Conceptual Design of Shielded Experimental Table for Thermal Conductivity Tester

Kwonpyo Hong, Dae-Gyu Park, Sang-Bok Ahn, Woo-Seog Ryu
Korea Atomic Energy Research Institute, PIE & Radwaste Division, Daedeok-daero 1045 Yuseong, Daejeon
kphong@kaeri.re.kr

1. Introduction

Recently additional experimental space and equipment have been required to perform the newly introduced Post Irradiation Examination(PIE) items such as Thermal Conductivity Tester(TCT) and Wire Electric Discharge Machine(WEDM) in Irradiated Materials Examination Facility(IMEF). As this experimental equipment treats radioactive specimens, it should be shielded and confined to meet the safety regulations. However, as its radioactivity is relatively lower than the radioactivity of specimen usually treated in hot cell, A simple structure - partial shielding and brief confinement – is considered to be enough.

2. Design

By using the available 7m x 6m space in service area of IMEF the experimental table for TCT was conceptually designed as well as some other experimental tables.

2.1 Design requirement

The experimental table should be proper in experiments with nuclear fuel specimen as well as irradiated metal specimen. Its shielding capacity should satisfy the dose limit onto operators, and it should protect the leakage of radioactive materials through the full process of experiment. It should be also available in import and export of specimen, loading and unloading onto the specimen holder of the equipment.

2.2 Design strategy and layout

The experimental table surrounding TCT is located at the upper left corner in the room as shown in Fig. 1. Its size was decided to 1.2 m x 1.2 m x 2.2 m(h) considering the operability. The experimental table consists of two parts, i.e. confinement box part and stand part. The confinement box is equipped with shielding plate, lead windows, and tongs. Only two faces among four side faces and bottom plate of confinement box need to be equipped with lead plates for shielding considering operator's accessible area. Other sides and top plate are equipped transparent acryl plates in order to confine the inner space. Inside of confinement negative pressure is maintained to prevent leakage of radioactive materials.

The rest area of examination room is assigned to other experimental equipment such as WEDM, Dimension measurement and so on.

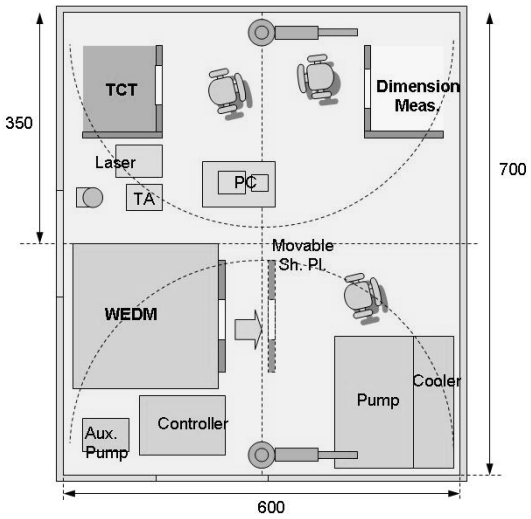

Fig. 1 Layout of examination room in service area of IMEF. (Dotted circle shows the coverage of jib crane.)

2.3 Design of experimental table for TCT

The designed feature of experimental box is as Fig. 2. The thickness of lead shielding plate of confinement box is 5 cm. About up to 3 mCi of ^{60}Co can be handled in the confinement box. The size of lead window was designed to 40 cm x 40 cm, which has same shielding capacity of lead plate. Operator's eye level was set to 160 cm from floor as hot cell windows. The table also equipped several tongs for handling of specimens inside the confinement box.

Bottom part of experimental table is simply a stainless steel stand. The total weight of experimental table is estimated about 2.7 ton.

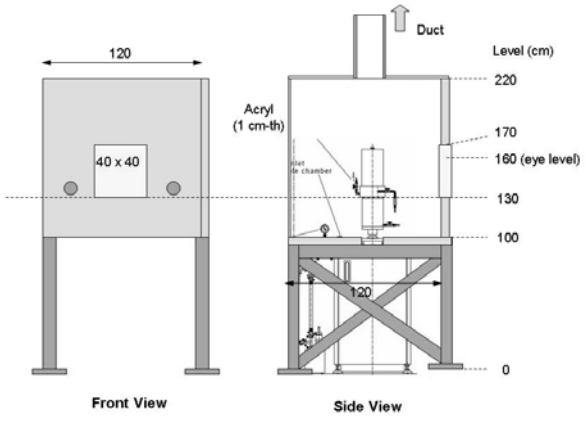

Fig. 2 Front and side views of the experimental table for TCT.

