Aircraft Design Competition

Request for proposal (RFP) **- High speed UAV**

Objectives:

This RFP asks for an original UAV design capable of reaching, in less than 15 minutes, a given target located at 150 km offshore, loiter over the target for 3 hours and then come back to the takeoff position in economic mode flight condition.

The winner team will have the opportunity to perform a wind tunnel test campaign in the transonic/Supersonic Wind tunnel at the VKI.

General design requirements:

- Airworthiness requirements: according to FAR23(A)
- Configuration: no restriction
- Powerplant: no restriction

Design features

- Low maintenance
- Low operating cost
- Flying controls: no restriction
- Structure: no restriction
- Landing gear: no restriction
- Power plant: no restriction
- Systems: no restriction
- Dimensions external: can be transported in a container (1m x 1.5m x 2m)

Payload

- Payload capacity: 2 kg excluding sensors and remote controls
- Payload volume: 0,3m x 0,3m x 0,3m

Performance:

- Takeoff: catapult launcher
- Landing: self landing, landing distance lower than 500 m on hard runway surface.
- Top speed: 800 km/h.
- Stall speed: less than 140 km/h at the maximum weight.
- Range: 150 km
- Endurance on site: 180 minutes (3h), Loiter speed: lower than 170 km/h
- Ceiling: no restriction
- Minimum turn radius: lower than 75 m

Rules

1. Only students are eligible to participate to this competition.
2. Electronic copy of every report in Adobe PDF format must be submitted by email to the VKI at the following address: christelle.debeer@vki.ac.be A “Signature” page must be included in the report and indicate all participants, including faculty and project advisors. Designs that are submitted must be the work of students, but guidance may come from the Faculty/Project Advisor.
3. Reports should be no more than 50 (total) double-spaced typewritten pages and typeset should be no smaller than 10pt Arial Font (including graphs, drawings, photographs, and appendix) on A4 paper. Only pages containing drawings may be fold-outs (A3 max).
4. The final evaluation will be done on the basis of the final design reports and on the quality of the scaled model.
5. Team competitions will be groups of not more than 8 and no less than 4 students.
6. The VKI has the right to change the requirements in the request for proposal at any time during the design competition. If this is the case, the VKI will inform all the participants.

Copyright

All submissions to the competition shall be the original work of the team members.

Schedule and Activity Sequences

Dates and addresses for submission of the proposal are given hereunder:

A. Letter of Intent : December 1, 2013
B. First Interim Report : March 31, 2014
C. Final Proposal : April 30, 2014
D. Announcement of Winners : May 22, 2014
E. Wind tunnel test of the winning project : to be determined with the winner team

Groups intending to submit a proposal must submit a one page “Letter of Intent” along with the signed attached Intent Form on or before the date specified above, at the following address: Christelle Debeer, christelle.debeer@vki.ac.be

Proposal Requirements

The technical proposal must be complete and should contain at least the following information:

1. Description of the technical approaches to comply with each of the requirements specified in the RFP.
2. A clear description of the phasing of tasks.
3. Descriptions, sketches, drawings and discussions of new techniques should be presented in sufficient detail to permit engineering evaluation of the proposal.
4. Exceptions to the proposed technical requirements should be identified and explained.
5. Trade-off studies performed to achieve the final design.
6. Description of design tools used to develop the design.

Clarity and completeness of the technical approach are primary factors in the evaluation of the proposals.

Basis for judging

Technical Content

1 Fulfilling of the original requirements
2 Correctness of theory, validity of reasoning used.
3 Pertinent validation analysis.
4 Presentation
5 Originality

Mock-up

1. The mock-up must be built according to the specifications

Supporting data

The technical proposal must convincingly demonstrate that the analysis methodology is realistic and that the design satisfies the requirements. The proposal should:

