Call for Proposals:

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

Call Text

Call Identifier

SP1-JTI-CS-2012-03

Index

Document change log

Date	*Topics Impacted*	*Description*

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.

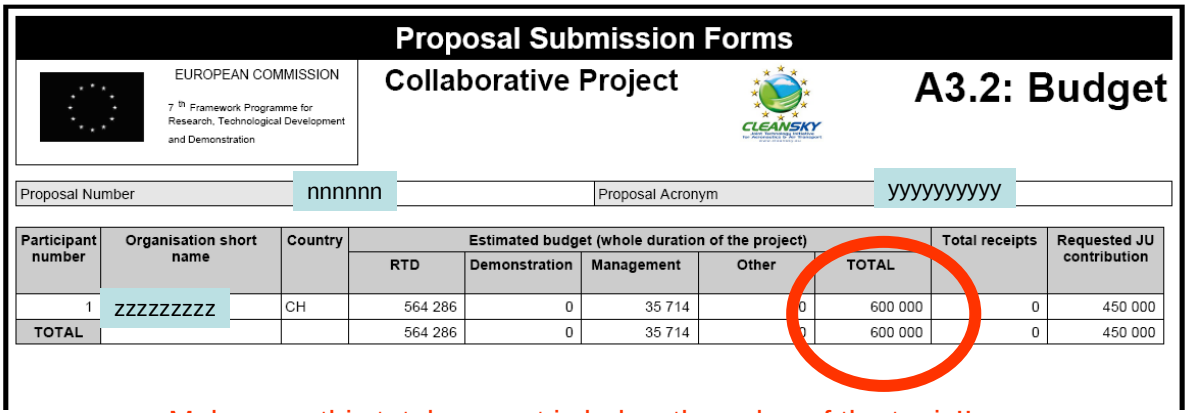
Each Topic fiche addresses the following points:

- Topic manager (not to be published)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

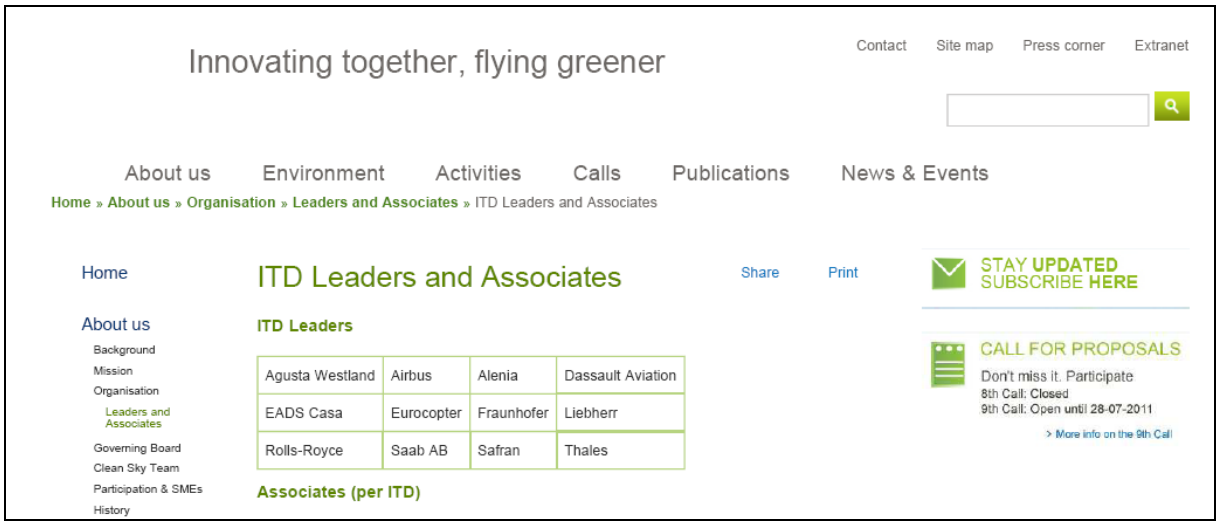
Make sure this total amount is below the value of the topic!!
Better, keep at least 5% margin.
Final amount is to be discussed in the negotiation.

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:



<u>Recommendation to applicants:</u>

In case of deviations from the requirements of the topic (in terms of deadlines, number and type of deliverables, and so on), pls state it at the beginning of your proposals as a Caveat, explaining the reasons and justifications for your choice.

You have to clarify your way of compliance with the topic at start of document, in order to properly prepare the evaluation.

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: 5 July 2012**
- **Call close: 18 October 2012, 17:00**

- Evaluations (indicative): 26-30 November 2012

- Start of negotiations (indicative): 19 December 2012
- Final date for signature of GA by Partner: 18 January 2013
- Final date for signature of GA by Clean Sky JU: 31 January 2013

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-2012-03@cleansky.eu

Questions received until **21 September 2012** will be considered.

A first version of the Q/A document will be released approx **7 September 2012**.

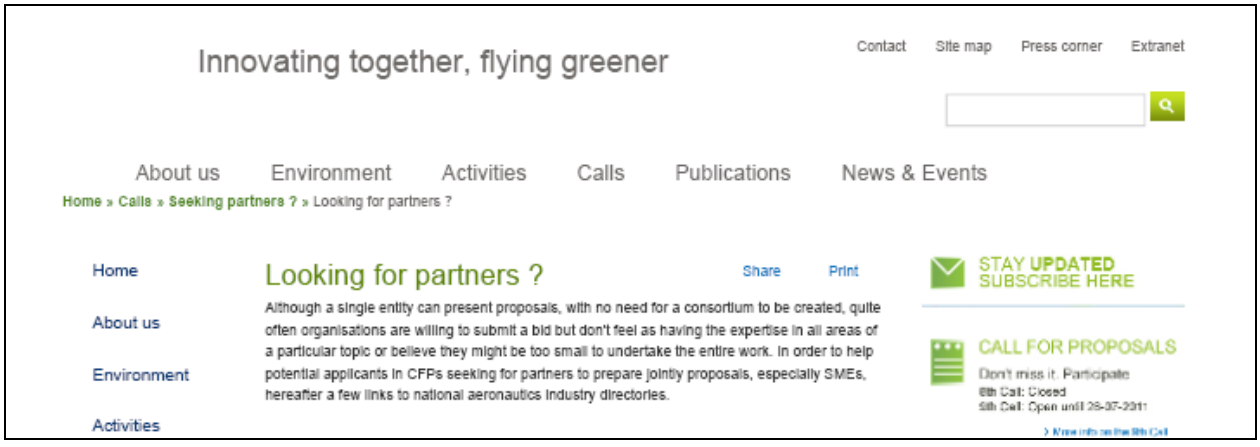
The final version of the Q/A document will be released approx **end September 2012**.

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.

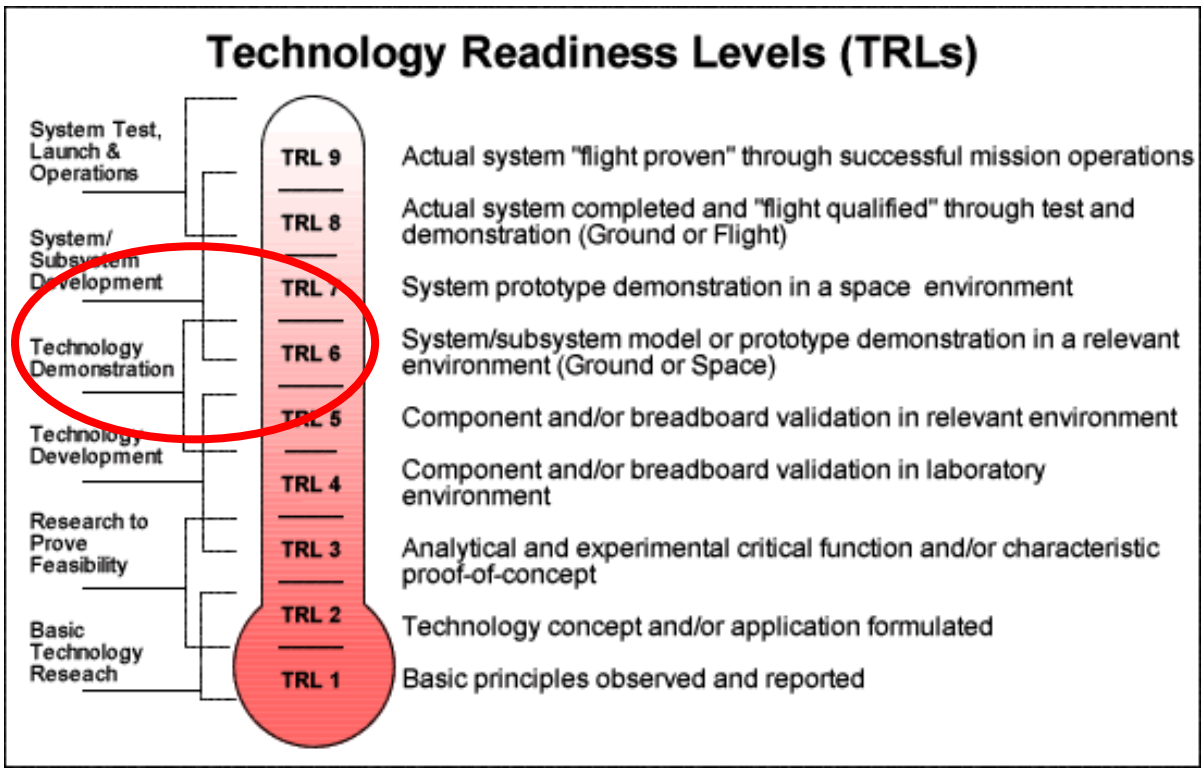
Looking for Partners?

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:



Identification	ITD - AREA - TOPIC	topics	VALUE	MAX FUND
JTI-CS-ECO	**Clean Sky - EcoDesign**	**7**	**1,270,000**	**952,500**
JTI-CS-ECO-01	*Area-01 - EDA (Eco-Design for Airframe)*		**1,270,000**	
JTI-CS-2012-3-ECO-01-058	Validation of TSAA coating technology. Development of procedures and standards manual. Technical and economical study.		100,000	
JTI-CS-2012-3-ECO-01-059	Design and Modification of existing spraying facilities for automated sol gel application.		140,000	
JTI-CS-2012-3-ECO-01-060	Investigation and Modification of existing standard universal milling machine in order to achieve LBW capabilities		200,000	
JTI-CS-2012-3-ECO-01-061	Sustainability assessment for EcoDesign-Guideline		200,000	
JTI-CS-2012-3-ECO-01-062	Technology Development for CFRP Recovery/ Recycling		150,000	
JTI-CS-2012-3-ECO-01-063	Extrapolation to industrial condition of a cured composite and thermoplastic recycling process		230,000	
JTI-CS-2012-3-ECO-01-064	Extrapolation to industrial condition of the liquid infusion manufacturing process		250,000	
JTI-CS-ECO-02	*Area-02 (EDS - Eco-Design for Systems)*		**0**	
JTI-CS-GRA	**Clean Sky - Green Regional Aircraft**	**1**	**400,000**	**300,000**
JTI-CS-GRA-01	*Area-01 - Low weight configurations*		**400,000**	
JTI-CS-2012-3-GRA-01-051	Methodology platform for prediction of damage event for self sensing curved composite panel subjected to real load conditions		400,000	
JTI-CS-GRA-02	*Area-02 - Low noise configurations*		**0**	
JTI-CS-GRA-03	*Area-03 - All electric aircraft*		**0**	
JTI-CS-GRA-04	*Area-04 - Mission and trajectory Management*		**0**	
JTI-CS-GRA-05	*Area-05 - New configurations*		**0**	
JTI-CS-GRC	**Clean Sky - Green Rotorcraft**	**5**	**2,550,000**	**1,912,500**
JTI-CS-GRC-01	*Area-01 - Innovative Rotor Blades*		**1,650,000**	
JTI-CS-2012-3-GRC-01-011	Low cost design approach through simulation and manufacture of new mould concepts for very high tolerance composite components		400,000	
JTI-CS-2012-3-GRC-01-012	Design and Manufacturing of an innovative oscillating airfoil provided with Gurney flap		900,000	
JTI-CS-2012-3-GRC-01-013	Development and Correlation of CFD Methods to Model Active Gurney Flaps on Helicopter Main Rotor Blades		350,000	
JTI-CS-GRC-02	*Area-02 - Reduced Drag of rotorcraft*		**600,000**	
JTI-CS-2012-3-GRC-02-008	Assessment of tiltrotor fuselage drag reduction by wind tunnel tests and CFD		600,000	
JTI-CS-GRC-03	*Area-03 - Integration of innovative electrical systems*		**0**	
JTI-CS-GRC-04	*Area-04 - Installation of diesel engines on light helicopters*		**0**	
JTI-CS-GRC-05	*Area-05 - Environmentally friendly flight paths*		**0**	
JTI-CS-GRC-06	*Area-06 - Eco Design for Rotorcraft*		**300,000**	
JTI-CS-2012-3-GRC-06-005	Recycling of Metallic Materials from Rotorcraft Transmissions		300,000	
JTI-CS-SAGE	**Clean Sky - Sustainable and Green Engines**	**12**	**18,450,000**	**13,837,500**
JTI-CS-SAGE-01	*Area-01 - Open Rotor Demo 1*		**0**	
JTI-CS-SAGE-02	*Area-02 - Open Rotor Demo 2*		**8,550,000**	
JTI-CS-2012-3-SAGE-02-025	SAGE2 Engine Mounting System		3,000,000	
JTI-CS-2012-3-SAGE-02-026	SAGE2 Engine In-flight Balancing System		4,000,000	
JTI-CS-2012-3-SAGE-02-027	Validation of high Load Capacity Gear Material		550,000	
JTI-CS-2012-3-SAGE-02-028	Study and durability of electrically insulative material in aircraft engine chemical environment		400,000	
JTI-CS-2012-3-SAGE-02-029	Development and validation of a metallurgically based simulation model for crack generation during welding and heat treatment of superalloys.		600,000	
JTI-CS-SAGE-03	*Area-03 - Large 3-shaft turbofan*		**6,400,000**	
JTI-CS-2012-3-SAGE-03-016	Surface protection of composite aeroengine components to enable weight savings in high temperature applications (≥360oC)		750,000	
JTI-CS-2012-3-SAGE-03-017	Electric Pump for Safety Critical Aero engine applications		1,750,000	
JTI-CS-2012-3-SAGE-03-018	Variable fluid metering unit for Aero engine applications		750,000	
JTI-CS-2012-3-SAGE-03-019	Development of materials, processes, and means to enable the application of piezoelectric materials in aero engine controls.		1,500,000	
JTI-CS-2012-3-SAGE-03-020	Net shape Hot Isostatic Pressing of IN718		1,650,000	
JTI-CS-SAGE-04	*Area-04 - Geared Turbofan*		**0**	
JTI-CS-SAGE-05	*Area-05 - Turboshaft*		**0**	
JTI-CS-SAGE-06	*Area-05 - Lean Burn*		**3,500,000**	
JTI-CS-2012-3-SAGE-06-001	Advanced materials for lean burn combustion system components using Laser- Additive Layer Manufacturing (L-ALM)		1,000,000	
JTI-CS-2012-3-SAGE-06-002	Economic manufacture of lean burn combustion liner tiles using Laser- Additive Layer Manufacturing		2,500,000	
JTI-CS-SFWA	**Clean Sky - Smart Fixed Wing Aircraft**	**8**	**10,725,000**	**8,043,750**
JTI-CS-SFWA-01	*Area01 – Smart Wing Technology*		**300,000**	
JTI-CS-2012-03-SFWA-01-053	Adaptation of a generic wind tunnel model for attachment line transition measurements (MAALTSU)		300,000	
JTI-CS-SFWA-02	*Area02 - New Configuration*		**9,750,000**	
JTI-CS-2012-03-SFWA-02-033	High speed wind tunnel test of Laminar configuration bizjet		2,000,000	
JTI-CS-2012-03-SFWA-02-034	Design, Manufacture and Wind Tunnel of a large laminar half model		4,400,000	
JTI-CS-2012-03-SFWA-02-035	Characterisation, Modelling & Passive Control of 3D transonic wing buffet		1,300,000	
JTI-CS-2012-03-SFWA-02-036	In-service assessment of Leading Edge Contamination and Damage		250,000	
JTI-CS-2012-03-SFWA-02-037	Blade trajectory testing		1,800,000	
JTI-CS-SFWA-03	*Area03 – Flight Demonstrators*		**675,000**	
JTI-CS-2012-03-SFWA-03-011	Wireless Sensor Nodes for continuous flight test measurements		400,000	
JTI-CS-2012-03-SFWA-03-012	Engine Pylon load measurements and prediction of accuracy		275,000	
JTI-CS-SGO	**Clean Sky - Systems for Green Operations**	**14**	**6,450,000**	**4,837,500**
JTI-CS-SGO-01	*Area-01 - Definition of Aircraft Solutions and explotation strategies*		**0**	
JTI-CS-SGO-02	*Area-02 - Management of Aircraft Energy*		**5,950,000**	
JTI-CS-2012-3-SGO-02-043	Aerospace housing for extreme environment		300,000	
JTI-CS-2012-3-SGO-02-045	Regenerative Snubber & innovative control algorithm		400,000	
JTI-CS-2012-3-SGO-02-046	High Dense Smart Power Capacitor (HDSPC) for next generation Aircraft converters		600,000	
JTI-CS-2012-3-SGO-02-054	Design and manufacturing of Flight test version of Electro-mechanical Wing Ice Protection assembly (Modified A320 slat 5)		500,000	
JTI-CS-2012-3-SGO-02-055	Tool for wiring optimization regarding lightning threat		800,000	
JTI-CS-2012-3-SGO-02-056	Integrated design tool to support EWIS optimisation		300,000	
JTI-CS-2012-3-SGO-02-057	High Voltage connectors and moving links		200,000	
JTI-CS-2012-3-SGO-02-058	Optimized power cable for skin effects		200,000	
JTI-CS-2012-3-SGO-02-059	Certified Code Generation of Model-Based Modelica Controllers		200,000	
JTI-CS-2012-3-SGO-02-060	Electrical Machine Magnetic Properties Characterisation Setup for Aerospace Application		800,000	
JTI-CS-2012-3-SGO-02-061	Technology development and fabrication of integrated solid-state power switches		650,000	
JTI-CS-2012-3-SGO-02-062	Concepts and solutions for health monitoring of electro mechanical actuators		500,000	
JTI-CS-2012-3-SGO-02-063	Investigation of electric components used in aerospace environment in terms of partial discharge issues		500,000	
JTI-CS-SGO-03	*Area-03 - Management of Trajectory and Mission*		**500,000**	
JTI-CS-2012-3-SGO-03-020	Adaptation of optimisation algorithm to avionics constraints		500,000	
JTI-CS-SGO-04	*Area-04 - Aircraft Demonstrators*		**0**	
JTI-CS-TEV	**Clean Sky - Technology Evaluator**	**0**	0	0.000
		topics	**VALUE**	**FUND**
	totals (€)	**47**	***39,845,000***	***29,883,750***

Clean Sky Joint Undertaking
Call SP1-JTI-CS-2012-03
Eco Design

Clean Sky – Eco Design

Identification	ITD - AREA - TOPIC	topics	VALUE	MAX FUND
JTI-CS-ECO	**Clean Sky - EcoDesign**	**7**	**1,270,000**	**952,500**
JTI-CS-ECO-01	*Area-01 - EDA (Eco-Design for Airframe)*		**1,270,000**	
JTI-CS-2012-3-ECO-01-058	Validation of TSAA coating technology. Development of procedures and standards manual. Technical and economical study.		100,000	
JTI-CS-2012-3-ECO-01-059	Design and Modification of existing spraying facilities for automated sol gel application.		140,000	
JTI-CS-2012-3-ECO-01-060	Investigation and Modification of existing standard universal milling machine in order to achieve LBW capabilities		200,000	
JTI-CS-2012-3-ECO-01-061	Sustainability assessment for EcoDesign-Guideline		200,000	
JTI-CS-2012-3-ECO-01-062	Technology Development for CFRP Recovery/ Recycling		150,000	
JTI-CS-2012-3-ECO-01-063	Extrapolation to industrial condition of a cured composite and thermoplastic recycling process		230,000	
JTI-CS-2012-3-ECO-01-064	Extrapolation to industrial condition of the liquid infusion manufacturing process		250,000	
JTI-CS-ECO-02	*Area-02 (EDS - Eco-Design for Systems)*		**0**	

Clean Sky Joint Undertaking
Call SP1-JTI-CS-2012-3-ECO-01-058

Topic Description

CfP topic number	Title		
JTI-CS-2012-3-ECO-01-058	**Validation of TSAA coating technology. Development of procedures and standards manual. Technical and economic study.**	**End date**	*To + 14*
		Start date	*To*

1. Topic Description

Chromic acid anodising has been traditionally used for aluminium alloy protection in aircraft structures due to the anticorrosive protection and excellent paint adhesion it provides. 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 Acid Anodizing (TSAA)** typically produces a 2 to 7µm thick layer and is promoted as an alternative to chromic acid anodizing by aircraft manufactures. Prior to the industrial application of this technology, a validation step is essential.

The objectives of this CfP are:

1. to develop the process procedures and standard manual for the Industrial application of TSAA

2. to validate the whole process including pre-treatments and post-treatments defined by the Topic Manager.

3. to compile a technical and economic study of the new TSAA technology as compared to the established chromic acid anodizing process

As a minimum, the process procedure will describe the following issues/thematic areas:

Scope

Classification

References

Definitions

Technical requirements, including Materials, Equipment, Preparation of solutions, Operating Conditions, Maintenance and regeneration, Procedure of Anodizing, Local repair of anodizing, Stripping of anodizing.

Properties that characterize the anodized film

Quality assurance provisions

Safety issues

The Process validation will include a pre-production qualification testing. These tests are to determine the conformance to the technical requirements of the Process procedure in real industrial conditions.

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

The following skills and equipment are required:

- TSA experimental and pilot-scale production 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.

- Experience in technologies industrialization.

3. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Feasibility of the process in the real industrial environment	To perform a benchmarking of existing industrial plant potentially suitable for the process	T_0 + 2
D2	Path to bring the selected industrial plant to the production phase	Evaluating the implementation plan, required equipment/layouts and possible modifications of existing industrial plants. Evaluating the industrial repercussion during their implementation in manufacturing plants	T_0 + 6
D3	Technical and economic impact	Evaluation of the technical and economic impact deriving from the introduction of the selected technology, as compared to exiting alternative technology (cost / performance evaluation). Establish the minimum conditions required to make the technology viable. Cost analysis with recurring and non recurring cost (RC & NRC) analysis for the TSAA treatment.	T_0 + 8
D4	Relevant parameters of the environmental impact during the production cycle	Evaluate the relevant parameters of their impact on the environment during the production cycle with reference to the healthy human oriented working. Verify that the real industrial conditions will not affect the environmental performances of the final products.	T_0 + 9
D5	Risk assessment plan	Establish risk assessment plan of the entire production process	T_0 + 12
D6	Manufacturing plan. Validation of the TSA	Elaborate the manufacturing plan for end item top assembly. Report with qualification test results.	T_0 + 13
D7	Process procedures and standard manual	To develop the process procedures and standard manual for the industrial application	T_0 + 14
D8	Final report	Report on the extrapolation to industrial condition of the TSAA treatment	T_0 + 14

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.

5. Remarks

Raw material will be provided by Topic Manager

Clean Sky Joint Undertaking
Call SP1-JTI-CS-2012-3-ECO-01-059

Topic Description

CfP topic number	Title		
JTI-CS-2012-3-ECO-01-059	**Design and Modification of existing spraying facilities for automated sol gel application.**	End date	*To + 14*
		Start date	*To*

1. Topic Description

A sol gel process is based on precipitation of organo functionalized alkoxydes in presence of acid or alkaline catalyst using precursors such as silane, silicate, zirconate or titanate. Sol gel coatings are eliminating the use of Crvi toxic and carcinogenic compounds. The concept is to replace the existing protection system anodising+paint which includes Cr compounds and to develop spraying techniques in replacement of in-bath ones, using green products. This will permit the treatment of very large parts, or welded ones, while suppressing huge tanks containing hazardous products and allowing the reduction of water consumption and of waste.

The combination of an innovative coating system with a robotic application will bring the technology one step forward.. Furthermore to the expected saving of resources will add an ecolonomic benefit.

The objective of this CfP is the upgrade (investigate and modify) the existing equipment to an automated sol gel system with robotic capabilities (preferably five axis movements). The system shall be capable to cover both flat as well as curved specimens (a characteristic example is a component of dimensions 1500 x 2100 mm with a Radius of 137 DEG Spray gun may be movable over rails The robotic system should be expandable.

The development will be performed in the frame of sol gel technology extrapolation to industrial conditions phase. For this purpose, the existing equipment (including: high speed spray gun, compressed air facility, water curtain installation in an enclosed area) will be available for modifications on Topic Manager Site. The final system will be tested and approved in Topic Manager Facilities. Series of coupons and limited number of components will be used for sol gel robotic spraying technology approval tests. The coating experiments will be performed with sol gel formulations and spraying requirements (e.g. thickness and uniformity of coating) specified by the Topic Manager and the coated products will simulate aircraft stiffened structures.

The Al alloy coupons and components will be provided by the Topic Manager.

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

The following skills and equipment are required:

- Robotic systems know how applications.
- Experience in spraying painting applications
- Know how on machinery modifications, custom-made tooling systems design and realization capabilities.

3. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Design of modification of existing equipment to new technology system.	Report and drawings	T0+7
D2	Modification of existing equipment (1st phase of pre-validated system)	New robotic sol gel pre-validated system	T0+10
D3	Production and delivery of coated test coupons in forms representative real aeronautical skin structures (at least five coupons dimensions 250 x 250 mm). Report and reference standards shall be included.	Coupons (at least 5 different configuration)	T0+11

D4	Thickness and Uniformity evaluation on sol gel coated coupons and components.	Report	T0+12
D5	Modification of existing equipment (2nd Phase-final acceptance)	New robotic system (key in hand)	T0 + 14

4. Topic value (€)

The total value of this work shall not exceed:

140,000 €

[One hundred forty 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
Call SP1-JTI-CS-2012-3-ECO-01-060

Topic Description

CfP topic number	Title		
JTI-CS-2012-3-ECO-01-060	**Investigation and Modification of existing standard universal milling machine in order to achieve LBW capabilities.Technical and economic study of the new LBW technology**	**End date**	*To + 14*
		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. Advanced aluminium alloys for aerospace applications 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.

The 1st objective of this CfP is to investigate and modify existing equipment (as a standard universal milling machine) to achieve a welding system with LBW capabilities. The study will be performed in the frame of LBW extrapolation to industrial conditions phase. The main target is to modulate existing equipment to a new technology. For this purpose, the existing equipment will be available for modifications either on Topic Manager site or in CfP winner installations. The final system will be tested and approved in Topic Manager facilities. Series of coupons and limited number of components will be used for welding approval tests. The welding experiments will be performed on conditions specified by Topic Manager and the welded products will simulate stiffened structures and inspected by NDT in order to assure the structural integrity.

The Al alloy coupons and components will be provided by Topic Manager.

The 2nd objective of this call is to issue technical and economical study of LBW technology and comparison with the riveting which will be replaced

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

The following skills and equipment are required:

- Laser Beam Welding know how.
- Proven Background and knowledge on laser welding of structural aerospace aluminium alloys
- Experience and facilities for mechanical testing of aluminium welded joints.
- Know How on machinery modifications, custom-made tooling systems design and realization capabilities.
-Experience in technologies industrialization.

3. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Feasibility of the process in the real industrial environment	To perform a benchmarking of existing industrial plant potentially suitable for the process	T_0 + 2
D2	Path to bring the selected industrial equipment through modifications to the production phase of the laser beam welding process	To evaluate the implementation plan, design the changes and proceed to the modification of the existing equipment to the new technology system. To evaluate the industrial repercussion during the implementation of the technology in the manufacturing plant	T_0 +6
D3	Technical and economical impact	Evaluation of the technical and economical impact from the introduction of the selected technology, compared to the existing alternative technologies (cost / performance evaluation). Establish the minimum conditions required to make the technology viable. Cost analysis with recurring and non recurring cost (RC & NRC) analysis for this process.	T_0 + 8
D4	Relevant parameters of the environmental impact during the production cycle	Evaluate the relevant parameters of their impact on the environment during the production cycle with reference to the healthy human oriented working.	T_0 + 9
D5	Modification of existing equipment (1st phase pre-validated system)	New LBW pre-validated system	T0+10
D6	Risk assessment plan	Establish risk assessment plan of the entire production process	T_0 + 12
D6	Manufacturing plan. 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. Mechanical testing of laser welded joints of Al alloy (including fatigue)	Elaborate the manufacturing plan for end item top assembly. Deliver coupons (at least 5 of T-joint configuration) Report on mechanical tests	T_0 + 13
D7	Process procedures and standard manual	To develop the process procedures and standard manual for the industrial application	T_0 + 14
D8	Final report. Modification of existing equipment (2nd phase-final acceptance)	Report on the extrapolation to industrial condition of the laserbeam welding process New LBW system (key in hand)	T_0 + 14

4. Topic value (€)

The total value of this work shall not exceed:

200,000 €

[Two hundred 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-2012-03-ECO-01-061

Topic Description

CfP topic number	Title		
JTI-CS-2012-3-ECO-01-061	**Sustainability assessment for EcoDesign-Guideline**	End date	*To + 16*
		Start date	*To*

1. Topic Description

Sustainability covers the aspects of environmental impact, economics, and social aspects. With this CfP, mainly the first two aspects will have to be addressed.

As of today, a minority of materials used in aircraft are recycled as their largest number is not even dismantled yet. If dismantled properly, kept and processed separately as shown in the PAMELA project, metals recycling into the initial quality proves feasible. These are mainly metal alloys amongst others Aluminum, Titanium, Copper and Beryllium used in turbines, rotors and landing gears. For other materials like from cabin interior, insulation material or coatings e.g. from turbine, recycling options are either available but not used in an industrial process, still in a research and development status or incineration is the treatment of choice.

The large number of different materials used in a/c is complicating an appropriate separation. This is not only a problem for polymer treatment, separating the different metal alloys used is not less challenging. More precise and effective separation processes are increasing the recyclability of materials, but are decreasing profitability due to raising costs likewise.

Eco Design for Airframe (EDA) is approaching this question from the technological end, by development of identification, dismantling, and recovery options.

This CfP is first aiming to address the challenge from the economic and environmental perspective. Starting from a market survey on the most important a/c and/or materials used in the actual CS EDA WP24 work, it is expected to collect (primary and secondary) materials and semi-finished products (e.g. sheets, wires) market data. For materials selection and before market survey work starts, a consolidation step of the selection list with the topic manager is expected.

In a second step, price or revenue expectations (ranges) have to be generated, in order to provide a data base for future economic assessment. If applicable, scenarios shall be used in order to make the data expected for the future more robust.

In a third step, a methodology proposal should combine the expected market data with the current and expected future steps for a/c dismantling, treatment, and recycling. The applicant is asked to describe and discuss current as well as future dismantling and treatment processes of a/c parts and materials from an economic point of view, and to provide a method for decision-making on future a/c end of life steps. The method shall take materials purity, its current and expected future market values and the total processing cost into account. It is required that the applicant is collecting economic process and materials information needed from the partners inside and outside the EDA consortium, and an approach on this data collection method has to be drafted in the applicants proposal.

Regarding dismantling and recycling of aircrafts, their parts and materials, the expected outcome is an economic method for decision-making along with an actual a/c industry specific set of data (materials, processes) covering both state of the art processes and those developed in the CleanSky Eco Design project in WP33.

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

The applying body or consortium is expected to have a track record in business development and market surveys. A strong link to technology, especially mechanical engineering, is expected, too. Additionally the applicant should have basic knowledge about materials used in aircraft construction.

Access to suppliers of a/c industry and/or raw materials suppliers is recommended to the applicant.

3. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Materials list	Selection of important materials or materials groups from end of life a/c for consolidation with topic manager	T0+2
D2	Market survey results	Market information on materials (primary/secondary) mentioned in D1	T0+7
D3	Future market scenarios	Prognosis of future market developments for materials (list of D1)	T0+9
D4	Method proposal for recycling processes selection	Method on recycling process selection based on market information, including example application to selected a/c part to decide on.	T0+14
D5	Sustainability study final version	Report on sustainability of a/c dismantling and recycling processes, describing basic data, method, and application example.	T0 + 16 Months

4. Topic value (€)

The total value of 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.

Clean Sky Joint Undertaking
SP1-JTI-CS-2012-03-ECO-01-062

Topic Description

CfP topic number	Title		
JTI-CS-2012-3-ECO-01-062	**Technology Development for CFRP Recovery/ Recycling**	End date	*To + 15*
		Start date	*To*

Special Clause

The text of this topic contains the basic information for the applicant to understand the need of the ITD Topic manager.
*However, more detailed data are available in a separate info package that can be provided on request to the interested applicant; due to the confidentiality content of this supplementary document, it is necessary to enter a Non Disclosure Agreement **(NDA)** with the Topic Manager Company.*
Therefore the applicant who is willing to receive this detailed info package is invited to write to the call mailbox confirming the request. He'll receive a NDA to sign in two originals and to send to the JU.
The NDA will be passed to the Topic Manager and, when signed, will be returned in one copy to the applicant together with the Specification document.
Questions concerning the confidential data delivered will be handled in a dedicated Q/A document, which will only be circulated to those applicants who have signed the Confidentiality Agreement.

1. Topic Description

The objective of the call is to develop a key process for recovery and recycling CFRP uncured scraps.

As a matter of fact the Topic Manager Company that is issuing this call for proposal has already developed a uncured CFRP scraps recycling process aimed to use, rather than waste, material scraped during lamination.

The process is therefore a background proprietary information owned by the above Company and covered by patent or application for patent in Italy, Europe, USA, etc.

Property of background information and results of the work performed within this call for proposal will be handled according to the rules of the program. Any subject willing to access to the information produced by this activities shall sign a Non Disclosure Agreement with the Topic Manager Company.

In the concerned process the uncured CFRP scrapes coming in any shape and dimension from cutting of excess during Unidirectional plies lamination are cut by a suitable device in small elements, after backing paper removal. These elements, in the following “CFRP chips”, have defined dimensions: 8 mm transverse to fibre direction x 50 mm parallel to fibre dimension.

After cutting the CFRP chips must be distributed rather uniformly over a backup paper to obtain a raw uncured plate of about 500 mm x1000 mm to be used subsequently as raw material to produce light weight structural elements.

It is object of this call for proposal the **development of a distribution module**, to distribute uniformly the above chips according to the following requirements.

The distribution Module shall be able to receive CFRP rectangular chips from cutting stage that feed the chips in a quite constant rate

1) The Distribution module will random orients and distribute the chips over a plate covered by a suitable baking paper. Plate will have a dimension of 500 mm transverse to fibre direction and 1000 mm parallel to fibre direction

2) Distribution shall be such that:

a. CFRP aerial weight will be 1000 (+/-200) gr/sqmt

b. Fibre orientation will be quasi isotropic i.e. 0°: 33 (+/-5)%, +/-45:33 (+/-5)%, 90°:33 (+/-5)%

In addition this distribution module will be such not to contaminate or alter CFRP chips. Therefore only allowed contact materials will be used and any process that can heat or cool or wet the materials shall be reviewed before application.

Note: the Topic Manager Company will provide to the selected Partner the pre-preg material for the necessary testing

A proposed Work Breakdown Structure and activities description are as follows:

WP	TITLE
WP1	**Trade-off Study**
Task 1.1	Feasibility study for distribution module
Task 1.2	Trade off different approaches
Task 1.3	Define parameters and key components of the selected process
Task 1.4	Define suitable method to measure Fiber areal weigh and fiber orientation distribution on the plate
WP2	**Design and Manufacturing**
Task 2.1	Detail design of distribution module
Task 2.2	Fabrication of distribution module
Task 2.3	Stand alone demo of distribution module
Task 2.4	Integration of Distribution module in the overall feeding, cutting, distribution system

WP1

Task 1.1 The objective of task 1.1 is to identify different methods/mechanism to implement chips distribution i.e. air stream, vibration etc. For each method the key parameters and components will be identified. In this task there will be also defined the geometrical constrains to fit in the overall system.

Task 1.2 The different methods/mechanism will be compared and the most suitable for implementation will be selected. This involve close interaction with the Topic Manager Company to check compatibility with the overall proprietary system.

Task 1.3 In this task the parameters and key elements of selected approach will be completely defined.

Task 1.4 will be devoted to define suitable method to measure fiber areal weight and fiber orientation distribution in at least 20 zone of the resulting CFRP plate.

WP2

Task 2.1 will be devoted to the detailed design of distribution module

Task 2.2 will be devoted to the fabrication of a working distribution module

Task 2.3 will be devoted to demonstrate the distribution module in a stand alone way i.e. CFRP chips will be feeded already cut. To demonstrate the proper working the supplier shall measure in a suitable way the distribution of CFRP areal weight and fiber distribution.

Task 2.4 will be devoted to integrate the distribution system in the overall feeding, cutting, compaction system developed by the Topic Manager Company as back ground. The integration will require a module to be delivered to the Topic Manager Company where the integration activities shall be performed.

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

The applicant shall have a background in the development and realization of mechanical device for uniform distribution of chips in any other fields and or have a know how on specific technique useful for the above application.

3. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Proposed approach document	Definition of possible approach	To + 1
D2	Trade-off document	Selection of most suitable approach and definition of key parameters/components	To + 2
D3	Distribution module drawings	Detail design of distribution module	To + 5
D4	Distribution Module Prototype	Distribution module will be fabricated	To + 11
D5	Stand-alone distribution module demonstration report	Distribution module demonstrated and measurement of Fibre areal weigh and fibre orientation will be reported	To + 12
D6	Integrated distribution module demonstration report	Distribution module will be integrated in the Topic Manager Company Overall system and demonstrated	To + 15

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.

Clean Sky Joint Undertaking
SP1-JTI-CS-2012-03-ECO-01-063

Topic Description

CfP topic number	Title		
JTI-CS-2012-3-ECO-01-063	**Extrapolation to industrial condition of a cured composite and thermoplastic recycling process**	End date	*To+12*
		Start date	*To*

1. Topic Description

Thermoset and thermoplastic composite materials are currently used in a wide range of applications in the aerospace industry. In fact, structural and non-structural aircraft components are more and more realised in carbon fiber reinforced thermosetting plastics (CFRP) and high T_g thermoplastic carbon fiber reinforced composites (TPC) in order to reduce weight and to optimise corrosion resistance and directional performances compared to the metallic solutions. Although recent optimization of processing technologies reduces the amount of trimming wastes and defective components, still the realization of an aircraft produces at least 10 % of composite wastes to be handled. Moreover, the increasingly massive use of composites in aircraft will make available hundreds of thousand tons of dismissed CFRP and TPC in a near future.

Researches carried out in recent years and still nowadays on-going are clearly proving the technical feasibility of using such CFRP and TPC materials as rigid fillers in emulsified thermoplastic commodity matrices, such as polystyrene, from separate collection of loose-fill and rigid shock absorbing packages (EPS). Processes like this needs to be up-scaled at industrial level, upon checking the technical, economical and environmental impact in real productive conditions.

Objective of this call is to develop a detailed plan, from technical feasibility to manufacturing, for the successful recycling process of cured composites and thermoplastics (through a mechano-physical approach), from aircraft production and dismantling, through the emulsification into reclaimed polystyrene and fabrication of pellets or semi-finished elements **with a market appeal from environmental, economic and technical points of view.**

The following activities shall be performed by the selected partner:

1. Feasibility study for the implementation of the recycling process in the **real industrial environment**
2. Definition of the path to bring that to the production phase
3. Evaluation of Industrial repercussion during the implementation in manufacturing plant
4. Study of the technical and economical impact deriving from its introduction and establish the minimum conditions required to make that viable
5. Evaluation of the relevant parameters of its impact on the environment during the production cycle with reference to the healthy human oriented working
6. Verification that the real industrial conditions will not affect the environmental performances
7. Establish the risk assessment plan
8. Elaboration of the manufacturing plan and standard manual for the Industrial application

In the following a proposed Work Breakdown Structure and tasks description of the activities to be performed:

WP	TITLE
WP 1	**Feasibility in the real industrial environment**
Task 1.1	Feasibility of grinding and sorting in the real industrial environment
Task 1.2	Feasibility of mixing and extruding of CFRP and TPC embedded in polystyrene gel in the real industrial environment
WP 2	**Path to bring the process to the production phase**
Task 2.1	Definition of the implementation plan, required equipment/layouts and possible modifications of existing industrial plants.
Task 2.2	Definition of the industrial repercussion during their implementation in manufacturing plants.
WP 3	**Technical and economical impact**
Task 3.1	Evaluation of the technical and economical impact
Task 3.2	Definition of the minimum conditions required to make them viable
Task 3.3	Evaluation of the relevant parameters of their impact on the environment during the production cycle
Task 3.4	Verification that the real industrial conditions will not affect the environmental performances of the final products
WP 4	**Risk assessment plan**
Task 4.1	Preparation of the risk assessment plan for the entire production process
WP 5	**Manufacturing plan**
Task 5.1	Preparation of the manufacturing plan for end item top assembly
WP 6	**Process procedures and standard manual**
Task 6.1	Development of the process procedures and of the standard manual for the industrial application

WP 1

To perform a benchmarking of existing industrial plant potentially suitable for the machining and grinding of CFRP and TPC and a benchmarking of existing industrial plants potentially suitable for mixing and extrusion of grinding and sorting gels of polymers containing rigid fillers.

