Design, Fabrication, and Commissioning of Pneumatic Transfer System

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1. Introduction

The Pneumatic Transfer System (PTS) of the Neutron Activation Analysis Facility (NAAF) transports sample capsules from the NAA Laboratory in the Service Building to the NAA irradiation tube in the reactor and, after irradiation, retrieves them back to the NAA Laboratory for detection and counting.

The PTS is solely designated for Instrumental Neutron Activation Analysis (INAA) purpose, utilizes the NAA irradiation holes in the reactor, and is dedicated to simple round-trip operation of sample capsules. The PTS is independently controlled by its own sequential control system either manually or automatically operable.

In the PTS, the capsules are transported by the pressurized gas. During the reactor's normal operation, to prevent high airborne radiation level in the counting room due to activated oxygen and argon gas contained in PTS air, nitrogen gas is used as a carrier gas. The PTS is designed to handle samples of low heat generation (less than 75W) and relatively low mass (less than 75g) to be irradiated for a time period of 1~240 minutes. However, the length of neutron irradiation time is depended on the neutron flux level or the purpose of experiment. The PTS is a closed system and shall maintain the leak-tightness during the operation.

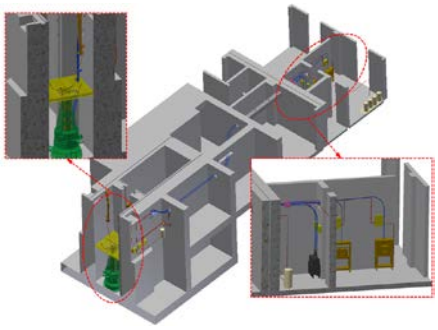

Fig. 1. General arrangement of PTS

2. Design and Fabrication of PTS

The major components of the PTS are as follows:

- Reactor irradiation tube
- Capsule transfer tubes
- Capsule loader and receiver
- Two-way diverter
- Nitrogen gas supply and exhaust system
- Sample capsule
- Operating system

All components of PTS in the NAAF is classified as safety class NNS, seismic category Non, and quality class S. However, the reactor irradiation tube assembly and transfer tubes in the reactor pool are classified as safety class NNS, seismic category II, and quality class T. The KEPIC Code, MGE [1] or ASME B31.1 [2] were used as a guide for design, manufacture and inspection for the reactor irradiation tube assembly and the transfer tubes in the reactor pool

The reactor irradiation tube assembly and capsule transfer pipe were designed to meet the design limits defined in the codes and standards including the structural and seismic analysis.

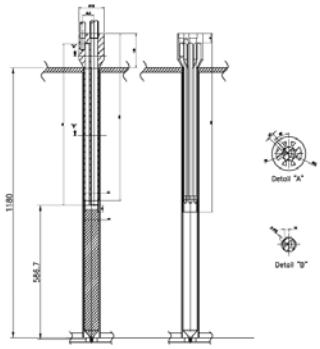

Fig. 2 Reactor irradiation tube

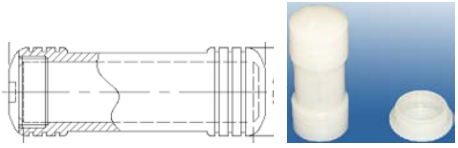

Fig. 3. Sample capsule

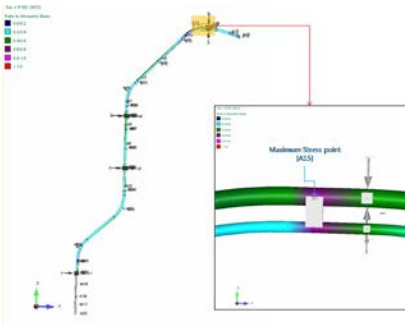

Fig. 4. Seismic analysis of capsule transfer pipe and its support of PTS

Fig. 5 shows the screen of the operating system of PTS. The PTS can be operated by manually or automatically as the operator specifies. And all sequence of operation can be monitored in real time. The operator can also set up the irradiation condition such as irradiation time and path of the capsule using this operating system

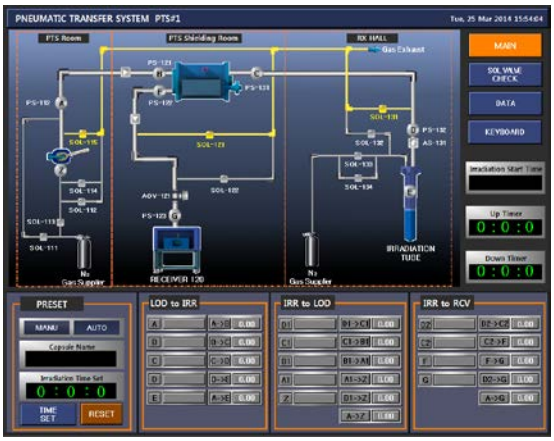

Fig. 5. Operating system of PTS

After finishing the fabrication and inspection of all the components, the factory acceptance test (FAT) was performed to verify that the PTS meets the performance requirements.

Fig. 6. Factory acceptance test of PTS.

3. Commissioning of PTS

The purpose of the commissioning test is to verify whether the performance of the PTS installed at the site meet design requirements, to generate key data for the operation of the NAAF.
The control system, function of photo sensor, operability of solenoid valve, and experiment data management system were verified to see if their function meet the requirements. In addition, the transfer time and its deviation of each PTS has been checked. Table I shows the acceptance criteria regarding the capsule transfer and the test results. All test results have satisfied the requirements.

Table I: Test result summary of capsule transfer time and its deviation

Test items	Acceptance criteria	Test results
PTS #1	Transfer time (LOD&RCV-110 → irradiation tube <10.0 sec.	satisfied
	Transfer time (irradiation tube → LOD&RCV-110) <8.0 sec.	satisfied
	Transfer time (irradiation tube → RCV-120) < 8.0 sec.	satisfied
	Deviation of transfer time < 5%	satisfied
PTS #3	Transfer time (LOD-210 → irradiation tube <10.0 sec.	satisfied
	Transfer time (irradiation tube → RCV-220) <8.0 sec.	satisfied
	Deviation of transfer time < 5%	satisfied
PTS #2	Transfer time (LOD&RCV-310 → irradiation tube <10.0 sec.	satisfied
	Transfer time (irradiation tube → LOD&RCV-310) <8.0 sec.	satisfied
	Deviation of transfer time < 5%	satisfied

Fig. 7. Pneumatic transfer system

3. Conclusions

The Pneumatic Transfer System (PTS) has been designed in accordance with the relevant codes and standards. And the structural integrity was carefully verified with stress analysis and seismic analysis. Each component of PTS was fabricated under strict quality control system of the manufacturer. After installation, the system performance test was carried out and the function was each component of PTS was check.

REFERENCES

[1] Korea Electric Power Industry Code (KEPIC), MGE, 2005 Edition with 2006 Addenda, “Piping”, Korea Electric Association.
[2] ASME B31.1, “Power Piping”, 2004 Edition, American Society of Mechanical Engineers.