Call for Proposals:

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

Call Text

Call Identifier

SP1-JTI-CS-2012-01 – B
Smart Fixed Wing Aircraft
Systems for Green Operations

See separate document for:
Eco Design
Green Rotorcraft
Green Regional Aircraft
Sustainable and Green Engines

Index

Document change log

Specialised and technical assistance:

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

EPSS Help desk support@epss-fp7.org

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

Introduction

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

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

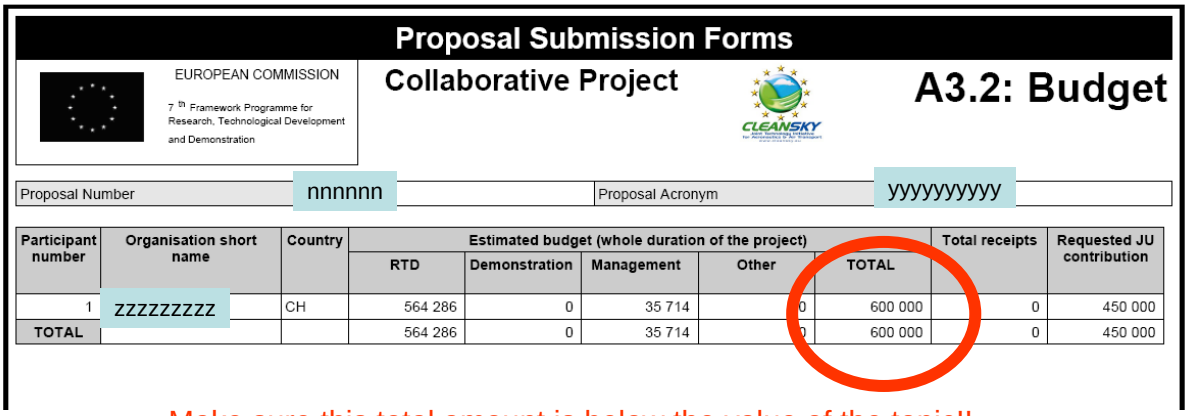
Each Topic fiche addresses the following points:

- Topic manager (not to be published)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

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

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

Recommendation to applicants:



Proposal Submission Forms

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

Collaborative Project

A3.2: Budget

Proposal Number	nnnnnn	Proposal Acronym	yyyyyyyyyy

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

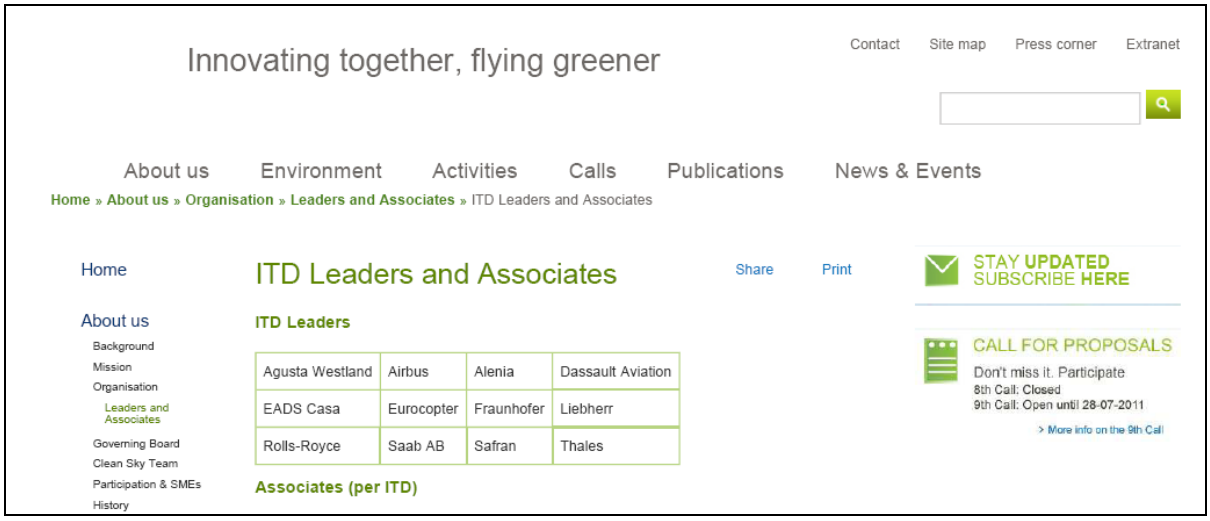
Make sure this total amount is below the value of the topic!!
Better, keep at least 5% margin.
Final amount is to be discussed in the negotiation.

Eligibility criteria

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

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

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



Evaluation

Thresholds:

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

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

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

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

Calendar of events:

- **Call Launch: 13 January 2012**
- **Call close: 3 April 2012, 17:00**

- Evaluations (indicative): 21-25 May 2012

- Start of negotiations (indicative): 25 June 2012
- Final date for signature of GA by Partner: 31 July 2012
- Final date for signature of GA by Clean Sky JU: 10 August 2012

Recommendation to get a PIC

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

Contacts:

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

info-call-2012-01@cleansky.eu

Questions received until **9 March 2012** will be considered.

A first version of the Q/A document will be released by **17 February 2012**.

