Development and Application of Customized Shielded Cask Transport System

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1. Introduction

The PADIRAC™ is a lead shielded container with a sliding shielded door, designed to move equipment, materials or waste into or out of any Alpha, Beta or Gamma containment while maintaining confinement and with full protection against irradiation [1]. A PADIRAC cask, RD 15, manufactured by La Calhène, is used in the ACPF hot-cell of KAERI. For the proper use and successful operation of the cask, a crane system is indispensable because it provides means to accurately adjust the position and orientation of the cask when connecting it to hot-cell door system. In this work, we propose a customized PADIRAC cask transport system used where no crane service is available near the docking position like ACPF hot-cell.

2. Design of Customized Transport System

2.1 Design Requirements

The ACPF hot-cell is located in a basement of the Irradiated Material Examination Facility of KAERI. Because crane service is not available for operating the cask, a crane system installed on the ceiling of the upper floor is used to lower the cask down through a hatch opening and place it on the transport system. Therefore, the transport system needs to move the cask to the hot-cell door and provide a proper means to adjust the position and orientation of the cask. More specific design requirements are as follows:

- Rail guided traveling unit
- Accurate adjustment of the position and orientation of the cask without the use of a crane
- Sufficient structural safety

2.2 Rail-guided Travelling Unit

The rail-guided travelling unit is driven by chain mechanism with simple structure, high reliability and low cost. In addition, a clutch is adopted to prevent slipping of the transport system after docking on the hot-cell. Two (low and high) speed modes are implemented for cautious docking after relatively rapid travelling. The motor base is designed for easy adjustment of the chain tension and maintenance.

2.3 Screw Elevator

As shown in Fig. 1, a double screw elevator lifts up and down the two sliding doors, coupled with keys, of an approximated mass of 750 kg. Each of the screw is provided with a nut so that the position of the door supported by the nut changes as the chain drive rotates the vertical screws. The chain tension can be adjusted by shifting the motor using the slotted mounting holes.

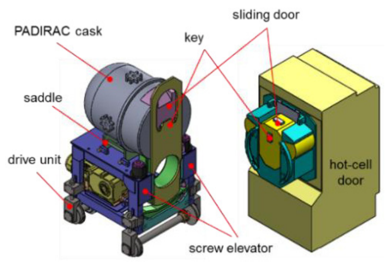

Fig. 1. PADIRAC transfer system and hot-cell door.

2.4 Adjustment of Cask Position and Orientation

Figure 2 shows adjustment mechanism for both a horizontal and vertical position of the PADIRAC cask. The vertical position and inclination of the support table can be adjusted by using a stud bolt and nut installed on the leg module. Hydraulic jacks are used to facilitate the adjustment by applying relatively small force. On the top plate of the transfer table, a saddle for placing the shielded cask is mounted and its orientation can be adjusted by using four bolts. In this way, the position and orientation of the cask can be adjusted without the use of a crane system.

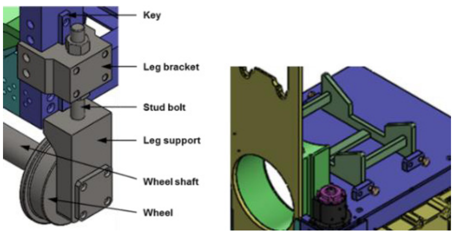

Fig. 2. Position and orientation adjustment mechanism.

2.5 Structural Analysis

To verify the structural safety of and find a proper shape for the transport system, structural analysis of a complete model of the transport system was conducted. A maximum stress of 48 MPa was observed in a nut housing, which was approximately 20% of the yielding stress of the material, as shown in Fig. 3. Moreover, the maximum deflection was approximately 0.25 mm.

3. Hot-cell Operation

Figure 4 shows the shielded cask transport system operated in the ACPF hot-cell. After introducing the transport system to the hot-cell, several mechanical and electrical tests were performed to check whether the transport system performed at a desired level. Several operation tests of the transport system showed that all design goals were achieve in general, especially accurate docking capability.

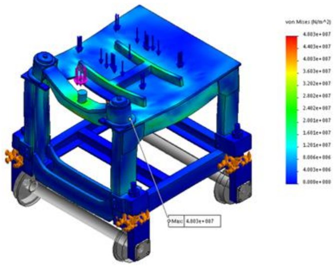

Fig. 3. Results of the stress analysis.

Fig. 4. The operation of shielded cask transport system.

4. Summary

In this work, we developed a customized shielded cask transport system which is equipped with a rail-guided travelling unit and a position adjustment unit for the cask without any crane service. The designed solid model was verified to have sufficient safety margin by using structural analysis. The developed system was introduced to a hot-cell and successfully tested and verified to have required target performance.

REFERENCES

[1] PADIRAC^{TM} a robust, safe transfer and transport solution, Getinge La Calhène.