

## PROGRESS ON THE ENGINEERING QUALIFICATION OF CN-RAFM STEEL

<sup>1</sup>Guoping YANG\*, <sup>1</sup>Long ZHANG, <sup>2</sup>Qian SHENG, <sup>1</sup>Hongbin LIAO, <sup>1</sup>Leran LIU, <sup>1</sup>Junshan WAN, <sup>1</sup>Jialin GONG, <sup>1</sup>Zhiqiang HU, <sup>1</sup>Chao QIN, <sup>1</sup>Enpeng YANG, <sup>1</sup>Hongxiang ZHANG, <sup>1</sup>Fengchao ZHAO, <sup>1</sup>Qixiang CAO, <sup>1</sup>Xiaoyu WANG, <sup>3</sup>Zhizhong JIANG, <sup>3</sup>Weiping LIU, <sup>3</sup>Yutao ZHAI

<sup>1</sup>Southwestern Institute of Physics, Chengdu, China

<sup>2</sup>China International Nuclear Fusion Energy Program Execution Center, Beijing, China

<sup>3</sup>Institute of Nuclear Energy Safety Technology, Chinese Academy of Sciences, Hefei, China

Email: yanggp@swip.ac.cn

The ITER Helium-Cooled Ceramic-Breeder Test Blanket Module (HCCB TBM) program is under development in China. It will be a key step for the testing and demonstration of tritium breeding blanket technologies including blanket materials. RAFM steel is chosen as structural material. Currently there are two candidate materials, CLF-1 and CLAM, have been developed in China.

To ensure the large-scale production capability for TBM manufacture in ITER and future fusion reactor blanket, to provide comprehensive database for HCCB TBM design, to provide basis for the HCCB TBM material selection, and to obtain PMA (Particular Material Appraisals) for pressure equipment as required by EU and French regulations of the materials using in HCCB TBM, Engineering Qualification of structural materials (CN-RAFM steel) was launched.

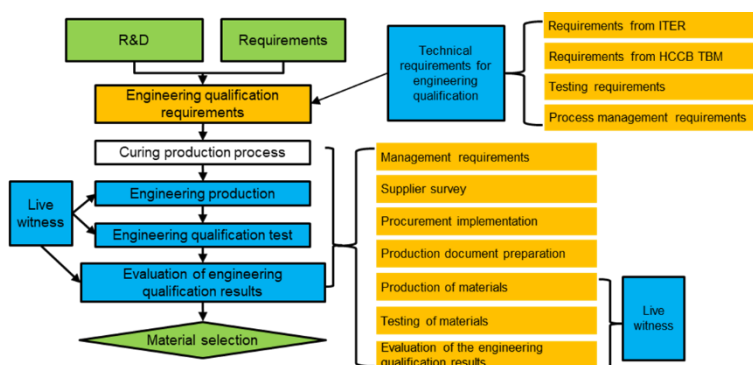


Figure 1 Flowchart of engineering qualification for CN-RAFM

For the engineering qualification of CLF-1 base steel, three 5-tons ingots were produced and 10mm, 30mm, 50mm rolled plates and 130mm forgings were delivered. Engineering qualification tests of CLF-1 for microstructure, physical properties (RT~700°C), tensile (RT~700°C), impact (-120°C~RT), creep (400°C~600°C), fatigue (RT, 300°C~600°C), fracture toughness (RT~600°C), thermal aging, compatibility with He coolant, etc., were completed. For the weld technology, qualification of welding procedures for 10mm LBW, 30mm TIG, and 50mm EBW were completed. Engineering qualification tests of three welds for microstructure, tensile (RT~700°C), impact (-120°C~RT) were completed, and creep (400°C~600°C), fatigue (RT, 300°C~600°C), fracture toughness (RT~600°C) testing are ongoing. For CLAM steel, same to CLF-1 steel, the above engineering qualification work is also ongoing.

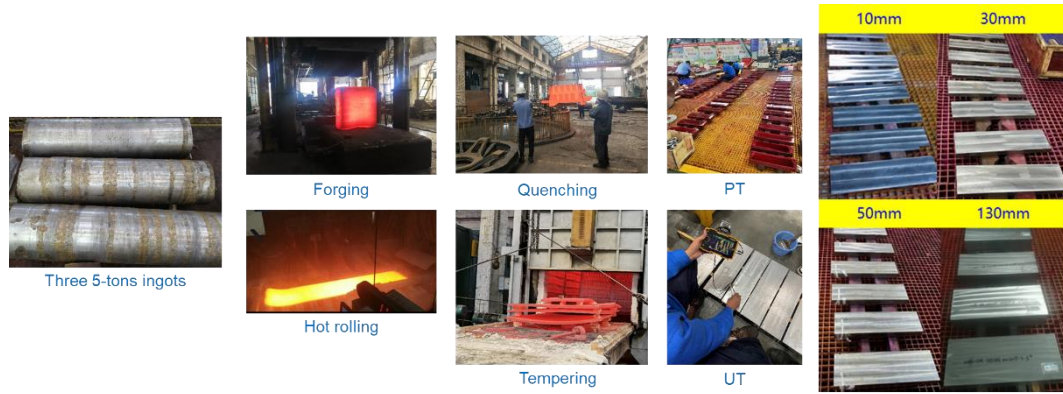


Figure 2 Three 5-tons ingots and corresponding plates of CLF-1 steel

The candidate materials already had certain neutron irradiation data, but after engineering qualification and the material selection, further neutron irradiation and post irradiation tests are also planned.

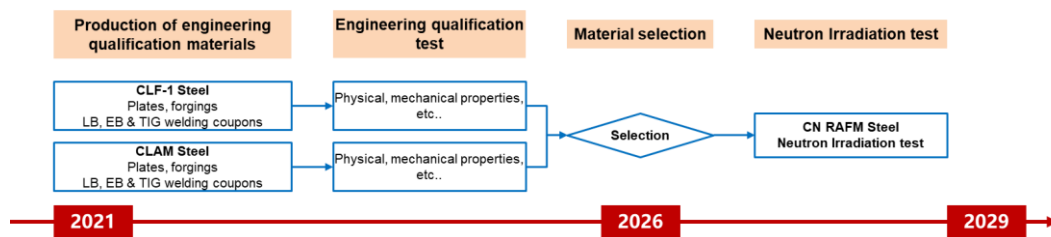


Figure 3 Time plan of engineering qualification for CN-RAFM

## ACKNOWLEDGEMENTS

This work was supported by the CN-HCCB-TBM procurement (CGB-HCCB-TBM) and the China National Key Fundamental Research Program (2022YFE03160002).