European Commission
Research Directorates

Clean Sky Joint Undertaking
Call SP1-JTI-CS-2012-02

Call for Proposals:

CLEAN SKY
RESEARCH and TECHNOLOGY DEVELOPMENT PROJECTS
(CS-RTD Projects):

Call Text

Call Identifier
SP1-JTI-CS-2012-02

Index

Document change log

Specialised and technical assistance:

CORDIS help desk http://cordis.europa.eu/guidance/helpdesk/home_en.html

EPSS Help desk support@epss-fp7.org

IPR help desk http://www.ipr-helpdesk.org

Introduction

Via the Calls for Proposal, Clean Sky aims to incorporate Partners to address very specific tasks which fit into the overall technical Work Programme and time schedule.

Due to the nature of these tasks, the Call is not set up using a set of themes, but it is conceived as a collection of very detailed Topics. The Call text therefore consists of a set of topic fiches, attached here.

Each Topic fiche addresses the following points:

- Topic manager (not to be published)
- Indicative start and Indicative End Dates of the activity
- Description of the task
- Indicative length of the proposal (where applicable)
- Specific skills required from the applicant
- Major deliverables and schedule
- Maximum Topic Budget value
- Remarks (where applicable)

The maximum allowed Topic budget relates to the total scope of work. A Maximum funding is also indicated.

Depending on the nature of the participant, the funding will be between 50% and 75% of the Topic maximum budget indicated. It has to be noted that the Topic budget excludes VAT, as this is not eligible within the frame of Clean Sky.

Recommendation to applicants:

Proposal Submission Forms

EUROPEAN COMMISSION
7 th Framework Programme for Research, Technological Development and Demonstration

Collaborative Project **A3.2: Budget**

Proposal Number: nnnnnn Proposal Acronym: yyyyyyyyyy

Participant number	Organisation short name	Country	Estimated budget (whole duration of the project)					Total receipts	Requested JU contribution
			RTD	Demonstration	Management	Other	TOTAL		
1	zzzzzzzzz	CH	564 286	0	35 714	0	600 000	0	450 000
TOTAL			564 286	0	35 714	0	600 000	0	450 000

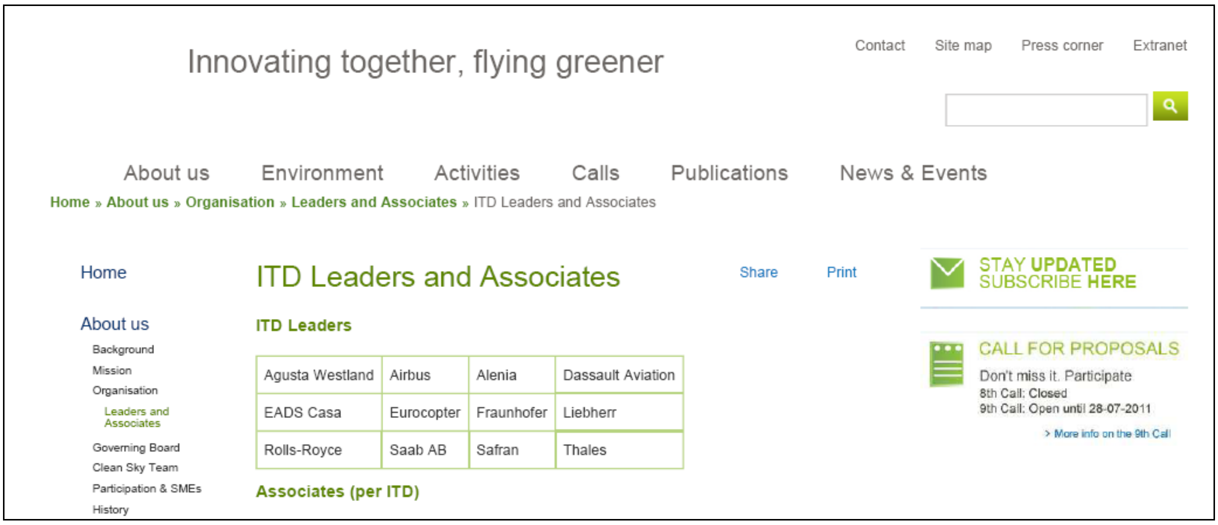
Make sure this total amount is below the value of the topic!!
Better, keep at least 5% margin.
Final amount is to be discussed in the negotiation.

Eligibility criteria

All applicants are requested to verify their actual status of "**affiliate**" with respect to the members of the relevant ITD for whose topic(s) they wish to submit a proposal. Applicants who are affiliated to any leader or associate of an ITD will be declared not eligible for the topics of that ITD.

Refer to art.12 of the Statute (*Council Regulation (EC) No 71/2007 of 20 December 2007 setting up the Clean Sky Joint Undertaking*) and to page 8 of the Guidelines.

Pls check on the Clean Sky web site the composition of the ITDs in the dedicated page:



Evaluation

Thresholds:

As indicated in section 4.6 of the *"Rules for Participation and Rules for Submission of Proposals and the related Evaluation, Selection and Award Procedures"*, each proposal will be evaluated on 6 criteria.

For a Proposal to be considered for funding, it needs to pass the following thresholds:

- **Minimum 3/5** score for each of the 6 criteria,
  AND
- **Minimum 20/30 total score**

Only one Grant Agreement (GA) shall be awarded per Topic.

Calendar of events:

- **Call Launch: 12 April 2012**
- **Call close: 10 July 2012, 17:00**

- Evaluations (indicative): 17-21 September 2012

- Start of negotiations (indicative): 24 October 2012
- Final date for signature of GA by Partner: 15 November 2012
- Final date for signature of GA by Clean Sky JU: 30 November 2012

Recommendation to get a PIC

The applicant is encouraged to apply for a PIC (Participant Identity Code) and to launch the process of validation as early as possible; this will speed up the process of negotiation in the event that your proposal is successful (see http://ec.europa.eu/research/participants/portal/appmanager/participants/portal)

Contacts:

All questions regarding the topics published in this Call can be addressed to:

info-call-2012-02@cleansky.eu

Questions received until **8 June 2012** will be considered.

A first version of the Q/A document will be released by **16 May 2012**.

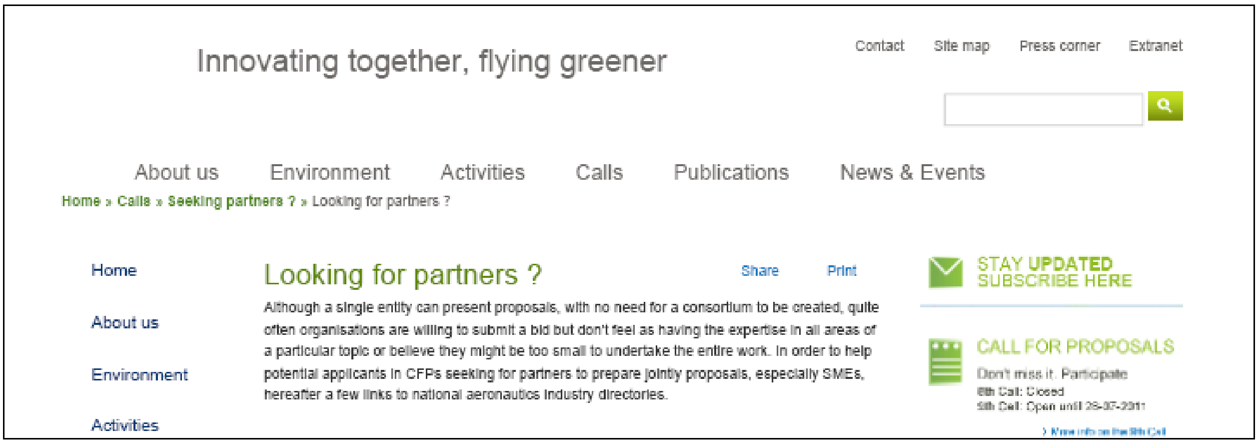
The final version of the Q/A document will be released by **18 June 2012**.

Questions having a general value, either on procedural aspects or specific technical clarifications concerning the call topics, when judged worth being disseminated, will be published in a specific section of the web site (www.cleansky.eu), together with the answers provided by the topic managers.

All interested applicants are suggested to consult periodically this section, to be updated on explanations being provided on the call content.

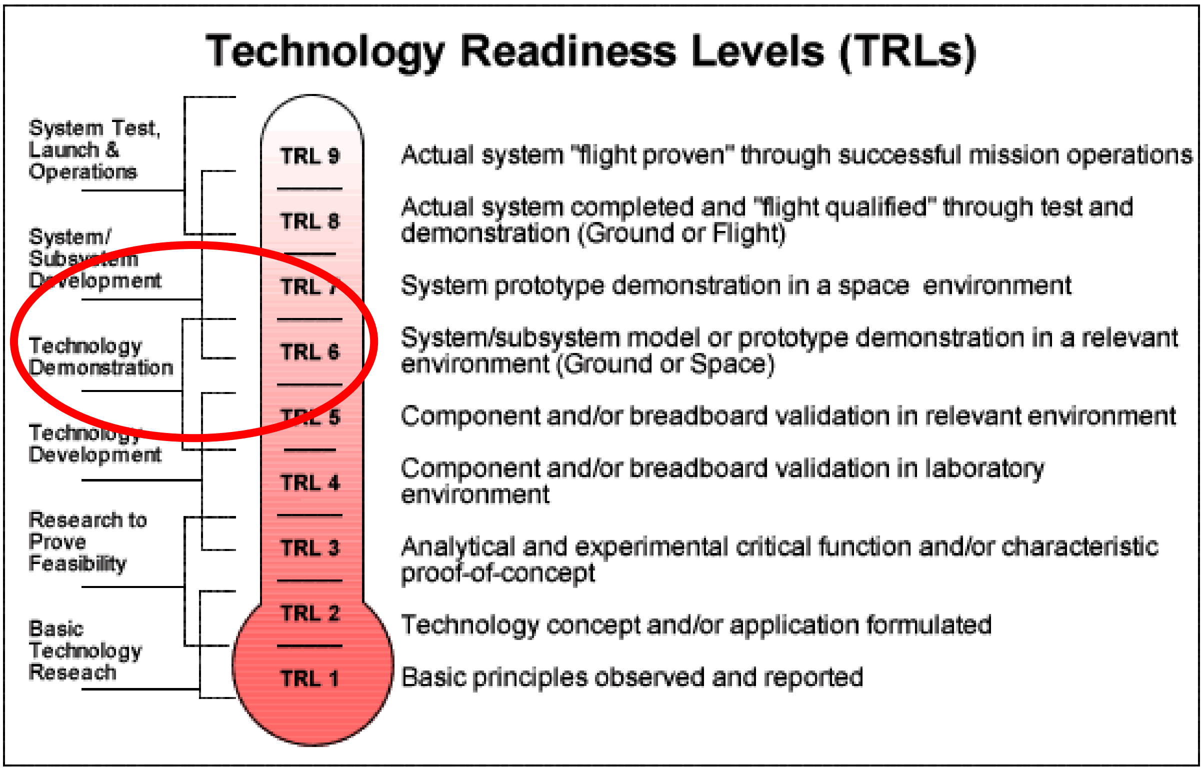
Looking for Partners?

If you are interested in checking available partners for a consortium to prepare a proposal, please be aware that on the Clean Sky web site there is a specific area with links to several databases of national aeronautical directories:



Reference to TRL:

When applicable or quoted in the text of topics, the applicants should be aware of the definition of Technology Readiness Levels, as per following chart, being TRL 6 the target for Clean Sky for all applicable technologies:



European Commission
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Clean Sky Joint Undertaking
Call SP1-JTI-CS-2012-02

Identification	ITD - AREA - TOPIC	topics	VALUE	MAX FUND
JTI-CS-ECO	**Clean Sky - EcoDesign**	**5**	**720,000**	**540,000**
JTI-CS-ECO-01	*Area-01 - EDA (Eco-Design for Airframe)*		**520,000**	
JTI-CS-2012-2-ECO-01-054	Chromium free surface pre-treatments and sealing of Tartaric Sulphuric Anodizing		150,000	
JTI-CS-2012-2-ECO-01-055	Laser welding of newly developed Al-Mg-Li alloy		150,000	
JTI-CS-2012-2-ECO-01-056	Development and demonstration of Direct Manufacturing technology for High Strength Aluminium Alloys		120,000	
JTI-CS-2012-2-ECO-01-057	Advanced Composite Integrated Skin Panel structural testing		100,000	
JTI-CS-ECO-02	*Area-02 (EDS - Eco-Design for Systems)*		**200,000**	
JTI-CS-2012-2-ECO-02-014	Characterization of batteries in expanded range of operation		200,000	
JTI-CS-GRA	**Clean Sky - Green Regional Aircraft**	**2**	**2,840,000**	**2,130,000**
JTI-CS-GRA-01	*Area-01 - Low weight configurations*		**240,000**	
JTI-CS-2012-2-GRA-01-050	Development of CNT doped reinforced aircraft composite parts		240,000	
JTI-CS-GRA-05	*Area-05 - New configurations*		**2,600,000**	
JTI-CS-2012-2-GRA-05-007	Development & optimization of advanced propulsion system installation through innovative complete A/C powered WT model		2,600,000	
JTI-CS-GRC	**Clean Sky - Green Rotorcraft**	**5**	**4,590,000**	**3,442,500**
JTI-CS-GRC-01	*Area-01 - Innovative Rotor Blades*		**710,000**	
JTI-CS-2012-2-GRC-01-010	Low weight, high energy efficient tooling for rotor blade manufacturing		710,000	
JTI-CS-GRC-02	*Area-02 - Reduced Drag of rotorcraft*		**800,000**	
JTI-CS-2012-2-GRC-02-007	Wind tunnel tests on a common helicopter platform and contribution to its optimised aerodynamic design		800,000	
JTI-CS-GRC-03	*Area-03 - Integration of innovative electrical systems*		**1,000,000**	
JTI-CS-2012-2-GRC-03-014	Design and Implementation of a Load Simulator Rig and Ground Test Bench Adaptation Kit for a HEMAS Test Rig		1,000,000	
JTI-CS-GRC-04	*Area-04 - Installation of diesel engines on light helicopters*		**0**	
JTI-CS-GRC-05	*Area-05 - Environmentally friendly flight paths*		**2,080,000**	
JTI-CS-2012-2-GRC-05-006	Sensoring and cockpit monitoring to reduce noise in manoeuvring flight		1,500,000	
JTI-CS-2012-2-GRC-05-007	Curved SBAS-guided IFR procedures for low noise rotorcraft operations		580,000	
JTI-CS-GRC-06	*Area-06 - Eco Design for Rotorcraft*		**0**	
JTI-CS-SAGE	**Clean Sky - Sustainable and Green Engines**	**9**	**16,350,000**	**12,262,500**
JTI-CS-SAGE-01	*Area-01 - Open Rotor Demo 1*		**0**	
JTI-CS-SAGE-02	*Area-02 - Open Rotor Demo 2*		**13,500,000**	
JTI-CS-2012-2-SAGE-02-019	Air cooled Oil Cooler development, test and supply for Open Rotor		2,000,000	
JTI-CS-2012-2-SAGE-02-020	Electro-hydraulic servo development, test and supply for Open Rotor		4,000,000	
JTI-CS-2012-2-SAGE-02-021	Propellers Blades Bearings Design and Manufacturing		1,500,000	
JTI-CS-2012-2-SAGE-02-022	Rotating cowls		2,000,000	
JTI-CS-2012-2-SAGE-02-023	Rotating nozzle		2,000,000	
JTI-CS-2012-2-SAGE-02-024	Rotating plug		2,000,000	
JTI-CS-SAGE-03	*Area-03 - Large 3-shaft turbofan*		**1,850,000**	
JTI-CS-2012-2-SAGE-03-014	Weight saving through used of CFRC components in high temperature application (=>360C) for efficient aero-engine design		850,000	
JTI-CS-2012-2-SAGE-03-015	Ring Rolling of IN718		1,000,000	
JTI-CS-SAGE-04	*Area-04 - Geared Turbofan*		**1,000,000**	
JTI-CS-2012-2-SAGE-04-019	Development of physically based simulation chain for microstructure evolution and resulting mechanical properties		1,000,000	
JTI-CS-SAGE-05	*Area-05 - Turboshaft*		**0**	
JTI-CS-SAGE-06	*Area-05 - Lean Burn*		**0**	
JTI-CS-SFWA	**Clean Sky - Smart Fixed Wing Aircraft**	**9**	**12,700,000**	**9,525,000**
JTI-CS-SFWA-01	*Area01 – Smart Wing Technology*		**1,700,000**	
JTI-CS-2012-2-SFWA-01-049	Demonstration of the feasibility of an in-flight anti-contamination device for business jets		650,000	
JTI-CS-2012-2-SFWA-01-050	Development and construction of master moulds for riblet application		350,000	
JTI-CS-2012-2-SFWA-01-051	New aircraft de-icing concept based on functional coatings coupled with electro-thermal system		400,000	
JTI-CS-2012-2-SFWA-01-052	Innovative aircraft ice protection system – sensing and modelling		300,000	
JTI-CS-SFWA-02	*Area02 - New Configuration*		**7,500,000**	
JTI-CS-2012-2-SFWA-02-029	Design and manufacturing of baseline low-speed, low-sweep wind tunnel model		1,000,000	
JTI-CS-2012-2-SFWA-02-030	Low speed aeroacoustic test of a large CROR rig in an open jet test section		1,300,000	
JTI-CS-2012-2-SFWA-02-031	Aeroacoustic and aerodynamic wind tunnel tests at low speed for a turbofan model equipped with TPS		2,000,000	
JTI-CS-2012-2-SFWA-02-032	Low speed aeroacoustic test of large CROR aircraft model in an open jet test section		3,200,000	
JTI-CS-SFWA-03	*Area03 – Flight Demonstrators*		**3,500,000**	
JTI-CS-2012-2-SFWA-03-010	BLADE wing structural test to derive test data for subsequent validation of GFEM modelling		3,500,000	
JTI-CS-SGO	**Clean Sky - Systems for Green Operations**	**12**	**5,940,000**	**4,455,000**
JTI-CS-SGO-01	*Area-01 - Definition of Aircraft Solutions and explotation strategies*		**0**	
JTI-CS-SGO-02	*Area-02 - Management of Aircraft Energy*		**4,540,000**	
JTI-CS-2012-2-SGO-02-034	EWIS Safety Analysis Tool		600,000	
JTI-CS-2012-2-SGO-02-036	Design and optimisation of locally reacting acoustic material		300,000	
JTI-CS-2012-2-SGO-02-047	Development and validation of sizing method for screw drives and thrust bearings		1,050,000	
JTI-CS-2012-2-SGO-02-048	Modelica Model Library Development Part II		200,000	
JTI-CS-2012-2-SGO-02-049	Smart erosion shield for hybrid deicing solutions		250,000	
JTI-CS-2012-2-SGO-02-050	Optimization of air jet pump design for acoustic application		300,000	
JTI-CS-2012-2-SGO-02-051	Ram-air fan optimization for electrical ECS application		600,000	
JTI-CS-2012-2-SGO-02-052	Electrical Starter / Generator disconnect system		700,000	
JTI-CS-2012-2-SGO-02-053	Design and manufacturing of the PFIDS Laser sources (VCSELs)		540,000	
JTI-CS-SGO-03	*Area-03 - Management of Trajectory and Mission*		**900,000**	
JTI-CS-2012-2-SGO-03-018	Operational expertise for function definition and validation - support to experimentations		400,000	
JTI-CS-2012-2-SGO-03-019	OTC-Operational (Technical) Constraints Model & OBM - Operation Business Model AUI - Aircraft Usage Impact Model		500,000	
JTI-CS-SGO-04	*Area-04 - Aircraft Demonstrators*		**500,000**	
JTI-CS-2012-2-SGO-04-005	Virtual integration of electrical equipment and rig correlation		500,000	
JTI-CS-TEV	**Clean Sky - Technology Evaluator**	**0**	0	0.000
		topics	**VALUE**	**FUND**
	totals (€)	**42**	***43,140,000***	***32,355,000***

Clean Sky – Eco Design

Identification	ITD - AREA - TOPIC	topics	VALUE	MAX FUND
JTI-CS-ECO	**Clean Sky - EcoDesign**	**5**	**720,000**	**540,000**
JTI-CS-ECO-01	*Area-01 - EDA (Eco-Design for Airframe)*		**520,000**	
JTI-CS-2012-2-ECO-01-054	Chromium free surface pre-treatments and sealing of Tartaric Sulphuric Anodizing		150,000	
JTI-CS-2012-2-ECO-01-055	Laser welding of newly developed Al-Mg-Li alloy		150,000	
JTI-CS-2012-2-ECO-01-056	Development and demonstration of Direct Manufacturing technology for High Strength Aluminium Alloys		120,000	
JTI-CS-2012-2-ECO-01-057	Advanced Composite Integrated Skin Panel structural testing		100,000	
JTI-CS-ECO-02	*Area-02 (EDS - Eco-Design for Systems)*		**200,000**	
JTI-CS-2012-2-ECO-02-014	Characterization of batteries in expanded range of operation		200,000	

Topic Description

CfP topic number	Title		
JTI-CS-2012-1-ECO-01-054	**Chromium free surface pre-treatments and sealing of Tartaric Sulphuric Anodizing**	**End date**	*To + 24*
		Start date	*To*

1. Topic Description

Chromic acid anodising has traditionally been widely used in protective schemes for aluminium alloy protection in aircraft structures due to the anticorrosive protection and excellent paint adhesion. However, because of the toxicological and environmental problems associated with hexavalent chromium, a range of investigations has emerged in recent years. Research efforts focused on the replacement of chromates in surface treatments are now widespread and many alternatives to chromic acid anodising have been proposed.

The Tartaric Sulfuric Anodizing (TSA) is typically 2 to 7µm thick, promoted as an alternative to chromic acid anodizing by aircraft manufactures. Regardless of the bath composition, for the anodic process to be fully effective aluminium alloys need to be prepared (cleaned-deox) and sealed or painted after anodising.

Up to now, the proposed pre-treatment and sealing solutions of TSA are not either effective or totally Chromium free. For example, the authorized sealing products are: Alodine 1200, Sodium dichromate, Potassium dichromate and Chromic acid.

The objective of this CfP is to investigate and propose cleaning and sealing products which comply with the requirements mentioned below after and which are CrVI free.

The new CrVI-free process shall perform equally or better to CCA when qualified for corrosion resistance and bonding or adhesion properties.

Requirements of the chromium free process of pre-treatment-TSA-sealing:

The coating system, i.e. anodizing and sealing, has to be in compliance with features such as:

- Total coverage, smooth, aesthetically pleasing
- Excellent substrate/coating bond
- Anodic film weight: The film weight shall be > 22 mg/dm2 when tested according to EN 12373-2.
- The thickness of the anodic film shall be in a range of 2 µm to 7µm. The thickness of the film shall be checked either by eddy current method (ISO 2360) and optical microscope (ISO 1463), or scanning electronic microscope (SEM), or equivalent examinations on a cross section of the anodic sample.
- Corrosion Resistance of painted specimens:

    a. Filiform corrosion : The filament length shall not exceed 2mm on either side of the scratches at 960h of exposure when tested in accordance with EN 3665

    b. There shall not be any corrosion, blister, extending further than 1,25mm on either side of the scratch at 3,000 h of exposure when tested in accordance with ISO 9227

- Corrosion Resistance of unpainted specimens:

    a. When tested in accordance to ISO 9227 the anodised and hot water sealed specimens shall show: Less than 2 pits / dm2 and no pit shall exceed 0,8mm in diameter. No patchy dark grey areas (spots, streaks or marks) after an exposure time of minimum 96hrs for 2024 T351 unclad and 7175 T7351 unclad. The specimen size shall allow an evaluation of an area of at least 1dm². Areas 2 mm from markings, edges and electrode contact marks remaining after processing shall not be considered for evaluation.

- Maximised paint adhesion (ISO 2409), on sealed or unsealed specimens. Gt0 (dry) and GT1 (wet).
- Fatigue testing

    The fatigue specimen shall be manufactured and tested in accordance to (EN 6072).

All the fatigue test values shall be plotted on the Wöhler curves (mean and minimum curves).

- Suitable for 2xxx series alloys and new aluminum alloys such as Al-Mg-Li.

• Applicable after Cr free surface preparation • Repaired (pickling and treatment or local touch-up) • Compliant with a conversion repair process • Environmentally acceptable in accordance to REACH • Morphology and Surface composition (SEM-EDS) The total estimated number of specimens is 400 (200 for 2024 T3 specimens and 200 for Al-Li alloy)

2. Special skills, certification or equipment expected from the applicant

The following skills and equipment are required: - TSA experimental and semi-productive facility - Experience and facilities for the coating characterization and testing. Proven background and knowledge on TSA of structural aerospace aluminium alloys. All the testing facilities of properties mentioned in above mentioned section 2.: "Requirements of the chromium free process of pre-treatment-TSA-sealing" must be performed by certified facilities. - Process , control, testing shall be safe for the environment and the workers.

3. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Development and optimization of pre-treatment in accordance to the test and requirements described in section 2.: "Requirements of the chromium free process of pre-treatment-TSA-sealing"	Report with qualification test , results, discussions & conclusions.	T0+8
D2	Development and optimization of sealing in accordance to the test and requirements described in section 2.: "Requirements of the chromium free process of pre-treatment-TSA-sealing"	Report with qualification test results, discussions & conclusions.	T0+12
D3	Description of full process of pre-treatment-anodizing-sealing	Report specifying the full process	T0+15
D4	Application of the new pre-treatment-TSA-sealing Chromium free process on a demonstrator which will be made by aluminium alloy representing a flat panel 400 x 900 mm with 3 stringers. The demonstrator will be provided by Topic Manager	Ddemonstrator and test report	T0+24

4. Topic value (€)

The total value of this work package shall not exceed: **€ 150.000** **[one hundred fifty thousand euro]** Please note that VAT is not applicable in the frame of the CleanSky program.

5. Remarks

Raw material will be provided by Topic Manager.

Topic Description

CfP topic number	Title		
JTI-CS-2012-1-ECO-01-055	**Laser welding of newly developed Al-Mg-Li alloy**	End date	*To + 24*
		Start date	*To*

1. Topic Description

Recent interest in reducing the weight of aircraft has focused attention on the use of aluminium alloys and associated joining technologies. Laser beam welding is one of the more promising methods for high speed welding of aluminium.

The objective is to study the laser weldability of a newly developed Al-Mg-Li alloy and the process parameters needed to obtain consistent laser welds and compare the mechanical behaviour with the conventional aluminium alloys series. The study will emphasize to the microstructure characteristics and the mechanical properties of the weld joint.

Advanced aluminium alloys for aerospace applications are continuously tested in research centers during the last decade. Commercial Al-Li alloys are targeted as advanced materials for aerospace technology primarily because of their low density, high specific modulus, and excellent fatigue and cryogenic toughness properties.

The superior fatigue crack propagation resistance of aluminium-lithium alloys, in comparison with that of conventional 2xxx and 7xxx alloys, is primarily due to high levels of crack tip shielding, meandering crack paths, and the resultant roughness-induced crack closure. However, the fact that these alloys derive their superior properties from the above mechanisms has certain implications with respect to small crack and variable-amplitude behaviour.

In addition these alloys can be welded, thus eliminating thousands of rivets resulting in a lighter and stronger integral structure. At present, fuselage structures are joined by mechanical fastening (stiffened panels). These stiffened panels are light and highly resistant metal sheets designed to cope with a variety of loading conditions. Stiffeners improve the strength and stability of the structure and are able of slowing down or arresting the growth of cracks in the panel. Around 50.000 rivets are needed to join these elements, thus increasing the global weight of the structure. Wings also consist in a skin-stringer-frame structure with the different elements joined together mechanically. Apart from adding weight to the aircraft structure, the mechanical fasteners mean a source of galvanic corrosion that limits the life of these elements.

Although Al-Li alloys have been already used in commercial and freight airplanes extensively, the next generation Al-Mg-Li alloys are very promising with further reduction of weight and increased mechanical properties.

The main concerns for the weldability of aluminium-lithium alloys are for porosity and hot crack susceptibility. However with proper selection of conditions and with some development work, these alloys could be easily welded in practice.

During the demonstration phase of the project, the developed LBW technology will be performed on a stiffened flat panel out of the new alloy Al-Mg-Li, named demonstrator B1, in order to evaluate the industrial application. The skin and the stiffener will be provided by Topic Manager. The demonstrator B1 is an aluminium panel 400 x 900 mm with 3 stringers spaced in equal distances.

The demonstrator shall be welded using the optimized parameters defined from the previous phase and then will be inspected by NDT in order to assure the structural integrity.

2. Special skills, certification or equipment expected from the applicant

The following skills and equipment are required:

- Laser Beam Welding facility
- Proven Background and knowledge on laser welding of structural aerospace aluminium alloys
- Experience and facilities for the microstructure characterization as well as modelling of microstruture evolution in laser welding and mechanical testing of aluminium welded joints.

Process control, detection shall be safe for the environment and workers and do not require important post cleaning.

3. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Development and optimization based on modelling and experimental effort of laser welding parameters. Data shall be provided.	Report	T0+10
D2	Production and delivery of defect-free laser welded test coupons in the form of T-joint (at least five coupons dimensions 250 x 250 mm). NDI report and reference standards shall be included.	Coupons (at least 5 of T-joint configuration)	T0+14
D3	Microstructure characterization of laser welded joints of Al-Mg-Li alloy (including SEM/EDX analysis)	Report	T0+18
D4	Mechanical testing of laser welded joints of Al-Mg-Li alloy (including fatigue) Comparison study between conventional 2024 riveted and laser welded Al-Mg-Li specimens	Report	T0+20
D5	Application of the new technology on a stiffened panel (B1 demonstrator) The demonstrator B1 is an aluminium panel 400 x 900 mm with 3 stringers spaced in equal distances.	Report and welded stiffened panel	T0 + 24

4. Topic value (€)

The total value of this work shall not exceed:

€ 150.000

[one hundred fifty thousand euro]

Please note that VAT is not applicable in the frame of the CleanSky program.

5. Remarks

Raw material will be provided by Topic Manager.

Clean Sky Joint Undertaking
SP1-JTI-CS-2012-02-ECO-01-056

Topic Description

CfP topic number	Title		
JTI-CS-2012-1-ECO-01-056	**Development and demonstration of Direct Manufacturing technology for High Strength Aluminium Alloys**	End date	*To + 18*
		Start date	*To*

1. Topic Description

Introduction

Currently Direct Manufacturing (DM) technology is developed primarily for titanium alloys and steels.

Aluminium alloys are represented by limited number of moderate strength Silicon contained alloys not suitable for aerospace applications.

The development of DM technology (DMLS, SLM, ALM) for High Strength Aluminium Alloys will allow to implement net shape manufacturing of numerous aircraft parts with Buy -to-Fly Ratio 10:1 and higher, to replace current design for weight saving and environmental benefits.

The objective of this call is to demonstrate DM technology for State of the Art High Strength Aluminium Alloys to use on aircrafts parts, complying with standard aviation criteria: strength, corrosion resistance and fatigue. Selected demonstrators must be evaluated to enable application of parts in aircraft.

The specimens and parts made by optimized DM technology need to be tested and proved for density, surface roughness, and corrosion resistance according to accepted aviation methods. Mechanical static and dynamic tests shall be carried out to ensure the process does not have any deleterious effects on the Aluminium alloy properties.

Work to be performed by the partners

The quantitative requirements are mentioned in the description of the deliverables.

- To demonstrate and optimize a DM technology for State of the Art High Strength Aluminium Alloys that can be applied in a serial production line.

-To perform CAD design

- To perform density tests.

- To perform anisotropy tests

- To perform corrosion resistance tests

- To perform surface roughness tests

- To perform mechanical tests on as manufactured material samples, on heat treated material samples, on HIP material samples (if needed). Fatigue and static properties should be assessed. Base material to be used shall be High Strength Aluminium Alloy with specific mechanical properties similar or better than Al 7050 T7451 (Refer to AMS 4050H).

2. Special skills, certification or equipment expected from the applicant

- Rich proved experience in DM
- Experience and suitable equipment for initial powder material characterization
- Proven experience in R&D and industrial collaboration
- Equipment to demonstrate the DM technology
- Ability to work and design with CAD
- Knowledge of High Strength Aluminium alloys chemical and mechanical properties
- Ability to perform corrosion tests according to ASTM's requirements
- Ability to perform mechanical test as requested and according to ASTM's requirements
- Familiarity with aviation regulations and requirements

3. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Methodological presentation and test plan - Document	1. Description of the selected solution for High Strength Al alloy powder 2. Description of DM technology for Aluminium Alloys 3. Accurate description of the tests to be performed, expected results and major milestones	To+2
D2	Base results - Technical analysis - Technical reports	Selected powder properties (density, size distribution, mechanical and chemical) Mechanical on as manufactured material (optimum chemistry and technology parameters(laser power, scan speed , schedule, layer thickness, protective atmosphere) : - 9 static samples (3 each direction L , T ,45 deg) - Perform hardness testing for optimization heat treatment parameters after DM on 3 samples - Perform density evaluation on 4 samples of material. Report shall include properties with graphs, pictures, metallographic and SEM/ EDAX examinations and any if anomalies result from the tests	To+6
D3	Demonstrator parts Technical report	-Build process for 2 types of demonstrator parts , two parts of each, build up volume approximately 150X150X150 mm - Re-design according to weight saving and aesthetic requirements - Actual and theoretical comparison (3D scan) - Surface roughness measurements - Quality methodology development	To+11
D4.1	Corrosion testing – Technical report	Tests specimens for comparative evaluation and perform corrosion test according to ASTM report that shall include surface properties with pictures, SEM and metallographic examination.	To+15
D4.2	Mechanical testing – Technical report	Perform static tests on integrally and separately as built specimens after heat optimized treatment Perform dynamic tests (S-N) and microscopic examination on as built, smooth machined (K_t=1) and notched specimens (K_t=2.3) (all after optimized heat treatment) S-N curves shall be provided for each lot (as built, machined and notched specimens) and for each direction (longitudinal, transverse and 45 deg) **6 samples for the static test,** **63 samples per the S-N dynamic test (1 sample per load, 7 loads minimum required)** **1 sample from the static test and 1 sample from each load of the dynamic test shall be examined by SEM, total 8 specimens per lot.**	To+16
D5	Environmental analysis – Technical report	Estimate the influence of the DM process from all environmental aspects including: energy consumption, pollution of gases, process waste, and cost analysis.	To+16
D6	Demonstrator - Final technical report - Reference part	Apply the DM on a reference part and gather all data in a technical report (mechanical properties, chemical properties, environmental aspects and economic analysis for the process)	To+18

4. Topic value (€)

The total value of this work shall not exceed:

€ 120.000

[one hundred fifty thousand euro]

Please note that VAT is not applicable in the frame of the CleanSky program.

5. Remarks

The aim is to bring the process to a TRL 6 stage.
IPR shall be dealt with applicable documents to partners under FP7 as per Grant Agreement for Partners and Implementation Agreement (ftp://ftp.cordis.europa.eu/).

Clean Sky Joint Undertaking
SP1-JTI-CS-2012-02-ECO-01-057

Topic Description

CfP topic number	Title		
JTI-CS-2012-2-ECO-01-057	**Advanced Composite Integrated Skin Panel structural testing**	End date	*To + 15 Months*
		Start date	*To*

1. Topic Description

Background

Traditional aircraft structures use Aluminium stiffened panels for fuselage, wing and tail plane skins. In recent years, as composite materials become more prevalent in modern aircraft structures, stiffened skin panels are manufactured from composite materials instead of Aluminium. The use of composite materials has the potential to reduce aircraft weight, and therefore fuel consumption, and also to reduce maintenance and operational costs. Stiffened panels can be made by attaching stiffeners to a thin panel or by producing integrally stiffened panels, reducing costly assembly operations as well as composite machining operations which are costly and polluting. The structural behaviour of integrally stiffened panels is normally better than that of panels with attached stiffeners, but the difference is difficult to quantify by analysis and is dependent on the manufacturing technology. Structural component tests are designed to evaluate the structural behaviour of panels and to calibrate and validate the structural analysis tools used in their design.

The current manufacturing technology used in most structural composites involves the use of pre-impregnated fabrics or tapes which are laid-up on tools, vacuum bagged and then put in an autoclave for a cure cycle involving elevated pressure and temperature. This manufacturing process uses a lot of energy, and is also expensive. A composite stiffened panel is developed as part of the JTI "Eco Design" technology demonstrator A2 – Stiffened panel component demonstrator for wing application by thermoset LCM. This innovative integrally stiffened panel is manufactured from a dry NCF (Non Crimp Fabric) pre-form of Carbon fiber plies, which is bonded by a one-shot injection process to high stiffness, pre-cured prepreg T-section stiffeners. LCM - Liquid Composite Moulding technology, in this case a process of Liquid Resin Infusion (LRI), has many ecological benefits as well as labour-cost benefits. Key benefits are:

- Less exposure of workers to hazardous materials
- Reduction in waste quantity and toxicity
- Reduction in energy consumption by use of an oven instead of an autoclave
- Cheaper raw materials with no shelf life limitations
- Ability to serially produce large and integrated structures

Coupon tests were performed which validated the material mechanical properties of the LRI process used.

Three panels will be tested: two LRI panels representing two wing skin panel configurations, and a third panel manufactured by a one-shot LRI process complete with advanced dry pre-form integral stringers. This third panel will be obtained from the "Development of advanced pre-forms for LCM technologies" call for partners, which is in progress.

Due to the innovative production process of the panels, there is some uncertainty as to the structural behaviour of the panels, and especially their critical mode of failure. Therefore the structural tests of the panels shall address these uncertainties as part of the development effort. Current tools used to determine stresses in test articles during a structural test are limited to specific pre-defined points or have limited resolution. To capture the initiation of damage in the panels during the test, a novel measurement procedure needs to be developed.

Objectives

A large scale test of a structural component is needed to confirm the structural performance of the ecological panel. An advanced measurement procedure will be developed to understand the structural behaviour of the panels and their failure modes. Acquired test data will also be used to compare the different panel behaviours.

The tests will validate the structural analysis methods used in the design of the panels, and also the applicability of the manufacturing process to the panels structural application, therefore providing a higher confidence level and advance the TRL (Technology Readiness Level) of the innovative manufacturing technology to TRL 6.

Test requirements

Three composite stiffened panels, representing a wing root skin, will be supplied to the partner for testing and validation. Approximate Maximum Panel size: 1300mm x 600mm. The panels will be tested by the partner in axial tension and compression:

The compression load required is at least 200 Ton (200,000 Kg).

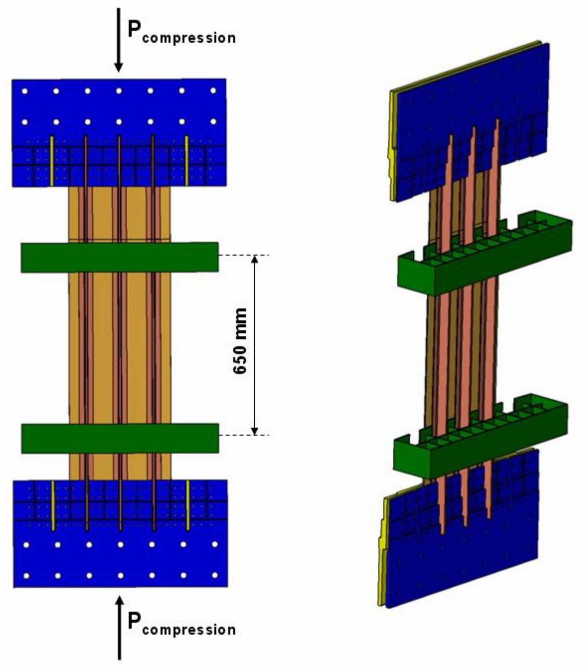
The tension load required is at least 150 Ton (150,000 Kg).

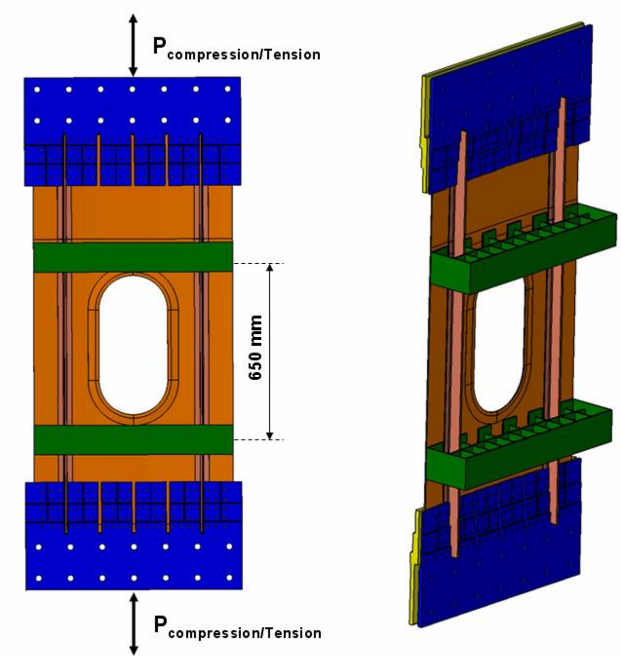
The first panel, with 3 stringers, will be tested for maximum compression capability.

The second panel, with 2 stringers and a simulated man-hole, will be tested in moderate compression and then for maximum tension capability.

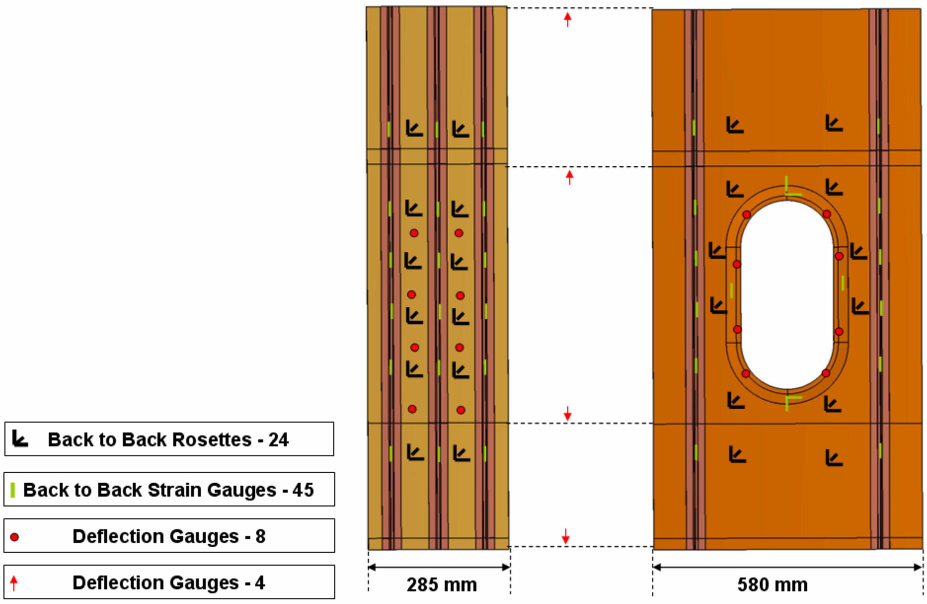
The third panel, which will be similar to the first panel, will also be tested for maximum compression capability.

The panels need to be stabilized at two stations along their length, approximately 650mm apart, as seen in the following figures. This is necessary in order to confine out-of-plane buckling to a specific area. The exact interface and design of the stabilizing elements will be defined with the partner.





Each test article will be instrumented with at least 24 tri-axial rosettes, 45 strain gauges and 12 deflection gauges, as illustrated in the following figures. This instrumentation will be used to backup and calibrate the advanced strain measurement system.