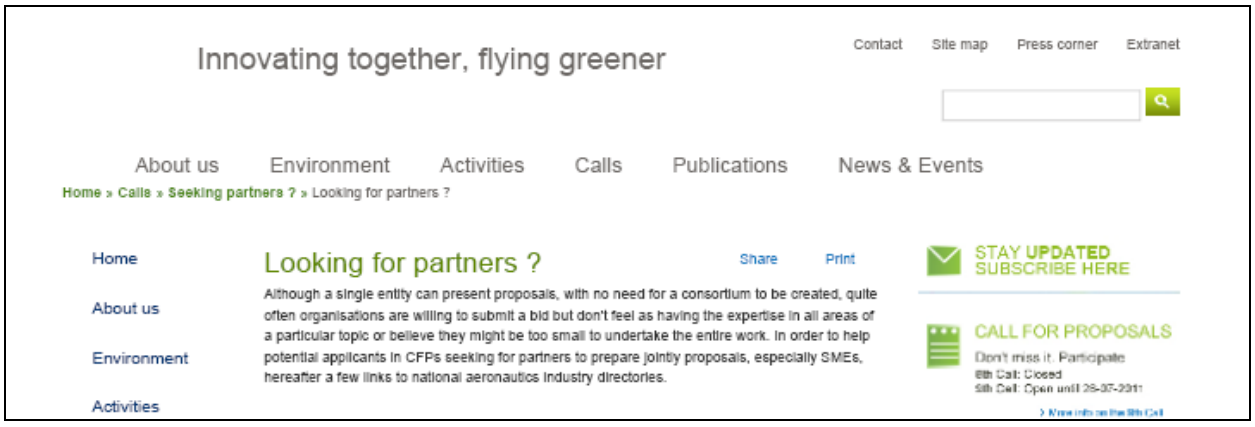
The final version of the Q/A document will be released by **18 March 2012**.

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.

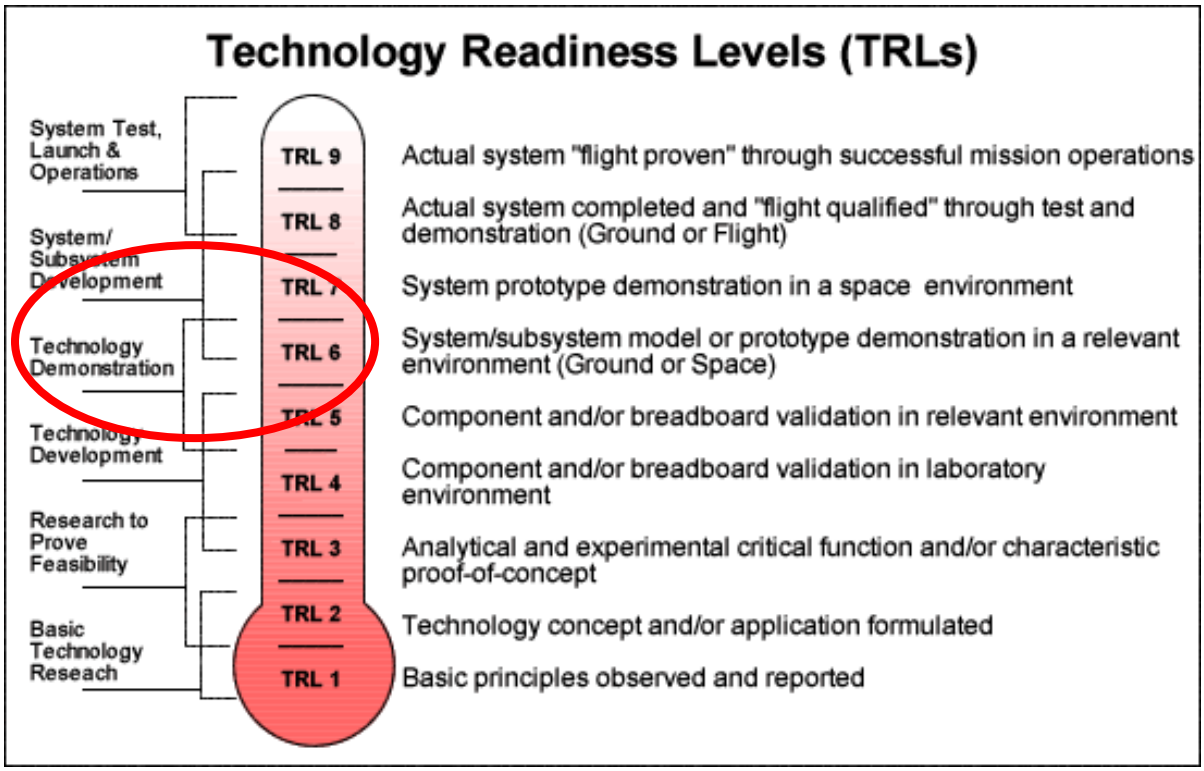
Looking for Partners?

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:



