# Entrance Key Consideration of RCC-MRx for TBM-shield

Seong Dae Park[a], Suk-Kwon Kim[a], Dong Won Lee[a], Jae-Sung Yoon[a], Hyoseong Gwon[b]
[b]*Korea Atomic Energy Research Institute, Daejeon, Republic of Korea*
[b]*Korea Institute of Fusion Energy, Daejeon, Republic of Korea*
[*]*Corresponding author: sdpark@kaeri.re.kr*

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## 1. Introduction

The TBM is a device that will be installed in ITER to produce and transport tritium [1-3]. In general, the TBM is divided into a TBM-box part to produce tritium and remove heat, and a TBM-shield part to reduce the intensity of radiation coming out of the back of the TBM. Currently, Korea is conducting a joint TBM design with the EU. It was negotiated that Korea would be responsible for designing and manufacturing the TBM-shield and the EU would lead the design and manufacturing of the TBM-box, and under the agreement, each country is designing and manufacturing each component.

The design and manufacture of the TBM-shield is based on the RCC-MRx French code. This study introduces the contents of RCC-MRx as applied to TBM-shields and summarizes the design and manufacturing considerations.

## 2. Entrance key of RCC-MRx

In order to apply the RCC-MRx [4] code, the entrance key for the component must be selected. The entrance key is make it possible to determine what rules of RCC-MRx code are applicable. The entrance key consists of six fields, which define what facility the component is categorized as, whether it is under pressure, etc. The detailed keys are as follows

### *2.1 key 1 (applicable use)*

Key 1 is to determine the intended use of the components being designed and manufactured. There are three choices in the code which are Components of nuclear reactor and its auxiliary systems or examination, handling or drive mechanisms, or components of irradiation devices. The definition of the component's intended use simply describes the character of the component itself, and the choice of key 1 alone does not affect the design and manufacture of the component.

### *2.2 Key 2 (RCC-MRx class)*

The RCC-MRx code has three quality classes in the design and construction rules. They correspond from 1 to 3 (class $N_{1Rx}$, $N_{2Rx}$, and $N_{3Rx}$) to a decreasing confidence in the security level regarding the different mechanical damage modes to which the equipment could be submitted due to the loading induced by operating conditions.

### *2.3 Key 3 (component type)*

Key 3 is where you decide what kind of component it is. This determines exactly what kind of component you are designing and manufacturing. This key indicates the type of component to which the component is vessels or pumps, valves, piping, bellows, box structures and heat exchangers. In general, the structural integrity of a component is determined through FEM analysis. In addition, if restrictive design conditions are required for each component type, there are specific rules, and these rules must be applied to the design separately from the FEM analysis. The specific rule provides information on the minimum required thickness for areas that are under pressure or need to be structurally sufficient.

In conjunction with key 2, key 3 is important because it determines the type of weld that is allowed in manufacturing. In addition to butt welds, fillet welds may also be used, and in some cases access to the back side of the weld may be limited, preventing surface inspection of the weld. Also, depending on the production environment, a permanent backing strip may be required. In some cases, full penetration welding is not possible and only partial penetration welding is performed. The RCC-MRx class of key 2 and the component type of key 3 determine the type of welding that can be used, so keys 2 and 3 should be carefully selected in consideration of the design and manufacturing method.

### *2.4 Key 4 (catalogue component)*

This key indicates, for irradiation devices, class 3 components, whether it is "Catalogue Component" or not.

### *2.5 Key 5 (Pressure equipment regulation applicable)*

This key indicates whether component is subjected to pressure equipment regulations applicable in France (ESP Decree [5]/ESPN Order [6]). The Directive and French Decree apply to the design, manufacture and conformity assessment of pressure equipment and

assemblies with a maximum allowable pressure greater than 0.5 bar over atmospheric pressure (1.5 bars absolute). These regulations introduce a categorization (Category I–IV, Category IV being the highest) of the pressure equipment, depending on the hazard due to pressure, volume of the vessel or diameter of the pipe, type of fluid and temperature.

ESPN has practically extended the application of the methodology foreseen by ESP and PED (ESR, conformity modules, etc.) to nuclear pressure equipment in France. ESPN has double classification of the equipment. ESPN includes some additional requirement on ESR depending on the nuclear level of the equipment.

### *2.6 Key 6 (applicable rules)*

Based on the value of keys 2 and 5, this key indicates all applicable rules as shown in Table 1. For Safety classified components, the relations between "Safety Classes" and "RCC-MRx classes" that must be applied are defined before the application of the Code. For key 5, it can be calculated and determined by the component's design conditions and operating environment. If key 5 is determined to be ESPN N2 class Cat.IV, the class of RCC-MRx can generally be N2, but a higher class of RCC-MRx can be applied if necessary to apply conservative design and manufacturing. The order of Subsections B, C, and D indicates a decreasing standard of acceptability in design and manufacture. In design, this means lowering the criteria for integrity of acceptable strength, and in manufacturing, it means progressively relaxing the criteria for what is acceptable for inspection in welds.

Table 1 Applicable rule of RCC-MRx

| | Key 2 = $N1_{Rx}$ | Key 2 = $N2_{Rx}$ | Key 2 = $N3_{Rx}$ |
|---|---|---|---|
| ESP Cat. I to IV | Subsection B + REC 3231 | Subsection C + REC 3231 | Subsection D + REC 3231 |
| ESPN $N1_{ESPN}$ Cat. I to IV | Subsection B + REC 3233 | Subsection B + REC 3233 | Subsection B + REC 3233 |
| ESPN $N2_{ESPN}$ Cat. I to IV | Subsection B + REC 3234 | Subsection C + REC 3234 | Subsection C + REC 3234 |
| ESPN $N3_{ESPN}$ Cat. I to IV | Subsection B + REC 3235 | Subsection C + REC 3235 | Subsection D + REC 3235 |

## 3. Entrance key for TBM-shield

The entrance keys are intended to give information on the application sections, subsection and regulation of the RCC-MRx code. TBM-shield is the components of nuclear reactor s and its auxiliary system. TBM-set is installed in ITER. TBM-shield is exactly auxiliary system of reactor. The key 2 of TBM-shield will be $N2_{Rx}$ or $N3_{Rx}$. According to Table 1, selective subsection and regulation is mostly determined the PED/ESPN class. The primary approach being considered is to select the same class of RCC-MRx as the ESPN class. The candidates for key 3 of TBM-shield is the vessels, box structure and heat exchanger. For vessels and heat exchanger, there are specific rules to apply the design of the TBM-shield. The box structure is being considered as a key 3 type as a priority. The TBM-shield is not a catalogue component in the key 4. The exact decision on key 5 and 6 has not yet been made. This is because it is possible to change from the N2ESPN class to the N3ESPN class due to changes in the operating conditions of ITER. The possible PED/ESPN ratings for the TBM Shield are ESPN N2 class Cat. IV or ESPN N3 class Cat. IV.

## 4 Further work

The Entrance key, which we discussed and determined previously, determines the type of welds that are allowed in manufacturing. The approximate shape of the TBM-shield is being designed while reviewing RCC-MRx code and manufacturability, and will be designed to reflect external design factors and specific dimensions.

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[5] Directive 97/23/EC of the European Parliament and of the Council of 29 May 1997 on the approximation of the Laws of the Member States concerning pressure equipment

[6] French Order dated 12th December 2005 concerning nuclear pressure equipment (Equipment Sous Pression Nucleaires- ESPN)