During the test, plots of edge displacement vs. load and strains vs. load for all rosettes and strain gauges shall be presented on screen. All the data shall be recorded and included in the test report. The tests shall be also filmed by video. An advanced method of measuring the displacements of the entire panel outer surface during the test shall be proposed by the partner, as well as a method of measuring the displacements of the stringers and the stress at the stringer bond lines. The developed evaluation method can involve the adaptation of methods, like Photogrammetry (ARAMIS) or fiber optic sensors (FBG) or any other suitable method.

The work will be divided into three phases:

In the first phase the exact interface between the partners' test fixture and the supplied panels shall be established, as well as the required measurements that need to be recorded and shown during the test. This phase shall be summarized in a detailed test procedure document.

The second phase shall be dedicated to development of the advanced measurement procedures, as well as preparation of the test specimens and the test facility according to the test procedure document.

The third phase shall include the actual tests and the preparation of a detailed test report, including all the test data.

2. Special skills, certification or equipment expected from the applicant

The applicant shall have the capability of applying the test loads.

The applicant shall have the capability to develop and apply novel measurement procedures.

The applicant shall have the capability to perform measurements of strain and deflection during the test.

The applicant shall have the capability to design and manufacture the test fixture connecting the test specimen to the loading and stabilizing elements.

3. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Test procedure document	Including the detailed test sequence and time table	T_0 + 2 Months
D2	Engineering drawing of test assembly, first definition of novel measurement procedure	Interface drawings, optional technologies for the advanced measurement procedure	T_0 + 4 Months
D3	Final test installation design, final definition of advanced measurement procedure	Test fixture detail and assembly drawings. advanced measurement procedure technology and layout.	T_0 + 10 Months
D4	Test readiness-preparation of test specimens and test facility	Report detailing the preparations made for the tests. Finalized test sequence and time table	T_0 + 12 Months
D5	Raw test data	Video & SG Readings	T_0 + 13 Months
D6	Final test report	Detailed report with all data collected.	T_0 + 15 Months

4. Topic value (€)

The total value of this work shall not exceed:

€ 100.000

[one hundred thousand euro]

Please note that VAT is not applicable in the frame of the CleanSky program.

Topic Description

CfP topic number	Title		
JTI-CS-2012-2-ECO-02-014	**Characterization of batteries in expanded range of operation**	End date	*To+18 Months*
		Start date	*To*

1. Topic Description

Green aircraft technology gains in efficiency over conventional technology using electrical power as a replacement for hydraulic and pneumatic power. When it is implemented with usual aircraft electrical components, the large weight of green aircraft systems offsets any saving offered by their higher efficiency on business jets and other types of small aircraft.

The part of green aircraft system in which the largest weight increase is observed is the electrical generation system. *Weight savings in this area could be a key to the economic viability of more ecologic aircraft systems.*

This topic aims to optimize the use of batteries in the electrical power generation and distribution system, in order to minimize the weight and heat dissipation of the total system. The partner will be supplied with aircraft batteries at the start of the project, and will be required to study innovative uses, and to provide models validated over the whole range of operation of these batteries. In addition, the partner will study and provide a method and a device for monitoring the state of health and the state of charge of all the Lithium batteries included in the project.

Three batteries designed for operation on 28V DC and/or 270V DC aircraft electrical networks will be characterized.

1. State of the Art

Aircraft currently use rechargeable batteries relying on lead-acid (LA) or nickel-cadmium (NiCd) chemistries. Recent models (F35) now employ Lithium-ion (Li) technology. Batteries fulfil two functions: to provide the energy needed to start the engines (when they are small enough) or the APU (when direct start of the engines requires too much power for the batteries), and to provide power for ancillary systems used when the aircraft is parked (manoeuvring doors, powering lights, essential avionics used during mission preparation, etc.).

In addition, batteries bring "non-breaking power transfer" capability to electrical power distribution networks they are connected to. This means that during transients, when power sources are reconfigured, the battery supplies power to the network for a short time, until a permanent source is reconnected. This is also known as a "buffer function".

As a consequence, batteries are not used as power sources in normal flight. They are used only on the ground, or when a failure in flight causes a reconfiguration of the power sources. Even in that case, batteries are only used as a transient source of power (on older airplanes with low emergency electrical power budgets, batteries were used as the ultimate source of electrical power).

Most current large aircraft employ 28V batteries which are kept fully charged. The distribution networks carries power regulated at 28V or slightly above, and batteries are recharged at constant voltage.

Lithium-ion batteries are normally disconnected from the network when they are fully charged, but the electronic switch can reconnect them fast enough for the buffer function to exist anyway. The higher voltage of Li cells usually renders a charger necessary, since the battery cannot get fully charged at the voltage of the DC network.

On current aircraft, the goal of the charging function is to store the largest amount of energy possible in the batteries, in order to minimize their size and weight.

Over-charging a battery generates losses and heat. Because Lithium batteries can have dangerous thermal runaway characteristics, at battery level and at cell level (when cells are connected in series), they are normally equipped with load-balancing electronics which ensure an equal voltage across each cell during the charge.

3. Limits of Current Technology

The following limitations are clearly understood:

Battery state of charge is the integral of charge current, reduced by internal current leaks, which are usually low. Nominal cell voltage can be measured at zero current.

While charging, the voltage difference between the charging voltage and the cell voltage correspond to power dissipated in heat by the battery. In addition, each type of chemistry has a maximum voltage which can be applied to each cell, which can be a function of the state of charge. Above this voltage, the cell is permanently damaged.

While supplying power, the voltage difference between the cell voltage and the power supply voltage corresponds to power dissipated in heat by the battery. The energetic efficiency of a battery is best when it is always operated at low power, and all voltages remain close to the nominal cell voltage.

Battery cells can be optimised for capacity (high energy), or for power (high power). Electric vehicle applications are usually high capacity systems, in which peak power is a fraction of the energy storage. Aircraft batteries are usually high power systems, and the cells are optimised for efficiency under high charge and discharge currents. When they are operated at the same power, same capacity high power cells are more efficient than high capacity cells.

At zero current, the nominal cell voltage which can be measured is a result of the state of charge and the state of health of the battery alone. For some cell chemistries, including lead-acid batteries this parameter is a good indicator of the state of charge.

When batteries age their internal resistance tends to increase. This parameter can be estimated if the current is measured and the nominal cell voltage is known. A battery with a degrading state of health has a reduced capacity. Internal resistance contributes to this reduction since batteries can only be discharged until the cell voltage reaches a predefined threshold, which depends on the type of cell. With a given discharge power profile, this threshold will be reached sooner when the internal resistance is elevated. In addition, the efficiency of the battery is degraded, and its heat losses increase.

In addition, cell charge balancing circuits allow a full charge of each cell in a serially connected stack, but it is classically associated with a conventional discharge mode which does not recover residual charge down to minimum voltage in each cell. The added charge only provides a minor advantage since it slightly increases the final stack voltage.

4. Requirements

The batteries supplied to the partner in the frame of this study will be simple battery stacks. Balancing electronics may be supplied with the Lithium battery, but the partner shall assume that they will not. The objective is to operate the battery systems on a large electrical test bench situated in the Paris, France area, where they will be connected to variable voltage DC electrical networks conforming to standard MIL-STD-704F, at 28V DC and 270V DC.

4.1 Activities

Having proposed a development plan in its application, the selected applicant shall perform the following activities:

- Provide an acceptance test plan (ATP) detailing the demonstrations of performance achievable using the applicant’s test means, and those only demonstrable on the EDS electrical test rig.

- A preliminary design review organised in presence of the EDS electrical test rig operator, and the topic manager representatives.

At this milestone, the interfaces between all the components and the performance requirements of each component will be frozen.

- Study of ancillaries in connexion with supporting test rig ancillaries, such as water or air for cooling, and external venting if needed,

- Detailed design of the proposed system, including detailed design of the battery sensor subsystems, detailed design of the battery safety devices, detailed design of the software and control laws, in the context of an evaluation at TRL 4-5 on the Eco Design for Systems electrical test rig.

- Creation of models of the system intended for use by aircraft integrators, as described below.

- Tests on technology samples required to complete the detailed design, if any, including the manufacturing of samples and test setups. The topic manager will not provide any technical data to the applicant other than the documents listed in paragraph 6, below.

- A critical design review organised in presence of the topic manager representatives. At this milestone, the detailed design of all components will be frozen, and a decision made to manufacture the components.

- Manufacturing of a minimum of 3 complete systems, one being for the rig, the second as a spare, and the third kept for support by the applicant. In addition, spare parts shall be manufactured in sufficient quantity to support the tests performed in the Clean Sky EDS project until 2015. Applicants should indicate how any issues, which might arise between the end of the topic contract and completion of the tests in 2015, can be managed.

- Define a minimum set of qualification testing ensuring safe operation on the EDS electrical test rig,

- Limited acceptance will be pronounced after performance tests performed on the applicant premises in presence of the EDS electrical test rig operator and of the representatives of the topic manager, during the First Article Inspection (FAI). Acceptance will be pronounced when the system fulfils all the requirements of the acceptance test plan. A limited number of tests may be performed on the EDS electrical test rig in presence of the applicant. All the critical validation steps must be performed before delivery to the EDS electrical test rig, including the demonstration of all the critical performance points.

- Delivery and installation of equipment on the EDS electrical test rig (Paris area, France).

Modelling activities beyond those supporting the optimized design of equipment, shall include the development and validation of a scalable (or several scalable) architecture models of the whole system, the development and validation of a scalable functional model of each component, and the development and validation of a behavioural model of each component. The architecture and functional models are required to be balanced in terms of energy: the difference between the power entering and leaving the system must correspond to stored energy, and stored energy must be eventually released. The functional and behavioural models shall be representative of probable failure conditions (probability of occurrence greater than 10^{-5}/fh) and shall be matched to each other. A behavioural model shall include an accurate model of the power electronics control laws. The functional model is an averaged model which will include all the power management functions required by this topic, including a model of high level dialogue with avionics, but which will correctly demonstrate transients which occur in normal, overload and failure cases, and will correctly model the errors of the current-voltage regulation, both transient and steady state. The shape of transients will be matched to the behavioural model for validation. The architectural model shall also include all the power management functions, the variable voltage behaviour but will typical use an idealized current-voltage characteristic. Architectural and functional models will have parameters which can vary over a realistic range to replicate the variability of externally observable characteristics (voltage, thresholds, timings, …) in a batch of production equipment (this capability is needed to model parallel operation of real, slightly different systems). The acceptance test plan can be a base to select the correct characteristics and their allowable variability. Failures will be triggered by inputs in all models.

Because testing at system level on the EDS electrical test rig involves a large number of components and suppliers, the applicant will be required to agree to support its own equipment for the duration of the EDS tests and repair it with diligence in case of failure at no additional cost, whatever the cause of failure is, even if the failure is caused by mishandling or failure of another equipment. Repair means returning the equipment to its originally approved definition.

Support also includes remediation of any demonstrated deficiency that would make the system unsuitable for the intended uses. The delivered system will be validated after 100 hours of failure-free operation on the EDS test rig, of which at least 50 hours should be in the final configuration of the delivered system. After validation, the partner is only committed to performing repairs. Any limitation to this support and repair policy shall be clearly explained in the proposal. The equipment of the applicant will only be handled by qualified professionals of the Eco Design consortium. Daily maintenance (normal care which would be performed by the crew or the lineman on an aircraft, and would not require an aircraft mechanic certificate) will normally by performed by the EDS test rig operator. The expected number of hours of operation of the rig should not require further normal maintenance.

4.2 System Components

The applicant shall deliver:

- A 28V DC battery system including:

A battery supplier by the EDS project

A battery monitoring system, which may be configured using hardware resources from the rig control system, or may have its own dedicated hardware

A battery safety subsystem ensuring disconnection from the network in case of dangerous conditions, casing protecting from external short circuits, and cooling capable of dealing with any failure case that is not extremely improbable

- Another 28V DC battery system, including the same functions as the first one, possibly sharing hardware resources with the first one, and integrating a battery supplied by the EDS project having a different chemistry

- Another 28V DC or 270V DC battery system including the same functions as the first one.

- The wiring between all the components of the system.

- the local control monitoring system, which could for instance measure temperatures at important points of the batteries, and interfaces the system to the rig control and monitoring subsystem. This component may be implemented using shared hardware resources of the rig control system.

- The tubing for fluid cooling of battery systems, until the connection to rig ancillary circuits,

- Any heat exchanger or other piece of ancillary equipment required to interface the system to the rig.

- Scalable architectural, scalable functional and behavioral models of the system.

- All the special tools needed to perform daily maintenance, if any.

4.3 Performance

The components added by the partner shall not reduce the performance of the batteries supplied by the EDS project.

The project shall develop innovative functions expanding the use of batteries in the field of

- Transient energy recovery (storage of short, high powered pulses),

- Network voltage regulation, active network filtering,

- Direct connection of stack to variable voltage networks for charge and recharge,

- Load sharing with alternators and other electrical sources.

<u>Electrical protections:</u>

- Before maximum delays of 0,5s the system shall de-energize itself in case of short-circuit (internal or external) so that further damage to the system is avoided.

- The battery system shall detect the failure conditions leading to an over-voltage and shall disconnect the battery from the network.

- The battery system shall be protected against dangerous established over current conditions, but this protection should not be triggered by transient inrush currents.

<u>Health monitoring:</u>

● The function must be capable of indicating the state of health of a battery which has been taken out of long term storage.

● In service, the function shall reliably indicate the state of charge and state of health of a battery, whose charge level is being regulated around a defined level (e.g. 70% of charge).

6. Input

The following documents will be available for the selected partner at T0.

● EDS electrical test rig technical description

● Any Modelica interface library made by the EDS project, if compliance with that library is required.

● Equipment configuration management and marking rules..

2. Special skills, certification or equipment expected from the applicant

The applicant shall have knowledge of the following standards:

● MIL-STD-704F Aircraft electrical power characteristics (as a guide line)
● MIL-HDBK-217F Reliability prediction for electronic component
● DO160F Environmental conditions and test procedures for airborne equipment
● DO178B Software considerations in airborne systems and equipment certification
● DO254 Design assurance guidance for airborne electronic hardware

In addition the applicant shall have appropriate capability to make multi-physics models in the Modelica language in order to evaluate and compare solutions globally) and a power electronic design (electronic simulation using SABER, thermal simulation, capability to develop averaged models in Modelica).

3. Major deliverables and schedule

Deliverable	Title	Description	Due date
D1	PDR	Preliminary Design Review	T0 + 3 months
D2	CDR	Critical Design Review	T0 + 4 months
D3	Manufacturing	Delivery of the complete system	T0 + 8 months
D4	Commissioning	Commissioning of the complete system	T0 + 10 months
D5	Documentation	Documentation	T0 + 10 months

4. Topic value (€)

The total value of biddings for this work package shall not exceed

€ 200.000,--

[Two hundred thousand euros]

Please note that VAT is not applicable in the frame of the *CleanSky* program.

Clean Sky – Green Regional Aircraft

Identification	ITD - AREA - TOPIC	topics	VALUE	MAX FUND
JTI-CS-GRA	**Clean Sky - Green Regional Aircraft**	**2**	**2,840,000**	**2,130,000**
JTI-CS-GRA-01	*Area-01 - Low weight configurations*		**240,000**	
JTI-CS-2012-2-GRA-01-050	Development of CNT doped reinforced aircraft composite parts		240,000	
JTI-CS-GRA-05	*Area-05 - New configurations*		**2,600,000**	
JTI-CS-2012-2-GRA-05-007	Development & optimization of advanced propulsion system installation through innovative complete A/C powered WT model		2,600,000	

Topic Description

CfP topic number	Title		
JTI-CS-2012-1-GRA-01-050	**Development of CNT doped reinforced aircraft composite parts and associated tooling, using the Liquid Resin Infusion method.**	**End date**	*T_0 + 16*
		Start date	*T_0*

1. Topic Description

1.1 – Scope of work

The Contractor shall define all the necessary steps to complete the manufacture of a large composite part with Carbon Nano Tube (CNT) doped resin and using the Liquid Resin Infusion (LRI) method. The contractor undertakes responsibility to the design and manufacture, the final tool necessary for the manufacturing of the part and also to define all the necessary tool accessories / materials needed during manufacturing.

The LRI method is defined as the process where a dry reinforcement is impregnated by resin with the aid of vacuum and the associated part is cured under vacuum in an oven (out of autoclave process).

The part under investigation should be typically a doubly curved panel with integrated stiffeners (typically "Ω" cross section) which could be either foam filled or as reinforced by CNTs. The typical dimensions of the part should be approximately 2x2 m, curvature Rxx.

The final part geometry (CAD models), which will be defined by the Topic manager, should be representative of a section of an aircraft composite bulkhead.

The part materials should be typically of structural aircraft parts: carbon reinforcement fabrics and epoxy resins

1.2 – Reference documents

Project: NOESIS (European Project) "Integration of carbon nanotubes (CNTs) on composite structures for the improvement of mechanical properties and development of sensing capabilities"

1.3 – Introduction

1.3.1 - Background

The incorporation of Carbon Nanotubes (CNTs) into a polymer matrix along with long fiber 1.

Reinforcements for producing hybrid composites have recently attracted significant attention. Due to its comparatively low manufacturing costs, the Liquid Resin Infusion process (LRI) is ideal for impregnating reinforcement fabrics with CNTs resin mixture. Several important parameters, such as the CNTs content, mixing procedure, duration, type of epoxy and CNTs functionalization, are critical for the LRI processes and have to be evaluated.

The most crucial point in the development of a CNT doped nanocomposite parts with enhanced mechanical properties is the solid dispersion of the nanoparticles in the matrix. While sonication is an effective method to disperse CNTs in a resin, the duration, intensity, and temperature of sonication need to be controlled in order to prevent damages imposed on CNTs and premature resin curing.

Moreover, creating interconnections between the carbon nanotubes surface and the polymer chain will lead to materials with improved strength and stability. These interconnections arise from the functional groups attached on the CNTs outer surface that can be used to form covalent bonds between the polymer and the nanotubes. Therefore, CNTs functionalization should be studied in detail in order to improve the quality of the produced part.

The mechanical properties of the output will be evaluated in order to decide the part configuation. If the CNTs could produce a stiffened panel according to the analysis specs then will be used as is otherwise a sandwich concept with foam core will be used for the design of the bulkhead part.

Furthermore the filtration effect that occurs during the LRI process must be investiagted in detail, so that resin impregnation of the fabrics is homogenous.

1.3.2 – Interfaces to ITD

The work is integrated within the WP 1.5.2 & 1.6.2 activities since one of its main objectives is the design and fabrication of two composite bulkheads for the ground demonstrator.

1.4 - Activity Description
The final composite part configuration will be provided by Topic Manager (CAD models / layup configuration will be provided).
The contractor is responsible for the following tasks:
T1. Definition of the manufacturing methodology to optimise the CNT dispersion in epoxy resins. Standard mechanical testing of coupons with CNT doped resin for characterization of properties of the CNT doped resin.
T2. Definition of the manufacturing methodology to produce an aircraft quality composite part by using the LRI method and the CNT doped resin. Standard mechanical testing of coupons with carbon reinforcement and CNT doped resin for characterization of properties of the final CNT doped composite.
T3. The definition of the tooling configuration for the production of the final composite part.
T4. Manufacturing of the final complete tool structure including all necessary integration accessories / secondary tools for the manufacturing of the stiffening elements, backing structure and tool face.
T5. Quality control on the final manufactured tool. This should include all critical measurements on the tool and associated accessories.
T6. Manufactrung of the final composite part by LRI method.
T7. Non Destructive Testing (NDI) US C-Scan of the final produced part.
T8. Quality control on the final manufactured part by critical measurements on the produced part.

2. Special skills, certification or equipment expected from the applicant

Expertise in tooling design and manufacturing (multi-part tooling) for aerospace quality composite parts. Expertise in the manufacturing of composite parts by LRI (out of autoclave process). Expertise in the manufacturing of CNT doped composite parts. Experience in NDI US C-Scan.

3. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Optimization of CNT dispersion in epoxy matrix	Report with Definition of methodology for CNTs dispersion. CNTs functionalization. Report with Definition of test matrix for Coupon level manufacturing and testing. Coupons testing and results conclusion Report	T0 + 3
D2	LRI of carbon composite fabrics with CNT doped epoxy resin	Definition of methodology for impregnation of dry fabrics with CNT doped resins. Equipment set up Definition of test matrix for Coupon level manufacturing and testing. Coupons testing and results conclusion	T0 + 6
D3	LRI tooling configuration (Design of final complete tool structure)	Final tool design configuration and necessary accessories for LRI of carbon dry fabrics with CNT doped resin	T0 + 9
D4	Manufacturing of final complete tool structure (including all necessary	Tool structure manufacturing. Tool delivery	T0 + 11
D5	Quality control documents of the final manufactured tool structure	Full documentation, with cad models of tool parts	T0 + 12
D6	Manufacturing of the final composite part (bulkhead section)	Final part manufacturing by LRI. Final part delivery	T0 + 14
D7	Non Destructive Testing	NDI of the final produced part	T0 + 15

D8	Quality control documents of the final part	Full documentation on tests performed on final part delivered	T0 + 16

4. Topic value (€)

Budget: The Maximum Allowed Topic Budget is

240.000,00 €

two hundred forty thousand Euro]

The maximum funding value is between 50% and 75% of the Maximum Allowed Topic Budget indicated above according to the CfP rules.
Please note that VAT is not applicable in the frame of the Clean Sky programme.

5. Remarks

During the period allocated for the CfP, additional information / requirements shall be provided by identifying materials, architecture, loads, in a joint preliminary phase to the contractor.

The contractor shall therefore adjust accordingly and embody the given information / requirements, prior to delivery of final product.

Clean Sky Joint Undertaking
SP1-JTI-CS-2012-02-GRA-05-007

Topic Description

CfP topic number	Title		
JTI-CS-2012-1-GRA-05-007	**Experimental development and optimization of an Advanced propulsion system installation on regional A/C through Innovative Complete Aircraft Powered Wind Tunnel Model.**	**End date**	$T_0 + 24$
		Start date	T_0

1. Topic Description

Short description :
An advanced rear-fuselage engine regional aircraft configuration integrating a Natural Laminar Flow (NLF) wing design should be experimentally developed through low-speed WT tests on a complete powered model. Within this test campaign tail planes sizing and position and power-plant integration should be optimized and the effect of wing tip shapes on the A/C aerodynamic performance should be evaluated as well.
In this context, main activities being the subject of the concerned topic are as follows:
- Design and manufacturing of a complete aircraft powered model, representative of a rear-fuselage Geared Turbo Fan 130-seat regional A/C configuration, equipped with high-lift devices, control movable surfaces, winglets (and other tip extensions), nose and main landing gears.
- Aerodynamic WT tests at subsonic speed and high Reynolds number (close to in-flight values), in order to validate the overall aircraft architecture and the rear-fuselage power plant integration, to optimize the tail planes configuration, to assess in a representative environment the aircraft high-lift performances in take-off and landing conditions.

1.1 Introduction
1.1.1 Background
Within the “New Configuration” (NC) domain of the Green Regional Aircraft ITD advanced technologies tailored to future regional airliners, developed in other domains of the same ITD and in other ITDs of the Clean Sky JTI, are integrated by taking into account several A/C configurations and different power plant architectures. The final aim is to contribute to drastically reduce the environmental impact of regional air transport over next decades, according to the strategic road map stated in the “Vision 2020” by ACARE.
In particular, technology innovation toward paramount concepts for a next-generation Green Regional rear-fuselage engine A/C configuration is considered, such as:
i) Advanced high aspect ratio Natural Laminar Flow wing to reduce fuel consumption and pollution at cruising flight condition;
ii) Innovative high lift system to reduce noise while preserving high lift performance.

1.1.2 Interfaces to ITD
The activity subject of the present Call for Proposals is concerning with the experimental validation in wind tunnel of low-speed aerodynamic performances of an advanced future regional A/C, integrating a NLF wing design and innovative power plant, as developed in the frame of the GRA ITD. To this aim a complete A/C WT model will be designed, manufactured and tested in a suitable experimental facility.
The input/output geometrical model data exchange will be handled through standard formats (IGES, CATIA, NASTRAN). The wind tunnel tests output data will be handled through technical reports and standard format on DVD.

1.2 Scope of work
Topics and expected outcomes of the activity inherent to the present CfP are dealing with:
i) Design & Manufacturing of a complete aircraft powered model, representative of the full-size configuration of a rear-fuselage GTF 130-seat regional A/C, equipped with high-lift devices, control movable surfaces, winglets / tip-extension, nose and main landing gears.
ii) Aerodynamic WT tests on the above aircraft model at low-speed (up to Mach ≈ 0.3) and Reynolds numbers close to those expected in-flight (Re ≈ 13 million) with the aims of: a) experimentally optimise power plant integration, engine location, empennages sizing & position and wing tip concepts; b) validate at take-off and landing condition the whole A/C configuration in terms of NLF wing high-lift design, rear-fuselage engine installation and tail-planes architecture.

1.3 Type of work
Mechanical design and structural (FEM) modelling of the aircraft WT model, aero-elasticity analyses, wind tunnel testing and experimental data acquisition.

1.4 Abbreviations & Definitions
A/C Aircraft
ACARE Advisory Council for Aerospace Research in Europe
CAD Computer Aided Design
CDR Critical Design Review
CFD Computational Fluid Dynamics
CfP Call for Proposals
CSM Computational Structural Mechanics
CT Thrust Coefficient
D&M Design & Manufacturing
FEM Finite Element Model
GRA Green Regional Aircraft
GTF Geared Turbo Fan
HW Hardware
ITD Integrated Technology Demonstrator
JTI Joint Technology Initiative
Mach Mach number
NLF Natural Laminar Flow
PDR Preliminary Design Review
PSP Pressure Sensitive Paint
Re Reynolds number
WT Wind Tunnel
WTT Wind Tunnel Tests
3D Three-Dimensional

1.5 Description of Work
According to the objectives described in par. 1.2, the concerned activity will develop through several work packages as described hereinafter.

1.5.1 WP 1 – WT Model Mechanical Design & Manufacturing

Task 1.1 - Mechanical Design of WT Model
Inputs:
i) Full-scale GTF aircraft configuration geometry
ii) Nacelle geometry
iii) Wind Tunnel model requirements
iv) Technical specification for WT testing
The first phase of the required work will be dealing with the mechanical design of the A/C modular wind tunnel model. Based on the choice of the wind tunnel (which is up to the Applicant), the model scale will be defined by considering the opposite needs of reaching adequate test conditions in terms of Reynolds number on one side, and of keeping the engine simulator power requirements within reasonable limits on the other side. A sketch of the aircraft model is shown in figure 1.

Figure 1 – Sketch of possible aircraft configuration

The model will be modular to cope with the following configurations:
a) Baseline Fuselage + engines + Wing
b) Baseline Fuselage + engines + Wing with tip extensions

c) Baseline Fuselage + engines + Wing with winglets
The tail plane has to be installed at least in three different positions in order to allow the optimisation of its configuration. Aileron deflections, leading and trailing edge High-Lift Devices deflections, Horizontal Tail setting, Elevator and Rudder deflections and Airbrake/Spoilers deflections have to be considered.
All aerodynamic control movables, both primary and secondary surfaces, are required to be set in discrete deflected positions. Use of brackets to connect movable control surfaces to relevant fixed parts can be used as a reference solution. Use of remote powered actuation can be anyway taken into account when such a solution brings advantages in terms of time/cost reduction.
The model will have to be designed and built in such a way to minimize deformations, during testing within the specified speed and incidence ranges, which will have to not exceed following values:
i) 1% (one per cent) of model span measured at wing tip at maximum loading;
ii) 1% (one per cent) of fuselage bow measured at nose and tail cone at maximum normal/bending loading.

Compliance with the above requirements shall be provided by the model designer by means of a specific technical report.

The following tolerances, intended as difference between the achieved (measured) value and the nominal one, shall be used:
1) Tolerance (Δz) over model external surface: 0.10 mm
2) Tolerance (Δz) over model overall vertical dimension: 2.00 mm
3) Tolerance (Δy) over model overall side dimensions: 2.00 mm
4) Tolerance (Δy) over model overall lateral asymmetry: 1.00 mm
5) Tolerance (Δy) over model overall longitudinal asymmetry: 1.00 mm
6) Tolerance (Δx) over model overall length: 3.00 mm
7) Tolerance ($\Delta°$) over movable surfaces deflection: 0.5 deg
8) Tolerance (Δx, Δy, Δz) over relative fixed to movable parts position: 0.5 mm

Outputs:
a) Aircraft WT model design report and CAD Files – **Deliverable D1.1.1**
b) Aircraft WT stress analysis report – **Deliverable D1.1.2**

Task 1.2 - Model Propulsion System
Inputs:
i) Nacelle geometry
ii) Engine requirements
The model during the tests will be powered by two Engine Simulators, one on each fuselage side. The Model Propulsion System shall enable to cope with following requirements:
a) To fit inside the engine nacelle external shape, as resulting from input CATIA surfaces;
b) To match Thrust Coefficient (CT) based on each engine simulator apparent thrust according to input data.

The capability to set and keep thrust developed by each of the Engine Simulators within 5% of the target value is required. The capability to set the thrust reversing devices at their open position is an additional desired, but not mandatory, option.
All the physical parameters related to the thrust provided by each Engine Simulator shall be gathered and recorded.
Nacelle has to be equipped with sensors, kulite type, for acoustic measurements (1). The layout of the sensors will be provided in the wind tunnel model requirements report.

Outputs:
a) Engine simulator design and instrumentation **– Deliverable D1.2.1**

Note
(1) Acoustic measurements are not part of the concerned WT tests but they will be performed during a subsequent test campaign in the frame of the GRA ITD program (see WP 3).

Task 1.3 WT model Instrumentation
Inputs:
i) Wind Tunnel Model Requirements
The model will be equipped with steady and unsteady pressure transducers. In particular, where PSP be not used to accomplish pressure plotting, at least 150 pressure taps will be located on the model.

Probes exact locations will be specified in the technical specification provided by the GRA ITD Member. Several, say 20 (twenty) kulites will be located on the nacelle in order to allow acquisition of pressure fluctuations for the acoustic measurements [see Note (1) above].

The Applicant shall propose a suitable way to integrate the probes (psi, Kulites) in order to realize nonintrusive experimental measurements of the flow field around the A/C model.
At least two accelerometers measuring wing tip accelerations will be installed for test security reasons in order to prevent possible occurrence of dynamic aero-elastic instability phenomena. These transducers shall be connected to an emergency test shut down system to cut off divergence development.

Outputs:
a) Aircraft WT model Instrumentation report - **Deliverable D1.3.1**

Task 1.4 WT model Manufacturing
Inputs:
i) CATIA files from task 1.1
ii) CATIA files from task 1.2
The Applicant should manufacture a complete wind tunnel aircraft model. In particular, the following parts have to be manufactured
a) Fuselage
b) Movable T-Tail plane equipped with Horizontal Tail, Elevator and Rudder
b) wings equipped with leading and trailing edge high-lift system, Ailerons, Airbrake/spoilers
c) wing tips
d) two sets of winglets
e) two engines simulators equipped with reverse thrust system

Outputs:
a) Aircraft WT model (HW) - **Deliverable D1.4.1**
b) Aircraft WT model manufacturing description - **Deliverable D1.4.2;**

1.5.2 WP 2 – Wind tunnel Test Activity
Task 2.1 – Static and dynamic ground vibration tests
Input:
i) Wing WT model (HW), Wing WT model aero-elasticity analyses (from WP1)
Prior to WT testing the wing model will be submitted to the following tests:
1) Static vibration tests in order to check the static deformation. The results will be checked by comparison with CFD analyses.
2) Dynamic vibration tests to measure the natural frequencies of the model.

Outputs:
a) Wing WT model static vibration tests report **– Deliverable D2.1.1**
b) Wing WT model dynamic vibration tests report - **Deliverable D2.1.2**

Task 2.2 –Wind Tunnel Test Campaign
Inputs:
i) Aircraft WT model (HW) from WP1
The wind tunnel test campaign will be performed at low-speed regime (Mach range ≈ 0.1 - 0.3) and Reynolds numbers close to those expected in-flight (Re ≈ 13 million) at take-off / first-climbing / descent / landing phases, in order to validate in a representative environment at high-lift conditions the aerodynamic characteristics of a GTF rear engine Green Regional Aircraft configuration.

The concerned tests will be split into following phases:
Phase #1
The first phase of testing will concern the optimization of the aircraft configuration in terms of stability and control by checking the best tail plane position, the tail plane sizing, the best configuration of the wing equipped with tips or winglets, etc.:
- Optimization of the Horizontal Tail plane position
- Power plant integration
- Wing with extended tips
- Wing with winglets

Following measurements are envisaged:
- Steady and unsteady pressure measurements;
- Aerodynamic forces balance measurements to gather lift, drag and pitching moment;
- Aerodynamic loads distributions (preference is given to advanced pressure plotting techniques such as PSP);
- Stability and control measurements.

At the end of this phase, a final optimized aircraft configuration will be available and it will be the subject, in the second testing phase, of a detailed experimental investigation.

Phase #2
The final optimized aircraft model will be tested in order to assess:
a) leading edge and trailing edge devices performances in high lift conditions;
b) ailerons, elevator, rudder and airbrake/spoilers performances;
c) engine and engine thrust reverser device performances;
d) aircraft stability and control.

Following measurements are envisaged:
- Steady and unsteady pressure measurements;
- Aerodynamic forces balance measurements to gather lift, drag, pitching moment and roll (bending) moment;
- Aerodynamic loads distributions (preference is given to advanced pressure plotting techniques such as PSP);
- Stability and control measurements.

Outputs:
a) WT tests plan – **Deliverable D2.2.1**
b) WT tests report – **Deliverable D2.2.2**

1.5.3 WP3 - Wind Tunnel Model Modifications
Inputs:
i) A/C WT model from WP2
ii) CAD drawings of other wind tunnel

The wind tunnel model, after the present wind tunnel test campaign will come back to the workshop in order to be modified for a next experimental test campaign to be performed in another wind tunnel in the frame of the GRA ITD program. It is expected that previous connection of the WT model to the test section will have to be changed to comply with the model mounting system of the other wind tunnel.
The compatibility of the A/C model mechanical design to the requirements of the other wind tunnel, as specified in the relevant user manual, has to be checked and guaranteed.

Outputs:
a) Description of the manufacturing of Aircraft WT model modification **- Deliverable D3.1.1**
b) Wind tunnel A/C modified model (HW) - **Deliverable D3.1.2**

1.6 Requirements
Sensitive information may be released at a later stage to the successful Applicant.

1.7 Milestones
M1 (T0 + 4 months): WT Model Preliminary Design Review
M2 (T0 + 6 months): WT Model Design
M3 (T0 + 16 months): WT Model manufacturing Acceptance
M4 (T0 + 18 months): Static and dynamic grounded vibration tests
M5 (T0 + 18 months) Wind Tunnel Test Plan
M6 (T0 + 21 months) Wind Tunnel Tests Results
M7 (T0 + 24 months) Modified WT Model manufacturing Acceptance

Review meetings to monitor on the work progress will be scheduled likely two weeks before the expected achievement of respective milestones above. On such occasions, recovery actions will be decided, in case of delayed activities, trying to stay in the overall initial planning.

2. Special skills, certification or equipment expected from the applicant

- Use of advanced computational tools for 3D aerodynamic (CFD) and aero-elastic/structural analyses (CFD/CSM coupling) is regarded as a paramount requirement to correctly address the physical phenomena involved.
- Large experience in designing and manufacturing of wind tunnel models for aeronautical applications
- Expertise in CATIA V5 software
- Large experience in WT tests on complete A/C model configurations. The characteristics (flow quality measurements techniques and data acquisition system) of the wind tunnel have to ensure highlyaccurate measure of aerodynamic forces and moments at testing conditions (Mach, Reynolds) as above specified.

As it concerns the WT model D&M (WP 1), the availability of an advanced software environment able to trace all technical requirements, their relevant solutions, possible mismatches between requirements and solutions is seen as a key factor of innovation applicable to the project organisation and management, in order to minisime risks and reduce costs. In this context, an extensive use of virtual mock-ups and virtual testing techniques is sought as an essential element.

3. Major deliverables and schedule

Deliverable Title Description (if applicable) Due date
D1.1.1 Aircraft WT model design report and CAD Files CAD and FEM models T0 + 6 months
D1.1.2 Aircraft WT stress analysis report REPORT T0 + 9 months
D1.2.1 Engine simulator design and instrumentation REPORT T0 + 9 months
D1.3.1 Aircraft WT model Instrumentation report REPORT T0 + 4 months
D1.4.1 Aircraft WT model delivery HW T0 + 15 months
D1.4.2 Aircraft WT model manufacturing description REPORT Model Acceptance T0 + 16 months
D2.1.1 Wing WT model static vibration tests report REPORT T0 + 17 months
D2.1.2 Wing WT model dynamic vibration tests report REPORT T0 + 18 months
D2.2.1 WT tests plan REPORT T0 + 18 months
D2.2.2 WT testing TEST REPORT T0 + 20 months
D3.1.1 Description of the manufacturing of Aircraft WT model modification REPORT Model Acceptance T0 + 23 months
D3.1.2 Wind tunnel model delivery HW T0 + 24 months

4. Topic value (€)

Budget: The Maximum Allowed Topic Budget is

2.600.000,00 €

[two million six hundred thousand Euro]

The maximum funding value is between 50% and 75% of the Maximum Allowed Topic Budget indicated above according to the CfP rules.
Please note that VAT is not applicable in the frame of the Clean Sky programme.

5. Remarks

The experimental validation of the architecture of a new Green Regional Aircraft in landing and take-off conditions and of the integrated technologies through a powered Wind Tunnel aircraft model with rear engines, and the possibility to successively use the same model for further dedicated experimental tests, is thought as a very innovative and challenging task. This, indeed, is considered as an essential requirement for the assessment of the concerned technologies in a WT environment representative of the low speed in-flight conditions, so as to achieve a step in the TRL. The overall phase related to the WT experimental activity will be monitored (under control of the GRA Member) according to a standard procedure. In particular, following steps / milestones are envisaged relatively to the WT model D&M process:
i) PDR to assess that requirements have been correctly addressed and relevant technical solutions identified;
ii) CDR (held at the end of the Design Development phase) to assess that the WT model design meets all technical requirements;
iii) Acceptance Review to assess that the "as built" model is such that all requirements are fulfilled and all acceptance tests are performed without still open issues.
A similar approach will apply to monitor the preparation of the WT facility (possible adaptations, experimental set-up) for the tests purpose
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Clean Sky – Green Rotorcraft

Identification	ITD - AREA - TOPIC	topics	VALUE	MAX FUND
JTI-CS-GRC	**Clean Sky - Green Rotorcraft**	**5**	**4,590,000**	**3,442,500**
JTI-CS-GRC-01	*Area-01 - Innovative Rotor Blades*		**710,000**	
JTI-CS-2012-2-GRC-01-010	Low weight, high energy efficient tooloing for rotor blade manufacturing		710,000	
JTI-CS-GRC-02	*Area-02 - Reduced Drag of rotorcraft*		**800,000**	
JTI-CS-2012-2-GRC-02-007	Wind tunnel tests on a common helicopter platform and contribution to its optimised aerodynamic design		800,000	
JTI-CS-GRC-03	*Area-03 - Integration of innovative electrical systems*		**1,000,000**	
JTI-CS-2012-2-GRC-03-014	Design and Implementation of a Load Simulator Rig and Ground Test Bench Adaptation Kit for a HEMAS Test Rig		1,000,000	
JTI-CS-GRC-04	*Area-04 - Installation of diesel engines on light helicopters*		**0**	
JTI-CS-GRC-05	*Area-05 - Environmentally friendly flight paths*		**2,080,000**	
JTI-CS-2012-2-GRC-05-006	Sensoring and cockpit monitoring to reduce noise in meneuvering flight		1,500,000	
JTI-CS-2012-2-GRC-05-007	Curved SBAS guided helicopter approaches for low noise landing - Safety & ATM compatibility		580,000	
JTI-CS-GRC-06	*Area-06 - Eco Design for Rotorcraft*		**0**	

Topic Description

CfP topic number	Title		
JTI-CS-2012-2-GRC-01-010	**Low weight, high energy efficient tooling for rotor blade manufacturing**	**End date**	T0+18M
		Start date	T0

1. Topic Description

1. Background:

Today the manufacturing of rotor blades with composite materials uses metallic moulds with self heated technology or external heating by heat presses or ovens are used. The weight of these moulds which are ~5,0 metres long (for rotor blades for light helicopters) is likely above 5t in mass, thus cranes are needed to handle these moulds in production. To heat up the this heavy metallic body of the mould from room temperature to a curing temperature of above 130°C is therefore highly energy consuming. Industrial manufacturing requires short turnaround times so that after curing of the blade, the mould needs to be cooled down quite quickly and defined which requires energy again. In the ITD an innovative new rotor blade is being designed and will be manufactured. For the manufacturing new moulds are necessary.

Advanced impregnation (e.g. liquid composite moulding, LCM) technologies enable the fast loading of the curing tool by using a pre-assembled preform. The manufacturing of these preforms, however, is a mandatory step and requires light, but also heatable, preform toolings.

2. Scope of work:

The idea is to develop, design and manufacture preform- and curing moulds for composite rotor blade manufacturing which is much lighter and easier to heat up and cool down as we do today with standard moulds – this leads to shorter cycle time and less energy consumption.Moreover the aspects of prototype processes (e.g. tolerance of the surfaces) should be considered. The curing mould shall be applicable to be used with special impregnation technologies (e.g. LCM) as well as with different resin systems.

The new set of moulds has to fulfil the following basic specification: heat range up to 135°C curing or activation temperature of the rotor blade. Homogenous heat transfer and distribution all over the rotor blade geometry. Stiffness of the mould in all directions should be comparable to actual metallic aluminium moulds in use. Closed cavity (vacuum and pressure compatibility) for resin impregnation manufturing process (up to 3 bar). The preform tools shall be light, one sided, fast heatable and compatbile with preforming technqiues.

Manufacturing process details (e.g. position of injection line, preform technology…) will be defined in GRC 1.3.5 after the freeze of the blade design. Manufacturing process simulation tools shall give confidence with respect to heat cycles and energy consumption as well as flow behaviours.Investigation and evaluation of different heating technologies to homogenously heat and cool the toolings

Design and Manufacturing of the moulds with respect to green aspects (low waste, health compatible materials, low energy consomption in serial production, low energy for production of the raw material and of the toolings itself, recyclability).

Within this CfP the specified requirements shall be proven and a "gate-to-gate" LCA for preforming and curing shall be done. Loading with preform and closing of the tool following specific requirements shall be demonstrated. Overall heat and energy management of the process shall be proposed (e.g. concept for heat recovery through heat exchange device).

2. Special skills, certification or equipment expected from the applicant

As we intend to take a new approach regarding tooling design and manufacturing we are open to any proposal. A specific certification for aerospace and airworthiness items is not required from the possible applicants.

Manufacturing process simulation to be applied: Heat flow and energy consumption, injection simulation is a wish. “Gate-to-gate” LCA comparison shall be done.