Clean Sky Joint Undertaking
Call SP1-JTI-CS-2012-01

Identification	ITD - AREA - TOPIC	topics	VALUE	MAX FUND
JTI-CS-SFWA	**Clean Sky - Smart Fixed Wing Aircraft**	**15**	**11.350.000**	**8.512.500**
JTI-CS-SFWA-01	*Area01 – Smart Wing Technology*		**4.500.000**	
JTI-CS-2012-1-SFWA-01-041	Icephobic coatings – development of test methods		350.000	
JTI-CS-2012-1-SFWA-01-042	Flow control actuator with fast switching elements; unsteady operation with mass transfer		400.000	
JTI-CS-2012-1-SFWA-01-043	Testing the operational performance and robustness of Active Flow Control hardware		400.000	
JTI-CS-2012-1-SFWA-01-044	MEMS Gyrometer – Maturity assessment of performance and integration		800.000	
JTI-CS-2012-1-SFWA-01-045	MEMS Gyrometer – Miniaturisation of the analogue electronics in an Asic		800.000	
JTI-CS-2012-1-SFWA-01-046	MEMS Accelerometer – Miniaturisation of the analogue electronics in an Asic		800.000	
JTI-CS-2012-1-SFWA-01-047	High Lift Actuator Electronics		700.000	
JTI-CS-2012-1-SFWA-01-048	Magnetic Gearbox		250.000	
JTI-CS-SFWA-02	*Area02 - New Configuration*		**6.850.000**	
JTI-CS-2012-1-SFWA-02-020	Development of an automated gap filler device		550.000	
JTI-CS-2012-1-SFWA-02-022	Design and manufacturing of an innovative cryogenic wind tunnel model with motorized empennage		1.800.000	
JTI-CS-2012-1-SFWA-02-024	Laminar Wing Optimisation using Adjoint Methods		250.000	
JTI-CS-2012-1-SFWA-02-025	Development of ice-fracture criteria for different ice-cases, in an electro-mechanical deicing system application		300.000	
JTI-CS-2012-1-SFWA-02-026	Experimental and numerical investigation of acoustic propagation through a boundary layer in high speed conditions (refraction		750.000	
JTI-CS-2012-1-SFWA-02-027	Transonic High Reynolds Number Testing of a Large Laminar Wing Half Model		1.200.000	
JTI-CS-2012-1-SFWA-02-028	Low speed aerodynamic test of large CROR aircraft model in a closed test section		2.000.000	
JTI-CS-SFWA-03	*Area03 – Flight Demonstrators*			
JTI-CS-SGO	**Clean Sky - Systems for Green Operations**	**14**	**6.540.000**	**4.905.000**
JTI-CS-SGO-01	*Area-01 - Definition of Aircraft Solutions and explotation strategies*			
JTI-CS-SGO-02	*Area-02 - Management of Aircraft Energy*		**4.700.000**	
JTI-CS-2012-1-SGO-02-021	Development of key technology components for high power-density power converters for rotorcraft swashplate actuator		350.000	
JTI-CS-2012-1-SGO-02-035	Disconnect device for jam tolerant linear actuators		800.000	
JTI-CS-2012-1-SGO-02-038	Passive cooling solution validation		300.000	
JTI-CS-2012-1-SGO-02-039	Optimisation of heat pipe to cool high speed motorised turbo-machine		300.000	
JTI-CS-2012-1-SGO-02-040	Compressor air inlet protection for electrical ECS		600.000	
JTI-CS-2012-1-SGO-02-041	Identification of a fluid for diphasic cooling adapted to aircraft applications		550.000	
JTI-CS-2012-1-SGO-02-042	Study and development of a carbon sleeve made by filament winding and directly wound on an electric motor rotor		200.000	
JTI-CS-2012-1-SGO-02-043	Aerospace housing for extreme environment		300.000	
JTI-CS-2012-1-SGO-02-044	Bus system housing for extreme environment		300.000	
JTI-CS-2012-1-SGO-02-045	Regenerative Snubber & innovative control algorithm		400.000	
JTI-CS-2012-1-SGO-02-046	High Dense Smart Power Capacitor (HDSPC) for next generation Aircraft converters		600.000	
JTI-CS-SGO-03	*Area-03 - Management of Trajectory and Mission*		**1.590.000**	
JTI-CS-2012-1-SGO-03-014	Smart Operations on Ground (SOG) power electronics with energy recycling system		1.390.000	
JTI-CS-2012-1-SGO-03-017	Real time optimiser for continuous descent approaches		200.000	
JTI-CS-SGO-04	*Area-04 - Aircraft Demonstrators*		**250.000**	
JTI-CS-2012-1-SGO-04-003	Solid State Power Controllers test benches		250.000	
JTI-CS-TEV	**Clean Sky - Technology Evaluator**	**0**	0	0,000

Clean Sky –SFWA

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JTI-CS-2012-1-SFWA-01-042	Flow control actuator with fast switching elements; unsteady operation with mass transfer		400.000	
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JTI-CS-2012-1-SFWA-01-048	Magnetic Gearbox		250.000	
JTI-CS-SFWA-02	*Area02 - New Configuration*		**6.850.000**	
JTI-CS-2012-1-SFWA-02-020	Development of an automated gap filler device		550.000	
JTI-CS-2012-1-SFWA-02-022	Design and manufacturing of an innovative cryogenic wind tunnel model with motorized empennage		1.800.000	
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JTI-CS-2012-1-SFWA-02-028	Low speed aerodynamic test of large CROR aircraft model in a closed test section		2.000.000	
JTI-CS-SFWA-03	*Area03 – Flight Demonstrators*			

Topic Description

CfP topic number	Title		
JTI-CS-2012-01-SFWA-01-041	**Icephobic Coatings – Development of test methods**	**End date**	*June 2012*
		Start date	*June 2013*

1. Topic Description

Icephobic coatings are being investigated as functional coatings for laminar flow. The coatings are intended to support the wing ice protection systems by reducing the formation or the adhesion of ice and consequently reducing the energy requirements of the system. Currently the most comprehensive method for measuring and understanding the icephobic nature of a coating is by performing icing wind tunnel tests. These tests require large dedicated wind tunnel facilities and would be too costly and impractical for production batch quality control and release testing purposes. For this reason a significant part of the research is dedicated to the development of suitable 'bench top' test methods that will allow accurate measurement of the icephobic nature of a coating, providing an indication of the long term icing performance of the tested surface.

Applicants for this topic will be expected to develop reliable test methods to characterise the anti-ice performance of coatings and surfaces. Suitable tests must include a level of artificial ageing to show how various surface properties may change over the service life of the coating with particular attention paid to icing performance. Work will be carried out with the support of the other partners involved in this particular work package.

Suitable applicants must be able to demonstrate the following:

- Knowledge of aerospace working practices and production methods;
- Access to icing wind tunnel facilities for the validation of proposed test methods;
- Knowledge of icephobic coating development and an understanding of the chemistry involved.

It is accepted that the method of evaluating the icing performance of a coating may involve a number of complementary procedures rather than one specific test.

SFWA partners are able to provide the following:

- Documents outlining the performance expectations of suitable coatings;
- A range of candidate coatings for evaluation;
- Access to the accumulated test data acquired from a wide range of tests and facilities worldwide.

Erosion testing, an important consideration for any candidate coatings, and other material considerations such as compatibility with aerospace fluids, other coatings, substrates, etc. will be carried out in parallel by other partners in the work package.

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

- Applicants shall demonstrate an understanding of quality systems and the need for qualification and batch release testing of coating products.
- Applicants shall demonstrate a good track record in the development of new test procedures and have experience or expert knowledge in icing tests.
- Candidates shall be able to provide evidence of their ability to meet tight timescales, delivering quality solutions on time and at cost.

