ITER multilayer plasma facing components: from small mock-ups to full scale prototypes of divertor Dome and FW pannel [[1]](#footnote-1)\*)

DOI: 10.34854/ICPAF.2023.50.2023.1.1.220

Piskarev P., Mazul I., Rodin I., Gervash A., Makhankov A., Kuznetsov V., Gureva T., Okunev A.

JSC “NIIEFA”, Saint Petersburg, Russia, piskarev@sintez.niiefa.spb.su.

The Procurement Arrangement signed between the ITER Organization (IO) and the ITER RF Domestic Agency implies the manufacture of enhanced heat flux First Wall Panels (FWP) and Divertor Domes. The FWP and Divertor Dome jointly called plasma-facing components (PFC) are among the most energy-intensive reactor systems. To verify the developed designs and manufacturing technologies of the PFC on the way to the start of production of "serial" ITER components, a step-by-step process was adopted, i.e., the development and calculation justification of the design, pilot production and experiments using small mock-ups, manufacturing and acceptance testing of a qualification prototype. This process ends with obtaining the status of readiness for the manufacture of the "serial" ITER components.

The “design by experiment” approach consisting in the optimization of the design and manufacturing solutions using the small mock-ups of the actual design of the PFC has made it possible to select the optimum parameters and to determine the scope of their application for those design elements the calculation justification of which is difficult or not reliable enough. Generally, this approach was used to specify the optimum and permissible size of the tiles which make up the protective armor of the PFC, as well as to determine the operational lifetime of the protective armor taking into account the selected technology and achievable level of weld integrity under long-term thermal cycling load and its maximum design values.

The small mock-ups were also used to try out the non-destructive examination procedures for the welds of the PFC multilayer metal structure such as ultrasonic, x-ray, liquid penetrant and visual examination procedures. The procedures for the factory acceptance tests (hydraulic and vacuum tests with leakage monitoring, thermocycling tests) were developed. The critical techniques of the PFC multilayer structure manufacturing were qualified, i.e., beryllium and tungsten armor brazing techniques, CuCrZr-IG/316L(N)-IG sealed bimetal joint production techniques (explosion welding and diffusion bonding under hot isostatic pressing). Assemblability, maintainability and testability of the developed PFC structure were optimized; the attainable accuracy of the parameters of the component was specified with consideration to the total manufacturing cycle and accumulated deformations.

The JSC “NIIEFA” activities listed above culminated in successful manufacturing and acceptance testing of the Divertor Dome prototype which then was delivered to the IO for integration of the Divertor components into one cassette. The activities with the FWP prototype are at the final stage at the moment.

Within the scope of the ITER project, on the way to the start of production of the “serial” Divertor Dome and FWP the JSC “NIIEFA” has gained the experience and competencies in the development of the PFC design, has created and embraced the unique manufacturing techniques, examination and testing procedures, has constructed the production and test facilities, as well as has established the cooperation with key participants of the manufacturing process. The above-mentioned experience and achievements are the reliable base for the start of the future national projects in the field of development and production of the PFCs for controlled thermonuclear facilities.

1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/L/E/ru/IA-Piskarev.docx) [↑](#footnote-ref-1)