3. Major deliverables and schedule

Deliverable	Title	Short Description (if applicable)	Due date (month)
D01	Tool and tool loading concept (Preform and Curing Tools).		T_0 +3 month
D02	Heat simulation of heating and cooling cycle (Preform and Curing Tools).		T_0 + 5 month
D03	Macro impregnation simulation (Curing Tool).		T_0 + 6 month
D04	Design Freeze Tool incl. drawings (Preform and Curing Tools).		T_0 + 10 month
D05	LCA assessment “gate-to-gate” definition (Preform and Curing Tools).		T_0 + 12 month
D06	Preform Tools manufactured and inspected		T_0 + 13 month
D07	Curing Tool manufactured and inspected		T_0 + 15 month
D08	Specification validation		T_0 + 18 month
D09	LCA report		T_0 + 18 month
D10	Final Documentation		T_0 + 18 month

4. Topic value (€)

The total anticipated eligible cost of the proposal including manpower, travel costs, consumables, equipment, other direct costs, indirect costs, and subcontracting shall not exceed:

€ 710,000 (VAT not applicable)

Seven hundred ten thousand euro

5. Remarks

- All core RTD activities have to be performed by the organisation(s) submitting the proposal. If some subcontracting is included in the proposal, it can only concern external support services for assistance with minor tasks that do not represent per se *project* tasks. The proposal must:

- indicate the tasks to be subcontracted;
- duly justify the recourse to each subcontract;
- provide an estimation of the costs for each subcontract. *(concerning subcontracting, see provisions of the Grant Agreement Annex II.7)*

- The expected maximum length of the technical proposal is 20 pages.

CfP topic number	Title		
JTI-CS-2012-02-GRC-02-007	**Wind tunnel tests on a common helicopter platform and contribution to its optimised aerodynamic design**	**End date**	T_0 + 30 months
		Start date	T_0 = Jan. 2013

1. Topic Description

1.1- Background:

The sub-project GRC2 "Drag reduction of airframe and non-lifting rotating systems" of the Green Rotorcraft ITD (GRC) aims among others at improving the aerodynamic characteristics of helicopter fuselages and rotor-heads. This implies a reduction of the drag, however possibly with a minor penalty on the down-force usually characterising fuselages in cruise flight. Several helicopter classes (light, medium and heavy) are considered within the GRC2 sub-project, in order to cover as wide as possible a range among the future fleet. For each helicopter class, numerical analysis of a baseline and of several improved configurations is carried out by means of Computational Fluid Dynamics (CFD). Expected benefits of identified solutions are then to be assessed through wind tunnel tests.

In this Call-for-Proposal (CfP), the successful applicant (the partner) shall support the GRC Consortium in the benefit assessment process for a helicopter of the heavy-weight class. In view of drag reduction and through the use of CFD, the GRC Consortium performs shape optimization of several elements of the common helicopter fuselage: *e.g.* aft body, rotor head cap, blade roots, remote controllable horizontal stabilizer. The partner shall assess in wind-tunnel the optimised fuselage retained versus the original one and quantify the drag reduction. The work comprises design and manufacturing of some model components (additionally to the ones already available), wind-tunnel test preparation and execution, and results post-processing. An optional CFD activity is suggested to support the analysis of experimental measurements.

1.2- Scope of work:

General Objective

The main objective of the present topic is, through wind tunnel measurements on a common helicopter platform, to assess potential benefits of passive shape optimisation activities on drag reduction, which are currently carried out by the GRC Consortium. The final goal is to minimise the drag of the fuselage, the rotor head and the empennage and check the effects on other helicopter characteristics.

To this end, the partner shall provide detailed wind-tunnel measurement data about two helicopter configurations termed as *original* and *optimised*. The original one is already available to the GRC Consortium whereas the optimised one shall be designed and manufactured by the partner. Both will comprise the cabin, the empennage and a rotor-head in rotating mode.

The main focus of the measurements is on the aerodynamics of the rotor-head and of the ramp area as well as the interaction of their respective wake with rear control surfaces (fin and remote controllable horizontal stabilizer). This makes two different model mounts necessary: one ensuring rotor-head measurements (*e.g.* strut mounting on the model floor), and one ensuring measurements on the backdoor (*e.g.* upside down strut mounting on the model top). (The architecture of the original model does not allow a mount from the empennage.) Hence both configurations are to be measured using both mounts.

The CfP activity is subdivided into two tasks along with an additional optional one:

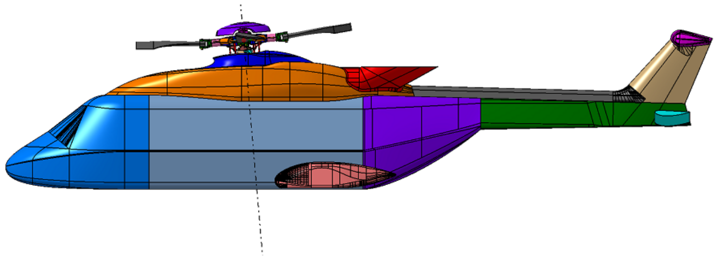
- **Task 1**: Preparation of the original and optimised models
- **Task 2**: Wind-tunnel tests on the original and optimised configurations
- **Task 3**: CFD analysis (optional)

Task 1: Preparation of the Original and Optimised Models

Hardware

Task 1 is dedicated to the preparation of both models of the original and optimised configurations. The original model is already available to the GRC Consortium coming from the FP7 European project GOAHEAD and is shown in the figure below. It has an overall length of 4.097m and a front area of $0.55m^2$ and will be provided to the partner as **Input02**. An existing rotor-head at the same model scale will also be provided as **Input03**. The hardware as well as CATIA files (**Input01 & Input04**) are included in the inputs.

To complete the original model and the optimised one, new elements need be manufactured. A list of existing parts and parts to be manufactured is given below. This list is to be seen as exhaustive and represents the upper bound on the number of components to be manufactured. Depending on the results of the optimization tasks performed by the GRC Consortium, some of the elements might be discarded.



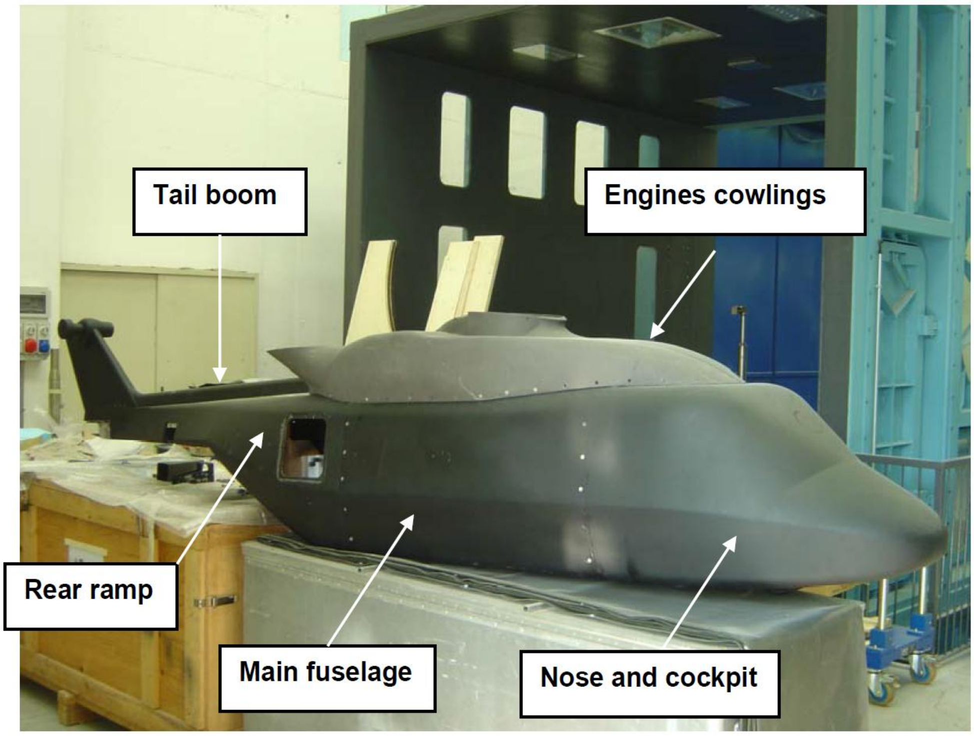
GRC common helicopter platform derived from the GOAHEAD wind-tunnel model

Available parts of the original model

- Original fuselage (see details in reference [1])
- Rotor-head with adjustable collective and cyclic pitch (no remote control required, prescribed angles only)

Status of the original model:

Pictures of the existing available components of the original model are presented below. In general, the available fuselage shapes are in good conditions. Minor repair actions and repainting are to be considered. In particular some existing instrumentations (hot films, thermocouple) that won't be used in the current experiment should be removed. The pictures below show also that air intakes and exhausts are currently open and should be closed. The second detailed picture shows also a different cowling and mast fairing that could also be used by the selected partner.



General view of the existing original configuration model

Detailed view of the existing original configuration model

Parts to be manufactured by the partner

Original configuration:

● internal structure to connect the fuselage and the rotor-head to the mount system (must allow support from lower and upper side of the model)

● system to set the collective and cyclic pitch angles of the rotating rotor-head to pre-defined values (existing rotor head is fully articulated but drive system is not available, detailed on the interface will be provided to the selected partners to develop a system allowing collective and cyclic pitch angles to be set)

● sponsons

● blade stubs and blade attachments

● hub cap

Optimised configuration:

● sponsons

● blade stubs and blade attachments

● hub cap

● mast fairing

● ramp area

● horizontal stabilizer

● passive control device for the hub cap

Note:

Through early interaction with the GRC Consortium, the partner shall make sure that the internal structure defined for the original configuration is appropriate for the optimised configuration too.

Instrumentation

Global loads on the model (all six components) are to be measured (internal or external balance). Surface pressures are to be measured on some of the model components. Simple pressure taps are foreseen for a large coverage of static measurements, whereas a certain number of pressure transducers shall be dedicated to unsteady measurements on critical areas. On the existing parts of the model, pressure taps are already included; they require be cleaning and checking. New pressures taps and unsteady transducers will be included for the new manufactured parts of the optimised configuration. A rough list of expected instrumentation on new manufactured components is given below:

Expected instrumentation on components of the optimised configuration:

● hub cap (static pressure taps: ~10, for non-rotating cases only)

● mast fairing (static pressure taps: ~20)

● ramp area (static pressure taps: ~20)

● horizontal stabilizer (static pressure taps: ~40, 2 sections at 2 spanwise location with 20 pressure taps)

● unsteady pressure transducers (~20 in total) to be fitted on components to be determined. The selected partner is in charge of the provision of the unsteady pressure transducers.

Inputs

● CATIA file of the original fuselage configuration and available information about the existing rotor-head (**Input01**)

● original fuselage model (**Input02**)

● already existing rotor-head (**Input03**)

● CATIA file of the optimised configuration (**Input04**)

Outputs

● CATIA files of all new parts

● Hardware of all new parts: original and optimised configurations

● Report on design and manufacturing of the original configuration (**D01**)

● Report on design and manufacturing of the optimised configuration (**D02**)

Reference

[1] Pahlke K., "The GOAHEAD Project", 33rd European Rotorcraft Forum, Kazan, Russia, September 11th-13th, 2007

Task 2: Wind-Tunnel Tests on the Original and Optimised Configurations

Task 2 deals with the preparation and conduction of wind-tunnel tests on both aforementioned configurations, in each case using both mount systems, for which two wind-tunnel entries are planned.

The same test matrix (**Input05** and **Input06**) shall be applied to both entries in order to ensure a proper drag comparison. Measurement repeatability shall be addressed during both wind-tunnel test entries. The flight conditions will include cruise flight at various angles of attack as well as various side-slip angles for wind speeds at least equal to 40m/s. Overall, the angles of attack and of side-slip are to remain within a range of ±20°; cross-points might also be considered. While testing, the rotor-head will be considered in non-rotating mode as well as in rotating mode for rotational speeds up to 1000 RPM.

For all test points, global loads, surface static and unsteady pressures shall be recorded. Particular care should be taken to the measurement of the drag component in order to be able to capture the expected drag reduction between the original and optimised configurations.

The possibility should also be allowed for a member of the GRC Consortium to perform PIV measurements with his own measurement system and at his own costs.

The measurement accuracy on loads and pressures is to be assessed through repeat measurements with at least a partial model dismount/mount in-between. An accuracy of 1% of the isolated fuselage drag is expected from the balance measurement which approximately corresponds to 0.5 N.

Post-processing of raw data is to include not only usual wind-tunnel corrections – including interference of the mount system – but also tolerance intervals on measured quantities.

Inputs:

● Specifications for the wind-tunnel test on the original configuration (**Input05**)

● Specifications for the wind-tunnel test on the optimised configuration (**Input06**)

Outputs:

● Raw and post-processed measurement data and technical report on the first wind-tunnel entry on the original configuration (**D03**)

● Raw and post-processed measurement data and technical report on the second wind-tunnel entry on the optimised configuration (**D04**)

● Original model and components provided as well as new manufactured hardware to be returned to the GRC consortium (location to be determined in Europe) (**D05**)

Task 3: CFD Analysis (optional)

Task 3 is optional. The GRC Consortium suggests that the partner runs few CFD computations for support of and correlation to the experiment. The shape optimisation activity (GRC Consortium only) is carried out, although at wind-tunnel model scale, however without mount system and in free stream conditions. Therefore CFD computations of the partner could address wind-tunnel and mount effects on the fuselage aerodynamics. It is up to the partner to submit a suggestion for approval by the GRC Consortium.

Inputs:

● CATIA file of the original configuration (**Input01**)

● CATIA file of the optimised configuration (**Input04**)

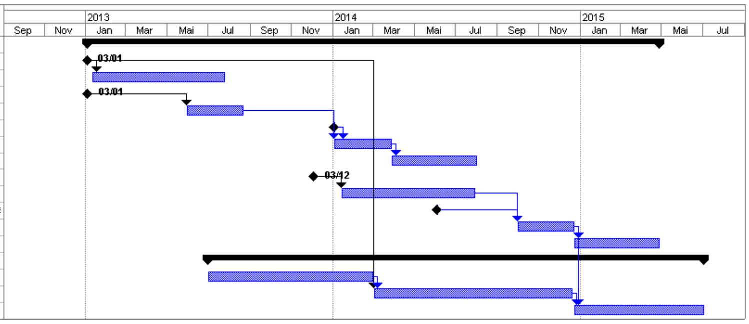
Outputs:

● Synthesis report on CFD activity (**D06**)

General Planning

An example of the expected planning with an assumed starting date T_0 in January 2013 reads as in the table below. However, this is of course only a suggestion and it is to be adapted by the partner to his own processes.

N°		Task Nr.	Task Name
1		**1**	**WT Test of the original geometry**
2		1.1	Input01: CATIA file of the original model delivered to the Partner
3		1.2	Manufacturing of new elements
4		1.3	Input02 & Input03: Existing model delivered to the Partner
5		1.4	Model adjustment
6		1.5	Input05: Specifications for the original configuration wind-tunnel tests
7		1.6	Wind tunnel test of the original configuration
8		1.7	Data analysis
9		1.8	Input04: CATIA file of the optimised model delivered to the Partner
10		1.9	Manufacturing of the optimised components
11		1.10	Input06: Specifications for the optimised configuration wind-tunnel tests
12		1.11	Wind tunnel test of the optimised configuration
13		1.12	Data analysis and synthesis
14		**2**	**CFD computations**
15		2.1	Original configuration
16		2.2	Optimised configuration
17		2.3	Comparison with WT data and synthesis



Evaluation of Proposals

Task 3 is genuinely optional and shall not be used to compensate deficiencies in the experimental part. Task 3 will not be part of the evaluation process. Preference will be put on a comprehensive and high quality experimental programme.

A detailed budget break-down for sub-tasks within Task 1 and Task 2, as well as identification of the critical points as seen by the applicant is recommended.

Contractual Aspects

The partner will be offered the possibility to sign the GRC Consortium Agreement so as to enter the GRC Consortium. Hence, as a GRC member, he will be allowed to attend all technical meetings relevant to his own activity. During meetings, he will be invited to contribute with his know-how to the optimisation activities related to the present common helicopter platform.

2. Special skills, certification or equipment expected from the applicant

The applicant must have qualified and demonstrated skills in wind-tunnel testing. Previous experience in wind-tunnel measurement campaigns on helicopter configurations would be most appreciated. Further requirements and specifications are listed below:

Wind-tunnel equipment and capabilities

Mandatory:

● wind speeds at least 40 m/s

● fuselage angle of attack from -20° to +20° (both mount systems)

● fuselage angle of side-slip from -20° to +20° (both mount systems)
● rotating rotor-hub using suitable driving system (around 1000rpm expected) and monitoring system
Optional:
● usual wind-tunnel corrections with the test-section either open or closed
● provision for optical access and seeding in view of PIV measurements

Measurement capabilities
Mandatory:
● global loads through an internal or external balance, all six components
● surface static pressures (~300 pressure taps in a full configuration to be measured)
● surface unsteady pressures (~20 unsteady pressure transducers in a full configuration to be measured)
Optional:
● loads on the rotor-head through an internal balance, all six components
● measurement of cross-points (α, β)

If the applicant offers CFD work in task 3, the following skills are encouraged.
CFD skills
Mandatory:
● CFD code solving the RANS equations
Optional:
● CFD code solving the URANS equations
● Moving body capabilities for rotating rotor head

3. Major Inputs, Deliverables and Schedule

Deliverable	Title	Short Description (if applicable)	Due date (month)
Input01	CATIA file of the original configuration	CATIA file of the original configuration delivered to the partner	T_0
Input02	Existing fuselage model	Existing fuselage model delivered to the partner	T_0
Input03	Existing rotor-head model	Existing rotor head model delivered to the partner	T_0
Input04	CATIA file of the optimised configuration	CATIA file of the optimised configuration delivered to the partner	T_0 + 11
D01	Design report of original configuration manufacturing	Report describing the model design and manufacturing process of the original configuration parts	T_0 + 12
D02	Design report of optimised configuration manufacturing	Report describing the model design and manufacturing process of the optimised configuration parts	T_0 + 18
Input05	Specifications for the original configuration wind-tunnel tests	A detailed measurement matrix will be specified	T_0+12
D03	Report on the original configuration wind-tunnel tests + raw and post-processed data	All measured data of the wind tunnel campaign on the original configuration	T_0+15
Input06	Specification for the optimised configuration wind-tunnel tests	A detailed measurement matrix will be specified	T_0+20
D04	Report on the optimised configuration wind-tunnel tests+ raw and post-processed data	All measured data of the wind tunnel campaign on the optimised configuration. Comparison to the original configuration.	T_0+27
D05	Original model and components	All new parts manufactured for the	T_0+27

	provided as well as new manufactured hardware to be returned to the GRC consortium	original and optimised configuration will be provided to the GRC consortium? after the wind-tunnel tests	
D06 Optional	Synthesis report on CFD activity	Summary of CFD activity including a comparison with experimental data	T_0+30

4. Topic value (€)

The anticipated total eligible costs of the proposal including manpower, travel costs, consumables, equipment, other direct costs, indirect costs, and subcontracting shall not exceed:

800,000/00 € (VAT not applicable).

(eight hundred thousand euros)

5. Remarks

● All core RTD activities have to be performed by the organisation(s) submitting the proposal. If some subcontracting is included in the proposal, it can only concern external support services for assistance with minor tasks that do not represent per se *project* tasks. The proposal must:

indicate the tasks to be subcontracted;

duly justify the recourse to each subcontract;

provide an estimation of the costs for each subcontract.

(concerning subcontracting, see provisions of the Grant Agreement Annex II.7)

The expected maximum length of the technical proposal is 50 pages.

Topic Description Sheet

Topic Nr. Title	Title		
JTI-CS-2012-02-GRC-03-014	**Design and Implementation of a Load Simulator Rig and Ground Test Bench Adaptation Kit for a HEMAS Test Rig**	End date	20-12-2015
		Start date	16-01-2013

1. Topic Description

Background:

In the frame of the GRC, verification activities will use an electrical test bench. This Electrical Test Bench (ETB) will support the electrical integration demonstration (generation, distribution, and electrical equipments) and the correlation of numerical models via the data measured on this platform.

A complete electrical aircraft network called Electrical Test Bench (also called Copper Bird), composed by different Equipment Under Test, will then be reproduced on ground in dedicated test facilities. These facilities will include all the necessary items to operate the network in a test lab environment.

This topic addresses then one of the EUT (the HEMAS) integration inside the ETB.

Scope of work:

The subject of this call for proposal is the design, manufacturing, acceptance on site & commissioning of a complete Adaptation Kit in order to integrate the HEMAS equipment batch inside a simulated aircraft architecture (ETB).

This HEMAS adaptation kit is composed by the interfaces to communicate the Helicopter Electro-Mechanical Actuator System (HEMAS) and the Electrical Test Bench.

All the parameter values mentioned in this document are preliminary to guide the CfP applicant to size the Adaptation Kit. Definitive values will be given to the selected applicant in a later stage of the project.

The general configuration is given in the following schematics.

For better understanding, the HEMAS adaptation kit is divided in three parts:

A. The functional interfaces of the HEMAS equipment batch to ETB.
B. Local control system and its HMI (Human Machine Interface)
C. Flight Control Computer (FCC) Simulator and Dynamic load simulator for HEMAS.

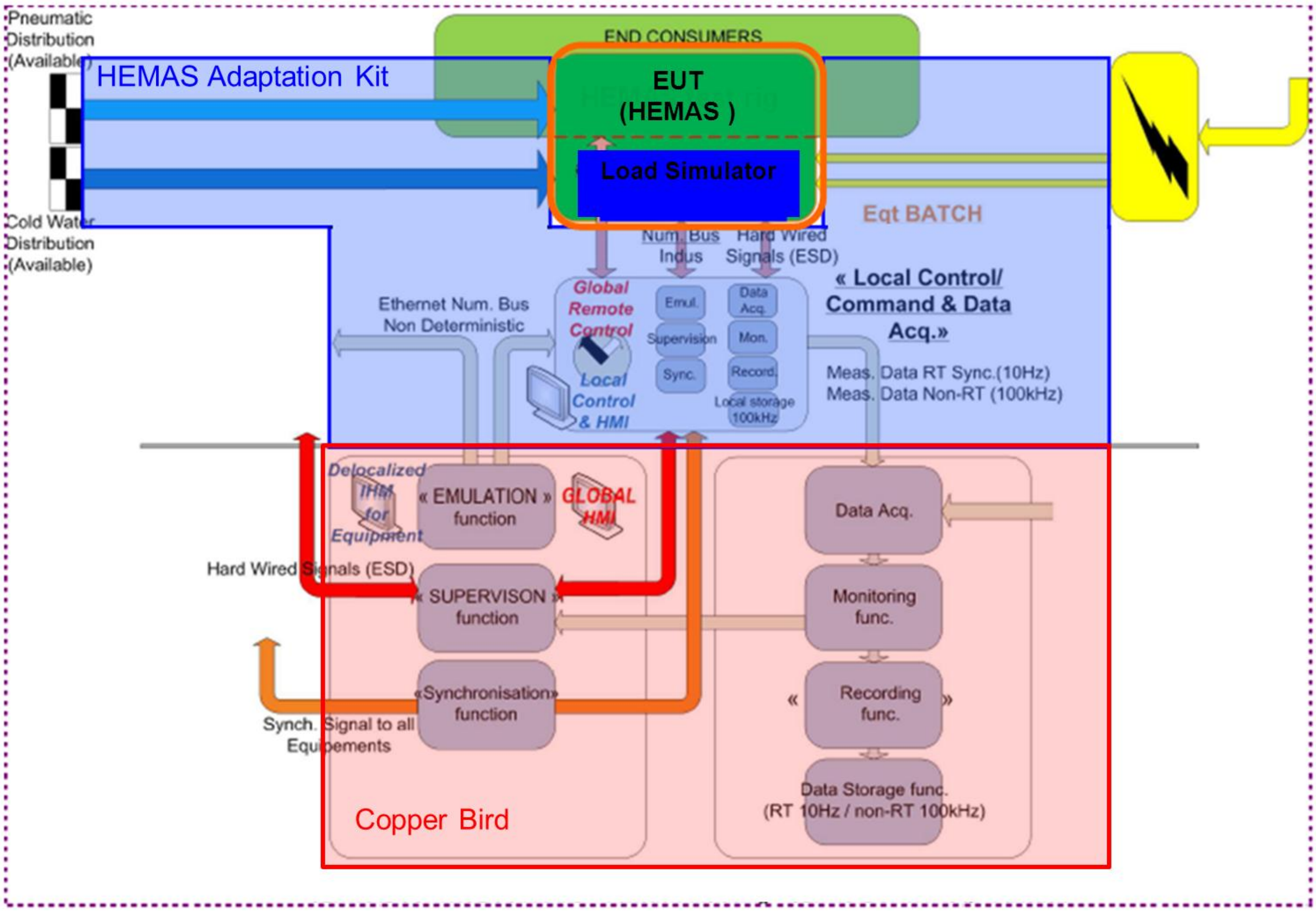


Figure 1: Scope of the HEMAS Adaptation Kit

Load Simulator: Pieces of hardware (as well as associated control system, dedicated sensors and conditioners, ancillaries) used to simulate a given external load phenomenon in order to test equipment in realistic condition (for instance antagonistic or helping aerodynamic equivalent loads for an Electromechanical Actuator).

Equipment Batch: An equipment batch consists of all the pieces of hardware and software delivered with the equipment in order to integrate and test the equipment on the ETB in the Copper Bird® environment (designation given to the facilities dedicated to electrical system testing). An equipment batch includes, but is not limited to, Load Simulator, Control system computers, measurement and data acquisition devices, converters, power and data connections to the Copper Bird®.

A) The picture shown above (Figure 1) describes the functional interfaces between the ETB facilities and the HEMAS equipment batch. These interfaces are those included in the HEMAS adaptation kit:

- The HEMAS equipment batch is represented in an **orange frame** showing the boundary between the actual EUT and the associated necessary component to operate this EUT in a realistic environment (Load Simulator system). Load banks might simulate the power consumption for non-delivered equipment within the frame of the CleanSky program.
- The ETB facilities will consist, for the HEMAS equipment batch, of an area of at least 12 m2 in the Test Hall with connections to:
    - Electrical power.
    - Pneumatics & Cold water. (TBC)

B) The Local Control System (at the center of the picture in *Figure 1*) exchanges data with HEMAS equipment batch and gives the option of controlling the system in a local or central mode (remotely from Global control room). It has the following functions:

- Modes & Controls in local mode / Emulation in remote mode: when in local control mode, the control and command order has to be generated through this local control system. When in remote mode, the equipment bench is controlled from the control room (local controls would remain inhibited).
- Managing the safety aspects of the HEMAS equipment batch.
- Controlling the load simulator. The antagonistic load profiles have to be generated and commissioned on the equipment batch.
- Acquiring data from Load Simulator sensors to monitor its status.
- Synchronizing the local bench clock with the global bench clock.
- Receiving set points and commands from the global bench (the "central" ETB functions have to be reproduced at the "local" equipment level).
- Managing the transmission of the generated synchronized real time measurement data to the Copper Bird data acquisition system.
- Providing the recording/storage of any non Real Time data.
- Providing sensors to measure the voltage and current provided to the HEMAS from the Copper Bird (4 measurement points):
  - Voltage range: 0-400V, bandwidth: 0-100Hz (TBC) + transients at higher frequency relevant for validation of power quality.
  - Current range: ±50A, bandwidth: 0-100Hz (TBC) + transients at higher frequency (power quality, current ripple, EMC)
  - Accuracies, Linearity,… (TBC)

C) Load and FCC Simulator: The Load Simulator, in spite of being part of HEMAS equipment batch as shown in Figure 1, shall be part of HEMAS adaptation kit. The picture shown on Figure 2 describes the general interfaces between the EUT and the FCC and Load simulators. Most of these interfaces are internal of the HEMAS equipment batch and therefore, independent of Copper Bird environment. FCC and Load simulators will consist on the following:

- FCC Simulator: Its software shall send configuration commands (e.g. stimulate a defined degraded system condition) and position demand values to the HEMAS equipment batch and shall read back at least actual position and HEMAS status. The FCC Simulator software shall be included in the Local control system platform. **Yellow blocks** in Figure 2.

- Load Simulator: A rig to be developed in order to simulate the inertial and dynamics loads that the EUT has to be able to support in the most real environment. **Orange blocks** in Figure 2.

  The Load Simulator shall provide sensors for data acquisition to measure following parameters:
  - Force at interface between Load Simulator and actuators (3 measurement point).Range ±50kN, bandwidth 0-100 Hz (TBC).
  - Speed/acceleration at interface between Load Simulator and actuators (3 measurement point).
  - Position at interface between Load Simulator and actuators (3 measurement point).
  - Accuracies, linearity,…(TBC).

  This Load Simulator shall interface with and be controlled from Local Control System. Further the following interfaces may be used as required:

  - Electrical power (connections to panel "P" in Copper Bird).
  - Pneumatics.
  - Cold water (for cooling).

A hydraulic supply infrastructure is not provided. If the Load Simulator is to be operated hydraulically, then an (electrically powered) hydraulic supply system shall be part of the HEMAS Adaptation Kit.

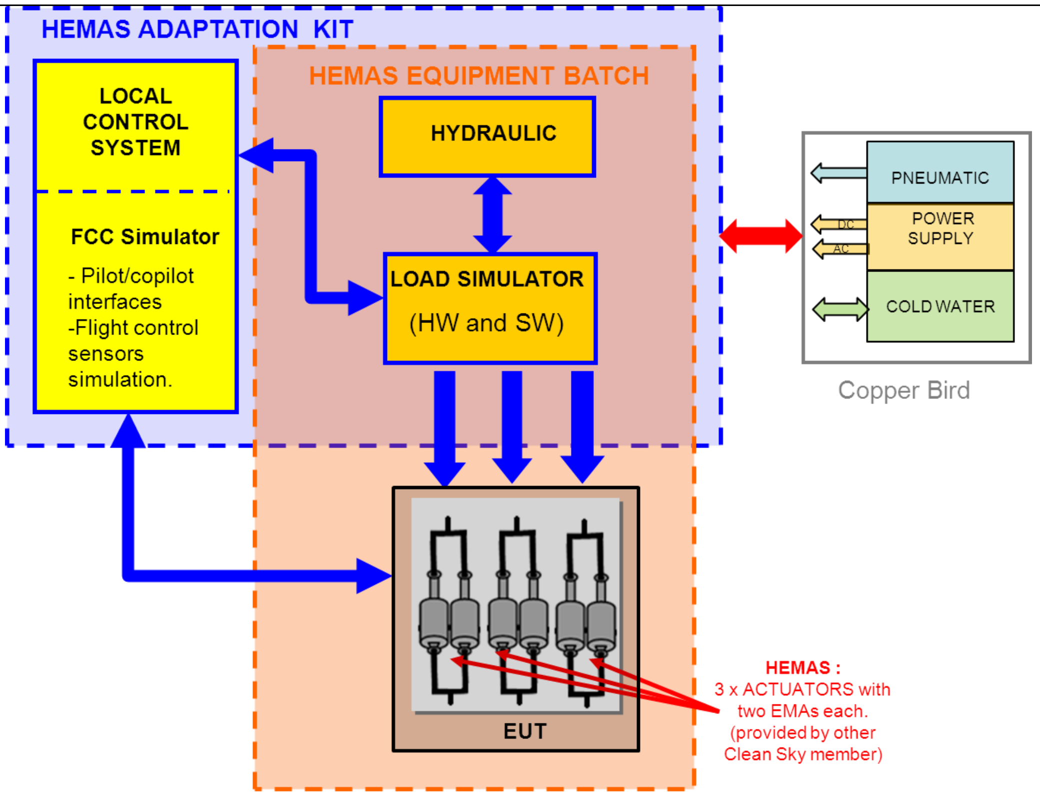


Figure 2: HEMAS equipment batch: HEMAS Load Simulator and HEMAS (EUT)

The Adaptation Kit is focused then on inputs/outputs to and from Copper Bird (**red** interface in Figure 2) and equipment batch (including Local Control System, FCC and Load Simulators, see **blue** interfaces in Figure 2).

The Integration/Adaptation kit of the HEMAS equipment batch inside Copper Bird requested by this CfP is highly conditioned by the Hardware and Software resultant of the Electrical Test Bench control system selected to be used in the Copper Bird, in addition to the final design of the HEMAS equipment batch (dashed orange frame in Figure 2 (the information of these two systems will be given to the applicant of this CfP at a later stage of the design activities). Therefore, detailed interfaces are TBD.

A/ Functional interfaces (wiring):

- Illustration:

The wiring scheme and interfaces scope of work are illustrated on Figure 1.
The dimensions of the working area will be around 4m x 3m .

- The CfP applicant shall provide:

- Documentation:
    - Description document for this complete proposal: performances, margin.
    - Bill of material.
    - Wiring schematics.
    - Assembly drawings.
    - Data sheet for all delivered hardware pieces.

- Installation / mounting / de-installation rules.
- Acceptance test procedures and reports – Certificate of conformity.
- User manual if necessary.

- Hardware
  - Wiring assemblies with all mating connectors (Power supply connections, data exchange connections (On/off orders, status, emergency power cut off, measurements required by ETB…))
  - Cooling water/ pneumatic distribution (if required by HEMAS Adaptation Kit).
  - Supports for harnesses and delivered hardware pieces (if needed).
  - Special Tooling (if required) for wires, equipments or connectors.

- The CfP applicant will not provide:
  - Wires associated to ETB control system.

B/ Local control system

- Interfaces

As stated before, the interfaces included in the local control system are those interconnections between the ETB and the HEMAS equipment batch. These interfaces will be mainly imposed by the control system design [Ref. 3] and the HEMAS (EUT) design. Information about both designs will be given to the selected applicant in a later stage of the project.

- The CfP applicant shall provide:

- Documentation (not limited to):
- Description document for this complete proposal: functions, performances, operations, flexibility & growth capabilities, reliability, and maintainability requirements if necessary. Precise delivery boundaries shall be indicated.
- Bill of material.
- Data sheet for all delivered hardware pieces.
- Sensors Initial calibration sheets.
- User manual.
- Installation / mounting / de-installation rules.
- Acceptance test procedures and reports – Certificate of conformity.

- Hardware material (not limited to):
- Sensors (and associated power supplies if any).
- Associated Conditioners boards and Chassis.
- Data storage pieces of equipment.
- Network wires for the control system.
- Personal computer where the control system software is embedded.

- Software (TBD depending on [Ref: 3] and HEMAS equipment batch final design):
- Executables files for developed Control Software pieces.

- The CfP applicant will not provide:
- ETB control and equipment batch with its internal sensors.

C/ FCC and Load Simulators

- Interfaces

A1) FCC Simulator: Its software shall be included in the Local Control System platform.

A2) Load Simulator: This system simulates the inertial, static and dynamics loads that the HEMAS actuators have to be able to support in the most real environment. Interfaces to electrical power, pneumatics, cold water and hydraulic (if required) system have to be proposed by the CfP applicant.

The Load Simulator will be able to load individually each actuator (composed by two HEMAS).

Load to be generated at actuator level:

- Operation mode of Load Simulator: closed loop force control
- External load per actuator: +/-40kN (dynamic), +/-50kN (static)
- Max. dynamic requirement: static offset 15kN (compression), amplitude 25kN, bandwidth: 0-30Hz, -3db
- Max. overshoot at operation against a hard stop at max speed: 5kN (TBC)
- Output speed of piston: 120mm/s max.

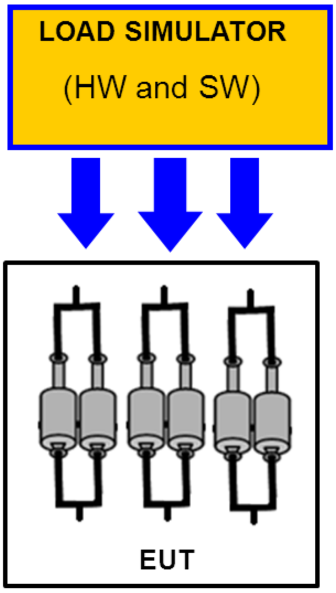


Figure 3: HEMAS Load simulator

Other information related to the interface between Load Simulator and EUT will be given to the selected applicant in a later stage of the project.

- <u>The CfP applicant shall provide:</u>
- Documentation (not limited to):
- Description document for this complete proposal: functions, performances, operations, flexibility & growth capabilities, reliability, and maintainability requirements if necessary. Precise delivery boundaries shall be indicated.
- Bill of material.
- Data sheet for all delivered hardware pieces.
- Sensors Initial calibration sheets.
- User manual.
- Installation / mounting / de-installation rules.
- Acceptance test procedures and reports – Certificate of conformity.

- Hardware material (not limited to):
- Load Simulator test rig
- Sensors (and associated power supplies if required).
- Associated Conditioners boards and Chassis.
- Data storage pieces of equipment.
- Wiring assemblies with all mating connectors (Power supply connections, data exchange connections)
- Cooling water/ pneumatic distribution (if required by Load Simulator).
- Hydraulic system for Load Simulator (if required).

- Supports for harnesses and delivered hardware pieces (if needed).
- Special Tooling (if required) for wires, equipments or connectors.
- Personal computer where the Load Simulator software are embedded

- Software:
  Executables files for developed FCC Simulator Software pieces.
- Control software for Load Simulator.

- The CfP applicant will not provide:
  Software related to HEMAS equipment batch

- Transportation:

The CfP applicant will be responsible to transport the developed HEMAS Adaptation Kit to the site where it will be used and put it in operation (commissioning and initial operation).

The above procedure will take place twice at two different locations (at Central Europe and Hispano Suiza Copper Bird rig).

2. Special Skills, certification or equipment expected from the applicant

a) Design

From a design point of view, the proposal should be detailed including validation and justification of the selected choices/solutions.

It shall be as innovative as possible and represent a “step-further” compared to the current applicant knowhow. References to already existing applications are welcome as illustrations.

b) Intention & motivation

During the design phase, the topic described in the previous paragraph shows area where **iterative** and **proactive cooperative work** is necessary to achieve the correct integration between HEMAS test equipment and control system on the ETB. The applicant shall then motivate its intention to join the program and particularly this topic requiring high involvement.

From the beginning of the installation phase until the initial commissioning was achieved, a support phase will be envisaged, in order to check the correct installation and functionality of the HEMAS equipment batch into the ETB environment. After this phase is completed, an actual testing campaign will be performed. The applicant shall also motivate its commitment in this in-service phase of the HEMAS Adaptation Kit.

c) Skills
Experience in laboratory or industrial test benches design, manufacture and installation is an asset.

d) Certification
Delivered items shall conform to the CE directives.

3. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
	KOM	Kick off Meeting	16-01-2013
D1	PDR	Preliminary Design Review	T0 + 3 month
D2	CDR	Critical Design Review	T0 + 6 month
D3	Manufacturing and delivery	Delivery of the complete systems	T0 + 12 month
D4	Commissioning and acceptance	Acceptance of the complete systems in site 1 (Central Europe)	T0 + 14 month
D5	Commissioning and acceptance	Disassembling, Transporting, Reassembling and Acceptance of the complete systems in site 2 (Copper Bird)	T0 + 26 month
D6	Support	Further to the commissioning on site, the CfP Supplier shall support the rig operations to correct potential faults during the CleanSky Program.	December 2015

4. Topic value (€)

The total value of biddings for this work package shall not exceed:

€ 1.000.000,--

[One million euro]

Please note that VAT is not applicable in the frame of the *CleanSky* program.

5. Applicable documents

The following applicable documents will be distributed to the selected applicant:

[Ref.1]: D3.8.1. "Interfaces definition for HEMAS for FCS"

[Ref.2]: CS JU/ITD GRC/MM,/3.5.2./33011 "Requirement Specification For Electro-Mechanical Flight Control Actuators for a Medium Helicopter"

[Ref. 3]: CB-0021 "Ground Electrical Test Bench/ Equipment Batch-Interface Control Document (ICD)-"

[Ref.4]: JTI-CS-2010-5-ECO-02-007 "Electrical Test Bench Control System" (CfP)

[Ref: 5]: CB-014 "Electrical Test Bench System Description Document"

6. Acronyms

A/C: Aircraft
CfP: Call for Proposal
EMA: Electromechanical Actuator
ETB: Electrical Test Bench / Copper Bird
EUT: Equipment Under Test
FCC. Flight Control Computer
GRC: Green RotorCraft
HEMAS: Helicopter Electromechanical Actuators System
HMI: Human / Machine Interface
IHM: Similar to HMI
ITD: Integrated Technology Demonstrator.
JTI: Joint Technology Initiative
RTD: Research, Technology & Development
TBC: To Be Confirmed
TBD: To Be Defined
VAT: Value Added Tax

7. Remarks

- All core RTD activities have to be performed by the organisation(s) submitting the proposal. If some subcontracting is included in the proposal, it can only concern external support services for assistance with minor tasks that do not represent per se *project* tasks. The proposal must:
    - Indicate the tasks to be subcontracted;
    - Duly justify the recourse to each subcontract;
    - Provide an estimation of the costs for each subcontract.

(concerning subcontracting, see provisions of the Grant Agreement Annex II.7)

Topic Description

CfP topic number	Title		
JTI-CS-2012-02-GRC-05-006	**Development and test of novel rotor measurement systems to estimate manoeuvring noise during rotorcraft approaches and departures**	**End date**	T0 +24 months
		Start date	T0

1. Topic Description

1.1- Background:

In the frame of the CLEANSKY Joint Undertaking, the Green Rotorcraft Integrated Technology Demonstrator is committed to develop and test new flight procedures for both helicopters and tiltrotors, aiming at significantly reduce environmental impact in terms of noise and gas emissions. Rotor external noise strongly depends on the instantaneous value of three vehicle parameters, the knowledge of which allows realistic estimates of rotorcraft acoustic impact: rotor tip-path-plane (TPP) angle of attack (AOA), thrust and airspeed.

Several published numerical studies (see for example Refs. [1], [2]) showed promising results in terms of noise abatement procedures based on steady evaluations of rotor acoustics and estimates of these three quantities, which are rather trivial in a simulated environment. Unfortunately, the usual vehicle attitude and rate of climb measurements provide sufficient information to reconstruct rotor AOA in steady conditions only. Moreover, the actual rotor thrust is hardly known in flight, either in trim or maneuvers, due to both the compexity of the relation between pilot controls and rotor forces and possible external perturbations and noise sources. Maneuvering flight conditions (for example acceleration, deceleration, turn entry) are quite typical of approach and departure procedures, expecially in case of wind or turbulence. So, the run-time, in-flight estimate of helicopter noise calls for novel solutions to measure rotor AOA and thrust.

The proposed activity will focus on the design, development and test of systems able to return run-time information on rotor thrust and AOA on production helicopters. These signals will be the input to a suitable noise prediction algorithm, derived from the software tools developed in GRC5, able to produce instantaneous estimates of vehicle external noise, to be displayed to the pilot enhancing his cues and situational awareness.

References

[1] H.-N. Chen, K.S. Brentner, S. Ananthan, J. G. Leishman, “A Computational Study of Helicopter RotorWakes and Noise Generated During Transient Maneuvers”, American Helicopter Society 61st Annual Forum, Grapevine, TX, June 1 – 3, 2005.

[2] A.L. Duc, P. Spiegel, F. Guntzer, M. Lummer, H. Buchholz, J. Götz, “Simulation of Complete Helicopter Noise in Maneuver Flight using Aeroacoustic Flight Test Database”, American Helicopter Society 64th Annual Forum, Montréal, Canada, April 26th – May 1st , 2008.

1.2- Scope of work:

The activity will be organized in three main tasks: (1) acoustic prediction, (2) innovative measurement system development, and (3) innovative in-flight monitoring.

[Task 1] Aim of this task is to show the limitations of the approach based on static acoustic maps, with and without in-flight rotor state measurements. A secondary outcome will be the assessment of the robustness of low-noise procedures to perturbations or deviations from the intended one.

The selected applicant will provide the expertise and tools to analyze rotor acoustics in maneuvering flight:

Phase I – Based on the technical details agreed with the helicopter manufacturer at the kick-off, he will adapt and upgrade, if necessary, in-house tools and capabilities to receive rotor aerodynamic loads as inputs from GRC5 consortium.