3. Major deliverables and schedule

Del. Ref. Nr.	Title	Description (if applicable)	Due
1	Detailed characterisation of coatings	Develop an understanding of the properties of a range of candidate coatings and identify the key parameters that have a direct influence on icing performance.	M0 + 6 months
2	Characterisation of a range of coating properties; evaluation report	Evaluate the possibility of developing test methods that can reliably quantify certain key parameters that indicate icing performance. Characterisation of a range of coating properties that can reliably indicate icing is one approach to quantifying performance	M0 + 7 months
3	Validated test method	Comparison of test method results against icing wind tunnel performance for a wide range of coatings to establish accuracy and repeatability of proposed test method. Test facilities must demonstrate compliance with ISO 17025.	M0 + 10 months
4	Final Report	Detailed report demonstrating the approach taken, the test results and a clear description of the testing regime for the quantification of icing performance.	M0 + 12 months

4. Topic value (€)

The total value of this work package shall not exceed:

350,000.-- €
[three hundred and fifty thousand euro]

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

5. Remarks

None

Topic Description

CfP topic number	Title		
JTI-CS-2012-01-SFWA-01-042	**Flow control actuator with fast switching elements; unsteady operation with mass transfer**	**End date**	*Oct 2015*
		Start date	*Oct 2012*

1. Topic Description

A mock-up of a flow control actuator subsystem has to be developed, designed, manufactured and tested. The mock-up shall simulate a flight-ready actuator prototype for controlling flow separation on the high lift devices of transport and business aircraft.

Such a subsystem typically consists of one central or several distributed devices which create(s) a pulsed flow from a steady, pressurized supply (e.g. fast switching valves).

The elements switching/pulsing the jet flow might be piezo-based. Regardless of the switching concept, a low weight is required for a future flight application. It is expected that the current state of the art – evaluated by “weight per flow rate” - will be reduced by a factor of 5 or more.

The applicant shall focus their actuator design work on the following priorities:

- Achieve sufficient flow control. In terms of system requirements, this means achieving high output velocities and large flow rates with high frequencies of pulsing and steep transients during the switching process.
- Ensure that the hardware is working in a robust manner over numerous operation cycles; the produced mock-up does not have to be flight ready.
- Ensure that the actuator is of low weight for later aircraft application. A compact size would be an advantage, but this must not necessarily mean Micro Electro Mechanical Systems (MEMS)-type dimensions.
- Allow pulsed mode operation of the actuator at sufficient high frequencies to delay thin boundary layer separation.
- The requirements are defined for valve-type systems to create a pulsating air flow with steep transients. Novel and/or innovative concepts are welcome. Should a concept be used without mass transfer during pulsed mode operation, however, it would definitelyhave to fulfil the above requirements. Any concept, whether valve or actuator, should feature a low pressure-loss characteristic in order to allow for pressure supply systems with low operation pressure.
- In addition to valve or actuator design, the applicant should either study or at least indicate and discuss possible electrical subsystems for the control of the valves/actuators, especially if they require significant electrical power. The downselected electrical system design should allow integration into a closed loop control algorithm for optimization of the operation modes and of high lift performance. It is not required that the subsystem for closed loop flow control be derived from current aircraft electrical systems, but the overall design should be compatible with future R&T work for future aircraft application.

The mock-up’s compliance with the above requirements has to be demonstrated in a laboratory. A wind tunnel test is not required.

In order to make the actuator design suitable for future transport and business aircraft, the typical requirements for flow control actuators for aircraft leading edges have to be fulfilled:

- Tangential slot of 1mm width on the whole span (more than 11m), except for some intermediate stiffeners between segments of slot. The exit angle to the surface should not exceed 30° (blowing pitch angle). The mock up itself has to be lab tested only, it is not required that the hardware be of 1:1 scale for aircraft application.
- The slot should be located in the 1stpercent of the airfoil chord. The actuator integration should be compatible with the aircraft leading edge.
- The peak velocity should be close to sonic velocity.

- The pulsing frequency should be adjustable up to 500 Hz. The concept must allow duty cycle variations (approximately between 20 and 80%) in order to tackle periodic events in thin boundary layers at wing leading edges. The transient of the outflow during the switching should be steep (<1ms), “smearing” motions or “sinusoidal” types of operation are not favoured.
- In summary, for the whole wing, a total flow rate of 2m³/s at 50% duty-cycle must be handled with operating frequencies up to 500Hz, enabling to pulse with sonic speed at the above described tangential slot. The system should be optimized for low “weight per flow rate”, e.g. the applicant may use one central valve for the full flow rate or a large number of small, distributed valves.

The proposed concept must consider issues like operability, reliability and maintenance. The applicant should consider the integration of the system into civil aircraft and - if possible - certification aspects although these do not apply to the mock-up. Industrial-type components may be considered where appropriate.

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

- The applicant should have a sound research background and an understanding of industry needs and expertise in the field of flow control actuator aero and system performance for low speed flow control.
- The applicant shall have capabilities for manufacturing a mock-up, providing system support and providing the equipment for system and aerodynamic measurements / investigations.
- The applicant should have a sound background in Active Flow Control (AFC) design & integration, power, control components and subsystems design.
- The applicant shall have the laboratory testing facilities and equipment required for the operation of the actuator specimen and initial functional testing; they should have capabilities to characterize the relevant parameters (exit velocity, frequency) in a laboratory environment.

Testing:

- The applicant shall show their ability to test the functionality of the system in the relevant conditions, a laboratory environment being considered as sufficient for functional hardware tests. The system performance shall be achieved and demonstrated via individual and combined system mock-up tests (valve response, electrical consumption, energy consumption needs, efficiency of the design). In addition to the monitoring of system data, the aerodynamic behaviour of the jet flow should be investigated via local and field measurements within and near the exit of the hole region (flow measurement and or flow visualization).

