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ITER transfer cask: Preliminary assessment of dose rate due to dust remained in the cask

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ABSTRACT

The Remote Handling tasks scheduled during the ITER maintenance shut-down require transportation of in-vessel components and remote-handling tools from the Vacuum Vessel (VV) ports to the Hot Cell Building (HCB). These components and tools will be moved using the Cask and Plug Remote Handling System (CPRHS).

During plasma operations, plasma facing components will be highly activated by neutrons and/or contaminated with tritium. After plasma operations, activated dust will be removed from the VV but some amounts will remain. Therefore, the CPRHS may be contaminated by residual activated dust due to the transportation of these components between the VV and the HCB. As the CPRHS is not shielded, residual activated dust may lead to a residual dose rate around the CPRHS.

To assess the risk of external exposition in case of human intervention for maintenance purpose inside or close to the CPRHS, dose rate estimations were performed around and inside the CPRHS for several initial dust configurations with the normalized value of 1 g of residual activated dust. The results of this study constitute a dosimetric data base and may support ITER Organization in the definition of a decontamination level and maintenance plan.

1. Introduction

The Remote Handling (RH) tasks scheduled during the ITER maintenance shutdown require transportation of in-vessel components and RH tools from the Vacuum Vessel (VV) ports to the Hot Cell Building (HCB). These components and tools will be moved using the Cask and Plug Remote Handling System (CPRHS). The CPRHS is a vital element in the successful performance of ITER. Its design and development must be planned and executed effectively to ensure the CPRHS is fit for purpose [1].

The CPRHS system comprises the following means [2–4]:

- the cask envelope system (CES) is designed to provide a confinement barrier but no shielding protection is associated with this system,
- the cask transport system (CTS) is designed to provide means for remote transportation and navigation of CES,
- the cask docking station system (CDSS) is designed to provide means to mechanical support and align the CES,
- the in-cask plug handling system (ICPHS) is designed to provide means to guide RH components during installation and removal.

During plasma operations, plasma facing components such as plugs, will be highly activated by neutrons and/or contaminated with tritium. After plasma operations, activated dust will be removed from the VV but trace amounts will remain. Therefore, the CPRHS, and more specifically the CES, may be contaminated by residual activated dust during the transportation of these components between the VV and the HCB. Activated dust in the CES can have two sources:

- migration from VV to CPRHS during the docking stage, especially close to the maintenance door,
- transfer from VV components or RH tools on which surfaces dust has adhered.

As the CES is not shielded, residual activated dust lead to a residual dose rate around the CES. In case of failure or incident during the transportation, hands-on operations may be needed to repair the CES, the ICPHS or the CTS. If the CES transports activated components, dose rate levels have already been estimated [5]. But if the CES do not transport any activated components but contain some residual activated dust, no dosimetric estimation has been published nowadays to our

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Table 1
Activated dust nuclides important for safety analysis.

Dust spectrum	Activity (Bq/kg) at plasma stop
W187	8.44E+13
W185	5.08E+12
W181	1.98E+12
Re186	2.82E+11
Re188	9.45E+11
Ta182	3.35E+10
Ta186	1.55E+10
Ta183	7.35E+09
Ta184	8.47E+09
Re184	1.86E+09
Co60	9.61E+08

Table 2
Energy groups recommended for ITER studies and used for gamma spectra determination.

Energy groups	High energy bound (MeV)
1	0.001
2	0.01
3	0.02
4	0.05
5	0.10
6	0.20
7	0.30
8	0.40
9	0.60
10	0.80
11	1.00
12	1.22
13	1.44
14	1.66
15	2.00
16	2.50
17	3.00
18	4.00
19	5.00
20	6.50
21	8.00
22	10.0
23	12.0
24	14.0

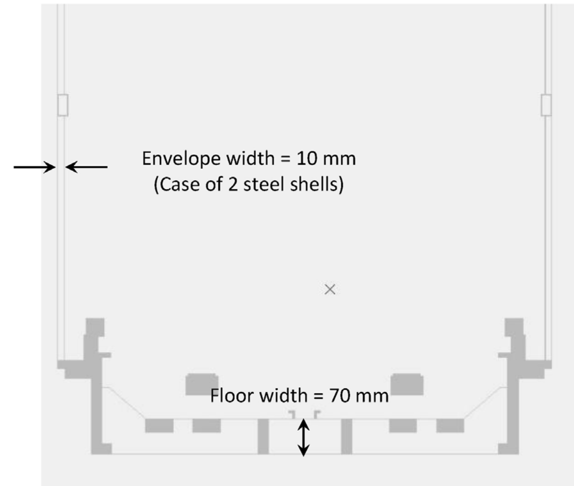

Fig. 2. Final view of the lower part of the CPRHS when two steel shells are taken into account for the envelope.

knowledge.

The objective of this study is to determine the mass of dust allowed in the cask for achieving less than 5 μSv/h for hands-on operations in and close to the cask. Dose rate estimations around and inside the CES were thus performed in the case of 1 g of residual activated dust remained in the CES. It is assumed that the workers will be wearing ventilated protective suits against radioactive contamination when working with tritium. The risk of internal exposure is thus limited [6]. In this evaluation we thus only considered the external dose rate from dust. Dose rates were estimated for several configurations representative of possible dust contamination with 1 g activated dust. Dose rate levels obtained for these configurations constitute a dosimetric data base (DDB) that could be used to estimate the dose rate level due to more complex dust sources obtained by mixing the several configurations defined in this study. This DDB constitutes an helpful tool for ITER Organization in the definition of a decontamination and maintenance plan.

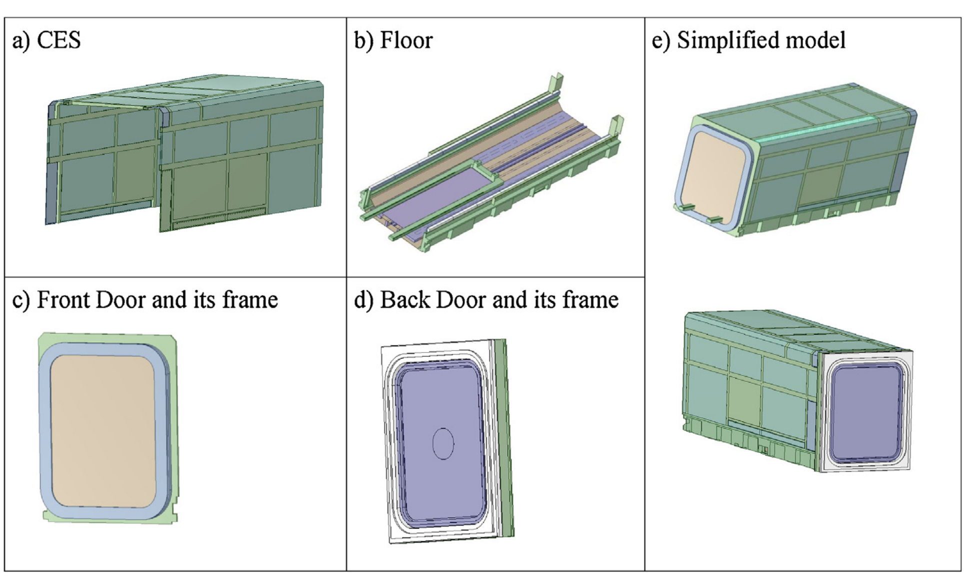

Fig. 1. Main parts of the CPRHS (CES (a), floor (b), front door (c) and back door (d)) remaining after the simplification process and final model of the CPRHS (e).