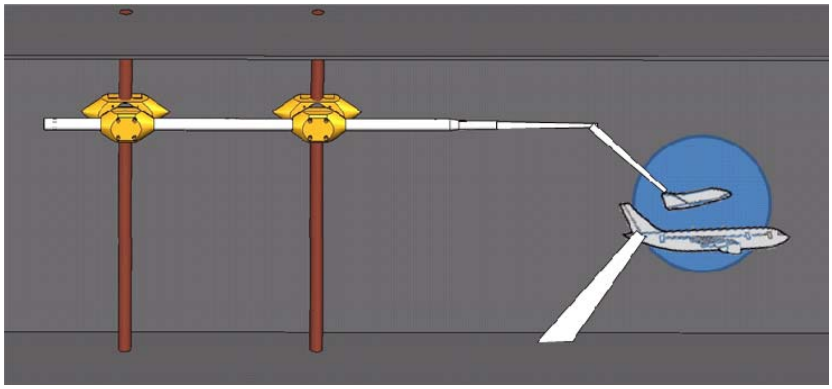
1. Present the validation dataset collected, show how it was used, and explain any method calibration performed.
2. Justify the final design, and describe the technologies, and technical approach used to meet the mission requirements.
3. Provide carpet and sizing plots used to guide the design selection. Describe sensitivity studies used.
4. Include a dimensioned 3-view general arrangement drawing.
5. Show a weight breakdown of the major components and systems.
6. Show weight and cg envelope.
7. Show estimated component drag build-ups (parasite) and drag polars.
8. Show estimated propulsion performance including engine power, fuel flow, and propulsive efficiency for all conditions.
9. Show estimated/computed stability for all flight and loading conditions. The following stability derivatives (they will be checked in the transonic/supersonic wind tunnel at the VKI)

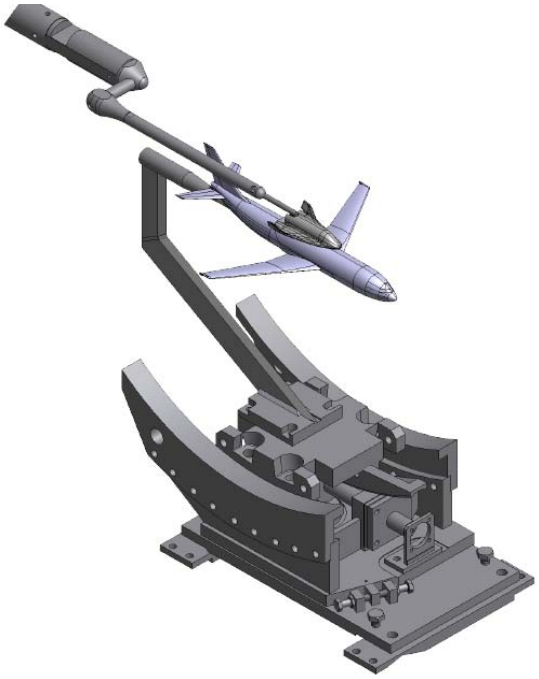
$C_{l\alpha}$	Lift due to angle of attack derivative
$C_{d\alpha}$	Drag due to angle of attack derivative
$C_{m\alpha}$	Pitching moment due to angle of attack derivative
C_{lu}	Lift due to speed derivative
C_{du}	Drag due to speed derivative
C_{mu}	Pitching moment due to speed derivative
C_{yb}	Side force due to sideslip derivative
C_{nb}	Yawing moment due to sideslip derivative

10. Polar Curve cd(cl)
11. Include descriptions of the major aircraft systems (size, weight, power consumption, …).
12. Describe any advanced technologies or design approaches and their relative benefits as used to obtain performance improvements.
13. Provide the cost estimation for production runs of 10 and 100 units.
14. Provide fixed and hourly cost estimates.

Délivrable:

1. The technical proposal document
2. The 3D-Model (file format IGES, STEP, STL)
3. Mockup :
    a. Dimension :
        i. Maximum span: 26.0 cm
        ii. Maximum blockage ratio: 1.1%. For information:
            - Size of the test section: 40 cm x 36 cm
            - Maximum frontal area of the mockup: 15.84 cm²
    b. Surface roughness : no restriction as the Re is low
    c. Material : no restriction (wood, aluminum, resin, …) but should resist to the mechanical and aerodynamic loads
    d. The mockup must be tested to withstand two times the expected mechanical aerodynamic loads in the wind tunnel. Pictures of tests must be provided.
    e. The model can be supported by two different mechanisms. A sting supported by two screws allows accurate angle of attack adjustment with a variation of 17°. The support coming from the bottom wall offers a lower blockage ration. The range of angle of attack is 34°. The detail of the interface will depend of the choice of the balance (range) and should be discuss later.





4. Poster
    a. Format : A1
    b. The poster must display:
        i. Three-view drawing
        ii. Name of the project
        iii. Name of the team
        iv. List of every members of the team
        v. Paragraph about:
            1. Costs
            2. Structure
            3. Landing gear
            4. Power plant
            5. Equipment
            6. External dimensions
            7. Areas
            8. Weight & loading
            9. Performance

Test period

Wind tunnel test of the winning project will be determined with the winner team.