WP 2

To define the implementation plan, required equipment/layouts and possible modifications of existing industrial plants in terms of: facilities and types of tools, lay-outs and workflow including process timing, manpower needed to run the facility and per unit of product, minimum rates that make the facility viable, energy and water requirements.
To evaluate the industrial repercussion during their implementation in manufacturing plants

WP 3

To evaluate the technical and economic impact deriving from the introduction of the selected technology, as compared to existing alternative technologies (cost / performance evaluation). To establish the minimum conditions required to make that viable. To evaluate the relevant parameters which impact on the environment during the production cycle with reference to the healthy human oriented working. To verify that the real industrial conditions will not affect the environmental performances of the final products

WP 4

To establish risk assessment plan of the entire production process

WP 5

To elaborate the manufacturing plan for end item top assembly

WP 6

To develop the process procedures and standard manual for the industrial application

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

The applicant (single organization or a consortium) needs to have the following facilities and knowledge:

- Strong knowledge on thermoset and thermoplastic resin based composites
- Extensive experience and capabilities for manufacturing thermoplastic composites and experience in process optimisation (availability of pilot-scale emulsion-based processing equipments able to assist the design of the industrial plant is considered an asset)
- Proven experience and capabilities in the realization of feasibility studies of industrial plants
- Certified experience in evaluation of environmental impact of materials and processes in an industrial environment.

3. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Feasibility of grinding and sorting in the real industrial environment	To perform a benchmarking of existing industrial plant potentially suitable for the machining and grinding of CFRP and TPC.	T_0 + 2
D2	Feasibility of mixing and extruding of CFRP and TPC embedded in polystyrene gel in the real industrial environment	To perform a benchmarking of existing industrial plants potentially suitable for mixing and extrusion of grinding and sorting gels of polymers containing rigid fillers.	T_0 + 4
D3	Path to bring the selected industrial plant to the production phase	To define the implementation plan, required equipment/layouts and possible modifications of existing industrial plants. Evaluating the industrial repercussion during their implementation in manufacturing plants	T_0 + 6
D4	Technical and economic impact	To evaluate the technical and economic impact deriving from the introduction of the selected technology, as compared to exiting alternative technologies (cost / performance evaluation). To establish the minimum conditions required to make them viable	T_0 + 8
D5	Relevant parameters of the environmental impact during the production cycle.	To evaluate the relevant parameters of their impact on the environment during the production cycle with reference to the healthy human oriented working. To verify that the real industrial conditions will not affect the environmental performances of the final products.	T_0 + 9
D6	Risk assessment plan	To establish risk assessment plan of the entire production process	T_0 + 11
D7	Manufacturing plan	To elaborate the manufacturing plan.	T_0 + 12
D8	Process procedures and standard manual	To develop the process procedures and standard manual for the industrial application	T_0 + 12
D9	Final report	Report on the extrapolation to industrial condition of the recycling process	T_0 + 12

4. Topic value (€)

The total value of this work package shall not exceed:

€ 230.000

[Two hundred thirty thousand euro]

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

5. Remarks

Note:
The Topic Manager Company will provide to the selected Partner the information about the recycling process of cured composites and thermoplastics (studied and developed in EDA WP A.2.4) necessary for the industrialization study

Legend of abbreviations:
Carbon Fiber Reinforced Plastics (CFRP)
Thermoplastic Composites (TPC)
Expanded Polystyrene (EPS)
Glass Transition Temperature (Tg)

Clean Sky Joint Undertaking
SP1-JTI-CS-2012-03-ECO-01-064

Topic Description

CfP topic number	Title		
JTI-CS-2012-3-ECO-01-064	**Extrapolation to industrial condition of the liquid infusion manufacturing process**	**End date**	*To + 14*
		Start date	*To*

1. Topic Description

Thermoset composite materials are currently used in a wide range of applications in the aerospace industry.

In fact, aircraft components are more and more realised in carbon fiber reinforced thermosetting plastics (CFRP) in order to reduce weight and to optimise corrosion resistance and directional performances compared to the metallic solutions.

Researches carried out in recent years and still nowadays on-going are proving the technical feasibility of the liquid infusion process to manufacture the structural aeronautical components. Processes like this needs to be up-scaled at industrial level, upon checking the technical, economical and environmental impact in real productive conditions.

Objective of this call is to develop a detailed plan, from technical feasibility to manufacturing, for the successful liquid infusion manufacturing process useful for the fabrication of aeronautical components **with a market appeal from environmental, economic and technical points of view.**

The following activities shall be performed by the selected partner:

1. Feasibility study for the implementation of the liquid infusion manufacturing process in the **real industrial environment**
2. Definition of the path to bring the process to the production phase
3. Evaluation of the industrial repercussion during its implementation in manufacturing plant
4. Study of the technical and economical impact deriving from its introduction and establish the minimum conditions required to make that viable
5. Evaluation of the relevant parameters of its impact on the environment during the production cycle with reference to the healthy human oriented working
6. Verification that the real industrial conditions will not affect the environmental performances
7. Establish the risk assessment plan
8. Preparation of the manufacturing plan and of the standard manual for the Industrial application

In the following a proposed Work Breakdown Structure and tasks description of the activities to be performed:

WP	TITLE
WP 1	**Feasibility in the real industrial environment**
Task 1.1	Feasibility study of liquid infusion manufacturing process in the real industrial environment
WP 2	**Path to bring process to the production phase**
Task 2.1	Evaluation of the implementation plan (required equipment/layouts and possible modifications of existing industrial plants).
Task 2.2	Evaluation of the industrial repercussion during their implementation in manufacturing plants.
WP 3	**Technical and economical impact**
Task 3.1	Evaluation of the technical and economical impact
Task 3.2	Identification of the minimum conditions required to make that viable
Task 3.3	Evaluation of the relevant parameters and their impact on the environment during the production cycle
Task 3.4	Verification that the real industrial conditions will not affect the environmental performances of the final products
WP 4	**Risk assessment plan**
Task 4.1	Preparation of the risk assessment plan for the entire production process
WP 5	**Manufacturing plan**
Task 5.1	Preparation of the manufacturing plan
WP 6	**Process procedures and standard manual**
Task 6.1	Development of the process procedures and standard manual for the industrial application

WP 1

To perform a feasibility of liquid infusion manufacturing process in the real industrial environment

WP 2

To define the implementation plan, required equipment/layouts and possible modifications of existing industrial plants in terms of: facilities and types of tools, lay-outs and workflow including process timing, manpower needed to run the facility and per unit of product, minimum rates that make the facility viable, energy and water requirements.
To evaluate the industrial repercussion during their implementation in manufacturing plants

WP 3

To evaluate the technical and economic impact deriving from the introduction of the selected technology, as compared to exiting alternative technologies (cost / performance evaluation). To establish the minimum conditions required to make that viable. To evaluates the relevant parameters which impact on the environment during the production cycle with reference to the healthy human oriented working. To verify that the real industrial conditions will not affect the environmental performances of the final products

WP 4

To establish the risk assessment plan for the entire production process

WP 5

To elaborate the manufacturing plan for end item top assembly

WP 6

To develop the process procedures and standard manual for the industrial application

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

The applicant (single organization or a consortium) needs to have the following facilities and knowledge:

- Knowledge on Aeronautic composites manufacturing innovative processes
- Proven experience and capabilities in the realization of feasibility studies of industrial plants
- Experience in evaluation of environmental impact of processes in an industrial environment

3. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Feasibility of liquid infusion in the real industrial environment	To perform a benchmarking of existing industrial plant potentially suitable for the liquid infusion manufacturing process	T_0 + 2
D2	Path to bring the selected industrial plant to the production phase	To evaluate the implementation plan, required equipment/layouts and possible modifications of existing industrial plants. To evaluate the industrial repercussion during their implementation in manufacturing plants	T_0 + 6
D3	Technical and economic impact	To evaluate of the technical and economical impact deriving from the introduction of the selected technology, as compared to exiting alternative technologies (cost / performance evaluation). Establish the minimum conditions required to make them viable	T_0 + 8
D4	Relevant parameters of the environmental impact during the production cycle	To evaluate the relevant parameters of their impact on the environment during the production cycle with reference to the healthy human oriented working. Verify that the real industrial conditions will not affect the environmental performances of the final products.	T_0 + 9
D5	Risk assessment plan	To establish risk assessment plan of the entire production process	T_0 + 12
D6	Manufacturing plan	To elaborate the manufacturing plan for end item top assembly	T_0 + 13
D7	Process procedures and standard manual	To develop the process procedures and standard manual for the industrial application	T_0 + 14
D8	Final report	Report on the extrapolation to industrial conditions of the liquid infusion process	T_0 + 14

4. Topic value (€)

The total value of this work package shall not exceed:

€ 250.000

[Two hundred fifty thousand euro]

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

5. Remarks

Note:
The Topic Manager Company will provide to the selected Partner the information about the liquid infusion manufacturing process (studied and developed in EDA WP A.2.2.2) necessary for the industrialization study

Legend of abbreviations:
Carbon Fiber Reinforced Plastics (CFRP)
Eco Design for Airframe (EDA)
WorkPackage (WP)

Clean Sky Joint Undertaking
Call SP1-JTI-CS-2012-02
Green Regional Aircraft

Clean Sky – Green Regional Aircraft

Identification	ITD - AREA - TOPIC	topics	VALUE	MAX FUND
JTI-CS-GRA	**Clean Sky - Green Regional Aircraft**	**1**	**400,000**	**300,000**
JTI-CS-GRA-01	*Area-01 - Low weight configurations*		**400,000**	
JTI-CS-2012-3-GRA-01-051	Methodology platform for prediction of damage event for self sensing curved composite panel subjected to real load conditions		400,000	
JTI-CS-GRA-02	*Area-02 - Low noise configurations*		**0**	
JTI-CS-GRA-03	*Area-03 - All electric aircraft*		**0**	
JTI-CS-GRA-04	*Area-04 - Mission and trajectory Management*		**0**	
JTI-CS-GRA-05	*Area-05 - New configurations*		**0**	

Clean Sky Joint Undertaking
SP1-JTI-CS-2012-03-GRA-01-051

Topic Description

CfP topic number	Title		
JTI-CS-2012-3-GRA-01-051	**Methodology platform for prediction of damage event for self-sensing curved composite panel subjected to real load conditions**	**Start date**	*T0*
		End date	*T0+24*

1. Topic Description

The proposal should be around 30 pages.

***Short description**:* JTI GRA aims to address low weight structures using a built-in real-time structural health monitoring (SHM) system. Unlike traditional NDT (non-destructive test) systems, the SHM system is designed to apply to a specific structure with a built-in network of sensors and actuators. Especially for composite aircraft structures where the influence of fatigue is low, this technique could potentially be economical and result in weight reduction of the structure, higher safety and reduced inspection time for damage identification. The aim of this project is to develop a methodology platform for impact and damage detection of a sensorised curved composite panel. All possible impact scenarios (hail, drop tool) and failure modes on the full scale component (top Fuselage panel) have to be considered. A methodology for optimising the sensor layout of the SHM system with high probability and reliability (including self-diagnostic) to detect any damage prior to it becoming critical is an important part of the platform. This is necessary in order to build a valid alternative method to conventional NDTs (for a certain safety level). Fundamental to this project is the extension of existing state of the art SHM methodology platform for flat composite stiffened panel to large scale curved composite panel subjected to real load conditions. The integrated platform must be developed based on sensor readings for Structural Health Monitoring of a curved stiffened composite panel. The platform's main function has to be divided into three categories: 1) Passive sensing, 2) Active sensing and 3) Optimal sensor positioning. The platform must have self-diagnostic capabilities, i.e. prior to its application the health of the sensors and their connection will be checked to avoid any false alarm. Passive sensing will result in impact location and force magnitude detection. Active sensing will be performed for damage detection. It should result in detecting the damage location and severity. The optimal sensor location will be provided, given the number of sensors and probability of detection. As a consequence, another outcome of this work is to set test procedure for a flight test to collect SHM data and to compare experimental/predicted values. The test must consist of the pristine in flight test, impact on the panel with a drop test (under, over and between the stringers from outside and inside panel) and multiple impacts on the panel (hail). The sensor data from the tests will be used for impact identification. SHM data collection needs to be done as well for detecting damage caused by the impact tests by actuating/sensing methods

1.1 Introduction

Damage in composite materials can lead to disastrous failures if they are not detected and fixed on time. A wide variety of damage modes in composites, such as delamination and fibre breakage introduced by impact, is difficult to be detected by conventional methods.

Structural Health Monitoring (SHM) provides a system with the ability to detect and interpret adverse changes in a structure even though the structure is in service. SHM systems can reduce the risk of the catastrophic failures, prolong the lifespan of the structures and reduce the cost of inspections. A number of methods have been proposed for damage detection based on comparing signals to baseline recorded from the undamaged structure. Lamb wave based diagnosis method is one of the most effective techniques in plate-like structures due to its sensitivity to small defects.

1.1.1 Background

The proposed work fits in the three work packages of GRA LWC "Enabling Technologies for Design", "Enabling Technologies for Maintenance" and "LWC Definition of Demonstrator". Obtaining some information about the intensity of an impact and its location on aircraft panels will help estimating the severity of possible damage due to the impact and subsequent actions. Furthermore, the predictability of impacts decrease uncertainties associated with loading conditions on a structure and therefore would result in less conservative design and as a result weight reduction.

In SHM technique, actuators are employed as well as sensors. Actuators generate guided waves in

the thin-walled structure (Lamb waves) and after travelling through the structure they are received by sensors. When there is a change in the state of the structure, such as damage, the received sensor signals change in comparison to the baseline signals, depending on the size and severity of the damage, excitation frequency, sensor/actuator pattern and distance of the sensor from the transducers network. Depending on the excitation frequency, Lamb waves can travel long distances without being significantly dispersed and therefore are effective for detecting distal damages.

Dispersion and attenuation of Lamb waves are two important properties, which are related. Dispersion is change in wave velocity with respect to frequency and attenuation is decrease in the wave amplitude with respect to the travelled distance. Increased dispersion causes higher attenuation and vice versa. In curved panels, the phase velocity is higher compared to flat panels, which will slightly increase the dispersion and attenuation of Lamb waves. This may imply that for similar excitation conditions, the Lamb wave SHM method can detect farther damages in flat panels compared to curved panels. The excitation modes will also be different in curved panels in comparison to flat panels.

A good baseline signal (pristine signal) is important for active sensing of in-flight panels. This baseline signal will vary under different load and vibration conditions. The challenge will be recording pristine signals during different load scenarios and comparing them with damage scatter signals obtained under the same load conditions.

1.1.2 Interfaces to ITD

The details of the integration of the developed module into the GRA LWC platform will be defined together with the successful applicant.

1.2 Reference documents NA

1.3 Scope of work: In this work, it is expected that a platform to predict impact damage event will be developed for curved composite panels subjected to real load conditions. The platform based on developed computational tools should be able to model an impact event on a sensorised curved composite panel and to detect impact force, location and the possible damage. The transducer configuration must be optimised to allow for effective detection of impact and subsequent damage. Passive sensing is applied first to detect an impact event (location and energy). Strategies for modelling different impact energies (small mass/ large mass) must be established and techniques developed to categorised the related impact force and location. The algorithms for impact force reconstruction should determine the duration, magnitude and distribution of contact force. The success of such algorithm should have been demonstrated on composite stiffened panel. Active sensing is applied to verify the existence of damage and to characterize it. The aim of this call is to extend an existing platform/methodologies verified for a flat stiffened panel to a real scale composite curved panel under real load conditions. There is a significant issue with regards to up scaling the methodologies to take into account the call real scale panel (5m x 1.7 m radius 4.5 m) as well as real load conditions (fatigue, hail, storm, etc). In addition the up-scaled methodologies are required to be suitable for analysis of large size panels involving appropriate degrees of freedom. The computational methodologies developed must include accurate modelling of curved composite panel, including robust modelling of advanced composites such as woven composites.

PZT sensors are used in passive sensing to record strains for impact detection. After detecting impact location and energy, a full impact analysis will be performed to see whether that level of energy can cause damage to initiate or propagate in the structure. Appropriate damage models have to be developed and applied for modelling advanced composites such as woven composite.

The technologies that have to be accounted for active sensing are fibre optic (FBG) and piezoelectric (PZT) sensors. PZTs act as both actuators (actuating Lamb waves) and sensors in active sensing to characterize damage (delamination, softening, debonding). PZT transducers have to be used on their own or in combination with other technologies to form a hybrid system (PZT actuator/FBG sensor).The SHM approaches for active sensing has to include Guided Ultrasonic Wave Propagation (GUWP) and Electro-Mechanical Impedance Method (EMI). The PZT transducers have to be used as self-diagnostic sensors. The real geometry and lay-up of the structures has to be accounted for in measuring the Impedance of the structure. The established code has to be capable of generating significant data which will be used in developing an appropriate metamodels for damage identification. Statistical analysis of the structure has to be carried out to evaluate the Probability of Detection (PoD) and the Probability of False Alarm (PoFA) for the proposed platform/methodologies.

The proposed code architecture is:

- Computational tools for passive sensing (impact force magnitude and location detection)
- Computational tools for active sensing (damage detection and characterisation)
- Computational tool for effective transducer positions for design of self-diagnostic structure

It should be mentioned that all the codes should be in compliance with Topic Manager information technology infrastructure standards.

1.4 Type of work: The type of work to be performed is the modelling and simulations using FEM codes for both Passive and Active sensing. Transducer models will be integrated with the FE to carry out the actuating and sensing in the damage characterisation code. The panel which will be analysed in this project is of size 5m x 1.7 m radius 4.5 m. For Lamb wave propagation analysis the plate must be meshed very fine. This will lead to computationally expensive simulations. The energy levels corresponding to each impact scenario must be described as well. When modelling the in flight scenario, the additional noise which will affect the data should be considered in the analysis. Attention must also be paid to the fact that the flying sensorised panel will have different baseline signals in different load and vibration scenarios (different manoeuvres). This is of high importance when the damage scattered signal will be compared to the pristine signal for detecting and identifying damage. Thus a good load history of the panel during the flight must be available.

1.5 Special skills, certification or equipment expected from the applicant

The applicant (single organization or a consortium) should have the following expertise:

- Demonstrable experience and capabilities for modelling guided wave methods for aerospace composite stiffened panels,
- Experience at modelling impact and damage in composite panels,
- Knowledge and experience in large scale FE analysis, dynamic analysis and fracture mechanics,
- Knowledge of the state of the art at European level research into methodologies developed related to aircraft composite research,
- Knowledge of high level programming for developing interactive and open environments,
- Previous track record in development of SHM methodologies/platform for composite stiffened panels

2. Major deliverables and schedule

Deliverable	Title	Due date
D1	Report on adopted methodologies developed for impact force magnitude and location	Month 6
D2	Software code module, source code and documentation for the developed methodologies in D1	Month 9
D3	Report on adopted methodologies for damage detection, identification and characterisation	Month 12
D4	Report on self-diagnostic methodologies of the curved composite panel	Month 12
D5	Software code module, source code and documentation for the developed methodologies in D3 and D4	Month 18
D6	Report on methodologies developed for effective positioning of sensors and actuators	Month 18
D7	Report on statistical analysis and probability of false alarm for impact detection	Month 24
D8	Software platform for curved panel, source code and documentation	Month 24
D9	Installation on a Platform for the final demonstration	Month 24

3. Topic value (K€)

The total value of the proposed package shall not exceed

400.000,00€

[Four hundred thousand Euro]

including all cost categories (personnel, computing, travels, etc.);

Funding: ranging from 50% to 75% of the budget

Clean Sky – Green Rotorcraft

Identification	ITD - AREA - TOPIC	topics	VALUE	MAX FUND
JTI-CS-GRC	**Clean Sky - Green Rotorcraft**	5	**2,550,000**	**1,912,500**
JTI-CS-GRC-01	*Area-01 - Innovative Rotor Blades*		**1,650,000**	
JTI-CS-2012-3-GRC-01-011	Low cost design approach through simulation and manufacture of new mould concepts for very high tolerance composite components		400,000	
JTI-CS-2012-3-GRC-01-012	Design and Manufacturing of an innovative oscillating airfoil provided with Gurney flap		900,000	
JTI-CS-2012-3-GRC-01-013	Development and Correlation of CFD Methods to Model Active Gurney Flaps on Helicopter Main Rotor Blades		350,000	
JTI-CS-GRC-02	*Area-02 - Reduced Drag of rotorcraft*		**600,000**	
JTI-CS-2012-3-GRC-02-008	Assessment of tiltrotor fuselage drag reduction by wind tunnel tests and CFD		600,000	
JTI-CS-GRC-03	*Area-03 - Integration of innovative electrical systems*		**0**	
JTI-CS-GRC-04	*Area-04 - Installation of diesel engines on light helicopters*		**0**	
JTI-CS-GRC-05	*Area-05 - Environmentally friendly flight paths*		**0**	
JTI-CS-GRC-06	*Area-06 - Eco Design for Rotorcraft*		**300,000**	
JTI-CS-2012-3-GRC-06-005	Recycling of Metallic Materials from Rotorcraft Transmissions		300,000	

Clean Sky Joint Undertaking
SP1-JTI-CS-2012-03-GRC-01-011

Topic Description

CfP topic number	Title		
JTI-CS-2012-3-GRC-01-011	**Low cost design approach through simulation and manufacture of new mould concepts for very high tolerance composite components**	**End date**	T0+14M
		Start date	T0

1. Topic Description

1. Background:

The Green Rotorcraft Consortium (GRC 1) are developing Active Rotor Technologies (ART) that will enable a helicopter to operate with a reduced tip speed of its main rotor whilst preserving current flight performance capabilities. Lower main rotor speed alone will significantly reduce rotor noise and fuel consumption, but without ART would otherwise severely compromise flight speed and payload.

In order to assess the capabilities of certain ART developed within GRC, it is intended that system demonstrators be manufactured, trialled and evaluated. The GRC-1 consortium therefore intends to design, develop and test a model helicopter rotor system that will incorporate a scaled ART mechanism, namely, an Active Gurney Flap (AGF). Note; the reference here to a model scaled rotor system refers to using a ground (fixed) experimental rotor rig system operated within a wind tunnel, not a radio controlled small scale helicopter.

In addition, and to achieve a 'greener' rotor blade product in the first instance, an important aim of the GRC-1 consortium is to develop alternative low cost close-mould manufacturing technologies for helicopter blades; to move beyond the state-of-the-art of preimpregnated (prepreg) technology. The high tolerances required and complexity of the blades lead to manufacturing with resin transfer moulding (RTM) as an attractive alternative.

Contributing to the aim of low cost manufacturing technologies, is the development of a low-cost, more efficient approach to mould and tooling design. In the design of tools and determination of correct process parameters, empirical trial and error based on experience inevitably lead to long development times and high costs. Furthermore, the implementation of virtual methods of process simulations coupled to mould design can lead to increased efficiency and decreased cost (and wasted energy) by reducing, and ultimately eliminating, physical pre-tests.

The aim of this topic is to design and build a suite of tools (preform tools, moulds and inserts) capable of manufacturing wind tunnel model rotor blades with an integrated AGF system. This includes a single moulding concept which can be used with both prepreg and RTM manufacturing. The mould will not only be used for cost and quality comparison between the two processing techniques, but also as a platform for implementation of virtual design methods and in-mould sensor technologies.

The challenge revolves around development of the following:

- "Virtual manufacturing" – to perform process simulations and mould design with minimal process testing to reduce cost of the design process. These process simulations involve, but are not limited to, flow simulation and thermal modelling and shall be coupled to, and validate, the mould design.
- Very high tolerance moulds designed such that any deformations of the manufactured blades are minimised on release from the tool. This will take account the different coefficients of thermal expansion of the composite materials that traditionally lead to shape distortion of unbalanced composite ply constructions.
- Efficient and even heat-up/cooling of the moulds for both processes
- Integration of in-line in-mould monitoring sensors, which will be used to verify the models during

production of the model blades and validate the virtual approach to the mould design process.

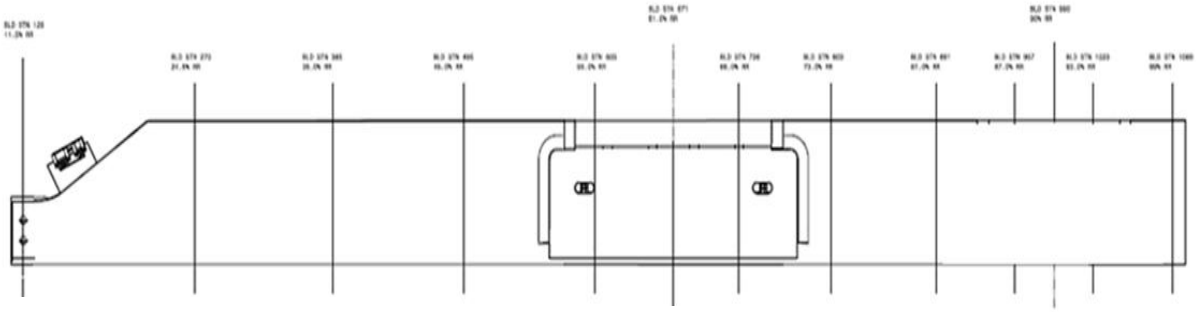
Model blade technical details

The AGF will be incorporated into model helicopter rotor blades manufactured from composite materials, having an approximate 90mm chord (aerofoil section) and approximately 1100 mm total span. The AGF region would have a span of approximately 100mm and be centred at about 65% of the rotor radius. The blade section will be of NACA 0012 profile potentially with an enlarged thickness trailing edge tab profile in the AGF region.

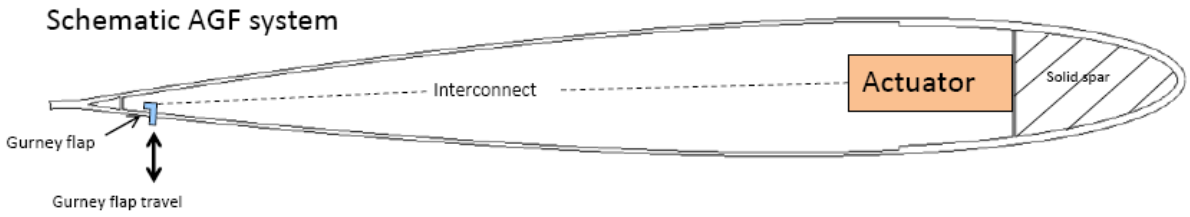
A description of the typical upper limits of size that would be expected for such a model rotor system follows:

number of blades	4
blade radius	1.1 m
blade chord	90 mm
blade twist (centre line to tip)	8°
1st aerofoil section radius	0.231 m
aerofoil profile – full span	NACA0012
tip planform	Rectangular
direction of rotation	CCW top view

Table 1. Model rotor configuration



View of lower blade surface



Possible AGF geometric layout

Leading particulars

1. The wind tunnel rotor blades will be manufactured using prepreg and RTM technologies, and from aerospace certified/qualified materials. The exact fibre reinforcement materials are still to be determined but will be dominated by woven and unidirectional carbon fibres. Strict alignment of the fibres have to be maintained.

2. The prepreg blade production process, including product, requires a holding temperature of 120°C, with a deviation of less than ±3°C over the product area. The filled mould heat-up rate shall be controllable.
3. The RTM blade production process, including product, requires a holding a temperature of 180°C, with a deviation of less than ±3°C over the product area. The filled mould heat-up rate shall be controllable and capable of at least 3°C/min. Injection and curing pressures are expected to be around 3 bars and 7 bars respectively.
4. Consideration needs to be given to controlling/minimising shape distortion through coefficient of thermal expansion problems that may result from the cooling down process from the cure temperature down to room temperature. Mould material choice is open to the bidder.
5. The rotor blades will be fitted with an Active Gurney Flap (AGF) mechanism, which will require a (partially) hollow structure and the ability to access this internal space after the mould process. As the AGF has not yet been designed, the particular details will be provided at the start of the programme.
6. The rotor blades are subjected to very high rotational forces, up to 3000G on the blade tip, which results in very strict requirements on identical mass distribution between each of the four rotor operating blades that will be produced. The target is better than ±3% variation in mass distribution, both locally and globally, between each blade.
7. The dimensional tolerances are yet to be determined but are expected to be very high: <±0.1mm on the aerodynamic profile.

Existing Green Rotorcraft Consortium to supply/control :

- Design description of the blade and the parts that make up the blade.

Typical expectations are that the spar will be a fabricated solid moulding, probably of carbon fibre. This will be dominated by unidirectional carbon fibre running the length of the spar and interleaved with Woven carbon fibre at the root end. The trailing edge skins will be of thin composite material construction (probably woven carbon fibre) and the trailing edge of a lightweight foam such as Rohacel. The AGF mechanism, manufactured in advance, will be fitted into a pocket removed from the skinned blade, over which a closing panel will be fitted. The exact definition of the blade is however the subject of soon to be started design activity hence is not yet fully defined. Note: It is currently *not* expected that the blade will be made as a one shot moulding due to the complexity of electrical connections required to provide power to actuators in the AGF region as well as the provision of data sensor output (strain gauges, position sensors etc).

- The design definition of the blade will be supplied as a computer generated model. Catia V4 and V5 are standard, however it may be possible to transfer such models into other formats.

Successful Bidding Organisation to supply:

A suite of tools suitable for the moulding of the above blade from composite materials by processes conversant with producing components with the following typical properties: the fibre volume fraction required is typically 57% and voiding has to be less than 1 percent. Composite ply position stop offs (spanwise and chordwise) are controlled to 0.25mm accuracy. The tooling and curing process must be designed so as to minimise any deformation of the manufactured items on release from the tool, since very tight geometric tolerances are required.

2. Scope of work:

The successful bidder will design and manufacture mould and tooling sets for two different manufacturing processes both aimed at producing the same net model rotor blade product. Comparisons can then be made between the two methods. The two manufacturing processes are:

- Pre-pregging
- Resin transfer moulding (RTM)

The successful bidder(s) would be expected to:

a) Set-up and execute the necessary process simulations, including flow simulation and thermal modelling. The choice of software package(s) is open to the bidder.

b) Design tooling sets capable of producing the scaled rotor blades using aerospace qualified composite materials. Software used should be compatible with Catia V4 and V5. The following is considered part of the tooling design:

- *Design of a single mould concept capable of meeting the strict dimensional requirements of the rotor blade*
- *Method for opening and closing the moulds. Either by means of a press or a self-contained system (tbd)*
- *Methods for heating and cooling the mould*
- *Methods for applying the necessary processing pressures*
- *Methods of integration of in-mould monitoring sensors*
- *Design of preform tooling, including a mould for a solid fibre D-spar*

c) Manufacturing of the suite of tools, including the novel moulds, all subcomponents and preform tooling as well as tooling required to produced finished blade test pieces for evaluative testing. The expectations are that the following tools will be required as a probable minimum set although this will be subject to consideration/change as the design of the blade progresses and/or the manufacturing process evolves;

- *Preform tools*
- *Prepreg/RTM mould*
- *Tool for AGF region cover patch*
- *Other - to be defined.*

d) Process testing/shape monitoring in order to validate the functionality of the mould and demonstrate that the parts will meet all requirements.

e) Integration and implementation of in-mould monitoring sensors to monitor the curing process and verify the process models.

Testing prior to acceptance

The tooling will have to undergo the following and other tests in advance of their being considered for the production of the wind tunnel rotor blades:

a) Geometrical measurements to validate the form (shape) and dimensions of the mould and tooling.

b) Heat survey to validate thermal behaviour of the mould, including heat-up rates and temperature uniformity of the mould

c) Assistance in the manufacture of one validation article per manufacturing process to demonstrate the functionality of the mould and tools (Manufacturing of the part will be performed at the Topic Manager's site).

d) Dimensional measurements, non-destructive and destructive testing of the moulded part

The costs of the above tests will be covered by the successful bidder

Further additional tests will be carried out by the existing CleanSky consortium to ensure that the whole blade tooling is functionally fit and safe for purpose.

Expectation of the bidder

The bidder, amongst other things, will be required to:

- Provide a detailed *Supplier Specification* for the tooling suite in response to the Topic Manager's *Requirements Specification* provided at the start of the tasking.
- Provide a report detailing software used in the design process and approach used in process simulation
- Assist the consortium member in the detailed design of the part in order to improve the manufacturability of the rotor blades.
- Design critical elements of the tooling (defined in the scope of work above) in collaboration with GRC1 members.
- Partake in the demonstration of the functionality of the tools by means of validation articles. Validation articles will be produced by, and at the site of, the Topic Manager.

- Deliver complete sets of tooling and equipment, necessary for the manufacturing of the model rotor blades.
- Assist in the technology transfer in order for the consortium member to be able to manufacture the rotor blades themselves.

Note: The GRC1 Topic Manager will provide the preliminary rotor blade design details at the start of the programme as far as they are understood at that point in time.

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

1. Be conversant with and have demonstrated abililties/capabilities for process simulations for composite manufacturing
2. Be conversant with and have demonstrated abililties/capabilities the demands of designing high tolerance composite manufacturing moulds and tools
3. Demonstrated capabilities and experience with the relevant manufacturing processes in order to manufacture the neccessary validation parts.
4. The winning bidder would be expected to provide sufficient hardware and software to meet the needs of a) the primary test objectives described in the scope of work b) all other necessary qualification and test activities that arise.
5. The winning bidder would be expected to provide, at any stage as requested by the Topic Manager, technical documents, drawings and descriptions, including electronic models, of the developed hardware.
6. Ability to support the design of the rotor blades, especially in regards to manufacturability.
7. Experience in the design and production of tooling for aerospace composite parts.
8. The winning bidder will be expected to be available for meetings at the consortium member's premises in The Netherlands. This cost must be covered by the succesful bidder.

3. Major deliverables and schedule

Deliverable	Title	Short Description (if applicable)	Due date (month)
D0	Receipt of Requirements Specification	Topic manager supplied document at issue 1 and amended thereafter	T_0
D1	Provide Detailed supplier Specification	Detailed supplier specification for the wind tunnel rotor blades in response to D0 explaining how the bidder proposes conducting the work	T_0 + 2 months
D2	Preliminary Design Review – PDR - report	Results of: a) first round of process simulations b) design concepts for moulds and tooling c) choices of in-mould sensors	T_0 + 4 months
D3	Update on design	Down-selection of mould, tooling and sensor concepts	T_0 + 5 months
D4	Critical Design Review – CDR - report	Results of process simulations and final design of suite of tools.	T_0 + 7 months
D5	Production of validation articles manufactured with pre-pregging and RTM technologies	Review and demonstration of: a) verification of the process models using the in-mould sensors and of the functionality of the moulds b) dimensional requirements of the validation articles are met c) the processing strategies d) consistency of mass of the article produced to the design	T_0 + 11 months
D6	Report on inspection of validation articles	Results of non-destructive and destructive tests	T_0 + 12 months
D7	Supply of complete suite of tools	Including modification from lessons learnt after D6 (In the event that any revisions are required).	T_0 + 14 months
D8	Final report	Wrap up report	T_0 + 14 months

The bidder is welcome to add additional deliverables as they see fit.

Note: Aside from these deliverables, the following are part of the scheduling:

- Monthly telecon updates
- Meeting and presentation at the Topic Manager's premises:
  - At kick-off T_0
  - At the PDR and CDR stages, coinciding with D2 and D4 respectively
  - At the review and demonstration stage of D5
  - At the final report stage of D8
- Support with setting up the delivered equipment to enable a fully working system at the Topic Manager's premises, between T_0 +7 and T_0+11 (and again at T_0+14 if required)

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:

400,000 euro

[Four hundred thousand euro]

(VAT not applicable)

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)

Clean Sky Joint Undertaking
SP1-JTI-CS-2012-03-GRC-01-012

Topic description

CfP topic number	Title		
JTI-CS-2012-3-GRC-01-012	**Design and Manufacturing of an innovative oscillating airfoil provided with Gurney flap**	**End date**	T0+18M
		Start date	T0

1. Topic Description

CfP - SHORT DESCRIPTION

The activities of the European research project CleanSky – JTI Green Rotorcraft Consortium (GRC1) - "Innovative Rotor Blade", are aiming at the development of active and passive technologies to provide the greatest possible reduction in rotor noise and fuel consumption. Particular attention is dedicated to the technologies able to alleviate the dynamic stall problem over the retreating rotor blade, especially during the flight at reduced speed.

Prior tasks have evaluated a range of potential technologies that could be incorporated within active segments of a helicopter main rotor blade to meet these needs and concluded that a variable height or 'Active' Gurney Flap' (AGF) offers the best overall potential. Conventionally, a Gurney flap is a small appendix perpendicular to the surface of the airfoil and located in the trailing edge area, more usually on the lower blade surface. The AGF is essentially a Gurney flap with the ability to alter its height from zero (fully retracted) to a maximum value (fully protruded). Its impact upon the performance of an airfoil can thus be varied and controlled during the rotor blade revolution.

SCOPE OF WORK

In order to validate the aerodynamic performance of an AGF system in steady and dynamic conditions, a wind tunnel test campaign on an airfoil oscillating in pitch and equipped with AGF is planned.

With reference to this activity, the present CfP sets the following two main objectives:

- the design and manufacturing of an instrumented 2D wind tunnel model provided with a remotely controlled AGF system;
- the design, development and assembly of a remotely controlled pitch-oscillating system for the testing of a 2D model;

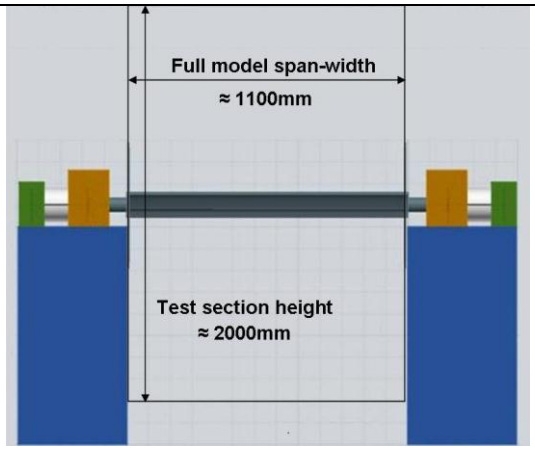
The successful bidder shall demonstrate the fulfilment of well defined requirements during some preliminary tests in "no-flow condition" prior to the acceptance of the above indicated systems. To this aim the building of a dedicated test rig for ground tests must be considered as part of the present CfP. The costs of the above tests shall be covered by the successful bidder.

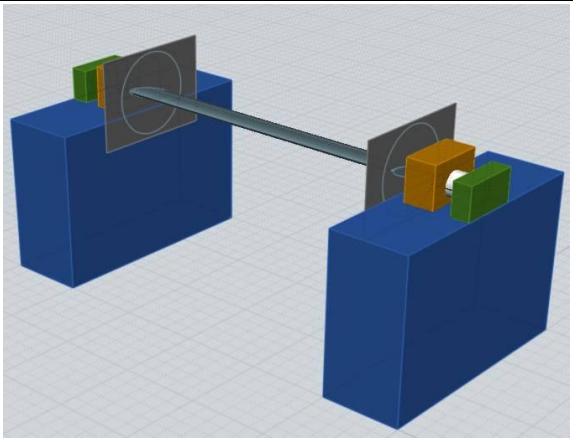
DETAILED DESCRIPTION

Remotely Controlled Pitch-Oscillating System

According to the GRC1 programme, 2D steady as well as dynamic oscillating tests shall be performed, at Mach numbers $M \in [0.2;0.6]$, in a subsonic/transonic wind tunnel whose test section is about 1.1m wide and 2m high. A dedicated pitch-oscillating system must be designed and realized for this purpose. Since the 2D model shall be installed in the horizontal position, in order to preserve the flow quality of the wind tunnel, the pitch-oscillating system shall be mounted on the external surfaces of the lateral walls of the wind tunnel test section, thus avoiding any device to be exposed to the flow.

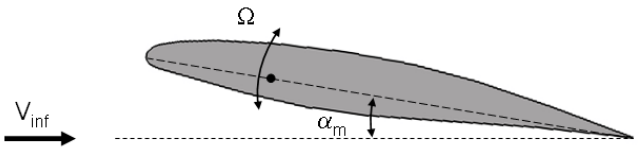
The figure below shows an example of the WT setup and the main dimensions of the test sections.





Wind tunnel setup

The system shall be powered with the standard industrial power supply (380V) and shall be able to generate a pitch-oscillating motion of the model around the axis located at 0,25 x/c (of the model) with the following laws:



Sinusoidal Law $\alpha = \alpha_m + a_0 \sin(\omega t)$.

