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Cask and plug handling system design in port cell☆

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ABSTRACT

The ITER maintenance strategy relies partly on the remote transfer of components from vacuum vessel to hot cells. This function will be fulfilled by transfer cask systems.

This paper describes the recent design progresses on interfaces in order to increase components handling feasibility by implementing continuous guiding features that avoid cantilevered loads on the in-cask tractor. Also the design has progressed in order to allow generic docking of the casks.

When the cask is connected to the port, it becomes part of the machine first confinement boundary, thus it must provide tightness continuity. This high level safety function was one of the main concerns of a finite element analysis study that has been performed to assess the behavior of the whole system. Numerical analysis methodology and results are explained and shown in order to highlight how it has reinforced the knowledge of the system.

1. Introduction

All ITER assembly and maintenance operations involving the handling of hazardous materials (typically beryllium during assembly and activated in-vessel component materials, and tritium during operation) will be carried out meeting established occupational safety guidelines. These are based on acceptance criteria, limiting personnel exposure to toxic substances (beryllium) and to ionizing radiations (from tritiated or neutron activated material) [1].

With the exception of NBRH Systems which have a dedicated remote maintenance cell all other remotely maintainable ITER plant items will be removed from the Tokamak Building and taken to the ITER Hot Cell for remote maintenance and repair [2]. This transport function will be fulfilled by remotely controlled transfer cask systems.

The Cask and Plug Remote Handling System (CPRHS) comprises a fleet of transfer casks and the in-cask equipment and tooling required for the handling of the following components and equipments [3]:

- Diagnostic plugs
- Test Blanket Module (TBM) plugs
- Electron Cyclotron Heating (ECH) plugs
- Ion Cyclotron Heating (ICH) plugs
- Lower Hybrid Heating (LHH) plugs
- Torus cryopumps
- Blanket RH Equipment – (with the associated handled components, for example Blanket Modules)
- Divertor RH system – (with associated handled components such as divertor cassettes, diagnostic racks + shielding, primary closure plates)
- In-vessel Viewing Syst. – Glow Discharge Cleaning Plugs
- Neutral Beam RH System (with associated handled components: upper port diagnostic tubes)
- Multi Purpose Deployer equipment

2. Transfer cask systems description

2.1. Functions

The main related high level functions for the Cask and Plug Remote Handling Systems are:

- Remote transfer of the equipment along the building floor and lift, between Vacuum Vessel (VV) and the Hot Cell Facility (HCF) through dedicated building galleries.
- Provide and maintain primary confinement barrier during all transfer phases of components between the VV and the HCF. This is a safety function.
- Install/Remove component (including In Vessel RH equipment) into/from VV or HCF Port.

☆ The views and opinions expressed herein do not necessarily reflect those of the ITER Organization.

