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Realization of Beam Port Assemblies in JRTR

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1. Introduction

Beam Port Assembly (BPA) is one of major facilities which provide neutron beam utilizations in research reactor. There are four BPAs in Jordan Research and Training Reactor (JRTR) which will be used for different beam applications. These BPAs in JRTR extend from the reactor structure assembly through the pool to the outside of reactor pool wall, and are embedded in reactor concrete island. Since part of the BPA in the pool is a first barrier of pool water, it shall be considered as a pressure retaining component. Therefore, the BPA shall be designed and constructed in accordance with the relevant codes and standards. In this paper, the design concepts which have been developed to meet requirements of the codes are described. Also, fabrication, inspection, test and installation results to realize the BPAs are provided.

2. Design

The BPAs are classified as safety class 3 according to NSSC Notice No. 2012-9 and are basically designed to satisfy the requirements of ASME Sec. III ND [3], as consequence.

2.1 Beam Port Housing and Flange

The beam port housing is applicable to the cylindrical wall of pressure vessel in the code. Therefore, following the design rule in the code of ASME Sec. III ND [3], thicknesses of the beam port housing are determined appropriately. Basically, the beam port housing is pressurized inside with helium during operation, thicknesses shall be verified in case of the internal pressure. However, since the part of it in the pool is also pressurized externally by the pool water, ND-3133 and charts in Sec. II, Part D, Subpart 3 [4] shall be additionally applied to prove that design thickness is larger than required minimum thickness under external pressure.

There are two flanges, beam port flange and window flange, in the BPA. The beam port flange are designed based on design rule for the flat head including gasket. However, it is difficult to apply design rules of ASME Sec. III ND [3] on the beam port window flange because the beam port window flange is not a regular shape of flat head with uniform thickness. As an alternative, method of design by analysis in ASME Sec. III NC [2] is applied to evaluate if the design thickness is properly determined.

2.2 Motor Box

Motor box connected directly with the beam port housing is also classified as a part of pressure retaining component and designed following the same design rules.

The cover of the motor box should have an electrical connection between the motor inside and the controller outside. However, it is difficult to find an electrical penetration that fulfils the requirements of the code. Therefore, double flanges are adopted. An outside flange usually acts as a part of pressure boundary. If the motor needs to be operated, an inside flange provide an electrical connection as keeping helium-leak tightness after removing the outside flange.

2.3 Expansion Joint and Clamp

A bellows type expansion joint is adopted between the beam port housing and the reactor structure assembly for absorbing loads under various conditions such as seismic event, thermal expansion and installation misalignment. The design of bellows is proved by the design rule and fatigue analysis for the cyclic loadings.

A convenient joining tool of the Quick Disconnecting System (QDS) is applied on connections between the expansion joint and the reactor structure assembly. This system has advantages for the operators to check the loosening of joint, and to maintain and replace the expansion joint assembly, if necessary, although it is designed as maintenance free.

2.4 Internal Components

Internal components of the BPA are mainly made of aluminum cases and high density concrete. The purpose of the internal components is to prevent emission of neutron beams from undesirable area before and during utilization. For this purpose, the tolerance of external dimensions is controlled tightly.

It is desired to make intrinsic handling devices cooperated with the high density concrete, because they are very heavy.

2.5 Rotary Driving System

Rotary driving system consists of motor, connector, controller, position indicators and motion transmitting mechanism. Two type of position indicators are implemented in the system. One is mechanical indicator which is always directly connected with the motion transmitting mechanism. It is used to find the accurate angle of the rotary plug when the controller lose position data. Another is proximity sensor which let the controller know if the neutron channel is open or close. The controller should check both the angle value and the proximity sensor simultaneously for safe operation.

3. Fabrication

The weldment shapes of the beam port housing and motor box are categorized and designed in accordance with ASME Sec. III ND. The welding process is performed appropriately by qualified welders and controlled strictly by certified holder.

All the fabrication processes such as rolling, machining, joining, etc. are performed following the requirements of the code and design specification. Every important step is witnessed and checked by designers and QA inspectors.

4. Inspection and Test

All the parts of the BPAs are inspected in accordance with requirements of the code and design specification. All the required non-destructive examinations are applied on the weldments.

Hydrostatic test is mandatory for the beam port housing and the motor box which is classified as pressure retaining components. Operation test for confirming position accuracy of the rotary driving system is required by the designer in case of the ST BPA. After pre-assembly in fabrication site, the operation test was performed over number of operation expected during life time as Figure 1.

Figure 1 Operation Test in Pre-Assembly

5. Installation

The laser tracker system [1] is used to assemble the BPAs preliminary in fabrication site and to install them in construction site.

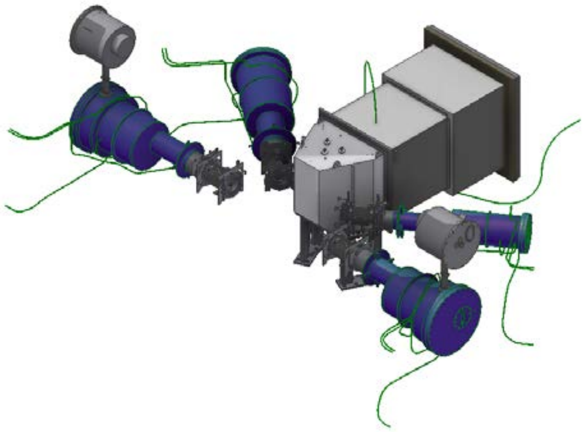

Figure 2 Configuration of BPAs and TCA in JRTR

6. Conclusions

The BPAs have been successfully realized to provide future neutron beam utilization in JRTR through good design, best practice fabrication, reliable proof test and elaborate installation.

REFERENCES

[1] J. W. Shin and Y. G. Cho, "Method for a neutron guide alignment in guide cassette using a laser tracker," Transaction of the KNS Autumn Meeting, pp. 645-646, 2008.

[2] ASME Boiler and Pressure Vessel Code, Section III, Division 1 – Subsection NC, "Class 2 Components", Rules for Construction of Nuclear Facility Components, American Society of Mechanical Engineers.

[3] ASME Boiler and Pressure Vessel Code, Section III, Division 1 – Subsection ND, "Class 3 Components", Rules for Construction of Nuclear Facility Components, American Society of Mechanical Engineers.

[4] ASME Boiler and Pressure Vessel Code, Section II, Part D, "Properties", MATERIALS, American Society of Mechanical Engineers.