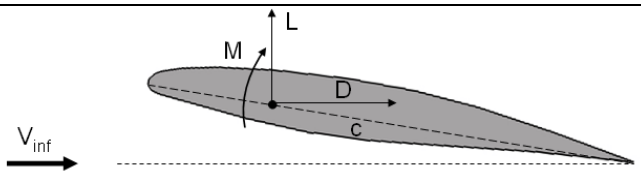
Ramp law $\alpha = \alpha_m + R_0 t$ with

$$\begin{cases} R_0 = 0 \rightarrow t < 0 \\ R_0 = R_v \rightarrow t > 0 \;\&\; t < \dfrac{\alpha_0}{R_v} \\ R_0 = \dfrac{a_0}{t} \rightarrow t \geq \dfrac{\alpha_0}{R_v} \end{cases}$$

where $\alpha_m \in [0°;10°]$, $\alpha_0 \in [2°;10°]$; $\omega = 2\pi f$ is the angular velocity and $R_v = [25°/s\,;250°/s]$ is the ramp velocity

Motion Laws of the Oscillating System

For the purpose of the GRC1 programme, the required range of the oscillation frequency to be realized in the wind tunnel is correlated to the selected model chord length. Therefore, considering that both parameters affect the aerodynamic and inertial loads acting on the model (and then the design and development of the oscillating system), three acceptable configurations (in terms of model chord and oscillating airfoil), are proposed and left to the applicant's choice for the design and development of the oscillating system. Moreover, for each of these configurations the expected aerodynamic peaks for Lift, Drag and pitching moment are reported in the table below per 1 meter span length.



Model chord length [m]	***Range of oscillating frequency [Hz]***	***Aerodynamic Loads***
0.30	0 - 21 Hz	L=17000 [N/meter span] D=7000 [N/meter span] M=1500 [N*m/meter span]
0.35	0 - 18 Hz	L=19500 [N/meter span] D=8000 [N/meter span] M=1800 [N*m/meter span]

0.40	0 - 16 Hz	L=23000 [N/meter span] D=9000 [N/meter span] M=2300 [N*m/meter span]

For the sizing of the pitch-oscillating system these loads must be combined with the inertial loads due to the oscillating motion and a Margin of Safety MoS=3 have to be applied. The applicant, on the basis of the design and manufacturing constraints, and of the expected steady and dynamic loads acting on the model, shall have the faculty to choose one of the following setups:

A. full span oscillating model. In this case the model shall have a span length of about 1.1m (= wind tunnel width);
B. the oscillating airfoil does not cover the full span length but extends at least 0.70m and is mounted astride the test section centre line. In this case, the external parts of the wing are fixed to the lateral walls and are separated from the movable oscillating wing by means of edge fences. Fixed and oscillating airfoils will likely have different shapes.

The oscillating system must be connected to a Remote Control System (RCS) located in the wind tunnel control room and positioned at about 20m far from the test section. The RCS shall be able to remotely control the following parameters:

1. Oscillation frequency (in the selected range) – accuracy 0.1 Hz;
2. Motion Laws (sinusoidal or ramp);
3. Ramp Velocity in the range [25°/s ; 250°/s] – accuracy 1°/s

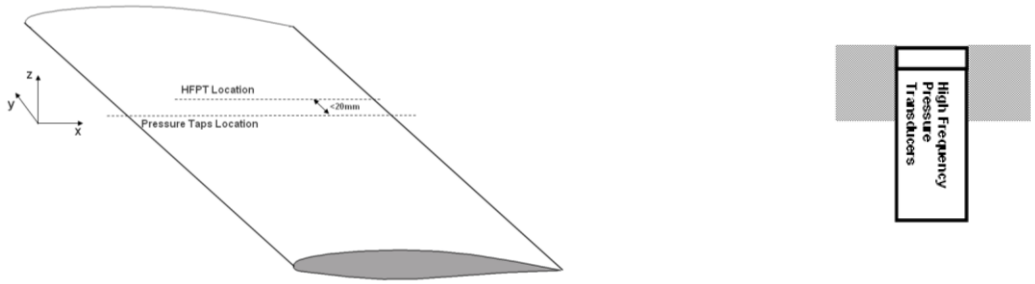
It is optional, but positive evaluated, the possibility of remotely control also the mean angle of attack α_m and the oscillation amplitude α_0. For both settings of the latter parameters, the required resolution is at least 1° and the accuracy in the model positioning is 0.1°.
The RCS shall be able to display in real-time and to record with a suitable number of samples/sec the angle of attack positioning with an accuracy of 0.1°. Moreover for safety reasons, the RCS shall be provided with an instantaneous shut-down system.
The pitch-oscillating RCS, the pc and the software (with user-friendly interface) for controlling, displaying and recording must be considered as part of the present call.
Finally, in order to allow a preliminary ground testing of the pitch-oscillating system before the wind tunnel installation, the realization of a dedicated test rig is also required in the present CfP.

Test article provided with Active Gurney Flap
The test article to be installed on the above described pitch-oscillating system shall be a 2D airfoil with a percentage thickness between 10% and 13%. According to the design of the pitch-oscillating system, the airfoil shall have a model chord between 0.30m and 0.40m and a maximum span length of 1.1m (“wall to wall” configuration).
In order to measure the pressure values on the model during the tests, the model shall be equipped with 50 steady pressure taps. The steady pressure taps shall have a hole diameter on the external model surface of about 0.5mm and the majority of them shall be located in the centre line of the airfoil, along a line parallel to the flow direction.

In order to measure the overall aerodynamic loads (i.e. lift, drag and pitching moment) two alternative methods can be proposed, with a preference being given to the first one:

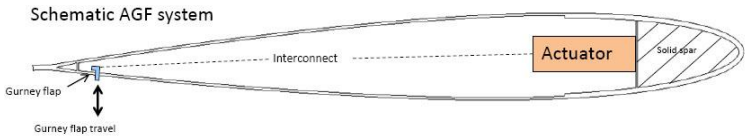
1. the test rig shall be equipped with a 3 components wind tunnel external balance with a suitable load range and accuracy

2. the test rig shall include a system of high frequency pressure transducers (HFPT); 30 HFPT transducers, to be considered as part of the present call, shall be installed in a section close to the steady pressure taps line and shall have a hole diameter lower than 0.5mm on the external surface of the model.
   Viscous drag measurements shall be made by a dedicated rake device for wake total pressure measurements. The rake device shall be equipped with about 40 HFPTs and installed in the test section downstream of the model on an already available support system.
   It is important to underline the global number of HFPTs is 70 (30 installed inside the model and 40 in the Wake rake device).
   In order to measure pressure fluctuations up to 2kHz, HFPTs shall have a natural frequency above 10kHz. The HFPTs shall be differential (15-30 PSI) or absolute type (30-50 PSI) and must perform a good quality measurement of the instantaneous pressure value. Suitable connectors must be foreseen for each sensor to speed up the configuration changing.

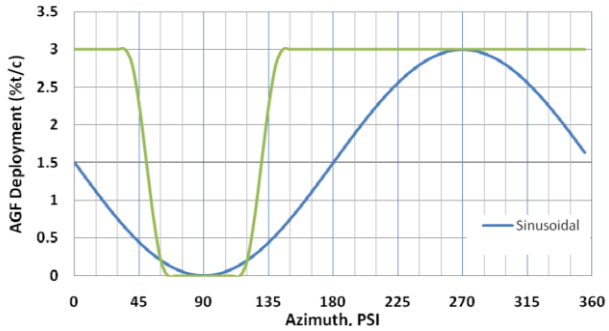


Pressure taps and unsteady sensors location – Unsteady pressure installation

In order to evaluate the AGF effects in steady and pitch-oscillating conditions the model shall be equipped with a steady and dynamic Gurney flap whose dynamic motion is orthogonal to the chord line. The device shall be mounted on the lower side of the airfoil. The fixed GF shall be located toward the trailing edge of the airfoil in a chordwise position between 95% and 100% of the chord length. The active GF shall be likely located at the 95% of the chord length only. The maximum protrusion length of the GF shall be included in a range between 1% and 3% of the chord length. Both harmonic and non-harmonic from 1/rev up to max 6/rev deployment laws shall be investigated (an N/rev GF deployment law means that N complete cycles of deployment are performed during one complete cycle of airfoil oscillation). To preserve the flow quality around the airfoil, the AGF actuation system shall be mounted inside the model or, as an alternative, on the external surfaces of the lateral walls of the wind tunnel test section. The AGF actuation system powered with the standard Industrial power supply (380V) shall be able to generate the following control laws:



Possible AGF geometric layout



- Sinusoidal Law $Z_{GF} = L_{GF}\sin(\omega_{GF}t)$.
- Non-harmonic 1/rev up to max 6/rev laws

where L_{GF} is the maximum protrusion length of the Gurney flap and $\omega_{GF} = 2\pi f_{GF}$ is the angular velocity.

AGF system

The AGF actuation system must be connected to a dedicated RCS located in the wind tunnel control room positioned at about 20m far from the test section. The RCS shall be able to remotely control the following parameters:

1. AGF frequency (in the selected range) – accuracy 0.1 Hz
2. Motion Laws (harmonic – non harmonic)

It is optional, but positive evaluated, the possibility of remotely controlling also the length of the Gurney flap L_{GF}. Independently of the manual or remote control of the latter parameter, the required accuracy in the Gurney flap positioning is 0.1mm.

The RCS shall be able to display in real-time and to record with suitable number of samples/sec the Z_{GF} position of the AGF during the whole run time.

The remote AGF control system, the pc and the software (with user-friendly interface) for controlling, displaying and recording must be considered as part of the present call.
It is important to highlight that the RCS of both the AGF and the pitch-oscillating systems have to be integrated with a high frequency acquisition system, namely, the NI-PXI1044 (currently used in WT for the acquisition of HFPTs) in order to allow synchronized tests.

General Remarks for the Applicant
Standing the various model configurations:

- steady tests on the model without Gurney flap (clean model): the model is installed on the already available turntable system;
- steady tests with fixed Gurney flap (different positions and lengths): the model is installed on the already available turntable system;
- steady tests with AGF: the model is installed on the already available turntable system;
- oscillating testing on the model without Gurney flap (clean model): the model is installed on the pitch-oscillating system;
- oscillating testing on the model with AGF: the model is installed on the pitch-oscillating system;

a modular design of the model is mandatory in order to speed up the configuration changing.
For the same reasons, all instrumentations installed inside the model (pressure piping, HFPTs, etc) must be equipped with suitable connectors.

The model and the pitching oscillating system will operate in the following pressure and temperature ranges:

- Pressure from 0.39 bara to 1.45bara;
- Temperature from 230K to 300K;
- 100% humidity.

More detailed technical information concerning the wind tunnel interface, turntable interfaces, instrumentation, model and pitch oscillating system requirements, etc, shall be provided to the successful bidder in a specific document before the beginning of the activity.

2. Special Skills

The candidate organization shall demonstrate:

- ✈ A well recognized background on electrical/pneumatic actuation and power electronics.
- ✈ Experience in Design (Catia V5) and manufacturing of wind tunnel models

3. Customer Support

The successful bidder shall provide customer support for a period from the delivery of the final configuration of the equipment until the completion of ground and wind tunnel tests scheduled in the first half of 2014.

4. Major deliverables and schedule

Deliverable	Title	Description	Due Date
D1	Preliminary Design Report	The document shall describe the preliminary design and the technical solution concerning the Pitch-Oscillating system, the Test Article and the AGF.	T0 + 04
D2	Final Design Report	The document shall describe the final design and the technical solution concerning the Pitch- Oscillating system, the Test Article and the AGF.	T0 + 08
D3	Stress Analysis Report	The document shall report all the necessary steady and dynamic stress analyses to provide evidence of the fulfilment of the required safety margin and the absence of resonance phenomena.	T0 + 10
D4	RCS description for controlling, monitoring and recording of the pitching oscillation and AGF systems	The document shall report the user manual for controlling, monitoring and recording the pitching oscillation and AGF systems.	T0 + 13
D5	Model Manufacturing Acceptance	The document shall demonstrate the compliance with all requirements concerning the model manufacturing.	T0 + 16
D6	Test Bench and Ground test Acceptance	Detailed test procedure aimed at showing the compliance with all requirements concerning the pitching oscillating and AGF systems and the functioning of all instrumentation installed inside the model.	T0 + 18

5. Topic Value (€)

The total value of the proposed package, is

900 000 €

[Nine hundred thousand Euro]

including all cost categories (personnel, computing, travels, instrumentation procurement, etc.)

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

Clean Sky Joint Undertaking
SP1-JTI-CS-2012-03-GRC-01-013

Topic Description

CfP topic number	Title		
JTI-CS-2012-3-GRC-01-013	**Development and Correlation of CFD Methods to Model Active Gurney Flaps on Helicopter Main Rotor Blades**	**End date**	T0+42 M
		Start date	T0

1. Topic Description

Background

The Green Rotorcraft Consortium (GRC 1) work described here relates to the development of Active Rotor Technologies (ART) that will enable a helicopter to operate with reduced power consumption or reduced main rotor tip speed whilst preserving current flight performance capabilities. Lower power consumption will lead to reduced fuel usage and exhaust emissions, while reduced main rotor speed will significantly reduce rotor noise.

Prior tasks have evaluated a range of potential technologies that could be incorporated within active segments of a helicopter main rotor blade to meet these needs and concluded that a variable height or 'Active Gurney Flap' (AGF) offers the best overall potential. Conventionally a Gurney Flap is a small 'wall' perpendicular to the surface of the aerofoil and located in the trailing edge area of the blade, more usually on the lower blade surface. The AGF is essentially a Gurney flap with the ability to alter its height from zero (fully retracted) to maximum (fully operative). Its impact upon the performance of an aerofoil can thus be varied and controlled. On a helicopter rotor blade the aerodynamic requirements change as the blade moves around the azimuth from the blade advancing to blade retreating condition. The AGF offers the possibility of 'conditioning' the performance of the rotor blades to match these changing requirements by using a pre-determined schedule of operation (i.e. progressively extended/retracted) as the blade rotates around the helicopter.

In order to assess the capabilities of an AGF system it is intended that system demonstrators be manufactured, trialled and evaluated. A number of wind tunnel tests are planned to take place along with a full scale whirl tower test. The first wind tunnel test is in the 2D tunnel at a European University facility in 2013. The second 2D tunnel test is at a European research centre facility in 2014, whilst a 3D model rotor test is planned for a large wind tunnel facility in 2014. Finally, the full scale whirl tower test is planned in 2015. These tests are important for evaluating AGF performance but also to validate the Computational Fluid Dynamics (CFD) methods.

The applicant has to select the most appropriate CFD tool suitable for this programme and should demonstrate a dedicated methodology to simulate AGF deployment. This capable tool must be validated against a large suite of available test data on standard rotor blade configurations to prove correlation with model or full scale test data.

To achieve these aims the Green Rotorcraft Consortium, with lead guidance provided by The Topic Manager, request bids from companies or consortiums to carry out the required development and validation of the CFD software against all sets of wind tunnel data and provide CFD predictions of AGF performance in the forward flight conditions supplied by the Topic Manager.

Scope of work

In order to satisfy the requirements for testing GRC Innovative Rotor Blades technologies, the Green Rotorcraft Consortium members wish to engage with an organisation (or consortium) that can validate their proposed CFD software. The work required from the successful organisation is:

- Make any modifications necessary to the CFD software proposed by the applicant in order to provide a capability for modelling the actual deployment method used in each test.
- Must provide source code and full documentation including code description, solver method, user guides and training in running the simulations, along with support to installation of software. All software used must be compatible with that used by the industrial partner.

- Use the above software to simulate 2D and 3D wind tunnel test cases and compare results with available wind tunnel test data, and so far as is practicable provide innovative corrections to steady and unsteady free-air forces and moments.
- Use the above software to simulate full scale rotor whirl tower test cases and compare results with available test data.
- Perform full-scale rotor forward flight performance simulations using the CFD software for 'blind' test conditions at various points in the level flight envelope with use of AGF. These will consist of a minimum of nine initial cases and a minimum of nine subsequent test cases covering a range of forward flight conditions and AGF deployment options, as specified by the Topic Manager.

Main required characteristics of the CFD Software

It is essential that the CFD solver identified has a proven capability in simulating rotor performance. The CFD solver must be a general-purpose method for the solution of the Euler and Navier-Stokes equations suitable to resolve the characteristics compressible unsteady flow field past helicopter rotor blades in hover and forward flight. The core method should be implicit in space and time with a resolution that is 2nd order in time and 3rd-order in space. The time marching method could follow the dual-time step approach; however the use of novel techniques to reduce solution time would be highly beneficial. The solver must be capable of addressing problems across the range of Mach numbers found on helicopter rotors. A detail description of software characteristics must be included in the Proposal, including all available turbulence modelling and simulation options. It is expected that the solver will have the capability to employ simple 1-equation turbulence models up to complex LES/DES schemes, and essential that it contain the standard popular 2-equation k-omega family models. It is expected that the limitations of the various turbulence models will be addressed in these studies.

In order to ensure easy mesh generation around complex geometries, Multi-block structured grids should be used. The capability for deforming and moving grids is seen as an advantage, along with the capability for sliding planes. It is useful to demonstrate the capability to specify solid-wall conditions within the flow-domain as this is considered a valid possibility for employing a moving Gurney flap. However, the applicant is free to use the most appropriate method and numerical scheme to implement and simulate an unsteady Gurney Flap deployment.

Furthermore, it is considered essential that the software is capable of operating in parallel mode and should use the industry-standard Message Passing Interface (MPI) library.

Details of Wind Tunnel and Whirl Tower Tests

There are four AGF tests that are planned for GRC1.

The first test is scheduled for the third quarter of 2013. This is a low speed 2D tunnel test of a wing section with full span AGF, on a full scale modified NACA0012 with thickened aft section to allow room for the AGF mechanism. The tunnel is unpressurised and capable of Mach numbers up to 0.2. This testing will comprise static aerofoil angles with static and dynamic AGF. Details of corrections to the wind tunnel data will be provided by the test facility.

The second test that will take place in a high speed wind tunnel is scheduled for the third quarter of 2014. This is a 2D tunnel test of a wing section but utilising a modified existing helicopter blade aerofoil section. The testing of a near full scale section (0.3 to 0.4m chord) will be at Mach numbers between 0.2 to 0.6. For this test there shall be full dynamic testing with both fixed and oscillating aerofoil section, and fixed and deployable AGF. The wind tunnel section will include 50 steady pressure taps on the upper and lower surface and 30 high frequency pressure transducers. Additionally, there shall be extra tests possible with fixed Gurney Flap located at a range of chordwise positions. Details of corrections to the wind tunnel data will be provided by the test facility.

The final wind tunnel test is a 3D model rotor test, planned to occur in the third quarter of 2014 in a large wind tunnel facility. This testing will comprise an isolated model rotor equipped with AGF devices. The rotor shall be tested at two rotational speeds and tunnel speeds of 45m/s to achieve high advance ratio conditions. PIV measurements are planned along with R&D tasks to infer surface

pressures from PIV results.

The full scale whirl tower test is planned for the third quarter of 2015, on a modified helicopter main rotor blade. This test will be used to prove AGF operation on an actual rotor blade and provide suitable aerodynamic data for CFD code validation.

Although testing is scheduled for the above defined date, the precise schedule will depend on the availability of the active sections/blades, suitable modifications to tunnel/whirl tower facilities and associated power and control systems. Therefore, the activities may be subject to re-planning as the GRC1 project develops.

Further Expectations

It is expected that the successful bidder will dedicate computing hardware to this work package throughout the contract period. Therefore, provisions for new hardware to be purchased specifically for computations of GRC1 test cases are acceptable but only within the JU rules for hardware acquisition and purchase.

Commercial Requirements

Detailed discussion of all relevant contractual requirements will take place following selection of the successful bidder. Management and protection of data transferred in support of this task is expected to be governed by a specific non-disclosure agreement (NDA), to be agreed as part of the detailed contract negotiations.

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

- The applicant must have demonstrated experience in CFD validation in the helicopter rotor field.
- Bidders are expected to demonstrate appropriate experience of CFD code development.
- Mesh generation must be done using ANSYS ICEM®, and post processing using TECPLOT®. All software used must be compatible with that used by the industrial partner.
- The winning bidder will be expected to provide full technical reports of any software upgrading, provide technical reports of all validation and blind test cases, and supply appropriate input and output files on suitable mass storage devices as required.

3. Major deliverables and schedule

Deliverable	Title	Short Description (if applicable)	Due date (month)
M0	Contract Effective.	Anticipated to be January 2013	T_0
D1	Code Modification Report.	Provide documentation describing any code modifications required to accurately model the final defined AGF deployment method	T_0 + 9 months
D2	Report on Validation of CFD against 2D 1st series Wind Tunnel test data.	Testing currently expected third quarter of 2013.	T_0 + 14 months
D3	1st Report on Forward Flight Blind Test Cases.	Description of first blind test case results.	T_0 + 18 months
D4	Report on Validation of CFD tool against 2nd series of Wind Tunnel test data.	Testing currently expected third quarter of 2014.	T_0 + 26 months
D5	Report on Validation of CFD tool against Model Rotor Wind Tunnel test data in a large wind tunnel.	Testing currently expected third quarter of 2014.	T_0 + 28 months
D6	Report on Validation of CFD tool against Full Scale Whirl Tower test data.	Testing currently expected third quarter of 2015.	T_0 + 38 months
D7	Final report on Forward Flight Blind Test Cases.	Description of complete blind test case results.	T_0 + 42 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:

€ 350 000

[Three hundred fifty thousand euro]

(VAT not applicable)

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 25 pages *with individual chapters for each of the key elements a) to e) defined in the scope of work*.

Clean Sky Joint Undertaking
SP1-JTI-CS-2012-03-GRC-02-008

Topic Description

CfP topic number	Title		
JTI-CS-2012-03-GRC-02-008	**Assessment of tiltrotor fuselage drag reduction by wind tunnel tests and CFD**	**End date**	T0 +24 months
		Start date	T0: June 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 aims among others at improving the aerodynamic characteristics of tiltrotor fuselages. This implies a reduction of the drag without penalties on other key characteristics in cruise flight. Within the GRC2 sub-project an optimization activity has been accomplished in order to reduce by Computational Fluid Dynamics (CFD) the drag levels of some specific components of the reference configuration (ERICA tiltrotor). Based on the baseline configuration, associates of the GRC Consortium performed shape optimization with CFD of different parts of the tiltrotor fuselage (nose, sponsons, wing/nacelle fairings, wing/fuselage fairings, empennages) for drag reduction and efficiency improvements purposes.

In this call-for-partner, the successful applicant will support the GRC Consortium in the benefit assessment process for the tiltrotor. The successful applicant of this call will experimentally assess in wind-tunnel tests the final optimized fuselage (without rotors) and will evaluate the drag reduction in comparison to the original configuration. The work comprises wind-tunnel test preparation, test execution and results analysis. Moreover, a CFD activity to evaluate rotor interactional effects and the full scale (free stream Mach dependent) characteristics is also required.

1.2- Scope of work:

General objectives

The overall objective of the current CfP is to make the full scale drag assessment of the tiltrotor ERICA including rotors effects by performing:

a) wind-tunnel tests of the isolated fuselage (no rotors) with the objective of accurate drag measurements to assess the benefit of the shape optimization activities performed by the GRC Consortium. The partner is expected to provide detailed experimental drag benefit measurement between the two configurations “basic” and “optimised”.

b) CFD validation of the optimized isolated model scale configuration (no rotors) in wind tunnel flow conditions

c) CFD full scale analysis of the optimized configuration including the rotor effects

Both basic and optimized wind-tunnel models (1/8 scaled) will be supplied by the GRC Consortium to the applicant. Additionally, the CAD surface models (CATIA V5®) of the basic and optimized geometries will be also supplied.

The CfP activity is split into two main tasks as hereafter described:

- Task 1: Wind-tunnel tests of the original and optimised configurations
- Task 2: CFD computations

Task 1: Wind-tunnel tests of the original and optimised configurations

This task includes the activity of wind-tunnel tests preparation and execution for the two configurations. The Figure 1 below depicts the main model features and dimensions (mm) of the basic geometry.

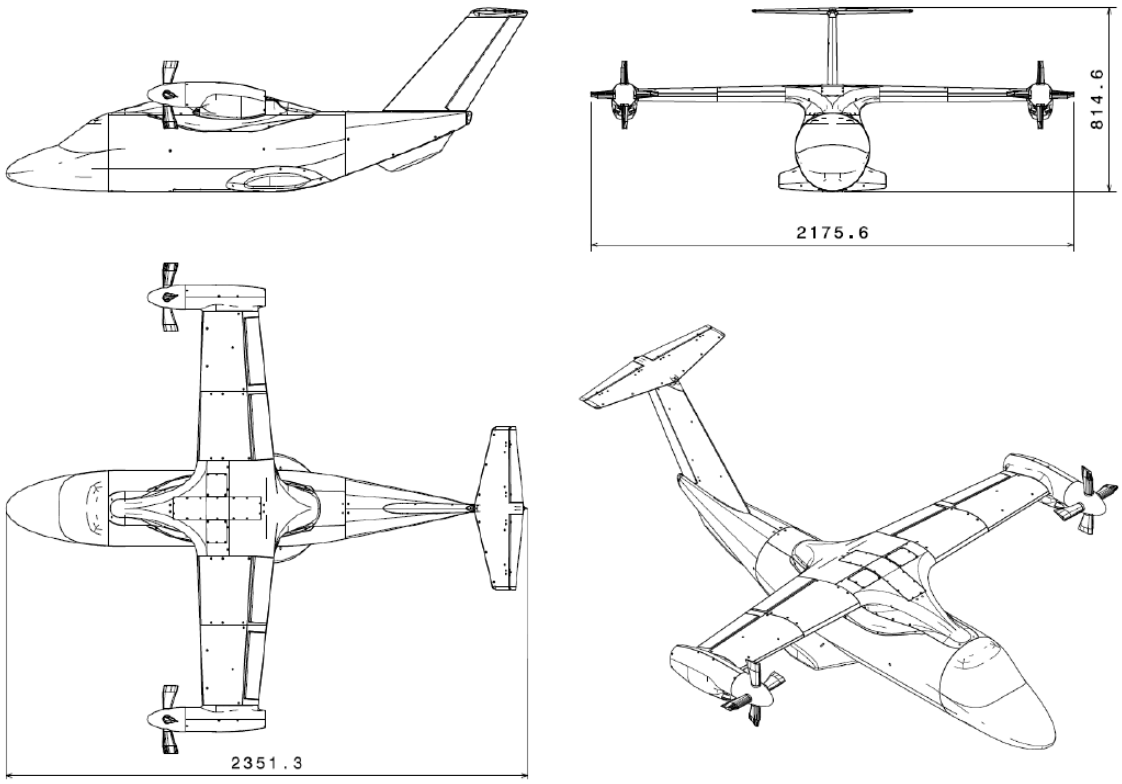


Figure 1 – Model main characteristics (dimensions in mm)

The next Figures 2 and 3 illustrate the model suspension system as used for the previous wind tunnel tests to characterize the basic configuration: a vertical strut. The vertical strut is connected to a structural internal box that hosts the main 6-components balance for global forces and moments measurements. The current internal box has been designed to host a RUAG 192-6I balance. The model includes two balances in the rotating wings to measure the local lift, drag and pitching moment of these movable devices.

The model is suitable for allocating the standard dummy pylon for support interference correction. The weight of the model is 100 Kg.

Figure 2: model suspension system (vertical strut)

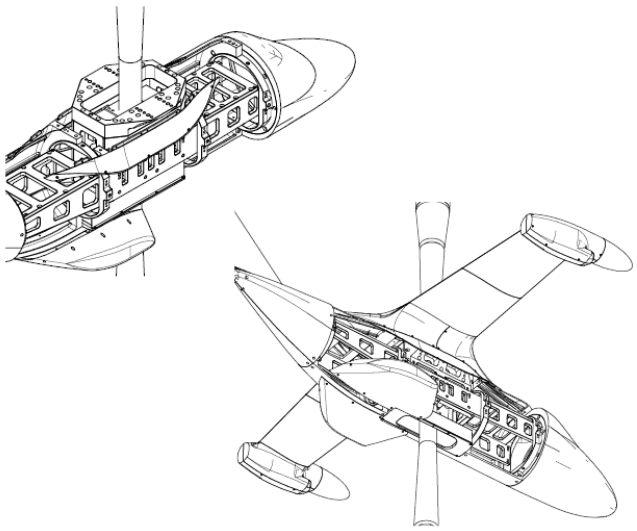


Figure 3: model suspension system (vertical strut and dummy pylon for interference corrections)

The optimised geometry of the affected components do not introduce significant variations into the main dimensions and/or weight.

The above suspension system is not mandatory for the activity: the applicant can propose alternative means to better fit the requirement (drag accuracy measurement). For this reason a rear sting is recommended as alternative supporting system. In this case (rear sting) the main structure must be supplied by the applicant, while the needed interfaces to accommodate the new proposed suspension system will be manufactured by the leading Company of this Proposal. On the contrary, it's mandatory the use of the RUAG 192-6I balance, otherwise the internal structural box has to be completely redesigned and manufactured. The RUAG 192-6I balance shall be provided by the Applicant.

In this Task 1, wind-tunnel tests of the original configuration will be performed for both the regular and upside down mountings (or other configurations according to the suspension system). Then, wind-tunnel tests of the optimised configuration will be performed. The flight conditions will include cruise flight at various angles of attack as well as various sideslip angles for wind speed up to 50 m/s.

For all test points, global forces (main balance) and local wing forces will be acquired. A particular attention should be paid to the accuracy of the drag component measurements in order to be able to capture expected drag reduction between the optimised and the original configurations.

Specific wind-tunnel capabilities requirements are listed in section 2.

Inputs from GRC Consortium:

- Wind tunnel model for the basic configuration wind-tunnel tests, without main balance and suspension system.
- Wind tunnel model components for the optimized configuration wind-tunnel tests without main balance and suspension system but with dedicated interface for the proposed model suspension device (the solution will be agreed during the Negotiation Phase).

Test campaign:

The test campaign has not the aim to fully characterize the configuration, but it's aimed to highlight the benefits of the new optimized configuration. For this reason the mandatory plan is as follows:

Basic Model:

a) Complete basic configuration in airplane mode: Pitch sweep at zero Yaw, Pitch sweep at ±5 of Yaw, Pitch sweep at ±10 of Yaw and the necessary test points for data reduction corrections.

Optimized Model (Basic Model + improved components):

a) Complete basic configuration in airplane mode **with new nose**: Pitch sweep at zero Yaw, Pitch sweep at ±5 of Yaw, Pitch sweep at ±10 of Yaw

b) Complete basic configuration in airplane mode **with new nose + new wing/fuselage fairing**: Pitch sweep at zero Yaw, Pitch sweep at ±5 of Yaw, Pitch sweep at ±10 of Yaw

c) Complete basic configuration in airplane mode **with new nose + new wing/fuselage fairing + new wing/nacelle fairing**: Pitch sweep at zero Yaw, Pitch sweep at ±5 of Yaw, Pitch sweep at ±10 of Yaw

d) Complete basic configuration in airplane mode **with new nose + new wing/fuselage fairing + new wing/nacelle fairing + new sponsons**: Pitch sweep at zero Yaw, Pitch sweep at ±5 of Yaw, Pitch sweep at ±10 of Yaw

e) Complete basic configuration in airplane mode **with new nose + new wing/fuselage fairing + new wing/nacelle fairing + new sponsons + new empennage**: Pitch sweep at zero Yaw, Pitch sweep at ±5 of Yaw, Pitch sweep at ±10 of Yaw

Moreover, the necessary test points for data reduction corrections shall be included in the above a) to e) items. Any specific experimental techniques the applicant wishes to apply to support this drag evaluation are welcome.

Ouputs from the Applicant:

- Wind-tunnel tests results including corrections for supporting system and all other noticeable effects (wall interferences, buoyancies, stream deviation, etc..)
- All raw and processed data
- Report on the basic configuration wind-tunnel tests
- Report on the optimised configuration wind-tunnel tests

Task 2: CFD computations

Being the wind tunnel tests in Task 1 to be performed on a so called force model (without rotors) at low speed, the complete characterisation of the configuration asks for a full scale data extension by means of CFD.

The applicant is then required to perform dedicated CFD computations to evaluate not only the rotor effects but also to predict the tiltrotor aerodynamic performances at full scale condition (Mach = 0.58).

A necessary step is to set up a fully validated computational modelling of the basic configuration by comparison with the available wind tunnel test data.

No blade geometry will be supplied to the applicants, but the rotor loads suitable for ‘actuator disc’ boundary condition modelling will be delivered. The Applicant has to detail in the Proposal the approach to be followed to accomplish the Task. This detailed process description will constitute one of the key drivers for the Applicant selection.

Inputs from GRC Consortium:

- CATIA V5® file of the original configuration (wind tunnel model)
- CATIA V5® file of the optimised configuration (wind tunnel model)
- Rotor data to support ‘actuator disc’ like methodology: inflow at the disc or other data needed. No blade geometry will be supplied.

- Flight conditions for full scale evaluation.

Ouputs from Applicant:

- Report on CFD activity
- All input/output files of the analysis

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

Wind-tunnel equipment and capabilities

The applicant must have a qualified and demonstrated skill in wind tunnel testing. It would even be preferred if he has already conducted wind tunnel test campaigns on fixed wing configurations. Detailed requirements and specifications for the applicant capabilities are listed below:

- Wind speeds suitable to guarantee 50 m/s during tests
- Fuselage angle of attack variation from -20° to +20° (regular and upside-down mounting)
- Fuselage side-slip angle variable from -20° to +20° (regular and upside-down mounting)
- Main balance to accurately measure the standard six components parameters of the overall configuration and suitable to be interfaced with the existing model box
- Acquisition of the two additional wing balances signals

CFD capabilities

The capability in applying CFD methods to a complex configuration like tiltrotor shall be proven in the proposal and it will be marked as an added value for the Applicant during the evaluation phase. There is not a specific request for the CFD tools, but the use of Fluent® or OpenFoam will be highly appreciated being, in these cases, the model input and output easily shared within the GRC Consortium and better exploited in future activities. In fact, the analytical results (input files) have to be imported into the GRC Consortium and re-run without any constraints related to a specific tool. So the full compliance with Fluent® and/or OpenFoam shall be guaranteed at least for surface and volume mesh import/export.

Moreover, being explicitly required the use of the 'actuator disc' approach for rotor inflow modelling, the development and implementation of this technique within OpenFoam will allow the exploitation of this particular feature within the CFD web community.

Legal

The partner will be asked to sign an Implementation Agreement.

Other

Finally, a Consortium is encouraged to respond at this call to better exploit the specific level of knowledge of each participating partner.

3. Major inputs, deliverables and schedule

Deliverable	Title	Short Description (if applicable)	Due date (month)
D1	Wind tunnel test report of basic and optimized configurations	Report describing the wind tunnel test activity including test plans, corrections, accuracy of the acquired data	T_0 + 18 (December 2014)
D2	Wind tunnel test data analysis	Report describing the results including the comparisons among different configurations	T_0 + 21 (March 2015)
D3-Part I	CFD analysis of the wind tunnel models	Report describing and showing blind test correlation at wind tunnel conditions (for both basic and optimized configurations), including all input/output files.	T_0 + 12 (June 2014)
D3-Part II	CFD analysis of the wind tunnel models	Report describing and showing the correlation with wind tunnel tests data of D1 (for both basic	T_0 + 21 (March 2015)

		and optimized configurations), including all input/output files.	
D4	CFD analysis of optimized configuration at full scale	Report describing and showing the evaluation of the aerodynamic performances at full scale including rotors effects (input/output files are also delivered).	T_0 + 24 (June 2015)

The applicant is expected to present a detailed planning of the activity compliant with the deliverable table above, including cost and resources sharing per activity. Also a risk assessment is required.

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 600,000 (VAT not applicable)

[Six 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)

- For the peculiarity of the activity a Consortium gathering selected expertise is welcome
- The expected maximum length of the technical proposal is 50 pages.

Clean Sky Joint Undertaking
SP1-JTI-CS-2012-03-GRC-06-005

Topic Description

CfP topic number	Title		
JTI-CS-2012-3-GRC-06-005	**Recycling of Metallic Materials from Rotorcraft Transmissions**	**End date**	*T0 + 12*
		Start date	*01-2013*

1. Topic Description

1. Background:

Helicopter power transmissions typically consist of a number of gearboxes which transmit power from the engines to the rotor systems via a series of shafts. Typically this system is primarily manufactured from metals with coatings to enhance surface hardness, lubrication or provide corrosion resistance. These coatings may be metallic, ceramic or polymeric in nature depending upon their function. The whole internal structure then operates in a lubricant product is applied.

The components of the transmission system have a finite life after which they must be withdrawn from service and disposed of. At the end of its service life, each component and the transmissions system as a whole must be returned to the materials market in a manner that is energy efficient and produces the minimum of environmentally sensitive waste product. This means that each part of the transmission assembly (shafts+gearbox) must be recycled within an environmentally friendly manner in order to restore cleanliness of the bulk materials.

The reycling system shall therefore;

Be capable of removing surface treatments cleanly and with minimum waste product.

Be capable of recycling the metallic materials to produce raw material of suitable quality for re-use

Minimise energy consumption in the recycling process

Use a minimum of substances listed in REACh candidate lists in waste products.

The aim of this CFP is to find a partner/ consortium to apply modern methods to the recycling process to aerospace materials and processes commonly found in helicopter gearboxes and drivetrains. It is anticipated that the methods of recycling materials are already available and the challenge will be to design and validate protocols for applying these methods in a cost effective and way to maximise re-use of material.

2. Scope of work

Each contributing participant will supply to the selected partner/ consortium details of the demonstrator components and assemblies developed within GRC 6.3 and 6.4 and also trial components where appropriate from these two work packages.

The partner/consortium will treat these information under confidentiality agreements.

The partner/consortium shall perform a review of available recycling methods so as to support the adoption of one or more of these methods.

The partner/ consortium shall apply the selected recycling methods to the two demonstrators of each ITD manager and provide associated detailed analysis.

The partner/ consortium shall provide knowledge and experience of the recycling process and appropriate markets.

The partner/ consortium shall have, or shall have access to, facilities capable of managing trial components to demonstrate process and costs entailed in the recycling process.

The partner/ consortium shall have the ability to measure cost and efficiency of the process/processes selected and to access potential markets for recycled materials

The partner/ consortium shall have program management skills and abilities to carefully follow and report enhancements and results of the relevant activities .

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

The applicants shall have knowledge of the recycling industry and shall have specialist knowledge of the chemical and other processes used in recycling metallic components in a clean and energy efficient manner. Expert knowledge of the appropriate markets will be essential.

The applicant shall have or shall have access to, facilities for metallic material recycling. And shall have a demonstrated capability to monitor energy usage and cost during the process**.**

3. Major deliverables and schedule

Deliverable	Title	Short Description (if applicable)	Due date (month)
D1	Review of available recycling methods	Report	To + 3 months
D2	Survey of gearbox components and suitability for recycling methods.	Report	To + 3 Months
D3	Detailed report on tests and analyses performed in the protocol design phase	Report	To + 6 Months
D4	Detailed protocol for the dismantling methodology with several steps : 1 - Separate the different parts 2 - Remove the surface treatment 3 - Recycling the materials (with minimized energy consumption)	Report	To + 6 Months
D5	Application of the dismantling methodology	Report	To + 9 Months
D6	Detailed report on the tests and analysis performed in the protocol validation phase	Report	To + 11 Months
D7	Evaluate the cost-effectiveness (operation cost and re-use percentage)	Report	To + 12 Months

4. Topic value (€)

The total value of this work package shall not exceed:

€ 300,000

[Three hundred thousand euro]

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

5. Remarks

The candidates should know that, in case that they are successful, they would have to sign an implementation agreement with several industrial companies which engage the chosen candidate not to disclose to a corporation, the information which have been transmitted by each of the competing companies.