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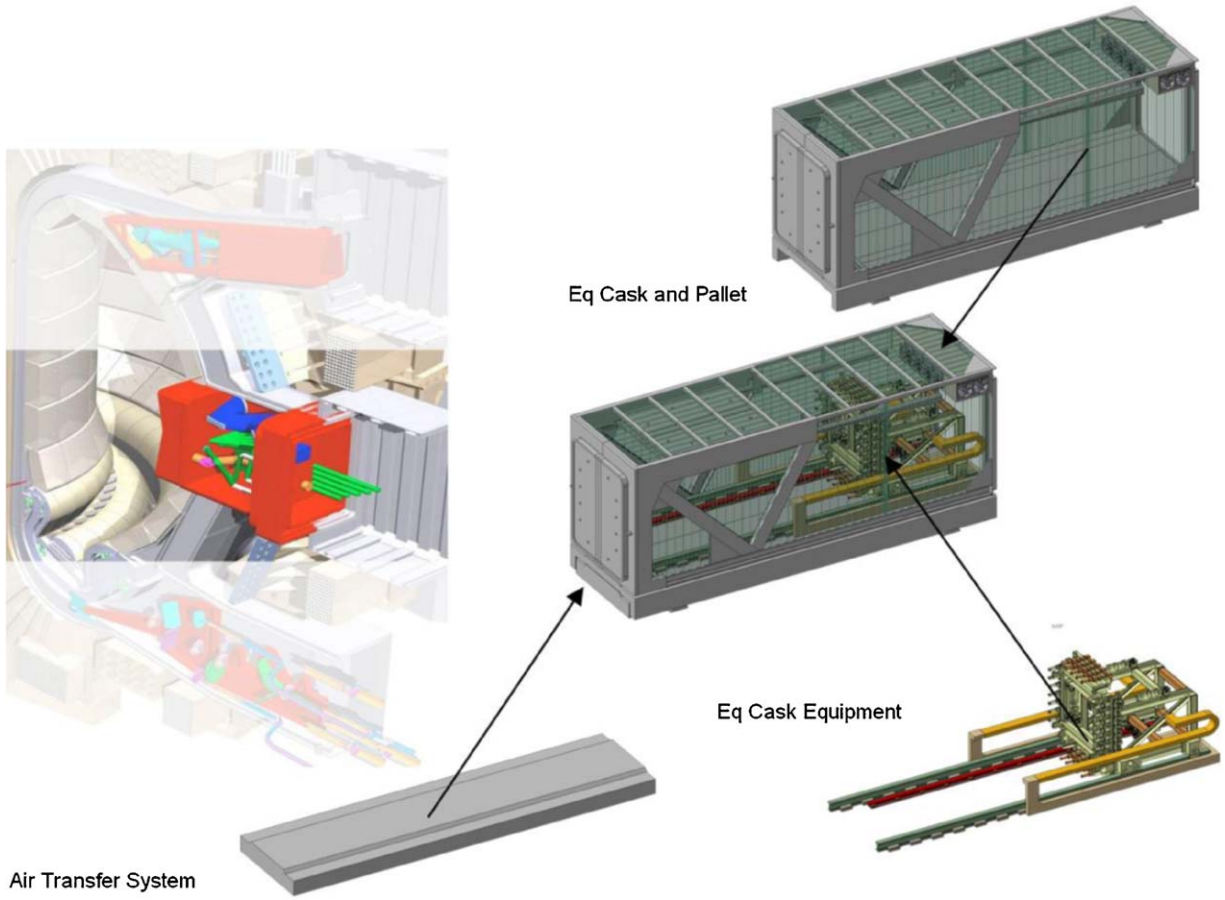

Fig. 1. Equatorial cask and plug handling equipment main components and layout.

- Docking/un-docking onto the VV or HCF docking flange including alignment features.

2.2. Description

The transfer cask systems are mainly composed of a sealed container and 6 degrees of freedom alignment mechanism mounted on a transport system. The alignment system is used to ensure correct docking of the cask with the vacuum vessel port.

The major functions of the cask are distributed among its main components (Fig. 1):

- Remote transfer between buildings is ensured by the cask transfer system (current design proposal is based on an air transfer system).

  Confinement is provided by:

o Envelope to provide physical confinement of the components.
o Front double seal door for docking and sealing with the port flanges.
o Rear double seal door for docking and sealing with rescue systems.

- Component handling is performed by in-cask equipment. This one can vary following the components to be handled.
- Alignment and docking functions of the envelope to the ports flanges are allowed by the pallet system.

2.3. Typologies and variants

The casks are used to handle several different components. Thus different types of casks have been defined (Table 1).

3. Interfaces design

3.1. Standardization

Over the past development years, design proposals have been made for some of the casks [1–3] following the design maturity of the components to be handled. The design progresses tend to standardize as much as possible the casks in order to minimize variants specificities.

Therefore, the design work methodology on interfaces consisted on considering all the possible casks in order to establish as often as possible standard interfacing features.

Table 1
Casks typologies and variants.

Transfer cask systems identification	Quantity
Upper port cask system	1
Upper port rescue system	1
Equatorial cask system	1
Intermediate IVT cask system	4
Main IVT cask system	4
Main MPD cask system	2
MPD service cask system	2
Equatorial cask rescue system	1
Intermediate IVT rescue system	1
Main IVT rescue system	1
MPD rescue system	1
Divertor cask system	2
Cryopump cask system	1
IVVS cask system	1
Divertor rescue system	1
Cryopump rescue system	1
IVVS rescue system	1