

## Installation technique of the in-pile plug assembly for the neutron guide system at HANARO

Jin-Won Shin, Yeong-Garp Cho, and Jung-Hee Lee

Korea Atomic Energy Research Institute, 1045 Daedeok-daero, Yuseong-gu, Daejeon 305-353, Korea  
jwshin@kaeri.re.kr

### 1. Introduction

The research reactor HANARO in Korea will be equipped with a neutron guide system, in order to transport cold neutrons from the cold neutron source to the neutron scattering instruments in the neutron guide hall near the reactor building. The neutron guide system of HANARO (Fig. 1) consists of the in-pile plug assembly, the primary shutter, and out-of-pile neutron guides with dedicated secondary shutters. Functions of the in-pile plug assembly are to shield the reactor environment from a nuclear radiation and to support the neutron guides and maintain them precisely oriented. It is most important for the constructing of the neutron guide system to install new in-pile plug assembly with neutron guides precisely at the beam port of the reactor in radiation environment. The installation tool was developed by KAERI, which enables the removal of old in-pile plug and the installation of the new in-pile plug assembly or the guide cassette under radiation shielding. This paper presents the installation technique of the in-pile plug assembly using this newly developed tool.

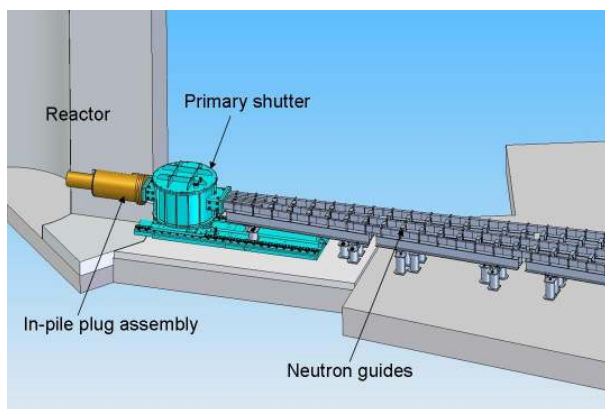


Fig. 1. The neutron guide system at HANARO

### 2. Development of the installation tool

The installation tool consists of a base rail, a carriage, a mounting adapter, an X-Y table, jacking screws, and a shielding block. The carriage (Fig. 2B) which supports other parts moves on the base rail (Fig. 2A) by the rotation of long screw. The linear motion of the carriage is guided by LM bearings on the base rail when the in-pile plug assembly accesses the beam port. When the in-pile plug assembly is mounted at the mounting adapter (Fig. 2C), it is needed to control the center coordinate in order to insert the plug at the exact center of the beam port. The X-Y table (Fig. 2D) is a part for the adjustment of the center coordinate of the in-pile plug

assembly. It is the 2 dimensional combination of jacking screws, bearings, rails, and plates. Jacking screws (Fig. 2E) are installed on the carriage for the adjustment of the horizontal angle of the plug. The deflection at the end of the in-pile plug assembly can happen by the accumulation of manufacturing tolerances of assembled parts. That makes it difficult to install the in-pile plug assembly at the exact location. So the horizontal angle of the in-pile plug assembly will be adjusted by jacking screws. The shielding block (Fig. 2F) which is made of lead protects gamma radiation during installation. Many holes in the shielding block are used for inserting long tools and kept closed by lead pins.

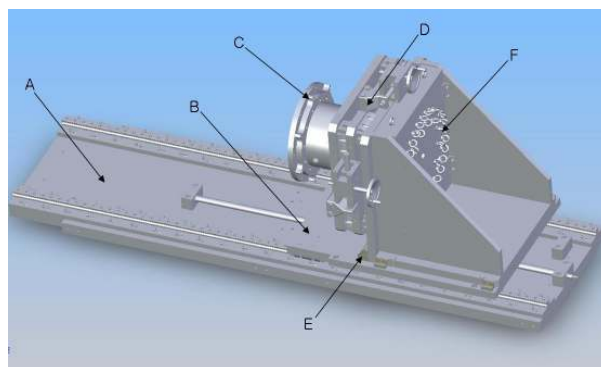


Fig. 2. The installation tool for the in-pile plug assembly (A: Base Rail, B: Carriage C: Mounting Adapter, D: X-Y Table, E: Jacking Screw, F: Shielding Block)

### 3. Removal process of the old plug

The old plug for 8m SANS at the CN beam port must be removed in order to install the in-pile plug assembly which includes in-pile guides. The old plug consists of a cylinder of 700mm diameter and 1123mm length with an extension cylinder of 387mm diameter and 741mm length. It is made of heavy concrete with a density of 5 t / m<sup>3</sup> and a weight is 3 tons. At the center of the cylinder, an opening of 130mm x 78mm crosses for the transition and collimation of the beam, coming from the reactor.