Top plate of confinement box has two separated parts – one is fixed part which is connected to HVAC duct, the other part is a hinge type door which is the pathway of specimen cask as shown in Fig 3. When specimen cask is imported through the upper door by crane, operator opens the cover of cask using tongs, and picks out the specimen, then loads the specimen onto the TCT specimen holder. Specimen export procedure is same but reverse with import procedure.

The confinement box could be removed from the experimental table by simply lifting it up if necessary.

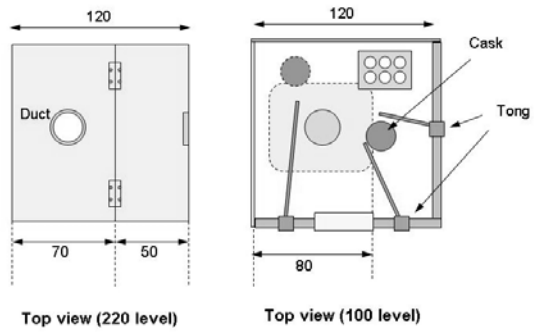

Fig. 3 Top views of the experimental table for TCT.

2.4 Auxiliary equipment in examination room

Because the examination room has no heavy component handling equipment inside, a pair of jib cranes were introduced as Fig. 4. The jib crane should have at least 1 ton of handling capacity each. The height of hook is 3.5 m from floor considering the height of experimental table and the ceiling height of room. This jib crane will be used in installation of experimental table and loading of specimen cask.

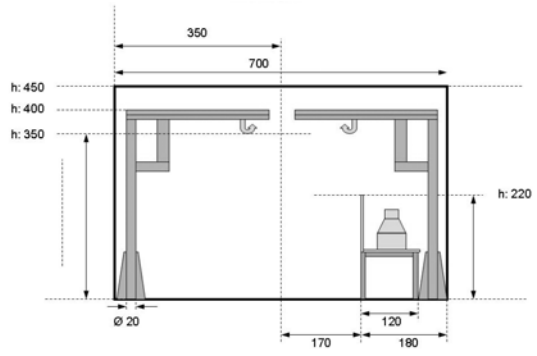

Fig. 4 Jib cranes for transportation of specimen cask or handling of experimental equipment.

2.5 Safety consideration

The confinement box of experimental table should satisfy the radiological safety. Although the confinement box does not have air tightness, the inside of confinement box has negative pressure(about 200 Pa lower than the outside) no leakage of radioactive gas or dust is foreseen.[1]

For the radiation shielding 5 cm of lead plate was applied in the confinement box. As shown in Fig. 5, it can attenuate the dose of 3 mCi of ^{60}Co source to less than 15 mR/h which is the permit limit of dose rate in IMEF service area.[1]

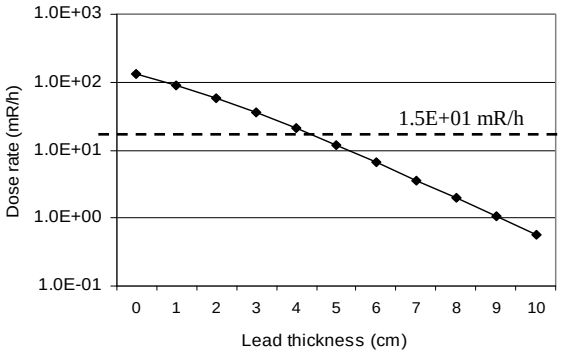

Fig. 5 Outer surface dose rate of containment box as lead plate thickness increases assuming 3 mCi of ^{60}Co inside.[2]

3. Conclusions

The shielded experimental table for TCT was conceptually designed. The experimental table has a confinement box of which the inner space is 1.2 m cubic. The thickness of shielding lead plate is 5 cm which enables handling 3 mCi of ^{60}Co or less. Maintaining negative pressure inside box the leakage of radioactive materials could be prevented. 40cm x 40cm of lead windows and several tongs are also to be equipped in the experimental table.

The experimental table is expected to be installed in IMEF this year after commissioning.

REFERENCES

[1] Safety Analysis Report of Irradiated Materials Examination Facility(ver. 13), p. 11-72, 77, 2009.
[2] MicroShield shielding calculation program (ver. 7).