Clean Sky Joint Undertaking
Call SP1-JTI-CS-2012-03
Sustainable and Green Engines

Clean Sky – Sustainable and Green Engines

Identification	ITD - AREA - TOPIC	topics	VALUE	MAX FUND
JTI-CS-SAGE	**Clean Sky - Sustainable and Green Engines**	**12**	**18,450,000**	**13,837,500**
JTI-CS-SAGE-01	*Area-01 - Open Rotor Demo 1*		**0**	
JTI-CS-SAGE-02	*Area-02 - Open Rotor Demo 2*		**8,550,000**	
JTI-CS-2012-3-SAGE-02-025	SAGE2 Engine Mounting System		3,000,000	
JTI-CS-2012-3-SAGE-02-026	SAGE2 Engine In-flight Balancing System		4,000,000	
JTI-CS-2012-3-SAGE-02-027	Validation of high Load Capacity Gear Material		550,000	
JTI-CS-2012-3-SAGE-02-028	Study and durability of electrically insulative material in aircraft engine chemical environment		400,000	
JTI-CS-2012-3-SAGE-02-029	Development and validation of a metallurgically based simulation model for crack generation during welding and heat treatment of superalloys.		600,000	
JTI-CS-SAGE-03	*Area-03 - Large 3-shaft turbofan*		**6,400,000**	
JTI-CS-2012-3-SAGE-03-016	Surface protection of composite aeroengine components to enable weight savings in high temperature applications (≥360oC)		750,000	
JTI-CS-2012-3-SAGE-03-017	Electric Pump for Safety Critical Aero engine applications		1,750,000	
JTI-CS-2012-3-SAGE-03-018	Variable fluid metering unit for Aero engine applications		750,000	
JTI-CS-2012-3-SAGE-03-019	Development of materials, processes, and means to enable the application of piezoelectric materials in aero engine controls.		1,500,000	
JTI-CS-2012-3-SAGE-03-020	Net shape Hot Isostatic Pressing of IN718		1,650,000	
JTI-CS-SAGE-04	*Area-04 - Geared Turbofan*		**0**	
JTI-CS-SAGE-05	*Area-05 - Turboshaft*		**0**	
JTI-CS-SAGE-06	*Area-05 - Lean Burn*		**3,500,000**	
JTI-CS-2012-3-SAGE-06-001	Advanced materials for lean burn combustion system components using Laser- Additive Layer Manufacturing (L-ALM)		1,000,000	
JTI-CS-2012-3-SAGE-06-002	Economic manufacture of lean burn combustion liner tiles using Laser- Additive Layer Manufacturing		2,500,000	

Clean Sky Joint Undertaking
SP1-JTI-CS-2012-03-SAGE-02-025

Topic Description

CfP topic number	Title		
JTI-CS-2012-03-SAGE-02-025	**SAGE2 Engine Mounting System**	**Start date**	T0
		End date	T0 + 33 months

1. Topic Description

Main goals

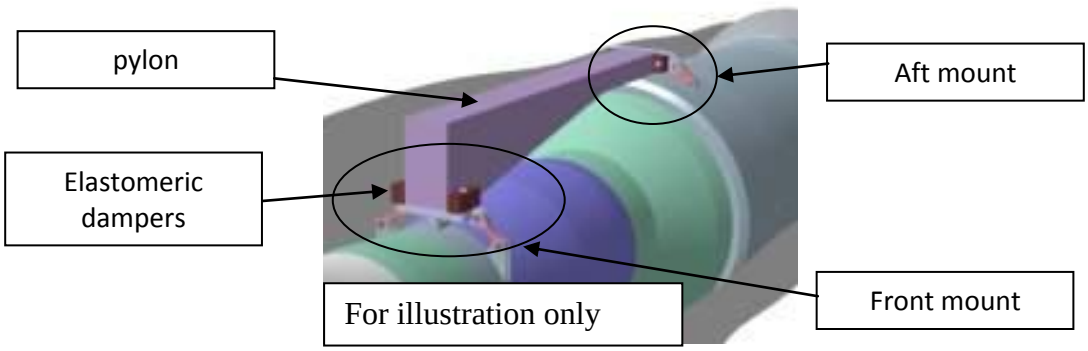
The SAGE2 Demonstration Project aims at designing, manufacturing & testing a Counter-Rotating Open-Rotor Demonstrator. It involves most of the best European Engine & Engine Modules & Sub-systems Manufacturers.

The SAGE2 demonstrator will be installed on a pylon located on a test bench (ground tests).

An Engine Mount System must be designed and manufactured so as to mount the engine on its pylon.

This Engine Mount System will be isostatic. In particular,

- The front mount will comprise a yoke, rods, ball joints that will be consistent with the donor engine interfaces.
- The aft mount will comprise a yoke, rods, and ball joints and a beam that will be consistent will the exhaust frame (to be designed by the topic manager).



It must be noticed that, in order to dampen the vibration induced by the propellers, elastomeric devices, that shall be provided by the supplier, will be introduced between the pylon and the Engine Mount System.

Task List. Engine Mounts System

Task 0: Management

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.

– Monthly 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's facility.

General Requirements:

– The partner shall work to a certified standard process.

Task 1: mount system design

The partner shall design the mounts and elastomeric dampers, according to the topic manager and to the airframer's demonstrator flight-worthiness requirements in case this mounts concept would be selected for flight tests.

The partner shall deliver to the topic manager the mount system data required for Whole Engine Model Analysis and for the Airframer's GFEM to be used for loads & Aero elastics loops

The partner shall deliver a design justification report of the mounts and elastomeric dampers

The partner shall support the technical review for mount system architecture approval organized by the topic manager.

Task 2: mount system component tests

The partner shall propose a mount system 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 and manufacturing or procurement of components based on existing test plan & test bench sketches
- 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 3: mount system delivery for ground test

The partner activities shall include:

- Manufacturing and/or procurement of the instrumented mounts and elastomeric dampers for engine assembly
- Conformity documents

Task 4: support to ground test (mounts)

The partner shall support the topic manager during the ground tests:

- monitoring
- measures analysis
- Hardware changes if required by engine dynamic behavior

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

- Experience in design, manufacturing, testing and certification of aircrat engine mounts is mandatory
- Experience in elastomeric dampers is mandatory
- Experience in dynamic and vibration engine complex environnement analysis 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
- English langage is mandatory

3. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Mount systems development plan	Including detailed risk analysis and mitigation proposal and a preliminary test pyramid	T0 + 1 month
D2	Mount system 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+1 months
D3	Design progress reports for mount systems	Design activities status	T0+7 months
D4	Mount system detailed design substantiation document for the critical design review	To approve design before hardware manufacturing engagement. Including Test pyramid, structural FEM model adapted for integration to global Aircraft FEM (GFEM) & local thermal model	T0+13 months
D7	Mount systems Components Tests benches readiness review	To verify test benches capability to meet validation plan requirements	T0+15 months
D8	Mount systems Components Tests completed – hardware inspection review	To substantiate mount systems design	T0+23 months
D10	Mount system hardware delivery	Engine assembly	T0+25 months
D11	Component Tests reports for mount systems	To contribute to engine test readiness review	T0+ 29 months
D12	Engine readiness review documentation: - Delivered Hardware status compared - Instrumentation - Test plan requirements	To contribute to engine test readiness review	T0+ 29 months
D13	Engine ground test report for mount systems	To contribute to engine after-test review	T0+ 33 months

4. Topic value (€)

Value of the topic is:

3.000.000,00

[Three million euro]

Clean Sky Joint Undertaking
SP1-JTI-CS-2012-03-SAGE-02-026

Topic Description

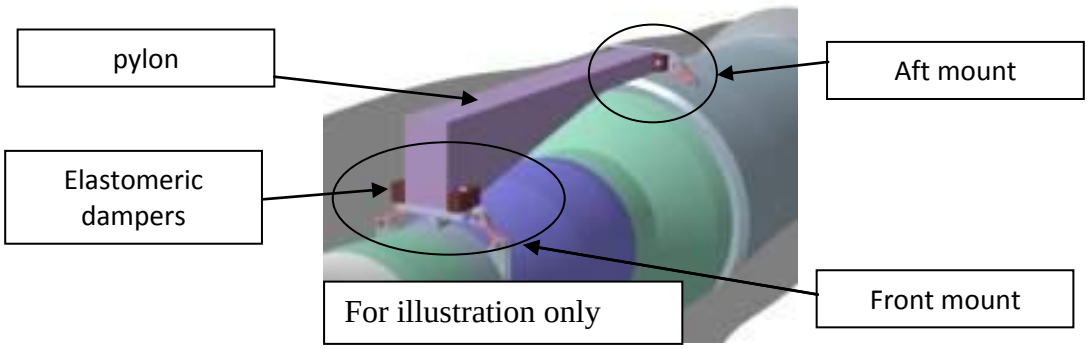
CfP topic number	Title		
JTI-CS-2012-03-SAGE-02-026	**SAGE2 Engine In-flight Balancing System**	**Start date**	T0
		End date	T0 + 33 months

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 Engine Inflight Balancing Device and Control System will be designed, manufactured and tested to achieve the following goals:

- To decrease the inflight vibratrions due to propeller unbalances
  - Mechanical unbalance (common unbalance due to geometry of the rotors and blades)
  - Aerodynamic unbalance due to blade to blade pitch mismatch
- Fewer maintenance cost due to trim balancing
- Less vibration level in the Aircraft ➔ more confortable flight for passengers and cabin crew
  - Power management (source+transmission+power needs)
  - Installation (electric power cables, oil feeding, ...) ➔ no oil feeding
  - Environment (Temperature, Chemical, fire proof, electromagnetism, ..)
  - Reliability/ Service life/ Maintenance cost/ accessibility
  - Part sharing ➔ accelerometers+actuators+controller+software

The Main issues to be adressed are :

- Balancing capability consistant with the topic manager's requirements
- Actuators time response ➔ from 1 to 10 sec
- In phase rotor identification (2 counter rotating rotors at same speed) ➔ to be adressed
- Weight ➔ Need balancing capability

Scope of call for proposal

Work Package 0: Management

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.

– Monthly 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's facility.

General Requirements:

– The partner shall work to a certified standard process.

Task list: Engine In Flight Balancing System

Task 1: Balancing system design:

- The partner shall design the engine in-flight balancing system according to the topic manager's requirements,

- The partner shall deliver to The topic manager the data required for Whole Engine Model Dynamic Analysis and engine DMU,

- The partner shall deliver a design justification report,

- The partner shall support the technical review for balancing system architecture approval organized by the topic manager.

Task 2: Balancing system component tests

The partner shall propose a balancing system verification plan including all the relevant component tests. 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 and manufacturing or procurement of components based on existing test plan & test bench sketches

- 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 3: Balancing system mount system delivery for ground test

The partner activities shall include:

- Manufacturing and/or procurement of the instrumented hardware for engine assembly

- Conformity documents

Task 4: support to ground test (Balancing system)

The partner shall support the topic manager during the ground tests:

- Monitoring

- Measures analysis

- Hardware changes if required by engine dynamic behavior

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

- Experience in design, manufacturing, testing and certification of aircraft engine in-flight balancing is mandatory
- Experience in elastomeric dampers is mandatory
- Experience in dynamic and vibration engine complex environnement analysis 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
- English langage is mandatory

3. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	balancing systems development plan	Including detailed risk analysis and mitigation proposal and a preliminary test pyramid	T0 + 1 month
D2	Balancing system 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+1 months
D3	Design progress reports for balancing systems	Design activities status	T0+7 months
D4	Balancing system detailed design substantiation document for Critical design review	To approve design before hardware manufacturing engagement	T0+13 months
D5	Balancing systems Components Tests benches readiness review	To verify test benches capability to meet validation plan requirements	T0+15 months
D6	Balancing systems Components Tests completed – hardware inspection review	To substantiate mount and balancing systems design	T0+23 months
D7	Balancing system hardware delivery	Engine assembly	T0+23 months
D8	Component Tests reports for balancing systems	To contribute to engine test readiness review	T0+ 29 months
D9	Engine readiness review documentation: - Delivered Hardware status compared - Instrumentation - Test plan requirements	To contribute to engine test readiness review	T0+ 29 months
D10	Engine ground test report for balancing systems	To contribute to engine after-test review	T0+ 33 months

4. Topic value (€)

Value of the topic is:

4,000,000.

[Four million euro]

Clean Sky Joint Undertaking
SP1-JTI-CS-2012-03-SAGE-02-027

Topic Description

CfP topic number	Title		
JTI-CS-2012-03-SAGE-02-027	**Validation of High Load Capacity Gear Material**	**Start date**	*01/01/2013*
		End date	*31/12/2013*

1. Topic Description

Open Rotor geared engine is a promising architecture for future aeronautical market due to significant reduction opportunities in fuel consumption compared to conventional engines.

The purpose of Geared Open Rotor demonstrator (SAGE 2) as part of the Sustainable and Green Engine (SAGE) platform is to advance the enabling technologies to achieve the necessary knowledge and validation.

The Geared Open Rotor architecture introduces a decoupling between the turbomachine speed and the propellers speeds to allow separate optimization of both systems, with overall efficiency gain of the whole engine, through the use of a Power Reduction Gearbox (PGB). Power Transmissions therefore enable this low emission novel engine architecture and represent a new core module.

The innovative technologies implemented on components and modules have to be matured in order to ensure a low risk introduction on the demonstrator.

For PGB design a critical to quality is the overall envelope (power density) to enable optimal integration into the engine and therefore an overall optimal engine performance.

To this end the usage of innovative material for high load capacity gears (e.g. M50 NIL Duplex Hardened, Ferrium Carburized) has been identified as a key technology.

In order to answer the needs of the SAGE 2 in terms of research, technological development and demonstration activities, it is planned to offer individual task to the industry, universities or any legal entity. The present Call for Proposal supports the high load capacity gear's materials implementation into the Power Reduction Gearbox designed by the Topic Manager (SAGE 2, Work Package 2.2.8).

The partners work includes the following tasks:

Task 1: Innovative materials for Next Generation PGB – Single Tooth Bending Fatigue Validation

Single Tooth Bending Fatigue (STBF) testing technique is already a known lean approach for characterization of gears materials.

However the topic manager policy is to determine design allowable by component testing. This is linked to the strong requirement about lightweight design for aeronautical gears which imposes safe margins to be as low as possible.

Nevertheless the level of accuracy, that both tools for stress & fatigue analyses and testing machines have reached, suggests the opportunity to validate the STBF approach for aeronautical gears as well thus enabling a leaner characterization.

Task 1 covers the STBF validation based on back to back statistical comparison of results with respect to component testing.

The testing campaign will use articles (gears) made in currently available material (e.g. AMS6308 carburized) designed and procured by the topic manager (indicative number: 90)

Proposed Test Plan and approach for STBF validation have to be delivered by Applicant when replying to this Call.

Task 2: Innovative Materials for Next Generation PGB - Characterization

Task 2 covers the following activities:

2.1 Determination of bending fatigue limit of the innovative material proposed by the topic manager (e.g. M50 NIL Duplex Hardened, Ferrium Carburized) through the optimized characterization process developed and validated in Task 1 (i.e. STBF testing).

2.2 Determination of material limits for pitting (surface fatigue) and scuffing (adhesive wear) through a component test (power recirculating rig required).

For both testing activities the test articles procurement will be managed as follows:

- Raw materials procurement by the topic manager
- Test Articles machining managed by Applicant
- Test Articles Heat Treatment managed by the topic manager

Proposed Test Plan and approach for material limits determination have to be delivered by Applicant when replying to this Call.

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

Necessary Equipment:

Power Recirculating Rig for gear component testing (bending, pitting, scuffing).

- rig should be able to accept dimension between gear axes of 140 mm

STBF rig for bending testing

Both equipments have to be already commissioned and general description including lesson learnt has to be presented by Applicant when replying to this Call.

Special Skills:

Design Capabilities (for Task 1 – STBF/Component comparison analysis & for Task 2 - T/As microgeometry review in collaboration with the topic manager)

Statistical Methodologies (for STBF validation and material limits determination)

Experience in Supply Chain management (for Task 2 T/A machining)

3. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1.1	STBF Correlation	STBF validation based on back to back comparison of testing results with respect to component testing	T0+3 (*)
D2.1a	Test Article procurement	Procurement of the test articles for the innovative material characterization	T0+5
D2.1b	Determination of bending fatigue limit	Bending test (on STBF rig)	T0+7
D2.2	Completion of material design limits identification for pitting and scuffing	Pitting & scuffing test (on components)	T0+12

(*) Test Articles assumed to be available @ T0+1

4. Topic value (€)

The proposed topic value is a maximum gross value for the proposed activity

550,000 €

[Five hundred fifty thousand euro]

5. Remarks

The proposal of the applicant has to include maximal realizable values for every given requirement.

A detailed work plan and time schedule is being expected.

A thorough financial plan must be attached as well. The applicant must fulfil the above mentioned requirements.

Clean Sky Joint Undertaking
SP1-JTI-CS-2012-03-SAGE-02-028

Topic Description

CfP topic number	Title		
JTI-CS-2012-03-SAGE-02-028	**Study and durability of electrical insulating material in aircraft engine chemical environment**	**Start date**	*Sept 2012*
		End date	*Dec 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 SAGE2 Demonstrator incorporates two conter-rotating propellers, which should be deiced. An electrical deicing system is studied to supply and transfer the power necessary to the deicing. For this system several type of electrical machines are considered. Each of these machines require organic dielectric materials to provide electrical insulation and avoid electrical discharge to occur.

Beside the harsh temperature conditions that these insulative materials shall withstand, it is also mandatory that they resist to engine fluids such as hyrocarbide lubricant.

The activities of this topic concern the study and durability of typical electrical insulating materials used in the Open-Rotor demonstrator deicing system electrical machine.

The partner shall perfom the following activities, in coordination with the deicing system design study:

Task 1: Project management:

Planning and steering activities for the project.

Quality management of the project.

Task 2: State-of-the-art of organic polymers and interfaces compatibility with hydrocarbide

Sate-of-the-art report on the organic polymers and interfaces behaviour in hydrocarbide fluids.

Sate-of-the-art report on the organic polymers and interfaces behaviour studying methods during hydrocarbide fluids ageing.

Task 3: Polymer hydrocarbide ageing test planning

Materials and interfaces process optimisation method

Materials and interfaces ageing behaviour evaluation methods with test parameters

Ageing test plan

Task 4: Material sample and interface test vehicules processing and charactirisation

Material process optimisation

Report on optimised material process

Material initial state characterisation

Material interface optimisation

Report on material interfaces process

Material interface intial state characterisation

Task 5: Ageing study

Material ageing behaviour characterisation

Material interface ageing behaviour characterisation

Task 6: Interpretation of test results and recommandations

Material and interface failure mode during hydrocarbide ageing report

Design recommandation report

Material chemistry optimisation proposal to meet with the requirement or enhance the ageing resistance

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

NB: a consortium of laboratories and/or compagnies may answer the call

Extensive experience in high temperature (above 200°C Tg or Tm) material testing and characterisation

Extensive experience in polymer and there interfaces ageing in hydrocarbide and harsh industrial fluids ageing

Extensive experience in polymer failure mode analysis

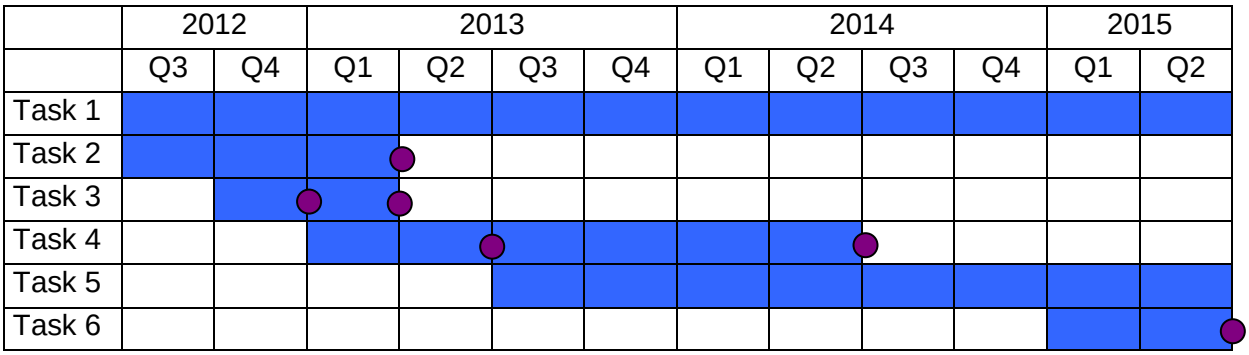
Experience in polymer interface testings

Experience in high performance polymer chemistry and synthesis

The applicant should have at disposal equipements and test means for high temperature polymer characterisation and testing

English language is mandatory

3. Major deliverables and schedule



Deliverable	Title	Description (if applicable)	Due date
D1-1	Monthly progress reports		Every month
D2-1	State of the art first report		March 2013
D3-1	Test plan and methodology – issue 1 : Material optimisation process method report		Dec 2012
D3-2	Test reports on material tests & analysis on test results and recommendations for task 4		March 2013
D4-1	Material sample initial state characterisation report and material sample for ageing study		June 2013
D4-2	Material interfaces sample initial state characterisation report and material sample for ageing study		June 2014
D5-1	Test results analysis & recommendations		June 2015

4. Topic value (€)

The proposed topic value is a maximum gross value for the proposed activity

400,000 €

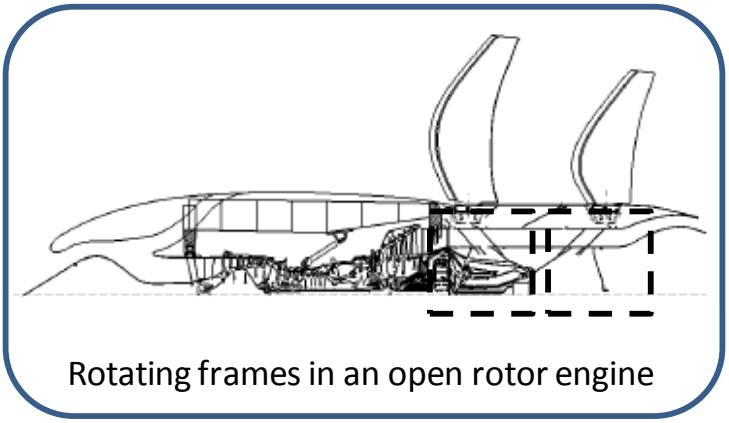
[Four hundred thousand euro]

Clean Sky Joint Undertaking
SP1-JTI-CS-2012-03-SAGE-02-029

Topic Description

CfP topic number	Title		
JTI-CS-2012-03-SAGE-02-029	**Development and validation of a metallurgically based simulation model for crack generation during welding and heat treatment of superalloys.**	**Start date**	*T0*
		End date	T0+30M

1. Topic Description


Rotating frames in an open rotor engine

The SAGE project aims at demonstration of engines and technologies to reduce fuel consumtion, weight and increased efficiency of engine components. Within the objectives of open rotor development in SAGE2, RTD activities are underway on engine and component development including rotating turbine frames. The rotating frames developed within the SAGE2 project can be considered as engine critical parts, and therefore subjected to corresponding requirements and regulations as such. Structural integrity and safety of engine critical parts have to be considered with regard to design, manufacturing aspects and in-service (maintenance and overhaul).It is currently foreseen that the rotating frames will be made in nickel based precipitation hardening superalloys. The two frames will be manufactured as weld assemblies in order to accomplish the future targets of light weight, cost efficient and reliable open rotor engines. Requirements for a safety critical component stipulate that effects of manufacturing processes are taken into account when the life and reliability of the component is stated. This requires quality control of the material and manufacturing process and complementary to this, a component lifing methodology.

Welding is a process that melts and alters the properties of the basic material form – usually forging or sheet metal. Current state of the art in understanding and predictive capability of effects on component level of weld joints is finite element based weld deformation modelling and residual stress.

For a safety critical component it is of highest importance to understand weld defect formation since the presence and character of defects must be known to predict life. Current methods developing, qualifying and characterizing welds are mainly experimentally based and requires a significant effort.

This CfP topic aims at understanding the metallurgical physics generating cracks during welding and subsequent heat treatment. This understanding should be formulated in predictive finite element based model(s) and crack criteria valid for at least three precipitation hardening superalloys. The anticipated approach is to combine weld/heat treatment simulation (thermo mechanical simulation) with fundamental weld metallurgical knowledge to derive crack criteria that can be used to predict material failure during both welding and heat treatment of complicated engine structures. Finally the model should be validated by welding two simplified demonstrator components incorporating 3D-weld geometries and mechanically constrained subcomponents in at least two superalloys or material states prior to welding.

Task 1: Management

Organisation:

– The partner shall nominate a team dedicated to the project and should inform CfP Topic manager about the name/names of this key staff. At minimum the responsibility of the following functions shall be clearly addressed: Programme (single point contact with Topic Manager), Engineering & Quality.

Time Schedule & Work package Description:

– The partner shall work to the agreed time-schedule (outlined in Part 3) 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 during negotiation based on the Partner's proposal.

Progress Reporting & Reviews:

– Monthly one-pager and 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 teleconference).

– 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 quarterly either by WEBEX orat Topic Manager's premises or at the partner's premises.

Task 2: Literature review and survey of weldability criteria for super alloys.

The first part of the project will be to thoroughly survey the scientific literature on existing weldability crack criteria and any combination of thermo mechanical weld/heat treatment simulation which have been coupled with fundamental material cracking behaviour. This review will serve as input to Task 3 below and should be reported and sent to Topic Manager for approval before proceeding to following task.

Task 3: Testing and microstructural investigation

Within Task 3, metallurgical testing and evaluation will be performed for 3 precipitation hardening superalloys of which one will be Alloy 718 and the two remaining decided by the topic manager at the start of the project. The topic manager will supply (sheet) material for weld testing. The tests will explore the chosen alloys' weldability using the following testing methods:

- Varestraint testing using TIG as baseline weld process (~40 specimen *2 materials - data for one material exists)
- Limited amount of Gleeble testing (or equivalent) to investigate warm cracking (15 tests for 3 materials)
- Differential scanning calorimetric testing (DSC)

Microstructural characterization using scanning electron microscope equipped with electron dispersive X-ray (SEM-EDX) equipment and light optical microscopy (LOM) should be performed on the above mentioned testing methods to build firm knowledge on material and cracking behaviour in welding and heat treatment of the specific alloy. The details of the test plan should be presented to the topic manager for approval before proceeding with manufacturing of test specimen and testing.

Task 4: Development of weld crack model and thermo mechanical simulation of Varestraint testing and Gleeble test

Based on the literature review in Task 2 and testing in Task 3, models and crack criteria for welding and heat treatment should be developed and made possible to incorporate as a subroutine in an existing finite element code (to be defined by the Topic manager). The model and software should be used to model the Varestraint and Gleeble tests performed in Task 3.

A suggestion of component geometry, weld procedure and test conditions for a demonstrator to validate the crack criteria should be made and communicated with the topic manager

Task 5: Validation of crack criteria

The demonstrator should be welded and heat treated in either two different superalloys or in two different material states (different solution heat treatment).

The demonstrator manufacturing process should be modelled with the FE-code and component deformation, residual stress and risk of cracking should be predicted both after welding and after heat treatment. The predicted results should be compared to properties measured during and after manufacturing of the demonstrator.

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

The CfP partner/consortium should have equipment or an available supply network for Varestraint, Gleeble and DSC testing.

The CfP partner/consortium should have equipment, or an available supply network, for manufacturing of test specimens used in Varestraint, Gleeble (or equivalent) and DSC tests.

The CfP partner/consortium should have significant experience from finite element based thermo mechanical weld simulation.

The CfP partner/consortium needs testing and analysis equipment for evaluating the material behaviour during the test campaigns, or an available supply network that can perform these trials. This includes e.g. heat treatments and metallographic work such as SEM-EDX and LOM.

Experience in performing applied collaborative industrial research in international environment is considered as essential.

3. Major deliverables and schedule 30 Months

Deliverable	Title	Description (if applicable)	Due date
D1	Detailed Project Plan.	Task 1: Schedule with milestones.	T0 + 1M
D2	Literature survey on superalloy weldability crack criteria	Task 2: Literature review and selection of type of criteria to develop.	T0 + 4M
D3	Test plan for weldcrack criteria development.	Task 3: Outline the test plan and await approval from Topic Manager. 1) Manufacture of specimens. 2) Perform testing.	T0 + 6M
D4	Test Report for Gleeble (or equivalent) testing	Task 3: Report including result of testing and post test microscopy.	T0+15
D5	Test Report for Varestraint testing	Task 3: Report including result of testing and post test microscopy.	T0+18
D6	First simulation of varestraint testing using a model for crack generation.	Task 4: Report of first simulation results of varestraint test with crack criteria for hot cracking. The report may be limited to one material.	T0 + 20M
D7	Proposed geometry and test conditions for validation	Task 4: The demonstrator component should be defined and in addition a test and analysis plan for the validation activity.	T0+20M
D8	Documentation of results from simulation of the different tests and materials conditions.	Task 4: The thermo mechanical simulation of Varestraint and Gleeble tests should be finalized. Crack criteria for hot and warm weld cracking should be incorporated.	T0 + 26M
D9	Documentation of results from validation of derived crack criteria.	Task 5: This report contains test results and analytical verification of the crack criteria.	T0+28M
D10	Final report summarizing all results and findings within this WP.	Task 6. A brief final report is requested that highlights the project findings and references all issued reports.	T0 + 30M

4. Topic value (€)

This topic value is a maximum gross value for the project.

Awards between 50% and 75% of this value may be made by the Clean Sky Joint Undertaking.

600,000 €
[Six hundred thousand euro]

5. Remarks

All documents are preferably written in English.

Clean Sky Joint Undertaking
SP1-JTI-CS-2012-03-SAGE-03-016

Topic Description

CfP topic number	Title		
JTI-CS-2012-3-SAGE-03-016	**Surface protection of composite aeroengine components to enable weight savings in high temperature applications (≥360°C)**	**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.
However the temperature capability of organic matrix composite materials and the need for protection from Foreign Object Damage and Erosion creates a boundary to further exploitation in turbofan engine applications. Protection systems are used in composites to attain the life cycle cost of the component by preventing degradation, water absorption and protecting from damage threats in-service. There are several protection systems available/well developed for low temperature applications. The main technological gap arises in applications that require high temperature capability materials in areas of the engine which are subject to aggressive environments. Current protection systems typically combine metals and low modulus materials in order to provide the required combination of cutting/deflection of FOD threats and providing protection to the underlying composite structure.
The durability of metallic leading edge joint and the erosion protection system in the high temperature environment is one of the main limitations on current high temperature applications. Developing and demonstrating surface protection systems with adequate joint Integrity and failure behaviour in order to minimise in service risk to downstream component is critical.
Application and repair of current surface protection systems is challenging and not cost effective, addressing the downfalls of application and repair methods is key to provide a high rate production solution for composite components.
The existing systems address very specific needs of FOD/erosion, however there are other threats to component integrity that may be improved by the surface protection system such as moisture ingress, heat/fire protection, environmental ageing.

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 objectives of the programme are to deliver either an integrated system or a combination of leading edge protection, FOD/erosion protection that meets the technical requirements for high temperature applications.
To demonstrate this technology the partner/consortium shall select a material system, demonstrate surface protection layer properties, define processing and joining parameters and with the Topic Manager input, design and manufacture test pieces for demonstration. In the following step the surface protection system performance, in terms of adhesion/erosion/FOD and environmental resistance/ageing 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: Selection and design of a surface protection system

• In this task the consortium will take the functional requirements described in the call and design a number of surface protection definitions and materials to meet those requirements.

• Limited tests on performance and application will be carried out to discriminate between the system designs and to downselect a preferred surface protection system.

• 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.

• Preliminary down-selection of surface protection system (LE and erosion coating arrangement versus single integrated system.)

Task 3: Determination of application characteristics and performance

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

• Perform sufficient application trials and 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 adhesion properties, erosion and impact behaviour of the surface protection 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, fire performance characterisation, UV stability of the surface protection 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 application and performance of the surface protection system in a critical failure mode.

• Design and 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 erosion and impact validation testing.

• Post failure sectioning, fractography/failure investigation and reporting.

Component demonstrator

• With the support of the Topic Manager, develop an application method for complex aerofoil-shape component demonstrator to enable validation of the material system for rate application.

• Design, manufacture or procure suitable tooling and bought-out parts for the surface protection application. Prove repeatability of surface protection application of components for visual, dimensional, destructive and non-destructive evaluation to meet the Topic Manager's drawing requirements and tolerances.

• Application of surface protection to representative aerofoil shaped components for rate application validation (twelve components will be provided by the Topic Manager.).

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

- Surface protection system development and application. Formulation development and processing and rate application would be an advantage.
- Extensive experience on understanding of composite component in-service requirements and validation/certification of new materials would be an advantage. 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 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	Surface protection specification characteristics	Determination of the material system characteristics to enable a specification to be written and the properties understood	T0+6M
D3.1	Application Specification	Processing variables and limits determined and robustness and quality validated	T0+9M
D3.2	Down-selection of surface protection system (single integrated system vs leading edge (LE) & coating)	Selection of surface protection system and application process	T0+9M
D3.3	Manufacture Test Panels	Test panels for mechanical and environmental testing specimens	T0+12M
D3.4	Mechanical/environmental 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 for application	Tooling ready for prove of application	T0+12M
D4.4	Application demonstrator and quality assurance	Coating application 12x	T0+23M

4. Topic value (€)

This topic value is a maximum gross value for the project.
Awards between 50% and 75% of this value may be made by the Clean Sky Joint Undertaking.

750,000 €

[Seven hundred and fifty thousand euro]

5. Remarks

A detailed work plan and time schedule is being expected. A profound financial plan must be attached as well. The applicant must fulfil the above mentioned requirements.

Clean Sky Joint Undertaking
SP1-JTI-CS-2012-03-SAGE-03-017

Topic Description

CfP topic number	Title		
JTI-CS-2012-3-SAGE-03-017	**Electric Pump for Safety Critical Aero engine applications**	**Start date**	Jan 2013
		End date	Dec 2014

1. Topic Description

The SAGE3 project aims at development and demonstration of a large 3-shaft bypass engine Demonstrator. RTD activities are foreseen on developing a electrically driven pumps to replace traditional mechanically driven variants in engine externals. The objective of the work package is to develop this technology and demonstrate to Technology Readiness Level (TRL)6.

Pumping applications can include fuel, oil and other fluidic substances depending on the engine application. For the purposes of exploring the viability of electric pumping solutions, the oil system is chosen as the candidate fluid for this demonstration.

It would be advantageous for the partner to consider how the unit could be designed to operate in various locations within the engine, eg. Core or fancase mounted with the associated implications in vibration and temperature environment.

The Partner should read this topic thoroughly and when preparing a proposal take particular notice of section 5 of this document - Remarks

The Partner shall in particular perform the following tasks:

Task 1 Design and analysis of electrically driven oil pump

The partner will work with the Topic Manager to agree a target specification against which to work. An outline of typical characteristics is included later in this section. Against this specification, the Partner will conduct the appropriate mechanical, electrical and electronic concept and detail design of both feed and scavenge elements of an oil pump suitable for deployment in a safety critical application within a large civil engine environment.

The Partner is expected to recommend new and novel pump configurations and will preferably demonstrate how the pump, associated electric motor and motor drive will interface to an Electronic Engine Controller. Whilst initial investigations into this technology have considered mechanically ganged multi-element gerotor based pumps driven through permanent magent electrical motors, the partner will be expected to consider alternative solutions for each technology area. Strategies to ensure the correct syncronisation between individual pumping elements (eg. Between feed and scavenge in the oil application) should also be addressed

The Partner will provide a detailed verification proposal for the new pump. The solution should be demonstrated to TRL6 (i.e. in an environment representative of an engine installation) and proposals should include a technology validation plan to show how this requirement will be met. If it is expected that the SAGE Members will contribute to the delivery of this plan then this should be highlighted.

Any material testing or manufacturing trials required to validate the design choices shall be carried out and reported by the Partner to the Topic Manager.

Task 2: Electrically driven pump manufacturing and assembly

The Partner will procure all materials and fittings and manufacture all material, test parts and components for rig testing necessary to support validation of the pump and support design and manufacturing technology.

It is expected that demonstration of the electrically driven pump technology will necessitate its' integration into a representative system demonstration or engine test. If it is agreed between the Partner and Topic Manager that such testing is required as part of the technology validation plan then

the Partner will also be required to provide a number of additional parts for this testing. Proposals should indicate how this will be supported and identify specific features requiring this level of validation.

Task 3: Electrically driven pump validation support

The partner will conduct and report on all testing as necessary to ensure that the unit meets the specification requirements as appropriate to demonstrate compliance to engine environemt TRL6.

If it is agreed that system demonstration or engine testing is required then the Partner shall support that testing through the preparation, test and appraisal phases. During any test facility build it is envisaged that on-site support will be required but on-call support would be acceptable during any testing that might be agreed. The Partner will supply all instrumentation necessary to validate the pump, motor and drive and components will be supplied already instrumented whenever possible.

Typical Electric oil pump operating environment

Temperature

The unit should be capable of operation in a typical ambient environment of -55ºC to 200ºC.

Vibration

Consideration should be made of how the unit might operate within the vibration spectrum of a typical large aero engine.

Compatible Fluids

The pump will be designed to operate on a range of engine oils, demonstrated to have acceptable characteristics under engine operating conditions. The pump shall be capable of using and compatible with oil conforming to SAE AS5780 HPC and also be compatible with all oil brands qualified to MIL PRF-23699 F.

Oil Pumping

The Oil Pump assembly provides a flow of oil to the Engine components for cooling and lubrication with typical flow rates, temperatures and pressures as shown in the following table:

Typical Feed Element Parameters		MHD MTO Nominal Requirement	ISA MTO Nominal Requirement
Inlet conditions			
Inlet temperature	ºC	172	152
Inlet Pressure	psia	25	26
Flows			
Pump flow at Pump inlet temperature	IGPH	1864	1801
Pump Discharge pressure (max)	psia	332	360

MHD – Maximum Hot Day; ISA – International Standard Atmosphere; MTO – Maximum Take Off; IGPH – Imperial Gallons per Hour

Sumps to be scavenged

The Oil Pump assembly provides a means of scavenging oil mixed with entrained air from multiple locations with typical characteristics as shown in the following table:

Typical Scavenge Element Parameters			MHD MTO Nominal Requirement	ISA MTO Nominal Requirement
Inlet temperature	ºC	Chamber #1	154	136
		Chamber #2	230	222
		Chamber #3	182	163
		Chamber #4	182	165
		Chamber #5	148	127
		Chamber #6	142	110
		Chamber #7	124	96
		Chamber #8	154	132
		Chamber #9	205	193
Nominal Scavenge Flow	lGPH	Chamber #1	414	408
		Chamber #2	529	494
		Chamber #3	145	135
		Chamber #4	112	103
		Chamber #5	73	70
		Chamber #6	140	140
		Chamber #7	92	92
		Chamber #8	110	110
		Chamber #9	443	506
Nominal Volumetric Air/Oil Ratio		Chamber #1	3	3
		Chamber #2	4	4
		Chamber #3	4	4
		Chamber #4	4	4
		Chamber #5	7.5	7.5
		Chamber #6	2.5	2.5
		Chamber #7	2.5	2.5
		Chamber #8	3	3
		Chamber #9	1.8	1.8
Nominal Total Volumetric Flow	lGPH	Chamber #1	1654	1631
		Chamber #2	2646	2470
		Chamber #3	723	674
		Chamber #4	559	515
		Chamber #5	621	592
		Chamber #6	490	490
		Chamber #7	322	322
		Chamber #8	440	440
		Chamber #9	1241	1416
Pump Inlet Pressure	psia	Chamber #1	21	21
		Chamber #2	127	152
		Chamber #3	127	152
		Chamber #4	127	152
		Chamber #5	48	56
		Chamber #6	20	22
		Chamber #7	20	22
		Chamber #8	20	22
		Chamber #9	20	22
Pump Discharge Pressure	psia	Chamber #1	48	50
		Chamber #2	48	50
		Chamber #3	48	50
		Chamber #4	48	50
		Chamber #5	48	50
		Chamber #6	48	50
		Chamber #7	48	50
		Chamber #8	48	50
		Chamber #9	48	50

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

Extensive experience in the detail design, development, manufacture and validation of electric drives and pumping technologies. In-service operation of aerospace applications would be advantageous. 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 parts is an asset. Availability of technologies at an high technology readiness level to minimise programme risks is an asset.

Experience in R&T and R&D programs. Experience of aerospace related research programs would be an advantage.

The Partner needs to be in the position to have access to the manufacturing facilities suitable for making an agreed set of equipment suitable for system integration or engine test if required.

The Partner needs to have access to rig test facilities for vibration & thermal endurance testing.

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
D1.1	Electric oil pump launch and concept review	Participate in launch review for project	January 2013
D1.2	Electric oil pump technical specification	Agreed specification against which to continue project	March 2013
D2.1	Electric oil pump Prelim Design Review		June 2013
D2.2	Electric oil pump Critical Design Review		Dec 2013
D3.1	Launch manufacture of tech demo hardware for validation testing		Jan 2014
D3.2	Deliver validation hardware		May 2014
D3.2	Validation testing		During 2014
D4.1	End of validation testing report issued		Dec 2014

4. Topic value (€)

This topic value is a maximum gross value for the project.

Awards between 50% and 75% of this value may be made by the Clean Sky Joint Undertaking. Note that VAT is not an eligible cost in the context of this RTD activity.

1,750,000€
[One million seven hundred and fifty thousand euro]

5. Remarks

Content of the proposal (including these items will significantly enhance the proposal)

1. A clear and precise budget breakdown should be provided, outlining spend in all areas of the programme (human resource, outsourcing, materials, capital spend, etc.)
2. A detailed Risk Assessment – key programme, technology, material, manufacturing and budget risks.
3. Detailed design and make plan with decision gates and contingency loops. The plan must include a clear material and feature selection process.
4. The proposal must include details of material supplier agreements. Lead times for material delivery, quantities, costs, contingencies, etc. should be indicated.
5. The proposal should include ROM estimates for unit cost and weight.
6. Verification of successful manufacture. Requirement to demonstrate in proposal how the Partner would ensure a unit is acceptable for useage within the engine conditions listed.
7. The partner should identify key certification drivers from appropriate regulatory bodies (eg. EASA CS-E) and show how compliance with those requirements will be demonstrated
8. Partner to suggest any parts of the manufacture process that could be improved / automated for main line unit delivery.
9. Partner to suggest how the technology under development could be applied to other market sector, and also how existing technology developments from other market sectors could be usefully adapted to meet the specific needs of this opportunity.