3. Major deliverables and schedule

Del. Ref. Nr.	Title	Description (if applicable)	Due
D01	Concept Report	Description of fluidic actuator with respect to performances and conceptual design including a comprehensive review of the current state-of-the-art for actuation and/or valve systems	M6
D02	Pre-design analysis	Critical Design Review including first power and pressured air consumption estimation	M12
D03	Actuator mock up Manufacturing	Construction and manufacturing of actuator and system needs allocated	M24
D04	Testing	Conduct tests with design variations and for demonstration of the system performance requirements including a first pre-analysis.	M32
D05	Technical report	Final test data analysis and final reporting, hardware delivery	M36

4. Topic value (€)

The total value of this work package shall not exceed:

400,000.-- €
[four hundred thousand euro]

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

5. Remarks

None

Topic Description

CfP topic number	Title		
JTI-CS-2012-01-SFWA-01-043	**Testing the operational performance and robustness of Active Flow Control hardware**	**End date**	*June 2014*
		Start date	*Dec 2012*

1. Topic Description

The aim of this CfP topic is to enable a detailed characterisation of the operational performance of Active Flow Control (AFC) technology and its specific components as developed in the Smart Fixed Wing Aircraft Integrated Technology Demonstrator (SFWA-ITD). This is required for the evaluation of the Technology Readiness Level (TRL) of the particular AFC technology. The objective within the SFWA-ITD is reaching a TRL level of 6.

Test activity to be performed by the applicant

Operational testing of AFC (experimental):

- Verify that hardware and associated software (if existing) satisfy the specified industrial requirements and detect possible concept design errors.
- Analyse hardware components and operating software in order to detect the differences between existing and required AFC performance and conditions (i.e. “bugs”), and to evaluate the features of the hardware and software component items.
- Operate an AFC system or component under specified industrial conditions; observe and record the results and evaluate the tested system or component based on the requirements specified by the industrial customer.

The testing of the robustness will have to address the following steps:

- Ad hoc testing: a testing phase where the tester tries to “break” the AFC system by randomly trying the system’s functionality. This will also include test to failure.
- Boundary value analysis/testing: an analysis that focuses on “corner cases” or values that are usually out of range as defined by the specification.
- Compatibility testing: testing whether hardware and associated AFC software are compatible with other elements of a system with which it should operate, e.g. flight control system.
- Endurance testing: checking for performance degradation or other problems which may occur during prolonged operation in realistic environmental conditions.
- Recovery testing: testing to confirm that the AFC system recovers from expected or unexpected events without loss of functionality or performance degradation, e.g. loss of electric power.
- Stress testing: testing to evaluate the load under which a system or component fails and how it fails.
- Harsh environment testing: hot/cold, humid, testing under vibrations, testing of various blockage effects.

Inputs

Fluidic actuators are the main components of the technologies put forward for testing. The work will be based on the AFC hardware provided by the applicant for technologies under evaluation in SFWA. Associated system components (e.g. driver units and associated software) for the basic functionality of the system are also considered as an input coming from the specific AFC technology under evaluation, and this should also be provided by the applicant. The applicant should work in close collaboration with partners in the SFWA consortium in order to deliver the technology at the requested state of the art.

Industrial requirements for testing will be delivered by Dassault and AIRBUS, the major industrial partners within the SFWA-ITD. Requirements for testing will be formulated with respect to the main purpose of this activity, i.e. the evaluation of the TRL level for the AFC technology under analysis.

Means of demonstration specifications and associated technical inputs will be delivered by INCAS. Tests will be performed onsite at INCAS, using appropriate test rigs and facilities. A common testing hardware for fluidic actuators will be provided, including electrical, pneumatic and hydraulic power supply units, pressure and temperature control units, auxiliary mechanical drivers and harsh environment testing systems. A state of the art data acquisition system will enable the basic evaluation of experimental data.

Small adaptations of the test rig based on the applicant's design may be facilitated using the existing workshop.

Outputs

The main deliverable of the proposed work is a report on the functional characteristics of the proposed AFC technology tested under industrial specifications. The report shall include at least the following major elements:

1. Basic functional testing report: this will address system performance with direct reference to functionalities under imposed industrial requirements.
2. Energy balance report: this will address overall system power requirements and input/output interaction with the environment, under industrial requirements.
3. System inspection report: this will address specific information on the hardware and software performance and integrity during and at the end of the tests, including relevant inspection of the major components involved.
4. A general evaluation report regarding the TRL of the AFC technology tested.

The applicant should use the test results in order to define a generic technology roadmap towards an optimized AFC system able to meet TRL6 requirements.

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

- With respect to the selected AFC technology for testing, the applicant shall provide all system components (hardware and associated software) for the AFC technology to be tested. The applicant should work in close collaboration with the partners in the consortium in order to deliver hardware components at the current state of the art technology under evaluation.
- For the testing activities involved, the applicant needs to show solid evidence of a strong research background and understanding of industry needs. Expertise in flow control systems, design of fluidic actuators and system performance for low speed flow control is a must.
- The applicant must have experience in experimental activities and testing of AFC with respect to industrial requirements, system support capabilities and equipment necessary for system and aerodynamic measurements / investigations.
- The applicant shall have experience in using laboratory testing facilities and equipment required for actuator specimen operation and initial functional testing, in addition to having capabilities to characterize the relevant parameters (e.g. exit velocity, frequency) in a laboratory environment.

3. Major deliverables and schedule

Del. Ref. Nr.	Title	Description (if applicable)	Due
1	Deliverable 1	Test matrix definition	M0 + 2 M
2	Deliverable 2	Test rig definition and instrumentation	M0 + 4 M
3	Deliverable 3	AFC testing reports	M0 + 14 M
4	Deliverable 4	TRL evaluation and AFC redesign and optimization	M0 + 18 M

4. Topic value (€)

The total value of this work package shall not exceed:

400,000.-- €
[four hundred thousand euro]

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

5. Remarks

Based on the test results, the applicant may re-design and optimize the AFC system taking into account industrial requirements, for further integration in the relevant demonstrator work packages.

Topic Description

CfP topic number	Title		
JTI-CS-2012-01-SFWA-01-044	**MEMS Gyrometer– Maturity assessment of performance and integration**	**End date**	*31/01/2014*
		Start date	*02/07/2012*

1. Topic Description

The integration of gyrometer and accelerometer sensors into multi axis Micro Inertial Measurement Units (MIMUs) is required in order to allow for the widespread dissemination of these products in the avionics domain, and especially in the field of integrated flow and load control systems as applied to the wings of civil aircraft.

Industry has not yet sufficiently advanced towards the development of a gyrometer which would be mature enough to fulfill requirements in terms of miniaturization, reliability, integrability and lifelong stability. The gyrometer currently being developed (Stage 1) by Thales, Gyrix G-HP-10, ensures that the required accuracy level is met in a serial production environment for all of the device's functions. The developed multi axis MIMU has not yet reached a sufficient Technology Readiness Level (TRL), however.

