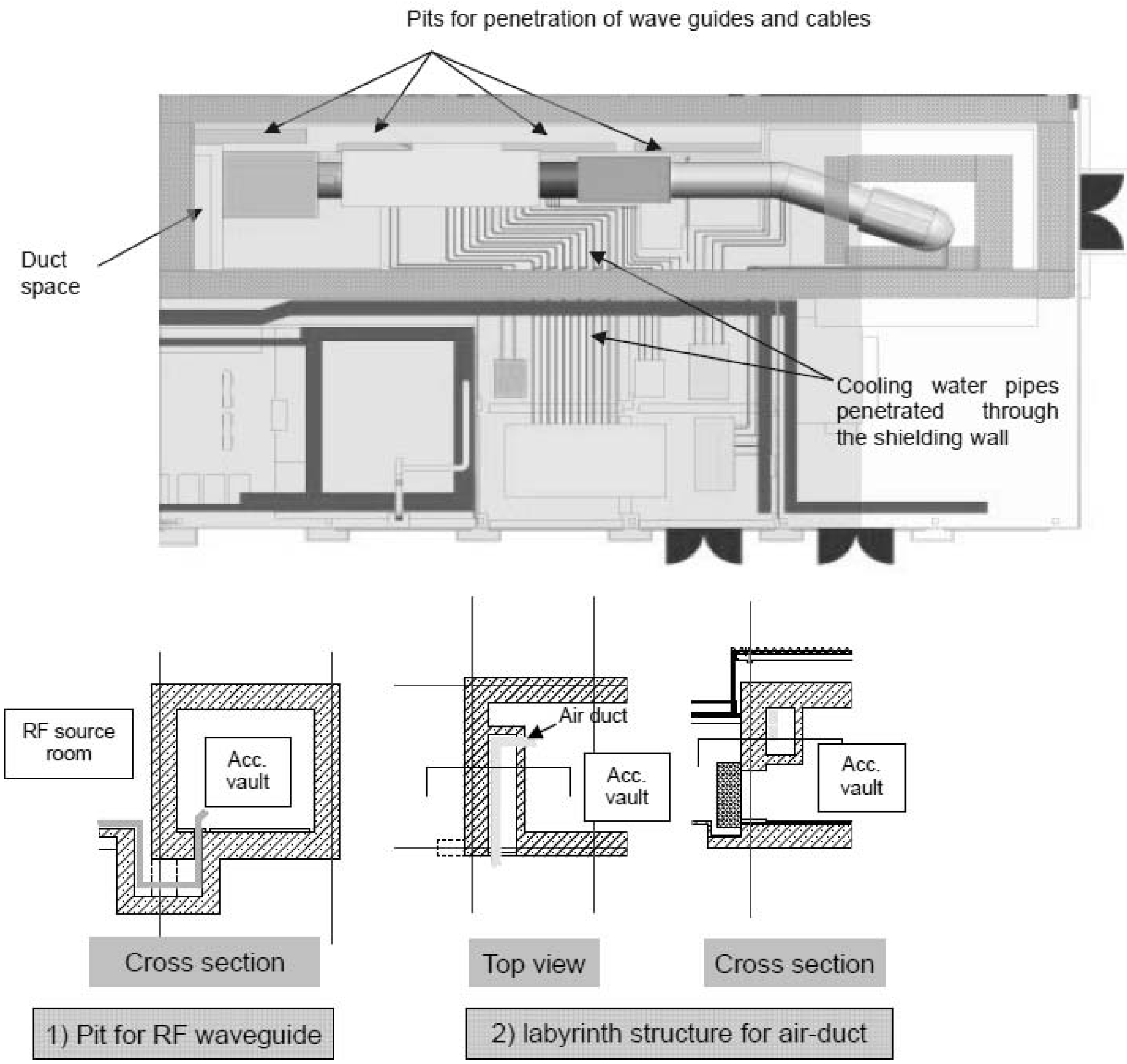

Fig 9 Penetrations in the accelerator vault and labyrinthine structures for neutron shielding

2.3 Characterization of the shielding concrete

Among important design requirements related to radiation safety, thickness and density of the concrete wall of the accelerator vault should be 1.5 m and more than 2.1 g/cm3 after the condition after drying for 4 weeks. The thickness of the floor slab and ceiling of the accelerator vault were controlled and measured by comparison of the levels before and after concrete work, that of the walls were controlled by measurements of dimensions of the formwork before the concrete work and that of the wall itself after the concrete work. Regarding the density of the concrete, a density of fresh concrete, which would satisfy the criterion of the density after 4 week drying process, was confirmed at a preliminary batch tempering. Then, the periods of drying the concrete of the individual parts of accelerator were kept to be more than the designated duration (4 weeks). The average of the densities measured for the individual parts of the accelerator vault was 2.405 g/cm^3. There was another element to be secured for the shielding concrete, i.e., hydrogen density. As a conservative condition, the value of hydrogen density 0.56 %wt applied for ITER was proposed for the safety analysis of neutron shielding. The real density was measured in Hachinohe Institute Technology and it was confirmed that the samples dried for 4 weeks more than 1 %wt hydrogen.

3. Summary

After the Agreement between the Government of Japan and the European Atomic Energy Community for the Joint Implementation of the Broader Approach Activities came into force, the site development in Rokkasho had been initiated and the designs of the individual research buildings to be built in the new site were carried out in accordance with the procurement process agreed by the both Implementation Agencies (i.e., JAEA and Fusion for Energy) and the individual Project Teams of IFERC and IFMIF/EVEDA. The site development has been almost completed and activities at the Administration and Research Building have been initiated. Construction of the other research buildings are in progress on schedule and will be completed in March 2010, followed by installation of variety of "in-kind" systems, components, equipments, etc., procured for researches and developments to be carried out for the Broader Approach activities.

Acknowledgement

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References

[1] The Agreement Between the Government of Japan and the European Atomic Energy Community for the Joint Implementation of the Broader Approach Activities, signed on 5th of February 2007 in Tokyo and came into force on .1st of July 2007.

[2] M. Sugimoto, P. Garin, K. Nakamura, K. Shinto, C. Vermare, F. Groeschel, J. Molla, J. Arnaud, Fusion Science and Technology, 56 (2009) 259-266.

[3] Pascal Garin 1, Masayoshi Sugimoto 2, on behalf of the Project Team and all involved Institutes, presented in ICFRM-14

[4] IFMIF International Team, "IFMIF Comprehensive Design Report, an activity of the Inter-national Energy Agency, Implementing Agreement for a Program of Research and Development on Fusion Materials," January 2004.