Clean Sky Joint Undertaking
SP1-JTI-CS-2012-03-SAGE-03-018

Topic Description

CfP topic number	Title		
JTI-CS-2012-3-SAGE-03-018	**Variable fluid metering unit for Aero engine applications**	**Start date**	Jan 2013
		End date	Dec 2014

1. Topic Description

The SAGE3 project aims at development and demonstration of a large 3-shaft bypass engine Demonstrator. RTD activities are foreseen on developing an electrically driven solution to replace traditional mechanically driven variants of engine externals. Part of this implementation is likely to include a variable metering unit to control fluid delivery into specific areas of the engine. The objective of the work package is to develop this technology and demonstrate to Technology Readiness Level (TRL)6.

Media typical of requiring this functionality can include fuel, oil and other fluidic substances depending on the engine application. For the purposes of exploring the viability of varaible metering solutions, engine oil is chosen as the candidate fluid for this demonstration.

It would be advantageous for the partner to consider how the unit could be designed to operate in various locations within the engine, eg. Core or fancase mounted with the associated implications in vibration and temperature environment.

The Partner should read this topic thoroughly and when preparing a proposal take particular notice of section 5 of this document - Remarks

The Partner shall in particular perform the following tasks:

Task 1 Design and analysis of variable metering unit

The partner will work with the Topic Manager to agree a target specification against which to work. An outline of typical characteristics is included later in this section. Against this specification, the Partner will conduct the appropriate mechanical, electrical and electronic concept and detail design as appropriate for a variable oil metering unit suitable for controlling the delivery of oil into individual regions of a large civil engine.

The Partner is expected to recommend new and novel configurations and will preferably demonstrate how the unit along with any associated drive components will interface to an Electronic Engine Controller. Whilst initial investigations into this technology have considered electro-hydraulic servo valve based configurations as a potential solution, the partner will be expected to consider alternative solutions for this technology.

The Partner will provide a detailed verification proposal for the new unit. The solution should be demonstrated to TRL6 (i.e. in an environment representative of an engine installation) and proposals should include a technology validation plan to show how this requirement will be met. If it is expected that the SAGE Members will contribute to the delivery of this plan then this should be highlighted.

Any material testing or manufacturing trials required to validate the design choices shall be carried out and reported by the Partner to the Topic Manager.

Task 2: Variable Metering unit manufacturing and assembly

The Partner will procure all materials and fittings and manufacture all material, test parts and components for rig testing necessary to support validation of the metering unit and support design and manufacturing technology.

It is expected that demonstration of the variable metering unit technology will necessitate its'

integration into a representative system demonstration or engine test. If it is agreed between the Partner and Topic Manager that such testing is required as part of the technology validation plan then the Partner will also be required to provide a number of additional parts for this testing. Proposals should indicate how this will be supported and identify specific features requiring this validation.

Task 3: Variable Metering unit validation support

The partner will conduct and report on all testing as necessary to ensure that the unit meets the specification requirements as appropriate to demonstrate compliance to engine environemt TRL6.

If it is agreed that system demonstration or engine testing is required then the Partner shall support that testing through the preparation, test and appraisal phases. During any test facility build it is envisaged that on-site support will be required but on-call support would be acceptable during any testing that might be agreed. The Partner will supply all instrumentation necessary to validate the pump, motor and drive and components will be supplied already instrumented whenever possible.

Typical Variable Metering Unit operating environment

Temperature

The unit should be capable of operation in a typical ambient environment of -55ºC to 200ºC.

Vibration

Consideration should be made of how the unit might operate within the vibration spectrum of a typical large aero engine.

Oil Metering

The variable metering unit controls a flow of oil to the Engine components for cooling and lubrication with typical flow rates, temperatures and pressures included in the following table:

Typical Metering Flow Parameters			MHD MTO Nominal Requirement	ISA MTO Nominal Requirement
Inlet conditions				
Inlet temperature		ºC	172	152
Inlet Pressure (max)		psia	332	360
Nominal Metered Flow	IGPH	Chamber #1	414	408
		Chamber #2	529	494
		Chamber #3	145	135
		Chamber #4	112	103
		Chamber #5	73	70
		Chamber #6	140	140
		Chamber #7	92	92
		Chamber #8	110	110
		Chamber #9	443	506

Compatible Fluids

The pump will be designed to operate on a range of engine oils, demonstrated to have acceptable characteristics under engine operating conditions. The pump shall be capable of using and compatible with oil conforming to SAE AS5780 HPC and also be compatible with all oil brands qualified to MIL PRF-23699 F.

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

Extensive experience in the detail design, development, manufacture and validation of electric drives and pumping technologies. In-service operation of aerospace applications would be advantageous. 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 parts is an asset. Availability of technologies at an high technology readiness level to minimise programme risks is an asset.

Experience in R&T and R&D programs. Experience of aerospace related research programs would be an advantage.

The Partner needs to be in the position to have access to the manufacturing facilities suitable for making an agreed set of equipment suitable for system integration or engine test if required.

The Partner needs to have access to rig test facilities for vibration & thermal endurance testing.

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
D1.1	Variable Metering Unit launch and concept review	Participate in launch review for project	January 2013
D1.2	Variable Metering Unit technical specification	Agreed specification against which to continue project	March 2013
D2.1	Variable Metering Unit Prelim Design Review		June 2013
D2.2	Variable Metering Unit Critical Design Review		Dec 2013
D3.1	Launch manufacture of tech demo hardware for validation testing		Jan 2014
D3.2	Deliver validation hardware		May 2014
D3.2	Validation testing		During 2014
D4.1	End of validation testing report issued		Dec 2014

4. Topic value (€)

This topic value is a maximum gross value for the project.
Awards between 50% and 75% of this value may be made by the Clean Sky Joint Undertaking. Note that VAT is not an eligible cost in the context of this RTD activity.

750,000€
[Seven hundred and fifty thousand euro]

5. Remarks

Content of the proposal (including these items will significantly enhance the proposal)

- A clear and precise budget breakdown should be provided, outlining spend in all areas of the programme (human resource, outsourcing, materials, capital spend, etc.)
- A detailed Risk Assessment – key programme, technology, material, manufacturing and budget risks.
- Detailed design and make plan with decision gates and contingency loops. The plan must include a clear material and feature selection process.
- The proposal must include details of material supplier agreements. Lead times for material delivery, quantities, costs, contingencies, etc. should be indicated.
- The proposal should include ROM estimates for unit cost and weight.
- Verification of successful manufacture. Requirement to demonstrate in proposal how the Partner would ensure a unit is acceptable for useage within the engine conditions listed.
- The partner should identify key certification drivers from appropriate regulatory bodies (eg. EASA CS-E) and show how compliance with those requirements will be demonstrated
- Partner to suggest any parts of the manufacture process that could be improved / automated for main line unit delivery.
- Partner to suggest how the technology under development could be applied to other market sector, and also how existing technology developments from other market sectors could be usefully adapted to meet the specific needs of this opportunity.

Clean Sky Joint Undertaking
SP1-JTI-CS-2012-03-SAGE-03-019

Topic Description

CfP topic number	Title		
JTI-CS-2012-3-SAGE-03-019	**Development of materials, processes, and means to enable the application of piezoelectric materials in aero engine controls.**	**Start date**	T0
		End date	T0 + 24 M

1. Topic Description

SAGE3 project aims at development and demonstration of a large 3-shaft bypass engine Demonstrator and technologies associated with future developments of this architecture. RTD activities are foreseen on developing electronic systems and sensors for application in the more aggressive environments of these future engines. The objective of this work package is to develop the packaging and protection technology that will enable these applications and demonstrate to Technology Readiness Level (TRL)6.

Novel engine configurations will require new sensing and control functions, and will also require present sensing and control functions to operate to more demanding performance and accuracy levels in harsher environments, whilst achieving significantly improved reliability and longer lives on wing. In order to achieve these benefits, and implement novel engine configurations capable of fully realising these benefits, it will be necessary to employ radically different engine control technologies.

Piezoelectric technology has been identified as a potentially key technology in the implementation of several different areas of functionality in engine controls. Full exploitation of engine level benefits from these novel controls will depend, though, on piezoelectric components being developed that are robust to these hostile, fluid wetted (and even fully immersed) environments.

This topic will develop and demonstrate the materials, encapsulation methods and manufacturing processes necessary to fully implement these piezoelectric sensing and control technologies in next generation green engines. The objective is to demonstrate robust operation of the devices under a full range of arduous operating environments and proposals to deliver this objective may focus on piezoelectric device development, packaging development or a combination.

The partner shall in particular perform the following tasks:

Task 1: Review and specification of appropriate controls functional, performance, and environmental requirements

Future engines controls functionality, performance, and environments will be reviewed and specific piezoelectric device requirements will be defined. Particular emphasis will be placed on the form of the devices, minimum performance requirements, and most extreme environmental requirements, including heat soakback, altitude descent, and thermal shock on go around.

Task 2: Materials and processes identification, development, and laboratory demonstrations

The devices identified in task 1 will require means to protect the active materials involved to ensure adequate functionality and performance are maintained throughout the operational envelope (including all extreme and emergency operating conditions) throughout the release life of the control systems.

This task covers identification of potential means to effect this protection, development of the active and protective materials involved and appropriate manufacturing and encapsulation processes.

This task also covers laboratory scale manufacturing of test pieces, and laboratory scale functional, performance, and preliminary environmental testing. These test pieces will be thoroughly examined post testing to determine the effectiveness of the protection afforded the active materials. The purpose of this testing and examination is to demonstrate the solutions identified are sufficientlly robust and practical to merit progression to task 3.

The materials and the test pieces manufactured will have to demonstrate compliance with typical engine environments expected on a SAGE future engine. Although this will vary from engine to engine, temperatures of the order of -56^{o}C to greater than +200^{o}C on soakback on the core can be expected.

Finally sufficient test pieces will be manufactured and supplied to task 3.

Task 3: Accelerated and sustained environmental testing

Active materials are inherently relatively robust compared to most other device technologies, but still have a number of potential failure modes. The specific active materials and devices selected in tasks 1 and 2 will be examined for potential failure modes in the applications, forms, and environments identified in task 1. It is expected that the devices will be subject to vibration, a range of steady state temperatures, thermal shock and exposure to contaminants such as fuel, oil and hydraulic fluid. Proposals may include further test proposals and potential combinations of conditions.

A robust environmental test programme will be defined and executed to expose any weaknesses inherent in the selected materials, manufacturing processes, and form of the identified devices over the full range of functional and performance testing. It is anticipated that this testing will feature both accelerated testing techniques where appropriate, and sustained environmental testing as necessary.

Where appropriate, some test pieces may be tested to destruction.

Task 4: Post environmental testing functional, performance, non-destructive testing, and destructive test assessments.

Active materials may suffer from deteriation at the molecular level, in addition to gross macroscopic effects.

After the particularly harsh test environment of task 3, all surviving test pieces will be subjected to functional and performance testing to map any deterioration that has occurred over the period of the testing.

After functional and performance testing, the test pieces will be microscopically examined. It is anticipated that this examination will initially be non-destructive. Subsequently test pieces will be microscopically examined to investigate any deterioration and contamination that has penetrated the test pieces, and may effect the materials at a molecular level.

Task 5: Exploitation Plan

Following completion of the above tasks, a plan will be generated showing the intended application of specific demonstrated environmentally robust piezoelectric devices and technologies to specific engine control functions to achieve the benefits of the Clean Sky programme. Establlishing this linkage is considered critical to the success of the programme.

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

A strong aerospace background is considered essential in order to correctly identify appropriate functional, performance, and environmental applications and requirements.

It is recognised that the manufacture of piezoelectric devices , electrical attach means, and environemntal protection technologies, require specialist skills and pedigree, and manufacturing and process equipment.

It is also recognised that very specialist materials groups and research institutions possess bodies of background experience and knowledge that will be particularly relevant to the execution of this programme of work.

Specific groups have also developed very specialist test technologies that may enable high value testing to be carried out in relatively short periods of time.

Clearly a range of environmental test facilities will be required, and specialist metrology may be required to accurately quantify performance and material degradation.

The partners need to demonstrate access to the full range of design, manufacturing, process, test, and analysis facilities required to meet the above goals.

The activity will be managed with a Phase & Gate approach and a management plan has to be provided.

3. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Requirements Specification	Specification of appropriate piezo devices functional, performance, and environmental requirements.	Month 3
D2	Test pieces and laboratory test results.	Test pieces will be designed, manufactured, and tested under laboratory conditions.	Month 12
D3	Environmental test results.	Full reports of the environmental testing, including functional and performance test results at conclusion of testing.	Month 21

D4	Results of microscopic analysis.	Detailed description and analysis of the condition of the test pieces after environmental test, specifically detailing the scope of production applicability.	Month 22
D5	Exploitation Plan	A plan giving specific detail on future application of fully environmentally robust piezoelectric devices in aero engine fuel systems.	Month 24
D4.1			

4. Topic value (€)

This topic value is a maximum gross value for the project.
Awards between 50% and 75% of this value may be made by the Clean Sky Joint Undertaking. Note that VAT is not an eligible cost in the context of this RTD activity.

1,500,000€

[One million five hundred thousand euro]

Clean Sky Joint Undertaking
SP1-JTI-CS-2012-03-SAGE-03-020

Topic Description

CfP topic number	Title		
JTI-CS-2012-3-SAGE-03-020	**Net shape Hot Isostatic Pressing of IN718**	**Start date**	*T0*
		End date	*T0+24M*

1. Topic Description

The objective of this call for proposal is to develop and validate a Powder Metallurgy based route allowing the manufacture of static IN718 parts per Net Shape Hot Isostatic Pressing, which results in substantial improvements in terms of material usage i.e. decrease of the buy-to-fly ratio with respect to current conventional route consisting of Melting + Forging. The activities within the project shall thus, assess the technical feasibility and economic potential of this technology under the assumption that the resulting metallurgical condition shall be equivalent in terms of mechanical capability to that achieved on forged IN718.

Current Melting+forging route is characterized by delivering buy-to-fly ratios typically in the range 2 to 10. The large amount of raw material being initially procured, albeit not used in the final component, has a twofold effect. On one hand, it scales up the requirements of raw material and energy *per-se, this being the first contribution to component cost*. Additionally, it increases manufacturing costs for the final part, as a considerable part of it is devoted to machining out the previously procured material.

The HIP-ping route is a technology capable of producing net-shape components. As such, it potentially allows significant reductions in terms of input material which can result in both reduction environmental footprint and cost.

The technical and economic feasibility of Net shape Hot Isostatic Pressing of IN718 requires however, to overcome a requirement which relates to can design and manufacture. For the HIP-ping route to be a suitable and feasible technology with IN718, there is a need to develop a HIP route and to undertake the optimization of canning technologies. In this regards, novel additive technologies such as SMD, SLM, SLD or similar ones, might bring new opportunities for can&product optimization as these allow the generation of complex geometries further allowing material optimizations.

This proposal covers two complementary aspects. On one hand, it deals with topics from a Manufacturing standpoint. On the other, it also addresses activities oriented to demonstrate an outcome based equivalence of the Hipping technology with the current one; i.e. materials mechanical capability and NDT. The combined effort shall result in a sound knowledge about the manufacturing process window, its effect upon the resulting material structure. This will allow a back-to-back comparison be drawn with current standard; i.e.casting+forging route.

This coupled effort (manufacturing+engineering) shall be completed with the development of modelling capabilities so that the results obtained herein can be extended to virtually any IN718 forged components.

With regards to the intended degree of maturity achieved by this Project; both, in terms of Manufacturing Capability Readiness Level and the Technology Readiness Level 5 these should be compatible with 6 and 5 respectively.

Find it hereby a breakdown of activities within the project:

- Development of a Sinter/HIP route
- Development of rules for can design (rheology and consolidation)
- Component design (with canning) and Manufacture
- Assessment of the resulting
  - Geometry
  - NDT
  - Metallurgical condition and Mechanical Properties

- Assesment of the machinability of the product
- Overall assessment of the technical and economic feasibility of this new route

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

- The applicant shall have a sound background on powder metallurgy, preferably with superalloys. It shall bring to the consortium its internal expertise together with the capability of integrating the relevant supply chain within the project i.e. from powder up to component manufacture (powder, can, hipping, machining, NDT and mechanical testing). The robustness of the partnership shall to this end, be very much appreciated.
- The applicant shall have or bring to the project the capability to develop and assess the resulting material condition and mechanical capability of the net-to-shape HIP route. This effort shall target at developing a manufacturing process capable to manufacture real components with a substantial benefit in terms of material usage. This activity will require launching specific trials (Design Of Experiments) on representative shapes for their metallurgical + mechanical validation.
- The applicant shall have or bring to the project the basic theoretical, experimental and preferably modelling capability to incorporate the effect of powder rheology, HIP densification in support of optimized can design.
- The applicant shall have or bring to the project the capability to manufacture optimized canning systems. Although conventional technologies could be used, novel additive technologies (SMD, SLM, SLD) or any other allowing the manufacture of 3D complex shapes will be preferred given their potential for product optimization.
- The applicant shall have or have access to laboratory testing facilities necessary for assessing the metallurgical condition and mechanical behaviour on IN718 HIP-ped products. At the later stages of the project, whereas full scale components will be manufactured, the usage of NADCAP approved Labs. will be rq´d. Note the later will typically involve conducting material tests such as tensile, low cycle fatigue, crack propagation, fracture toughness, stress rupture and creep strain among others.

3. Task Description, and main deliverables and schedule

Expected Full duration of the project: 24 Months
Work Package (WP) Description and Deliverables (if applicable)

Work Package 1: Management.

Duration: **24 months**

Organisation:

- The partner shall nominate a team dedicated to the project and should inform the project manager about the name/names of the key staff. At least the responsible persons for following functions shall be identified; Program (single point of contact with the Topic Manager), Technical and Quality

Time Schedule and Planning:

- The partner shall be 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 and reviews:

- Monthly progress reports in writing shall be provided by the partner, referring to all agreed Work Package, technical achievement, time schedule, potential risks and proposal for risk mitigation
- Regular coordination meetings shall be setup (preferably via telecom of through web link)
- 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's site / facilities

Work Package 2: Current Limits of technology, Selection of Suitable Components within and definition of activities oriented to their challenge

Duration: **2 months**

This Work Package shall focus on the compilation of the requirements from the OEM. These will involve geometrical aspects for the final components as well as target material usage and mechanical properties for the HIP-ped product. It is to be highlighted the target mechanical properties within the HIP-ped component shall be comparable with those achieved currently per forging of IN718.

Together with the specific needs, this WP shall highlight the current limits of the HIP-ping technology so that_activities within Work Packages 3 to 5 are defined to challenge them. Finally this WP shall define the total number and type of components investigated and the amount of development and validation work with each of them within the limits of the existing budget.

Work Package 3: Development of a Sinter/Hip Route.

Duration: **24 months**

This Work Package will deliver an optimum Sinter/Hip process window. This shall focus primarily on the effect of powder atomization and chemistry but also in the interactions with can design per WP4. Within this Work Package Lab.Scale Sinter/Hip trials will be conducted and the resulting product be assessed with a view on density, metallurgical condition and preliminary assessment of the material mechanical capability. With regards to the chemistry of the powder used within this WP, formulations within the requirements of regular IN718 will be the first choice.

A joint effort with WP 4 will study the interactions with the canning system. For this some trials might be needed with specific canning configurations as developed within WP 4. WP 3 will focus on the identification of a process window delivering a sound matl. structure; i.e. dense with adequate microstructure and reasonable mechanical properties.

The information generated within this WP will additionally feed the requirements for Powder Manufacture (chemistry and characteristics of the powder).

Finally, machining trials shall be conducted to assess the machinability of the densified IN718 product in comparison with forging IN718

Activities within this WP; in particular, with regards to Powder Manufacture the Sinter/Hip conditions etc. shall be reviewed in the light of the capability of the Supply Chain within Work Package 5.

Task 4; Can design and manufacture* allowing optimized material usage

Duration: **21 months**

This Task shall define design rules and manufacturing technologies for optimum can design for the components defined in WP2. Efforts shall also be devoted to challenge the limits highlighted therein. For this, the feasibility of novel additive technologies (SMD, SLM, SLD or any other) will be considered.

Rheological considerations together with experimental work in conjunction with the activities within WP 3 will drive the generation of modelling capabilities for can design. Sinter Hip trials at subcomponent level might be needed within WP3 to validate modelling capabilities. Modelling Activities within WP 4 will target at the Canning-Hipping interaction.

The development of the optimum can system shall bear among others the following criteria:

- Availability and cost of material; from its raw form to the final can
- Suitability with the manufacture of the canning system; conventional vs. novel
- Functional suitability for the can; transfer of loads, ability to be sealed off, weldability, others
- Chemical compatibility with IN718; i.e. avoiding cross contamination
- Machinability (similar to IN718) should the can be removed or capability to be reused

Activities within this WP; in particular, with regards to Can Design and Manufacture etc. shall be continuously bought off in the light of the capability of the Supply Chain within Work Package 5.

Task 5 Component Manufacture and preliminary validation of technology

Duration: **18 months**

This Task will integrate the technologies developed within WP Nos. 3 and 4 up to the point of manufacturing components, conducting the relevant machining and NDT inspections as well as conducting the cutup with the metallurgical and mechanical assessment with them.

This activity should bring a balanced effort between the total number of components investigated and the amount of manufacturing development effort and validation work within the budget premises as defined in WP 2. The validation work at component level shall be conducted on NADCAP approved Labs. Validation 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, stress rupture, creep strain etc.

4. Topic value (€)

The total value of this project shall not exceed

€ 1,650,000

[One million six hundred fifty thousand euro]

This budget shall cover technology developments both in terms of SINTER/HIP as well as Canning. It shall also include manufacturing development efforts from powder to canning and component manufacture (HIP+Machining+NDT inspection).
Finally, a reasonable amount of effort shall be devoted to material testing and metallurgical validation of the manufactured hardware. Approx. figures for the latter amount to circa 300,000€.

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

5. Deliverables

WP	Activity	Deliverable	Title	Due Date
1	Management	1.-	Management Meetings and Proggress Meetings	T0+1M
2	Define requirements and target components	2.-	Definition of Current Limits of technology Selection of Suitable Components; definition of the process/product development plan and validation requirements	T0+2M
3	Definition of a Sinter/HIP route	3.1.-	Development of a Sinter/Hip Route. (Iteration 1)	T0+9M
		3.1.-	Machinability of the product	T0+12M
		3.2.-	Development of a Sinter/Hip Route. (Iteration 2)	T0+21M
4	Technology Development; can design and manufacture allowing optimized material usage	4.1.-	Rules for Can design per the selected manufacturing method (Iteration 1)	T0+12M
		4.2.-	Rules for Can design per the selected manufacturing method (Iteration 2)	T0+22M
5	Component Manufacture and validation of technology	5.1.-	Powder Manufacture	T0+12M
		5.2.-	Can Design&Manufacture	T0+15M
		5.3.-	Sinter/HIP trials	T0+18M
		5.4.-	NDT inspection	T0+19M
		5.5.-	Machining Trials	T0+19M
		5.6.-	Results of the Cutup; metallurgical and mechanical testing	T0+24M

Clean Sky Joint Undertaking
SP1-JTI-CS-2012-03-SAGE-06-001

Topic Description

CfP topic number	Title		
JTI-CS-2012-3-SAGE-06-001	**Advanced materials for lean burn combustion system components using Laser- Additive Layer Manufacturing (L-ALM)**	**Start date**	T0
		End date	T0 + 18months

1. Topic Description

SAGE6 project aims at development and demonstration of a Lean Burn Combustion System in support of the ACARE 2020 goals and Flightpath 2050. RTD activities are required to develop economic manufacturing methods for the novel combustion components, foreseen as required for realisation of lean burn engines.

Using European 'best-of breed' laser- Additive Layer Manufacturing (L-ALM) equipment, the objective of the work package is to develop process parameters, necessary machine settings and heat treatments to produce nickel superalloy material from L-ALM suitable for high temperature applications to Technology Readiness Level (TRL) 6- "technology demonstrator- prototype demonstration in a relevent environment".

Laser Additive Layer Manufacturing of combustion components is being demonstrated at TRL4, and demonstrated the technical capable of forming the required complex geometries. The supply of rig and engine test components in 'easy to weld'- alloys has become commonplace. There remains however the need to process the most advanced ('unweldable') nickel superalloys (with high levels of gamma-prime hardening elements) in the geometries of lean burn combustion components.

C1023, CM247LC and similar advanced alloys have be L-ALM processed and a good microstructure reported after post processing, however mechanical properties are as-yet unknown for fully heat treated material. The capability to produce the desired geometries in these advanced materials remains undemonstrated to Technology Readiness Level (TRL) 6- "technology demonstrator-prototype demonstration in a relevent environment".

A leading supplier of nickel superalloy components for combustion parts is required.

The Partner shall in particular perform the following tasks:

Task 1- Management

Organisation:

The Partner shall nominate a team dedicated to the project and inform Topic Manager project manager about the name/names of this key staff. There shall be a project manager who is the single point contact with Topic Manager.

Time Schedule & Work-package Description:

The Partner shall work to an agreed time-schedule & work-package description, being that laid out here, further detailed as required and agreed with Topic Manager 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 achievements, time schedules, potential risks and proposals for risk mitigation.

Regular coordination meetings shall be conducted via telecom or at locations of Topic Manager choosing with the Partner providing reasonable visibility on its activities and an adequate level of information.

The activities will be managed with a Phase & Gate approach. Topic Manager will approve gates and authorise progress to subsequent phases.

The Partner shall submit a final report to Topic Manager (Task 6) summarising the achievements, futher requirements (if any) and articulating a route to commercial access thereby enabling widespread manufacturing using of the capabilities developed here

Task 2 Reporting on the State of the Art and recommendations

The Partner shall study the relevent literature and report to Topic Manager on the state of the art and its own capabilities. The Partner will recommend new and novel process methodologies for L-ALM processing and heat treating a suitable candidate nickel superalloy of interest.

Task 3 Scoping of process development experiments

Materials will be down-selected from the candidate materials based on performance and ease of processing. A materials development program will be documented by the Partner and agreed with Topic Manager including a representative combustion component geometry with defined accuracy and surface finish requirements.

A procurement plan for the variance trials of the developed process shall be agreed upon for the necessasary materials and resource access to enable variance trials to be performed in a timely manner.

This development will address the mechanical properties required for the combustion component applications (typically equivalent to cast) in the down selected material.

Task 4 Materials development experimentation

The partner shall dilligently execute the materials development program agreed at Task 3, reporting regularly to Rolls Royce. Analysis of the materials data generated will be carried out by the Partner.

Processes yielding adequate mechanical properties will be tested to ensure that they are also suitable for building the representative combustion component geometry (crack-free) to the accuracy and surface finish requirements agreed in Task 2.

If problems persist an alternative material or geometry may be selected.

This task completes once a process capable of building the selected material, the selected geometry and achieving the required mechanical properties has been demonstrated.

Task 5 Variance trials

The Partner shall take the process output from Task 4 and test for stability and repeatability to TRL-level 6. Tests will be performed within batch (across the build plate), through powder recycling/reuse and across machines.

Task 6 Reporting, cost modelling and recommendations

The Partner shall prepare a report for Topic Manager on the materials development and include a cost model for early stage production and recommendations for both materials improvements and cost reduction.

This report shall summarise the achievements, futher requirements (if any) and articulate a route to commercial access thereby enabling widespread manufacturing using of the capabilities developed here.

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

Suitably qualified experts in L-ALM of nickel alloys and extensive experience in process development, process validation and manufacture of nickel superalloy aeroengine parts.

Experience in managing R&T and R&D programs in cooperation with Rolls Royce; in particular experience of working with and reporting to Topic Manager materials experts.

The relevent environment to perform the development work and demonstrate the deliverables. This should include the necessary best of breed L-ALM equipment and supporting anciliary equipment and facilities to develop processes and operate at TRL level 6.

3. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Representative geometry built in selected material with a process yielding acceptable mechanical properties	Completion of materials development in this program	T+12 months
D2	Final reporting- mechanical properties, accuracy and surface finish of representative design, cost model, recommendations for improvements and plan for commercial access at higher TRL		T+18 months

4. Topic value (€)

This topic value is a maximum gross value for the project.

Awards between 50% and 75% of this value may be made by the Clean Sky Joint Undertaking. Note that VAT is not an eligible cost in the context of this RTD activity.

1,000,000 €
[One million euro]

5. Remarks

Content of the proposal (including these items will significantly enhance the proposal)

10. A clear and precise budget breakdown should be provided, outlining spend in all areas of the programme (human resource, outsourcing, materials, capital spend, etc.)
11. A detailed Risk Assessment – key programme, technology, material, manufacturing and budget risks.
12. Detailed design and make plan with decision gates and contingency loops. The plan must include a clear feature selection process.
13. The proposal must include details of supplier agreements and dependencies on sub-systems and access to IP held by third parties.
14. The proposal should clearly describe the methods by which the Partner will demonstrate technical equivalence to best of breed L-ALM methods and demonstrate productivity improvements.

Clean Sky Joint Undertaking
SP1-JTI-CS-2012-03-SAGE-06-002

Topic Description

CfP topic number	Title		
JTI-CS-2012-03-SAGE-06-002	**Economic manufacture of lean burn combustion liner tiles using Laser-Additive Layer Manufacturing**	**Start date**	T0
		End date	T0 + 36 months

1. Topic Description

SAGE6 project aims at development and demonstration of a Lean Burn Combustion System in support of the ACARE 2020 goals and Flightpath 2050. RTD activities are required to develop economic manufacturing methods for the novel combustion cooling systems, foreseen as required for realisation of low emissions engines.

The objective of the work package is to develop an economic manufacturing technology and demonstrate to Technology Readiness Level (TRL) 6- "technology demonstrator- prototype demonstration in a relevent environment".

Low emission combustion requires systems to be cooled more effectively and by less coolant air flow. This requires a better control and direction of coolant and results in more complex combustion component concepts than currently in use. The most effective cooling designs are difficult to form conventionally and existing manufactuing methods require compromises that reduce performance or life.

Laser Additive Layer Manufacturing of tiles is being demonstrated at TRL4- technically capable of forming the required complex geometries in nickel superalloys. The equipment used however is for general purpose prototyping of low volumes of rig parts and is not capable of high volume low cost production for flight.

Further, the known developments of existing systems descrease processing time by increasing laser power, scan speed and scan area from a single laser and as a result show a loss of resolution, surface finish and materials quality. This presents a significant problem for take-up of this technology for engine parts manufacture and whilst a development project to attempt a solution to these problems is possible, it faces major technical obstacles.

What is required is a future-proof production, multi-laser machine enabling low unit cost manufacture, scalable both in speed and build envelop size for higher volumes and part size without change in laser melt characteristics. It should demonstrate equivalence to best of breed additive manufacturing methods and demonstrate cost competitiveness and design flexibility.

Such a machine shall demonstrate high quality processes that are unaffected as speed and volume is scaled by the addition of further lasers and which demonstrates an at least 2x improvement in productivity over current known solutions whilst retaining existing materials integrity without revalidation. A seamless transition for materials properties and geometrical accuracy is required in the move into production.

The Partner shall in particular perform the following tasks:

Task 1- Management

Organisation:

The Partner shall nominate a team dedicated to the project and inform Topic Manager project manager about the name/names of this key staff. There shall be a project manager who is the single point contact with Topic Manager.

Time Schedule & Work-package Description:

The Partner shall work to an agreed time-schedule & work-package description, being that laid out here, further detailed as required and agreed with Topic Manager 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 achievements, time schedules, potential risks and proposals for risk mitigation.

Regular coordination meetings shall be conducted via telecom or at locations of Topic Manager choosing with the Partner providing reasonable visibility on its activities and an adequate level of information.

The activities will be managed with a Phase & Gate approach. Topic Manager will approve gates and authorise progress to subsequent phases.

The Partner shall submit a final report to Topic Manager summarising the achievements, further requirements (if any) and articulating a route to commercial access thereby enabling widespread manufacturing using the capabilities developed.

Task 2 Concept development, subsystem selection and technical risk analysis

The Partner shall agree with Topic Manager a preferred design concept, sub-system choices and design validation plan.

This concept shall be capable of delivering the key deliverables from this project;

a) Scalable process speed and area whilst retaining the same process quality (materials mechanical performace, build accuracy and surface finish).

b) Mistake-proof concepts for manufacturing using this technology- loading of data files (geometry, process recipe), materials and consumables

The Partner is expected to recommend new and novel integration of lasers and apply best of breed solutions from European laser and scanner suppliers.

A risk analysis shall be carried out on this design concept and the sub-systems identified and a work plan agreed with Topic Manager for the resolution and mitigation of key technical risks. This plan shall include physical verification where practicable.

Task 3 Resolution of technical risks identified- design, build and operation of a rig

A rig shall be designed, built and operated demonstrating the design concept and satisfactory compliance is achievable for the key sub-systems (e.g. scanners) with the design requirements.

In particular this rig should demostrate the necessary overlay accuracy, spot shape and size and focus from each laser position addressing a build plane consistent with building high quality multiple small objects and a single large object lying across multiple laser fields.

At the end of this task key risks should be resolved or mitigated to the satisfaction of Topic Manager.

Task 4 Design of alpha machine embodying technical solutions identified

This task will run concurrently with the rig design and build

The Partner shall complete a machine design and component, vendor and sub-system selection embodying the goals, concepts and risk mitigations developed earlier in this Project.

The design intent will be to demonstrate a process speed increase of at least 2x and preferably 3x over commercially avaliable best of breed (single laser) machines, with no degredation in process quality.

A build plan shall be produced by the Partner and agreed with Topic Manager.

Task 5: Manufacture, assembly and de-bug prototype machine

The Partner will procure all necessary materials, sub-systems including lasers (at least 2), scanners (at least 2), commission software and all necessary parts. This procurement will run concurrently with assembly to compress project time as far as possible.

The prototype machine will be operated, debugged and validated sufficiently to demonstrate to Topic Manager that design goals have, in principle, been met.

Task 6: Operation of prototype demonstrating process capabilities have been met

Topic Manager will agree with Partner on the reference design and materials properties to be demonstrated.

The Partner shall operate the prototype in a production environment to build the reference design and compare the build accuracy, materials mechanical properties and productivity to agreed benchmarks.

Task 7: Development of improvement plan

Taking account of measured performance the Partner shall develop technical and productivity improvement plans and report then to Topic Manager. They should detail any further requirements to achieve high volume low cost manufacturing use at TRL 8.

The partner shall develop a continuous cost reduction program to reduce the production cycle time, manufacturing cost and consumption of energy and consumables.

Prototype minimum capability requirements:

- Materials properties, geometric accurace and surface finish equivalent to currently validated processes at TRL4
- Capable of unmanned operation and remote monitoring
- 20micron layer thickness, thicker layers selectable
- Simultaneous operation of 2 of 200W Ytterbium doped fibre lasers (capable of at least 3) addressing a 300mm minimum sized build plane
- Operating environment suitable for the building of high quality Nickel based parts e.g. temperature controlled low oxygen Argon purged (or evacuated) environment
- Safe and ergonomic operation, loading/unloading and maintenance
- Touch panel human interface to a control system. Computing split between machine operations and file handling that may be local to the machine- or remote
- Remote loading and manipulation of component files to be built
- Software and mechanical design concept offering scalability in number of lasers, size of build plan (x, y) and height (z) of part built
- All key process parameters shall have methods for calibration by reference to national standards

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

Extensive experience in laser Additive Layer Manufacturing process development, process validation and manufacture of nickel superalloy aeroengine parts.

Experience of the necessary quality control systems requirements is essential.

Experience of managing the development and construction of sophisticated production machines for use in high technologly industries

The relevent environment to demonstrate the deliverables. This should include the necessary anciliary equipment and facilities to test and demonstate the prototype compatability with a manufacturing environment and best of breed commercial systems for benchmarking activities

Successful experience of application of innovative manufacturing and material technologies to reduce cost of part.

Experience in managing R&T and R&D programs in co-operation with Rolls Royce.

The Partner needs to be in the position to have access to the manufacturing facilities suitable for evaluating the machinery developed and benchmarking against best-of breed commercial systems.

3. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Rig demonstration of the design concept completed		T +18 months
D2	Reference design built by prototype in a production environment		T +33 months
D3	Final Report issued		T +36 months

4. Topic value (€)

This topic value is a maximum gross value for the project.
Awards between 50% and 75% of this value may be made by the Clean Sky Joint Undertaking. Note that VAT is not an eligible cost in the context of this RTD activity

2,500,000€
[Two million five hundred thousand euro]

5. Remarks

Content of the proposal (including these items will significantly enhance the proposal)

- A clear and precise budget breakdown should be provided, outlining spend in all areas of the programme (human resource, outsourcing, materials, capital spend, etc.)
- A detailed Risk Assessment – key programme, technology, material, manufacturing and budget risks.
- Detailed design and make plan with decision gates and contingency loops. The plan must include a clear feature selection process.
- The proposal must include details of supplier agreements and dependencies on sub-systems and access to IP held by third parties.
- The proposal should clearly describe the methods by which the Partner will demonstrate technical equivalence to best of breed additive manufacturing methods and demonstrate cost competitiveness and design flexibility.

Clean Sky –Smart Fixed Wing Aircraft

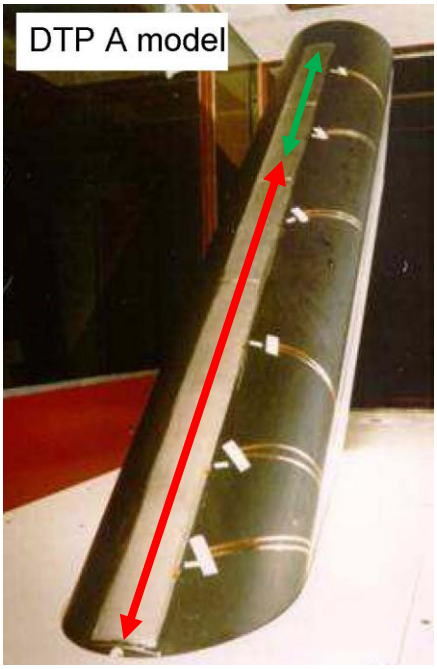
Identification	ITD - AREA - TOPIC	topics	VALUE	MAX FUND
JTI-CS-SFWA	**Clean Sky - Smart Fixed Wing Aircraft**	**8**	**10,725,000**	**8,043,750**
JTI-CS-SFWA-01	*Area01 – Smart Wing Technology*		**300,000**	
JTI-CS-2012-03-SFWA-01-053	Adaptation of a generic wind tunnel model for attachment line transition measurements (MAALTSU)		300,000	
JTI-CS-SFWA-02	*Area02 - New Configuration*		**9,750,000**	
JTI-CS-2012-03-SFWA-02-033	High speed wind tunnel test of Laminar configuration bizjet		2,000,000	
JTI-CS-2012-03-SFWA-02-034	Design, Manufacture and Wind Tunnel of a large laminar half model		4,400,000	
JTI-CS-2012-03-SFWA-02-035	Characterisation, Modelling & Passive Control of 3D transonic wing buffet		1,300,000	
JTI-CS-2012-03-SFWA-02-036	In-service assessment of Leading Edge Contamination and Damage		250,000	
JTI-CS-2012-03-SFWA-02-037	Blade trajectory testing		1,800,000	
JTI-CS-SFWA-03	*Area03 – Flight Demonstrators*		**675,000**	
JTI-CS-2012-03-SFWA-03-011	Wireless Sensor Nodes for continuous flight test measurements		400,000	
JTI-CS-2012-03-SFWA-03-012	Engine Pylon load measurements and prediction of accuracy		275,000	

Topic Description

CfP Topic Number	Title		
JTI-CS-2012-03-SFWA-01-053	**ADAPTATION OF A GENERIC WIND TUNNEL MODEL FOR ATTACHMENT LINE TRANSITION MEASUREMENTS**	**Start Date**	01-2013
		End Date	09-2013

1. Topic Description

Clean Sky is investigating the application of Hybrid Laminar Flow Technology (HLFC) for drag reduction. One specific issue is the delay of attachment line contamination with the help of boundary layer suction. To investigate this topic, a wind tunnel test is planned with an existing model from previous projects which is shown in Fig.s 1 and 2 below [compare D. Arnal, J-C. Juillen, J. Reneaux & G. Gasparian, 1997, *Effect of wall suction on leading edge contamination*, Aerospace Science and Technology, No. 8, pp. 505-517]



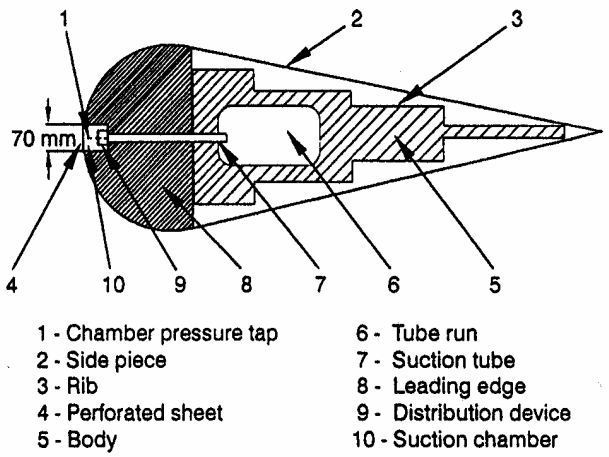


Figure 1: Photo of DTP-A model Figure 2: Cross-section of DTP-A model

The model has a circular leading edge with a radius of 20 cm and a triangular after body. The chord is constant with a length of 120 cm. The span of the model is 220 cm. Its leading edge is equipped with a suction chamber with a width of approximately 7 cm.