S1 Wind Tunnel description

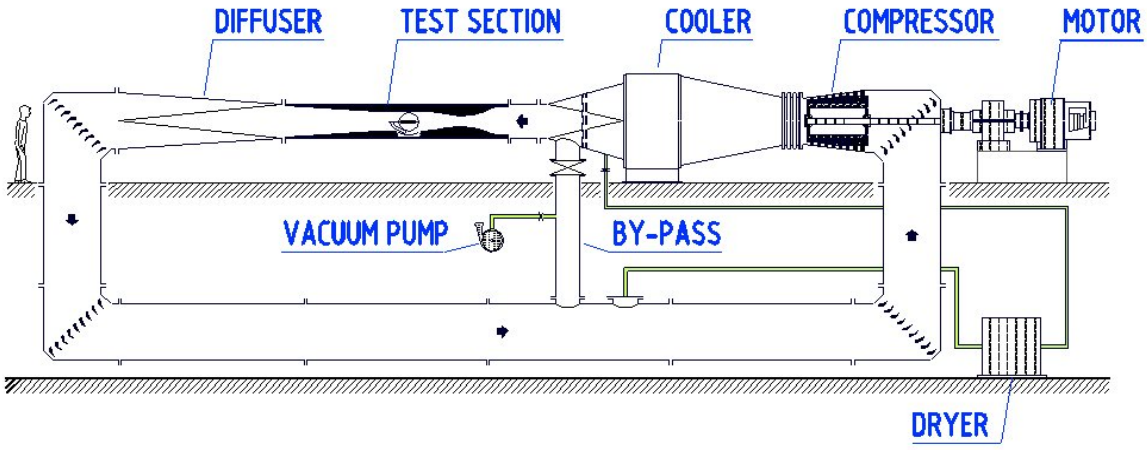


Figure 1: VKI-S1 wind tunnel

The VKI supersonic/transonic wind tunnel S-1 (Figure 1) is a continuous closed circuit facility of the Ackeret type, driven by a 615 kW axial flow compressor. Two 0.4 m x 0.36 m test sections are available: contoured nozzles with M = 2.0 and a slotted transonic section with variable Mach number, from 0.3 to 1.05. A typical unit Reynolds number is 4 x 106/m. The test section contains a three-degree-of-freedom traversing mechanism for model and/or probe support, as well as a variable incidence mechanism (up to 34 degrees).

Mach	P0 (Pa)	P∞ (Pa)	Re /L_{ref} L_{ref}=0.077m	Tt (K)	T∞ (K)	ρ∞ (kg/m^3)	U∞ (m/s)	Mach [-]
0.5	26685	22514	199372	299	285	0.2755	168.72	0.4988
0.6	26681	20891	223397	305	285	0.2558	203.42	0.6016
0.69	26772	19421	238617	313	285	0.2374	234.54	0.6930
0.8	26695	17565	248745	321	285	0.2151	269.50	0.7970
0.89	27110	16248	257901	329	283	0.2000	299.32	0.8874
2.0	9430	1193	87876	300	167	0.0249	519.25	2.0065

