
		Request for Quotation			
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Project: TurboReflex GA No. 764545					
Project title:		Turbo Reflex program "Horizon 2020" Disc Burst tests			

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1 Background:

GES invites quotation for supplying intentional disc burst test.

The objective of the project is to develop more precise burst speed prediction for gas turbine discs based on FEM approach. The funding is from EU program Horizon 2020 and TURBO-REFLEX project. The current work scope is part of task 3.1 of TURBO-REFLEX project. Overall the task 3.1 is led by MAN Energy Solutions SE. Further details can be found in <https://www.turbo-reflex.eu/>.

Two different burst failure scenarios are under the scope of the study. GES will deliver the discs geometry for the two different failure scenarios. The disc component for the burst tests will be provided by MAN Energy Solutions SE (MAN SE), therefore all MAN SE non-disclosure / confidentiality agreements have to be honored.

2 About the project:

- a) This request for quotation is part of Turbo-Reflex Project. Nature of work is subcontracting.
- b) Turbo-Reflex project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 764545.
- c) Subcontracting guidelines of Horizon 2020 are applicable. The Grant agreement can be found in the link below.
http://ec.europa.eu/research/participants/data/ref/h2020/grants_manual/amga/h2020-amga_en.pdf
- d) All below obligations must be accepted by supplier:
 - Avoiding conflicts of interest (see Article 35)
 - Maintaining confidentiality (see Article 36)
 - Promoting the action and give visibility to the EU funding (see Article 38)
 - Liability for damages (see Article 46)
- e) Following sentence should be included in the quotation or the offer: "In connection to TURBO-REFLEX EU Project towards WP3 Mechanical Integrity in Flexible Operation (T3.1 Burst Tests)"

3 Geometry:

The burst test will be performed for two different failure mode: hoop mode and rim peel mode. The geometries were developed by GES and can be slightly modified for better fixation in the spin test pit. The average disc weight is approximately 45kg.

All discs are non-bladed with flat surface at the disc rim.

The test assumes testing for a disk mounted in the arbor without any bolt connections. Therefore, arbor design should be adjusted to this specific condition. Alternatively, the arbor with bolted connection can be considered. This requires consultation with specialists of the spin pit test provider etc.

The geometry for hoop mode is presented in Fig. 1 and geometry for rim peel model in Fig. 2. The detailed drawings and 3D models (parasolid files) are enclosed in the appendix.

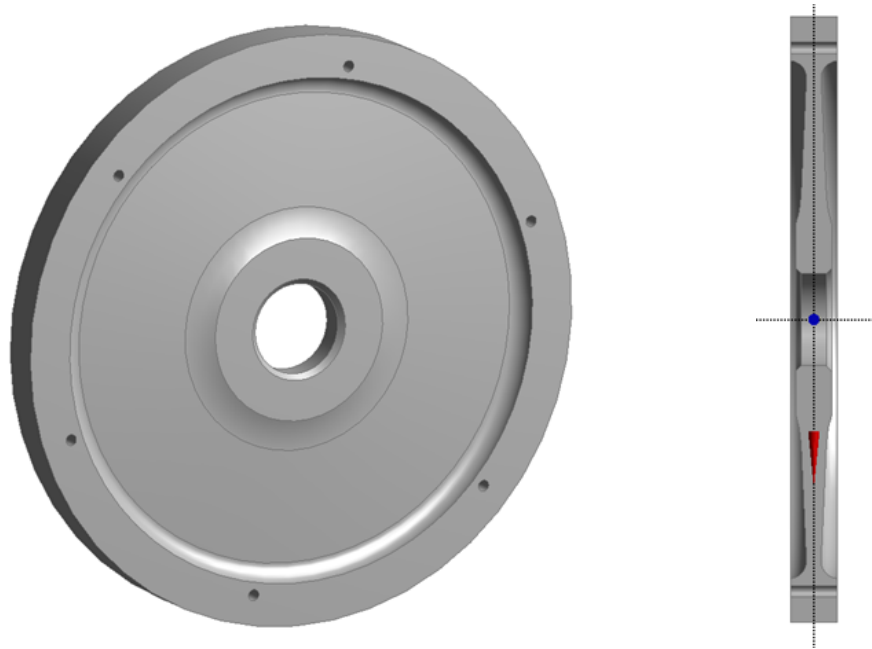


Fig. 1 Disc geometry for hoop mode failure (10002751915)