The first step is to remove the flange which covers the old plug at the CN beam port. After attaching a kind of adapter at the top of the flange, it is possible to extract and transport the flange by the flange carriage mounted on the installation tool. The second step is to insert a small plug into the opening of the old plug to close the outcome of the beam from the reactor. The third step is to extract the old plug and put it into a plug cask which allows the radiation protection at the moment of extraction and transport. KAERI developed the plug cask (Fig. 3) which includes a part of the

extraction mechanism. It consists of an adapting plate for the plug fixation, V blocks for the plug extraction and support, and lead plates for shielding of the plug.

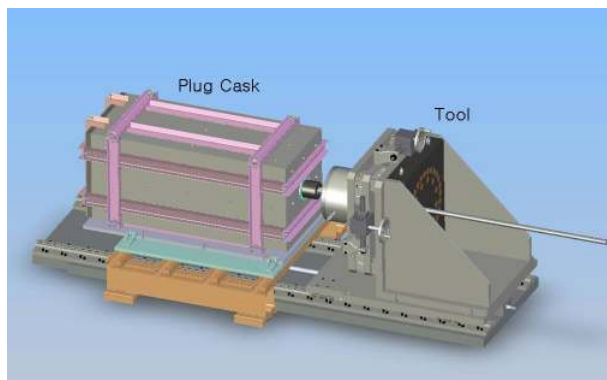


Fig. 3. The plug cask for the shielding and transport of the plug

Fig. 4 shows the removal process of the old plug from the CN beam port using the plug cask and the installation tool. The old plug is extracted from the beam port and put into a plug cask by a long tool connected with the adapting plate inside the plug cask. The final step of the removal process is to transport the plug cask to a storage using overhead crane after covering the upper and the front side of the cask.

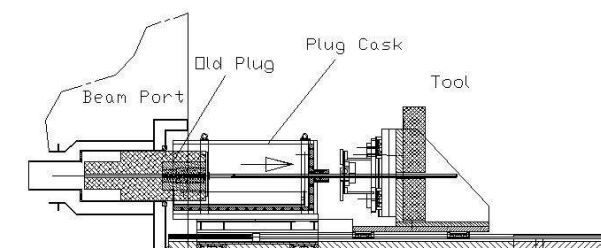


Fig. 4. The removal process of the old plug at CN beam port

#### 4. Installation process of the in-pile plug assembly

The in-pile plug assembly contains a neutron guide cassette in which five guides are aligned with each angles. It consists of a main plug with the front plug, a plug base table with a ring flange, a guide cassette, and a blind flange with a window. It has a two-stepped cylindrical shape with a 380mm (diameter) x 735mm (length) and a 700mm (diameter) x 1170mm (length) [1].

The first step of the installation is to insert the plug base table with the ring flange into the beam port. The plug base table supports the plug during a mounting, and in its final position. The second step is to push the plug into the beam port after mounting it on the adapter of the installation tool as shown in Fig. 5. It is possible to adjust the center coordinate and the horizontal angle of the plug using X-Y table and jacking screws. The plug is fixed to the plug base table by the axial link

when it is successfully installed. The final step is to install the blind flange with a metal O-ring at the ring flange. The O-ring is used for preventing the leakage of Helium inside the CN beam port.

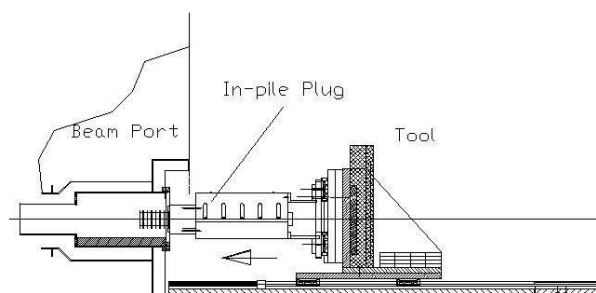


Fig. 5. The installation process of the in-pile plug assembly at CN beam port

#### 5. Conclusion

KAERI developed the installation tool of the in-pile plug assembly for the construction of the neutron guide system. This tool enables the removal of the old plug for 8M SANS and the installation of the new in-pile plug assembly with a guide cassette under radiation shielding. Also the procedure for the replacement of the plug at the CN beam port using this tool was established.

#### REFERENCE

- [1] J. W. Shin, Y. G. Cho, B. S. Seong, S. J. Cho and J. S. Ryu, "Conceptual Design of the In-pile Plug Assembly and the Primary Shutter for the Cold Neutron Research Facility in HANARO," Transaction of the Korean Nuclear Society Autumn Meeting, pp. 70-71, 2006