Table 1: Test conditions

Available balance

Balance #1

Size : 8 x 8 x 53 mm

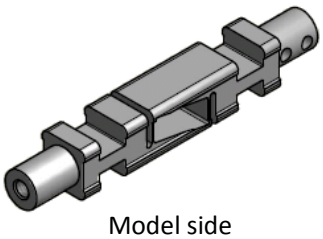
Sting side

Matière : 35 Ni Cr 18 traité

Nickelage chimique après usinage

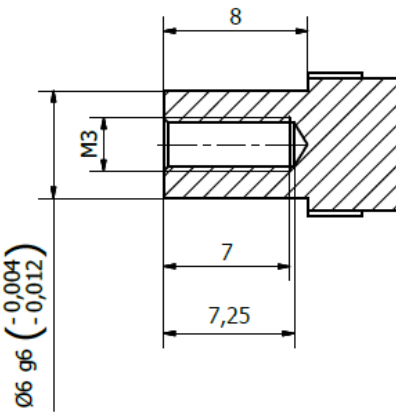
RE : 135000-160000 N/cm²

Fx : 20 FZ : 40 MY : 0.4



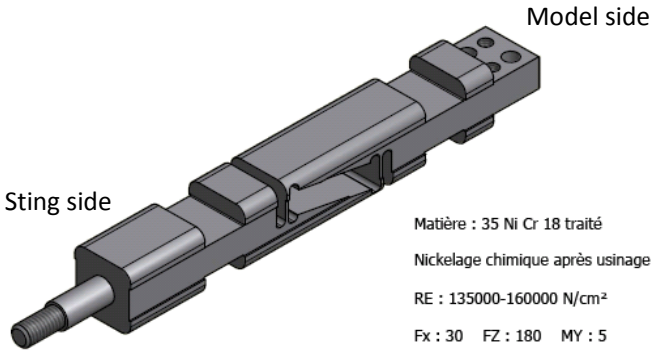
Model side

Model Side

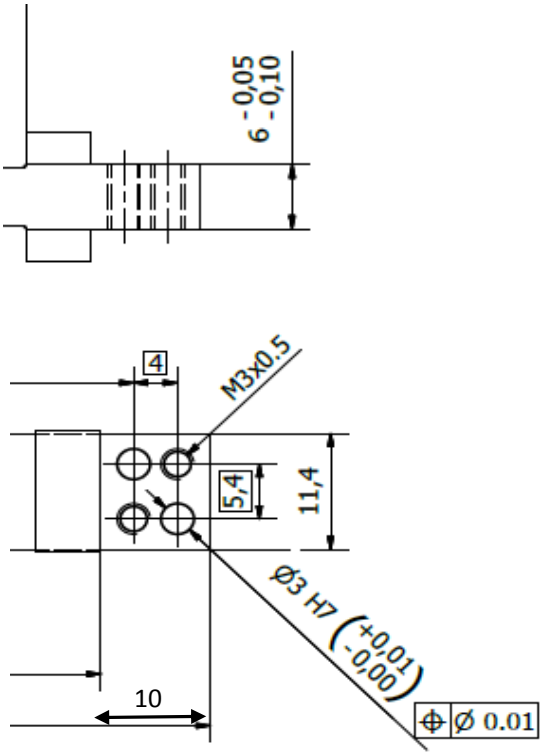


Balance #2

Size : 12 x 12 x 106 mm

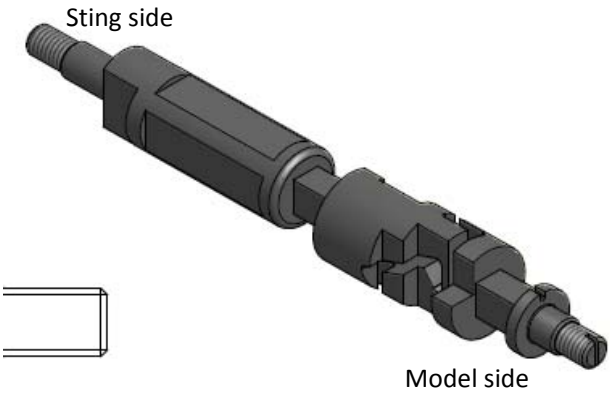


Model Side



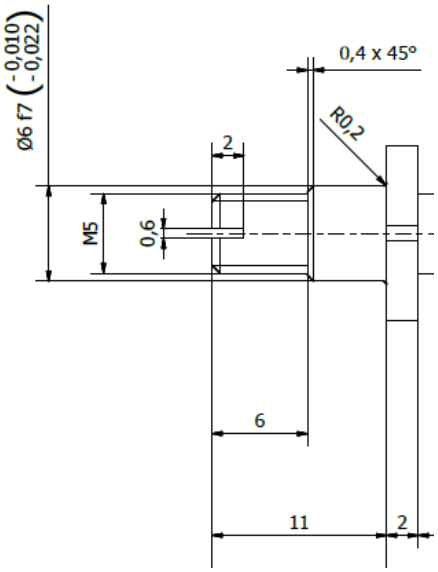
Balance #3

Size : ø15 x 113 mm



Force axiale:	120 N
Force normale:	60 N
Force latérale:	50 N
Moment tangage:	1650 Nmm
Moment lacet:	1200 Nmm

Model Side



INTENT FORM

REQUEST FOR PROPOSAL

Team Name:
Supervisor Name:
University:

Student Name	Email Address

In order to be eligible for the High Speed UAV Design Competition, you must complete this form and return it to Christelle Debeer christelle.debeer@vki.ac.be, before December 1, 2013, along with a one page “Letter of Intent” as noted in Section III, “Schedule and Activity Sequences”.