The applicant should modify the main body of the model to allow for the installation of interchangeable inserts with different micro-perforated suction surfaces. These inserts should cover the existing suction chamber (item 10 of Figure 2). The applicant should produce three different inserts, each with a micro-perforated metallic suction panel (approximately 7 cm wide, 220 cm long and approximately 0.8 mm thick). The thickness should be such that there are no deformations during the tests in the wind tunnel. The lower part of the insert with a length of 180 cm (marked with a red arrow in Figure 1) should be perforated. The upper part with a length of 40 cm (marked with a green arrow in Figure 1) should be a solid surface. The installation of the lower part of the inserts should be such that they could easily be interchanged.

The perforation shall be according to the following hole specifications:

Insert 1: Hole diameter 45 µm – hole distance 0.5 mm

Insert 2: Hole diameter 90 µm – hole distance 0.9 mm
Insert 3: Hole diameter 130 µm – hole distance 1.3 mm

The inserts should be installed with the following specifications:

Any forward facing steps must be smaller than 0.2 mm.
Any backward facing steps must be smaller than 0.1 mm.
Any gaps must have a width smaller than 0.8 mm.

The roughness Ra of the upper part of the panel surface should be below 0.5 µm.

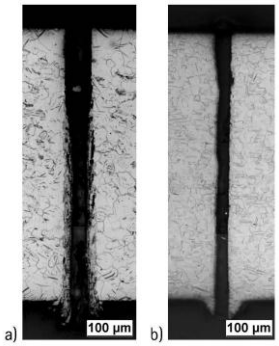


Figure 3: Image of suction holes

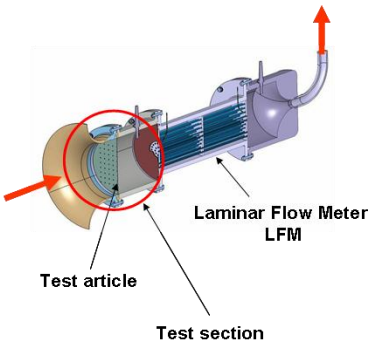


Figure 4: Flow meter.

To check the quality of the micro-perforation, the applicant should provide microscope images similar to those of Figure 3.

Furthermore, to estimate the pressure loss characteristics of the flow through the micro-perforation with an available flow meter similar to Figure 4, the applicant should provide for each perforation two circular test pieces with outer diameter $156^{+0,0}_{-0,5}$ mm. The perforated area should be either circular with minimal diameter of 110 mm and maximal diameter of 140 mm, or quadratic with sides between 88 mm and 99 mm.

Interactions with the ONERA Model Shop department would be mandatory: details as well as milestones would be defined in connection with the discussions between the Applicant and the topic manager and/or his deputy.

Drawings of the DTP-A model would be of course provided to the Applicant by the ONERA Model Shop Department.

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

- The applicant should be experienced with manufacturing, adaptation and repair of wind tunnel models.
- The applicant should be able to produce the micro-perforation with a suitable drilling technique such as laser drilling or electron beam drilling.
- The applicant should be able to produce circular test specimen and images of cross-sections using a microscope.

3. Major Deliverables and Schedule

Del. Ref. Nr.	Title	Description (if applicable)	Due
1	Kick-off meeting	Presentation of drilling method to Airbus and ONERA	M0
2	Test pieces	Delivery of test specimen for flow meter. Delivery of cross-section images of the holes similar to Figure 4	M0 + 3 M
3	Inserts	Delivery of 3 inserts to ONERA model shop in Lille	M0 + 7 M
4	Integration	Final integration of inserts into model together with ONERA model shop in Lille	M0 + 9 M

4. Topic value

The total value of biddings for this project shall not exceed

300,000€
[Three hundred thousand Euro]

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

5. Estimated spend profile (k€)

2009	2010	2011	2012	2013	2014	2015
-	-	-	-	300	-	-

Topic Description

CfP Topic Number	Title		
JTI-CS-2012-03-SFWA-02-033	**HIGH SPEED WIND TUNNEL TEST OF A LAMINAR CONFIGURATION BIZJET**	**Start Date**	01-2013
		End Date	06-2014

1. Topic Description

This topic is devoted to the preparation and realization of a challenging wind tunnel test of an innovative model representative of a next generation business jet. The wings are designed under NLF (Natural Laminar Flow) constraints to provide a real breakthrough in cruise efficiency.

The main objectives of this test are:

- Provide drag & buffet onset data for NLF aircraft development. These data will be the core of the future aircraft design phase as reference data.
- Provide data to validate CFD industrial method for laminar/turbulent transition location prediction
- Provide experience and define process for tests of future aircraft with NLF wings

The model will be a full aircraft 1,6m span with two sets of wings, a motorized empennage and a set of through-flow nacelles. The model will be provided to the applicant for the tests. Design and manufacture of the model is planned to span 9 month with a start date on the 1st of January 2013. The test can therefore be expected in Q1 2014.

The model is designed for very low temperatures (Ts=115K) and high pressure (3.5 bar).

The applicant has to provide a wind tunnel able to achieve flight Reynolds numbers. The targeted flow characteristics are:

- Re/m=65 Millions at M=0,75
- Mach number up to M=0,85
- Laminar capacity (low turbulence levels and contamination)

Instrumentation of the model includes around 40 unsteady pressure transducers and 100 conventional pressure tapings on each set of wings and some accelerometers. The applicant shall propose an innovative and accurate way to measure the extension of laminarity on both, upper and lower side of the wings. If this instrumentation/way to measure laminarity implies some modification or some special specification for the model, support of the applicant shall have to be provided to the model manufacturer. Analysis and interpretation of the measured wind tunnel test data will be the responsibility of the relevant SFWA teams. Measurement of the model deformation during the tests is needed.

The test programme shall include:

- Continuous traverse polars at different Mach and Reynolds numbers under free transition and transition triggered conditions for both drag and buffet onset purposes
- Visualisation of the extension of the laminar flow at different CL, Mach and Reynolds numbers
- Effect of different trailing edge designs (to mimic variable camber devices)
- Effect of different HTP deflection to assess trim drag purposes (HTP is motorized)

A total of ten different configurations have to be tested.

This applicant has to support the following activities:

- Preparation of the wind tunnel test including support during model design & manufacture for:
  - design of the motorized HTP (integration of systems required by the wind-tunnel for the HTP monitoring) &
  - the integration of laminarity measurement system proposed by the applicant (preparation of the skin for the TSP if used for example)
  - The integration of the strut and balance inside the model

The applicant has to conduct the Wind Tunnel Test; during the test the applicant

- will provide the Topic Manager with preliminary aerodynamic (steady & unsteady) & laminarity extension data
- Provide the final data after the test on relevant support (hard disk for example). These data shall include all the classical aerodynamic data measured from the balance, model deformation system, embedded instrumentation (steady & unsteady pressure, accelerometers, …) and the additional data of extension of laminarity on the wings (tecplot file of the wing with laminar/turbulent zone as a variable for example).

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

- The applicant shall have a significant expertise in High Speed High Reynolds Wind tunnel test with important area of laminarity on the skin of the model
- The applicant shall provide a wind tunnel compatible with both the test conditions (M≤0.85, Re/m=65 Millions) capable of hosting a 1.6m span model. The wind tunnel flow is to be as clean as possible for laminar testing (avoiding or justifying contamination level & justifying a turbulence level under different condition). Former experience is mandatory.
- The applicant shall propose an innovative and accurate way to measure the extension of laminarity on both upper and lower surface of the wings (TPS is preferred by the Topic Manager)

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 + 6 M
2	Minutes of the WTT	Short sum-up of the WTT campaign	M0 + 12 M
3	Final Report	Report and data	M0 + 18 M

4. Topic value

The total value of biddings for this project shall not exceed

2,000,000€
[Two million euro]

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

5. Estimated spend profile (k€)

2009	2010	2011	2012	2013	2014	2015
-	-	-	-	300	1700	-

Topic Description

CfP Topic Number	Title		
JTI-CS-2012-03-SFWA-02-034	**DESIGN, MANUFACTURE AND WIND TUNNEL TEST OF A LARGE LAMINAR HALF MODEL**	**Start Date**	01-2013
		End Date	06-2015

1. Topic Description

Within the Clean Sky Smart Fixed Wing Aircraft programme there are Technology Streams in NLF (Natural Laminar Flow) and HLFC (Hybrid Laminar Flow Control) that are responsible for driving those technologies towards TRL6. Success at that level will be contingent upon information derived from a variety of sources including large scale tests, simulations and integration studies. This particular topic also addresses issues within the Technology Stream "Buffet Characterisation and Control" that is not expected to achieve such a high level of TRL within SFWA.

This Call for Proposal (CfP) topic describes a proposal to design, manufacture and test a combined Hybrid Laminar Flow Control (HLFC) and Natural Laminar Flow (NLF) wing at transonic conditions and high Reynolds number ($Re/m \geq 10x10^6$). Since this topic covers many technical disciplines it is strongly suggested that an application would represent a Consortium of Partners who will collaborate to complete the programme.

The global objectives for the overall programme are:

- Confirmation of surface quality requirements for NLF and HLFC on fully representative structures at near flight Reynolds numbers. This will include the effects of representative surface waviness and roughness, fasteners, erosion shields and leading edge joints.
- Aerodynamic evaluation of innovative structural concepts for the wing box cover and leading edge zones.
- Characterisation of the buffet associated with a high Reynolds number laminar wing and its control.
- Evaluation of the potential for passive or active HLFC and the robustness of such systems, according to appropriate / available suction systems and perforated panels

The applicant(s) for this CfP will be expected to design, manufacture and test a large half-span wind tunnel model. The overall model will have a semi-span of approximately 4.5m and a mean aerodynamic chord of approximately 1.5m. The wing will be divided into an inner and an outer section. The inner half of the span will be dedicated to a demonstration of HLFC technology with a suction system present in the zone ahead of a notional front spar location. The outer half of the wing will be dedicated to a demonstration of NLF technology with an expected extent of laminarity back to at least 60% chord on the upper surface only.

The global planform and sectional shape will be defined by the Airbus Wing Shape team. Airbus will also provide details of the HLFC design, including the chamber layout, structural topology, skin thicknesses, suction hole diameter, spacing & tolerances and suction rates.

The applicant(s) will be responsible for the design of the model structure, instrumentation and wind tunnel interface in close liaison with Airbus. Of particular interest will be the requirement to maintain the internal structure, in certain relevant zones, to be as near to that envisaged for a real aircraft and possible flight test application. While it is likely that the test dynamic pressure will be higher than the real flight case, such differences should be accounted for and the surface requirements e.g. surface waviness under loads, used as design constraints. The full range of surface quality requirements will be defined by topic manager within the Negotiation phase of the process.

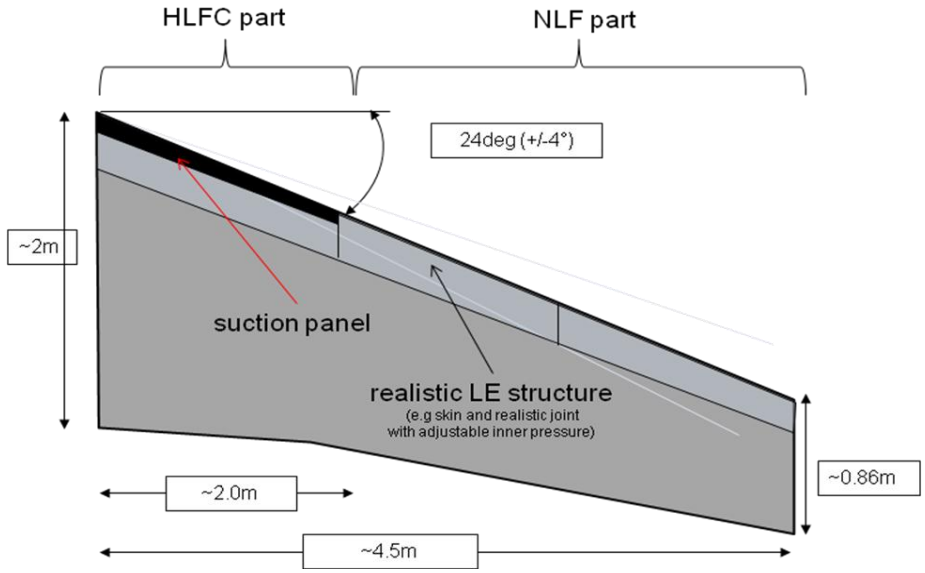


Figure 1: Schematic of model layout (to be confirmed)

The manufacturing of the model shall be a compromise between a true representation of an HLFC/NLF leading edge zone and a main wing structure (wing box and trailing edge) that is designed to withstand the loads, minimise cost but enable modification to suit future test programmes in the same wind tunnel. As such it is not expected that the bulk of the model should be non-metallic except where that is required to reflect specific NLF/HLFC solutions. However the static response of the wing box under load should be representative of the aircraft in flight (allowing for the raised dynamic pressure in the test). The applicant should be able to perform the drilling of the micro-perforated suction panel, according to requirements defined by Airbus. This may be identified as a specific sub-contract due to the unique nature of the required capability.

The model shall be mounted on a tunnel wall/floor and enabled to move to vary the incidence of the wing. All the normal model instrumentation shall be required to include: a number of surface pressure sections, unsteady pressure sensors for buffet evaluation, accelerometers, model deformation sensors (to measure both the gross bending of the wing under load and the detailed local deformations of the surface at the leading edge) and infra-red transition detection. Wind Tunnel measurement techniques such as the ability to perform pressure sensitive paint and wake surveys (at about one chord length behind the model trailing edge) would also be highly desirable.

It is expected that the test envelope will range from mid subsonic Mach numbers up to the onset of high speed buffet ($0.4<M<0.85$). The Reynolds number of the tests should be a minimum of $15x10^6$ based on mean aerodynamic chord The initial test campaign shall be a 2 week entry in the wind tunnel with a start date towards the end of 2014. The precise details of the test programme will be discussed within the negotiation phase. Only a limited data analysis to ensure data quality will be required within this programme.

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

- It is anticipated that fulfilment of all the programme objectives will only be met by a consortium covering the main design, manufacture and test activities.
- Experience in former NLF or HLFC European or collaborative programmes would be highly appreciated
- Each separate applicant will be required to demonstrate a proven track record in their respective contribution.

3. Major Deliverables and Schedule

Del. Ref. Nr.	Title	Description (if applicable)	Due
1	Model Design	A full set of Design for Manufacture data that meets the test constraints as specified by the wind tunnel Operator and the Customer.	M0 + 6 M
2	Final model acceptance	Wind tunnel model is complete and has passed acceptance criteria as specified by both the Customer and the Wind Tunnel host/operator	M0 + 18 M
3	Completion of WT test and delivery of data	Final delivery of validated test data to Customer	M0 + 27 M

4. Topic value

The total value of biddings for this project shall not exceed

4,400,000 €
[Four million four hundred thousand euro]

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

5. Estimated spend profile (k€)

2009	2010	2011	2012	2013	2014	2015
-	-	-	-	1.000	3.000	400

Topic Description

CfP Topic Number	Title		
JTI-CS-2012-03-SFWA-02-035	**CHARACTERISATION, MODELLING & PASSIVE CONTROL OF 3D TRANSONIC WING BUFFET**	**Start Date**	01-2013
		End Date	06-2014

1. Topic Description

There is great interest in developing passive or active means to control the 3D transonic buffet on transport aircraft wings. This requires a greater understanding than currently exists within European industry of the details of the associated physical phenomena and the main characteristics of 3D buffet, and of the key parameters which influence these characteristics. It also requires validated means to model 3D buffet using CFD, both at very high fidelity and at an “industrial” level appropriate to routine use during the wing design process.
In this Call for Proposals interested applicants are invited to make a proposal to deliver this increased understanding and also the improved modelling of 3D transonic buffet. This is to be achieved through a relatively highly-paced research programme, making use of large scale, highly instrumented wind tunnel testing and very high fidelity CFD. Analysis of this new information is to be used to supplement existing understanding and published data, where the latter are to be captured in a pre-cursor Knowledge Capture exercise, which is also to form part of the proposal.

Support provided by SFWA partners :

- Expert input into the buffet characterisation, including attendance at Technical Workshops and assistance in the specification of the detailed requirements for the wind tunnel test
- External shape for passive buffet control devices (3D bumps) for inclusion on the model

Further conditions :
- Given the timescale and budget constraints it is assumed that an existing large wind tunnel model will be used, adapted for the purpose. This model is to be provided by the applicant(s) & identified & described in the proposal
- The model design should be of large civil transport aircraft geometry & must produce 3D buffet behaviour representative of such an aircraft. The proposal should include supporting evidence of the expected typical buffet behaviour of the model (experimental or CFD)
- Testing should be at mid- to high- Reynolds numbers but testing at or near full-scale Reynolds numbers is not required (the space requirement for inclusion of the required instrumentation are likely to drive the model scale anyway)
- Good coverage with unsteady pressure sensors of the region of the buffet onset and initial development must be achieved. It is suggested that this implies a minimum of 3 rows each of 5 Kulites (or equivalent).

- Other measurements should include standard force-balance measurements, good coverage of mean pressure measurements and accelerometers. Use of PSP or other advanced techniques is encouraged, provided the technique is already well-established in the test facility
- The test matrix should allow some variations in the onset flow conditions (e.g. boundary layer characteristics) ahead of the buffet location. An outline test matrix should be included in the proposal.

- The applicants must be prepared to share the model geometry readily with the SFWA partners involved in development of buffet control technologies (within the existing terms of the SFWA Consortium Agreement & without the requirement for additional restrictions or side-agreements). A publishable geometry would be ideal, but this is not an absolute requirement.

- The high fidelity CFD is to be performed using a maximum of 2 (but 1 is sufficient) well-established, mature codes already validated for prediction of transonic flows. The CFD is to be used only to

generate increased physical understanding in an efficient manner. Any extended CFD validation exercise (e.g. comparing multiple codes) will not be acceptable.

- The CFD method used as the basis for the development of an industrial process for simulation of buffet and buffet control must correspond reasonably with current industry-standard tools. The code to be used should be identified in the proposal & the choice justified.

- In order to allow rapid and efficient exploitation of the outputs, the project must achieve continuous and effective communication with the key stakeholders in SFWA throughout its life. The proposal should indicate how this is to be achieved.

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

- Appropriate wind tunnel model representative of a civil transport aircraft wing
- Wind tunnel model instrumentation design & equipping
- Unsteady pressure sensors (e.g. Kulites), accelerometers, force balance & relevant data acquisition equipment
- Comprehensive coverage for mean pressures – standard pressure taps or PSP or similar
- Large transonic wind tunnel
- Surface flow visualisation – e.g. oil flows but more advanced alternatives welcome & potentially an advantage
- Mature very high fidelity CFD method (LES/hybrid-RANS) validated for transonic wing flows
- Large high performance computing (HPC) capacity
- Industrial standard RANS CFD method
- Deep knowledge of transonic wing aerodynamics, shock-boundary-layer interaction and buffet

3. Major Deliverables and Schedule

Del. Ref. Nr.	Title	Description (if applicable)	Due
D2.1.3-xx-01	Summary of knowledge capture and initial characterisation of 3D buffet	Technical report detailing conclusions from knowledge capture exercise, input from subject matter experts (SMEs) and Technical Workshops	M0 + 6 M
D2.1.3-xx-02	Wind tunnel model	Fully-instrumented large-scale wind tunnel model and passive buffet control devices	M0 + 9 M
D2.1.3-xx-03	Wind tunnel test report	Summary of test programme, including details of instrumentation and any specialist techniques	M0 + 12 M
D2.1.3-xx-04	Report on high fidelity CFD calculations	Technical report detailing & justifying approach taken to generation of high fidelity CFD results	M0 + 12 M
D2.1.3-xx-05	Report describing industrial CFD methodology	Technical report specifying an industrial CFD methodology for buffet prediction and design of buffet control devices, including a description of the process leading to this specification	M0 + 18 M
D2.1.3-xx-06	Final report	Detailed final report describing results of the analysis of wind tunnel and CFD data	M0 + 18 M

4. Topic value

The total value of biddings for this project shall not exceed

1,300,000 €
[One million three hundred thousand euro]

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

5. Estimated spend profile (k€)

2009	2010	2011	2012	2013	2014	2015
-	-	-	-	1 000 000	300	-

Topic Description

CfP Topic Number	Title		
JTI-CS-2012-03-SFWA-02-036	**IN-SERVICE ASSESSMENT OF LEADING-EDGE CONTAMINATION AND DAMAGE**	**Start Date**	Jan-2013
		End Date	Apr-2014

1. Topic Description

The CleanSky Smart Fixed Wing Aircraft Integrated Technology Demonstrator (SFWA-ITD) consortium is interested in understanding the typical level of contamination and minor damage to a wing leading-edge in operational service. Ideally this would include improved information about the rate of insect or other contamination accumulation and its dependence on climatic zones, seasons and environment as well as the cleaning impact of flight through rain, or clouds and any impact of WIPS (Wing Ice Protection System) operation. In addition, the consortium would like to apply different surface treatments and examine the impact of these.

In this Call for Proposals topic, interested applicants are requested to install a camera inside an aircraft that can view a section of the normal wing slatted leading-edge. Camera recordings would then be made during operational flights and basic information about each flight also noted. These recordings would be backed up by specific leading edge inspections when appropriate.

The flights could either be short range (to increase number of flight cycles) or long range (to increase operation in different climatic zones and seasons) or more preferably a mixture of both, with possible application to more than one aircraft. The duration of the trial should be from 3 to 6 months depending on the number of flight cycles and the type of aircraft.

Activities to be developed by the applicant (and properly assesses in terms of implications for implementation):

- Install a camera and recording equipment inside an in-service aircraft that can view a section of the wing leading-edge. Providing the viewing area is 2 – 3m then the spanwise location should be defined to suit the camera choice and installation.
- Ensure camera view to be of suitable quality to be able to capture insect contaminations within the recordings. Typical insect residues of interest are in the sub-millimetre scale.
- Ensure camera to be able to see either a fixed leading edge or when the slats are retracted
- To test and verify that the system will deliver the required information
- Record the view of the wing leading-edge during each flight
- Record details about each flight, such as date, time, origin and destination, weather conditions during climb-out and descent, cloud level during cruise, use of WIPS, altitude when slats were retracted or deployed
- Before a specific number of flights, to photograph visible area and count number of insect contaminations to check against camera view
- To record any cleaning performed over the trial period
- To perform visual inspection of leading-edge section and record any scratches and gouges before commencement of trial, after every month, and at end of trial
- To apply different surface treatments as required by SFWA partners
- To collect the recordings and data for post processing

Activities to be done by applicant for data processing:

- To post process the collected data into an easy to use format
- To post process recordings and analyse data
- To produce results showing, for the given area:
    - Probability of insect contamination above high-lift device retraction altitudes as a function of climatic zone and season
    - Probability of insect contamination below high-lift device retraction altitudes as a function of climatic zone and season
    - Probability of other types of contamination with description

- Effect of low altitude weather on cleaning the contamination
- Effect of high altitude cloud ice crystals on cleaning the contamination
- Effect of WIPS operation on cleaning the contamination
- The effect of different surface treatments on the above
- The probability of a scratch and information on cause
- The probability of a gouge and information on cause
- Information on any other damage

Support provided by SFWA consortium partners:

- Specification of the required information from the tests and the required data processing
- New surface treatments to be applied

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

- The applicant should be able to provide suitable aircraft operating a regular scheduled airline service
- The applicant should have the capability to provide and install suitable camera equipment and recording devices inside an aircraft
- The applicant should be able to inspect the viewable area, apply surface treatments and collect the required data

3. Major Deliverables and Schedule

Del. Ref. Nr.	Title	Description (if applicable)	Due
1	Camera and recording equipment installation proposal	Description and justification of the proposed camera installation, the recording equipment installation, the viewable area and the expected quality. Also expected aircraft routes during the trial period	M0 + 3 M
2	Initial test of camera and recording equipment	Installation of the devices and testing to verify the viewable area, the quality and that the required data can be collected	M0 + 6 M
3	Initial inspection results	Inspection of viewable area before start of trial	M0 + 6 M
4	Mid trial test analysis and recommendations	Report showing preliminary results and any recommendations or changes to ensure test success	M0 + 9 M
5	Trial results	All basic data and post processed data collected from tests	M0 + 12 M
6	Final report	Final report showing test procedure, data analysis, conclusions and recommendations	M0 + 15 M

4. Topic value

The total value of biddings for this project shall not exceed

250,000 €
[Two hundred and fifty thousand euro]

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

5. Estimated spend profile (k€)

2009	2010	2011	2012	2013	2014	2015
-	-	-	-	175	75	-

6. Remarks

The applicant will be assumed to have read and understood the restrictions and requirements for subcontracting applicable for a CFP activity. The applicant may represent a consortium of bidders to cover the individual aspects of this proposal e.g. flight operations, camera provision, analysis.

Topic Description

CfP Topic Number	Title		
JTI-CS-2012-03-SFWA-02-037	**BLADE TRAJECTORY TESTING**	**Start Date**	03-2013
		End Date	11-2014

1. Topic Description

General background and purpose of the tests

In the scope of the future certification of a Counter Rotating Open Rotor (CROR) engine powered aircraft, aircraft manufacturer have to address and assume the event of engine burst including the release / loss of a fragment of an Open Rotor Blade in order to assess and mitigate the A/C risks.

For the associated risk assessment, several features of Fragment Model of Open Rotor Blade Release (ORBR) are not directly established by regulation and should be fixed through specific demonstration. This is particularly the case for the fragment trajectory model features.

The general and final purpose of the “Blade trajectory” tests specified in this topic is to support the demonstration of an ORBR fragment trajectory model, for a predefined CROR engine design.

Secondary or induced purpose of the testing is the better understanding of driving parameters leading the trajectory of the blade fragment and the validation of numerical tools (FE, CFD, etc...).

The following activities have to be performed by the applicant. The work will be embedded in the trajectory modelling activities of the so called “task consortium”.

1 – Windtunnel testing with rotation motion device (WP1)

The performance of this workpackage WP1 includes:

- Test setup definition
- design and manufacturing of all test samples needed for the performance of the test
- any test rig manufacturing or adaptation needed for the performance of the test
- performance of tests
- Data reduction, final data release and analysis.

Purpose of the testing
The windtunnel testing with a rotating device aims to support the validation of the simulation tools able to predict the debris trajectory with representativeness of aerodynamic effects, with different initial conditions of fragment rupture and pitch angles.

Principle of the testing
The test sample representing the fragment is installed on a rotating device inside a windtunnel. The combined effects of constant windtunnel airflow and rotation create a specific flow condition on the test sample. The speed settings and rotation axis orientation values will be varied for each test and specified by the task consortium such as to represent the real fragment conditions.
The resulting forces and momentum applied to the fragment will be measured as an input (outside of this work package) to correlate and validate numerical tools.
These tests do not include any (free) release of parts or test sample.

Specification of testing conditions
The test articles subject to testing shall be representative of the aerodynamic shape of the of Blade fragment. These shapes together with specific mass and inertia properties will be provided by the task consortium as an input to the applicant.
Several fragment sizes (a minimum of 2 and up to 5) and associated specific shapes will need to be considered. The fragment size could vary from 800 mm to 1600 mm. Associated test article shall be designed and manufactured.

The windtunnel provided by the applicant shall be able to supply the following airflow on the test sample:

- Air temperature, density: Standard temperature and pressure conditions
- Maximum Wind Tunnel required airspeed: 280 m/s
- Tunnel airspeed must be adjustable during testing. Task consortium will provide the specified airspeed values for each testing

A rotating device has to be provided which allows to apply a rotating motion to the test sample whose:

- Rotation axis shall be aligned with the Centre of gravity of the represented fragment.
- Rotation axis orientation must be adjustable in a range of angle between rotation axis and the wind tunnel airflow axis from 0° to 90° as shown on fig. 1.
  This angle variation capability is not required to operate during the test itself, although it could be found of interest by the applicant to increase test productivity.
- Rotation speed of the Blade fragment test article must be adjustable, as specified by the Task consortium with a maximum value of 120 rad/s during testing.
- Pitch angle of the Blade fragment test article shall be adjustable in a range from +/- 20° compared to the baseline sample orientation that is approximately shown on fig.1. This baseline orientation will be provided by the task consortium. The “pitch” angle adjustment capability is not required to operate during the test itself, although it could be found of interest by the applicant to increase test productivity.
- The blade fragment test article support shall minimise its aerodynamic perturbation to the blade fragment throughout the test envelop. Proper demonstration shall be done by the applicant during the test setup definition phase.

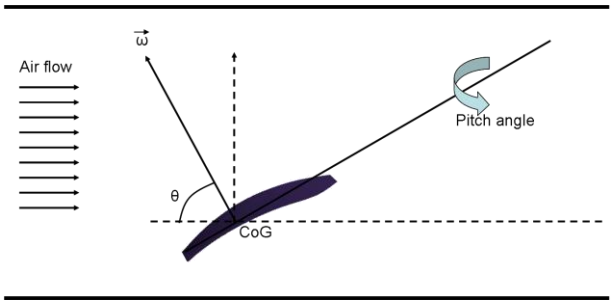


Fig. 1: Description of rotation axis, Windtunnel airflow, angle and “pitch” angle

Specification of main output data and testing measurements system

The following main parameters shall be measured:

- Specified test conditions values
- Accurate history of forces and momentums (6 components) applying on the fragment test sample measured every 5° (at a maximum) considering a test sample rotation cycle.

The history of forces and momentums shall be recorded at least for five successive cycles of rotation of the sample, showing a maximum difference in the measured values of 5% from one cycle among others. Each force and moment measurement accuracy shall be within 1% of measured value within the specified test range.

The applicant shall address the test setup dynamic behaviour such as:

- No critical resonances are present within the test range;
- Predicted deflexions are compatible with required measurement accuracies.

2 - Rotating Blade testing with fragment release (WP2)

The performance of this workpackage WP2 includes:

- Any test rig manufacturing or adaptation needed for the performance of the test
- Design and manufacturing of all test samples needed for the performance of the test
- Performance of tests
- Data reduction, final data release and analysis.

Purpose of the testing
The outputs of rotating blade testing with fragment release will be used to analyse the trajectory of the blade fragment in the early phase of the release, where aerodynamic effects are assumed not significant, and particularly when fragment may impact the following blade.
The results will also be (outside of this work package) coupled with the results of WP1 in order to consolidate and validate the numerical tools.

Principle of the testing
A blade is installed on a rotor in order to reproduce the same conditions (orientation, position, speeds) of and Open Rotor Blade before failure event. A controlled (almost) instantaneous separation of the blade allows a fragment to be released. The trajectory / kinetics of the fragment is recorded.

Specification of testing conditions
The blade fragment that will be released in the tests shall be representative of:
- the aerodynamic shape of the of real Blade fragment
- the inertia features (Mass, CoG, position, etc...) of the real Blade fragment

These detailed data will be provided by the task consortium.
The fragment size could vary from 800 mm to 1600 mm
The mass of the largest fragment could reach 17 Kg.

Before the release of the fragment during testing, the fragment speed and orientations conditions shall be according to the real blade without failure, with the following features:
- the tip of the Blade is approximately 2.2 meters from the engine axis
- the rotation speed of the rotor could vary between 80 to 120 rad/s
- the pitch of the blade shall be adjustable

The test conditions do not need to be representative of aerodynamic effects.
However, the test bench environment shall prevent an airflow perturbation due to coupling with blade rotation (vacuum test, outdoor conditions or large testing room could be acceptable).
The release system shall permit a precise control of the angle of rotor at which the fragment is separating.
A few limited numbers of tests (up to 10) will require to be performed with an additional “following” blade installed on the rotor, adjacent to the blade subject to fragment release.
This “following” blade (that might be impacted by the fragment) is required only to be representative of the blade shape.

Specification of main output data and testing measurement system
The following main parameters shall be measured:
- specified test conditions values before and at the moment of fragment release
- the accurate 3D measurements of the blade fragment trajectory, positions and orientations (including pitch angle), once the fragment released
- Video recording capturing the fragment trajectory

Regarding the 3D measurements:
- These data and the free trajectory of the blade fragment shall be observable in the testing mean for a distance of typically 5 meters, at a minimum 2 meters along the fragment trajectory.
- A video recording system is assumed necessary to capture the 3D measurement data. In this case, a minimum acquisition at least a frequency of 1 MHz is required to catch the influence of the dynamic phenomena.
- An artificial lighting system might be required depending on the video camera system.

3 – Options and alternative testing
Several options and alternative on the requirements might be considered by the applicant in the proposal as described here-below.

Similitude tests using scale factor

All tests are specified considering full scale testing and the proposal shall by default address the full scale testing requirements.
However, If the applicant have confidence and could provide reasonable evidence that testing at a reduced scale is both feasible, representative of the studied phenomena and should give representative results to validate the different CFD or FE tools, proposals with such (lower) scale testing is acceptable as alternative to full scale testing. The proposal shall benefit from this reduced complexity to provide wider scope of results (could be additional testing).

If such option is selected, the applicant shall specify in the proposal the intent representativeness of the proposed test according to the testing means and the scaled values of test conditions (inertia, speeds, size, etc...).

Rotating Blade testing with fragment release and airflow representative conditions

The applicant may choose to consider the following testing as alternative to the Rotating Blade testing with fragment release (WP2).
The difference with the WP2 is as follows:

- The testing shall be representative of the aerodynamic effects and therefore of the surrounding A/C airflow that applies on the real fragment
- The rotating assembly (before release) and, once release, the fragment itself shall be subject of a constant homogeneous airflow (that could be supplied by a windtunnel for instance) whose features are:
  - maximum speed up to 225 m/s
  - direction along the rotating assembly axis
- the required total number of test

If a windtunnel is used, the test section of the wind tunnel should be sufficient in particular to observe the blade trajectory as specified in the WP2.

Other alternative testing

As alternative to WP1 and/or WP2, the applicant may choose to propose another type of testing..In this case, the series of tests that will be proposed shall provide an equivalent representativeness of the studied phenomena, equivalent results, and an equivalent number of tested conditions than the ones specified in WP1 and WP2.
In case alternative tests are proposed, the proposal shall contain all necessary information in order to provide evidence that the results are equivalent and overall adequate of the tests proposed in WP1 and/or WP2.

4 – Test campaign & number of tests

The following table provides for each of type of testing the required number of test campaigns, the minimum and maximum numbers of tested conditions.
Typically, a testing condition corresponds to a test run assuming:

- Frozen settings of pitch angle, fragment shape and □ angle for the WP1
- Frozen settings of pitch angle, fragment shape & inertia and specified speeds for the WP2

	Number of tested conditions			Number of test campaign
	Total	per test campaign		
Testing Type	Min.	Min.	Max.	
Windtunnel test with fragment Rotating device (WP1)	75	25	50	2
Rotating Blade Bench with Fragment release (WP2)	40	10	30	2
Rotating Blade testing with fragment release and airflow representative conditions (Alternative WP2)	10	3	8	2

Table 1 – Summary of number of tested conditions and test campaigns

5 - Required data for the proposal

The proposal shall contain at least the following information:
Common to all WP:
- The exact number of test sample and test conditions
- The options or alternative considerations, if any

Specific to WP1:
- Description of experimental set-up and initial view on compliance with respect to requirements expressed in the current call for proposal
- Description of the system used to adjust the pitch angle and the rotation axis
- Description and accuracy of the force & momentum measurement system
- Assessment of blade flow representativness (wind-tunnel airflow homogeneity and blade support influence

Specific to WP2:
- Description of experimental setup, including the system of fragment release
- Description of the fragment residual kinetic energy protections if needed by the bench installation
- Description of the 3D measurement system including:
  - The number and main features of the camera used for this purpose
  - Artificial lighting, if any. In the opposite case, the applicant shall provide information explaining why artificial lighting is not needed

6 - Option of constituting a consortium

The work packages may be divided in several sub-work packages particularly in the case where a consortium of several entities/companies applies to this Call for Proposal

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

- The applicant should have a sound industrial background in complex testing activities
- The applicant has to demonstrate experience in similar complex wind tunnel experiment and/or high dynamic impact measures
- Appropriate Certificates and ISO standards

3. Major Deliverables and Schedule

The deliverable list may be adjusted if the applicant proposes an alternate test strategy as mentioned in chapter 3. Updated deliverable list is subject to negotiation between the applicant and the task consortium at CFP contract award.

Ref. Nr.	Title	Description (if applicable)	Due
1	Progress report (1)	Test preparation progress report including detailed test specifications for the first campaign	M0 + 3 M
2	Test campaign 1 result presentation (1)	Presentation of test results of campaign 1	M0 + 9 M
3	Test campaign 1 result report (1)	Report of test campaign1 with all data including video recording	M0 + 10 M
4	Test campaign 2 result presentation (1)	Presentation of test results of campaign 2	M0 + 15 M
5	Final Test result report	Final Report of all test campaigns with all data including video recording	M0 + 20 M

(1) These deliverables will be split in several deliverables which will be noted as -a, -b depending on the concerned WP (WP1 or WP2).

4. Topic value

The total value of biddings for this project shall not exceed

1,800,000 €
[One million height hundred thousand euro]

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

5. Estimated spend profile (k€)

2009	2010	2011	2012	2013	2014	2015
-	-	-	-	1.000	800	-

Topic Description

CfP Topic Number	Title		
JTI-CS-2012-03-SFWA-03-011	**Wireless Sensor Nodes for continuous flight test measurements**	**Start Date**	02-2013
		End Date	09-2014

1. Topic Description

Main objective within this Call for proposal topic is the development of an autonomous wireless sensor node for flight test installation. Required is a synchronisation in the regime of 0,1ms, sample rates up to 50kHz and a resolution of up to 16bit. Beyond this the applicant should provide concepts for safe data transmission.

Two scenarios are envisaged: acoustic and pressure measurements on non-rotating frames on the aircraft's outer skin, and - second – similar measurements on rotating elements in a harsh environment. The option for the additional measurements of strains, accelerations and vibrations should be demonstrated in the proposal.

In order to keep installation efforts to a minimum while maximising reliability, the equipment should operate without cabling and connectors to a power source. An appropriate method for energy harvesting or local power charge / storage must be addressed (maximum energy consumption < 1W).

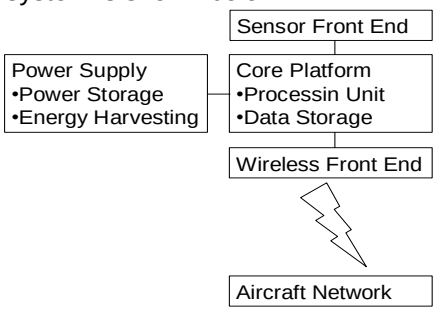
In order to ensure compatibility to the aircraft's overall wireless architecture, the successful applicant will later be provided with top level requirements that cannot be disclosed in this public document. The same procedure will apply to the system architecture regarding the definition of interfaces to possible sensor front-ends and links to flight test installations.

The applicant has to

- design,
- manufacture
- support testing

for the developed wireless self-contained platform.

A generic architecture for such a system is shown below.



This CfP Topic is divided into 6 main Tasks

- Task 1: System Architecture (end2end)
  implementation of top level requirements disclosed after the proposal evaluation regarding interfaces, physical and system integration of the processing platform including the data storage devices, the power supply, the sensor and wireless front end
- Task 2: Wireless Network Architecture

  shall consider a low power protocol approach as well as a network communication architecture suitable for energy efficient wireless data transmission. A jamming awareness function shall be

considered. A backup mode in case of loss of primary wireless infrastructure shall be developed.

- Task 4: Power Supply

  This task shall provide the whole power supply system including energy harvesting for the application scenario on a rotating frame in harsh environment and also consider the development of energy storage or harvesting system (non-rotating, harsh environment, minimum of 24h lifetime environmental data provided separately). The developed unit shall be low weight, low size and of flat dimensions (less than 2,5mm).

- Task 5: Evaluation

  Evaluation tests will be performed by the topic manager with the support of the successful applicant. The applicant has to provide at least 10 prototypes and perform an assessment for non-disturbance of aircraft flight safety. The sensor node shall pass Technology Readiness Level 5 at the end of the Call duration. Specific requirements for this maturity assessment will be provided by topic manager to the successful applicant.