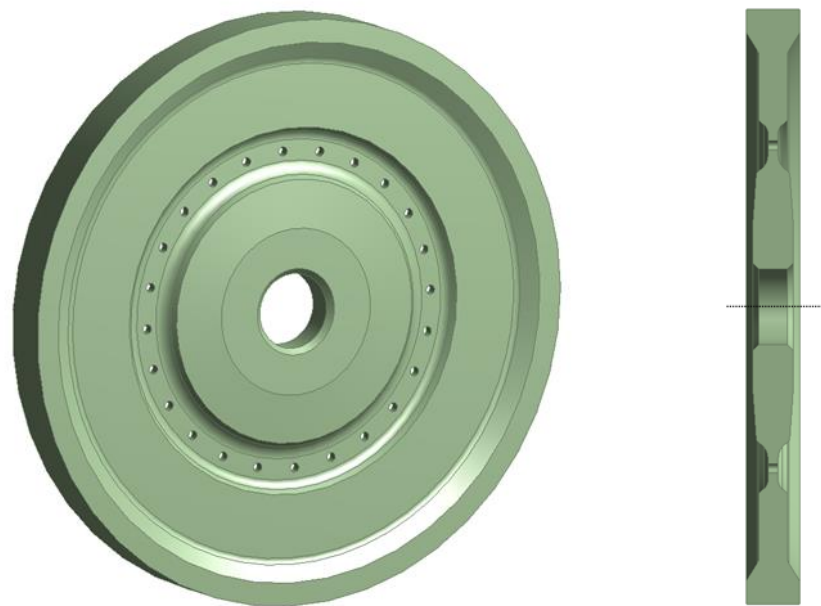


Fig. 2 Disc geometry for rim peel mode failure (10002747713)

4 Materials:

The discs are made out of X12CrMoWVNbN10-1-1 (rim peel mode, Figure-2) and Inconel 718 (hoop mode, Figure-1). More details are provided in later sections.

5 Test condition:

Predicted disc burst speed is 21000 rpm for hoop mode of Inconel 718 disc and 17000 rpm for rim peel mode of X12CrMoWVNbN10-1-1. Due to several uncertainties – the predicted burst speed is expected to vary -30% to + 20 %.

The test must be under vacuum condition and at room temperature. A couple of optional items are requested: high speed camera & test under temperature.

6 Requirements:

Following requirements have to be provided:

- speed measurement
- constant vibration & unbalance monitoring
- the top surface of the disc rim constant radial growth monitoring via laser or other reliable non-contact probes
- The axial flat surface of the disc constant axial displacement monitoring via laser or other reliable non-contact probes
- the disc rim shape constant monitoring
- high speed camera installation on demand (7500 to 10000 frames per second)
- air temperature monitoring near to the disc rim

7 Arbor design:

The arbore design should be provided by supplier to handle two different failure mode.

GES or MAN SE will not manufacture the arbor or any components. Only the machined disc will be delivered.

8 Test program:

Test	Disk Drawing Number	Failure Mode	Material	Test Objective	Optional	
					High Speed Camera	Elevated temperature
TEST C	10002747713	Rim Peel	X12CrMoWVNbN10-1-1	burst	Yes	local heating at thin web
TEST D	10002751915	Hoop	Inconel 718	burst	Yes	local heating at bore or full heating
TEST E	10002405705	Hoop	Steel (type - to be decided later)	overspeed*	No	No
TEST F	10002747713	Rim Peel	X12CrMoWVNbN10-1-4	overspeed*	No	No

* w/o intentional burst

9 Pricing:

All prices should include final report (report specification below) and shipping back discs or disc fragments as well as the arbor to the MAN Energy Solutions SE in Oberhausen, Germany

The price should be given with the specification of the following:

- a. Arbore design and adjustment (all stress, rotor dynamic analysis or any other calculations associated to this topic is within the scope of the spin pit test supplier)
- b. Arbor manufacturing
- c. Test pit preparation and balancing
- d. Test

- e. Instrumentation as indicated in point 6
- f. Fast shutting camera
- g. Data postprocessing with relevant report. Report should include:
 - Arbor design
 - Arbor strength assessment
 - Arbor RDA results
 - Arbor drawings
 - Arbor quality inspection after manufacturing
 - Assembly procedure and balancing
 - Vibration/unbalance over time
 - Displacements of the rim over time and disc rim shape detection
 - Temperature over time
 - Pressure over time.
 - Failure mode description

It might be required to stop the test(s) at particular speed(s) and thereafter the system is brought to a standstill. A full dis-assembly, measurement of key dimensions, followed by re-assembly, re-balancing might be required at some speeds. This procedure is optional. It shall be decided and fully defined during the course of the project.

Test repeat with new disc (for TEST C, D, E and F according to the test program). Alternatively, please provide the same price for bolted design of the arbor.







10 Disclaimer:

All data provided on the following slides is for information purposes only, explicitly non-binding and subject to changes without further notice.

11 Additional information:

- a) The supplier has to demonstrate having experience in conduction burst test with un-bolted arbor design.
- b) Offers can be submitted until 18.04.2019.

12 Enclosure:

Disk Drawing Number	Drawing	3D Parasolid (representative model & not the manufacturing model)
10002747713	 DRW_10002747713_001_00#0.pdf	 Steel_disc tapered _24holes.x_t
10002751915	 DRW_10002751915_001_00#0.pdf	 IN718 DISC 6 holes .x_t
10002405705	 DRW_10002405705_001_03#0.pdf	 Kompressorscheibe _10_f_Bersttest_112: