Design basis – Target wheel

DOCUMENT REVISION HISTORY

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SUMMARY

This document presents the definition and classification of loads according to RCC-MRx for the target wheel, drive and shaft. The information given herein constitutes part of the input required for the structural assessment of the component.

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1. INTRODUCTION

This document presents the design basis for the target wheel.

2. OVERVIEW DESCRIPTION OF TARGET WHEEL

The target wheel design is outlined in Figure 1 and

Figure **2** below. The wheel is divided into 36 internal compartments. Each compartment is filled with 185 tungsten blocks with dimensions 10 x 30 x 80 mm. The tungsten blocks are fixed in their positions by bottom and top cassettes.

The pressure vessel is a flat bottom and top cover, connected along the outside perimeter to a thin semi-torus and to the inside perimeter to a center helium distributor.

Moreover, the bottom and top covers are connected by welding to the compartments separators and hence these separators act structurally as webs.

The semi-torus is the proton beam entrance window (BWE). The helium inlet flow enters the compartments below and above the tungsten blocks and returns through the 2 mm gaps arranged between the tungsten blocks, thereby cooling these.

The helium distributor is connected to a vertical shaft which transports the inlet and outlet helium and rotates the wheel.

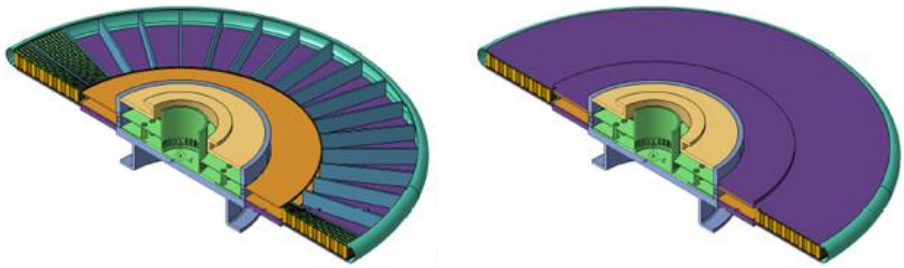

Figure 1. Target wheel.

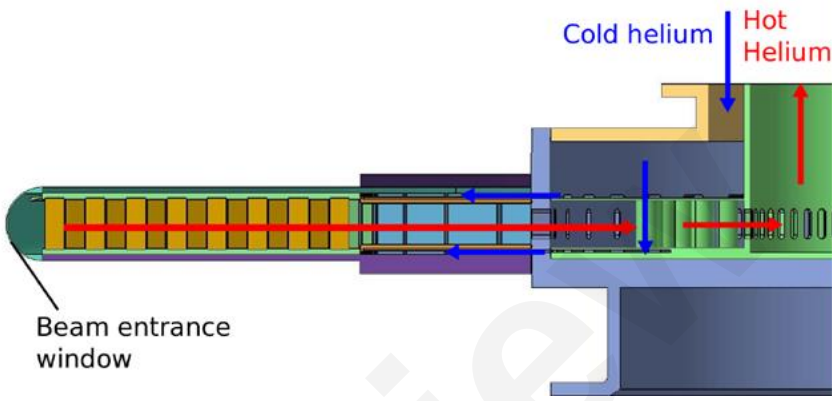

Figure 2. Section illustrating the helium flow.

3. CLASSIFICATION & APPLICABLE CODE

Classification and design data are presented in [2].

4. LOADS & OPERATING CONDITIONS

Operating Conditions in RCC- MRx are denoted SF. [Section 3 RB 3130].

SF 1 and 2 are operating conditions associated with Normal operation, start and stop, and normal operational incidents. Both are evaluated according to acceptance criteria for Level A. [Section 3 RB 3153].

SF 3 Conditions are Operating Conditions which are rare, and leads to shutdown and inspection. These may be evaluated according to Level A or Level C criteria. Level C criteria requires inspection of component before returning to service. Since Level C criteria do not require fatigue analysis, maximum occurrances during component lifetime should be less than 10. [Section 3 RB 3153]

SF 4 Conditions are highly improbable but relevant for safety. These may be evaluated according to Level A, Level C or Level D criteria. A loading only limited by Level D criteria may cause permanent damage to component.

Design Conditions

RCC MRx does not include criteria to evaluate the Loading 'Design Conditions' if the combination of Design Temperature and Design Pressure is not a loading which is expected to occur. The Criteria level for this fictitious load case is Level 0, meaning it should be evaluated against applicable legislation.[Section 3 RB 3155].

In the case of target wheel, drive and shaft, loads shall be evaluated according to acceptance criteria for lLevel A.

The component experiences irradiation above negligible levels. The estimated maximum radiation damage in the component from five years operation is 6 dpa.

4.1. Normal operating loads- loads at SF1 operating conditions

Nr	Event	Load description & definition
SF1-1	Normal accelerator heat load	[1]
SF1-2	Temperature transients associated with normal stop and start of accelerator	[1]
SF1-3	Local unbalance in helium flow	[1]
SF1-4	Operation with one helium blower	[1]
SF1-5	Normal postulated unbalance	[1]

Table 1. Normal operating loads.

4.2. Loads at SF2 operating conditions

SF2 operating conditions are normal operating incidents. Level A evaluation criteria applies.

The normal operating incident loads given in **Table 2** shall be considered.

Nr	Event	Load description & definition
SF2-1	Pressure variations	[1] Load limit defined by MPS mitigation
SF2-2	Temperature variation	[1] Load limit defined by MPS mitigation
SF2-3	Flow variation	[1] Load limit defined by MPS mitigation
SF2-4	Simultaneous trip of accelerator and helium cooling system with residual heat generation	[1]
SF2-5	Rotational speed variations	[1] Load limit defined by MPS mitigation
SF2-6	Unsyncronized target rotation	[1] Load limit defined by MPS mitigation
SF2-7	Failure of rastering magnets	[1]
SF2-8	Failure of quadropoles	[1]
SF2-9	Self induced vibration with maximum unbalance	[1]

Table 2. Normal operating incident loads.

4.3. Loads at SF4 operating conditions

SF4 operating conditions are highly improbable operating conditions whose effect nonetheless need be considered. The ASME nomenclature is faulted conditions which is adopted herein. Level D evaluation criteria applies.

The faulted operating loads given in Table 3 shall be considered.

Nr	Event	Load description & definition
SF4-1	Pressure variation	[1] Load limit defined by TSS mitigation
SF4-2	Temperature variations	[1] Load limit defined by TSS mitigation
SF4-3	Flow variations	[1] Load limit defined by TSS mitigation
SF4-4	Rotational speed variations	[1] Load limit defined by TSS mitigation
SF4-5	Unsyncronized target rotation	[1] Total loss of syncronization. Beam hits in worst possible position.
SF4-6	Safe shutdown earthquake	[1] Load limit defined by TSS mitigation

Table 3. Faulted operating loads

5. REFERENCES

[1] ESS-0060625 Load Definitions for Target Wheel, Drive and Shaft

[2] ESS-0037038 WP2 Target wheel, drive and shaft Design Specification