The purpose of this CfP topic is the assessment of parameters such as cost, power consumption, weight, integration and variability, all of which have to meet critical values in order for the expected performance level to be reached, while keeping the degree of miniaturisation and sensor accuracy very close to the intrinsic level of accuracy of the cell containing the Micro Electro Mechanical System (MEMS)'s sensitive element. The applicant has to demonstrate a TRL of 5, i.e. component validation in relevant environment.

The applicant shall perform the following activities:

- Miniaturisation of the existing gyrometer cell (cell = sensing element + packaging);
- Evaluation of critical manufacturing parameters and their effects on performance;
- Assessment of critical parameters variability through several manufacturing lots;
- Manufacturing of a set of about 20 cells and assessment of in-service operational repeatability.

The SFWA partners will provide the cell design and metrology skills for the evaluation of the cell.

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

- The applicant has to provide evidence of industrial experience in Silicon On Insulator (SOI) MEMS manufacturing.
- The applicant has to provide evidence of industrial experience in manufacturing long term stable MEMS ceramic packaging under vacuum below 10-3mbar (lifetime > 20 years).
- The applicant should have the capability to perform metrology during front-end and back-end processes.
- The applicant must provide evidence of experience in high accuracy notch free Deep Reactive Ion Etching (DRIE) (< 0.2 µm accuracy) on thick SOI with its own production equipment.
- The applicant must have knowledge in the manufacturing and testing of high Q factor capacitive MEMS gyrometers like Gyrix.

3. Major deliverables and schedule

Del. Ref. Nr.	Title	Description (if applicable)	Due
D136.4.1	Cell Miniaturisation	Miniaturisation of the Gyrix Cell (sensing element + package) Definition file available for consultation	01/10/2012
D136.4.2	Manufacturing parameters	Report on the evaluation of critical manufacturing parameters and their effects on performance	01/01/2013
D136.4.3	Variability evaluation	Report on the assessment of critical parameters variability through several manufacturing lots (quantity to	01/07/2013

		be defined by applicant)	
D136.4.4	Sensors evaluation	Manufacturing of 20 Gyrix cells and stability evaluation in relevant environment	31/12/2013
D136.4.5	Final Report	Joint final summary (results, conclusions and recommendations) by applicant and SFWA	31/01/2014

4. Topic value (€)

The total value of this work package shall not exceed:

800,000.-- €
[eight hundred thousand euro]

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

5. Remarks

None

Topic Description

CfP topic number	Title		
JTI-CS-2012-01-SFWA-01-045	**MEMS Gyrometer – Miniaturisation of the analogue electronics in an Asic**	**End date**	*31/01/2014*
		Start date	*02/07/2012*

1. Topic Description

The integration of gyrometer and accelerometer sensors into multi axis Micro Inertial Measurement Units (MIMUs) is required in order to allow for the widespread dissemination of these products throughout the avionics field, and especially in the field of integrated flow and load control systems as applied to the wings of civil aircraft.

Industry has not yet sufficiently advanced towards the development of a gyrometer which would be mature enough to fulfill requirements in terms of miniaturization, reliability, integrability and lifelong stability. The gyrometer currently under development (Stage 1) by Thales, Gyrix G-HP-10, ensures that the required accuracy level is reached in a serial production environment for all of the device's functions. The developed multi axis MIMU has not yet reached a sufficient Technology Readiness Level (TRL), however.

The purpose of this CfP topic is the miniaturisation of the Gyrix analogue and mixed-signal electronics in an Asic. The applicant shall demonstrate compliance with the specifications through a characterisation plan including functional tests, tests on regulated voltages and tests on power consumption.

Activities to be performed by the applicant include:

- Design of the Asic;
- Manufacturing and validation of dies.

Support provided by SFWA partners includes:

- Specification of the Asic;
- Participation to design reviews.

Further requirements:

- Dies have to be less than 5x5 mm in size.

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

- The applicant has to provide evidence of industrial experience in Micro Electro Mechanical System (MEMS) analogue and mixed-signal Asic design.
- If fabless, the applicant has to provide evidence of industrial experience managing fabrication in an external foundry.
- Very low noise preamp (< 40 fA /√Hz @ 10 KHz) and high voltage (20V) bias are mandatory critical building blocks.
- Skills in medium speed/high accuracy (16 bits/300 KS/s) ADC and DAC should be justified.
- The applicant has to provide evidence of experience in analogue Asic development for high performance gyrometers (a few °/h) or for other, equally demanding devices.

3. Major deliverables and schedule

Del. Ref. Nr.	Title	Description (if applicable)	Due
D136.5.1	Design	Design of the Asic Design file available for consultation Device compliance matrix	01/12/2012
D136.5.2	Test	Report on Asic characterisation	01/09/2013
D136.5.3	Final Report	Joint final summary (results, conclusions and recommendations)	31/01/2014

		by applicant and SFWA	

4. Topic value (€)

The total value of this work package shall not exceed:

800,000.-- €
[eight hundred thousand euro]

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

5. Remarks

- The proposal should present the applicant's skills in the field of MEMS Asic design.
- A detailed Asic specification could be sent to the successful applicant after the exchange of the Expression of Interest and of a Non-Disclosure Agreement.

Topic Description

CfP topic number	Title		
JTI-CS-2012-01-SFWA-01-046	**MEMS Accelerometer – Miniaturisation of the analogue electronics in an Asic**	**End date**	*31/01/2014*
		Start date	*02/07/2012*

1. Topic Description

The integration of gyrometer and accelerometer sensors into multi axis Micro Inertial Measurement Units (MIMUs) is required in order to allow for the widespread dissemination of these products throughout the avionics field, and especially in the field of integrated flow and load control systems as applied to the wings of civil aircraft.