Phase II – He will perform the necessary unsteady acoustic analyses;

Phase III – He will compare the acoustic results to experimental data (comprising vehicle response, rotor flapping and acoustic measurements) as obtained in specific flight test campaigns of GRC5 consortium.

[Task 2] Aim of this task is the development of the innovative rotor measurement system.

Phase I – The applicant will perform a comprehensive review of technologies available on the market to provide safe, reliable and airworthy measurement systems of rotor AOA and thrust, using contact (for example mechanical) or contactless (for example optical or laser) sensors, and will agree with the rotorcraft manufacturer of the GRC5 consortium the requirements of the innovative system to develop. This phase will allow the selection of the most promising approach, followed by the design phase and by a Preliminary Design Review with the rotorcraft manufacturer. The developed system shall be made up of (i) innovative sensor system; (ii) necessary signal conditioning system, able to aquire, filter and compensate sensor signals producing digital outputs to feed rotorcraft on-board system (e.g. AFCS). In case the sensor system is installed on rotating components (e.g. hub or blades), sensors will typically provide analog signals feeding rotor slip ring (or similar apparatus, responsability of the manufacturer), which will in turn transmit the information to the conditioning system installed on non-rotating helicopter components. Although not flight-critical, the design of the innovative measurement system is expected to provide airworthiness, with the perspective of application on production helicopters.

Phase II – After acceptance of the designed system, the applicant will develop and test a full-scale prototype to show compliance with the required levels of accuracy, safety, environmental compatibility and reliability.

Phase III – After formal acceptance by the helicopter manufacturer through a Critical Design Review, the prototype will be tested on the actual helicopter (interface with helicopter on-board systems) to execute on-ground verification tests. This configuration will be employed in the final on-ground demonstration with the in-flight monitoring system (see Point (3) below) fed by helicopter systems, thus validating system functionalities and testing the new pilot MMI.

Phase IV (not mandatory) – Based on the novel measurement system, the applicant is also invited to investigate and develop innovative concepts and algorithms in the fields of control laws, in-flight helicopter monitoring or identification, to show further potential benefits in pilot/vehicle capability to execute precise low-noise procedures with minimal workload. Numerical or laboratory demonstration is considered adequate for this subtask of the project.

[Task 3] Aim of this task is the development of the innovative in-flight monitoring system.

The developed system will be based on an acoustic prediction algorithm (provided by GRC5 consortium), taking as inputs the rotor states (AOA, thrust, advance ratio) and displaying to the pilot suitable information on the produced external noise.

Phase I – The selected applicant will agree with the helicopter manufacturer MMI system requirements in terms of hardware and software interfaces, safety and design standards and environmental conditions, see for istance FAA AC 25-11A. Then, he will study the best indicator to synthesize external noise information enhancing awareness without impacting pilot workload.

Phase II – The applicant will integrate the final software package on a stand-alone hardware prototype (like a tablet pc or similar) and provide it for test in a real-time vehicle simulator provided by the helicopter manufacturer.

Phase III – Final on-ground demonstration (see Task 2, Phase III above) will feature the same hardware prototype connected to helicopter on-board systems for MMI test with pilots.

The applicant will receive suitable inputs by the GRC5 consortium and specifically by the involved vehicle manufacturer, as follows:

- experimental flight and acoustic data, as provided by GRC5 flight test activities, and all the necessary support to analyze them;
- vehicle system detailed design data as required by the activity (to be agreed);
- possible previous background on rotor measurement systems, MMI and applications.

The contribution is expected to last for about 2 years (not mandatory), starting from T0.

2. Special skills, certification or equipment expected from the applicant

To achieve the expected contributions, skills and capabilities are required in the following domains:

(1) unsteady rotor noise prediction;

(2) design, development and test of measurement systems, in particular associated to noise and vibration reduction aerospace applications;

(3) conceivement of simple airborne display systems.

To support these capabilities, the following tools, facilities and process standards are considered mandatory:

(1) advanced unsteady acoustic numerical tool;

(2) experimental lab to perform structural and fatigue tests on the developed measurement system;

(3) proven experience in designing systems compliant with FAR/CS 27/29.

Proven capabilities in the following areas will be considered desireable:

(1) capability to comply with MIL-810 / RTCA DO-160 and RTCA DO-254;

(2) previous participations in national or European research projects or working groups.

3. Major inputs, deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Requirements of the innovative rotor measurement system	Review of current and future monitoring technologies applicable to rotors, with a focus on rotor force and blade angle measurements. System requirement specification.	T_0+4 M
D2	Pilot Acoustic Indicator requirements	Document on possible alternative display solutions and final requirements agreed with GRC5 helicopter manufacturer	T_0+6 M
D3	Measurement system Preliminary Design Document	Result of the Preliminary Design Review, reporting the design and development activity performed	T_0+9 M
D4	Unsteady noise predictions and correlation with flight test data	Report of the preliminary activities on unsteady noise prediction performed, and comparison against GRC5 acoustic data in steady and maneuvering flight	T_0+12 M
D5	Pilot Acoustic Indicator Design Document	Report of the preliminary tests on the design and implemenation of pilot external noise indicator	T_0+15 M
D6	Measurement system Critical Design Document	Result of the Critical Design Review, reporting the experimental test activity performed	T_0+19 M
D7	Impact of maneuvering flight on rotorcraft noise during helicopter approaches and departures	Application of noise prediction tools to analyze the robustness of low-noise trajectories to perturbations	T_0+21 M
D8	Final demonstrations	Report on the demonstrations of the final measurement system and of the developed pilot indicator	T_0+24 M

4. Topic value (€)

The total anticipated eligible cost of the proposal including manpower, travel costs, consumables, equipment, other direct costs, indirect costs, and subcontracting shall not exceed:

EUR 1 500 000.00 (VAT not applicable)

[One million five hundred thousand euro]

5. Remarks

- All core RTD activities have to be performed by the organisation(s) submitting the proposal. If some subcontracting is included in the proposal, it can only concern external support services for assistance with minor tasks that do not represent per se *project* tasks. The proposal must : - indicate the tasks to be subcontracted ; - duly justify the recourse to each subcontract ; - provide an estimation of the costs for each subcontract. (concerning subcontracting, see provisions of the Grant Agreement Annex II.7) - The expected maximum length of the technical proposal is 50 pages.

Clean Sky Joint Undertaking
JTI-CS-2012-02-GRC-05-007

Topic Description

CfP topic number	Title		
JTI-CS-2012-02-GRC-05-007	**Curved SBAS-guided IFR procedures for low noise rotorcraft operations**	End date	Dec-2012
		Start date	Dec-2014

1. Topic Description

The Environment-Friendly Flight Path project (GRC-5) is committed to develop and test new rotorcraft-specific flight procedures aiming to reduce significantly the noise impact in approaches and departures. Among the solutions minimising noise impact, one consists to follow curved approach paths to avoid overfly of noise sensitive areas. For IFR operations, curved segments require the procedure to be developed under the RNP-AR (Required Navigation Performance – Autorisation Required) ICAO specification which relies on GNSS for lateral guidance and barometric sensor for vertical guidance. In a short future, the amendment of ICAO PBN (Performance Based Navigation) will also allow curved segments in the initial, intermediate and missed approach paths of procedures developed under other specifications (RNP1, RNP0.3 and RNP-APCH).

Introduction of full SBAS guidance (lateral and vertical) to follow the curved segments of the procedures listed above would enhance flight path accuracy as neccessary to achieve the most efficient noise minimisation, including for SNI (Simultaneous Non Interfering) operations at airports.

To support the development of low noise / helicopter-specific IFR curved approaches under SBAS guidance, the GRC-5 looks for a Partner, or a Consortium composed of few participants, having expertise in ICAO PBN (Performance Based Navigation) criteria and in the design of RNP & RNP-AR approaches procedures.

In particular, the work of the Partner (or Consortium) will contribute to the achievement of the following work packages of GRC-5,:

- GRC 5.5: Definition of Low Noise IFR Procedures relying on satellite navigation (GNSS)
- GRC 5.6: Final In-Flight Demonstrations & Conclusions

The work will address the definition of IFR procedures for rotorcraft including curved segments and relying on SBAS (EGNOS in Europe) both for lateral and vertical guidance. ICAO PBN and dissiminated information from other projects related to rotorcraft-specific IFR procedures will be used as background material. In particular, the Partner (or Consortium) will exchange information with GARDEN, another CleanSky project which is currently running.

Two main variants will be considered:

- Full RNP-AR curved procedure down to decision altitude/height (DA/DH) under SBAS guidance
- RNP-AR or RNP0.3 curved procedure joining a LPV Final Approach Segment in the very last part of the approach (RNP-AR / RNP0.3 + LPV), both under SBAS guidance

The contribution is expected to last for 2 years, starting from Dec. 2012 and stopping in Dec. 2014.

2. Special skills, certification or equipment expected from the applicant

To achieve successfully the expected contributions, skills and capabilities are required in the following domains:

- Air navigation ICAO regulations (PanOps, PBN manual, RNP, RNP-APCH & RNP-AR specifications), including the most recent criteria and those currently in preparation by ICAO rulemaking groups
- Detailed analysis of ICAO procedure design criteria (understanding rationale of existing criteria and ability to propose new ones)
- Satellite navigation (GNSS), in particular SBAS
- Detailed design, charting and safety analysis of IFR procedures, in particular RNP-AR procedures including curved segments

3. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Existing design criteria and requirements for IFR procedures including curved segments	This document shall review design criteria for curved segments in RNP-AR, RNP0.3, and RNP-APCH navigation specifications, including a comprehensive analysis of the flight path protection surfaces in the horizontal and vertical plane.	T_0+ 4M
D2	Assessment of SBAS guidance benefits for curved segments in RNP-AR and RNPx (*) rotorcraft IFR procedures (*) RNPx: RNP0.3 or RNP-APCH	This document shall identify and assess the benefits brought by the SBAS guidance in curved segments, compared to basic GNSS and Baro VNAV in horizontal and vertical, respectively.	T_0+ 6M
D3	Design criteria for curved segments flown under full SBAS guidance in RNP-AR and RNPx rotorcraft IFR procedures	This document shall propose design criteria for curved segments flown with full (horizontal / vertical) SBAS guidance that could be submitted later to the ICAO IFPP (Instrument Flight Procedure Panel).	T_0+ 12M
D4	Design criteria for curved segments flown under full SBAS guidance in RNP-AR and RNPx rotorcraft IFR procedures with LPV segment in final approach path	Same objectives as D3 but with transition to straight-in LPV segment in the last part of the final approach.	T_0+ 12M
D5	Adaptation of design criteria for curved segments to criteria to Point-in-Space (PINS) RNP-AR and RNPx procedures	Starting from the criteria elaborated previously, this document shall propose adaptations that are required for application to rotorcraft IFR procedures to / from a Point-in-Space (PinS)	T_0+ 15M
D6	Business Case for curved IFR rotorcraft procedures	Comparison of benefits and constraints of the different solutions (RNP-AR, RNPx) for curved rotorcraft IFR procedures	T_0+ 18M
D7	Safety study for curved PinS RNPx IFR rotorcraft procedures	Safety study for a generic curved PinS RNPx IFR rotorcraft procedure	T_0+ 22M
D8	Detailed design and implementation of a PinS SBAS-guided curved helicopter approach to an heliport	Based on the work achieved in D3, D4 and D5, this deliverable shall propose a detailed definition (including charting) of a PinS SBAS guided curved approach procedure relying on RNP0.3 to a heliport. Selection of the heliport will be done in agreement with the Topic Manager	To+ 22M
D9	Dissemination activities & Final report	User Forum to present the results to rotorcraft operators, ANSPs, Rulemaking bodies and other relevant stakeholders. Final report summarising the outcomes of the project	To+ 24M

4. Topic value (€)

The total anticipated eligible cost of the proposal including manpower, travel costs, consumables, equipment, other direct costs, indirect costs, and subcontracting shall not exceed:

€ 580,000 (VAT not applicable)

[Five hundred eighty thousand euro]

Clean Sky – Sustainable and Green Engines

Identification	ITD - AREA - TOPIC	topics	VALUE	MAX FUND
JTI-CS-SAGE	**Clean Sky - Sustainable and Green Engines**	**9**	**16,350,000**	**12,262,500**
JTI-CS-SAGE-01	*Area-01 - Open Rotor Demo 1*		**0**	
JTI-CS-SAGE-02	*Area-02 - Open Rotor Demo 2*		**13,500,000**	
JTI-CS-2012-2-SAGE-02-019	Air cooled Oil Cooler development, test and supply for Open Rotor		2,000,000	
JTI-CS-2012-2-SAGE-02-020	Electro-hydraulic servo development, test and supply for Open Rotor		4,000,000	
JTI-CS-2012-2-SAGE-02-021	Propellers Blades Bearings Design and Manufacturing		1,500,000	
JTI-CS-2012-2-SAGE-02-022	Rotating cowls		2,000,000	
JTI-CS-2012-2-SAGE-02-023	Rotating nozzle		2,000,000	
JTI-CS-2012-2-SAGE-02-024	Rotating plug		2,000,000	
JTI-CS-SAGE-03	*Area-03 - Large 3-shaft turbofan*		**1,850,000**	
JTI-CS-2012-2-SAGE-03-014	Weight saving through used of CFRC components in high temperature application (=>360oC) for efficient aero-engine design		850,000	
JTI-CS-2012-2-SAGE-03-015	Ring Rolling of IN718		1,000,000	
JTI-CS-SAGE-04	*Area-04 - Geared Turbofan*		**1,000,000**	
JTI-CS-2012-2-SAGE-04-019	Development of physically based simulation chain for microstructure evolution and resulting mechanical properties		1,000,000	
JTI-CS-SAGE-05	*Area-05 - Turboshaft*		**0**	
JTI-CS-SAGE-06	*Area-05 - Lean Burn*		**0**	

Topic Description

CfP topic number	Title		
JTI-CS-2012-02-SAGE-02-019	Air cooled Oil Cooler development, test and supply for Open Rotor	**Start date**	*02/01/2013*
		End date	*20/12/2015*

1. Topic Description

The SAGE2 Demonstration Project aims at designing, manufacturing & testing a Counter-Rotating Open-Rotor Demonstrator. It involves most of the best European Engine & Engine Modules & Sub-systems Manufacturers.

The CROR engine architecture is a challenge for the oil system and especially heat management

During concept analysis, heat management has been assessed and requirements corresponding to an Air-oil cooler have been identified.

These Air-oil cooler requirements lead to specific hardware with important volume and weight. Specific work is required to:

- on one hand improve air-oil cooler integration into the propulsion system to minimize weight and drag impact
- on another hand improve air-oil cooler technology to comply with new propulsion system architecture requirements.

For the engine demonstrator, it is required to develop, test and supply a specific air-oil cooler. Depending on the maturity level of improved technology, it can be partially, completely or not implemented for the engine demonstrator prototypes.

Call for proposal technical perimeter:

- Prototype Air-oil cooler for the engine demonstrator
- Prototype samples for optimized technology
- Any test bench modification or development required to test specific product dedicated to the Open Rotor application

Models:

- ACOC model delivery will be required during design phase for integration into the propulsion system model: CAD models and performance models

Tests required before ACOC delivery for the engine demonstrator application:

- preliminary list of tests (but not exhaustive) to be conducted by applicant includes:
    - performance test
    - Burst pressure test
    - Vibration test
    - fire proofness test

Scope of call for proposal:

Product optimization for target engine: optionnal activities to demonstrate news concept on samples up to Technology Readiness Level 4 (TRL4)

- preliminary & detailed design of optimized product
- manufacturing and/or procurement of samples

- performance tests of optimized samples
- Conclusions on optimized product performance and further improvement possibilities

Product supply for demonstrator engine:

- preliminary & detailed design of engine demonstrator ACOC
- Support for product integration into the propulsion system environment
- manufacturing and/or procurement of components for product assembly
- All tests required before product delivery to the engine demonstrator
- Support for product operation during engine tests on ground (France)

Test bench modification or development required for Open Rotor ACOC

- preliminary and detailed design of test bench or test bench modifications required to verify ACOC before delivery to engine application, based on quality requirements agreed with Snecma (refer to preliminary list above)..
- manufacturing and/or procurement of components for test bench
- design, procurement and implementation of instrumentation required for the different tests on applicant site in addition to engine tests on ground and possibly future test in flight

Organisation:

– The partner shall nominate a team dedicated to the project and should inform Snecma project manager about the name/names of this key staff. At least the responsibility of the following functions shall be clearly addressed: Program (single point contact with Snecma), Design and Validation Lead.

Time Schedule & Workpackage Description:

– The partner is working to the agreed time-schedule & work-package description.

– Both, the time-schedule and the work-package description laid out in this Call shall be further detailed as required and agreed at the beginning of the project.

Progress Reporting & Reviews:

– Quarterly progress reports in writing shall be provided by the partner, referring to all agreed work packages, technical achievement, time schedule, potential risks and proposal for risk mitigation.

– Regular coordination meetings shall be conducted via telecom.

– The partner shall support reporting and agreed review meetings with reasonable visibility on its activities and an adequate level of information.

– The review meetings shall be held in Topic manager facility.

General Requirements:

– The partner shall work to a certified standard process.

Other activities:

- ACOC components modeling (for integration into the propulsion system driven by Snecma: CAD model and performance model).

Other comments:

- Possible co-located activities on Snecma site for short periods of time during preliminary and detailed design phase in order to facilitate ACOC integration into the propulsion system environment and interface management.
- To secure module and engine tests, spare parts will be required to cope for potential failure during verification and/or integration and/or engine tests. Number of spare parts will be defined in

accordance with Snecma – preliminary value to take into account is 3 prototypes to be delivered to the engine demonstrator..

- Quality requirements for delivered parts will be “flight worthy” as Open rotor demonstration engine is likely to be tested in flight without re-furbishing
- Applicants will have access to ACOC requirements and propulsion system integration constraints after signing an NDA with Snecma

2. Special skills, certification or equipment expected from the applicant

Experience in design, manufacturing and certification of ACOC’s or similar technologies for aircarft engines is mandatory

Availability of test benches to support test campaigns is mandatory

English langage in mandatory

Activities shall be conducted using ISO standards

3. Major deliverables and schedule

Estimated project start: T0 = January 2nd 2013

Deliverable	Title	Description (if applicable)	Due date
D1	Development plan	Including detailed risk analysis and mitigation proposal	T0 + 1 month
D2	Engine demo ACOC and test bench Preliminary Design Review	ACOC for demo & test bench Preliminary Design Review	T0 + 4 months
D3	Engine demo ACOC and test bench Detailed Design review	ACOC for demo & test bench Critical Design Review	T0 + 10 months
D4	Engine demo ACOC prototypes and test bench available for qualification tests	ACOC for demo & test bench Test Readiness Review	T0 + 15 months
D5	ACOC prototypes delivery for engine demo	ACOC’s for demo Acceptation Review	T0 + 18 months
D6	Optimized ACOC test results on samples	Optimized ACOC Test Results Review	T0 + 34 months
D7	Final conclusions	Closure report	T0 + 36 months

4. Topic value (€)

The total anticipated eligible cost of the proposal including manpower, travel costs, consumables, equipment, other direct costs, indirect costs, and subcontracting shall not exceed:

€ 2.000.000 (VAT not applicable)

[Two million euro]

5. Remarks

Regular phone call meetings (will be held with SNECMA to deal with technical and program questions.

Face to face workshops will be organized approximately every 4 months on Snecma site and/or on test bench site

Topic Description

CfP topic number	Title		
JTI-CS-2012-02-SAGE-02-020	**Electro-hydraulic servo development, test and supply for Open Rotor**	End date	*20/12/2015*
		Start date	*02/01/2013*

1. Topic Description

The SAGE2 Demonstration Project aims at designing, manufacturing & testing a Counter-Rotating Open-Rotor Demonstrator. It involves most of the best European Engine & Engine Modules & Sub-systems Manufacturers.

The CROR engine architecture is a challenge for the Pitch Actuation System (PASys) and especially the performance requirements associated to high flow levels needed to actuate the blades pitch

During concept analysis, Pitch Actuation System architecture has been selected and servo control requirements have been identified.

This servo requirements lead to specific hardware with important volume and weight. Specific work is required to:

- on one hand improve servo control technology in order to have optimized technology available at least by the date of entry into service of this new engine architecture,
- on another hand develop, test and supply the servo required for the engine demonstrator.

Depending on the maturity level of the optimized technology, it can be partially, completely or not implemented for the engine demonstrator prototypes.

Call for proposal technical perimeter:

- Proptotype servos for front and aft rotor of the engine demonstrator,
- Prototype servo with optimized technology validated at TRL4,
- Any test bench modification or development required to test specific product dedicated to the Open Rotor application,
- Optionnal activity: performance test of Pitch Control Unit on appliquant test bench. The Pitch Control Unit is the hydro-mechanical Unit designed and manufactured by Snecma for the engine demonstrator in which appliquant's servo's are integrated.

Models:

- Servo model delivery will be required during design phase for integration into engine model: CAD models and functionnal models.

Tests required before servo delivery for the engine demonstrator application:

Preliminary list of tests (but not exhaustive) to be conducted by applicant includes:

- Performance test,
- Vibration test,
- Fire proofness test,
- Electric test.

Scope of call for proposal:

Product optimization for target engine:

- Preliminary & detailed design of optimized product
- Manufacturing and/or procurement of components for optimized product assembly

- Performance tests of optimized product to validate Technology Readiness Level 4

- Conclusions on optimized product performance and further improvement possibilities

Product supply for demonstrator engine:

- Preliminary & detailed design of engine demonstrator products

- Support for product integration into the Pitch Control Unit designed by Snecma

- Manufacturing and/or procurement of components for product assembly

- All tests required before product delivery for engine demonstrator

- Support for product operation during integration tests with Pitch Change Mechanism on PCM's partners site located in Europe, including servo behaviour analysis and trouble shooting

- Support for engine tests on ground (France) including servo behaviour analysis and trouble shooting

Test bench modification or development required for Open Rotor servo's

- Preliminary and detailed design of test bench or test bench modifications required to verify servo's before delivery to engine application, based on quality requirements agreed with Snecma (refer to preliminary list above)..

- Manufacturing and/or procurement of components for test bench

- Design, procurement and implementation of instrumentation required for the different tests on applicant site in addition to engine tests on ground and possibly future test in flight

Organisation:

– The partner shall nominate a team dedicated to the project and should inform Snecma project manager about the name/names of this key staff. At least the responsibility of the following functions shall be clearly addressed: Program (single point contact with Snecma), Design and Validation Lead.

Time Schedule & Workpackage Description:

– The partner is working to the agreed time-schedule & work-package description.

– Both, the time-schedule and the work-package description laid out in this Call shall be further detailed as required and agreed at the beginning of the project.

Progress Reporting & Reviews:

– Quarterly progress reports in writing shall be provided by the partner, referring to all agreed work packages, technical achievement, time schedule, potential risks and proposal for risk mitigation.

– Regular coordination meetings shall be conducted via telecom.

– The partner shall support reporting and agreed review meetings with reasonable visibility on its activities and an adequate level of information.

– The review meetings shall be held in Topic Manager facility.

General Requirements:

– The partner shall work to a certified standard process.

Other activities:

- Servo components modeling (for integration into the engine model driven by Snecma: CAD model and functionnal simulation)

- Possible co-located activities on Snecma site for short periods of time during detailed design phase in order to facilitate servo integration and interface management.

- Optionnal activity: Run Pitch Control Unit performance tests on appliquant test bench. The Pitch Control Unit is the hydro-mechanical Unit designed and manufactured by Snecma for the engine demonstrator in which appliquant's servo's are integrated.

Other comments:

- To secure module and engine tests, spare parts will be required to cope for potential failure during verification and/or integration and/or engine tests. Number of spare parts will be defined in accordance with Snecma – preliminary value to take into account is 5 sets of 2 servo prototypes (front & aft rotors) for engine demonstrator.

- Quality requirements for delivered parts will be "flight worthy" as Open rotor demonstrator engine is designed to be tested in flight without re-furbishing

Applicants will have access to servo requirements and engine integration constraints after signing an NDA with Topic Manager.

2. Special skills, certification or equipment expected from the applicant

Experience in design, manufacturing and certification of electro-hydraulic servo's or similar technologies for aircarft engines is mandatory.

Availability of test benches to support test campaigns is mandatory.

English langage is mandatory.

Activities shall be conducted using ISO standards.

3. Major deliverables and schedule

Estimated project start: T0 = January 2nd 2013

Deliverable	Title	Description (if applicable)	Due date
D1	Development plan	Including detailed risk analysis and mitigation proposal	T0 + 1 month
D2	Engine demo servo's and test bench Preliminary Design Review	Servos for demo & test bench Preliminary Design Review	T0 + 4 months
D3	Engine demo servo's and test bench Detailed Design Review	Servos for demo & test bench Critical Design Review	T0 + 10 months
D4	Engine demo servo prototypes and test bench available for qualification tests	Servos for demo & test bench Test Readiness Review	T0 + 15 months
D5	Servo prototypes delivery for engine demo	Servos for demo Acceptation Review	T0 + 18 months
D6	New generation servo's Preliminary Design Review	New generation servo's Preliminary Design Review	T0 + 12 months
D7	New generation servo's Detailed Design Review	New generation servo's Critical Design Review	T0 + 22 months
D8	New generation servo prototypes available for qualification tests	New generation servo's Test Readiness Review	T0 + 30 months
D9	New generation servo's test results	New generation servo's Test Results Review	T0 + 34 months
D10	Final conclusions	Closure report	T0 + 36 months

4. Topic value (€)

The total anticipated eligible cost of the proposal including manpower, travel costs, consumables, equipment, other direct costs, indirect costs, and subcontracting shall not exceed: **€ 4.000.000** (VAT not applicable) [Four millions euro]

5. Remarks

Regular phone call meetings (will be held with Topic Manager to deal with technical and program questions. Face to face workshops will be organized approximately every 4 months on Topic Manager site and/or on test bench site

Topic Description

CfP topic number	Title		
JTI-CS-2012-02-SAGE-02-021	**Propellers Blades Bearings Design and Manufacturing**	End date	*T0 + 16 months*
		Start date	*T0*

1. Topic Description

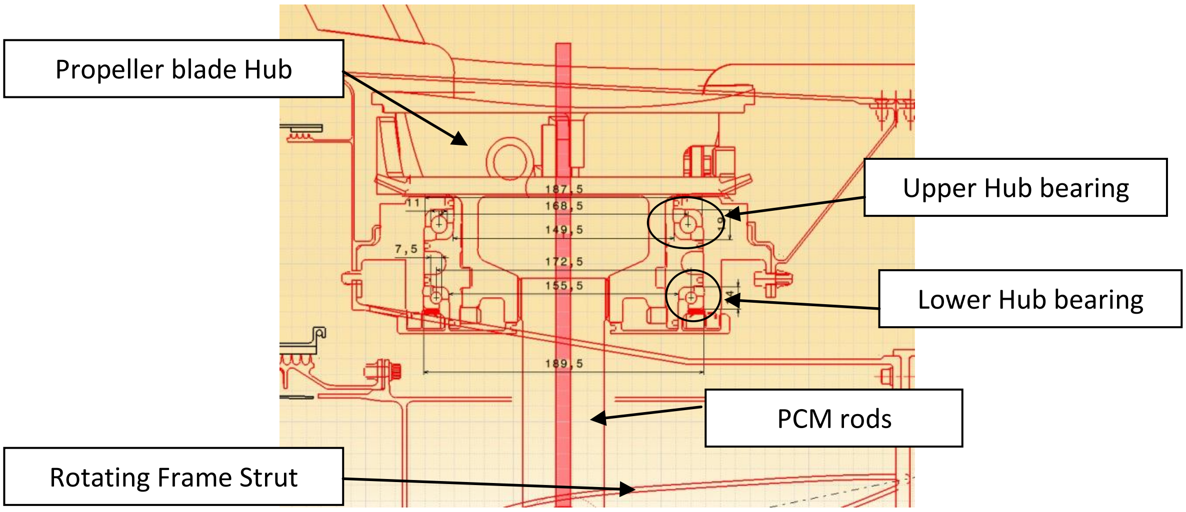
Main goals
The SAGE2 Demonstration Project aims at designing, manufacturing & testing a Counter-Rotating Open-Rotor Demonstrator. It involves most of the best European Engine & Engine Modules & Sub-systems Manufacturers.

The SAGE2 demonstrator will be installed on a pylon located
- on a test bench (ground tests)
- at the rear side of an A340's fuselage (flight test)

The SAGE2 demonstator is a geared/pusher configuration engine with includes contra-rotative propellers which are actuated by two pitch control mechanisms (PCM). Rods of the PCM are located in the struts of rotating frames. For each rod two bearings are required to insure rotation of the blades controlled by PCM.

Bearings located at the hub of propeller blades are the focus of the proposal.

Note that all drawings given in this description are for illustration only and do not represent the final bearing design.



For illustration purpose

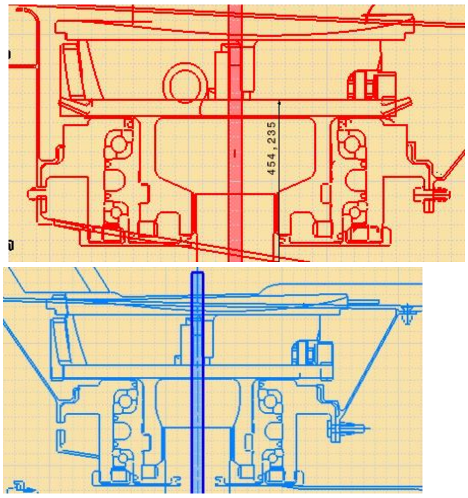
The Propellers Blades bearings will be designed, manufactured and tested (component tests are required necessary to demonstrate the behaviour with different loads cases – TRL 5 is required) to achieve the following goals :

- To sustain the radial load of the propeller blade load in operating condition due centrifugal forces and unbalance loads
- To sustain axial and tengential loads due to aerodymic forces on the blade

The Main issues to be adressed are :

Configuration :

- Forward Propellers bearings : 2x12 (upper and lower)
- Rear Propellers bearings : 2x10 (upper and lower)



For illustration purpose

Geometrical Parameters :
- Outer diameter of bearing is : 200 mm (max Forward) and 160 mm (max Rear)
- Inter bearings axial distance is : 50 mm (max Forward and Rear)
- Study to have the same technology and to have same bearings for both forward and rear propellers.

Thermal environment
- Temperature level is : 200°C in normal condition and about 250°C (max)

Lubrication :
- Self lubrication is required
- Oil or grease operating temperature range is from – 55°C to 200°C

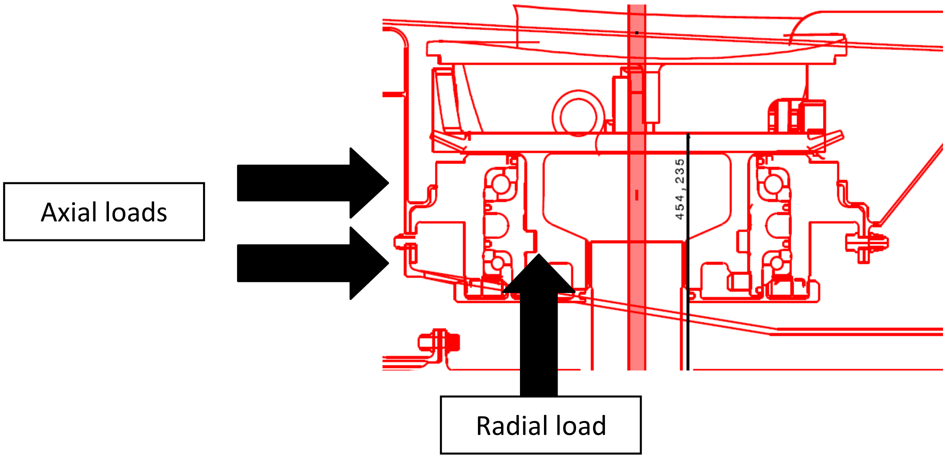
Loads :
No burst, no blocage with the following operating conditions

Upper bearing

		« Redline »	« 2xFc »
Radial load (=axial for bearing due to centrifugal force)	Static	425000 N	625000 N
Axial load (= radial for bearing due aerodynamic forces and moments)	Static	136000 N	0 N
	Dynamics	34000 N	0 N

Lower bearing

		« Redline »	« 2xFc »
Radial load (=axial for bearing due to centrifugal force)	Static	0 N (only pre-load)	0 N (only pre-load)
Axial load (= radial for bearing due aerodynamic forces and moments)	Static	128500 N	0 N
	Dynamics	32000 N	0 N



Scope of call for proposal

Task 1: Management

Organisation:
– The partner shall nominate a team dedicated to the project and should inform The topic manager about the name/names of this key staff. At least the responsibility of the following functions shall be clearly addressed: Program (single point contact with The topic manager), Design Lead, and Validation Lead (Measurement Systems Development).

Time Schedule & Workpackage Description:
– The partner is working to the agreed time-schedule & work-package description.
– Both, the time-schedule and the work-package description laid out in this Call shall be further detailed as required and agreed at the beginning of the project.

Progress Reporting & Reviews:
– Quarterly progress reports in writing shall be provided by the partner, referring to all agreed workpackages, technical achievement, time schedule, potential risks and proposal for risk mitigation.
– Regular coordination meetings shall be conducted via telecom.
– The partner shall support reporting and agreed review meetings with reasonable visibility on its activities and an adequate level of information.
– The review meetings shall be held at the topic manager facility.

General Requirements:
– The partner shall work to a certified standard process.

Task 2: Bearing design
The partner shall design bearings in the environment according to the topic manager and flight test safety Requirements
The partner shall deliver to the topic manager the bearings data required for Whole Engine Model Analysis
The partner shall deliver a design justification report of the bearings
The partner shall support the technical review for bearings architecture approval organized by the topic manager

Task 3: bearings manufacturing
The partner shall manufacture 28 Forward Propellers bearings and 24 Rear Propellers bearings : according to the topic manager and flight test safety requirements.
The partner shall support the manufacturing review organized by the topic manager Quality.
The partner shall must to perform the Industrial Validation Report with the Topic manager Quality.
The partner shall must to perform the drawing bearings

Task 4: bearings component tests
The partner shall propose a bearing verification plan. This verification plan will be approved by The topic manager through a technical review.
The partner component test activities shall include:
- Detailed design of test benches based on existing test plan & test bench sketches
- Manufacturing or procurement of at least 4 bearings
- Design and procurement of instrumentation required for the different tests
- Test benches modifications and commissionning including test bench control and instrumentation
- Testing of the relevant parts
- Tests results analysis
- Test results report

Task 5: bearings and environment delivery for ground test
The partner activities shall include:
- Manufacturing and/or procurement of the instrumented bearings for engine assembly
- Conformity documents

2. Special skills, certification or equipment expected from the applicant

- Experience in design, manufacturing, testing and certification of aircrat engine bearings is mandatory
- Experience in test bench design and modification is mandatory
- Experience in endurance tests or other relevant tests contributing to risks abatment is mandatory
- Availability of test benches to support test campaign is mandatory

3. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Bearings development plan	Including detailed risk analysis and mitigation proposal	T0 + 1 month
D2	Bearings preliminary design substantiation document for Preliminary design review	To check the feasibility and to freeze the architecture and interfaces, to identify the validation plan.	T0 + 3 months
D3	Design progress reports for bearings (monthly reports)	Design activities status	T0 + 2 months
D4	Bearings detailed design substantiation document for critical design review	To approve design before hardware manufacturing engagement	T0 + 6 months
D5	Bearings Components Tests benches readiness review	To verify test benches capability to meet validation plan requirements	T0 + 10 months
D6	Bearings and environment Components Tests completed – hardware inspection review	To substantiate mount and balancing systems design	T0 + 15 months
D7	Component Tests reports for bearings systems	To contribute to engine test readiness review	T0+ 16 months

4. Topic value (€)

The total anticipated eligible cost of the proposal including manpower, travel costs, consumables, equipment, other direct costs, indirect costs, and subcontracting shall not exceed:

€ 1.500.000 (VAT not applicable)

[One million five hundred thousand euro]

Topic Description

CfP topic number	Title		
JTI-CS-2012-02-SAGE-02-022	**Rotating cowls**	**Start date**	T0
		End date	T0 + *32* months

1. Topic Description

Main goals

The SAGE2 Demonstration Project aims at designing, manufacturing & testing a Counter-Rotating Open-Rotor Demonstrator. It involves most of the best European Engine & Engine Modules & Sub-systems Manufacturers.

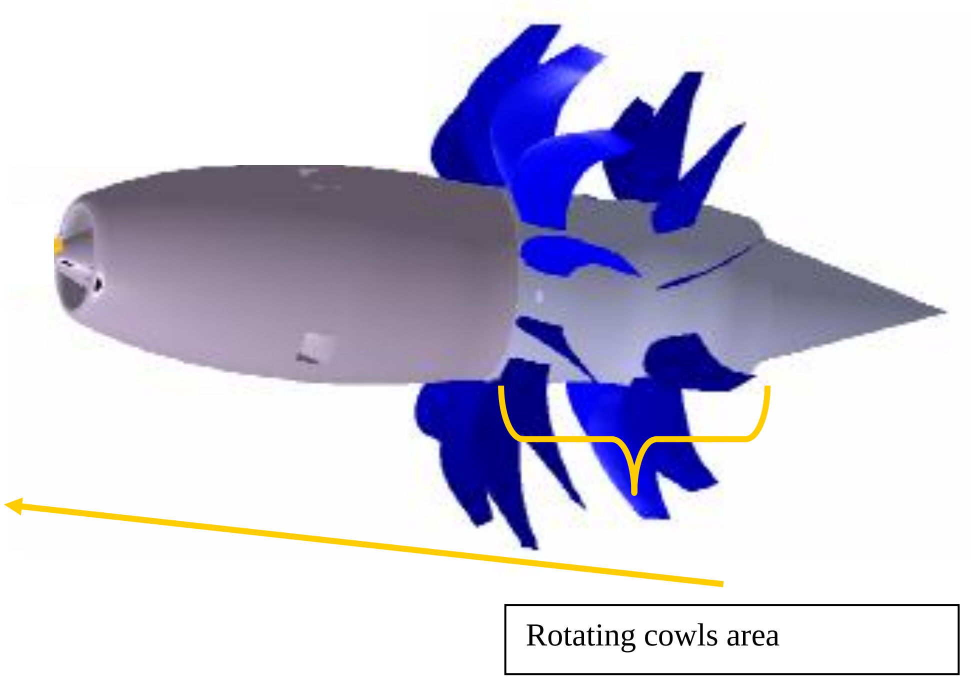
The SAGE2 demonstrator will be installed on a pylon located on a test bench (ground tests). The components have to be designed and manufactured to a flightworthy standard. Two sets of components are planned in this CfP.

This call is for a very innovative solution to the cowling around the engine. The cowling must be airtight, and counter-rotating to the engine. This implies a very tight sliding seal similar to that inside the engine, but it must cope with higher dispolacements than found within the engine. For this enivironment, it is felt a very innovative sealing arrangement will be needed as classical rubber and labyrinth seals will not easily be applicable.

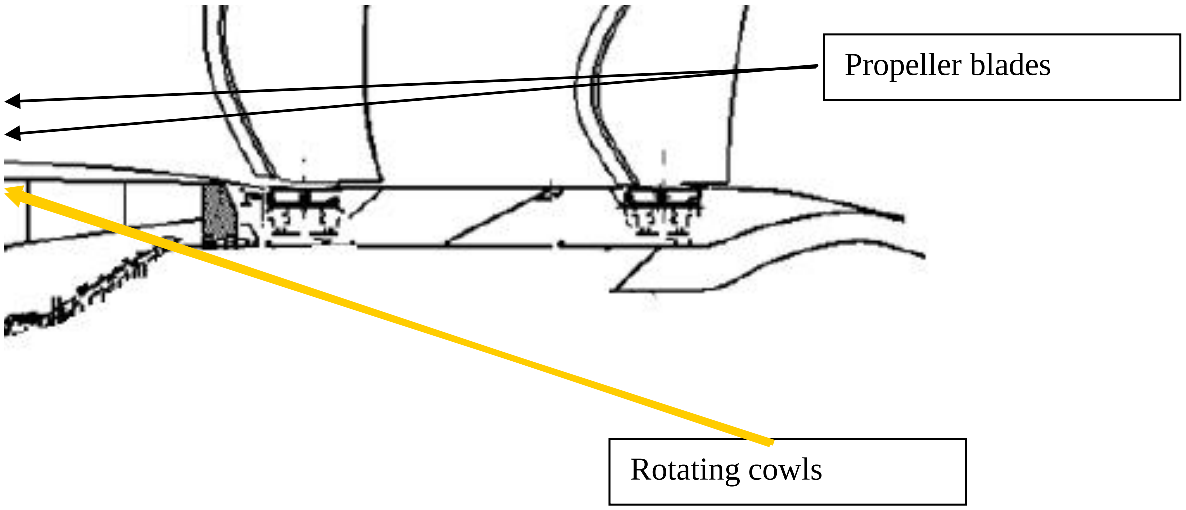
In additon, the cowling system must include an integral ventilation system duct and scoop, which will require new solutions not currenlty available.

The environment of the cowl is a very high temperature, leading to the necessity of consideration of material choice, and cooling techniques in order to meet a viable flightworthy weight whilst being able to resist the high temperatures.

Description of the rotating cowl:



Sage 2 Nacelle overview



The rotating cowls are located on the aft part of the nacelle they encompass the root of the propeller blade.

They are installed on a diameter of around 1600 mm. and their width is around 800mm.

The maximum rotating speed is about 1300 rpm.

There are two rotating cowls assembly corresponding to the two rotors.

These two cowl assemblies are counter-rotating

The rotating cowls will be easily removable ans in several parts to give access to the blade roots and to the pitch mechanism.

They will be submitted to temperature up to 200° C (to be confirmed at the propulsion system concept review).

They will be airtight and they will be fitted with sliding tightness seals.

They will embody some ventilation devices like scoops to insure the blade root ventilation.

They will be submitted to a ventilation presure around 0.5 bars, to centrifugal loads and dynamic loads due to the rotation.

They shall meet demonstrator life requirements (1000 hours)

They shall meet step and gap requirements (to be defined at propulsion system concept review)

They shall meet balancing requirement (to be defined at propulsion system concept review)

They shall be compliant with ground test and "permit to flight" safety requirements derived from rotating parts certification requirements

They should be as light as possible.

They should be also probably fireproof or at least fire resistant. The requirement will be specified at the propulsion system concept review

The combination of ventilation needs, loads and temperature make this a challenging and innovative nacelle structure.

They may be metallic or composite structure, the lighter solution will be prefered.

The work expected is starting from a preliminary design supplied by the topic manager:

Make a detailed design

Make the structural substantiation including required component tests

Make the fire, ventilation substantiation including required component tests

To validate the structural allowable of the proposed materials

To manufacture parts necessary for component tests and the demonstrator elements fitted on the engine demonstrator

To support the test campains

Report and analyze the tests results

Management

Organisation:

– The partner shall nominate a team dedicated to the project and should inform the topic manager project manager about the name/names of this key staff. At least the responsibility of the following functions shall be clearly addressed: Program (single point contact with the topic manager), Design Lead, and Validation Lead (Measurement Systems Development).

Time Schedule & Workpackage Description:

– The partner is working to the agreed time-schedule & work-package description.

– Both, the time-schedule and the work-package description laid out in this Call shall be further detailed as required and agreed at the beginning of the project.

Progress Reporting & Reviews:

- Quarterly progress reports in writing shall be provided by the partner, referring to all agreed workpackages, technical achievement, time schedule, potential risks and proposal for risk mitigation.
- Regular coordination meetings shall be conducted via telecom.
- The partner shall support reporting and agreed review meetings with reasonable visibility on its activities and an adequate level of information.
- The review meetings shall be held at the topic manager facility.
- It is also expected that the partners participate to workshop with co-located teams to work on the interfaces documents.