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

The applicant/applicants should have an expertise in

- manufacturing and lay-out of measurement equipment for data acquisition
- ultra low power electronics and processing,
- energy harvesting,
- wireless & AC network architecture, protocols and wireless data transmission,
- system integration.
- The applicant should have a full ISO 9001:2000, ISO 14001:2004 certificate and experiences in developments and qualification according to RTCA and/or MIL standards for aircraft.

3. Major Deliverables and Schedule

Ref. Nr.	Title	Description (if applicable)	Due
D1.1	System architecture, front end interfaces and power consumption requirements	Full definition of the system architecture and initial interface and power consumption requirements	M0 + 3M
D1.2	Preliminary power supply concept	Provide a preliminary concept for power supply	M0 + 06M
D1.3	Sensor Front End	Provide sensor front end	M0 + 12M
D1.4.0	Power supply concept	Description of the various aspects of the power supply	M0 + 12M
D1.4.1	Power Supply Prototype	Provide a power supply prototype	M0 + 12M
D1.5.0	Wireless Network architecture	Wireless network architecture available	M0 + 12M
D1.5.1	Jamming Awareness Concept	Concept for jamming awareness and countermeasures for the wireless network	M0 + 06M
D1.6.0	Prototype autonomous low power wireless sensor node	Provision of prototype autonomous low power wireless sensor node	M0 + 14M
D1.6.1	Final autonomous low power wireless sensor node	Provision of final autonomous low power wireless sensor node	M0 + 19M
D1.7	Final result report		M0 + 19M

4. Topic value

The total value of biddings for this project shall not exceed

400,000 €
[Four hundred thousand euro]

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

5. Estimated spend profile (k€)

2009	2010	2011	2012	2013	2014	2015
-	-	-	-	250	150	-

Topic Description

CfP Topic Number	Title		
JTI-CS-2012-03-SFWA-03-012	**ENGINE PYLON LOAD MEASUREMENTS AND PREDICTION OF ACCURACY**	**Start Date**	01-2013
		End Date	06-2014

1. Topic Description

The main objective of this topic is to provide a technical solution to accurately measure all the loads encountered by a pylon which supports a Counter Rotating Open Rotor (CROR) engine in flight.

The topic is divided in the following tasks:

Task 1: Development of a numerical model representing the in-flight data measurement system to be integrated to a pylon and fuselage arrangement, provided by Airbus.

The model should integrate analytical and more advanced models such as FEM. It should accurately predict the expected precision of the measurement concept.

The study should:

- Take into account all the loads acting on a CROR pylon & fuselage, for various flight phases.
- Provide the 6 components of the loads transmitted by the pylon to the fuselage; characterise its precision, taking into account the flight attitude and the other parameters potentially impacting the measurement.
- Deliver the required accuracy of the measurement concept

Task 2: Optimisation of the developed concept as well as providing post processing capabilities to reach the target accuracy of the measurement concept (less than 1% of full scale in X direction, and less than 3% in Y and Z plus moments for a standard flight mission, especially in Cruise Flight conditions). This task will be performed in coordination with Airbus structural teams.

Task 3: Implementation of the concept into a small scale mock-up of the measurement system for validation of the concept including structural deformation effects, vibrations, G vector direction effects, etc, and calibration of the model. Delivery of the mock-up (hardware and software).

Task 4: Update of the concept to define a flight worthy measurement system configuration adapted to the Open Rotor Flight Test Demonstrator; integration of the concept to the digital mock-up (with the support of airbus flight test team).

The result of this CFP will enable SFWA integration team to design the final measurement system needed for the CROR flying test bed; this, however, is outside of the scope of this CFP.

This call aims to provide studies and perform lab tests to reach a Technology Readiness Level of 4 (set-up validated in a laboratory environment). A second CFP may be launched later to reach TRL6 to validate the concept in flight in a relevant configuration before application on the CROR engine

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

The applicant(s) should have an expertise in:

- echanical studies including analytical and FEM, for displacement, stress & loads
- Measurements, techniques for loads/displacement
- Understanding of aircraft physics
- Lay-out of measurement equipment for flight testing
- Lab testing for in-flight measurements
- System integration

3. Major Deliverables and Schedule

Ref. Nr.	Title	Description (if applicable)	Due
1	Prerequisites for a measurement setup	Synthesis of the requirements provided by Airbus and ways to reach the objectives	M0 + 2 M
2	Analytical and FEM models	Provide the models and the conclusions to fulfil the needs	M0 + 5 M
3	Concept Layout and System Architecture	Provide a preliminary layout of the measurement concept and the system architecture	M0 + 10 M
4	Adapted concept on A/C	Integration of the constraints CROR FTB with Airbus Digital Mock-Up	M0 + 12 M
5	Test Matrix for Mock-up tests		M0 + 12 M
6	Mock-up tests	Perform tests of prototypes on a relevant mock-up on ground	M0 + 15 M
7	Mock-up test report	Analysis and results of the lab tests	M0 + 17 M
8	Final Task Report	Synthesis of the work and way forward to TRL6	M0 + 18 M

4. Topic value

The total value of this project shall not exceed

275.000,00 €
[Two hundred and seventy-five thousand euro]

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

5. Estimated spend profile (k€)

2009	2010	2011	2012	2013	2014	2015
-	-	-	-	150k€	125k€	-

Clean Sky Joint Undertaking
Call SP1-JTI-CS-2012-03
Systems for Green Operations

Clean Sky –Systems for Green Operations

Identification	ITD - AREA - TOPIC	topics	VALUE	MAX FUND
JTI-CS-SGO	**Clean Sky - Systems for Green Operations**	**14**	**6,450,000**	**4,837,500**
JTI-CS-SGO-01	*Area-01 - Definition of Aircraft Solutions and explotation strategies*		**0**	
JTI-CS-SGO-02	*Area-02 - Management of Aircraft Energy*		**5,950,000**	
JTI-CS-2012-3-SGO-02-043	Aerospace housing for extreme environment		300,000	
JTI-CS-2012-3-SGO-02-045	Regenerative Snubber & innovative control algorithm		400,000	
JTI-CS-2012-3-SGO-02-046	High Dense Smart Power Capacitor (HDSPC) for next generation Aircraft converters		600,000	
JTI-CS-2012-3-SGO-02-054	Design and manufacturing of Flight test version of Electro-mechanical Wing Ice Protection assembly (Modified A320 slat 5)		500,000	
JTI-CS-2012-3-SGO-02-055	Tool for wiring optimization regarding lightning threat		800,000	
JTI-CS-2012-3-SGO-02-056	Integrated design tool to support EWIS optimisation		300,000	
JTI-CS-2012-3-SGO-02-057	High Voltage connectors and moving links		200,000	
JTI-CS-2012-3-SGO-02-058	Optimized power cable for skin effects		200,000	
JTI-CS-2012-3-SGO-02-059	Certified Code Generation of Model-Based Modelica Controllers		200,000	
JTI-CS-2012-3-SGO-02-060	Electrical Machine Magnetic Properties Characterisation Setup for Aerospace Application		800,000	
JTI-CS-2012-3-SGO-02-061	Technology development and fabrication of integrated solid-state power switches		650,000	
JTI-CS-2012-3-SGO-02-062	Concepts and solutions for health monitoring of electro mechanical actuators		500,000	
JTI-CS-2012-3-SGO-02-063	Investigation of electric components used in aerospace environment in terms of partial discharge issues		500,000	
JTI-CS-SGO-03	*Area-03 - Management of Trajectory and Mission*		**500,000**	
JTI-CS-2012-3-SGO-03-020	Adaptation of optimisation algorithm to avionics constraints		500,000	
JTI-CS-SGO-04	*Area-04 - Aircraft Demonstrators*		**0**	

Clean Sky Joint Undertaking
JTI-CS-2012-03-SGO-02-043

Topic description

CfP Nbr	Title		
JTI-CS-2012-3-SGO-02-043	**Aerospace housing for extreme environment**	**End date**	01/08/2014
		Start date	01/02/2013

1. Background

The housing for electronics and especially for power electronics in aerospace applications contributes greatly to weight, costs and reliability of the respective devices. In order to achieve higher power density, lower weight and lower costs the optimisation of the housing is a must.

The proper “hermetic sealed housing” protects the electronics against the environment, ensures EMC and supports the thermal management.

2. Scope of work

Aim of the proposed work package is an integrated solution for a hermetic sealed low weight and low cost power electronic housing for unpressurised area (DO160). A lightweight composite cover has to be developed for hermetic sealed housings. The objective of the proposed work package is a reduced weight of 40% to state of art covers made of anodized aluminium with electrically conductive bonding areas (Alodine 1200), attachment points for electronic components and cost neutrality. The cover will be used in combination of aluminium housings where power electronic components are mounted directly on the housing wall (cooling fins) for heat spreading and dissipation as well as the PCB’s fixation is realized via attachment points. The housing is used for non-pressurized and non-controlled temperature locations as well as high level vibration areas on an aircraft according to RTCA DO160, e.g.

- Steady State-Altitude (Section 4, category D2)
- Temperature Variation (Section 5, category A)
- External Humidity Environment (Section6, category C)
- Operational Vibrations (Section8, category R – E&E1)

This work package also comprises subjects as

- Corrosion-resistance against external environment (humidity, salt/spray, sand/dust, fluid susceptibility, icing, …)
- Integrated indirect lightning-, EMC- and electrical bonding concepts

for optimized gasket concepts. After the conceptual design one housing shall be implemented for an example application with existing PCB’s and power electronic components.

3. Type of work

- Bibliography / concepts of materials and construction technologies and their evaluation against state of art
- Risk mitigation: setting up samples and tests for critical issues
- Construction of cover for example application
- Verification tests

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

SME and/or laboratory having a significant experience on:

- Composite materials and surface treatment
- Experience with hermetic sealed (aerospace) housing for electronics

- Ability to perform structural, thermal and fatigue analysis
- Knowledge of bonding, corrosion protection, thermal management, screw fixation technologies, high voltage protection measures for housings

5. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Design concept report	Description of concepts, evaluation matrixes for e. g. material, solution for relevant subtopics as bonding, vibration, corrosion, sealing, cooling. Furthermore weight reduction and cost saving potential shall be outlined	01/08/2013
D2	Risk mitigation report	Report on solutions and tests for critical issues	01/11/2013
D3	Housing for example application	Hardware (application data, PCB's and power electronic components) will be provided to the applicant	01/02/2014
D4	Verification and test report		01/08/2014

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

7. Remarks

If required more detailed information can be released during publication/proposal phase after signature of a NDA agreement

Reporting

Periodic progress reports will be established.

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

Clean Sky Joint Undertaking
JTI-CS-2012-03-SGO-02-045

Topic description

CfP Nbr	Title		
JTI-CS-2012-3-SGO-02-045	**Regenerative Snubber and Innovative control algorithm for high efficient aircraft converter**	**End date**	T0 + 36M
		Start date	T0 (Assumed February 2013)

1. Background and context

Power electronics for next generation aircraft needs high power density (greater than 10kW/l) to solve weight and volume. Emergent large gap semiconductor technology will help to achieve part of this objective but existent and common control algorithm and snubbers circuits used in converters based on standard silicon devices shall be reconsidered and adapted to this new technology of components.

One part of purpose of this call for proposal (CfP) is to explore innovative topologies of regenerative snubbers more adapted for aircraft power converters (like Power Suppliers, Static Inverters, Motor Controllers) using large gap semiconductors in order to reuse power losses and increase highly their efficiency.

The other part of purpose of this CfP is to investigate on more robust and efficient control algorithm of aircraft converters with using regenerative snubbers.

In this innovative approach at control and snubbers part of converter design, criteria of compactness, weight reduction and conformity with EMC and harsh aeronautic environment will be also an important part of this study.

This CfP is a scientific and industrial challenge, which provides opportunity of competitiveness on this important improvement part of power electronics dedicated for more electrical aircraft for European partners of Cleansky.

2. Scope of work

This study of regenerative snubber and innovative control algorithm for high efficient aircraft converter shall include **following technical parts and activities:**

a) State of the art & trade study of existing and advanced topologies of regenerative snubbers & control algorithms.

b) Selection and study of limited topologies of regenerative snubbers and innovative control algorithms adapted to a specific aircraft converter.

- Verification of *compatibility of suggested solutions with aeronautic environment including CEM aspects,*
- *Verification and validation of suggested solutions applied to a specific converter with large gap semiconductors*
- *Simulation of optimisation and evaluation of benefits on converter's efficiency*

c) Description of final hardware design solution proposed for snubber and control algorithm

d) Validation tests of demonstrators applied on existent and specified aircraft converter

e) Manufacturing and delivery of minimum five hardware samples for internal verification and validation at aircraft converters levels.

The minimum expected feedback of this work for technical part is:

- Better knowledge on the design criteria and rules to build regenerative snubbers and efficient algorithm of control part of aircraft converters based on gallium nitride (GaN) and silicon carbide (SiC) power switches.
- Better view on capability to improve the efficiency of converter with using these snubbers and adequate robust control algorithm.

Applicants should emphasize when relevant any links or complementarities with previous projects, such as FP7 CREAM project or others call for proposal in Cleansky.

3. Type of work

The activities of this work shall be limited to 36 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 march (To Be Confirmed) **2012):**

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 existing and innovative solutions explored at laboratory level

Task 3: (T0+9M): Preliminary design review of technical proposal in accordance with specification.

Task 4: (T0+15M): Report of simulation study of selected regenerative snubber design and innovative control algorithm applied to existent converter

Task 5: (T0+18M): Final design Review of technical proposal for snubbers and control algorithm.

Task 6: (T0+24M): Report of hardware tests performed with selected regenerative snubber and innovative control algorithm to existent aircraft converter.

Task 7: (T0+28M): Delivery of minimum five hardware samples for internal verification and validation

Task 8: (T0+32M): Report of prospective to extend the design proposal to the others topologies of converters.

Task 9: (T0+36M): Final report (synthesis and conclusion).

Progress reports will be requested every two months.

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

For this study, the applicant shall satisfy following minimum criteria:

- Good background and experience in snubbers design and advanced material (large gap semi-conductors) used for power electronics operating in harsh 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.

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	• State of the art of existing circuits of regenerative snubbers and innovative control algorithm explored at laboratory level • Analysis of benefits and drawbacks of potential solutions. • Preliminary selection of topologies	T0+5M
D3	Preliminary Design Review (PDR) of technical proposal according the specification of the need and of the selected converter application	• Technical description of concept, structure, functionality and technologies of proposed solutions for regenerative snubbers and control algorithm. • Minimum of two solutions shall be proposed: baseline and backup plane	PDR: T0+9M

Deliverable	Title	Description (if applicable)	Due date
D4	Report delivery of simulation study of selected solutions	• Simulation tool to be defined during specification phase	T0+15M
D5	CDR: Critical Design Review of frozen solutions of regenerative snubber and control algorithm selected for hardware design and analysis	• Material and technical documents necessary to validate criteria of selected design will be defined during specification phase	T0+18M
D6	Report delivery of hardware tests performed with selected solutions of snubbers and control algorithm	• Application to a specific existent converter defined during specification or PDR phase.	T0+24M
D7	Delivery of minimum 5 hardware prototypes of snubbers and control algorithm boards	• These prototypes will be tested for internal verification and validation on aircraft converters	T0+28M
D8	Report delivery on prospective view for potential improvements and extension of studied solutions to others aircraft converters topologies	• Methodology …	T0+32M
D9	Final report	• Synthesis and conclusion of study	T0 + 36M

6. Topic value (€)

The **maximum value** for this topic is

400,000 €

[Four hundred thousand euro]

Please note any proposal above this value will be NOT be eligible.

Clean Sky Joint Undertaking
JTI-CS-2012-03-SGO-02-046

Topic description

CfP Nbr	Title		
JTI-CS-2012-3-SGO-02-046	**High Dense Smart Power Capacitor (HDSPC) for next generation Aircraft converters**	**End date**	T0 + 36M
		Start date	T0 (Assumed February 2013)

1. Background and context

Power electronics for next generation aircraft needs a drastic reduction of weight, size and shall operate in harsh thermal and mechanical environment.

Today, thanks to the emergent large gap semiconductor technology, the design of power switches with dedicated drivers using SOI technology allow to achieve this objective. Whereas, the passives of high power systems make up 40−50 percent of the Volume and weight and are unable to match the power electronics expected for More Electrical Aircraft.

The goal of this CfP is to develop, build and test a **H**igh **D**ense **S**mart **P**ower **C**apacitor (**HDSPC**) capable of operating over 200 °C and suitable with objective of weight reduction, electrical performances, reliability, service life …& cost objective

The applicant shall explore polymer chemistries to withstand high temperatures and rugged environments, while novel processing chemistry is improving the breakdown resistance and losses of high permittivity of selected materials.

Additionally, the applicant will integrate the capacitors with dedicated electronics and sensors to provide smart self diagnostics, & flexibility in capacitor banks of the future.

This call for proposal is a scientific and industrial challenges which provides opportunity of competitiveness on this important improvement part of power electronics for European partners of Cleansky.

2. Scope of work

This study of high dense smart power capacitor (HSSPC) shall include **following technical parts and activities:**

a) State of the art & trade study of existing and advanced capacitors material explored at laboratory level

b) Selection and study of adequate capacitor technologies (at minimum two) potentially suitable with the specification.

- Verification of *compatibility of suggested solutions with aeronautic environment including physical, electrical and thermal performances,*
- *Simulation study and optimisation of geometrical shape applied to the two minimum preliminary selected solutions of capacitors technology.*
- *Verification and validation of suggested solutions through tests of preliminary demonstrators (including performances and aging tests)*

c) Description of final hardware design of capacitor solution proposed and its self-diagnostic circuit.

d) Validation tests at component and converter levels of the second generation of demonstrators of capacitors equipped with self-diagnostic circuit

e) Extend the study of HDSPC capacitor to industrial and economic prospective.

The minimum expected feedback of this work for technical part is:

- Better knowledge on the design criteria and rules to build the needed capacitors based on available and advanced dielectric material like PEN-HV, PTFE, PI …
- Better knowledge on electrical and thermal and physical performances and capabilities of these types of capacitors (HDSPC) manufactured and tested during this project.

- Better knowledge on health monitoring part (the smart part) of this innovative capacitor concept to be highly integrated in the design of future generation of power converters dedicated for aircraft application.
- Prospective view for industrialization and economic study of first and potential next generation of HDSPC devices.

If available, the applicant shall use benefits and progress made on this needed technology studied for electrical vehicles and others previous European research programs on this subject.

3. Type of work

The activities of this work shall be limited to 36 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 in beginning of 2012):

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+4M): Review of trade-off of capacitors suitable with the specification

Task 3: (T0+8M): Preliminary design review of technical proposal in accordance with specification (selection of capacitor material technology, preselection of optimized geometrical shape, size, weight and expected electrical, and thermal performances based on simulation results).

Task 4: (T0+12M): Set of minimum 20 samples for verification and validation of physical and electro thermal performances

Task 5: (T0+18M): Test report of results preliminary samples.

Task 6: (T0+20M): Final design Review of technical proposal for HDSPC demonstrators with electronic design of self-diagnostic and its implementation on the component.

Task 7: (T0+24M): Set of minimum quantity of 20 demonstrators equipped with electronic self-diagnostic circuit.

Task 8: (T0+32M): Test report of validated samples at the applicant laboratory.

Task 9: (T0+36M): Final report delivery including technical development, industrial and economic parts.

Progress reports will be requested every two months.

Two scientific thesis for investigation parts will be suggested: one of these thesis will focus on the study of adequate capacitor material and geometrical shape impacts on electro thermal performances and the second thesis will focus on the study of aging phenomenon on selected capacitor raw materials and on the integration of adequate health monitoring and self diagnostic circuit of these capacitors types.

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

For this study, the applicant shall satisfy following minimum criteria:

- Good background and experience in capacitors technologies for power electronics operating in harsh environment,
- Good background and experience on self-diagnostic and health monitoring electronic circuits dedicated for power electronic devices.
- 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.

5. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Requirements Analysis	Review and finalisation of requirements specification (clause by clause) and SOW (statement of work)	T0+2M
D2	Review of trade-off study of capacitors technologies potentially suitable with the need.	state of the art of existing capacitors and advanced materials explored at laboratory level Analysis of benefits and drawbacks of potential solutions. Preliminary selection of capacitors materials technology	T0+4M
D3	Preliminary Design Review (PDR) of technical proposal according the specification of the need	Preliminary Selection of minimum two solutions of capacitors technologies (baseline and backup plane) shall be proposed; Simulation analysis and preliminary tests or technical evidence criteria to validate the preselection material	PDR: T0+8M
D4	Report delivery of simulation study of selected solutions	Simulation tool to be defined during specification phase	T0+10M
D5	Manufacturing of minimum 20 samples for performance and aging tests	Set of minimum 20 demonstrators for validation with electro thermal and physical specification Endurance and aging tests shall be defined and started	T0+12M
D6	Report delivery of test results obtained with preliminary samples		T0+18M
D7	CDR : Critical Design Review of frozen solutions of HDSPC capacitors with detailed circuit of the self diagnostic and health monitoring parts	Material and technical documents necessary to validate criteria of selected design will be defined during specification phase	CDR: T0+20M
D8	Set of minimum quantity of 20HDSPC capacitors with implemented self diagnostic circuit shall be delivered	Evaluation at component and at converter level will be performed	T0+24M
D9	Test validation report delivery		T0+32M
D9	Final report to clause the work	Synthesis, conclusion and prospective view for potential improvement, industrial and economic study shall be included in this report.	T0+36M

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.

Clean Sky Joint Undertaking
JTI-CS-2012-03-SGO-02-054

Topic description

CfP Nbr	Title		
JTI-CS-2012-3-SGO-02-054	**Design and manufacturing of Flight test version of Electro-mechanical Wing Ice Protection assembly (Modified A320 slat 5)**	**End date**	04-2014
		Start date	02-2013

1. Background

Electro-Mechanical Wing Ice Protection (EMEDS) is used today on smaller aircrafts. In the framework of JTI/Clean Sky Systems for Green Operations (SGO) the technology is adapted and integrated into large aircraft wings. EMEDS offers an innovative way to significantly reduce the power needed to protect the wings from ice build-up. The technology uses electrically powered actuators to crack and shed the ice.

The technology has been tested in ice wind tunnels and will now proceed to be tested during flight in an Airbus A320 where one slat on one wing will be equipped with an EMEDS system.

This call for proposal aims to select a partner that will make the detail design and manufacture the A320 slat 5 for flight test which will incorporate the electro-mechanical ice protection system.

The design is not aimed for serial production it is just one slat for flight test.

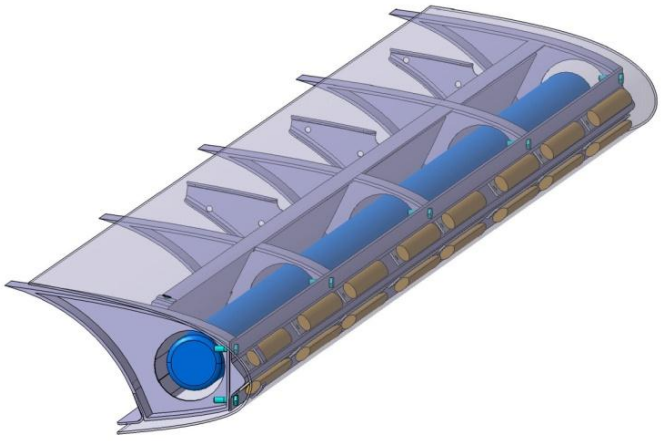


Figure 1 EMEDS slat overview

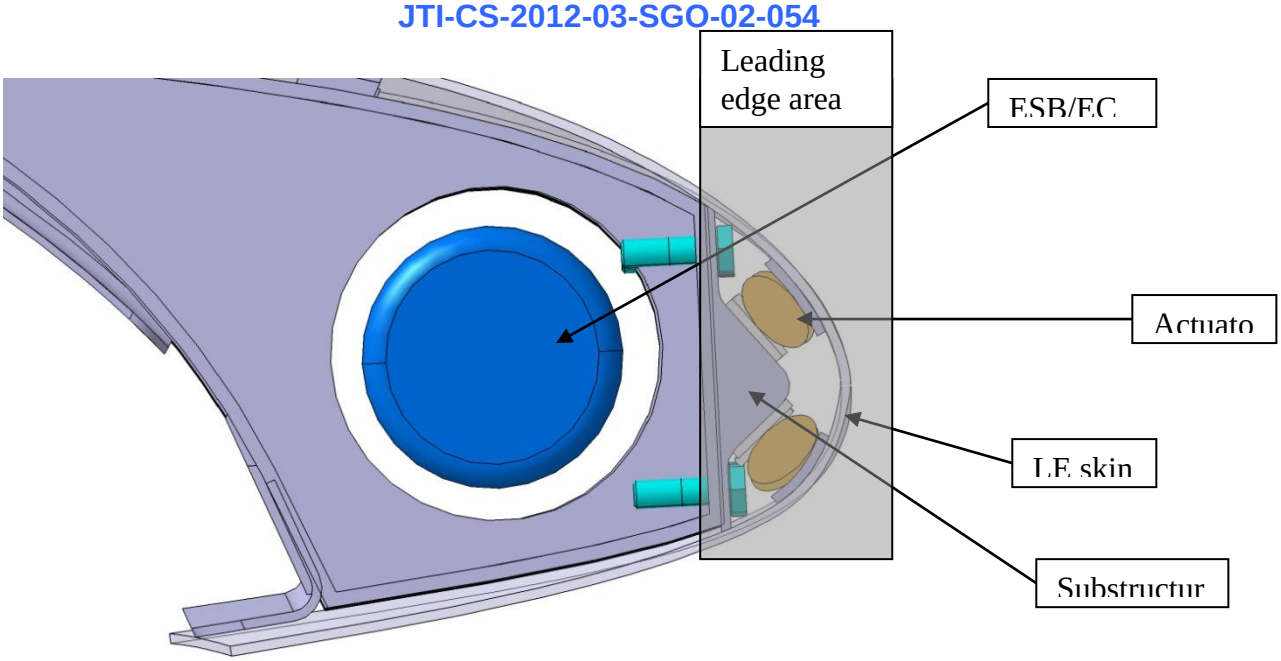


Figure 2 Leading edge detail view

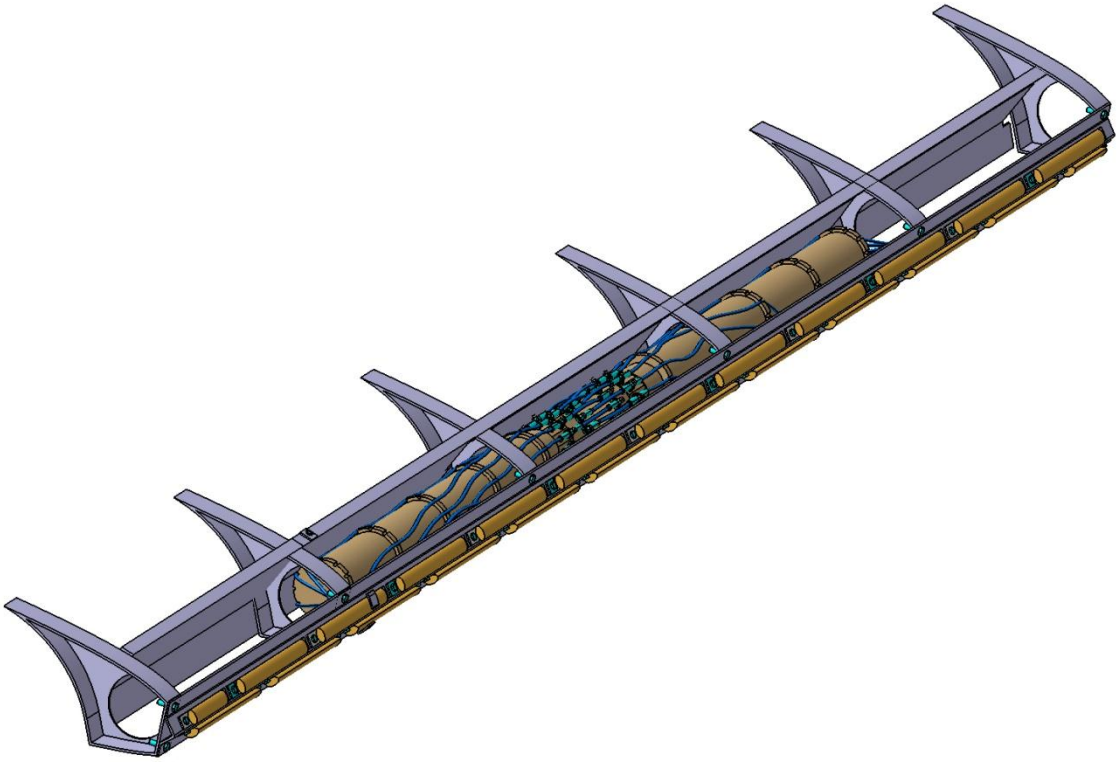


Figure 3 ESB/ECU draft installation

2. Scope of work

The SGO ITD (Integrated Technology demonstrator) member will make a proposal of the design which is based on the ice wind tunnel testing performed as part of JTI Clean Sky SGO. The selected partner will then make the detail design and manufacture the flight test slat based on the proposal. The size of the slat is about 2500*400 mm. The detailed design will cover integration of electro-mechanical actuators and Energy Storage Bank (ESB)/ Energy Control Unit (ECU) into the slat. Also part of the detail design is the harness installation from the wing to the slat.

The slat can either be a modified A320 slat or manufactured as a new item depending on what is most efficient. This is a task for the applicant to decide.

System components and a typical EMEDS installation are shown in Figure 1 to Figure 3.

Work package description				**Responsible**
WP1.	Requirements specification			**Applicant**/(SGO ITD member)
WP2.	Design			**Applicant**
	a.	Outer geometry		SGO ITD member
	b.	Structure design		Applicant
	c.	EMEDS installation design (Leading edge area)		SGO ITD member
		i.	Actuator position	
		ii.	LE skin design	
		iii.	Substructure design	
	d.	System component installation		Applicant
		i.	Wiring installation inside of slat	
		ii.	Actuator and ESB/ECU installation	
		iii.	Slat to Wing harness installation	
WP3.	Stress analysis			**Applicant**
	a.	Loads		SGO ITD member
	b.	Total stress analysis/documentation		Applicant
WP4.	Manufacturing			**Applicant**
	a.	Manufacturing of one slat		
	b.	System components installation		
WP5.	Airworthiness documentation			**Applicant**
	a.	Test flight certification		
WP6.	Support			**Applicant**
	a.	Installation support		
	b.	Flight test support		

3. Type of work

- Design and integration together with SGO ITD member of the EMEDS system in an A320 slat 5
- Manufacture of flight test slat and delivery to Airbus
- Airworthiness documentation for a very limited number of flights
- Support during Installation on aircraft
- Support during test campaign

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

The applicant shall have the competence and applicable approvals, for instance EASA (European Aviation Safety Agency), to design and manufacture a flight worthy slat.

5. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Object	Due date
D1	Requirements specification	WP1	Report	03-2013
D2	Preliminary Design report	WP2	Report	05-2013
D3	Preliminary Stress report	WP3	Report	05-2013
D4	Preliminary Design Review passed successfully	Overall review	PDR Minutes of Meeting	06-2013
D5	Final Design report	WP2	Report	09-2013
D6	Final Stress report	WP3	Report	09-2013
D7	Critical Design Review passed successfully	Overall review	CDR Minutes of Meeting	10-2013
D8	Delivery of airworthy A320 slat 5 with EMEDS ice protection for flight test	WP4	Slat	04-2014
D9	Airworthiness documentation	WP5	Report	06-2014

6. Topic value (€)

The **maximum value** for this topic is
500,000 €
[Five hundred thousand euro]

Clean Sky Joint Undertaking
JTI-CS-2012-03-SGO-02-055

Topic description

CfP Nbr	Title		
JTI-CS-2012-3-SGO-02-055	**Tool for wiring optimization regarding lightning threat**	**End date**	31/06/2014
		Start date	01/01/2013

1. Background

Composite materials such as CFRP (Carbon Fiber Reinforced Plastic) are increasingly used in the design of new generation aircraft in place of traditional metallic structures and skin. These composite materials do not have the same electrical properties as metallic material.

So the design of these new aircrafts has to include a new electrical network to ensure a number of electrical functions and in particular lightning effect protection. This network called ALEEN (ALmost Equipotential Electrical Network) by LABINAL cannot be as protective as a metallic body respect to the lightning aggression. This new network is sized to optimize the lighting compatibility taking into account the harness protection or configuration as parameter. This could lead to increase the harness protection and/or the equipment circuit protection, increasing as well the mass embedded.

The aircraft manufacturers, the wiring installers, and the equipments providers have to work in partnership to optimize the EWIS network using the skills' trades with benefits.

Currently wiring installation configurations are included in the 3D simulation tools Thus, we need a lot of 3D simulations to optimize EWIS installation and technology. Free degrees are to be given to the installer to benefit of these skills.

Indeed, the electrical harness installer has reserved space where he has to place the harness. This space is called space allocation. If the electromagnetic characteristic of the space allocation is known, the longitudinal electric field will be coupled on the harness in a 2D tool able to calculate transmission parameters matrix and solve BLT equation to give voltage and current at different location on the electrical network.

The aim of this call is to give tools based on a methodology which optimize the electrical network (harnesses protection, protection device circuit, harnesses routing...) regarding the lightning aggression taking into account the skills' trades.

2. Scope of work

The call for proposal aims to select a partner that will be in charge of the development of a methodology and tools aiming to calculate, at the equipment level, the open circuit voltage and the short circuit current induced by a lightning strike.

The first step will be a study of the method able to separate the modelling of the lightning strike on an aircraft. In particular, the study will focus on the ability to place harnesses in a 2D space allocation where the electromagnetic field is known. This set of electromagnetic field will be stored in a data base. The placement has to be done without re-calculate the electromagnetic field. The evaluation of the limits in term of frequency, impedance of harnesses, errors will be evaluated by the partner. Partner will have to develop an interface called CHAPL, which allows easier change of a harness position in the 2D space allocation with automatic update the impedance matrix, voltage and current using a leader BLT Network model.

The second step consists in creating an interface (GUI) between WP leader electrical databases (source impedance, load impedance, routing harness, electromagnetic field...) and CRIPTE code. CRIPTE code has been identified by the WP leader as one code able to calculate the voltage and

current on an electrical network, from electromagnetic fields, using theory of topology applied to MTL (Multiconductor transmission-line) theory. The interface tool has to simplify the placement of harnesses in space in CRIPTE code and respect the limit obtained in the first step study.

The last step of the study will be an experimental validation. In that case, a tool will be developed to calculate electromagnetic field in allocation space reserved to electrical harnesses taking into account geometry and material properties of aircraft structure, provided through a CAD tool, and lightning strike scenario. The electromagnetic field obtained will be an input of the interface developed in the second step to calculate the voltage and current at equipment level.

3. Type of work

The selected partner shall deliver a methodology, software tools and a user manual of the software tools.

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

Research institute specialized in the field of electrical engineering and SME experienced in electrical simulation software tool.

The partner should be able to upgrade and make the maintenance of the tools during the clean sky program. The industrialisation and the maintenance of the tools is not part of the call for proposal.

Partner will develop methodology and tools compatibles with ONERA software: CRIPTE.

5. Major Deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Study and Description of the method		31.05.2013
D2	Simplified electromagnetic field data base and CHAPL tool including the user manual		30.11.2013
D3	Interface between CRIPTE and WP leader electrical database and CHAPL		30.02.2014
D4	Validation test plan for CHAPL		30.03.2014
D5	Validation test results		31.05.2014

6. Topic value (€)

The **maximum value** for this topic is

800,000 €
[Eight hundred thousand euro]*

**Please note any proposal above this value will be NOT be eligible.*

7. Remarks

CAD tool will be CATIA. The Digital Mock Up contains 3D geometry of composite skin and airplane structure, ALEEN physical data, EWIS space reservation, localisation of the connectors and terminal equipments. It contains information about materials.

Validation of the method: The WP Leader will adapt a simplified mock-up of an airplane section (size about 1/10) developed and manufactured in SGO. The mock-up is representative of the impedance of the electrical network in term of composite skin, ALEEN network and EWIS Network (space reservation in a first step and then representative harnesses). This Mock-up has been designed with CATIA and an electrical design tool of WP Leader as input data to use by partner to determine, with the electromagnetic fields, the voltage and current.

A first level of validation will consist in a preliminary validation of the method, performed by the partner using simple test case and simulation with a validated software.

A second level of validation will be performed by test.

Measurements voltage and current, carried out by the WP leader, will be compared with the computed results of the partner with current injection on the mock-up simulated the lightning strike.

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, equipment impedance, etc. Exchange files with the interface to be created shall be in XML format.

Clean Sky Joint Undertaking
JTI-CS-2012-03-SGO-02-056

Topic description

CfP Nbr	Title		
JTI-CS-2012-3-SGO-02-056	Integrated design tool to support EWIS optimisation	**End date**	31/06/2014
		Start date	01/01/2013

1. Background

In the present economical context, the reduction of fuel consumption becomes imperative. Thus, the weight of the electrical system has to be diminished by minimising the total mass under constraints.

The sizing of electrical cables' gauges is made nowadays using two physical criteria:

Thermal – translated by a maximum heating value, relative to the normal ambient temperature; the maximum operating temperature that a cable can reach without damage of the insulation or the conductive core is taken into account for sizing circuit breakers (fault functioning);

Electrical - maximum voltage drop on the electrical supply link, taking into account all the cables composing the link in question.

The thermal sizing is made using standards that furnish the dependency between the temperature and the current circulating in the cable. In spite of their ease of use, these standards do not take into account the real operating conditions. They furnish the previously mentioned dependencies in the case of single wires in free air. The same standards furnish a set of bundle derating curves, in which the hypothesis of homogenous bundles is made.

These standard dependencies are plotted for a single configuration in which it is supposed that all the equipments function in the same time. This assumption is not realistic in several cases, like:

- the case of equipments that have to work only during certain flight phases (landing gear, galleys, etc.)

- the case of equipments disposing of primary, secondary and emergency supply circuits (these cables should not be supplied in the same time).

Moreover, the standards do not take into account any differentiation between special cables.

It becomes obvious that these methods are obsolete and that the sizing of the cables should be rethought using new rules that take into account the real loading rate of the cables in the different bundles and the overheating corresponding to each type and gauge of cable. The second major component allowing the sizing of the cables is the electrical one. The choice of the gauges should be made with respect to the maximum voltage drop criteria imposed while considering the compatibility of the different cables composing the electrical link. Another important factor to be considered is the inductive character of the supply cables that cannot be neglected anymore due to the size of the gauges used and the increase of the normal functioning frequency. Last, but not least, the sizing of the cables should take into account the influence of the different flight phases and of the areas' in which the cable passes (pressure and temperature will vary depending on the area traversed).

In the new "more composite and more electric aircraft" context, the environment of the electrical wiring system is modified. The increase of the steady state functioning frequency leads to the increase of the inductive components of the conductive elements and of the mutual couplings between them that eventually have to be taken into account when designing the electrical system. The optimisation of electrical systems will take these aspects into account as an input data.

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2. Scope of work

The aim of this call for proposal is to select a partner for the development of a cable gauges optimization software. The partner selected at the end of the procedure shall have 18 months to provide a validated tool.

As presented in the previous paragraph, the cable gauge sizing problem is a multi-physics problem. Thermal and electrical aspects are to be taken into account in the first place, but the software should be conceived with regard to the possibility of introducing additional constraints, like considering the electromagnetical environment created by the current return network, the structure of the aircraft, the fuselage, and the couplings that may occur between all these elements.

The wiring system in question is a large scale system, containing more than 1000 wire harnesses, 40000 pathway segments, 10000 connectors, corresponding to more than 150 km of cables. The electrical links between two equipment generally include several segments (pathway segments). These wire segments may have different gauges. The optimization of the different wire gauges is the scope of this study.

The choice of these gauges is subject to constraints like:
- flight phase durations
- variable environmental parameters (temperature, pressure) according to the zones of the aircraft
- electrical consumption cycle for each wire connection
- unknown and non-controllable position of wires in the harness
- impedance of the supply loop.

The WP leader has identified two major axes for this study that should be treated:

1° defining and developing some optimization techniques suitable for large scale systems; the objective function will be at first a mono-objective function - the minimization of the cable mass under constraints; the objective function may evolve to a multi-objective function by adding costs, for example.

2° developing a model reduction strategy and adapting the optimization process accordingly.

The WP Leader will furnish all the necessary input data concerning the system to be optimized: system configuration, gauge range, data related to the environment, impedance of the supply loop (this data is furnished by the GENIAL project, JTI-CS-2011-1-SGO-02-032, on “Current return simulation (methodology & tool)”).