Industry has not yet sufficiently advanced towards the development of an accelerometer which would be mature enough to fulfill requirements in terms of miniaturization, reliability, integrability and lifelong stability.The accelerometer under development (Stage 1) by Thales, Accix A-HP-10, ensures that the required accuracy level is reached in a serial production environment for all of the device's functions. The developed multi axis MIMU has not yet reached a sufficient Technology Readiness Level (TRL), however.

The purpose of this CfP topic is the miniaturisation of the Accix analogue and mixed-signal electronics in an Asic. The applicant shall demonstrate compliance with the specifications through a characterisation plan including: functional tests, tests on regulated voltages and tests on power consumption.

Activities to be performed by the applicant include:
- Design of the Asic;
- Manufacturing and validation of dies.

Support to be provided by the SFWA partners:
- Specification of the Asic;
- Participation to design reviews.

Further requirements:
- Dies have to be less than 5x5 mm in size.

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

- The applicant has to provide evidence of industrial experience in MEMS analogue, mixed-signal Asic design. Digital blocks integration in a System on Chip (SoC) approach is also required.
- If fabless, the applicant has to provide evidence of industrial experience managing fabrication in an external foundry.
- Very low noise preamp (< 40 fA /√Hz @ 10 KHz) and high voltage (10V) bias are mandatory critical building blocks.
- Skills in medium speed/high accuracy (16 bits/300 KS/s) ADC and DAC should be justified.
- The applicant has to provide evidence of experience in analogue Asic development for high performance accelerometer (< 1 mg accuracy) or for other, equally demanding devices.

3. Major deliverables and schedule

Del. Ref. Nr.	Title	Description (if applicable)	Due
D136.6.1	MEMS accelerometer design	Design of the Asic Design file available for consultation Device compliance matrix	01/12/2012
D136.6.2	MEMS accelerometer Tests	Report on Asic characterisation	01/09/2013
D136.6.3	MEMS accelerometer final Report	Joint final summary of applicant and SFWA on results, conclusions and recommendations	31/01/2014

4. Topic value (€)

The total value of this work package shall not exceed:

800,000.-- €
[eight hundred thousand euro]

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

5. Remarks

- The proposal should present the applicant's skills in the field of MEMS Asic design.
- A detailed Asic specification could be sent to the applicant after the exchange of the Expression of Interest and of the Non-Disclosure Agreement.

Topic Description

CfP topic number	Title		
JTI-CS-2012-01-SFWA-01-047	**High Lift Actuator Electronics**	**End date**	*April 2014*
		Start date	*July 2012*

1. Topic Description

This CfP topic addresses the design and manufacturing of an electronic controller for slat or flap surfaces which are part of the aircraft's high lift system. The controller is linked to two aircraft slat/flap computers and is to be designed with two legs (one Master and one Slave). It is intended to provide power to electrical units which will replace conventional hybrid systems (hydraulic and electrical) and to control redundant motors (two to three coils).

Functions of the electronic unit:

- to embed a clamping function to sustain a regenerative phase of the motor (the energy from the electrical motor regeneration, used as a brake in some stages, shall be dissipated and not rejected);
- to drive two brake solenoids;
- to drive two to three electrical motors with an innovative control/command;
- to receive a slat/flap position and to manage electrical motors and brakes to reach it (position loop, speed loop, close loop);
- to be interfaced with 540VDC power supply;
- to communicate with the slat/flap control computer.

Key Design Drivers:

- The targeted weight is 6Kg;
- The targeted electronics power is 5KW;
- The targeted Mean Time Between Failure (MTBF) is 50,000 flight hours;
- The targeted electronics design life is 80,000 flight hours;
- The electronics close loop frequency is 20KHz;
- The software development assurance level is D (for demonstrator);
- The hardware development assurance level is B (for demonstrator);
- The electronics shall respect the safety & reliability objectives described hereafter:

Architecture description	Goal
Degraded performance operation	2.0 E-05
Loss of electronics function	2.0 E-07
Erroneous electronics function (un-commanded action)	5.0 E-07

This centralized controller shall challenge cost and weight while sustaining high availability objectives.

The topic requires manufacturing a demonstrator suitable for aircraft application including maintenance and certification considerations. If successfully validated, this demonstrator might be qualified and embedded in an aircraft for flight tests.

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The demonstrator shall sustain aerospace environmental conditions (DO 160E – applicable levels to be shared later) among which:

- Operating at -40°C/+70°C with full performances;
- Operating at -55°C/+90°C with acceptable degraded performances.

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

- Significant experience in aeronautical electronics' safety and reliability.
- Significant skills in innovative electrical motor control and command.
- Significant experience in compact electronics (system on chip for example) addressing power constraints.
- Experience in fulfilling a DO160-E qualification.
- Significant skills in high voltage power management (filtering).
- Experience in delivering documents for in-flight tests.

3. Major deliverables and schedule

Del. Ref. Nr.	Title	Description (if applicable)	Due
1	Architecture trade off document	Identification of key design drivers for the architecture. Intermediary design review	M0 + 3 M
2	Digital Mock-up available	Set-up of a digital mock-up for concept validation	M0 + 6 M
3	Preliminary Design Dossier	Demonstration via a digital mock-up of the validity of the concept. Preliminary design review	M0 + 7 M
4	Detailed Design Dossier	Detailed proof of concept of the design. Validation of concept. Critical design review	M0 + 10 M
5	Demonstrator hardware available	Release of the Demonstrator	M0 + 18 M
6	Validation Report	Report assessing functional, performances, environmental, weight, cost and MTBF results	M0 + 22 M

4. Topic value (€)

The total value of this work package shall not exceed:

700,000.-- €
[seven hundred thousand euro]

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

5. Remarks

None

Topic Description

CfP topic number	Title		
JTI-CS-2012-01-SFWA-01-048	**Magnetic Gearbox**	**End date**	*April 2014*
		Start date	*July 2012*

1. Topic Description

This application targets new generation aircraft actuation systems. A magnetic gear is analogous to a mechanical planetary gear. It is able to transmit high torque in a volume that is similar to that of a mechanical gear by using an array of powerful rare earth permanent magnets. With the exception of its bearings, it does not have any contacting parts and has the following advantages over a mechanical gearbox:

- High efficiency;
- No wear or lubrication;
- Through wall transmission;
- Reduced maintenance;
- Improved reliability;
- Torque fuse protection;
- Reduced noise & vibration.