General Requirements: – The partner shall work to a certified standard process. The mains steps will be To perform the activities required to support the Preliminary Design Review for the element To perform the activities required to support the Critical Design Review for the element To manufacture the element for component and ground testing To prepare and support the review of the component before the ground tests To prepare and support the propulsion system after test review for the component To prepare and support the review before delivery of a flightworthy component

2. Special skills, certification or equipment expected from the applicant

The main expected skills are: Knowledge in aeronautical structure design and manufacturing submited to middle range temperature Ability to develop or adapt a new system of dynamic sealing Knowledge in aeronautical structural and engine regulations Knowledge in advanced aeronautical material

3. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1 PDR review	PDR actions closure report		T0 +4
D2 CDR review	CDR presentation		T0 + 11
D3 Rotating Cowls manufacturing	Rotating Cowls manufacturing report	Quality and acceptance report of the manufactured elements	T0 +22
D4 Review before ground tests	Review before Ground test presentation	Structural and safety presentation before the ground tests	T0 + 25
D5 Review before Flight tests	Review of the flightworthy component	Structural and safety presentation of the flightworthy component	T0 + 28
D6 Tests reports	Tests reports		T0 + 31
D7 Test reports analysis	Test reports analysis	Summary of the tests, lessons learnt	T0 + 32

4. Topic value (€)

The total anticipated eligible cost of the proposal including manpower, travel costs, consumables, equipment, other direct costs, indirect costs, and subcontracting shall not exceed: **€ 2.000.000** (VAT not applicable) [Two millions Euro]

CfP topic number	Title		
JTI-CS-2012-02-SAGE-02-023	**Rotating nozzle**	Start date	T0
		End date	T0 + *32* months

1. Topic Description

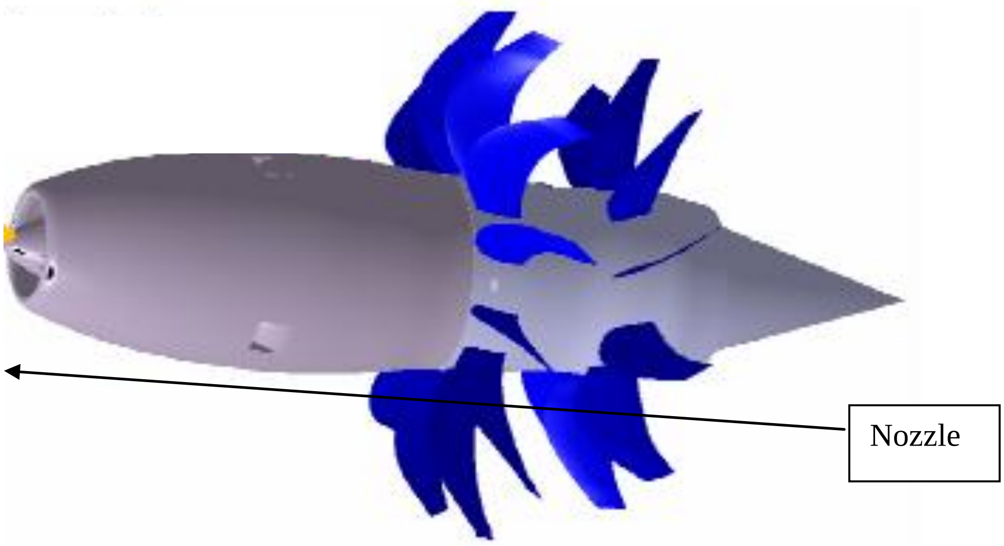
Main goals

The SAGE2 Demonstration Project aims at designing, manufacturing & testing a Counter-Rotating Open-Rotor Demonstrator. It involves most of the best European Engine & Engine Modules & Sub-systems Manufacturers.

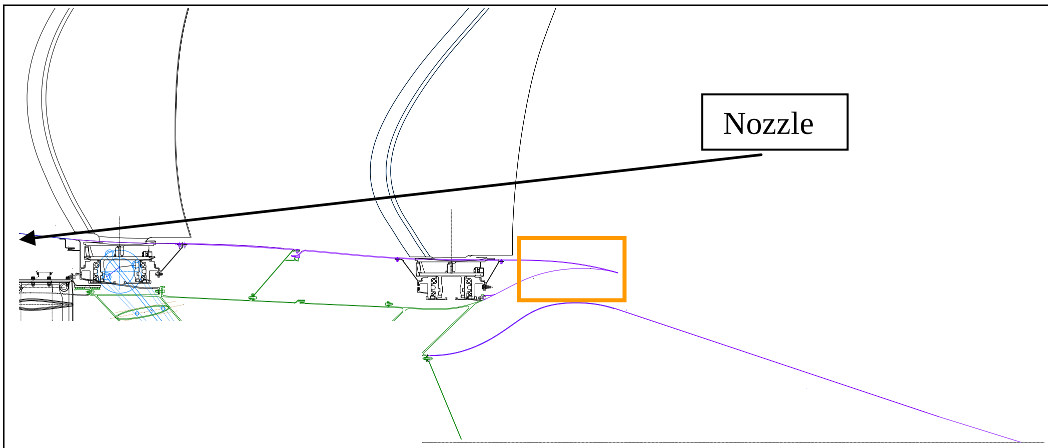
The SAGE2 demonstrator will be installed on a pylon located on a test bench (ground tests). The components have to be designed and manufactured to a flightworthy standard. Two sets of components are planned in this CfP.

The solution requested via this call will require innovative solutions to the issues of temperature, whilst achieving the weight and strength necessary. The noise environment may lead to a need to treat acoustically the nozzle to reduce the engine noise emissions. This design must then be made so that the exhaust nozzle can rotate at up to 1300 rpm, which will demand strong focus on the balancing of the part in design and subsequent manufacture. This rotation in itself will demand a novel approach to the material to ensure the part can survive the fatigue and high dynamic stresses that the assembly will have.

Description of the rotating nozzle:



SAGE2 Nacelle overview



Aft end of the engine installation (half section not to scale)

The nozzle is located at the aft of the nacelle, it is the part of the exhaust system.

Its dimensions are about 1500mm diameter for 700mm length

It will rotate at about 1300 rpm maximum.

The expected maximum exhaust flow temperature are about 600°C.

It may be partially fitted with an acoustic absorbing liner. The acoustic treatment requirement will be specified for the propulsion system concept review

It shall meet demonstrator life requirements (1000 hours)

It is an important part of the nacelle rear end ventilation system, and shall be able to provide a calibrated exhaust section.

It will be at the boundary with structure able to withstand low to middle temperature that would be protected to the exhaust high temperatures.

It shall be designed to cope with differential thermal expension due to different material or different temperatures.

It shall meet balancing requirement (to be defined at propulsion system concept review)

It shall be compliant with ground test and “permit to flight” safety requirements derived from rotating parts certification requirements

Due to its aft postion it should be lighter as possible, it will be submitted to centrifugical and dynamic loads due to the rotation added to loads due to the temperature and exhaust flow.

It may be metallic or from high temperature composite construction or a mixed of these technologies.

The work expected is starting from a preliminary design proposed by the topic manager:

Make a detailed design

Make the structural substantiation including component tests required by the substantiation

To validate the structural allowable of the proposed materials

To manufacture the parts necessary for component tests and demonstrator elements fitted on the engine demonstrator

To support the test campaigns

Report and analyze the tests results

Management

Organisation:

– The partner shall nominate a team dedicated to the project and should inform the topic manager project manager about the name/names of this key staff. At least the responsibility of the following functions shall be clearly addressed: Program (single point contact with the topic manager), Design Lead, and Validation Lead (Measurement Systems Development).

Time Schedule & Workpackage Description:

– The partner is working to the agreed time-schedule & work-package description.

– Both, the time-schedule and the work-package description laid out in this Call shall be further detailed as required and agreed at the beginning of the project.

Progress Reporting & Reviews: Quarterly progress reports in writing shall be provided by the partner, referring to all agreed workpackages, technical achievement, time schedule, potential risks and proposal for risk mitigation.

– Regular coordination meetings shall be conducted via telecom.
– The partner shall support reporting and agreed review meetings with reasonable visibility on its activities and an adequate level of information.
– The review meetings shall be held at the topic manager facility.
- It is also expected that the partners participate to workshop with co located teams to work on the interfaces documents.
– Quarterly progress reports in writing shall be provided by the partner, referring to all agreed workpackages, technical achievement, time schedule, potential risks and proposal for risk mitigation.
– Regular coordination meetings shall be conducted via telecom.
– The partner shall support reporting and agreed review meetings with reasonable visibility on its activities and an adequate level of information.
– The review meetings shall be held at the topic manager facility.
- It is also expected that the partners participate to workshop with co located teams to work on the interfaces documents.

General Requirements:

– The partner shall work to a certified standard process.

The mains steps will be:

To perform the activities required to support the Preliminary Design Review for the element

To perform the activities required to support the Critical Design Review for the element

To manufacture the element

To prepare and support the review before the ground tests for the element

To prepare and support the propulsion system after test review for the component

To prepare and support the review of a flighworthy component.

2. Special skills, certification or equipment expected from the applicant

The main expected skills are:

Knowledge in areonautical structure design and manufacturing submited to high temperature

Ability to develop or adapt a new system of dynamic sealing

Knowledge in aeronautical structural and engine regulations

Knowledge in advanced aeronautical material

3. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1 PDR review	PDR actions closure report		T0 +4
D2 CDR review	CDR presentation		T0 + 11
D3 Rotating nozzle manufacturing	Rotating nozzle manufacturing report	Quality and acceptance report of the manufactured elements	T0 +22
D4 Review before ground tests	Review before Ground test presentation	Structural and safety presentation before the ground tests	T0 + 25
D5 Review before Flight tests	Review of a flightworthy component	Structural and safety presentation of a flightworthy component	T0 + 28
D6 Tests reports	Tests reports		T0 + 31
D7 Test reports analysis	Test reports analysis	Summary of the tests, lessons learnt	T0 + 32

4. Topic value (€)

The total anticipated eligible cost of the proposal including manpower, travel costs, consumables, equipment, other direct costs, indirect costs, and subcontracting shall not exceed:

€ 2.000.000 (VAT not applicable)

[Two millions Euro]

Topic Description

CfP topic number	Title		
JTI-CS-2012-02-SAGE-02-024	**Rotating plug**	**Start date**	T0
		End date	T0 + *32* months

1. Topic Description

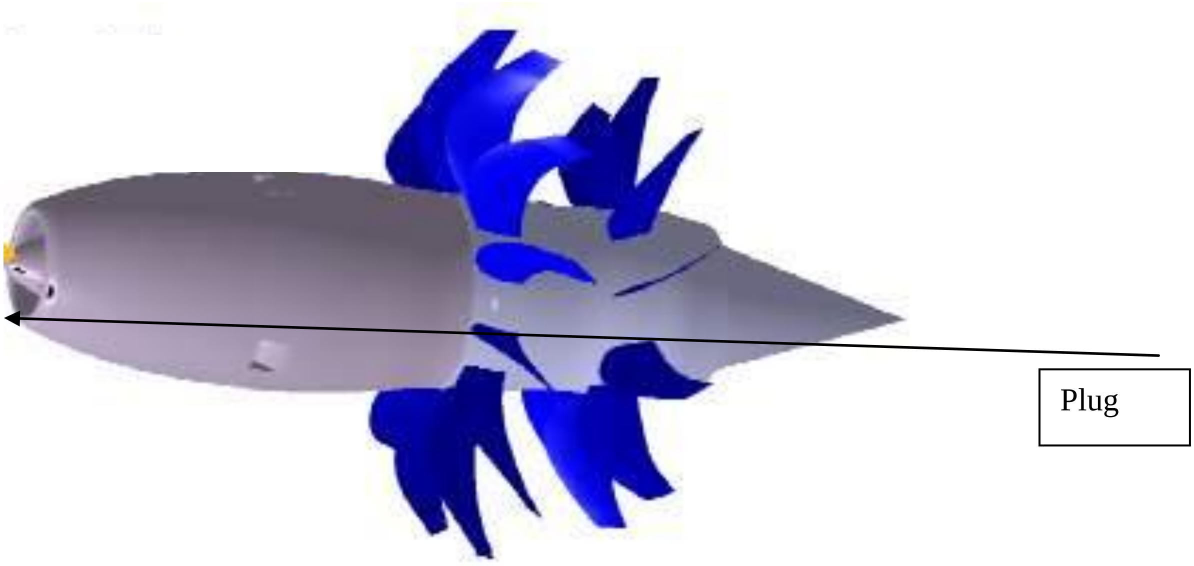
Main goals

The SAGE2 Demonstration Project aims at designing, manufacturing & testing a Counter-Rotating Open-Rotor Demonstrator. It involves most of the best European Engine & Engine Modules & Sub-systems Manufacturers.

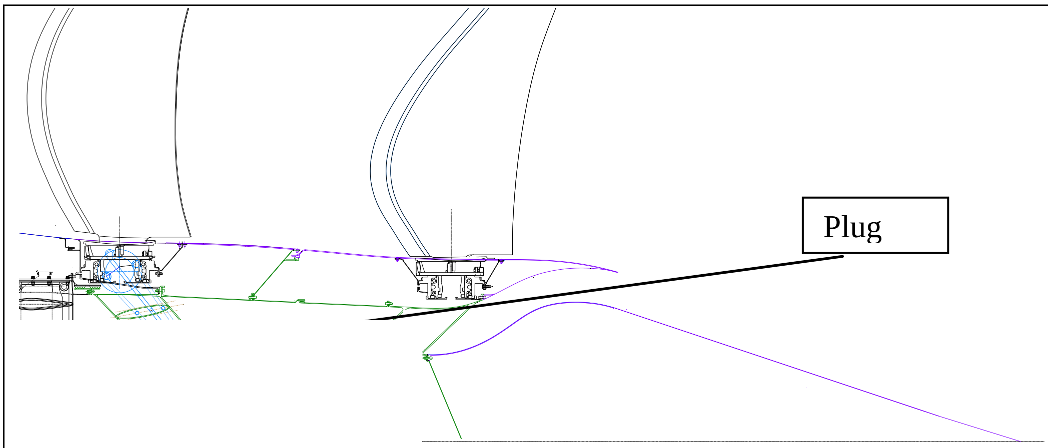
The SAGE2 demonstrator will be installed on a pylon located on a test bench (ground tests). The components have to be designed and manufactured to a flightworthy standard. Two sets of components are planned in this CfP.

The solution requested via this call will require innovative solutions to the issues of temperature, whilst achieving the weight and strength necessary. The noise environment may lead to a need to treat acoustically the nozzle to reduce the engine noise emissions. This design must then be made so that the exhaust nozzle can rotate at up to 1300 rpm, which will demand strong focus on the balancing of the part in design and subsequent manufacture. This rotation in itself will demand a novel approach to the material to ensure the part can survive the fatigue and high dynamic stresses that the assembly will have.

Description of the rotating plug:



SAGE2 Nacelle overview



Aft end of the engine installation (half section not to scale)

The plug is located at the very aft of the nacelle, it is the part of the exhaust system.

Its dimensions are about 1100mm diameter for 2300mm long.

It will rotate at about 1300 rpm maximum.

The maximum expected exhaust gas flow temperature are about 600°C.

It may be partially fitted with an acoustic absorbing liner. The acoustic treatment requirement will be specified for the propulsion system concept review

It shall meet demonstrator life requirements (1000 hours)

It shall be easily removable from the engine structure and for these probabably made in several parts.

Due to its aft position it shall be compliant with balancing requirements and should be lighter as possible, it will be submitted to centrifugical and dynamic loads due to the rotation added to loads due to the temperature and exhaust flow.

It shall comply with engine rotating parts certification requirements.

It may be metallic or from high temperature composite construction or a mixed of these technologies.

The work expected is starting from a preliminary design proposed by the topic manager:

Make a detailed design

Make the structural substantiation including component tests required by the substantiation

To validate the structural allowable of the proposed materials

To manufacture parts necessary for component tests and the demonstrator elements fitted on the engine demonstrator

To support the ground test campain

Report and analyze the tests results

Management

Organisation:

– The partner shall nominate a team dedicated to the project and should inform the project manager about the name/names of this key staff. At least the responsibility of the following functions shall be clearly addressed: Program (single point contact for the topic manager), Design Lead, and Validation Lead (Measurement Systems Development).

Time Schedule & Workpackage Description:

– The partner is working to the agreed time-schedule & work-package description.

– Both, the time-schedule and the work-package description laid out in this Call shall be further detailed as required and agreed at the beginning of the project.

Progress Reporting & Reviews:

–Quarterly progress reports in writing shall be provided by the partner, referring to all agreed workpackages, technical achievement, time schedule, potential risks and proposal for risk mitigation.

–Regular coordination meetings shall be conducted via telecom.

–The partner shall support reporting and agreed review meetings with reasonable visibility on its activities and an adequate level of information.

–The review meetings shall be held at the topic manager facility.

-It is also expected that the partners participate to workshop with co located teams to work on the interfaces documents.

General Requirements:

– The partner shall work to a certified standard process.

The mains steps will be:

To perform the activities required tosupport the Preliminary Design Review for the element

To perform the activities required to support the Critical Design Review for the element

To manufacture the element and to perform the component tests required by the design substantiation for engine ground test and permit to flight

To prepare and support the review before the ground tests for the element

To prepare and support the propulsion system after test review for the component

To prepare and support the review before the a flightworthy part is delivered

2. Special skills, certification or equipment expected from the applicant

The main expected skills are:

Knowledge in aeronautical structure design and manufacturing submited to high temperature

Ability to develop or adapt a new system of dynamic sealing

Knowledge in aeronautical structural and engine regulations

Knowledge in advanced aeronautical material

3. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1 PDR review	PDR actions closure report		T0 +4
D2 CDR review	CDR presentation		T0 + 11
D3 Plug manufacturing	Plug manufacturing report	Quality and acceptance report of the manufactured elements	T0 +22
D4 Review before ground tests	Review before Ground test presentation	Structural and safety presentation before the ground tests	T0 + 25
D5 Engine permit to flight review	Review of the flightworthy component	Structural and safety presentation of a flightworthy component Permit to flight substantiation document	T0 + 28
D6 Tests reports	Tests reports		T0 + 31
D7 Test reports analysis	Test reports analysis	Summary of the tests, lessons learnt	T0 + 32

4. Topic value (€)

The total anticipated eligible cost of the proposal including manpower, travel costs, consumables, equipment, other direct costs, indirect costs, and subcontracting shall not exceed: **€ 2.000.000** (VAT not applicable) [Two millions Euro]

Topic Description

CfP topic number	Title		
JTI-CS-2012-02-SAGE-03-014	**Weight saving through used of CFRC components in high temperature application (=>360°C) for efficient aero-engine design**	**Start date**	*T0*
		End date	*T0 + 24M*

1. Topic Description

SAGE 3 aims to demonstrate technologies that will improve the efficiency of large 3-shaft turbofan engines through weight reduction, and that will contribute to noise reduction through innovative engine externals, composite fan system, compressor structures and low-pressure turbine design. Furthermore to develop enabling manufacturing technologies and materials where these are necessary to deliver the engine technologies for demonstration.

Composite materials, because of the high specific stiffness, strength and possibilities for moulding high tailored integrated components to near net shape with limited need for secondary finishing operations are able to offer very attractive weight reduction and the possibility of cost reduction compared with incumbent materials. Reduced component weight provides the potential for wider system weight reductions leading to substantial opportunities for improved fuel efficiency and reduced emissions

The excellent fatigue performance and damage tolerance of carbon fibre reinforced organic matrix composites provide significant potential for reducing the weight of major components in the gas turbine engine and increasing their operating life when used in applications prone to vibration.

However the temperature capability of organic matrix composite materials creates a boundary to further exploitation in turbofan engine applications. Although a number of aerospace qualified high temperature systems are available, their processing characteristics, environmental sensitivity, cost and other legislative export restrictions limit their attractiveness and prevent substantial weight and fuel efficiency benefits from being realised.

In order to answer the needs of the SAGE3 in terms of research, technological development and demonstration activities, it is planned to offer individual tasks to the industry, universities or any legal entity. Therefore, the present Call for Proposal supports the further development of advance materials for high temperature applications.

The objective of this proposal is to deliver a cost effective organic matrix resin with 360°C temperature capability which exhibits both robust performance and processing characteristics that will enable high rate production of carbon fibre reinforced organic matrix composite components. Possible applications of this technology are the vanes at the first stage of an IP/LP Compressor.

To demonstrate this technology the partner/consortium shall select a material system, demonstrate resin properties, define processing parameters and with the Topic Manager input, design and manufacture test pieces for demonstration. In the following step the composite material performance, in terms of temperature, stiffness, strength and environmental resistance shall be tested following internationally recognised test methods.

Based on the given requirements, the partners work includes the following tasks:

Task 1: Management

Organisation:

• The partner/consortium shall nominate a team dedicated to the project and should inform the Topic Manager about the name/names of the key staff. At least the responsibility of the following functions shall be clearly addressed: Programme lead (single point contact with the Topic Manager), technical specialist and quality leader.

Time Schedule & Work-package Description:

• The partner/consortium is working to the agreed time-schedule and work-package description.

• The time-schedule and the work-package description laid out in this Call shall be further detailed as required and agreed at the beginning of the project.

Progress Reporting & Reviews:

• Regular coordination meetings shall be installed (preferred as telephone conference).

• The partner/consortium shall support reporting and agreed quarterly progress review meetings with reasonable visibility on its activities and an adequate level of information referring to all agreed work-packages, technical achievement, time schedule, potential risks and proposal for risk mitigation.

• Annual written reports will be provided to the Clean Sky Joint Undertaking are also to be provided to the Topic Manager.

General Requirements:

• The partner/consortium shall work to a certified standard process.

• The proposal should include an exploitation plan for material technology indicating the range of industry and component for which the material may be applicable.

Task 2: Development of a Polymer Formulation and Format

• In this task the consortium will take the functional requirements described in the call and select from a number of candidate material systems a formulation and format that will be required processing in order to manufacture panels and components.

• The partner/consortium will characterise the chemical, physical, thermal and mechanical properties of the material system and identify and address any concerns related to Health Safety and Environmental characteristics to form the basis of a material specification.

Task 3: Determination of processing characteristics and performance

• The partner/consortium will determine the key processing characteristics of the material system and, supported by the Topic Manager, determine a suitable processing specification and tolerances to achieve the desired component manufacturing capability, performance and quality.

• Perform sufficient manufacturing trials and post-moulding destructive and non destructive evaluation and testing to validate the robustness of the processing specification.

• Manufacture and non-destructive evaluation of panels for testing

• Following internationally agreed testing methods characterise the elastic and strength properties of the material system at a range of temperatures and equilibrium moisture contents

• Perform selected testing of the material system when exposed to a range of pooling and non-pooling engine fluids (fuels, oils, hydraulic fluids etc.) and at a range of temperatures

• Perform tests, with support from the Topic Manager to determine thermal oxidative stability, micro-crack resistance under thermal shock and fire performance characterisation of the material system.

Task 4: Validation of Performance

Sub-element demonstrator

• With the support of the Topic Manager develop and design a suitable sub-element specimen to demonstrate and validate the material system performance in a critical failure mode.

• Design, manufacture or procure suitable tooling and bought-out parts for the sub-element manufacture.

• Manufacture of sub-element demonstrator components for material system validation (estimated number of specimens=30).

• Sub-element static and fatigue validation testing

• Post failure sectioning, fractography/failure investigation and reporting

Component demonstrator

• With the support of the Topic Manager develop and design the aerofoil-shape component demonstrator to enable validate the material system for rate manufacture.

Figure 1 - Typical vane geometry (note that the components to be manufactured will be agreed between the Partner and Topic Manager but this illustration shows typical level of complexity.)

• Design, manufacture or procure suitable tooling and bought-out parts for the component manufacture. Figure 1 illustrates a typical vane geometry to clarify the complexity level for the manufacture tooling.

• Manufacture of components for visual, dimensional, destructive and non-destructive evaluation to meet the Topic Manager drawing requirements and tolerances

• Manufacture of components for rate manufacture validation (12 conforming components). The components shall be tested by the Topic Manager at later date.

2. Special skills, certification or equipment expected from the applicant

- Resin development and manufacture. Preform development would be an advantage
- Extensive experience in the detail design, development and manufacture of light weight composite parts for high performance aerospace applications. Experience of suitable quality control systems is essential.
- Successful experience, with demonstrable benefits, of application of innovative manufacturing and material technologies to reduce weight and cost of aerospace parts is an asset. Availability of technologies at an high readiness level to minimise programme risks is an asset.
- Experience in aerospace R&T and R&D programmes.
- The partner/consortium needs to demonstrate to have access to the manufacturing facilities required to meet the goals.
- The activity will be managed with a Phase & Gate approach and management plan has to be provided. the Topic Manager will approve gates and authorise progress to subsequent phases.
- Technical/programme documentation, including planning, drawings, manufacturing and inspection reports, must be made available to the Topic Manager.

3. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Detailed Project Plan	schedule with milestones, technical specification of process and equipment	T0+1M
D2.1	Material Selection	Selection of high temperature resin meeting functional and processing requirements	T0+3M
D2.2	Material specification characteristics	Determination of the material system characteristics to enable a specification to be written and the properties understood	T0+6M
D3.1	Processing Specification	Processing variables and limits determined and robustness and quality validated	T0+9M
D3.2	Material and MoM system selection	Selection of material system and MoM	T0+9M
D3.3	Manufacture Test Panels	Test panels for mechanical and environmental testing specimens	T0+12M
D3.4	Mechanical Test Report	Results of mechanical testing, environmental and thermal exposure testing reported	T0+14M
D4.1	Sub-element and tool design and manufacture	Tooling ready for production tests and manufacture of 30 sub-element specimens	T0+12M
D4.2	Test sub-elements and Test Report	Results of static and fatigue tests reported	T0+18M
D4.3	Demonstrator and tool design	Tooling ready for production tests	T0+12M
D4.4	Manufacture demonstrator and quality assurance	Manufacture 12x	T0+23M

4. Topic value (€)

The total anticipated eligible cost of the proposal including manpower, travel costs, consumables, equipment, other direct costs, indirect costs, and subcontracting shall not exceed:

€ 850.000 (VAT not applicable)

[Eight hundred and fifty thousand Euro]

Clean Sky Joint Undertaking
JTI-CS-2012-02-SAGE-03-015

Topic Description

CfP topic number	Title		
JTI-CS-2012-02-SAGE-03-015	**Ring Rolling of IN718**	Start date End date	*T0* *T0+30M*

1. Topic Description

The subject of this call for proposal is the development and validation of a **R**ing **R**olling (RR) alone route for disc manufacture in IN718 Superalloy. This manufacturing route is a potential alternative to the current standard, which depends to a higher or lesser extent on **C**lose **D**ie **F**orging (**CDF**).

This proposal covers two sets of complementary aspects. On one hand, it covers topics with a Manufacturing insight. On the other, it deals with issues which are relevant from an engineering viewpoint. The latter is of particular importance in the case of discs as they are required to satisfy high demanding requirements in terms of integrity and life.

From the manufacturing standpoint, this project will require the development of a sound knowledge of the evolution of IN718 material structure as a result of continuous rolling. This will require generating both basic and experimental knowledge upon the effect of hot forming parameters on the resulting material (micro) structure. All manufacturing attempts shall target the best material usage (profiling or near-net shaping) so that this aspect is no longer a potential drawback when compared with CDF.

From an end-user viewpoint, this CfP will target demonstrating equivalence of both material structure and mechanical properties with that resulting from the current route, which does involve to a higher or lesser extent Close Die Forging. This activity will require accounting for the potential contribution of anisotropy on the structure / properties as this is expected to be different from that obtained by Close Die Forging. Engineering activities will require conducting material testing and sub-element testing for back-to-back comparison and to demonstrate equivalence with the current standard.

Full duration of the project: 4 years

- **Project Stage 1.- Review of requirements; identification of gaps.**

Duration: **1 month**

This activity shall focus on the compilation of the requirements from the OEMs. These will involve details with regards to the intended material structure as well as its expected mechanical properties. Additionally, a state of the art compilation shall be completed with regards to the existing modelling technology, Ring Rolling manufacturing capability etc. At this Project Stage a deliverable shall be issued with detailed definition of the specific needs; experimental, modelling etc. to take over the further Stages of the Project.

- **Project Stage 2.- Feasibility Study 1; Manufacturing at Subscale Level**

Duration: **12 months**

As part of this Project Stage, the manufacture of subscale components will be launched. This activity shall allow definition of a feasible geometry and process window to obtain the required material structure. The information generated hereby will additionally feed Modelling Activities. The Project at this Stage shall deliver a feasible geometry and process window and expected outcomes in terms of material structure to feed Project Stage 3. A critical review of the information generated at this very point shall feed a decision being taken to continue with the Project.

- **Project Stage 3.- Feasibility Study 2; Manufacturing at Component Level**

Duration: **12 months**

As part of this Project Stage, the manufacture of representative shapes will be launched. Although details of the geometry cannot be fixed upfront, preliminary values are as follows: ID~800mm, Height

≐150 thickness ~130mm. A number of manufacturing attempts will be completed to get a reasonable process map. A detailed evaluation of the resulting material structure together with a simple material characterisation shall be completed to drive a back-to-back comparison with that resulting from conventionally processed (Close Die Forging) IN718. The Project at this Stage shall deliver detailed information from the manufacturing trials and review and comparison against the initial predictions conducted in Stage 2 and the requirement per Stage 1. A critical review of those results shall support the definition of the detailed activities to be undertaken in Stage 4.

- **Project Stage 4.- Mechanical Testing Validation**

Duration: **5 months**

Data generated in Stage 3 shall allow a comparison to be made with previously existing data. Similarities or differences found between the material structure obtained by Ring Rolling vs. Close Die Forging and the preliminary mechanical data will feed and drive the definition of additional mechanical testing. The later will typically involve in addition to conventional material tests, completing sub-element testing, covering component representative loading conditions.

2. Special skills, certification or equipment expected from the applicant

• The applicant shall have a sound background on superalloys, their metallurgy and forming technologies; i.e. hot forming. This knowledge shall include both theoretical and experimental aspects.

□□The applicant shall be able to design a process (tooling and associated equipment included) and have the capability to manufacture with the relevant process controls, representative ring geometries. This existing capability shall allow exploring the potential and limitations of a Ring Rolling alone forging route. This activity might require launching specific trials (Design Of Experiments) on representative rings so as to evaluate the cross effect of the relevant forging parameters in order to cover from simple up to profiled rings.

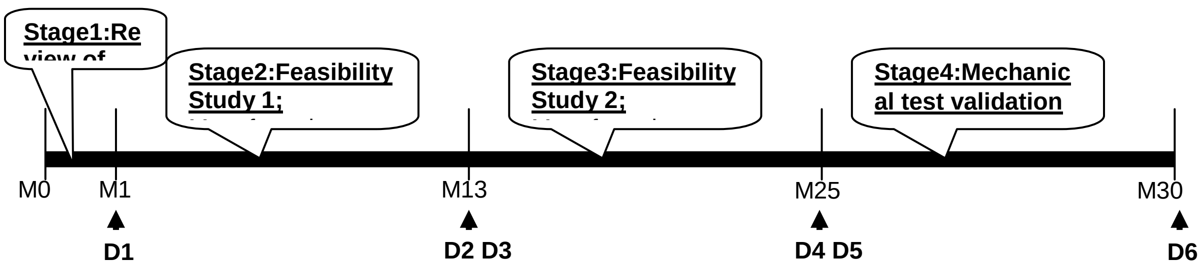
□□The applicant shall already have the basic theoretical and experimental knowledge on material flow behaviour while forging. It is acknowledged some dedicated (lab scale or otherwise) testing might be needed to cover Ring Rolling.

□□The applicant shall already have the capability to understand and predict material structure as a result of Forging Processes. Although some degree to experience and awareness on the specificities of Ring Rolling is preferred, it shall be able to develop and validate a material model to cover Ring Rolling alone and to incorporate it to a process modelling software tool.

□□The applicant shall have or have access to laboratory testing facilities necessary for assessing the metallurgical condition and mechanical behaviour of IN718; either in the various intermediate stages while being rolled or the final product.

The later will typically involve the following tests being conducted covering different geometries and loading conditions: tensile and or compression, low cycle fatigue, crack propagation, fracture toughness etc.

3. Major deliverables and schedule



Deliverable	Title	Description (if applicable)	Due date
D1	Review of requirements and gaps identification report	Compilation of the requirements, of the state of the art analysis.	M0+1M
D2	Subscale components manufacturing		M13
D3	Geometry and process window report	Report specifying the feasible geometry and process window and expected outcomes in terms of material structure	M13
D4	Manufacturing trials at component level.		M25
D5	Trials detailed analysis report	Report summarising the resulting material structure , back to back comparison with close die forging and comparison with requirements in D1	M25
D6	Mechanical tests analysis report	Report summarising the mechanical tests performed and the analysed data.	M30

4. Topic value (€)

Budget: The Maximum Allowed Topic Budget is

1.000.000,00 €

[one million Euro]

The maximum funding value is between 50% and 75% of the Maximum Allowed Topic Budget indicated above according to the CfP rules.
Please note that VAT is not applicable in the frame of the Clean Sky programme.

Topic Description

CfP topic number	Title		
JTI-CS-2012-02-SAGE-04-019	**Development of physically based simulation chain for microstructure evolution and resulting mechanical properties focused on additive manufacturing processes**	Start date	*T0*
		End date	*T0+36M*

1. Topic Description

A first generation of geared turbofan engine (GTF) technology has found its way into the regional and narrow body market due to significant reductions in fuel consumption and noise compared to conventional turbo fan engines.

The purpose of the advanced GTF demonstrator as part of the Sustainable and Green Engine (SAGE) platform is to further advance these technologies and to achieve a next step change in fuel burn reduction combined with an additional decrease in noise emission. Components and modules with new technologies are to be developed, implemented and validated through rig testing as required before integration into a donor engine and SAGE4 full engine demonstration. The successful validation of technologies for this aircraft engine concept will then facilitate the early introduction of innovative new products into the market, and significantly reduce the environmental impact of air transport.

In order to answer the needs of the SAGE4 geared turbofan in terms of research, technological development and demonstration activities, it is planned to offer individual tasks to the industry, universities or any legal entity. Therefore, the present Call for Proposal supports the further development of manufacturing methods with a high optimization potential to allow alternate designs of environment-friendly aero-engine components, fabricated by means of an additive manufacturing process.

The specification of additive manufacturing methods is a challenging task due to the high degree of freedom within process parameters can be varied. To bail out the optimisation potential and guarantee all aviation specific safety requirements as well, it is fundamental to understand allowable process parameter variations without loosing part integrity and stable mechanical properties. It is known that unfavourable combinations result e.g. in porosity, incomplete fusion, segregation or directed solidification with anisotropic material behaviour or locally different response to heat treatment cycles.

To manage this task, the actual Call for Proposal is requesting to generate and validate a simulation chain for microstructure evolution and resulting mechanical properties focused on additive manufacturing processes. All modelling approaches should be physically based to adopt developed tools to future machinery generations as well as further materials of interest in an easy way.

In dependence on JTI-CS-2010-05-SAGE-04-008 which is focussed on more general part properties, like distortion and residual stresses, this proposal claims on simulation of interplay between beam and powder, local microstructure evolution and corresponding mechanical properties of a local substructure to eliminate the risk of before mentioned just local failures.

Regarding MERLIN, another substantial Level-1 FP7 project the difference is in length scale where simulation has to be applied. Based on state of the art techniques, it is not appropriate to work towards an integrated tool for all length scales due to different approaches, system requirements and e.g. calculation times.

Summing up this CfP topic activity synergizes the other projects by closing the simulation gap concerning the formation of local property and their interaction with direct neighbourhood.

Application of the simulation chain ends in a detailed understanding of the formation of failures and how to avoid them for robust process design, which is another important step to allow a design driven manufacturing for future aero engines parts optimized in weight and function. As a result, it is shown how to couple the different approaches and which link is needed to handle the interdisciplinary question within a multi scale simulation framework. All models have to be validated on given reference geometries and boundary conditions.

Parallel product introduction is accelerated and Clean Sky objectives can be reached earlier or with an wider product range. Additionally, the opportunity is offered to work close together with SLM machinery supplier for further improvements by identification of key parameters due to virtual sensitivity studies.

Based on the given targets, the partners work includes the following tasks:

Task 1: Management

Organisation:

– The partner shall nominate a team dedicated to the project and should inform MTU Aero Engines GmbH project manager about the name/names of this key staff. At least the responsibility of the following functions shall be clearly addressed: Program (single point contact with MTU Aero Engines), Techniques & Quality.

Time Schedule & Work Package Description:

– The partner is working to the agreed time-schedule & work package description.

– Both, the time-schedule and the work package description laid out in this Call shall be further detailed as required and agreed at the beginning of the project.

Progress Reporting & Reviews:

– Quarterly progress reports in writing shall be provided by the partner, referring to all agreed work packages, technical achievement, time schedule, potential risks and proposal for risk mitigation.

– Regular coordination meetings shall be installed (preferred as telecom).

– The partner shall support reporting and agreed review meetings with reasonable visibility on its activities and an adequate level of information.

– The review meetings shall be held in MTU Aero Engines facility.

General Requirements:

– The partner shall work to a certified standard process.

Task 2: Meltpool Physics

The objective of this task is to simulate the interplay between beam and powder. The first question is about transferability of electron beam adsorption models to laser machinery. From a physical point of view, laser adsorption is much more complex e.g. due to reflexion processes within the powder bed. Methods for abstraction should be prepared to handle SEBM as well as SLM. If necessary, a separate model for laser beam adsorption has to be developed and validated. This model must be able to capture the following main parameters:

- focus position
- beam energy
- scanning velocity
- track pitch
- metal powder (bulk density, particle size distribution, particle morphology, layer thickness)
- wetting
- pre-/ and postheating of powder bed

Primarily the tool must be able to predict effects of parameter variations on surface quality, porosity and incomplete weldung resulting in a material disconnection.

Special emphasis lies on the simulation of grain structure and orientation formation in a semi-empirical way to use the detailed understanding generated in task 3 for a larger simulation domain. Consequently it must be possible to export the temperature field and couple it to a detailed, physically based solidification simulation specified in task 3.

After succesful application, the influence of radiation of thermal energy and convection of heat to inert gas stream above the powder bed have to be investigated. Addionally, the effect of foreign particles with different wetting behavior e.g. oxides inside recycled powder must be evaluated in context to previous mentioned parameters and resulting failures.

With respect to the adressed specific problems, potential proposals should be based on an already existing simulation tool which can be enhanced to cover task 2. Current technical capabilities and limitations have to be displayed within the proposal.

Task 3 : Solidification and Heat Treatment

Based on task 2, the solidification of molten powder has to be modeled within a phase-field approach. Focus is on a detailed unterstanding about the formation of local grain structure, especially on the changeover between equiaxed and directed solidification. Therefore, the tool must be able to import the temperature field of task 2 and acount for different ambience conditions. This means for example the existence of powder or already solidificated melt from a previous layer in direct neighbourhood to the meltpool.

The structure information has to include grain size, orientation and aspect ratio depending on typical process parameters listed in task 2.

The simulation should also provide information about the segregation behaviour and precipitation kinetics during temperature-time-cyles or pre- and postheating. Therefore, a connection to thermodynamic and mobility databases is necessary. Following databases are available at MTU Aero Engines GmbH or allowed to use:

- ttni8.tdb (ThermoTech Ltd.) and niba1.mob (WTM, University Erlangen-Nuernberg)
- mc_ni_v1.012.tdb and mc_ni_v1.000.ddb (MatCalc)
- freely available databases

In case of using freely available databases, their comparability to commerical ones has to be demonstrated.

Task 3 is coupled to task 4 due to the possibility of exporting the structure information for setting up crystal elasticity and plasticity calculations based on the simulated grain structure. This is completed by the temperature field which was imported from task 2 and manipulated by crystallisation heat. In other direction, the simulation tool claimed within this task should be able to import a plastic strain field calculated in task 4 for the simulation of grain coarsening and texture development during high temperature heat treatment.

In order to adopt the model for different alloys, a procedure how to determine or fit critical input values, e.g. melt viscosity depending on temperature and chemistry as well as interfacial energy between solid an melt, must be shown.

If feasible, the consideration of interplay between solidification and meltpool flow would present an additional advantage.

Task 4: Local Deformation Behaviour

Task 4 realises the connection between previous simulated microstructure evolution and mechanical properties. This can be achieved by implementation of a crystal elasticity and plasticity deformation model in combination with classical finite element methods. Within this framework Abaqus or CalculiX have to be used as FE-solver.

Focus is on the calculation of yield and tensile strength for a given grain structure based on simulations done in task 3. Due to different alloys and changes in e.g. precipitate phase fractions a model including material specific parametrisation is requested. Process relevant thermal gradients require also a temperature dependent modeling approach. The tool must provide the capability to exchange necessary information between task 3 and 4 directly in both directions. This means the import of grain morphology, orientation, precipitate status and temperature field as well as an export of resulting plastic strain fields for the calculation of grain coarsening and texture formation.

In order to adopt the model for different alloys a procedure how to determine or fit critical input values, e.g. specific hardening behavior, must be shown. This is especially needed for alloys not available as single crystals.

In consequence, the output-tool of task 4 is able to predict anisotropic material behaviour and initiation of heat cracking as well as possible interactions with foreign particles or pores. Therefore, setups of at least 40 grains must be easily (calculation time) manageable.

The potential to expand the approach to reproduction of cyclic load responses and/ or viscoplastic material behavior presents an additional advantage. This applies also for an automatism to import EBSD patterns.

Overall

In relation to the intended simulation chain all information will be probably two dimensional. Because of this, at least task 4 has to investigate supposible effects out of a third dimension by e.g. synthetic microstructures.

During the development technical readiness of all previous claimed simulation, tools must be demonstrated on characteristic experiments. In case one chain link (simulation or characterisation) fails the partners must prepare fall-back alternatives for compensation of missing information within the simulation chain. If necessary, MTU Aero Engines GmbH will try to provide testing capabilities or already available experimental results from microstructure characterisation.

The material of interest is primarily IN718 as typical forge alloy with low precipitate phase fractions and slow precipitate kinetics. Since in future parts made of Mar M-247 with high Gamma Prime volume fraction and fast thermokinetics will be built, all tools must be able to handle typical cast Nickelbase Superalloys as well.

Each task should end with a sensitivity study to identify critical parameters or parameter combinations. A soft coupling of all tools is achieved and operational reliability is shown for a Clean Sky demo part.

This necessitates also the implementation of each tool into the softwarearchitecture of MTU Aero Engines GmbH. Therefore, an early cooperation with relevant departments is necessary.

2. Special skills, certification or equipment expected from the applicant

Scale bridging simulation capabilities and experience in coupling microstructure evolution with mechanical properties.

Ability to model and simulate the behaviour of melting and cooling of metals by providing multiple years of experience in usage of multi-physics simulation environments.

General materials knowledge in terms of aerospace relevant manufacturing processes (e.g. friction welding, friction stir welding, grinding, laser welding, electron beam welding).

Specific knowledge in alloys relevant to aerospace applications, especially Nickelbase Superalloys with high Gamma Prime volume fraction as well as their deformation behaviour in terms of dislocation mechanisms typically for these alloys.

Profound knowledge of technical requirements in terms of aero engines components (e.g. strength, surface and microstructure quality, specifications, process control, quality requirements).

Intensive knowledge in the development of simulation approaches for manufacturing processes, including structural, process and material aspects.

In-house validation of the simulation results in terms of manufacturing with different laser and electron beam ALM equipment as well as technology for high resolution microstructure characterization to validate models from task 2 to 4.

3. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Detailed Work Flow Analysis	Report: Interfaces and data formats technically specified; Best available technology and conclusions documented; Boundary conditions for software executability at MTU aligned	T0 + 6M
D2	Proof of Principle	Report and Animation/Video when possible: Demonstration of coupling and interplay between all tasks	T0 + 12M
D3	Individual Model Validation	Report: Separate validation of each model for addressed materials; Boundary definition within each tool allows interpolation	T0 + 21M
D4	Simulation Chain Application	Report and Animation/Video when possible: Application to a Clean Sky demo part	T0 + 24M
D5	First Software Transfer	Tool integration at MTU Aero Engines GmbH and user training to define further emphasis regarding software development	T0 + 26M
D6	Validation of Simulation Chain and Optimisation	Report and Animation/Video when possible: Overall approach is validated on demo part; Proposals for optimisation are prepared for integration until D7	T0 + 30M
D7	Final Software Test		T0 + 34M
D8	Final Report and Sensibility Study	According to scientific standard and including manuals as well as tutorials	T0 + 36M

4. Topic value (€)

Budget: The Maximum Allowed Topic Budget is **1.000.000,00 €** [one million Euro] The maximum funding value is between 50% and 75% of the Maximum Allowed Topic Budget indicated above according to the CfP rules. Please note that VAT is not applicable in the frame of the Clean Sky programme.

Clean Sky –Smart Fixed Wing Aircraft

Identification	ITD - AREA - TOPIC	topics	VALUE	MAX FUND
JTI-CS-SFWA	**Clean Sky - Smart Fixed Wing Aircraft**	**9**	**12,700,000**	**9,525,000**
JTI-CS-SFWA-01	*Area01 – Smart Wing Technology*		**1,700,000**	
JTI-CS-2012-2-SFWA-01-049	Demonstration of the feasibility of an in-flight anti-contamination device for business jets		650,000	
JTI-CS-2012-2-SFWA-01-050	Development and construction of master moulds for riblet application		350,000	
JTI-CS-2012-2-SFWA-01-051	New aircraft de-icing concept based on functional coatings coupled with electro-thermal system		400,000	
JTI-CS-2012-2-SFWA-01-052	Innovative aircraft ice protection system – sensing and modelling		300,000	
JTI-CS-SFWA-02	*Area02 - New Configuration*		**7,500,000**	
JTI-CS-2012-2-SFWA-02-029	Design and manufacturing of baseline low-speed, low-sweep wind tunnel model		1,000,000	
JTI-CS-2012-2-SFWA-02-030	Low speed aeroacoustic test of a large CROR rig in an open jet test section		1,300,000	
JTI-CS-2012-2-SFWA-02-031	Aeroacoustic and aerodynamic wind tunnel tests at low speed for a turbofan model equipped with TPS		2,000,000	
JTI-CS-2012-2-SFWA-02-032	Low speed aeroacoustic test of large CROR aircraft model in an open jet test section		3,200,000	
JTI-CS-SFWA-03	*Area03 – Flight Demonstrators*		**3,500,000**	
JTI-CS-2012-2-SFWA-03-010	BLADE wing structural test to derive test data for subsequent validation of GFEM modelling		3,500,000	

Clean Sky Joint Undertaking
JTI-CS-2012-02-SFWA-01-049

Topic Description

CfP Topic Number	Title		
JTI-CS-2012-02-SFWA-01-049	**Demonstration of the feasibility of an in-flight anti-contamination device for business jets**	Start Date	Nov 2012
		End Date	Nov 2014

1. Topic Description

A promising solution for future aircraft and business jets drag reduction for fuel consumption savings is a laminar wing design. The accretion of insect on the leading edge being one of the major disturbances of the laminar flow, the present CfP topic aims to design, manufacture, test and validate an in-flight wing leading edge cleaning device system prototype suitable for a business jet.

The device must be capable of cleaning the wing leading edges after take-off when leaving the ""insect-zone"", the top limit of which is at around 500m above ground level.

Extra general requirements for the cleaning system are:
- The system must clean up around 5% of the chord wing pressure and suction sides.
- The wing surfaces must not be altered by the introduction of cracks or joints.
- The system must be fully integrated within the aircraft systems and also be hidden when not in use.

Experiments must validate, in the closest to real operational conditions:
- The efficiency in terms of cleaning:

The height of insect debris should not exceed 80µm after cleaning. The selected cleaning principle must be compatible with flight conditions in terms of relative wind and temperature.
- The feasibility in structural terms:

The presence of the cleaning device on the leading edge during flight shall avoid damaging the wing structure and shall minimize the weight penalty on the aircraft. The cleaning device must remain on the leading edge even under off-nominal conditions and the holding of the cleaning device must not scratch the surface, the cleaning principle selected being compatible with the coating of the wing surface.
- The feasibility in terms of dynamics:

The cleaning system motion must be controllable at any time under post-take-off aerodynamics constraints.

Considering the other environmental conditions (humidity, salt fog, chemicals, erosion and so on, as defined in RTCA DO160D certification) encountered by the aircraft, there shall be no need to validate these by means of experiments but the design of the device shall take in considerations such constraints.

The applicant also has to pay particular attention to the potential industrialisation of the product which will be developed during this study.

The applicant shall perform the following work :
- Preliminary design of the cleaning system

The goal is to select a cleaning principle and to pre-design a prototype cleaning device.

- Final design of the cleaning system and prototype final definition

The goal is to adapt the cleaning device to the wing, taking into account particularly operational conditions, the aircraft interfaces and cleaning kinematics. Dassault will provide the detailed specifications of the wing to be equipped, including a CATIA model. The wing will present the following features :
  - Wing span: around 12 m; root thickness: around 40cm, decreasing to the tip;
  - Fixed leading edge (no slats);
  - Laminar design on the upper-side and lower side of the wing until around 50% of the

chord. Therefore, as stated in the introduction, the cleaning device installation shall not destroy the laminar properties of the wing.

The pictures below illustrate the integration constraints of the cleaning device :

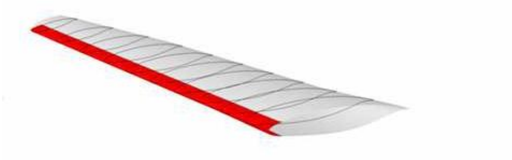


Fig. 1 General 3D view showing the zone to be cleaned

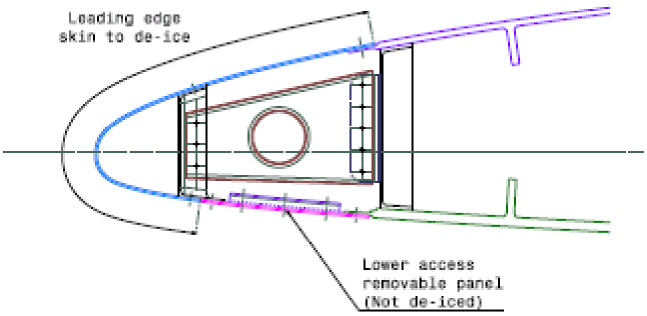


Fig. 2 Wing cross section showing the internal structure and the de-iced areas

A mid-term milestone will be attached to the delivery of the final design (see 3. Major Deliverables, Milestones and Schedule). This will correspond to the achievement of a Technology Readiness Level of 4 and will allow for the go-ahead to be given to the final manufacturing and testing of the prototype.

- Experimental setup design and definition of tests

The experimental strategy and the associated planning have to be defined. This task also includes the design of the experimental platform, the manufacturing of the prototype and of the other parts required to run experiments as well as the final assembly.

- Experiments

The ground experiments shall be run in at least two rounds, including wind tunnel tests, in order to allow for iterations on the prototype design. No flight tests are required. The optimised prototype must also be designed according to production constraints and be based, as much as possible, on aeronautical components and materials which are already certified.

- Synthesis and recommendations for the cleaning device industrialisation, if successful.

2. Special Skills, Certification or Equipment expected from the Applicant

- Experience in the design of mechanical devices for aircraft
- Experience in wind tunnel testing
- Experience in experimental motion control
- Experience in aircraft systems integration
- Experience in the aerodynamic and structural modelling of aircraft systems

3. Major Deliverables and Schedule

Ref. Nr.	Title	Due
D 1	Design of the in-flight cleaning system prototype	M6
D 2	Definition of the experimental setup and planning of the test campaign	M9
D 3	Intermediate conclusions of the experiments	M14
D 4 ML 1	Definition of the final prototype Available detailed design of the final prototype for validation	M15
D 5	Final report	M24

4. Topic value

The total value of biddings for this work package shall not exceed

650.000,00 €

[six hundred and fifty thousand euro]

Please note that VAT is not applicable in the frame of the CleanSky program.

CfP Topic Number	Title		
JTI-CS-2012-02-SFWA-01-050	**Development and construction of master moulds for riblet application**	Start Date	Jan 2013
		End Date	Dec 2013

1. Topic Description

Background :

Painted riblets, very small grooves of about a hundred microns with sharp ridges embossed into the aircraft's painted surface, may reduce the surface drag significantly under turbulent flow conditions. An applicator was built for use at laboratory scale and another CfP topic, which is currently running, aims at building an applicator for large aircraft parts. These applicators work with a patched matrix. The single step process of application and UV-curing is shown in Figure 1 below. The substrate with a UV-curable laquer and a UV-transparent silicone matrix with the negative structure of the riblets are displayed. The curing process takes place through the UV-transparent silicone stamp. The riblet paint structure after curing is shown in Figure 2.

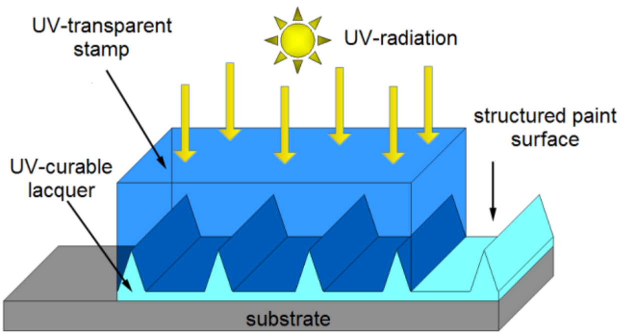


Figure 1: Application and curing of riblet painting through the silicone matrix

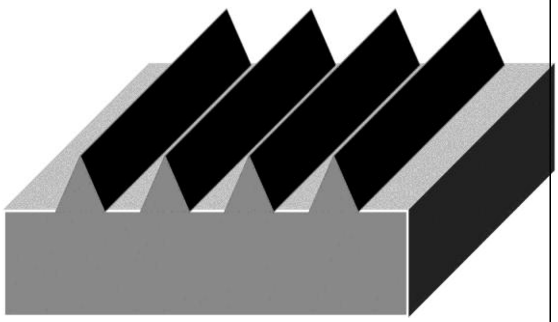


Figure 2: Final riblet structure on a substrate

Scope of work :

The applicant has to design and manufacture two master moulds for silicone matrices with overall dimensions of 1200 mm x 1200 mm with two different riblet geometries.

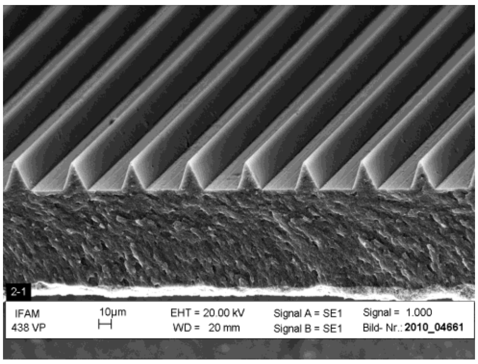


Figure 3: Scanning Electron Microscope of the painted Riblet-structure on metal substrate

The SEM micrograph shows the painted riblet-structure with the very sharp tips to get an impression of the precision needed to manufacture a master mould.

Description of work :

The subject of this CfP topic is the development and construction of a mould for the riblet silicone matrix with a negative structure of the riblets (see Figure 1) used for the application of riblet paint on aircraft external surfaces (fuselage, wing, Horizontal Tail Plane). The expected outcomes of the work are two master moulds (ideally metal shims with a thickness <300µm) with positive riblet geometry to produce a negative riblet structure on the siliconebelt. The defined geometries are shown in the following figure:

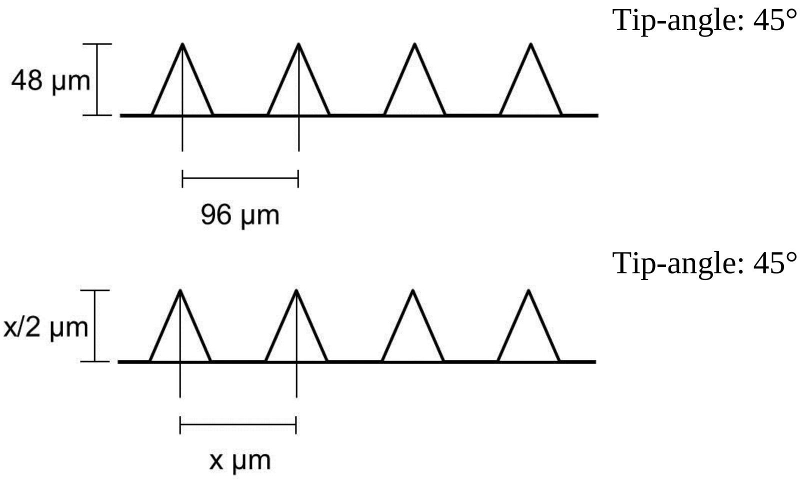


Figure 4: Riblet geometry

For the second geometry the value of x has to be defined. The tip-radius of the riblets has to be very sharp (0,5 µm). The tip-angle is 45°. This is one major quality criterion. It is also important to realize the distance from tip to tip of 96 microns (+/-2 microns). The precision of the painted structure will be controlled by SEM.

It is also very important that the silicone matrices which can be produced by this master mould are seamless with no defects in the microstructure and no joints in the patch over the required area of 1200x1200mm. Additionally the applicant should perform a study regarding the feasibility of producing a cylindrical shim for the production of silicone belts (see Figure 5 below) with a diameter of 382mm and a height of 500mm out of the above described flat shims.

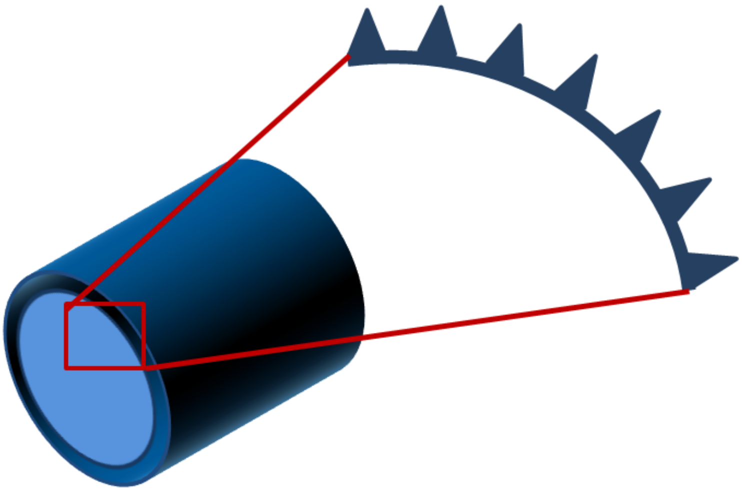


Figure 5 : Scheme of the cylindrical shim and the enlarged Riblet structure

A seam will probably be unavoidable. This should be both as invisible as possible and smooth enough to have no influence on the functionality of the applied riblet structure. It is expected that the feasibility will be shown by a paper study supplemented by small scale experiments (e.g. a small welded piece).

2. Special Skills, Certification or Equipment expected from the Applicant

- The applicant has to have a verifiable expertise in the manufacturing of micro- and nano structured surfaces
- The applicant has to have experience in the manufacturing of master moulds made of metal shims

3. Major Deliverables and Schedule

Del. Ref. Nr.	Title	Description (if applicable)	Due
1	Design of the device, tools	Report on the design approach including drawings, list of parts, etc.	M0 + 3 M
2	Manufactured hardware	First mould has to be manufactured including quality check of riblet matrix	M0 + 6 M
3	End report	Second mould has to be manufactured including quality check of riblet matrix End-report	M0 + 12 M

4. Topic value

The total value of biddings for this work package shall not exceed

350.000,00 €

[three hundred and fifty thousand euro]

Please note that VAT is not applicable in the frame of the CleanSky program.

CfP Topic Number	Title		
JTI-CS-2012-02-SFWA-01-051	**New aircraft de-icing concept based on functional coatings coupled with electro-thermal system**	**Start Date**	Nov 2012
		End Date	May 2015

1. Topic Description

Laminar wing design involves a surface free of contamination, be it due to insect impact or to ice accretion. Dimensions higher than 100 µm shall be avoided.

Techniques are currently available which avoid ice formation (anti-icing techniques) or which perform ice de-cohesion (de-icing techniques). These may be based on thermal, mechanical or thermo-mechanical activation. Whereas these active techniques have now reached a high level of development, little attention has been paid to their combination with passive coating strategies based on icephobic or superhydrophobic coatings.

This CfP topic focuses on a dual approach combining anti-icing/de-icing electro-thermal systems with passive coatings. In such systems, and at low temperatures, the water which has been heated can freeze further on the wing. This phenomenon is called 'run-back icing' and may be dangerous for the aircraft or diminish the laminar benefit.

The goal of this CfP topic is to propose and test new concepts based on passive coatings which would minimize run-back icing and optimize the efficiency of electro-thermal systems. This means the development and manufacturing of model coatings and the experimental characterization of these coatings, individually at first and combined with an electro-thermal system in a second instance.

The applicant shall propose a research program organized around three axes:

I. The understanding of the respective roles of the chemistry and the topography of the interfaces involved in the adhesion of cooled water and ice. After an initial literature review, tests will be performed on model materials with respectively well controlled surface chemistry on the one hand and well controlled surface topography on the other hand. The outcome of these tests will be the definition of the more relevant parameters for ice adhesion.
II. The development of mixed anti-icing and de-icing concepts through the combination of smart coatings with electro-thermal systems.
III. The validation of these mixed strategies through a wind tunnel aircraft demonstrator.

Axis 1 and Axis 2 will require the development of a specific experimental setup to perform dynamic wettability tests.

2. Special Skills, Certification or Equipment expected from the Applicant

The partner or the group of partners must have the facilities and knowledge necessary to implement the whole process of applying functional coatings (textured process materials and coating deposition process) to wing-specific materials. They must also be able to characterize them through physical, chemical and multi-scale surface analysis.

Two specific skills are required:

1. ice adhesion tests (micro-mechanical and chemical interaction between ice and coating)
2. static/dynamical wettability measurements in representative conditions of wing environment (from -20 °C to room temperature).

It would be greatly appreciated if the applicant had facilities for developing dedicated experimental devices.

3. Major Deliverables and Schedule

Ref. Nr.	Title	Description (if applicable)	Due
D1 (Axis I)	Literature review on the role of topography versus chemistry in wettability	Report Documents including, for icephobic, superhydrophobic and superhydrophilic applications, selected coating materials, surface topographies and surfaces treatments processes	T0+5 month
D2 (Axis II)	Conception and optimization of dynamic wettability characterization equipment	Development of a specific demonstrator to study coating performance on a laboratory scale.	T0+10 month
D3 (Axis III)	Characterization of wettability and ice adhesion in static and dynamic conditions	Report Selecting icephobic coating design to be manufactured and subsequently tested.	T0 +18 month
D4 (Axis III)	Selection of mixed coating/electro-thermal strategies	Report Selecting icephobic coating/electron-thermal design	T0+24 month
D5	Synthesis report	Conclusion – proposal for an optimized de-icing strategy and concept	T0+30 month

4. Topic value

The total value of biddings for this work package shall not exceed
400.000,00 €
[four hundred thousand euro]

Please note that VAT is not applicable in the frame of the CleanSky program.

Clean Sky Joint Undertaking
JTI-CS-2012-02-SFWA-01-052

CfP Topic Number	Title		
JTI-CS-2012-02-SFWA-01-052	**Innovative aircraft ice protection system – sensing and modelling**	**Start Date**	Jan 2013
		End Date	March 2014

1. Topic Description

Introduction

Within the Clean Sky project, the Smart Fixed Wing Aircraft Integrated Technology Demonstrator explores the application of Natural Laminar Flow (NLF), Hybrid laminar Flow Control (HLFC) and Fluidic Controlled Surfaces (FCS) to a range of aircraft concepts. Those technologies result in wing sections that have distinctly different shapes compared to normal turbulent sections, principally in the leading edge region. A feature is that the leading edge radius is typically much smaller for laminar wings and the available volume in the leading edge is reduced. This results in aerodynamic characteristics that are identifiably different to turbulent sections even when the laminar wing is operating fully turbulent. In addition, the change of section will modify the distribution and rate of build up of ice compared to the turbulent reference. In order to optimise the leading edge design it is important to maximize the function and minimise the impact of the ice protection system. This forms the basis for this Call for Proposal (CfP) topic.

The increased sensitivity of laminar wings to ice accretion in all flight phases defines the global ambition of this activity. The overall aim is to produce a system model of a future wing ice protection system that is capable of active control of ice for either de-icing or ice avoidance. Such a system may require the development of new, innovative sensing and communication technologies. The outputs from this activity should be equally relevant to NLF, HLFC and FCS wings.

Description of the CfP topic

This CfP topic will have 3 main objectives:

1. the development of a system architecture model for an active ice protection system;
2. the development of innovative sensing options to support the active ice protection strategy;
3. an overall aircraft model that demonstrates the effectiveness of the new ice protection system.

The scope of the work should include applications for both composite and metallic components, NLF and HLFC technologies and a variety of ice protection strategies e.g. electro-thermal, electro-mechanical etc. The final combination of ice protection models and capabilities should be capable of demonstrating a contribution to reduced fuel burn for integrated wing solutions.

The development and the design of actuators for ice removal are excluded from this CfP topic. Ice removal from leading edge movables and the engine inlets is also excluded.

Scope of the work

Task 1: Development of a model for asymmetry of an unevenly iced aircraft.

The objective of this task is to develop a system model of the aircraft response to asymmetric build-up of ice either before system activation or as a response to isolated system failures. This model is intended to be used as a top level input to the ice protection system to ensure that aircraft symmetry is maintained during all flight phases with or without a fully functional ice protection system. The sensitivity of the aircraft to asymmetric ice accretion will also be used to define the requirements of the sensing system and/or components.

Ice build-up on a generic wing and its resulting effect on drag and lift shall be modelled. The wing shall be divided in the model into segments/zones since each wing segment may have different ice build-up characteristics and some zones may react differently to similar ice shapes. You may choose any sensors you wish as input to the model as long as the global impact on the aircraft is included in an assessment of overall benefit. The use of sensors already present in the aircraft to augment the ice protection system should be considered.

A verified (not validated) model of the systems architecture shall be delivered where the degree of asymmetry is estimated as a function of chosen sensors and system faults in various zones. The model shall also be able to suggest how the local ice protection system in the different zones shall be controlled to overcome any asymmetry. A Matlab/Simulink environment shall be used, i.e. a system model shall be delivered.

The model shall be open for any partner to use within the SFWA project.

Task 2: Sensors for ice detection and measurement

Based on requirements to be derived from Task 1 and from existing aircraft ice protection requirements that will be made available after Contract award, this task will investigate both new innovative sensing technologies and the dual use of existing sensors as part of the global ice protection system.

The sensing system should be capable of detecting isolated asymmetric build up of ice both in terms of thickness and rate of accumulation on wings. It is expected that appropriate tests to confirm the function of the sensing system will be conducted within this CfP topic. The re-design of existing sensors is acceptable. The sensing system may have functions that increase the accuracy of the system. The final objective of the sensing system is to maintain full functionality for different types of ice and variations in humidity and temperature and yet preserve a low weight on the aircraft.

A verified and validated Matlab/Simulink model shall be delivered to describe the sensor system output as a function of ice layer thickness, ice build up rate and/or ice/no ice. How well the sensing system maintains full functionality for different types of ice and variations in humidity and temperature shall be shown and delivered. Weight estimate shall be delivered.

It is expected that any relevant background knowledge will be made available by the successful applicant for the research work and for future use. Relevant knowledge should be declared as part of the original submission.

2. Special Skills, Certification or Equipment expected from the Applicant

Task 1: The applicant should have several of the following skills and knowledge:
- Knowledge of requirements for flight control systems for civil aviation;
- Aerodynamic skills;
- Modelling experience (Matlab/Simulink).

Task 2: The applicant should have several of the following skills and knowledge
- Ice build-up modelling;
- Experience in ice protection systems;
- Modelling experience (Matlab/Simulink);
- Ice sensors experience including experience in ice measurement.

The following equipment is required in Task 2
- Ice wind tunnel for tests of sensors.

Task 1+2: The tool Matlab/Simulink is required.

3. Major Deliverables and Schedule

Ref. Nr.	Title	Description (if applicable)	Due
1	Task 2: Review and approval of sensor specification. Review of work plan.	Milestone	M0+ 3 M
2	Task 2: Review and approval of feasibility of proposed sensors to be implemented in model.	Milestone	M0+ 6 M
3	Task 2: Delivery of model for ice detection/measurement sensors	Model	M0 + 12 M
4	Task 2: Report consisting of a summary of the work and results.	Report	M0 + 13 M
5	Task 1: Review of work and model plan	Milestone	M0 + 3 M
6	Task 1: Delivery of model	Model	M0 + 12 M
7	Task 1: Report consisting of a summary of the work and results.	Report	M0 + 13 M
8	Final report	Report	M0 + 15 M

4. Topic value

The total value of biddings for this work package shall not exceed
300.000,00 €
[three hundred thousand euro]

Please note that VAT is not applicable in the frame of the CleanSky program.

Topic Description

CfP Topic Number	Title		
JTI-CS-2012-02-SFWA-02-029	**Design and manufacturing of baseline low-speed, low-sweep wind tunnel model**	**Start Date**	March 2013
		End Date	Dec 2013

1. Topic Description

This topic is devoted to the manufacturing of a large scale half-model for testing in a pressurized low speed wind tunnel (WT). The fuselage will be provided by Dassault-Aviation. It may be modified for this test but should be designed to be returned to its supplied condition for future use on another WT. These modifications should be considered as part of this CFP topic.

Most of the model design will be completed under a previous CfP topic (JTI-CS-2010-3-SFWA-02-007), Some adaptation of the design to the final geometry may nevertheless be necessary as part of this topic.

The parts to be manufactured are therefore:
- A left-hand side modular wing;
- A set of body-wing fairings to fit with the fuselage;
- A left hand side cross-shaped Horizontal Tail Plane (HTP) that fits with the former model HTP root chord;
- A simplified main landing gear and its cavity.

The wing will be an innovative low sweep high aspect-ratio design with an airfoil designed to be laminar in cruise conditions (M=0.75 – 43kft). Innovative high-lift systems are outputs of related SFWA studies and shall include:
- Krueger slats;
- Innovative Flaps devices;
- Conventional single and double slotted flap.

Wing modularity also includes:
- A removable leading edge for different leading edge concepts;
- Spoilers and airbrakes;
- Ailerons.

General Size of the model

The model is a left-hand-side half-wing with high aspect ratio (between 9 and 12) and low sweep (between 15 and 25°).

At model scale, the half-wing will be roughly 2.25 m in span for an area of about 1 m^2.

At model scale, the HTP will be 0.8 m in span for an area of 0.26 m^2.

The generic Falcon fuselage will be provided by Dassault-Aviation and adapted to the new wing by the applicant. One can therefore imagine the wing shim of the new wing to be designed as the older Falcon wing and the external shape of the body-wing fairing to be modified to fit the new fairing-wing intersection.

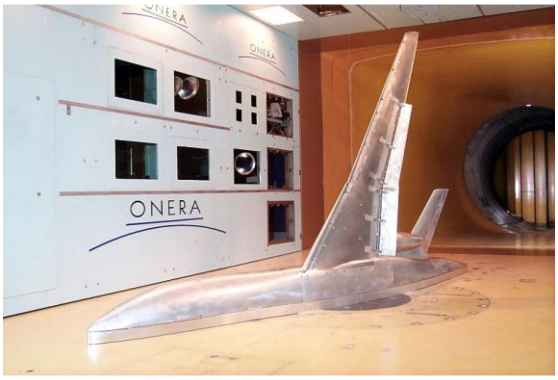


Figure 1: Provided generic Falcon fuselage with nacelles with a generic Falcon Wing

Fuselage description

In the current FALCON model, from which the fuselage will be provided as part of this topic, the wing is directly attached to the balance via an interface plate. The same setting will be used for the model. Karman (the belly fairing) will be modified and/or rebuilt to fit with the new wing depending on the modifications needed.

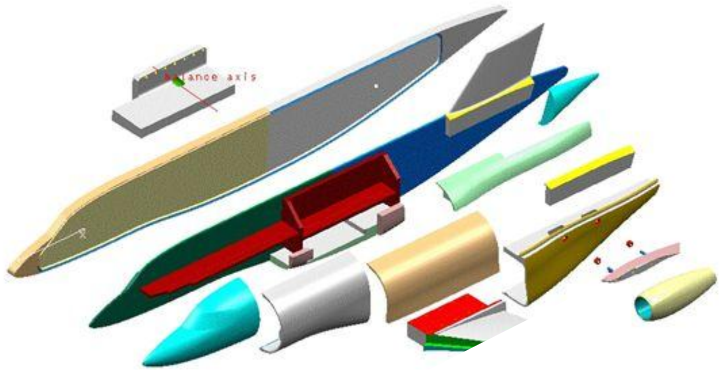


Figure 2: Cutaway of the fuselage

Wing description

Wing modularity

The wing includes:

- A common wing-box from around 25% chord to 60% chord.
- A removable leading edge with
    - 4 different parts in span;
    - For each part in span, 3 different leading edge shapes.

Some 12 different leading edge parts with an expected chord extension of 25% are therefore required.

- A modular trailing edge architecture capable of 3 different trailing edge concepts:
    - Conventional single slotted flaps
        - Clean configuration: the flaps are at 0° deflection;
        - Take-off configuration including a +-5° modification deflection system. The brackets shall permit a slight capacity of overlap and gap settings (roughly a X and Z setting capacity);
        - Landing configuration including a +-5° modification deflection system. The brackets shall permit a slight capacity of overlap and gap settings (roughly a X and Z setting capacity).

- Innovative Flap devices:
  - Clean configuration: the flaps are at 0° of deflection;
  - Take-off configuration: at a given extension, a bracket that enables a camber setting from -20° to 20°. The brackets shall also permit a slight capacity of overlap and gap settings (roughly a X and Z setting capacity);
  - Landing configuration: at a given extension, a bracket that enables a camber setting from -20° to 45°. The brackets shall also permit a slight capacity of overlap and gap settings (roughly a X and Z setting capacity).

- Double-slotted or double camber flaps:
  - Clean configuration: the flaps are at 0° of deflection;
  - Take-off configuration including a +-5° modification deflection system. The brackets shall permit a slight capacity of overlap and gap settings (roughly a X and Z setting capacity);
  - Landing configuration including a +-5° modification deflection system. The brackets shall permit a slight capacity of overlap and gap settings (roughly a X and Z setting capacity);
  - The second part of the flap (second camber device) shall permit a -20° to 20° deflection capacity.

In terms of moving parts, one shall therefore consider:

- 3 different inner and outer flaps;
- 2 sets of flap roofs (one for the “Smart Flaps” and one for the other two sets of flaps)
  - For the conventional flap roof, 4 spoilers/airbrakes have to be considered with 4 deflections each;
  - For the “Smart Flap” roof, the applicant shall design an all moving flap roof divided in 4 or 5 parts in span. All the parts shall rotate on a hinge at the root in chord but brackets will be necessary to assure the different deflection under WT loads.

In order to simplify the model, and if financial issues arise, it may be possible to use a single set of inner and outer flaps for both the double camber and mono camber devices, if the applicant can define a deflection system that leaves the “clean” flap free of external disturbances (such as brackets).

- An aileron.
- A set of Kruger slats with slight capacity of gap and overlap settings. The Kruger slat will be dedicated to only one set of leading-edge. This specific set of leading edge shall therefore also present a removable lower panel to mimic the open cavity when the slat is deployed. The Krueger slat will be divided in 4 parts in span and for each part, 3 different set of brackets will be manufactured to enable a different slat deflection.
- A simplified main landing gear with doors will be manufactured and integrated into the wing in a generic cavity. The cavity will be closable with a dedicated part at the lower wing shape for clean and take-off configurations.

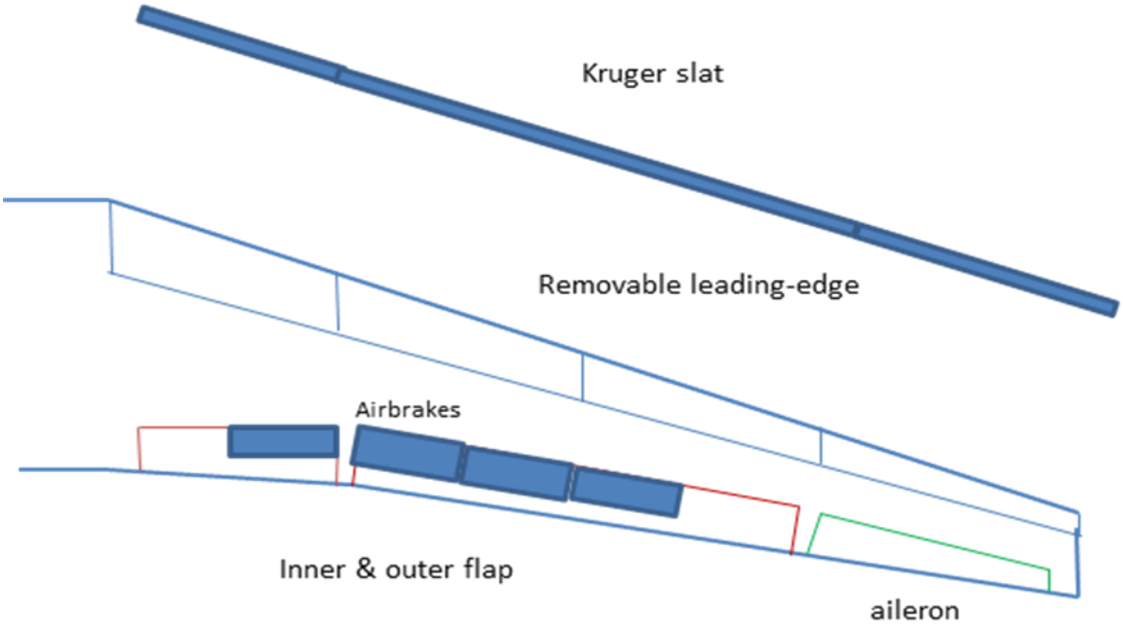


Figure 3: Illustration of wing plan-view and expected modularity

Wing Instrumentation

The wing will be equipped with 4 lines of around 100 pressure probes. In a given line, there will be some pressure taps in the

- Wing-box;
- Leading-edge;
- Flap (pressure needed for all deflections);
- Aileron.

To achieve quick-change capacity during the test, one shall therefore consider the installation of quick connectors for the taps in the moving parts.

Four strain gauges will be installed on the upper part of the wing.

HTP description

The HTP will be a simple one-piece, all movable part, which means that no movable elevator is required as part of this topic. This new HTP will match with the old HTP attachment fitting in order to minimize manufacture and to enable a trim capacity.

Model loads

Expected loads on the wing model are (X Chord-Wise ; Y Span-Wise; Z Normal):

- Fx = 4000 N
- Fy = -10000 N
- Fz = 50000 N
- Mx = -4000 Nm
- My = -10000 Nm
- Mz = 5200 Nm

The expected normal loads on moving parts are:

- Inner flap: 800 N
- Outer Flap : 1800 N
- Slats (loads for the full span) : 3200 N

Expected loads on the HTP model are:

- Fx = -3400 N
- Mx = -900 Nm
- My = -350 Nm (at 40% chord)
- One can increase these values by 20% to take into account the dynamic loads at stall

Shape tolerances

The applicant shall respect the given tolerances:

Shape tolerance	+-0,1	mm
Root airfoil angle setting	+-0,1	°
Local twist (root airfoil reference)	+-0,075	°
Moving surfaces deflection (flap, slat, aileron)	+-0,1	°
Flap overlap & gap setting	+-0,15	mm
Slat overlap & gap setting	+-0,1	mm
Leading-edge roughness including slats & flaps (x/c > 0,25)	Ra<0,2	µm
Other parts Roughness	Ra<0,4	µm
Slat & Leading-Edge Waviness (x/C < 0,25)	< 0,5	%
Pressure taps diameter	0,4	mm

The applicant shall also adjust the different parts to avoid any backward or forward facing step at the skin of the model. One shall pay special attention to the leading-edge/wing-box adjustment where some sealing is needed to avoid upper/lower wing contamination.

Control of the model

The applicant shall include a critical design review of the model. A detailed document will be provided by Dassault to complete the following instructions, in order to specify inspection requirements according to the final geometry of the model. The specification will concern single parts as well as the overall model inspection (size, dihedral, twist of the wing…).

Due to the high loads of the WT test, the applicant is also asked to proceed with a control of gap and overlap for the flap and slat under representative loads for each configuration (Take-off & Landing).

Planning of the topic

This topic is devoted to the manufacturing of parts of the low speed model. The structural design of the model is to be performed by Aircraft Research Association Limited, UK as part of the previously mentioned CfP topic (JTI-CS-2010-3-SFWA-02-007). This structural design work is expected to begin in January 2013 and to last two to three months. The CAD-File of the model will be in CATIA V5 R18 readable format. The CAD file will be provided by Dassault directly to the applicant. The outputs of former studies are therefore :

- The CAD file of the model to be manufactured with its structural design, including:
    - Instrumentation integration

   - Type of raw material to use in given parts (steel, aluminium, …)
   - Fasteners
   - …
- Justification of the model design in regards of the loads foreseen during the WTT.

The subsequent manufacturing of the model parts may therefore start, as part of this CfP topic, in March 2013. It is of course assumed that if there is a delay in finalizing this first part of the work, this topic (beginning and end) will be delayed accordingly.

The shipment of the complete model and the needed storage boxes are the responsibility of the applicant.

2. Special Skills, Certification or Equipment expected from the Applicant

- The applicant shall have extensive experience in designing and manufacturing models for pressurized WTs in the aeronautical field.
- The applicant shall comply with Dassault-Aviation procedures concerning WT model design and manufacturing. These procedures will be provided in the model requirement document to be issued in Q4 2012.
- The applicant shall be proficient in using Dassault Systèmes CATIA V5 R18 Software.

3. Major Deliverables and Schedule

Del. Ref. Nr.	Title	Description (if applicable)	Due
1	Model final design review		M0 + 2 M
2	Model control Review		M0 + 9 M
3	Model set of drawings		M0 + 9 M
4	Supply of the model at the WT		M0 + 9 M

4. Topic value

The total value of biddings for this work package shall not exceed

1.000.000,00 €
[one million euro]

Please note that VAT is not applicable in the frame of the CleanSky program.

Topic Description

CfP Topic Number	Title		
JTI-CS-2012-02-SFWA-02-030	**Low Speed Aeroacoustic Test of a Large Open Rotor Rig**	**Start Date**	Jan 2013
		End Date	Aug 2013

1. Topic Description

Clean Sky is investigating the potential of Counter Rotating Open Rotor (CROR) engines. In the Smart Fixed Wing Aircraft (SFWA) technology demonstrator there is a dedicated Technology Stream addressing the aerodynamic performance and acoustic signature of such engines. In this framework a low speed aero-acoustic Wind Tunnel (WT) Test has to be conducted with an existing rig.

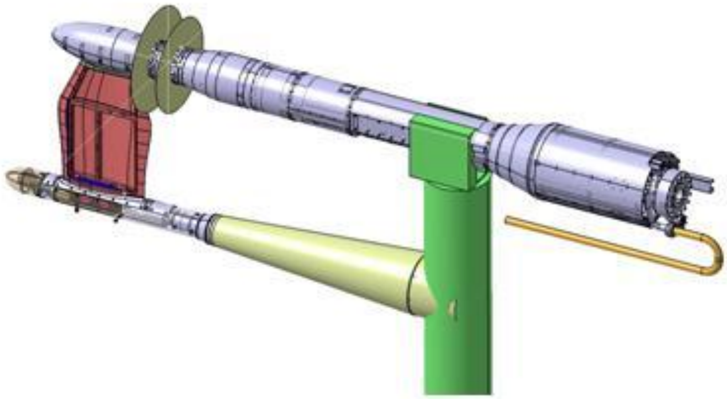
Specifications of the rig, which is to be equipped with one CROR engine, are as follows:
- Large scale CROR-powered rig;
- 0,85m propeller diameter;
- One 425kW per shaft counter rotating engine (max total 708kW), requiring pressurized air with a maximum mass flow of 12kg/s at 70 bar pressure at turbine entry.
- The model is mounted on a suitable support structure with engine feed and return air.

The applicant shall develop optimised engine feed and return lines (minimized pressure losses) to assure availability of maximum engine power.

The applicant shall test the model in a large low speed WT of their choice. This must be able to cover the following conditions:
- Mach number ≥ 0.22;
- The tunnel should have an anechoic open test section for Far Field noise evaluation;
- The test section should be larger than 8m of width by 6m of height;
- The model test support shall be acoustically treated and compatible with variable yawing angles, while keeping the propellers on the axis of rotation and out of the influence of the shear layer;
- The applicant shall apply advanced steady and unsteady acoustic measurement methods.

An innovative approach is requested in setting up and operating a fast data acquisition system able to record all unsteady pressures and balance data at high sampling rates with at least one day of storage capacity on the facilities' local data acquisition system.

The applicant shall apply innovative acoustic measurement such that CROR noise signature is captured both in the flow of the tunnel but also out of the flow, within the open jet test section. Moreover the applicant must ensure that those measurements are synchronized with rig engines such that local Open Rotor flow physics could be correlated to Far Field noise signature. In particular, the applicant shall put in place innovative in-flow measurement that minimizes the effect of reflection and boundary layer from the inflow device itself to its measured signal.



2. Special Skills, Certification or Equipment expected from the Applicant

Mandatory skills:
- Recognized skills in external aerodynamic & aero-acoustic experimental characterization;
- Recognized skills in aerodynamic steady and unsteady measurements, and in the storing and processing of acoustic data;
- Availability of experienced tunnel staff ensuring high productivity testing, including model changes and operation of the pressurized engine simulators.

Mandatory equipment:
- Large low speed closed WT capable of Mach 0.22, with a test section greater than 8m wide by 6m high;
- Ability to supply the required mass flow and pressure to the rig;
- Advanced steady and unsteady acquisition and storage systems.

3. Major Deliverables and Schedule

Ref. Nr.	Title	Description (if applicable)	Due
1	WT Test campaign description	Complete description of the WT test campaign, including all activities related to model installation, shake down, testing and model de-rig for80 hours of productive testing	M0 + 1M (by start of Test)
2	Preliminary test data	Delivery of complete preliminary test database, including raw data, steady state data & dynamic data (including all acoustic data near & far Field)	M0 + 2M (at test completion)
3	Final test data	Delivery of complete final test database, including raw data, steady state data & dynamic data (including all acoustic data near & far Field)	M0 + 3M (i.e. 1 month after the test)
4	WT Test Report	Test report to include full description of the experimental setup including a detailed run log and validated data description	M0 + 3M (i.e. 1 month after the test)

4. Topic value

The total value of biddings for this work package shall not exceed **1.300.000,00 €** [one million three hundred thousand euro] Please note that VAT is not applicable in the frame of the CleanSky program.

