

OFFICE NATIONAL

D'ETUDES ET DE RECHERCHES AEROSPATIALES

 29, avenue de la division Leclerc – Châtillon

WIND TUNNEL DIVISION

BELLOWS DESIGN AND MANUFACTURING FOR VARIOUS

UNCOUPLING DEVICES

Technical Specifications

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1. INTRODUCTION

The present document describes the specifications for the design and manufacturing of various kinds of bellows. These bellows will be used for the final manufacturing of several decoupling devices (consisting in pipes and bellows):

- HP (High Pressure) compressed air circuit;
- CCL (Boundary Layer Control) air circuit;
- Coolant circuit.

In the rest of the document, PS stands for Service Pressure, TS for Service Temperature.

2. BELLOWS DEFINITION

Type	Quantity needed	PS internal (bar)	TS (°C)	ID min (mm)	OD max (mm)	Max radial deflection (mm)	Max angular deflection (°)	Max total length with their necks (mm)
HP	12	50	+40	56	66	1	2	70
CCL	12	15	+40	26	36	1	2	70
Coolant	8	5	+40	16	25	1	2	30

The material of the bellows has to be in agreement with PED (Pressure Equipment Directive 2014/68/UE). So, the material has to be procured under the standard EN 10028-7:2016. The provider is free to choose the material most suited to reach the required performance of the bellows. Such materials as Inconel 625, stainless steel AISI316 or equivalent can be considered.

The bellows have to respect as much as possible the dimensions above with the following tolerances :

- 0/+3mm for the ID
- +/-5mm for the OD

These bellows will be used to manufacture various air/coolant decoupling devices, consisting in bellows and several pipes lengths (straight and bent as shown below).

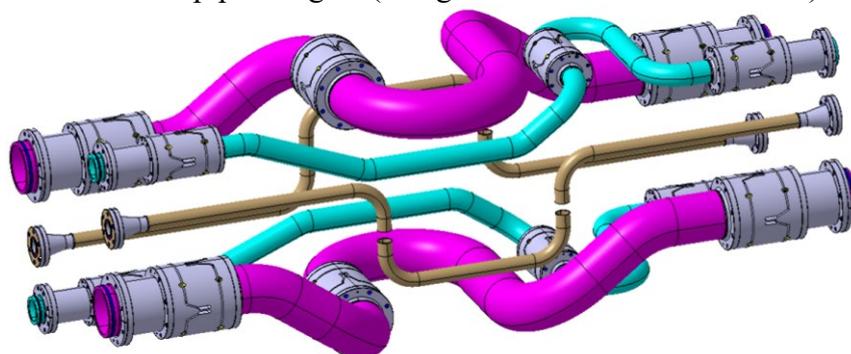


Figure 1: decoupling system

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These decoupling devices are located inside a large scale wind-tunnel aircraft model in order to supply air turbines with HP air lines, provide coolant fluid to slipping systems and allow for boundary layer control at dedicated locations on the model. The decoupling devices are installed around a six-component balance which measures the three forces and the three moments generated on the model by the wind-tunnel flow. These decoupling devices have to be as flexible as possible in order to limit their parasitic stiffnesses in parallel to the intrinsic stiffness of the multi-components balance.

The lateral stiffnesses (in the two directions perpendicular to the internal flow direction) have to be identical for each type of bellow (minimal manufacturing dispersion). The objective values of the stiffnesses are the following ones:

- **HP : 100N/mm +/-30%**
- **CCL : 40N/mm +/-30% Coolant : 10N/mm +/-30%**

The manufacturing of the rings will be taken in charge by the provider of the bellows. The design of these rings will be commonly performed by ONERA and the provider and validated by ONERA at the CDR (the figure below shows an example of bellows with rings).

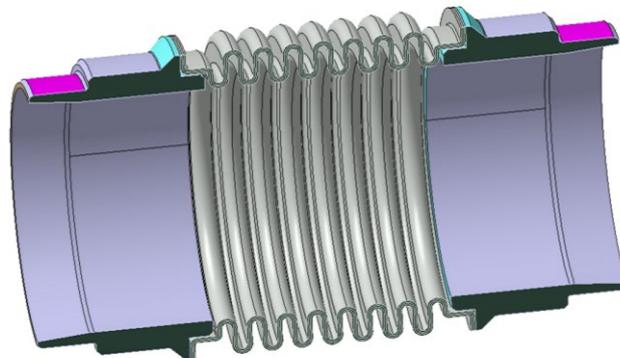


Figure 2: example of bellow + rings assembly

The welding between the bellows and rings will be taken in charge by the provider of the bellows.

The HP and CCL bellows will be submitted to a hydrostatic proof test at a pressure of 1.43xPS. The provider will be in charge of these tests. The provider will design and manufacture the hydrostatic proof tools for HP and CCL bellows and will be validated by ONERA (the figure below shows an example of hydrostatic proof test).

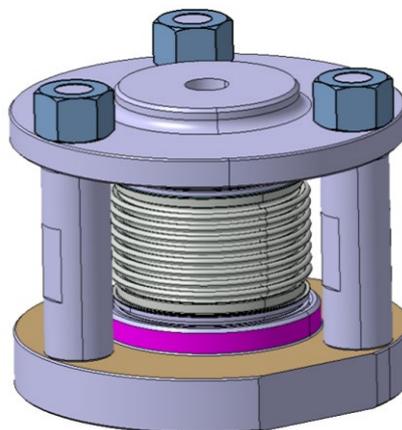


Figure 3: example of hydrostatic proof test set-up

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3. DELIVERIES

The provider in charge of the project has to deliver:

- the design report for the three types of bellows to be considered, including FE (Finite Element) analysis or other type of mechanical strength assessment for both PS and proof test situations. Number of cycles that each type of bellow can sustain will be documented in details;
- CAD files and detailed drawings of the bellows (format to be defined) and their rings;
- all manufactured bellows with their welded rings;
- material certificate 3.1b (EN 10204) for each raw material procurement;
- each of the bellows will be geometrically controlled, a control report will be provided for each bellow;
- all documents related to the welding :
 - QMOS ;
 - DMOS ;
 - QS ;
 - non-destructive inspection report ;
 - reports related to the hydrostatic tests (1.43xPS).
- declaration of conformity.

The bellows + rings assemblies, once manufactured, controlled and proof-tested will be delivered to ONERA at Châtillon in a robust transport box in order to protect the hardware. This box will not be used for long time storage.

4. ORGANIZATION OF THE PROJECT

The provider will be in charge of organizing :

- PDR
 - Design report delivery
- CDR
 - Stress report and details drawings delivery
- Factory Acceptance Tests :
 - Dimensions and stiffness controls of all the bellows
 - Hydrostatic tests of all the bellows
 - Report delivery
 - ONERA will physically attend the FAT
- Transportation of the hardware after ONERA validation during the FAT to ONERA Châtillon site

ONERA will perform a visual inspection of the hardware once the latter delivered to ONERA Châtillon.

NB 1 : PDR and CDR can be carried out either physically or by visioconference.

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