The first step will consist in the development of a global optimization strategy. Several methods will be proposed by the partner with an additional performance analysis. The partner will define a thermal and electrical model reduction strategy and will adapt an optimization process accordingly. At this moment, a hierarchical organization of the constraints in the optimization process seems a good solution for obtaining a sequential process that could be more easily computed. Only electrical and thermal aspects evoked previously, applied only to the supplied cables that have to be optimized, will be considered at the beginning. The partner will foresee the introduction of other constraints later.

The second step will consist in the development of optimization software. The input data provided by the WP Leader will be the standard charts and the electrical database of the WP Leader. An interface between the software and the electrical database of the WP Leader will be necessary.

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 (software expert, optimisation expert, etc.) to this proposal.

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

The partner should be experienced in large system optimisation problems.

The partner should have a strong, proven experienced in simulation software tools.

The partner should have his own developed simulation tools.

The partner should be able to upgrade and accomplish all maintenance works on the tools during the clean sky program.

5. Major Deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Description of the optimization methods and model reduction techniques		M6
D2	First software release and associated user manual		M12
D3	Software test and validation plan		M12
D4	Validation procedure results		M18
D5	Final software release		M18
D6	User manual		M18

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.*

7. Remarks

The electrical database for the study will be furnished by the WP Leader in .xml format.

Clean Sky Joint Undertaking
JTI-CS-2012-03-SGO-02-057

Topic description

CfP Nbr	Title		
JTI-CS-2012-3-SGO-02-057	**High Voltage connectors and moving links**	**End date**	31/06/2014
		Start date	01/01/2013

1. Background

Since few years, to develop the more electrical aircraft, researcher works for the use of electrical systems in place of hydraulic systems for a lot of function requiring high load capacities.

This new approach involves the development of electrical equipments like motors or actuators able to supply these high loads which needs a high electrical power. The trend is to increase the voltage to 230 VAC, +/-270 Vdc and/or 540 PWM.

This situation has an impact on the harness components like connective devices, wires,.., They must be adapted to the characteristics of the new voltage and needs to be qualified according to the constraints for an use in all aircraft flight conditions and for all areas (pressurized or unpressurized).

The aim of this call for proposal is to work on connectors compliant with 540 volts PWM.

2. Scope of work

The call for proposal aims to select a partner that will be in charge of the study of new connectors able to withstand the constraints of the 540 volts PWM in an aeronautical environment.

The first step will be to do a state of art and to look for the following points:

→identify the new constraints applicable to connectors

→look if the existing standards of connector like EN or MIL already used in aeronautical field are compatible or not

→search for the difference between these standards and the real need

→list the improvements to upgrade the components

The particular points to investigate are the insulation performance, the partial discharges behaviour, the EMI/EMC point of view, and the lifetime.

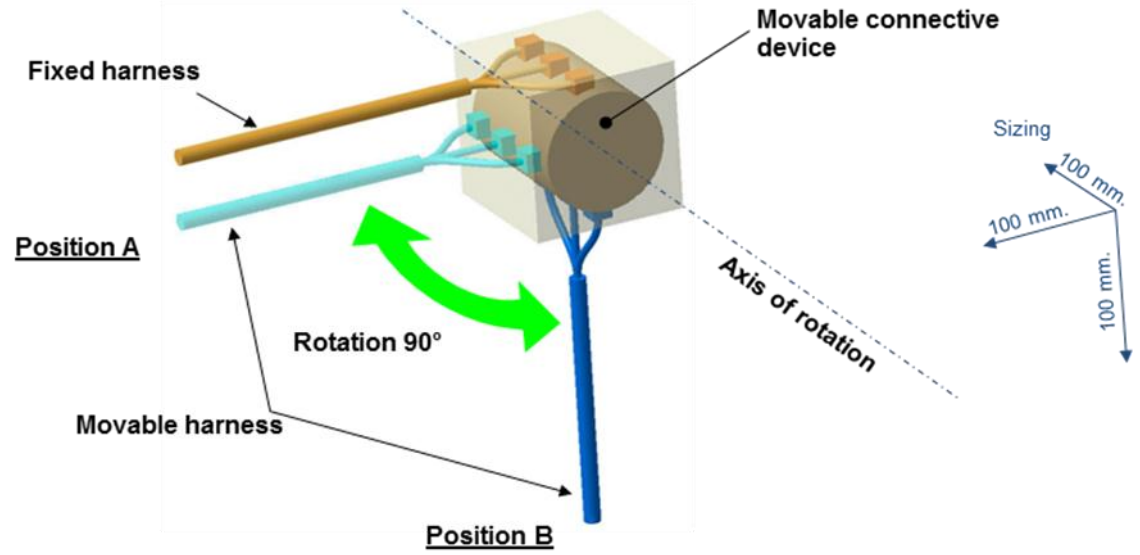
The second step consists to design 2 type of prototypes:

1) a by-product of the existing standards EN/MIL or a new type of “static” connector taking into account all the electrical constraints and the environmental conditions for an use into pressurized or unpressurized area of the aircraft.

The range of sizes and arrangement will be decided during this step.

2) an innovative movable connective device able to withstand a relative movement of the two connected harnesses like shown on the example below with the same functional conditions than previously described.

This step will include too a proposal for a validation program.



These 2 prototypes will be design for 540V PWM and 50kVA.

The third step will be to manufacture and provide at least 5 samples for each connectors.

The last step will be to perform validation tests to demonstrate the capability of the new design to withstand the identified constraints.

3. Type of work

The selected partner shall deliver a complete study including the following tasks:

state of art and analysis, technical proposals, 3D design, manufacturing, validation tests plan and tests results.

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

This call for proposal applies to a connective devices manufacturer with innovative capabilities and an important knowledge in aeronautical field.

The partner should be able to study, design and manufacture the products.

5. Major Deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	State of art and constraints analysis	Results of 1st step	31.02.2012
D2	Technical proposals and specification	Issued from 2nd step	30.05.2013
D3	Validation test plan		30.05.2013
D4	3D design of the samples	CAO study of classical and movable connectors	30.11.2013
D5	Sample delivery		30.02.2014
D6	Validation test results		31.06.2014

6. Topic value (€)

The **maximum value** for this topic is

200,000 €

[Two hundred thousand euro]*.

**Please note any proposal above this value will be NOT be eligible.*

7. Remarks

The partner will benefit of the support and the expertise of Topic Manager in the field of aircraft wiring.

Clean Sky Joint Undertaking
JTI-CS-2012-03-SGO-02-058

Topic description

CfP Nbr	Title		
JTI-CS-2012-3-SGO-02-058	**Optimize Power cable for Skin Effects**	**End date**	31/06/2014
		Start date	01/01/2013

1. Background

Aircraft engines have historically generated and transported electric power at low voltage levels as this has provided a safe and reliable means of energy transport. With the advent of technology such as the More Electric Aircraft (MEA), there are increased electrical power demand from the engines. The replacement of such systems with electrical alternatives will provide significant aircraft efficiency benefits resulting in better environmental performance due to reduced fuel consumption, gain in flexibility and health monitoring.

The concept of the MEA to All Electric Aircraft (AEA) where electrical power plays a prevailing role requires the development of reliable and efficient equipments.

The MEA represents recently the major driver for increasing the generation of the electric power. Moreover, it is directs the research into new generations options. Different electric power generation disciplines are used in aircraft. These schemes are summarized in the following:

- The constant frequency (CF) options are the most common. However, the need for unreliable gearbox to match between the engine speed and the generator requirements of fixed speed. The CF is alternatively termed Integrated Drive Generator (IDG).

- Variable Speed Constant Frequency (VSCF) DC link system is now the preferred option for the most new military application and some commercial aircraft. Currently, the range of VSCF DC link system has been widened due to the recent advancements in field of high power electronic switches.

- Variable Speed Constant Frequency (VSCF) cycloconverters convert directly the variable frequency AC input power with fixed frequency and magnitude. The power generation efficiency of the cycloconverter increase as lagging power factor decrease, which would be beneficial if this technique, is applied to motor loads with significant lagging power factors.

- Variable frequency (VF), typified frequency wild, is the most recent electric power generation contender. The promising features of VF are the small size, weight, volume, and cost as compared with other aircraft electrical power generation options. However VF may pose significant risk at higher power levels, particularly with high power motor loads; furthermore, the cost of motor controllers required due to the variation in the supply frequency, need to be taken into consideration when assessing the VF.

Innovations in the area of power components as all components associated are required to enable realization of MEA.

The aircraft power system usually consists of a combination of 115 V 400Hz AC for large loads and 28 VDC for avionics, flight control and battery-driven vital services. However, adopting the new generation options as VF requires using power electronics to convert all the motor/generator outputs into a single high voltage DC distribution system. The value of the system voltage is suggested to be 270 or 540V. Using a high value for the distribution system has the advantages of reducing the weight, the size and the losses, while increasing the levels of the transmitted power. The exact value,

however, is determined by a number of factors such as, the capabilities of DC switchgear, the availability of the components and the risk of corona discharge (or Partial Discharge PD) at high altitude and reduced pressure.

Electrical wiring provides links in various signals form between devices. This network, more and more significant and crucial, given the scope of its function, must be reviewed and adapted to the news constrains regarding the power transmission such as: High Voltage Direct Current (HVDC), High Voltage Alternative Current (HVDC) and Pulse Width Modulation (PWM).

For reasons bind to voltage level increasing, several signals nature and VF, the design and development of new cable is required to adapt to different types of signals and to optimize equipments operations..

2. Scope of work

This proposal is part of further work carried out as part of Clean Sky. This act to develop cables to comply with aircraft requirements and having optimized functional characteristics. Two types of cable will be developed:

- Link starter-generator (feeders of power transmission AC/DC: PWM transmission in starter-phase/ AC transmission in generator-phase)
- Specific transmission of PWM

Innovation in the field of cable concerns taking into account skin effect optimize. This act the improvement of conductor part of the cable, their topology and their behavior to electric stress. The aim of this call of proposal is to design, develop and manufacturing new conductor of cable with optimizes skin effect.

The aircraft systems use converters to drive power loads such as synchronous or asynchronous motors. This power is carried by cables call “Power cables” and covers a wide frequency range up to several 100Hz. The power cable currently used have cylindrical conductor part which, taking into account skin effect are not optimized for a weight. For example, the resistance to 2kHz of Aluminium AWG000 is doubled in comparison with DC resistance. However, high frequency signals are also transmitted by power cable and more specifically to switching frequency on the level of the order several 10kHz. It is necessary to construct a precise model and manufacturing power cable, taking into account various phenomena that appear when the frequency increases.
The news advances must make in performance of the conductor taking account the optimum operation conditions.

The partner selected at the term of this procedure, shall have 18 month to realize the prototypes at TRL5 level in justifying aircraft requirements. These schemes are summarized in the realization of power cable which the different steps are:

- The study of the state of the art including existing product their application and the know models.
- Step of electric and thermal conductor modelling in the frequency range up 100 kHz and the conductor parametric models.
- Making of sufficient length of different prototype (3) gauges (AWG8, AWG2, AWG00) and two (2) specific gauges (TBD) optimized for operation in the band 0-20kHz (switching frequency included)

- Step of test and validation: Thermal, Electric, mechanic, strip
- Step of validation by justification: aircraft requirements
- Providing of coil (length 200m) for specific gauge (TBD)

This summary shows an overview. The implementation of the cable harness will be envisaged, including electric contacts adaption mostly optimize crimping process.

They define the characteristic of the cable diversity, reflecting their behavior according to stress. The variation of these parameters allows to develop specific cable. The values parameters will be studied in the state of the art and specified in the design specification.
In some case such as PWM transmission, the conductor part will be composed by the mixture of strands enameled thread with bares conductors. The combination of both will ensure even distribution of current density.

The partner shall take into account some specifities relative to functional and environmental aircraft stress.

This cable shall operate without damage and in correspondence with their functional specification in the environmental specified by RTCDO.
LABINAL would to make different type of cable harnesses that will have specific features and optimize according to their configuration. The new cable will allow provide modular harnesses. Preliminary study will be conducted for the prototypes implementation and their development. This act the integration of all components makes up the harness and the technique used.

3. Type of work

The selected partner shall write the state of the art, the specification in collaboration with Topic Manager. Design and manufacturing the prototype

The partner shall provide all the necessary resources (safety expert, respect of standards requirements, materials, etc.) to this proposal.

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

The partner should have a matured experience in design and cable development.

The partner should be experienced in manufacturing components.

The partner should have his own recognized (by the aviation community) tool.

The partner should be able to upgrade and make the implementation during the clean sky program.

5. Major Deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Writting of State of the art		31.05.2013
D2	Parametric model of the conductor		30.10.2013
D3	Validation of Test Plan		30.11.2013
D4	Conductors prototypes		30.12.2013
D5	Test report		31.05.2014
D6	Specific conductor coil		31.05.2014

6. Topic value (€)

The **maximum value** for this topic is

200,000 €

[Two hundred thousand euro]

**Please note any proposal above this value will be NOT be eligible.*

7. Remarks

Specification of requirements, Validation Test Plan and the specific gauge type will be provided by the Topic manager.

Clean Sky Joint Undertaking
JTI-CS-2012-03-SGO-02-059

Topic description

CfP Nbr	Title		
JTI-CS-2012-3-SGO-02-059	**Certified Code Generation of Model-Based Modelica Controllers**	**End date**	July 2015
		Start date	Feb. 2013

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. In particular, models that span the full operating region shall be directly usable in control systems of the aircraft, in order to improve significantly the behaviour.

The Systems for Green Operations ITD is looking for specialists to become partners of the consortium to extend a tool chain that is certified to generate controller code for use in embedded systems of civil aircrafts, so that both standard input/output Modelica[1] controller blocks, as well as advanced nonlinear Modelica controllers can be included in the tool chain.

2. 2. Scope of work

In Clean Sky SGO ITD, several members are working on modelling and simulation of aircraft systems with the multi-domain modelling language Modelica (www.Modelica.org). The final goal is to not only utilize these models for design and evaluation, but also to directly use Modelica controller models for generation of certified code in embedded systems. On one hand this will improve the system design process, since controllers developed in Modelica won't need to be coded manually in a different language. On the other hand advanced nonlinear controllers could possibly be certified and thus applied on-board an aircraft. Examples are system controllers of, e.g., electric ECS, and energy management controllers for load or thermal management. By invoking Modelica models of the nonlinear system models a first step towards model-based algorithms is made. Afterall, if the code is certified, the controllers may be used directly on real prototypes, with evident benefits on the developing and testing time, as well as on improved performance in the whole operating region.

The task to be carried out shall include:

(1) Defining the requirements about the type of models that shall be handled (at hand of at least two different benchmark examples provided by the topic manager in the area of Systems for Green Operations ITD).

(2) Defining the requirements so that the models identified in (1) can be automatically transformed to C-code that is qualified according to DO-178B, level A, for civil aircrafts.

(3) Identifying a subset of the Modelica language (version 3.3) and of symbolic transformation and compiler techniques so that the requirements of (1) and (2) can be fulfilled.

(4) Implementing a prototype of a tool chain.

(5) Supporting the evaluation of the prototype coordinated by the topic manager.

3. Type of work

The selected partner has to define the requirements, has to design and implement the prototype of a tool chain for code generation of Modelica controller models qualified according to DO-178B, level A. The prototype is evaluated by the topic manager and the partner has to support him in this respect, especially by providing the prototype to the topic manager and his partners for the evaluation without costs. The requirement documents of (1) and (2) above, as well as the analysis in (3) has to be provided in documents available to the public. The tool improvements must be made available in the existing tool chain of the partner as a product.

[1] Modelica® is a registered trademark of the Modelica Association.

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

The partner(s) shall provide specific and detailed skills in the topic area of this call for proposals.

- Outstanding know-how in the certification/qualification process according to DO-178B.
- Outstanding know-how of the object-oriented modelling language Modelica.
- Have an existing tool chain to generate DO-178B qualified code from a high level definition of controllers.
- Have an existing Modelica tool, or use an open source Modelica tool, and be able to adapt this tool for the task to be carried out.

5. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Concept document defining the requirements of the Modelica models that shall be handled	Technical report (public)	T0 + 6 months
D2	Concept document defining the requirements to automatically generate qualified code for the models defined in D1	Technical report (public)	T0 + 9 months
D3	Concept document defining a subset of the Modelica language and of symbolic transformation and compiler techniques to fulfil D2.	Technical report (public)	T0 + 12 months
D4	Prototype of a tool chain for D1-D3 (version 1).	Technical report and Tool	T0 + 24 months
D5	Prototype of a tool chain for D1-D3 (version 2).	Technical report and Tool	T0 + 30 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

- The topic value under (6) is the upper bound for the total budget (so the sum of funding and contributor expenses).

Clean Sky Joint Undertaking
JTI-CS-2012-03-SGO-02-060

Topic description

CfP Nbr	Title		
JTI-CS-2012-3-SGO-02-060	**Electrical Machine Magnetic Properties Characterisation Setup for Aerospace Application**	**End date**	October 2014
		Start date	October 2013

1. Background and context

Electrical machines being developed within the CleanSky programme are adopting novel magnetic materials working close to the material limits and excited by non-conventional waveforms in an effort to save materials and weight. To enable larger power density the magnetic materials are often operated in deep saturation especially when large peak torques are required when compared to rated values. This is typical in many actuation applications. Achieving this torque is often highly dependent on the material characteristics in a region which is typically not defined by the materials suppliers.

High performance aerospace machines are increasingly adopting large pole numbers or go at high mechanical speeds – both of which push the supplying waveforms to high frequency. As the practical switching frequencies of power drive electronics are limited, the supply waveforms are often harmonic-rich. The losses incurred in the material and hence the performance of the electrical machine is highly dependent on the material characteristics.

Standard tests do exist however most materials operate outside the tested bands and in different regimes. In addition to this the processes on the materials during manufacturing also lead to the materials display substantially different characteristics. Existing loss data, provided by the steel manufactures, in accordance with existing standards only cater for sinusoidal, pulsating field losses which provide a mere starting point, rather than correct reference for the designer.

The purpose of this CFP is to develop a test setup able to characterise magnetic materials when excited with pulsating or rotational fields at high frequency and high flux density. It is envisaged that PWM waveforms will also need accounting for. This CfP will help the European aeronautic partners to have better knowledge on the design criteria of aerospace electrical machines and have a reliable test method to guarantee that the materials will behave as expected in the application at hand.

2. Scope of work

The aim of this CfP is to find a partner who has the necessary experience and capabilities to develop and manufacture a high performance magnetic materials characterization setup with the necessary flexibility to accommodate aerospace motor requirements. The partner will be required to provide a solution for the characterization in terms of B-H characteristics and losses of the soft and hard materials being used within the electrical machines developed by the SGO team.

The selected partner will first review and summarize the different measurement techniques and possible setup for characterizing the magnetizing curves and losses of electrical steel. It will then be expected that the partner will design and manufacture a test setup able to handle soft and hard magnetic materials used for high performance electrical machines

Due to the inherent nonlinear magnetising nature of ferromagnetic materials, iron losses generally prove to be the hardest type of losses to correctly quantify a priori. Compounding the problem even further, the machines considered for high performance aerospace applications often operate at high excitation frequencies, driven by non-linear devices/converters which in turn introduce further harmonics to the already high fundamental frequency. Iron losses can be broadly categorised by the type of localised magnetic field which induces them, namely a one-dimensional time varying field (stator teeth) is responsible for setting up pulsating loses, and a two-dimensional time varying field (such as that present at the root of the stator teeth) will set up rotational field losses. Both loss mechanisms differ in a number of ways, and in the reality both are present simultaneously within

rotating electrical machine. A key aim of this CFP is to develop the ability to distinguish and determine the iron loss components, thus allowing the designer to better estimate the losses and consequently result in a motor which is fit for purpose.

The flexible test setup will be expected to fulfill the following requirements:

- Digitized measurement setup which can give reliable and repeatable results
- Measurement in accordance with all relevant international standards
- Flexible modular setup able to measure different materials including solids and laminates including Grain-oriented, non-grain-oriented electrical steels, CoFe, SiFe etc,,,
- Measurement of hard magnetic materials characteristics
- Ability to measure and distinguish between pulsating and rotational losses
- Ability to emulate PWM waveforms
- Relevant software for data acquisition and processing

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

A company with demonstrable experience in electrical steel loss characterisation and measurement. It is essential that the applicant has the necessary experience and track record of developing instrumentation for industrial applications. The successful candidate has also to have a proven track record of research and development in the area of novel methodologies for loss measurements.

4. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Test methodology review report	Review of test setups and methodologies to characterise power-electronics fed steels	T0+1
D2	Preliminary Design Review	Proposed methodology of testing magnetic materials characteristics in terms of BH curves and losses.	T0+2
D3	Critical Design review	Design review of test setup and detail of expected results.	T0+4
D4	Delivery and installation of test setup		T0+12

5. Topic value (€)

The **maximum value** for this topic is

800,000 €

[Eight hundred thousand euro]

Please note any proposal above this value will be NOT be eligible.

Clean Sky Joint Undertaking
JTI-CS-2012-03-SGO-02-061

Topic description

CfP Nbr	Title		
JTI-CS-2012-3-SGO-02-061	**Technology development and fabrication of integrated solid-state power switches**	**End date**	June 2014
		Start date	January 2013

1. Background

This activity within WPxyz of SGO is concerned with the design, fabrication and evaluation of a highly integrated matrix converter. The converter will be based on fully bond-wire-less double-sided cooled *sandwich* power module technology. The activity aims to demonstrate TRL6 technology maturity and deliver a fully functional power converter. Sandwich packages have no bond wires, can be cooled from both sides delivering improved thermal performance and can be optimised to give exceptionally low parasitic inductance. At system level, unprecedented power densities, efficiency and reliability can be achieved. However, the assembly of such structures can be quite complex and its technology readiness level is dependent on a number of choices for the specifically selected packaging and cooling features.

The key target of this work is therefore to ensure the achievement of TRL6 technology maturity, by developing, delivering and testing optimum interconnect and cooling solutions. The Topic Manager is seeking a partner who can contribute to the targets detailed below.

2. Scope of work

1) Design study:

Prepare a fully justified electro-thermal and thermo-mechanical design for the planar module assembly process, addressing both Silicon (Si) and Silicon Carbide (SiC) technology and according to design guidelines provided by the Topic Manager.

2) Planar module fabrication and assembly:

Establish reliable technologies to realise contact features and interconnect posts on DBC (Direct Bonded Copper) or AMB (Active Metal Brazed) substrates and on the top metallisation of power devices.

The target minimum feature size is 0.3 mm x 0.3 mm with a height of at least 0.5 mm. Materials, co-planarity and compliance to suit the chosen assembly process based on design study 1) and in service requirements. The applicant should have access to and be in a position to procure latest technology devices, both in Si and SiC and substrates; ideally, the applicant should be autonomous in finishing/preparing the devices for use in a sandwich type package (e.g., solderable/sinterable top-surface).

3) Integrated gate driver:

As part of this activity, the integration inside the power switch of a monolithically integrated driver stage will be investigated. The circuit design will be discussed and specified in collaboration with the Topic Manager. Monolithically integrated drivers will be fabricated and included in the same package as the power switch.

4) Cooling:

State-of-the-art cooling solutions will be investigated, including both passive and active options. In particular, special attention will be devoted to the development of jet-impingement direct substrate liquid cooled solutions. Heat-sinks will be manufactured and delivered together with the power switches to be assembled into a power system. The heat-sink will allocate a suitable number of basic switches to maximise modularity and ease of system assembly.

5) Power switch manufacturing route:

Establish a manufacturing and assembly process for the power switch suitable for TRL6 demonstration and higher.

3. Type of work

1) Design study:

A mixture of electro-thermal and thermo-mechanical simulation will be required to establish optimum design choices for the proposed substrate and module assembly. The study will encompass both Silicon (Si) and Silicon Carbide (SiC) based electronics.

2) Technologies for sandwich packaging fabrication at TRL6 level:

Investigate manufacturing and assembly processes including solder and solder-less solutions. Study optimum interconnect materials, geometries and sizes for a specific case-study and define optimum solutions for both Si and SiC power switches. Interconnect can include a mixture of soldered and non-soldered solid posts and will include both electrical/mechanical interconnects and thermal/mechanical interconnects.

3) Monolithic gate-driver design and integration

Investigate options for integrating in Si, SiC or Si-on-Insulator (SoI) as many functionalities as possible of a standard matrix converter gate-driver design.

4) Cooling:

A part of this activity will specifically target the design and fabrication of optimum cooling solutions, including jet impingement direct-substrate cooling.

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

The successful partner will have demonstrated expertise and manufacturing capability of solid-state power switches for the avionic/aerospace industry. They will be independent in manufacturing and/or sourcing the required assembly parts, including interconnects and heat-sink; the partner will have access to latest technology semiconductor power devices and substrates. Experience in the application of electrical, thermal and mechanical co-design is essential as is the knowledge and capability of carrying out technology qualification tests in conformity with standard avionic specifications to ensure the achievement of TRL6 level.

The partner will have experience and be certified for the industrial development of power switches for avionic/aerospace applications and be confident with innovative interconnect, packaging and cooling solutions. The partner will include at least a power switch manufacturer of proven experience in the avionic domain, equipped and resourced to provide the type and number of modules required for programme evaluation. Finally, the partner will be able to demonstrate an established track record in working with industry and academia on power module technologies for aerospace applications.

5. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Detailed substrate and process design	Fully justified design including mechanical, thermal and life models	March 2013
D2	Power switches	Samples of power switches to pre-agreed specification with Topic Manager available	July 2013
D3	Cooling solution	Samples of heat-sinks/liquid cooler to match D2 available	October 2013
D4	Monolithically integrated gate driver	Samples of monolithically integrated (i.e., single chip) gate-drivers available (1 per power switch at least)	Jan. 2014
D5	Prototypes at TRL6 specification	Integrated power converter cell available for functional testing	March 2014

6. Topic value (€)

The **maximum value** for this topic is

650,000 €
[Six hundred fifty thousand euro]

Clean Sky Joint Undertaking
JTI-CS-2012-03-SGO-02-062

Topic description

CfP Nbr	Title		
JTI-CS-2012-3-SGO-02-062	**Concepts and solutions for health monitoring of electro mechanical actuators.**	**End date**	15.12.2014
		Start date	15.01.2013

1. Background

The health monitoring is an essential issue to operate electro mechanical actuators (EMA) on condition.

Due to the high criticality of actuator jamming in a Helicopter actuation system means needs to be developed to monitor the health of the drive train. On-line monitoring of failure mechanism of actuators is not established today, not even a basis for reliable failure detection is known.

2. Scope of work

Following topics are to be addresses during the work which is related to two different types of spindles.

- Identification of most likely failures occurring at ball screws and roller screws
- Procure and prepare defined HW with the identified failures.
- Perform test with the “defect” and “non defect” specimen.
- Record of data which may be used for failure detection and identification
- Analyse the recorded data
- Transformation of the test results to simulation models.
- Definition of failure monitors based on the simulation models.

3. Type of work

- Procurement and preparation of test specimen
- Practical Tests
- Analytical research

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

Capabilities of mechanical hardware testing and analytical background to establish simulation models

5. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Test specimen		
D2	Test results		
D3	Simulation Models		
D4	Algorithms for failure detection		

6. Topic value (€)

The **maximum value** for this topic is

500,000 €
[Five hundred thousand euro]

Clean Sky Joint Undertaking
JTI-CS-2012-03-SGO-02-063

Topic description

CfP Nbr	Title		
JTI-CS-2012-3-SGO-02-063	**Investigation of electric components used in aerospace environment in terms of partial discharge issues.**	**End date**	Dec-2014
		Start date	Jan-2013

1. Background

In the course of increasing power electronic applications in modern aircrafts, voltage levels up to 1000Vpeak shall be respected for the design of the corresponding system components.

Among other considerations electrical discharge effects has to be considered for the design of the electrical insulation systems of all related components. Electrical discharge effects cause damages to insulation systems which may lead to early defects and significantly reduced in-service life of the components.

The operation of components in an aerospace environment brings additional challenges for the equipment development in this area.

Electrical discharge effects have to be considered in design, qualification and production phase of aerospace power electronic components.

Up to now there are no international standards for design or verification existing for aerospace applications.

The intended study of electrical discharge effects within power electronic components is dedicated for more electrical aircraft in the frame of Cleansky project.

2. Scope of work

The study shall investigate power electronic components operating in aerospace environments and exposed to high voltages (up to 1000Vrms) regarding potentially partial discharge effects.

The power electronic components which shall be covered by the study are electrical motors and electrical brakes respectively solenoids including wiring and connectors.

The main subjects of the study shall be as follows:

- Evaluation of design methods and improvements in order to get a component design which is free of electrical discharge effects or resistant against such effects within its defined operating conditions.

- Evaluation of adequate processes and methods which are suitable to verify that the components are free of or resistant against electrical discharge effects within the specified operating conditions in an aerospace environment.

- Evaluation of corresponding adequate production acceptance test methods

3. Type of work

The activities of this work shall be limited to 24 months' time period.

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

University or SME having significant experience in:

- Corona / Partial discharge testing for aerospace applications
- Electrical aerospace equipment
- Insulation materials for aerospace environment

5. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Design guidelines		January, 2014
D2	Verification methods		July, 2014
D3	Production acceptance test methods		December, 2014

6. Topic value (€)

The **maximum value** for this topic is estimated at

500.000 €

[Five hundred thousand euro]

Please note any proposal above this value will be NOT be eligible.

Clean Sky Joint Undertaking
JTI-CS-2012-02-SGO-03-020

Topic description

CfP Nbr	Title		
JTI-CS-2012-3-SGO-03-020	**Adaptation of optimization algorithms to avionics constraints**	**Start date**	01/03/2013
		End date	31/12/2014

1. Background

The Clean Sky project, Systems for Green Operations ITD, is looking for a supplier of a parametric optimization package for trajectory optimization in an industrial context, to become a partner of the consortium.

Joint ventures with legal personality and liability can also respond to this topic Call for Proposal.

Introduction: Clean Sky SGO MTM project objectives and context of the topic

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.

Once an optimum trajectory will be found, it will be evaluated against current state of the art route. Simulations will be performed with emissions and noise models to assess the improvement of environmental performance achieved by the trajectory of the aircraft. Since the technologies and systems developed for trajectory and mission optimisation need to be inserted in the overall economical models of the airlines, which influence these operators choices, the operational “cost” of trajectory will also be assessed.

Implementation of these optimisations is foreseen either on-board, in an avionics computer, or on ground, using computing tools in a laboratory or in an airline operations centre. The activities of MTM will bring implementation prototypes of these technologies to avionics systems demonstration platforms.

Context of the topic

Trajectory optimization is still an open scientific topic. A reason for this is that related problems are often stated in an infinite dimensional framework where both state and control have to be expressed as a function of the independent variable. Among available solutions, one can use so-called “direct methods” [1] where a finite dimension (*i.e.* more tractable) approximating problem is stated. The latter belongs to the class of NonLinear Programming problems (NLP), and can be solved having a recourse to various numerical techniques [2]. Among them, gradient-based methods are a class of iterative algorithms which are designed to find a local minimum of the NLP, starting from user-given initial values of the optimization parameters. Figure 1 shows a typical sketch of an optimization process, emphasizing the role of the NLP Algorithm.

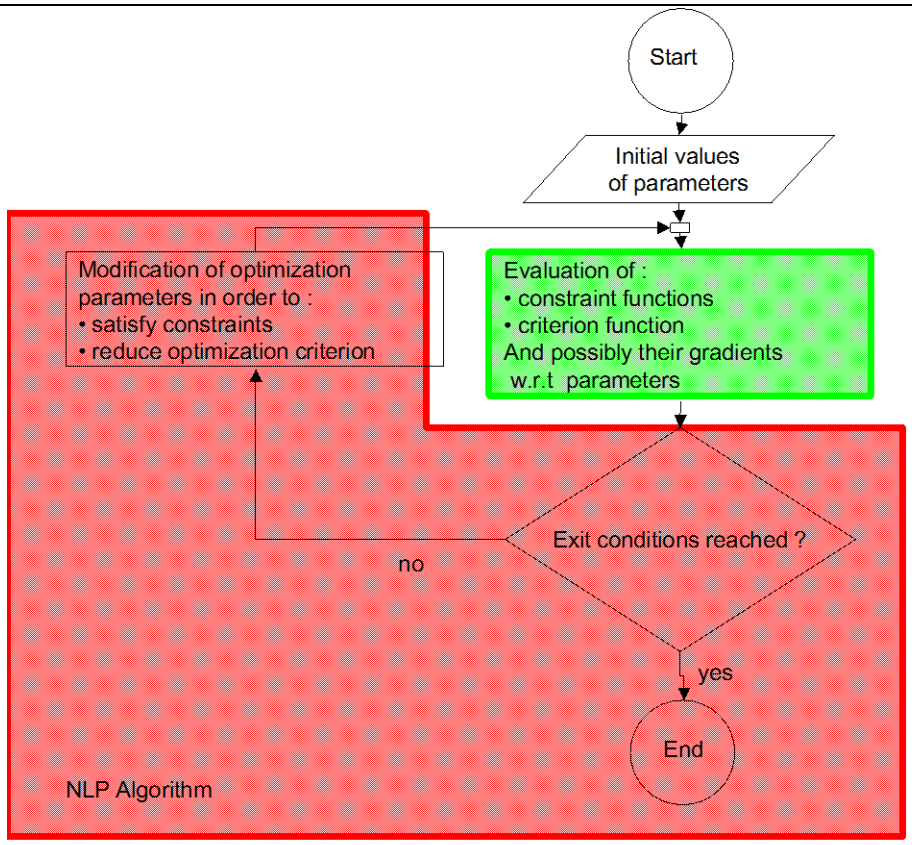


Figure 4: Optimization process

State of the art NLP packages have long been either commercially or freely available to end-users of trajectory optimization tools. Even though being option-selectable, these solvers do not provide much insight for choosing a configuration that is tightly fitted to the problem. Indeed, these packages are designed for the most wide class of optimization problems and can therefore exhibit a lack of robustness and efficiency when applied to specific problems.

Therefore, if direct methods are to be used in an onboard tactical trajectory optimization process, then the availability of a reliable and robust NLP software package seems to be an enabler for economical sustainability.

Other calls for proposal have been launched in order to improve computational aspects of trajectory optimization tools, such as [3]. However, the latter focuses on the NLP problem formulation, but does not put any particular emphasis on the NLP solution strategy.

[1] Betts, J.T. *Practical Methods for Optimal Control Using Nonlinear Programming*. SIAM, 2001

[2] Nocedal, J. and Wright, S.J. *Numerical Optimization*. Springer, 2006.

[3] *Fast optimiser for continuous descent approaches*. JTI-CS-2012-01-SGO-03-017. 2012

2. Scope of work

In this context, the aim of this call for proposal is to take a step towards industrialization by making available a NLP optimization software package which is sharply fitted to the constraints of trajectory optimization arising from the aeronautics industry. In the situation of civil aviation, the trajectory optimization task could be executed in the following environments (not exhaustive), each one featuring its own constraints :

- A ground-based operating center,
- An embedded tool not directly connected to avionics,
- An avionic module.

To these ends, specific topics to be adressed are the following :

- Computational performance : computation time, number of operations, memory storage requirements. The computation time required to achieve the optimization can be mainly attributed to the linear algebra and the cost of evaluating cost function, constraints functions, cost gradient and constraints Jacobian with respect to the optimization parameters. The amount to which one of these two factors are relevant depends on the trajectory optimization method which is under consideration : shooting or direct transcription. In the first case, the cost of evaluating the data of the problem is usually the main contributor, whereas the second case is more balanced. Anyhow, the computation time is approximately proportional to the number of iterations during the optimization. It appears that the number of iterations can differ from one solver to the other when applied to the same problem.
- Conservative iteration steps : if the user of a trajectory optimization is able to provide a suboptimal feasible trajectory, then it is important that the solver can perform so-called “conservative” iterates. This means that the process of improving a solution shall be compatible with feasibility of constraints at every step. Besides, successive steps shall not worsen the optimization criterion.
- Solution availability : the fact that the optimization process might be onboard could require that it can be stopped at any time, thus able to provide the best solution so far. These are practical sofware aspects which are relevant from a user standpoint;
- Solution validity status : when the optimization is stopped due to either an external or an internal event, it is important that the validity status of the solution be available. In particular, the user of the optimization tool shall be able to know if the solution is feasible or infeasible, optimal or suboptimal. To be more specific, if some constraints are not satisfied, the solver should inform which ones.
- Robustness to erroneous input values : during the optimization process, the iterates which are evaluated can sometimes lead to erroneous computations of problem functions and first derivatives. For instance, these erroneous values can be NaN or the infinity. The ability of the solver to take appropriate actions such as step reduction or step cancellation is seen as an important robustness contributor.

Algorithm strategy

Foreseen methods are gradient-based methods including the following :

- Interior-point algorithms. If such a technique is proposed, it should be based on the existing solver IPOPT [4].
- Active-set Sequential Quadratic Programming

In particular, probabilistic optimization algorithms such as genetic algorithms or ant colony algorithm are outside the scope of the topic.

Inputs of the optimization package

The optimization package shall take at least the following input elements :

- An initial guess of the optimization parameters from which successive iterations are performed;
- A pointer to a user-provided function returning criterion for a given set of parameters;
- A pointer to a user-provided function returning both equality and inequality constraints for a given set of parameters.

The optimization package shall also handle the following items which could optionnaly be user-provided :

- A pointer to a function returning the gradient of the criterion with respect to the parameters, as a function of optimization parameters;
- A pointer to a function returning the Jacobian of both equality and inequality constraints with respect to the parameters, as a function of optimization parameters.

The optimization package shall be able to compute the aforementionned data if these are not provided by the user.

Outputs of the optimization package

The optimization package shall provide the following elements :

- numerical values of the optimization parameters after processing;
- numerical values of both Lagrange multipliers and Kuhn-Tucker multipliers relative to constraints;
- the reason the solver stopped : interrupted (with explicit error message), maximum number of iteration, etc.
- other recorded data which will be further precised during the development.

Test scenarii

The CUTEr environment (http://www.cuter.rl.ac.uk/) consists in a series of optimization problems which helps evaluating the robustness and computational performance of optimization packages. Among these problems, some arise from the discretization of optimal control problems. As a consequence, they seem to be good candidates for validation test cases.

In addition, a set of actual trajectory optimization problems, based on SGO-ITD studies and development will also be used to assess the optimiser performance.

Support

The model and the tool will be delivered to the topic manager in order to contribute to the studies on the ITD

technologies.

The partner organization shall have the capability to maintain the software toolbox and the software

package – i.e. to further adapt, optimize, and produce updated versions.

Several updated versions of these software package and toolbox will be developped during the timeframe of

the topic (see §5. Major deliverables and schedule) to allow problems fix and evolutions.

[4] A. Wächter and L. T. Biegler. On the implementation of a primal-dual interior point filter line search algorithm for large-scale nonlinear programming. *Mathematical Programming*, 106(1):25-57, 2006.

3. Type of work

Specification, design, development and testing of a mock-up of a robust optimization algorithm for trajectory optimization.

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

The candidate organization shall have recognized experience in numerical optimization in the class of so-called nonlinear programming problems.

The answer to this call for proposal must include a detailed technical description of the solution with the associated evidence of the expertise and pre-existing know how.

Availability of a pre-existing off-the-shelf solfware package will be appreciated.

5. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Problem Definition (PD):	Formal Definition of the problem, completing the requirements described in the full topic description : • Required input and output data • Constraints • Expected performance • Use cases The content of this document is defined and agreed in cooperation with the topic manager or his appointed representative, through technical workshops.	31/05/13
D2	Technical Specification document (TS)	Set of functional and non functional requirements applicable to the software tool, derived from the Problem Definition.	31/07/13
D3	Software package design document (SDD)	Description of the design of the optimization algorithm	31/10/13
D4	Validation Test Plan (VTP)	Acceptance validation tests shall be further detailed through technical workshops	31/10/13
D6	Optimization package delivery (V1):	Delivery of the software version of the optimization algorithm and associated documentation including • source code : optimization algorithm and test code • User Manual document (UM) • Validation Test Report (VTR), i.e. description of tests results and conclusions • (if required) Update of previous documents : TS, SDD, VTP, VTR	31/03/14
D7	Problem report and model modification request document (PRD)	Compilation and analysis of problem reports and modification requests agreed in cooperation with the topic manager or his appointed representative.	15/05/14
D8	Optimization package delivery (V2):	Delivery of an updated software version of the optimization algorithm and associated documentation including • source code : optimization algorithm and test code • User Manual document (UM) • Validation Test Report (VTR), i.e. description of tests results and conclusions • (if required) Update of previous documents : TS, SDD, VTP, VTR	30/11/14

Deliverable	Title	Description (if applicable)	Due date
D9	Final Acceptance Test Report (ATR)	Description of the tests performed at the topic manager facility, their results and conclusions. This deliverable will be accepted through an acceptance review led by the topic manager.	31/12/14

6. Topic value (€)

The total value of this work package shall not exceed:

500,000€
[Five hundred thousand euro]

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.

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

Intellectual Property

The chosen partners shall not forbid the use of any output provided by this call for proposal, so that it can be used by ITD-SGO partners.

Clean Sky –Technology Evaluator

No topics in this Call