Topic Description

CfP Topic Number	Title		
JTI-CS-2012-02-SFWA-02-031	**Aeroacoustic and aerodynamic wind tunnel tests at low speed for a turbofan model equipped with TPS**	**Start Date**	Jan 2013
		End Date	Sept 2013

1. Topic Description

This topic is devoted to a low speed, low Reynolds Wind Tunnel Test of a representative large scale powered model. The design of the model is an output of former SFWA studies.

In this challenging WTT, several critical aspects of the shielding empennage technology will be evaluated:
- Aerodynamic interaction of the Horizontal Tail Plane/Vertical Tail Plane (HTP/VTP) with the jet exhaust for critical flight phases such as take-off and landing;
- Acoustic shielding of the engine turbomachinery noise by the empennage;
- Dynamic loads on the Horizontal Tail Plane (HTP) under aircraft stall or engine in reverse mode;
- Ground effect behavior.

The WTT is divided into two main parts: one part is devoted to acoustics measurement with/without TPS (Turbine Powered Simulator) and the other part to aerodynamic behavior of the HTP with TPS running with and without ground effect.

Model Description

The model is to be designed and manufactured by a consortium composed of:
- Aircraft Research Association Ltd (ARA) & Future Advance Manufacturing (FAM). They are responsible for the design and manufacture of the aft fuselage, the U-Tail, the powered nacelles (integration & feed of the TPS and the wing);
- Dassault-Aviation & INCAS who share the design and manufacturing of the front & central fuselage including the strut & balance integration.

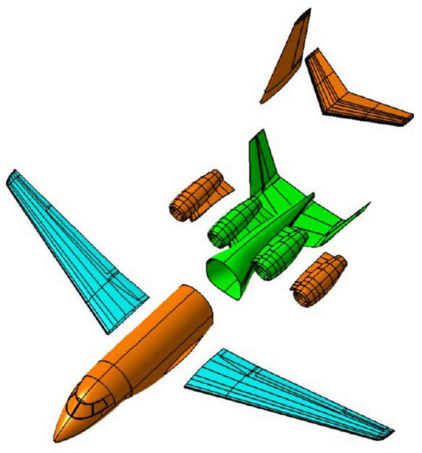


Figure 4: Cutaway of the model: ARA sections in green, FAM sections in blue & Dassault/INCAS sections in orange

Major characteristics of the model are:
- Around 4m length and 5m span;
- Around 1000Kg;

- Fitted with ONERA-DNW owned 7.8" TPS;
- Maximum loads to be taken into account for the model are:
  - Fz = 5500 N;
  - Fy = 2800 N;
  - Fz = 35000 N;
  - Mx = 2700 N.m;
  - My = -5500 N.m;
  - Mz = 1650 N.m.

Instrumentation of the model is described below:

- Around 110 Kulite XCQ-062 5 psi in one TPS nacelle;
- 10 Kulite transducers on U-Tail and cross-shaped tail;
- 240 pressure taps on the wing;
- 90 pressure taps on the U-Tail;
- 60 pressure taps on the +-shaped Tail;
- One strain gauge on Krueger slat;
- One strain gauge on U & + shaped Tail.

The fully equipped model (Kulite transducers and TPS) will be provided to the applicant by the consortium, nevertheless the interface parts between :

- The strut and the balance and
- The strut and the isolated TPS

are part of this topic. The applicant shall in particular provide a solution to fit the isolated TPS in the same position/attitude as the installed TPS.

WTT DESCRIPTION

A low speed WTT at atmospheric conditions is requested. Maximum speed of the free-stream should be 85m/s. It is divided in two major parts:

- Open section acoustics WTT with different objectives/configurations:
  - Isolated TPS to identify the TPS noise (spectrum, directivity, …) with/without free-stream flow;
  - Installed TPS mainly for shielding & reflectivity effects (U-Tail, cross shaped tail, wing…);
  - Airframe noise to identify the innovative laminar wing noise.
- Close section WTT for aerodynamics with TPS
  - With/without Ground effect.

Therefore, the following capability of the WT are required:

- Angle of attack from -5° to 25° for aerodynamics (closed section);
- Side-slip angle from -20° to 20° for aerodynamics (closed section);
- Ground effect capacity with moving belt;
- Open/close section;
- Acoustic treatment of the strut & WT walls in open section;
- 85m/s maximum free-stream flow at atmospheric conditions;
- Capability to deal with the ARA/FAM model (4x5m) in terms of tunnel section and balance integration. The balance will be provided by the WT.
- Compressed air capacity to feed the TPS (1.5 kg/s maximum mass flow for each TPS);
- Kulite acquisition system for a maximum of 120 Kulite transducers at a time (+ the WT Kulite transducers needed for acoustics acquisition);
- Antenna and array (1 fly-over and 2 lateral array) of microphones on the ground for acoustics data acquisition;
- Far-field antenna for TPS acoustics directivity (no X-wise traverse needed).

Description of acoustics acquisition system

The following characteristics of the acoustics acquisition system are required:

- 3 lines of microphones on the ground under the model
  - 1 line for fly-over;
  - 2 lines for lateral;
  - For these lines, the microphones would be located X-wise every 10° from the nozzle exit upstream and downstream (at least 10 meters in each direction if possible, depending on the distance between the model and the ground). And the lateral microphones will be located at an angle of about 50°/55° from the model (around 10 meters between each line of microphones if possible).
- Far-field antenna located between the nozzle exit of the model and the end of the empennage;
- Array of microphones on the ground for airframe noise identification.

Calibration of the TPS
The TPS will be calibrated in its nacelle before the test for installed thrust and WT corrections evaluation.

WTT Matrix
The following configurations and polars are expected.

Isolated TPS

One shall consider stabilized points in the angle of attack in order to identify the TPS noise:

- With and without free-stream flow (V=0 & 60m/s);
- With different TPS regimes (RPM): TPS off and at 5 different regimes.

One nominal angle of attack will be studied. 22 different stabilized points are therefore expected, each of them including:

- Far field array;
- Array of microphones that mimic fly-over (1 line) and lateral (2 lines) acoustics certification points.
- 110 Kulite transducers from the TPS nacelle

Installed TPS

For the installed TPS configuration, it is assumed that only one nacelle shall be equipped with TPS, the other one being through-flow.

Around ten different configurations will be tested (Clean, Take-off, different HTPs…). For all of these configurations, three different TPS regimes will be tested with and without free-stream flow (60m/s). One nominal angle of attack will be identified under stabilized conditions.

The instrumentation of the WT & model for this test part is:

- Kulite transducers from the TPS nacelle (around 110 transducers);
- Pressure taps from the wing & HTP;
- Far field array;
- 3 arrays of microphones on the test section ground (2 for lateral and one fly-over).

Airframe noise

For this part of the test, the nacelles are assumed to be through-flow ones.

A dozen of different configurations will be tested (clean, take-off, with or without slat, with or without landing gears…). For all of these configurations, three different angles of attack will be tested with three different free-stream conditions (50/60 & 70m/s).

The instrumentation of the WT & model for this test part is:

- 1 fly-over and one 2 lateral array of microphones;
- Far-field antenna;
- Antenna on the test section ground for noise source identification;
- Pressure taps from the wing & HTP;
- Noise source for the calibration of the antenna.

Aerodynamic Test

For aerodynamics, it is assumed that both nacelles are fitted with TPS. TPS "off" points are to be considered in wind-milling conditions. Most of the points will be alpha sweep, an additional 20% polars are to be considered for side slip angle sweep. The following configurations will be tested:

- Clean configuration with different HTP/VTP configurations. For each configuration, elevators trim settings and TPS regime modifications will be performed.
- Take-off configuration with different HTP/VTP configurations. For each configuration, elevators trim settings and TPS regime modifications will be performed. Some polars are in ground effect.
- Landing configuration with different HTP/VTP configurations. For each configuration, elevators trim settings and TPS regime modifications will be performed. Some points are in ground effect. Reverse mode (on one TPS only) will be also tested.
- A limited wing sweep effect will be performed with cross-shaped tail for the three configurations (Clean, Take-off & Landing).

The acquisition of a total of 120 Kulite transducers & all of the pressure taps are requested for this part of the test.

The estimated number of alpha sweeps is 120.

Data provided during and after the test

The applicant shall provide data during (preliminary data, in order to monitor the test) and after the test (final data).

For acoustics, examples of data required include (the following is a non exhaustive list which will need consolidating during further talks between the applicant and the Topic Manager):

- Temporal data without treatment for the airframe noise;
- Beamforming data for the airframe noise;
- Location of the microphones on the ground and of the centre balance on the model for each flight point;
- Corrected fine band data for far-field microphones;
- Location of the microphones as part of the fly-over and lateral arrays;
- Spectral data & RMS value (specification to be written by both the applicant and the TM before the test);
- Aerodynamic data (model, free-stream flow) of the measured flight points;
- TPS characteristics (thrust, RPM, mass-flow …).

For aerodynamics, examples of data required include (the following is a non exhaustive list which will need consolidating during further talks between the applicant and the TM):

- Aerodynamic data of the model (Cl, Cd, pitching moment…) and free-stream flow (speed, dynamic pressure, Reynolds number...);
- TPS characteristics (thrust, RPM, mass-flow, …);
- Temporal & spectral data from the Kulite transducers (including RMS);
- Outputs data from the strain gauges;
- Videos of the model if special visualization techniques are used (mini tuft, bouillies, Infra Red…).

During the test & for all configurations tested, photos shall be taken which shall also be part of the data provided after the test.

All data will be provided on dedicated storage support (hard disk, DVD …) in ASCII format.

Planning of the Topic
The Model will be available during the second quarter of 2013. The WTT is therefore expected to run at the end of Q2 2013 or during Q3 2013. As the WT operator is involved in interfacing the strut with the model, the topic shall begin in 2013 at the earliest if an adaptation of the model is needed. The test will be performed under the leadership of Dassault-Aviation and with the cooperation of:

- ONERA (acoustics)
- INCAS (Model provider & acoustics)
- ARA/FAM (Model provider)

2. Special Skills, Certification or Equipment expected from the Applicant

- The Applicant shall provide a WT section capable of the whole program presented above
- Model Size & Weights;
- Air speed;
- TPS alimentation in compressed air;
- Acoustics measurement capacity and limited background noise;
- Ground effect with moving belt capacity.
- The Applicant shall have extensive experience in low speed testing with TPS.
- The Applicant shall have extensive experience in acoustics measurements.

3. Major Deliverables and Schedule

Del. Ref. Nr.	Title	Description (if applicable)	Due
1	Test program	Instrumentation of the WT and list of test points	M0 + 2 M
2	Strut interfaces design	Definition and launching of the manufacturing of the interface parts	M0 + 4 M
3	Calibration report	Report concerning the calibration of the TPS	M0 + 5 M
4	Minutes of WTT	Short sum-up of the WTT campaign	M0 + 8 M
5	Final report	Report and data	M0 + 9 M

4. Topic value

The total value of biddings for this work package shall not exceed

2.000.000,00 €
[two million euro]

Please note that VAT is not applicable in the frame of the CleanSky program.

Topic Description

CfP Topic Number	Title		
JTI-CS-2012-02-SFWA-02-032	**Low speed aeroacoustic test of large aircraft model with open rotor engines**	Start Date	Oct 2012
		End Date	April 2013

1. Topic Description

Clean Sky is investigating the potential of Counter Rotating Open Rotor (CROR) engines. In the Smart Fixed Wing Aircraft (SFWA) technology demonstrator there is a dedicated Technology Stream addressing the aerodynamic performance and acoustic signature of such engines. In this framework a low speed aero-acoustic Wind Tunnel (WT) Test has to be conducted with an existing model.

Specifications of the model, which is to be equipped with two engines, are as follows:
- 5.11m full span;
- Two 170kW per shaft counter rotating engines, one on each side of the fuselage, each requiring pressurized air with a maximum mass flow of 7.2kg/s at 80 bar pressure;
- The model is mounted on a dorsal sting with feed and return air for the two engines;
- The maximum model dead weight is 17,000 N.

The applicant shall develop optimised engine feed and return lines (minimized pressure losses) to assure availability of maximum engine power.

The applicant shall test the model in a large low speed WT of their choice. This must be able to cover the following conditions:
- Mach number up to 0.22;
- The tunnel should have an anechoic open test section for Far Field noise evaluation;
- The test section should be larger than 8m of width by 6m of height;
- The model test support shall be acoustically treated and compatible with variable pitch & yawing angles, while keeping the model on the axis of rotation and out of the influence of the shear layer;
- The applicant shall apply both advanced acoustic and steady and unsteady aerodynamic measurement methods.

An innovative approach is requested in setting-up and operating a fast data acquisition system able to record all unsteady pressures and rotating thrust balance data at high sampling rates with at least one day of storage capacity on the facilities' local data acquisition system.

The applicant shall apply innovative acoustic measurement such that CROR noise signature is captured both in the flow of the tunnel but also out of the flow, within the open jet test section. Moreover the applicant must ensure that those measurements are synchronized with rig engines such that local Open Rotor flow physics could be correlated to Far Field noise signature. In particular, the applicant shall put in place innovative in-flow measurement that minimizes the effect of reflection and boundary layer from the inflow device itself to its measured signal.

2. Special Skills, Certification or Equipment expected from the Applicant

Mandatory skills:
- Recognized skills in external aerodynamic and aero-acoustic experimental characterization.

Mandatory equipment:
- Large Open Jet low speed wind tunnel capable of Mach 0.22 with a measuring test section bigger than 8 m x 6 m;
- Advanced acoustic instrumentation and acquisitions systems.

3. Major Deliverables and Schedule

Ref. Nr.	Title	Description (if applicable)	Due
1	WT Test campaign description	Complete description of the WT test campaign, including all activities related to model installation, shake down, testing and model de-rig for 240 hours of productive testing	M0 + 1M (by start of test)
2	Preliminary test data	Delivery of complete preliminary test database, including raw data, steady state data & dynamic data (including all acoustic data near & far Field)	M0 + 3M (at test completion)
3	Final test data	Delivery of complete final test database, including raw data, steady state data & dynamic data (including all acoustic data near & far Field)	M0 + 4M (i.e. 1 month after the test)
4	WT Test Report	Test report to include full description of the experimental setup including a detailed run log and validated data description	M0 + 5M (i.e. 2 month after the test)

4. Topic value

The total value of biddings for this work package shall not exceed

3.200.000,00 €
[three million two hundred thousand euro]

Please note that VAT is not applicable in the frame of the CleanSky program.

Topic Description

CfP Topic Number	Title		
JTI-CS-2012-02-SFWA-03-010	**BLADE* wing structural test to derive test data for subsequent validation of GFEM modelling**	Start Date	Oct 2012
		End Date	Aug 2014

1. Topic Description

Project description:

The *BLADE (*Breakthrough Laminar Aircraft Demonstrator in Europe*) wing development project aims to design, manufacture, assemble and perform flight demonstrations of an aerodynamically optimised natural laminar flow wing.

In order to obtain a permit to fly for the BLADE wings assembled to the A340 flight test aircraft, structural test data is required to validate the Finite Element Models (FEM).

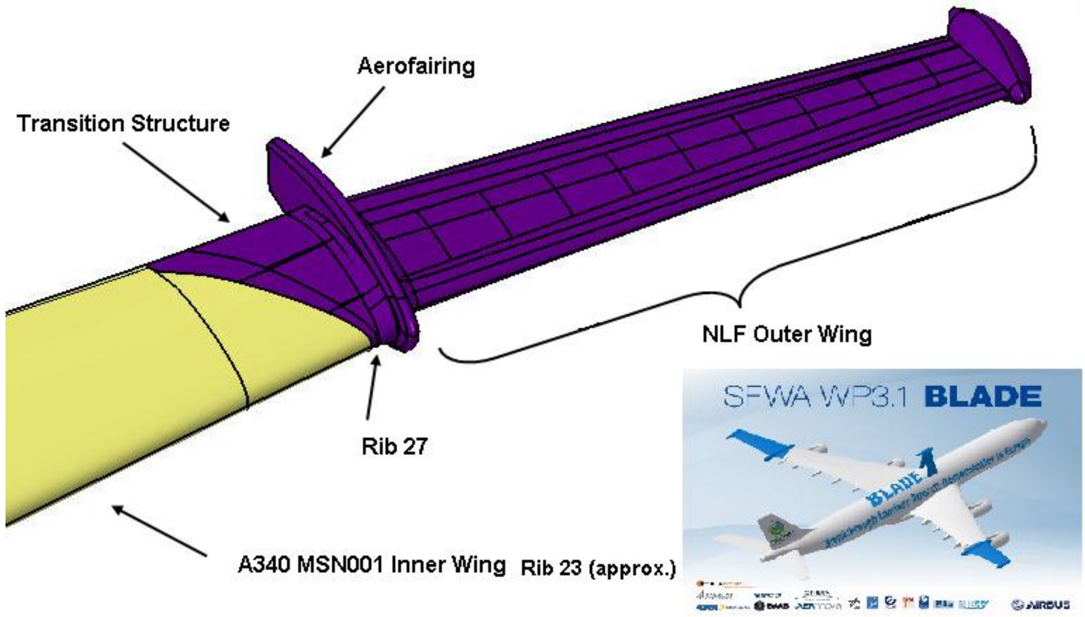


Figure 1: Test section overview

Topic Detail:
The applicant shall develop an innovative low cost test method for application of up bend only test loads on a fully functional flight test aircraft. The test philosophy is to demonstrate that major components tests can be performed on flight test aircraft. The ability to prove this method could reduce the burden of major component tests for the certification of future aircraft or derivatives. A successful completion of this topic would provide the applicant with expertise and evidence to apply the same innovative test solutions to future production aircraft test packages.

Topic requirements
The applicant has to perform all engineering requirements to derive static test data for the blade outer wing, transition structure and inner wing through to rib bay 23. Note: Subsequent validation of the GFEM using test data is not covered by this Call for Proposal.

The test shall be performed on the A340 MSN1 flight demonstration aircraft after the installation of the NLF outer wing boxes, both port and starboard wings shall be subject to test. Test shall be performed in a pre-defined aircraft hangar located at the Airbus Toulouse facility.

Scope of activities required:
- Test management, co-ordination, planning and communications with the wider BLADE team.
- Definition of test loading method and control system.
- Definition and provision of test data acquisition system (assumes provision for test actuator loads and displacements, up to1000 ¼ bridge and up to 100 full bridge channels simultaneously at a maximum of 50 load intervals per test case).
- Design, stress analysis and manufacture of all test rig and aircraft interface parts.
- Design drawings locating aircraft instrumentation, and subsequent installation and commissioning of instrumentation (including displacement transducers, strain gauges and associated cable routings).
- Assembly of test loading method around aircraft.
- Test commissioning, and subsequent test performance.
- Provision of test data and formal test report.
- Removal of all test equipment in preparation for flight demonstration.

It is assumed that the test facility provided by Airbus shall supply three phase electricity, a pneumatic system (for operation of hand tools) and general amenities (water, waste, commercial electricity supply). The applicant shall be responsible for the provision of a hydraulic supply as required.

2. Special Skills, Certification or Equipment expected from the Applicant

Skills and Approvals:
- EN9001 or equivalent quality approval;
- UKAS or equivalent qualification for static structural testing;
- Design tools (Catia v5 Revision 18) and approvals for checking;
- Appropriate stress approvals;
- Instrumentation application approvals.

1.

Equipment
- Data acquisition and real time test monitoring equipment (assume 10 monitoring stations);
- Multi-actuator control system equipment;
- All instrumentation equipment (Load cells, displacement transducers, strain gauges,etc).

3. Major Deliverables and Schedule

Del. Ref. Nr.	Title	Description (if applicable)	Due
WP 1d	Test Definition	Customer sign off	M0+ 2M
WP 1e	Concept design review	Documented evaluation	M0 + 2M
WP 1f	Preliminary design review (PDR)	Pass review and Completed Pro-forma	M0 + 5M
WP 1g	Critical Design Review (CDR)	Pass review and Completed Pro-forma	M0 + 7M
WP 2a	Test parts manufacture	Delivery notes / CoCs	M0 + 12M
WP 2b	Rig to specimen assembly complete	Design authority sign off	M0 + 16M
WP 2c	Instrumentation commissioned	Commissioning document	M0 + 17M
WP 2e	Control System commissioned	Commissioning document	M0 + 17M
WP 3a	Test Readiness Review (TRR)	Pass review and Completed Pro-forma	M0 + 18M
WP 3b	Test Completion	Raw test data delivery	M0 + 20M
WP 3c	Aircraft released to flight test	Data drop preliminary test report	M0 + 20M
WP 3d	Full Test Report	Issued to customer	M0 + 22M

4. Topic value

The total value of biddings for this work package shall not exceed

3.500.000,00 €
[three million five hundred thousand euro]

Please note that VAT is not applicable in the frame of the CleanSky program.

Clean Sky –Systems for Green Operations

Identification	ITD - AREA - TOPIC	topics	VALUE	MAX FUND
JTI-CS-SGO	**Clean Sky - Systems for Green Operations**	**12**	**5,940,000**	**4,455,000**
JTI-CS-SGO-01	*Area-01 - Definition of Aircraft Solutions and explotation strategies*		**0**	
JTI-CS-SGO-02	*Area-02 - Management of Aircraft Energy*		**4,540,000**	
JTI-CS-2012-2-SGO-02-034	EWIS Safety Analysis Tool		600,000	
JTI-CS-2012-2-SGO-02-036	Design and optimisation of locally reacting acoustic material		300,000	
JTI-CS-2012-2-SGO-02-047	Development and validation of sizing method for screw drives and thrust bearings		1,050,000	
JTI-CS-2012-2-SGO-02-048	Modelica Model Library Development Part II		200,000	
JTI-CS-2012-2-SGO-02-049	Smart erosion shield for hybrid deicing solutions		250,000	
JTI-CS-2012-2-SGO-02-050	Optimization of air jet pump design for acoustic application		300,000	
JTI-CS-2012-2-SGO-02-051	Ram-air fan optimization for electrical ECS application		600,000	
JTI-CS-2012-2-SGO-02-052	Electrical Starter / Generator disconnect system		700,000	
JTI-CS-2012-2-SGO-02-053	Design and manufacturing of the PFIDS Laser sources (VCSELs)		540,000	
JTI-CS-SGO-03	*Area-03 - Management of Trajectory and Mission*		**900,000**	
JTI-CS-2012-2-SGO-03-018	Operational expertise for function definition and validation - support to experimentations		400,000	
JTI-CS-2012-2-SGO-03-019	OTC-Operational (Technical) Constraints Model & OBM - Operation Business Model AUI - Aircraft Usage Impact Model		500,000	
JTI-CS-SGO-04	*Area-04 - Aircraft Demonstrators*		**500,000**	
JTI-CS-2012-2-SGO-04-005	Virtual integration of electrical equipment and rig correlation		500,000	

Topic Description

CfP Nbr	Title		
JTI-CS-2012-2-SGO-02-034	**EWIS Safety Analysis Tool**	End date	31/03/2014
		Start date	01/10/2012

1. Topic description

1. Background

Until just over a decade ago, internal electrical wiring was not considered a source of safety risks among civil aircraft fleet. But a series of fatal airplanes crashes in the span of just a few years quickly raised the visibility of wiring-related failures and alerted regulators to the critical nature of aircraft wiring. People learned that the wiring systems in aging planes might be leading to a dangerous situation.

At this end, the US government Administration and the Federal Aviation Administration (FAA) have instructed the Aging Transport System Rulemaking Advisory Committee (ATSRAC) to investigate on this issue. The role of ATSRAC was to analyze the effects of aging transport systems, to develop and provide recommendations to mitigate them. The results of the ATSRAC final report have helped to provide new regulations on EWIS safety analysis, particularly on the FAR 25 and CS25 subpart H.

Historically, safety analyses do not address the Electrical Wire Interconnect System (EWIS) failure fully or at all. In safety analyses that address EWIS failures directly, random EWIS failures are treated as basic events that enter into the bottom of system fault trees. The failures rates used are of the order of 1.0E-7/Flight hour (FH) (for both connector and wire failures). These rates come from standard reliability databases that are not aviation specific; therefore, their applicability to failures rates aboard aircraft is uncertain.

Moreover, today's jet aircraft relies even more on sophisticated electrical systems and computers, in which the reliability of wiring, power feeder cables, connectors, and circuit protection devices is crucial. Wiring is now seen as vital to systems that support an aircraft-level function, and wiring must be designed, modified, monitored, and maintained as such. As the CS25 section 1705 recommends, the EWIS must be considered as an important separate system, as important as hydraulic, pneumatic, structural, and other systems.

During the last decade, there has been an evolving understanding of the importance of the EWIS in aircraft safety. Even though the new rules relating to EWIS, specifically CS25 Section 1709 and his Acceptance Means of Compliance (AMC) released on September 2008, give a flowchart method to assess the safety of an aircraft (based on the SAE ARP 4761), discussion continues about how the EWIS should be analyzed in an aircraft safety assessment.

So the safety assessment of the new aircrafts has to include the EWIS as a system, which must be analyzed. Today, we agreed that in order to respect this new regulation a good way to proceed is to use the existing safety tools. Nowadays, there are a lot of safety tools which are used to give or help to give a safety assessment in aviation.

2. Scope of work

The aim of this call of proposal is to develop a safety analysis tool for EWIS. The partner selected at the term of this procedure, shall have 18 month to realize the study.
This tool shall answer to the CS25 Subpart H EWIS regulation and in particular to the §CS25.1709: EWIS must be designed and installed so that:

(a) Each catastrophic failure condition

(1) Is extremely improbable, and

(2) Does not result from a single failure

And

(b) Each hazardous failure condition is extremely remote

… as well as to the acceptable means of compliance which come with the requirements and precise them.

The partner / The tool shall, in particular, base its analysis on a qualitative approach and lean on the flowcharts from §AMC 25.1709 that illustrate the concepts of safety analysis. The partner shall, too, use the concepts from §CS25.1309 to provide a thorough and structured analysis of the EWIS and its associated components. However, the partner shall take into account some specificities relative to EWIS:

- Consideration of all bundles in the aircraft, even those which are not linked to essential systems in the aircraft (effectively, a failure on one harness can have repercussions on the adjacent harnesses)
- Consideration of functional & physical failures because it can also lead to “hazardous” or event “catastrophic” failure conditions.

Before the creation of the tool, the first step shall consist in developing the method to be used (based on CS25.1309 and CS25.1709 and the flowcharts presented above). The partner shall present clearly the method to be used and show the good understanding of the requirements. A deliverable shall summarize the main requirements and how he will respond to them. This report will also mention the needs and difficulties of the selected partner.

The second part of the study shall be dedicated to the development of the safety analysis tool for EWIS in Aircraft. That he decides to develop a new tool or to use an already existing tool, the partner shall take into account some specific needs:

- To be able to interface with the tools from the caller.
- To integrate different type of data base, and in particular in XML format.
- To provide an automatic EWIS safety analysis (reports, estimations, graphics, charts, etc…)

The third part will consist in the test on a real case of the EWIS Risk Analysis Tool. An evaluation on a EWIS system will be performed with an aircraft manufacturer (to be defined) in order to assess of the viability of the tool. The evaluation of the tool will be done by both the aircraft manufacturer and by the caller of the proposal. The final assessment and validity of the tool will then be given.

3. Type of work

The selected partner shall deliver a methodology, a software tool and a user manual of the software tool.

The partner shall provide all the necessary resources (safety expert, respect of standards requirements, software expert, materials, etc.) to this proposal.

4. Special skills, certification or equipment expected from the applicant

The partner should be used to work within the scope of the aviation standards and requirements (FAA and EASA: CS 25 subpart H, especially part 25.1709, 25.1309 and respective AMC).

The partner should have a matured experience in safety (ARP 4761, ARP 4754, etc.).

The partner should be experienced in simulation software tools.

The partner should have his own recognized (by the aviation community) tool.

The partner should be able to upgrade and make the maintenance of the tools during the clean sky program.

5. Major Deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Preliminary Description method (description of the method)		31.03.2013
D2	Tool including the user manual		30.09.2013
D3	Interface between tool and WP leader electrical database		30.09.2013
D4	Validation test plan for the tool		30.09.2013
D5	Description and justification of the method's application scope		30.09.2013
D6	Validation test results		31.03.2014
D7	Tool update including user manual		31.03.2014

6. Topic value (€)

The **maximum value** for this topic is:

600.000 €*.

[Six hundred thousand Euro]

**Please note any proposal above this value will be NOT be eligible.*

7. Remarks

A preliminary research on the existing EWIS safety analysis tool can be done in order to help the selected partner to understand the needs of the caller. Additional tools can be added in order to help in the risk analysis of the EWIS (Arc tracking, reflectometry technology, etc.)

EWIS database contains EWIS electrical and physical data usable for the topic such as geometry and length of each cable, the system they support, bundles, zones, the routing of cables in the space reservation, the BOM of the wire harnesses, failure rates, etc. Exchange files with the interface to be created shall be in XML format.

Topic description

CfP Nbr	Title		
JTI-CS-2012-2-SGO-02-036	**Design and optimisation of locally reacting acoustic material**	End date	30.12.2014
		Start date	01.11.2012

1. Topic description

1. Background

In the frame of Clean Sky SGO ITD, one of the project members is developing an electrically driven air system enabling both air conditioning and thermal loads management.

This air system is composed of an air jet pump or electrical air fan that generates noise at the aircraft skin. High frequency noise reduction is achieved using passive treatment. Interest is in developing locally reacting material that would bring further acoustic attenuation to the low and mid-frequencies.

The final objective is to reach a maturity level equivalent to TRL 5, which is a validation of the technical properties of proposed solution in a realistic environment.

2. Scope of work

The objective is to define two innovative acoustic treatment solutions to reduce the noise generated by a generic mid-frequency source.

For the prototype definition a generic enhancement jet pump design will be proposed by the SGO-member and adjusted in collaboration with the partner. This will allow for design optimized solutions to be proposed by the partner.

The main characteristics to be considered could be the following:

- Inner diameter ~ [150-300] mm / Outer diameter ~ [200-400] mm
- Proposed duct treated length ~ 500 mm
- Duct flow velocity to be considered ~ M=0.3
- Frequency range of required attenuation ~ [500-3500] Hz
- Target of 10dB of attenuation
- Maximum allowable weight TBC

3. Type of work

The work will separated into three work packages:

WP0: Concept proposals for innovative acoustic materials solutions (TRL 3)

A panel of suitable solutions for the final application will be proposed.

The partner should propose a selection of 5 acoustic treatment concepts that fit to the general requirements. The proposed concept should be based on analytical simulation or analysis of performance. Among these suitable materials, the partner should propose SDOF (Single Degree of Freedom) and/or MDOF (multiple Degrees Of Freedom) based solutions.

WP1: Prototype concept selection and laboratory test phase (TRL 4)

Validation of analytical predictions of the proposed concepts. The validation should be based on laboratory tests and if possible numerical simulation.

WP2: Validation of prototypes at system level (TRL 5)

Perform analysis for integration of proposed solutions in an industrial context

Production of 2 prototypes for system level test phase

The test phase in representative conditions (pressure, temperature, mass flow) will be carried out by the CFP partner

4. Special skills, certification or equipment expected from the applicant

Partner(s) (company, SME, laboratory) with significant experience in one the following pending on the WP
- Locally reacting acoustic material design
- Acoustic modelling/prediction of acoustic treatment performance
- Laboratory test with grazing flow

5. Major Deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Acoustic material design proposal for fan and jet pump application	Report including acoustic properties based on laboratory tests or simulation	30.03.2013
D2	Industrial process/assembly proposal	Report	30.09.2013
D3	Prototypes fabrication and testing	Prototypes available	30.03.2014
D4	Prototypes testing	Test report	30.06.2014
D5	Synthesis report	Synthesis report including recommendations for acoustic optimization in air fan and jet pump applications	30.12.2014

6. Topic value (€)

The **maximum value** for this topic is:

300.000 €.

[Three hundred thousand Euro]

Please note any proposal above this value will be NOT be eligible.

Topic description

CfP Nbr	Title		
JTI-CS-2012-2-SGO-02-047	**Development and validation of sizing method for screw drives and thrust bearings**	End date	Oct-2015
		Start date	Nov-2012

1. Topic description

1. Background

The "Systems for Green Operations – Management of Aircraft Energy" research consortium investigates new system technologies for more environmentally friendly aircraft. One approach towards this target is the "electrification" of aircraft systems under the headline of the More Electric Aircraft. This includes the development of electrically powered alternatives for hitherto hydraulically or pneumatically powered systems. Envisioned benefits are:

- better energy efficiency of electrically powered systems
- increased safety due to elimination of poisonous and flammable hydraulic fluids
- reduced weight and complexity of power transmission paths, weight benefit on a/c level
- easier and reduced maintenance due to easier installation, elimination of the possibility of hydraulic leaks and better diagnosability

In this context, one challenge is the development of electromechanical alternatives to hydraulic servo-actuators as used today for primary and secondary flight controls, gear extension/retraction, steering, braking and many other auxiliary applications. Essential elements of such electromechanical actuators (EMAs) that were not required in hydraulic servo-actuators are rolling contact drive train elements through which the axial loads on the actuators are transferred, specifically thrust bearings and ball or roller screw transmissions. They are required for conversion of rotation / torque into a linear motion / force.

The operating profile for many of these servo actuators and thus the rolling elements is dominated by small amplitude and repetitive movements with frequent speed reversals and "stand-still" periods. This is detrimental for the lubricant film between the rolling surfaces that strongly affects life and fatigue of these elements. At the same time, external loads are present even in "stand-still" and can be very dynamic. These operating conditions are not covered by the established standards ISO 281 / ISO 3408 that are commonly used for sizing of rolling contact machine elements. The application of large safety factors to address the uncommon operating profile is not a satisfactory solution, as weight optimized design is an imperative for aircraft systems. Still – to account for the uncertainties in the applied sizing method and insufficient experimental evidence for the specific application - the rolling contact machine elements are assigned with high failure probabilities which negatively affect system safety analysis and reliability predictions. Application of specific development tests and an iterative approach to establish and verify application specific optimized designs is time consuming and expensive.

The swash plate actuation system of a helicopter is a specific and particularly challenging study case for this design challenge. EMAs for this application are being developed in one of the work packages of Clean Sky – Systems for Green Operations ITD to replace the hydraulic actuators presently used. It is the target to deliver full scale demonstration hardware, validate it in aircraft relevant environment and thus shorten significantly the time to market of the solutions developed.

The swash plate system of a helicopter provides lift, pitch and roll control. The loss of any of these control functions is classified catastrophic mandating a very robust and fault-tolerant design of the 3-degree-of-freedom swash plate actuation system. The conventional hydraulic swash plate actuation system to be replaced consists of three hydraulic linear actuators arranged around the helicopter main gear box with lower attachment points to this gearbox and upper attachment points to the static swash plate. It has a proven track record over decades of operation and hundreds of helicopters of the present world wide fleet.

To provide a rough quantitative impression of the loading conditions, the mechanical transmission elements shall operate under applied axial forces in the range of -20kN – 50kN oscillating at frequencies between 20 and 30Hz. The amplitude of movement of the screw is typically very low and in the range of 1-2 rad at frequencies of 0.6 to 10Hz. Ambient temperatures are between -45 and +110°C. Robustness is required under oscillating external loads (including load reversal), vibrations and limited exposure to temperatures of up to about 300°C (fire hazard zone). The axial backlash should be below 0.05mm at end of life, ideally zero backlash. Required design life is about 20000 operating hours.

The work under this call shall provide a substantial contribution to establish, to theoretically and experimentally substantiate and to verify for the described study case a reliable and practicable design and sizing method for rolling contact machine elements: thrust bearings and ball screws as a minimum, ideally roller screws as well.

Any proposal to this call shall describe and justify the approach to the design problem outlined above with a focus on the described study case. Ideally the scope of the proposed approach as well covers a wide field of the applications indicated above. Flight control applications are of particular relevance. The relevant experience (preferably with relevance to aerospace applications), industrial expertise and scientific background of the consortium of applicants shall be clearly elaborated.

2. Scope of work

The work programme can be structured by four work packages as described below. However the applicant(s) may propose a different work breakdown structure.

WP 1) Literature study and evaluation of previous (own) work versus at least specific operation conditions in the h/c swash plate study case. Ideally a broader range of flight control applications is covered.

Perform a study on past investigations and publications on life, fatigue and reliability of rolling contact bearings for application conditions as briefly described above (different from ISO 281 / ISO 3408). Identify shortcomings of the sizing method ISO 281 / ISO 3408, and other established methods.

This evaluation shall cover at least the following aspects:

- Similarities between the operation conditions in past investigations and the conditions of the h/c swashplate actuators study case.

- Expected and unexpected deviations in observed fatigue and component life vs. values as would be expected from ISO 281 / ISO 3408.

Preferably the study will also cover

- Similarities between the operation conditions in past investigations and the conditions of other flight control actuators.

- Fatigue to failure propagation in relevant operation conditions: progressive predictable (how?) failure vs. abrupt failure. For ball screws, the ball return should be addressed. For roller screws, the synchronization mechanics of the rollers and other relevant parts besides the rolling contacts should be addressed.

D1 is the final deliverable for this work package.

WP 2) Development of sizing method and corresponding validation methodology

A sizing method for rolling contact thrust bearings and screw transmissions shall be developed. This sizing method shall address specific operation conditions in flight control linear output EMAs. It shall consider at least

- everything considered in ISO 281 / 3408
- amplitude and frequency of displacement AND load
- target reliability and
- ambient temperature.

This sizing method is ideally complemented by design guidelines in terms of lubrication, surface treatment/coatings, ball recirculation (ball screw), synchronization mechanics (roller screw)…

A validation test plan for the proposed sizing method shall be developed. This validation test plan shall include as a subset the verification testing required for the thrust bearings and screw transmission(s) for the h/c swashplate study case.

D3 and D4 are the main deliverables for this work package.

WP 3) Design and realization of test specimen and test means

Preliminary and detailed design of the screws and thrust bearings including mechanical interfaces:

- basic geometry and interface drawings
- loads analysis
- surface treatment, coatings
- lubrication
- detailed design and documentation for thrust bearings and screw transmission for h/c swashplate study case.
- definition and design of test means required for the validation methodology proposed in WP2 and specifically for the helicopter swashplate study case
- procurement / manufacturing of hardware
- integration, commissioning and initial operation of the test means and test specimen.

Hardware produced in this WP shall include 8 sets of screws and thrust bearings for the helicopter swash plate study case (according to interface specifications from the caller) for delivery to the caller. It shall also include the required number of specimen for the verification of the design for the study case and the validation of the sizing method proposed in WP2. This may require production/procurement of different sizes of screws and bearings.

D2, D5 and D6 are the main deliverables for this work package. D2 shall be the basis for a preliminary design review (PDR), D5 for a critical design review (CDR).

4) Validation testing

This work package covers the validation testing itself and the evaluation of results.

Validation testing shall specifically address the following aspects:

- Oscillating screw movement at adjustable amplitudes
- Oscillating external loads (including reversals of the direction of the load)
- A test scenario resembling the h/c swashplate actuators study case.
- Measurement of friction and backlash

Ideally this test campaign will generate data that could be applied for prognostics, trending and failure anticipation.

The final report shall analyse whether the experimental evidence backs-up the sizing method proposed in WP2. Further it shall analyse the results of the test campaign vs. the design recommendations elaborated in WP2.

D7 is the main deliverable for this WP.

An intermediate test review shall be prepared and held about half way through the validation testing phase, i.e. about Dec-2014. The caller shall be invited to this review and the details for the remaining part of the test campaign shall be agreed between consortium and caller.

3. Type of work

The selected applicant(s) shall

- Perform a study on past investigations and publications on life, fatigue and reliability of rolling contact bearings for application conditions as briefly described above (different from ISO 281 / ISO 3408). Identify shortcomings of the sizing method ISO 281 / ISO 3408 or other established methods as applicable.
- Propose screw, nut and bearing designs most suitable for the helicopter swashplate study case as described above. This proposal shall also address selected materials, surface treatment/coating and lubrication.
- Establish a method to size the thrust bearings and at least one type of transmission mechanisms (ball and/or roller screws) taking into account at least amplitude and frequency of displacement AND load, target reliability and ambient temperature.
- Define fatigue/life tests in cooperation with the caller.
- Manufacture and/or procure test specimen of thrust bearings and screws for an example application as outlined above in sufficient numbers to support life/fatigue tests and deliver 8 specimen to the caller. The specimen to be delivered to the caller will require specific design of the mechanical interfaces to enable their integration into full scale actuator demonstrators (TRL4 – no flight qualification) for helicopter swash plate actuation.
- Perform and evaluate fatigue/life tests to validate the proposed sizing method.
- Provide detailed documentation of all steps described above.

4. Special skills, certification or equipment expected from the applicant

Organizations or consortia bidding for this programme shall have industrially relevant experience in design and/or application of rolling contact thrust bearings and rotation to linear transmission mechanisms (ball and/or roller screws). At least one applicant of the consortium shall be a manufacturer of rotation to linear transmission mechanisms.

The applicant(s) should provide all necessary resources (expertise, machines, tooling, materials, test means, etc.) required to perform the tasks described above. If not available, the development/sourcing of such resources, specifically machines, tooling and test means, shall be part of the proposal.

Aerospace experience is required.

5. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Literature study	Study of existing sizing methods for rolling contact thrust bearings and screw drives and evaluation vs. application specific loading conditions for h/c swashplate actuators and for aerospace EMAs in general.	Apr-2013
D2	Design proposal for rolling contact trust bearings and screw transmissions in h/c swashplate study case.	This shall include surface treatment, coatings, lubrication. This deliverable shall be the basis for a PDR	Oct-2013
D3	Sizing method for rolling contact thrust bearings and screw transmissions	This sizing method shall address specific operation conditions in flight control linear output EMAs. It shall consider at least amplitude and frequency of displacement AND load, target reliability and ambient temperature.	Oct-2013
D4	Validation test plan for the proposed sizing method.	This shall include as a subset the validation testing of the thrust bearings and screw transmission(s) for the h/c swashplate study case.	Dec-2013
D5	CDR – Critical Design Review	Detailed design and corresponding design documentation for thrust bearings and screw	Dec-2013

		transmission for h/c swashplate study case.	
D6	Test facilities and initial set of test specimen	Hardware required for start of validation testing and for delivery to the caller is manufactured. Prototypes delivered to the caller.	May-2014
D7	Validation test report and test analysis	Validation of the proposed sizing method and verification of the specimen design for the h/c swashplate study case. Substantiation of design guidelines.	Sep-2015

6. Topic value (€)

The **maximum value** for this topic is:

1.050.000 €.

[One million fifty thousand Euro]

7. Remarks

The expected maximum length of the proposal Part B is 40 pages (Arial, font size 10).

The developed sizing method for thrust bearings and screw transmissions under cyclic loads (including load reversals) and oscillating movements with typically small amplitudes shall be disclosed at least to the caller. It is however strongly suggested to disseminate the proposed method to a broader scientific audience to help establish a generally applicable sizing method comparable to ISO 281 / ISO 3408 for the specific operation conditions of actuators for flight control surfaces. For this purpose it might be useful to include in the consortium a university or research institute with experience and a good scientific network in the field.

Topic description

CfP Nbr	Title		
JTI-CS-2012-2-SGO-02-048	**Modelica Model Library Development, part 2**	**End date**	T0+24 M
		Start date	T0

1. Topic description

1. Background

The Systems for Green Operations ITD of Clean Sky aims to demonstrate substantial environmental and economic benefits of more electric aircraft systems technologies. The design and validation of such highly integrated systems urge the need for more co-operative development processes involving aircraft, engine, and equipment manufacturers. The design process has to be supported through advanced modelling and simulation capabilities. Therefore the goal of the consortium is to define standardised modelling methods and tools in each phase of the energy system design process.

The Systems for Green Operations ITD is looking a Modelica modelling specialist to become a partner of the consortium for implementation of the following Modelica library:

Modelica interface to thermodynamic property computations for media frequently used in aircraft.

2. Scope of work

Modelica interface to thermodynamic property computations for media frequently used in aircraft

In Clean Sky SGO ITD, several members are working on modelling and simulation of thermal aircraft systems (such as environmental control systems, supplemental cooling systems, thermal management). These efforts rely on accurate representations of the thermodynamic properties of the involved fluids.

To allow exchanging thermodynamic property models in aircraft system models, such representations are implemented following a standardized interface. For this purpose, several ITD members adopted the established Modelica.Media[1] interface proposed by the non-profit Modelica Association [1], a de-facto standard in equation-based, object-oriented modelling of thermo-fluid systems.

This powerful interface and the associated library were applied very successfully by several ITD members. For this reason, it shall be developed further in the scope of this call for proposals. An example for such development is to refactor the current interface into a Modelica class framework for interfaces, templates and implementations allowing independently exchanging thermodynamic and transporting property computations. A proposal shall describe an initial concept for such a development and discuss at least the following goals

- Reduce complexity of property model implementations .
- Increase readability and maintainability of the interface and library.
- Compute properties of multi-component and multi-phase mixtures.
- Provide a Modelica external (C-) interface to thermodynamic property databases such as RefProp, FluidProp, MultiFlash[1]

After selection by the ITD, the proposal author shall then submit a concise concept document on this and the following aspects taking into account further remarks raised by the Topic Manager and then implement the improved Modelica.Media interface and library.

The library shall then be extended with functionality to systematically test existing or new media models. Depending on the developed structure, all elements such as templates and implementations shall be tested as to whether all functions are implemented, whether algorithms compute results successfully, whether all functions are successfully used in small fluid network models, and so on.

Additionally, a plotting facility (in Modelica or an external scripting language such as Python – to be

[1] Modelica is a registered trademark of the Modelica Association. MultiFlash is a trademark of Infochem Computer Services Ltd. UK.

discussed with the topic manager) shall allow to automatically generating plots of thermodynamic properties from the Modelica property functions. The functionality shall allow generating at least pressure-enthalpy, pressure-temperature and temperature-entropy charts, Mollier diagrams and psychrometric charts. The user shall be able to interact to, for instance, specify whether to plot axes logarithmically or not.

The library shall then be documented extensively, both with respect to the newly developed structure (c.f. Concept Document) and the implemented thermodynamic property models. With respect to the latter, the scope and content of the Modelica.Fluid.Dissipation package of the Modelica Standard Library serve as a notional example.

The library shall then be released for inclusion in the Modelica Standard Library under the Modelica License 2.0 (see http://www.modelica.org/licenses/ModelicaLicense2). The scope and functionality shall not be reduced with respect to earlier versions of the Modelica.Media library.

This topic is related to work contracted in an earlier call (JTI-CS-2011-1-SGO-02-026) and shall be coordinated with the latter.

3. Type of work

Modelica interface to thermodynamic property computations for media frequently used in aircraft

The selected partner has to design, implement, test and document a thermodynamic property interface and Modelica library that has at least the scope of the Modelica.Media library version 3.2 and is released in open source under the Modelica License 2. Furthermore, automatic plotting of the property functions in Modelica or an external program has to be provided.

4. Special skills, certification or equipment expected from the applicant

The partner shall provide specific and detailed skills in the topic area of this call for proposals.

- Outstanding know-how of the object-oriented modelling language Modelica, the Modelica.Media library, and thermodynamic property models,
- Experience in using Modelica media models in steady-state and dynamic thermo-fluid network models in advanced industrial applications.
- Experience in multicomponent, multi-phase mixture media models.

5. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Concept Document for Property Computation Interface	Technical report	T0 + 6 months
D2	Preliminary version of Media interface library with updated Concept Document	Modelica library and technical report	T0 + 12 months
D3	Preliminary version of Media interface library with testing functionality	Modelica library	T0 + 15 months
D4	Preliminary version of Media interface library with testing and plotting functionality	Modelica library	T0 + 18 months
D5	Documentation and final version of fully documented Media interface library	Technical report and Modelica library	T0 + 24 months

6. Topic value (€)

The total value of biddings for this work package shall not exceed :

€ 200.000,--

[Two hundred thousand euro]

Please note that VAT is not applicable in the frame of the CleanSky program

7. Remarks

[1] Elmqvist H., Tummescheit H. and Otter M.: "Object-Oriented Modeling of Thermo-Fluid Systems", pp. 269-286, Proceedings of the Third International Modelica Conference, Linköping, November 3-4, 2003.

- The topic value under (6) is the upper bound for the total budget (so the sum of funding and contributor expenses).
- CleanSky “Founding members” as well as “Associate Partners” within “CleanSky – Systems for Green Operations” cannot apply for this call. This rule excludes the following organizations: Aeronamic, Agusta Westland, Aircelle, Airbus, Alenia, Cranfield University, Dassault Aviation, Diehl Aerospace, DLR, EADS, Eurocopter, Fraunhofer, Galileo Avionica, Hispano.Suiza, Labinal, Liebherr, Messier, NLR, Rolls-Royce, Saab, Safran, Techspace Aero, Technofan, Thales, TU Delft, University of Malta, University of Nottingham, Zodiac.

Topic description

CfP Nbr	Title		
JTI-CS-2012-2-SGO-02-049	**Smart erosion shield for electro-mechanical de-icers.**	End date	May 2014
		Start date	Oct 2012

1. Topic description

1. Background

The Hybrid Low Power Ice Protection System developed in the frame of Clean Sky JTI is using electro-mechanical devices that shed ice which is accreted on the leading edge of the wing. The wing leading edge structure comprises electromechanical actuators generating forces and inducing deformations on the metallic skin of the leading edge also named “erosion shield”, these deformations shall be such that it de-bond ice in a deterministic manner.

The aim of the proposed work is to review the current design of the erosion shield and propose new design concepts that will maximize its deformation when submitted to the electromechanical actuators forces and also provide the capabilities to control the geometry of the deformations.

2. Scope of work

The aim of the contracted activity is to design a new smart erosion shield structure with controlled deformations. The smart erosion shield must have a specific and structured mechanical design that will maximize its deformation when submitted to the electromechanical actuators forces and also provide the capabilities to control the geometry of the deformations.

The objectives can be divided in Six steps as follows:

1- Investigate and propose technical concepts (erosion shield materials and mechanical structure design) to reach controlled deformation modes with minimum efforts generated by the electromechanical actuators.

2- Use FEM simulation to find key parameters and elementary design structure patterns able to maximise the expected deformations (dimensions, material, design structure patterns variations). Verify if each proposed design is compliant with fatigue leading edge requirements. Select the best design solutions.

3- Manufacturing of erosion shield mock-ups based on the selected designs structure patterns and materials.

4- Test erosion shield mock-ups, validate models generated in task 3 and optimize design concepts.

5- Manufacturing of erosion shield prototype based on the best design combination tested in t 4.

6- Test the prototype erosion shield manufactured in task 5..

3. Type of work

Establish with SGO Member detailed specification of the erosion shield part: functional, environmental and wing integration requirements.

Use FEM simulation tools (structural mechanics field) for erosion shield deformations models.

Use materials knowledge and expertise (metallic and composites) to build efficient erosion shield designs.

4. Special skills, certification or equipment expected from the applicant

Wing structure knowledge (Knowledge in slats structure would be an advantage).

Expertise on metallic and composites materials manufacturing and assembly.

Expertise and tools for FEM simulation in the structural mechanics field.

Ability to deliver the required mock-ups and prototypes.

5. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Agreed Detailed Specification		November 2012
D2	Design concepts Review	Technical concepts review.	January 2013
D3 Task 2	Design Concepts models and parametric study leading to the selection of promising concepts		May 2013
D4 Task 3	Delivery of erosion shield mock-ups		July 2013
D5 Task 4	Concept validation and Optimization	Concept validation and Optimization report	October 2013
D6 Task 5	Delivery of optimized erosion-shield prototype		December 2014

6. Topic value (€)

The total value of this work package shall not exceed:

250,000.--€
[two hundred fifty.thousand euro]

Proposal above this value will be considered as not eligible.
Please note that VAT is not applicable in the frame of the CleanSky programme

Clean Sky Joint Undertaking
JTI-CS-2012-02-SGO-02-050

Topic description

CfP Nbr	Title		
JTI-CS-2012-2-SGO-02-050	**Optimization of air jet pump design for acoustic application**	**End date**	30.09.2014
		Start date	01.10.2012

1. Topic description

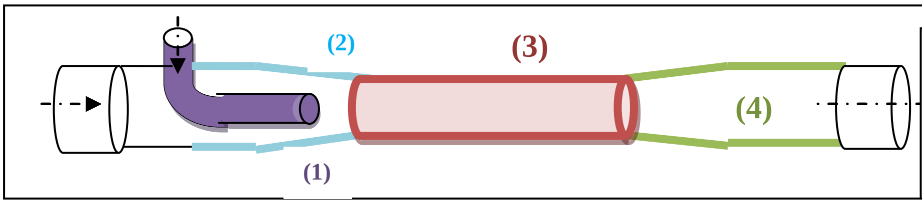
1. Background

In the frame of Clean Sky SGO ITD, one of the project members is developing an electrically driven air system enabling both air conditioning and thermal loads management.

This air system is composed of an air jet pump which is, roughly speaking, an injector confined in a duct. The purpose can be either mixing of primary and secondary jets or entrainment of secondary stream by the primary jet.

The jet pump part generates noise which radiates directly at the aircraft skin through the ram air outlet. Despite passive treatment, the noise generated is overpassing the affordable limit. The duct surrounding the injector affects drastically the flow structure, rendering jet-based model non applicable directly.

The work objective is to propose an optimized design for a low noise subsonic jet pump.



2. Scope of work

This call for proposal is divided into three separate work packages:

- WP0: Numerical optimization for a low noise subsonic jet pump
- WP1: Development of a jet pump demonstrator (TRL4)
- WP2: Unsteady simulation of a jet pump simplified geometry

This call for proposal aims to select a partner for ***each work package*** who has to:

- WP0: Numerical optimization for a low noise subsonic jet pump

The work package aims at providing an optimization of the various geometries to be tested and simulated in WP1 and WP2. This constitutes a pre-requisite. The baseline configuration will be provided by the SGO-member as well as guidelines for the design based on predicted acoustic radiation at duct outlet using a stochastic method.

- WP1: Manufacture and test a jet pump demonstrator, with several 3D nozzle and diffuser shapes.

The partner is responsible for the manufacturing and the test phase.

-> Acoustic measurements will be performed on all the configurations to quantify the impact of modifications. Based on the acquired results, a down-selection of shaped will be performed with the SGO-member.

-> Aerodynamic tests will be performed on the best configuration or the two best ones, together with the baseline.

- WP2: perform unsteady numerical simulation of simplified jet pump demonstrator geometry.

A LES simulation would be well adapted to address the problem as a perfect description of what happens at the duct boundary is not required. The primary flow is a compressible flow (M~0.8/0.9).

Two calculations will be run on two configurations: one for the baseline, one for the low-noise.

This part could fit for a post-doctoral position.

3. Type of work

WP0: Numerical optimization for a low noise subsonic jet pump

In this part, the partner will perform a numerical optimization of the jet pump design, starting from a baseline configuration defined by the SGO-member. Optimization will concern the injector geometry, the diffusor shape and the mixing to injector surface ratio. Only the air path needs to be modelled by the partner.

WP1: Manufacture and test a jet pump demonstrator

The jet pump demonstrator will be designed by the partner and under specification of the SGO-member, as an assembly of 5 modular parts.

-> Part 1: nozzle injector: modified shapes to test the impact of standard noise mitigation devices on confined flow. The following shapes would be considered: modification of the lip thickness of the injector nozzle, addition of lobbed mixers, chevrons, tabs…This list not being exhaustive.

-> Part 2: converging part: optimisation of nozzle injector outlet position relative to the inlet of mixing part.

-> Part 3: several diameter and length of mixing part, which will be made of glass to perform PIV/LDV.

-> Part 4: diffuser shape: variation of diffusor angle, sudden increase of diameter to shorten total length of system.

-> Part 5: acoustic treatment, to be optimised for mid-frequency range reduction. This treatment can be installed in parts 3 and 4.

The partner will perform acoustic test at jet pump outlet (far field directivity) and PIV or LDV test inside the mixing part

WP2: unsteady simulation of a jet pump configuration

The objective is to simulate the confined jet flow, using preferably a LES method or a DES.

-> The mesh convergence study has not been performed by the SGO-member and would need investigation by the partner.

Key parameters: Re_D~7x10^5 and M~0.8

fpeak~600-800Hz due to duct modes and jet pump total length~1m

The key steps are thought to be the following for the numerical part:

-> Preparation and calculations for the two configurations: baseline and the optimized low-noise

-> Sound propagation inside the end of mixing part and the diffuser. The acoustic calculation could be done using high order scheme. The secondary duct upstream the nozzle injector will not be modelled, allowing structured mesh. However, the swirl effect due to the injector bend-duct shape should be taken into account.

-> Acoustic propagation at duct diffuser outlet (integral technique could be used) to simulate the acoustic far-field pressure at microphone location (~20D)

A comparison to experimental data is expected:

- Comparison of time averaged quantities to aerodynamic experimental data
- Spectral analysis to compare to acoustic experimental data

4. Special skills, certification or equipment expected from the applicant

The applicant (company, university, SME) should have:

- Test facility to perform acoustic and PIV/LDV aerodynamic tests on jet pump demonstrator with different configurations
- Ability to perform and get results using LES simulation

5. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D0.1	Jet pump design optimization	Detailed designs of optimized jet pump and	30.04.2013
D1.1	Jet pump demonstrator manufacturing	All parts available for testing	30.10.2013
D1.2	Acoustic tests report	Results available for down selection	30.12.2013
D1.3	Baseline aerodynamic tests report	Baseline results available	28.02.2014
D1.4	Alternate aerodynamic tests report	All results available	30.04.2014
D2.1	Report on LES results	Results file tecplot readable format	30.06.2014
D2.2	Report on LES results	Comparison to experimental results	30.09.2014

6. Topic value (€)

The total value of this work package shall not exceed:

300,000.--€

[three hundred.thousand euro]

Proposal above this value will be considered as not eligible.
Please note that VAT is not applicable in the frame of the CleanSky programme

Topic description

CfP Nbr	Title		
JTI-CS-2012-2-SGO-02-051	**Ram air fan optimization for electrical ECS application**	End date	30.12.2014
		Start date	01-11-2012

1. Topic description

1. Background

On an electrical ECS pack, outside air is used to remove heat from the cooled system. The outside air flow is generated on ground thanks to a vacuum device. The present subject deals with electrical fan solution used as vacuum device for ram air flow generation.

The challenge of optimizing such a component for this application is double.

First, from aerodynamic point of view, the fan shall be capable to generate pressure drop whatever the flow without surge issues. Indeed, the ram air fan is used to suck main air flow through ECS pack main heat exchanger for cabin cooling and in the meantime to suck small amount of flow through ECS pack electrical motor stator for cooling. Due to ECS control logics, the fan shall be also capable to ensure ECS motor stator cooling without any flow from main heat exchanger. In this case it shall provide the same pressure rise with a very limited flow.

Then, the fan is installed downstream of the ECS main heat exchanger. Therefore, high temperature air can enter the fan and specific concept shall be implemented for fan integration to enable fan mechanical and electrical subpart cooling.

Finally, technology and solution selected to comply with these last constraints shall minimize impact on performance efficiency and component reliability and availability so as to achieve global ECS objectives.

2. Scope of work

The proposed work package can be separated into three sub-topics:

1) Analysis of aerodynamic issues and elaboration of a solution avoiding fan surge in limited flow conditions

2) Validation of the proposed aerodynamic concept through laboratory test on a prototype

3) Analysis and development of a solution enabling thermal management of the fan in hot air condition.

3. Type of work

The type of work is a function of each sub-topic:

1) Bibliographic search, brainstorming, and predesign of several aerodynamic concepts. Trade off to select the most suitable solution.

2) Detail design of the selected solution, prototype manufacturing and performance testing to validate flow capability and isentropic performances.

3) Bibliographic search, brainstorming and creative work, preliminary technical design of an electrical fan which may involve component integration optimization and thermal analysis so as to withstand high temperature conditions.

4. Special skills, certification or equipment expected from the applicant

SME and/or laboratory having a significant experience on::

1) Engineering and knowledge of air fan aerodynamic.

2) CFD modelling and simulation (using Star-CCM+ by CD-adapco or software to be discussed with Liebherr).

3) Engineering and demonstrator production experience.

4) Electrical fan integration and thermal modelling experience

5. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1.1	Bibliographic search report on fan antisurge technologies	3 months	30.03.2013
D1.2	High flow range fan technologies description and selection report	9 months	30.11.2013
D2.1	Prototype fan design report	6 months	30.05.2014
D2.2	Prototype fan	6 months	30.09.2014
D2.3	Prototype fan test and performance validation report	3 months	30.12.2014
D3.1	Bibliographic search report on high temperature electrical fan concept	3 months	30.03.2013
D3.2	Preliminary design/sizing of chosen fan thermal management solution	9 months	30.11.2013
D3.3	Detailed design of chosen fan thermal management solution	6 months	30.05.2014

6. Topic value (€)

The total value of this work package shall not exceed:

600,000.--€

[six hundred.thousand euro]

Proposal above this value will be considered as not eligible.
Please note that VAT is not applicable in the frame of the CleanSky programme

7. Remarks

Each of the three sub-topics may be considered as separate work packages, to be attributed to single or different partners.

Following relevance of proposed technical solution and evaluation of its efficiency by the partner, The Topic Manager may eventually test the prototype in a representative environment using an electrical pack.

Clean Sky Joint Undertaking
JTI-CS-2012-02-SGO-02-052

Topic description

CfP Nbr	Title		
JTI-CS-2012-2-SGO-02-052	**Electrical Starter / Generator disconnect system**	End date	T0 + 30M
		Start date	T0: October 2012

1. Topic description

1. Background and context

New generation aircraft need high level of electrical power.

To answer this requirement, the electric generators increased in volume and thus their weight increased

To solve weight and volume this new high power electrical machines are designed be able to work in two modes:

Mode 1: starter to start the aircraft engine

Mode 2: generator to give electrical energy to the aircraft.

By this way, the current electrical generator of limited power and the pneumatic starter can be replaced by only one high power electrical starter-generator.

For safety reason, to protect the machines and engine gearbox, the starter-generator need to include a disconnect system.

Under the effect of an electrical pulse, this system has to allow to separate mechanically the gearbox from the starter-generator. The transmission of the mechanical energy is then no more possible. In mode 1, the starter cannot drive any more the gearbox. In mode 2 the gearbox cannot drive any more the electrical generator.

The purpose of this (CfP) is:

1) to explore innovative topologies and technologies of disconnect systems adapted for aircraft electrical generator using these high power machines as a starter and choose the best topology.

2) to develop, build and test the chosen disconnect system capable of operating (approximate figures to be confirmed in full specification):

-up to –55°C to 200°C

-within the speed range 0 to 24000 rpm

- between -400 to and 400 Nm

- at a weight around 2 kg max

- with very high reliability

- with resetability capability (system resetable with starter generator still installed on aircraft, at least 6 times)

- with testability on aircraft

- including manufacturing robustness, service life …& cost objective

In this approach of disconnect system, criteria of compactness, weight reduction and conformity with harsh aeronautic engine environment (i.e 10 g) will be also an important part of this study.

This CfP is a technological and industrial challenge which provides opportunity of competitiveness on this important improvement part of disconnect system dedicated for new high power starter-generator for more electrical aircraft for European partners of Cleansky..

2. Scope of work

This study of disconnect system shall include following technical parts and activities:

1) Specification review

2) Trade studies of innovative disconnect system technologies,

3) Definition of criteria for solutions analysis,

4) Comparative analysis and solution selection,

5) Description of final hardware design solution proposed. Verification and justification of compatibility of chosen solution with aeronautic environment,

6) Methodology and definition of verification tests,

7) Design and Manufacturing of the solution,

8) Carrying out the tests,

9) Analysis of results and conclusion regarding installation in a starter-generator.

The tests will be done on 5 (tbc) disconnect equipments.

Test conditions shall include parameters such as temperature, stress, fatigue, aging.

Tools will be required to do the tests in the required conditions (ex: real part under stress).

3. Type of work

The activities of this work shall be limited to 30 months time period. A kick-off meeting, a progress meeting and final meeting will be scheduled with topic manager. This project is split into following tasks proposed for the applicant activities:

At T0 (assumed October 2012 (To Be Confirmed)**):**

Kick of meeting to start project. Review of technical specification and planning to be frozen.

Task 1: (T0+2M): Clause by clause and final specification version.

Task 2: (T0+5M): Report of trade study of innovative solutions explored with different technologies (concepts, schematics, working drawings)

Task 3: (T0+6M): Criteria definition for trade study analysis.

Task 4: (T0+9M): Preliminary design review of trade studies in accordance with specification. On the basis of the chosen criteria comparison of the different solutions. Solution selection.

Task 5: (T0+15M): Critical design review of technical proposal for disconnect system. Review of the justification report of hardware solution dimensioning, demonstrating the compatibility with mechanical, electrical, thermal and fluidic environment of the starter-generator and the aeronautical environments.

Task 6: (T0+22M): Review of verification and validation tests procedure

Task 7: (T0+24M): Delivery of five (relevant value to be defined) hardware samples for verification and validation

Task 8: (T0+29M): Review of tests report (analysis of the test results, report and conclusions)

Task 9: (T0+30M): Review of final report synthesis and conclusion

Progress reports will be requested every two months.

Detailed definition of the test plan, with the aim of covering extensive combinations of electrical, mechanical (vibration, shocks,…), temperature, test parameters, definition of the acceptance criteria, will be a joint activity with Topic Manager.

4. Special skills, certification or equipment expected from the applicant

For this study, the applicant shall satisfy following minimum criteria:

- Company with a very opened and innovative spirit,
- Good background and experience in electro-mechanical design and advanced technologies operating in harsh aeronautic environment,
- Insurance shall be provided to manage this work in time without delay for study and development phases.
- Adequate equipment with tools, for thermal, electrical and mechanical simulations, manufacturing process and test benches to develop and test requested demonstrators in respect with milestone of delivery,
- Available resources to execute the respective tasks should be stated in the proposal.
- Laboratory for material tests (if not sub-contacted), in various environment conditions.
- Expertise on metallic, composite and plastic materials used at high temperature level
- Experience in aeronautics material tests, and qualification methodology.

5. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Requirements Analysis	Review and finalisation of module requirements specification (clause by clause) and SOW (statement of work)	T0+2M
D2	Report of trade study of potentials topologies suitable with the specification	Concepts of innovative solutions defined by schematics, working drawing, description Minimum of three potential solutions shall be proposed.	T0+5M
D3	Report of criteria definition	List of criteria to be used for solution choice	T0 + 6M
D4	Preliminary Design Review (PDR) of trade studies according the specification of the need and of the starter-generator environment	Analysis of benefits and drawbacks of potential solutions Technical description of concept , structure, functionality and technologies of proposed solutions. Selection of solution.	PDR: T0+9M
D5	Critical Design Review of frozen solutions of disconnect system selected for hardware design and analysis	Design file, bill of material and technical documents necessary to justify solution dimensioning, demonstrating the compatibility with mechanical, electrical, thermal and fluidic environment of the starter-generator and the aeronautical environments.	CDR T0+15M
D6	Delivery of tests plan and tests procedures	This document will define the list of tests to be applied, the tests sequence, the procedure to make these tests and the number of equipment to be summated to the tests.	T0+22M
D7	Delivery of 5 hardware prototypes of disconnect system	These prototypes will be tested for verification and validation on mechanical, temperature, electrical, aeronautic environment	T0+24M
D8	Reports of tests performed with selected solutions	Tests reports	T0+29M
D9	Final report	Synthesis and conclusion of study	T0 + 30M

6. Topic value (€)

The total value of this work package shall not exceed:

700,000.--€
[seven hundred.thousand euro]

Proposal above this value will be considered as not eligible.
Please note that VAT is not applicable in the frame of the CleanSky programme

Clean Sky Joint Undertaking

JTI-CS-2012-02-SGO-02-053

Topic description

CfP Nbr	Title		
JTI-CS-2012-2-SGO-02-053	**Design and manufacturing of the PFIDS Laser Sources (VCSELs).**	End date	Oct 2013 (T0+64)
		Start date	Oct 2012 (T0+52)

1. Topic description

1. Background

The Primary in Flight Ice Detection System (PFIDS) developed in the frame of Clean Sky JTI is based on an innovative optical sensing technology. This sensing technology uses two emitters in a specific spectral range.

No light emitting device exist yet on the market, having the required characteristics : wavelength, reliability, high efficiency, optical power, large circular output beam, low drifts versus temperature and current…

While it is possible to find some Fabry-Perot lasers on the market with an emitting spectral bandwidth close to the proper wavelengths, the spectral bandwidth of those laser diodes is too large and they can't be operated for the whole temperature range seen by the PFIDS. Also, the reliability of the standard laser diode is known to be lower than expected in the PFIDS system.

The Vertical Cavity Surface Emitting Lasers (VCSEL) has the advantage over the standard edge-emitting diodes to be reliable, to have a large operating temperature range, to have a circular emitting area and to be highly reproducible.

This description specifies the development for the two VCSELs to be used in the PFIDS system and their specification.

2. Scope of work

The aim of the contracted activity is to design and manufacture the VCSELs for the PFIDS. Two VCSELs emitting at two different wavelengths in very specific regions of the electromagnetic spectrum are necessary to implement the ice detection technique. This spectral range is situated between wavelengths of 1400nm to 1600nm The specifications of those VCSELs are extensively described in paragraph 4.

Objectives can be divided in three as follows :

- The first objective of this activity is to design such VCSELs and commit on performance objectives established at the beginning of the activity.
- The second objective is to manufacture the corresponding wafers, perform preliminary tests and report results.
- The third and final objective is to encapsulate the chips in a package (TO or other kind) which may include a lens, and to proceed to final tests and report results.

The project will end with the manufacture of a certain amount of prototypes to be agreed on.

3. Type of work

Establish with the SGO Member detailed specifications of the two VCSELs to be developed and agree on performance. This phase will use semi-conductor physics simulation tools. Manufacture the corresponding wafers and test them, on the wafer itself or on cut chips, and report the preliminary results before the remaining work. Encapsulate a few VCSELs in the specified packaging, perform electrical and optical tests, and report results. Assemble (encapsulate), test according to the specifications and deliver prototypes.

4. Special skills, certification or equipment expected from the applicant

Opto-electronic devices like VCSELs are mainly used for telecom applications. The present need is for a sensing application to be used in an aeronautical environment. Environmental tests are therefore particularly important. The applicant should have experience in the development of VCSELs for sensing applications and harsh environments (both temperature and vibrations).

The two VCSELs needed are defined as the lower band VCSEL (LB) and the higher band VCSEL (HB). The emitting area of the two VCSELs should be circular and its diameter should be close to 100µm and the same for both emitters.

The main optoelectronic specifications of those VCSELs are described hereafter. Those specifications are given as a basis for discussion, and are not yet intended to be contractual figures.

Specifications are given for a temperature of T°=25°C, unless otherwise noted.

For the lower band VCSEL:

Parameters (Conditions)	Symbol	Min	Typical	Max
Peak emitting wavelength – nm	λ_{peak}	1425	1435	1435
Spectral bandwidth – nm	$\Delta\lambda$			3
Optical power at λ_{peak} – mW (at +70°C)	P_{opt}	2		
Beam divergence at -3dB (deg)	α			20
Absolute wavelength drift vs T° - nm/°	$d\lambda/dT°$			0.11
Modulation bandwidth (MHz)	f_{-3dB}	200		

And for the higher band VCSEL:

Parameters (Conditions)	Symbol	Min	Typical	Max
Peak emitting wavelength – nm	λ_{peak}	1545	1550	1555
Spectral bandwidth - nm	$\Delta\lambda$			3
Optical power at λ_{peak} – mW (at +70°C)	P_{opt}	2		
Beam divergence at -3dB (deg)	α			20
Wavelength drift vs T° - nm/°	$d\lambda/dT°$			0.11
Modulation bandwidth (MHz)	f_{-3dB}	200		

TBD: To Be Defined.

The threshold currents and the operating forward voltage of both VCSELs are to be defined, and their typical behaviour should be characterized on the whole temperature range.

The operating temperature range of those emitters will be -55°C to +70°C. The reliability of those VCSELs should be 100FIT (Failure in time as defined in the UTE C 80-810) for an average temperature of +40°C.

A thermoelectric cooler may be used in order to obtain the specifications in emitting power or wavelength, but this is not a desirable solution.

The VCSEL chips are to be integrated into a standard TO-type header. A solution with an integrated lens on the package window is to be discussed later.

5. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Agreed Detailed Specification	Performance Commitment after analysis with the SGO member and simulation.	November 2012 (T0+53)
D2	Preliminary Tests Report	Test and report of parameters that can be tested directly on the wafers.	February 2013 (T0+56)
D3	Delivery of Final Test Report and first Prototypes	Electrical and optical Tests of encapsulated chips. Delivery of first prototypes	April 2013 (T0+58)
D4	End of Prototypes Delivery. End of Activity Reporting.		October 2013 (T0+64)
D5			

6. Topic value (€)

The total value of this work package shall not exceed:

540,000.--€

[five hundred and forty thousand euro]

Proposal above this value will be considered as not eligible.
Please note that VAT is not applicable in the frame of the CleanSky programme

Clean Sky Joint Undertaking
JTI-CS-2012-02-SGO-03-018

Topic description

CfP Nbr	Title		
JTI-CS-2012-2-SGO-03-018	**Operational expertise for function definition and validation - support to experimentations**	Start date	*1/1/2013*
		End date	*30/4/2014*

1. Topic description

1. Background

The Clean Sky project, Systems for Green Operations ITD, is looking for a supplier of wide spectrum operational expertise, to become a partner of the consortium.

<u>Introduction: Clean Sky SGO MTM project objectives and context of the topic</u>

The System for Green Operations research consortium of Clean Sky aims to demonstrate substantial reductions of environmental impacts in civil commercial mainline, regional aircraft and business jet domains.

The Management of Trajectory and Mission (MTM) branch of the Systems for Green Operations research consortium aims at developing technologies to reduce chemical emissions (CO2 and NOx) and Noise. One of the main field of research considered by MTM to reach these objectives is to optimize in-flight 4D trajectories, including the overall missions profiles, through mathematical optimisation.

The function to be assessed are focused on the departure trajectory and the optimisation of long range cruise (ECO take off and ECO cruise).

Such optimisations will lead to novel ways to operate the aircraft, either during the flight preparation phase or the actual flight. These new operations should not incur an unbearable increase in workload or disrupt the workflow between parties involved in the everyday operation of the aircraft (airline operation center, ATC, flight crews …). Given the global nature of air transport industry, it is important to get a feedback representative of the different operationnal environments where the aircraft is bound to be used.

The consortium is looking at the involvement of a partner capable of providing first hand access to field operators in order to assess the operationnal relevance of the new devised operating techniques.

<u>Context of use</u>

The operational expertise sought for in this call will be used for the following purposes :

-Collect supplementary information on current operationnal techniques to complete the need analyses performed in previous works.

- Assist in the development and validate the assessment scenarios together with the function developpers

-Assess the operation methods developped in SGO for flying improved trajectories:

The latter assessment will be carried out in fixed base simulations involving a qualified flight crew provided by the applicant

The applicant will also have to provide insight to other operational actors duties (AOC members, ground crews). First hand experience from members of the applicant organisation is a major asset for this task

2. Scope of work

Description of work
The consortium wishes to enter into partnership with a supplier able to provide a broad spectrum of operational insight for the purpose of need analysis and operability assessment of future departure and cruise trajectories derived from SGO studies. The end-result of this topic is the participation of flight crews and other operators (AOC members, flight dispatches …) for the activities aforementionned carried out at the premises of consortium members that require to. The activity will be carried out along the 18 months of the project. They are inserted in the overall Human Machine Interface development cycle leading to the assessment of usability of ECO Take Off and ECO Cruise functions for TRL 5 demonstrations. The first work to be accomplished will be to complete a task and need analysis of the mission preparation and departure management by all the individuals involved (both flight crew and ground personnel).Results from an initial task and need analysis, covering aircraft operation in general will be provided to the applicant. From this basis, a more focused analysis applicable to the context of ECO-take off and ECO cruise will be carried out. The work will involve direct participation of the developpers of the function (i.e. SGO members). The second work will be the participation in the development of test scenarios consistent with the current operation of airlines. This participation will be focused on the validation of scenarios proposed by SGO members even though some upfront counseling may also be required in the selection of scenarios. Finally the applicant will ensure the participation of flight crews to the assessment sessions carried out at the premises of the SGO members, and will contribute to the analysis of the results of these assessment sessions. As an order of magnitude the quantitative involvment of crews could be : 6 crews, 2 full day sessions each.

3. Type of work

Provision of operational expertise in order to perform operability assessments and need analysis, simulation scenario definition and experiment result analysis.

4. Special skills, certification or equipment expected from the applicant

The candidate organization shall have recognized operational expertise, human factors expertise being considered an asset. The applicant shall be able to involve flight crews (either in-house or contracted) for the assessment sessions..

5. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Task and need analysis	A textual description of the different ways to operate the aircraft according to different airline profiles during the mission preparation and departure preparation phases, and cruise.	T0+5months
D2	Assessment scenario description and briefing guide	As a result of the cooperation with SGO members in the preparation of the assessment scenarios. Textual description of simulation scenario and briefing guide.	T0+8months
D3	Flight crew profiles	A description of the profiles (non nominative) of the flight crews attending the assessment session, as well as the rationales behind the selection process	T0+9months
D4	Assessment analysis	Analysis of the results of the assessment sessions carried out in Q1 2014	T0+17months

6. Topic value (€)

The total value of this work package shall not exceed:

400,000.--€

[four hundred thousand euro]

Proposal above this value will be considered as not eligible.

Please note that VAT is not applicable in the frame of the CleanSky programme

7. Remarks

Reporting

Periodic progress reports – typically monthly - will be established including the following elements:

- Description of activities performed
- Specification, design and development steps achieved
- Tests results technical reports
- Status of the next deliverables and review milestones
- Updated planning
- Action items

Meeting and review policy

- Management & progress meetings shall be periodically planned during all the project to evaluate activities progress, agree on requirements and results assessments, prepare milestones and reviews, and deal with project management issues.

- Technical meetings shall take place on SGO Topic' s manager request, in order to discuss in details specific technical points

- Review meetings shall materialize the major steps and to state if all the works and documents foreseen for these review have been performed and are acceptable. Each deliverable shall be accepted by a review meeting

Topic description

CfP Nbr	Title		
JTI-CS-2012-2-SGO-03-019	**Airline Operations Model**	End date	March 2013
	OTC-Operational (Technical) Constraints Model & OBM - Operation Business Model AUI - Aircraft Usage Impact Model	Start date	October 2012

1. Topic description

1. Background

A key activity within the Mission and Trajectory Management (MTM) strand within the Systems for Green Operation (SGO) Integrated Technology Demonstrator (ITD) is the development of optimisation tools to enable optimisation of flight trajectories and missions.

The optimisation tool is based on a framework that is capable of linking different models, potentially written in different languages and formats, in order to set up the optimisation problem at hand. The framework, called GATAC, includes an optimisation suite and, though a graphical user interface, allows the user to set up the optimisation problem accordingly.

A significant part of this work involves the customisation of existent models and the development of new models to provide an environment in which more complex trajectory optimisation problems can be addressed. To this effect, airframe (aerodynamic), engine performance, noise and emission models, amongst others, have already been developed and these have allowed optimisations of trajectories and missions to be carried out successfully.

The capability of the optimisation activities, based on the models available to the GATAC optimisation work, is limited to a trade-off between fuel consumption, time of flight and emissions. A need now arises to introduce the factor of operational cost into the optimisation strategy.

As a result, an operational model is required for use within the GATAC environment. This operational model is to, amongst others, address operation (technical and logistic) constraints and the impact of aircraft usage, as well as include an operational business model.

This model is intended to give the consortium the capability of taking into account the costs and constraints typically faced by airline operators so that the optimisations can be executed with such factors taken into account.

2. Scope of work

The scope of the work is to deliver a software model or suite of models (executable, accompanied by the source code, user manual and any associated documentation) that can run in optimisation executions within the GATAC framework.

The model or suite of models shall be capable of realistic representation of airline operating costs in order to be able to provide a realistic indication of the overall costs associated with the flight time, fuel burn, noise and emissions of the flight mission being optimised.

The model shall be written in a suitable engineering language such as JAVA or C++, using a standard object-oriented approach and industry-standard code development practices. It shall be modular in nature, supporting further development in future and all data that is application specific shall be arranged in a format that is easily updated to enable the specifics of the conditions being modelled (ie the specific airline model) to be changed easily. For example, such data may be stored in an excel spreadsheet or in a file in XML format. In this way, generic equations should be used that will allow the modelling of a specific operational model through the definition of stored data.

The model shall be capable of modelling various functions, including:

- Operational constraints, including technical and logistic. Examples include constraints that emerge from fleet equipage and availability, limitations of operations (such as ETOPS, payload/range, etc), operational practices, limitations of turn-around times, the impact of flight time on and the aircraft usage schedule, etc.

- Operating costs, such as those associated with fuel burn, crew flight time, aircraft depreciation, maintenance and landing fee costs, etc. and operational overheads of the operator. Cost schemes such as that involving Carbon Trading and noise should be included.

- The impact of longer flight time on airline operational costs, with consideration, amongst others, of the costs related to the impact on aircraft utilisation, flight scheduling, time slot rescheduling and fleet size.

The model is expected to handle a number of inputs, such as fuel burn. cost of fuel and taxes, etc., time of flight, emissions and operational scenario (such as number of aircraft in fleet, schedule, etc) and generate an output in terms of cost.

NOTE: Within the SGO ITD, the optimisation activities currently focus on individual flights ie: a single gate-to-gate activity. The models are therefore required to be able to handle the costs associated with a particular flight and must include the impact the flight time has on overall cost. However, the ability of models to handle fleet-wide or multiple aircraft operations in a single optimisation scenario/run is considered a significant asset.

The work will start with a detailed specification of the performance and capabilities of the planned models and code. Data representing a typical airline of choice operating a) medium range large jet transports (such as the A320 series), b) large long range (such as the A330) and c) regional aircraft (such as the ATR 42/72 series) shall be provided with the models. All models and associated data should be validated against real operational data. The integration of the models and the demonstration of their use within the GATAC framework, as well as the training of users, also fall within the scope of the work.

3. Type of work

Software and operational modelling.

4. Special skills, certification or equipment expected from the applicant

The proposer/s should have demonstrated experience in

- software programming at an industrial level
- airline operational research
- operations modelling
- model validation

5. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Model Specification Report	Document	February 2012
D2	Model executable, source code and associated documentation	Software	February 2013
D3	Model Validation Report	Document	October 2013
D4	User Manual	Document	February 2013
D5	User Training	Workshop	February 2013

6. Topic value (€)

The total value of this work package shall not exceed:

500,000.--€

[five hundred thousand euro]

Proposal above this value will be considered as not eligible.
Please note that VAT is not applicable in the frame of the CleanSky programme

Topic description

CfP Nbr	Title		
JTI-CS-2012-2-SGO-04-005	**Virtual integration of electrical equipment and rig correlation**	End date	T_0+24 months
		Start date	T_0= October 2012

1. Topic description

1. Background

The Systems for Green Operations ITD of Clean Sky aims to demonstrate substantial performance and economic benefits of more electric aircraft systems technologies. For electrical systems, comprehensive validation activities are mandatory to allow such a demonstration. Indeed, by correlating performances and design margins of both network and equipment, aircraft manufacturers ensure safe and reliable operation: any subsystem not complying with its specification requirements may lead the network exceeding its operating limits, further leading to improper operation and additional failures.

In Clean Sky SGO, definition and validation of the electrical network will be done in a complementary way:

- by simulation studies using advanced simulation methods and tools defined in WP2.1.5,

- by demonstration of equipment and network operation on a test rig in WP4.2.1.

2. Scope of work

In this framework, WP4.2.5 concentrates on the detailed modelling and simulation of the electrical system. This task has proven in the past to be key for system optimisation and extended verification. The Systems for Green Operations ITD is looking for a simulation and integration specialist to become a partner of the consortium taking part in V&V activities by performing the following tasks:

- validation of the simulation models against actual equipment performance,

- integration of the various equipment simulation models so as to perform simulation studies for different candidate network architectures,

- definition of the test procedures on the test rig.

3. Type of work

The validation of highly integrated systems requires both actual and virtual platforms – a test rig and a simulation benchmark.

Simulation is a vital tool not only for system optimisation at equipment and aircraft levels, but also to validate their behaviour in normal and degraded operation modes. For that purpose, WP2.1.5 provides methods and tools for test and verification. This includes a recommendation on the tool providing the best modeling and simulation capabilities for WP4.2.5 activities, between MODELICA and SABER.

The main tasks of this CfP applicant will be to:

- write a specification document defining the simulation model requirements;

- collect simulation models (about 5) and data from equipment suppliers and electrical system architecture from aircraft manufacturer;

- validate each equipment model, according to methods defined in WP2.1.5, at both "behavioural" and "functional" levels (rather);

- define and run single-model stand-alone simulation to characterise simulated equipment performance

- demonstrate correlation between simulation results and rig test results, which implies iterative interaction with equipment suppliers so as to obtain validated simulation models;

- integrate single simulation models gathered so as to perform global network simulations – such as power quality analyses, degraded operation characterisation, assessment of selectivity and stability... – according to requirements from aircraft manufacturer. Some of these results must be correlated with rig test results and expectations;

To provide an indication of the amount of work, a typical architecture would consist of a generator, a power center and 5 loads. Exhaustive validation of logics is not included in the scope of this activity.

WP4.2.1 will cover the activities of actual equipment tests on a hardware test rig. Validation and verification of actual equipment and network performances on a representative test rig are mandatory to demonstrate compliance with performance requirements and to assess architectures. Related task for the CfP applicant is to write the detailed test procedures to be performed on the test bench in SGO WP4.2, including data processing requirements to perform the correlation activity previously defined.

This activity includes about 5 stand-alone equipment test procedures and an integrated network test procedure to characterise the network behaviour – such as power quality in normal and degraded operation, protection selectivity...

4. Special skills, certification or equipment expected from the applicant

Knowledge on the state-of-the-art modelling and simulation technologies in MODELICA and SABER environments is requested. Experience in integrating simulation models from equipment suppliers in a large electrical network simulation is the most critical skill for selection. The answer to this call for proposal must include a detailed description of the experience in the design and integration process of aircraft electric systems system using SABER and/or MODELICA and latest projects closely cooperated with aircraft manufacturers.

Practical experience on V&V process, including description/planning of electrical tests and experimental/simulation correlation activities must also be demonstrated.

Due to the tight schedule of the requested activity, the proved expertise of the applicants in the concerned technological field will be a key factor of selection.

5. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Specification document for simulation model requirements		T_0+1
D2	Delivery of collected equipment simulation models		T_0+6 / T_0+12 / T_0+18
D3	Intermediate and final reports demonstrating compliance of equipment modelling requirements and showing the simulation test results run for single-equipment characterisation		T_0+6 / T_0+12 / T_0+18
D4	Report synthesising correlation of simulation results with rig test results		T_0+24
D5	Detailed procedures for experimental equipment characterisation on the test rig		T_0+6 / T_0+12 / T_0+18

6. Topic value (€)

The total value of this work package shall not exceed:

500,000.--€

[five hundred thousand euro]

Proposal above this value will be considered as not eligible.
Please note that VAT is not applicable in the frame of the CleanSky programme

Clean Sky –Technology Evaluator

No topics in this Call