It is intended to be operated in line with a mechanical gearbox as a secondary reduction stage in commonly used applications such as hybrid systems composed of hydraulics and electrical devices. The reduction box must integrate a torque limiter function and filter out the mechanical vibrations of its environment.

The first stage of the study to be conducted by the applicant shall provide theoretical estimates of the weight, cost and reliability of a magnetic gearbox sampled over a wide range of reduction rates, torques and diameters (using a parametric model) as shown in the example below:

Parameter	Scanned values	Array size
Diameter (mm)	50, 100, 150, 200, 250, 300	6
Gear ratio	2, 4, 6, 8, 10, 14, 18, 20, 24	9
Torque (Nm)	10, 25, 50, 100, 200, 300, 400	7
	Total number of designs	378

WEIGHT	COST*	MTBF
?	?	?

*Assuming a production of approximately 800 units per year

From the above mentioned theoretical figures, the system's weight, cost and reliability optima have to be determined, assuming an integration of the gearbox at system level. For the chosen configuration, the optimum shall be defined by the applicant and validated through the manufacture of a demonstrator suitable for aircraft application, including maintenance and certification considerations. If successfully validated, this demonstrator might be qualified and embedded in an aircraft for flight tests.

The demonstrator shall sustain aerospace environmental conditions (DO 160E – applicable levels to be shared later) among which:

- Operating at -40°C/+70°C with full performances;
- Operating at -55°C/+90°C with acceptable degraded performances.

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

- Demonstrated knowledge of and experience with magnetic gear boxes.
- Ability to design and manufacture magnetic gear boxes.
- Ability to work in and adapt to a flexible environment.
- Knowledge of permanent magnets.
- Knowledge of aeronautical qualification and certification processes.

3. Major deliverables and schedule

Ref. Nr.	Title	Description (if applicable)	Due	Budget
1	Report of Weight & Cost; first estimates	MRB Weight/Rough Order of Magnitude (ROM) cost estimations over a wide range of reduction rates and associated torques. ROM estimates. Preliminary Design Review	M0 + 3 M	€55K
2	Report of Weight & Cost; accurate estimates	MRB Weight/Cost Accurate estimations over a narrow range of reduction rates and associated torques. Critical design review	M0 + 6 M	
3	Demonstrator specification document	Specification of an optimised demonstrator targeted for integration on aircraft system level	M0 + 7 M	€15K
4	Full scale demonstrator hardware	Design and manufacturing of a demonstrator	M0 + 13 M	€80K
5	Performance Verification	Measure performance envelope of demonstrator to ensure acceptance for qualification stage.	M0 + 15 M	€50K
6	Validation Report	Final document providing the results of the test and recommendations	M0 + 20 M	€50K

4. Topic value (€)

The total value of this work package shall not exceed:

250,000.-- €
[two hundred andfifty thousand euro]

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

5. Remarks

None

Topic Description

CfP topic number	Title		
JTI-CS-2012-01-SFWA-02-020	**Development of an automated gap filler device**	**End date**	*June 2013*
		Start date	*June 2012*

1. Topic Description

Natural Laminar Flow (NLF) has been identified as a key technology to contribute to the reduction of emissions for future generations of transport aircraft. A key objective for the SFWA programme is to take this technology to a Technology Readiness Level (TRL) level of 6 and a number of major flight and ground demonstrations are being coordinated to meet that objective.

A Ground Based Demonstrator (GBD) is being designed with the aim of demonstrating full systems and structural integration of the leading edge zone at full scale. It is expected that the GBD will include a joint between the composite wing box upper cover and the leading edge that might be either metallic or composite. The current baseline is a joggled joint that has been shown to meet the surface quality requirements for NLF providing it can be adequately filled.

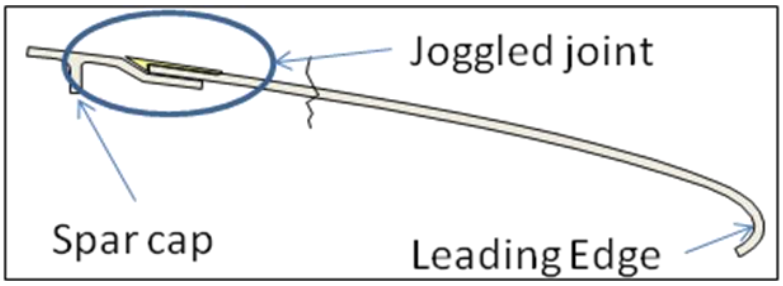

Figure 1: Joggled joint

While filled joints are in themselves not new or unique to NLF wings it is considered challenging to achieve a rapid filling of a joint that maintains the surface quality to the specified values. The global aim of this CfP topic is the development of a prototype tool that can apply filler into a joggled joint in a fully 3-D environment (i.e. with sweep and taper) and achieves a surface finish within NLF tolerances. In order to meet the tolerances it may be acceptable that the filler extends beyond the boundaries of the joint providing the surface quality is not compromised. It is possible that, if the tool proves successful then, further applications to more general treatment of gaps and surface discontinuities such as dents, repairs or scratches, could be considered.

The applicant has to develop a prototype of an automated gap filler device. The device should be configured to demonstrate its function on the assembled ground based demonstrator. Typical gap widths are of the order of 3mm with depths in excess of 4mm and it is required that the final step height of the filled gap be within the tolerance of +/-0.1mm. The joint may be positioned in a region of mild double curvature. The device should be capable of operation within an assembly line and also as part of remote site maintenance. Full details of the surface requirements will be provided to the successful applicant. At this stage it should be accepted that the necessary surface requirements will be more stringent than those for a conventional wing with turbulent air flow.

The work programme will be expected to include: a background study, benchtop prototyping, software development, benchtop trials, measurements of performance, optimisation where necessary, design refinement and technical drawings and the manufacture of a final prototype for more extensive evaluation and demonstration.

At the end of the programme a detailed technical report will be published together with requirements

for final compliance and marking.

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

- The applicant shall demonstrate an awareness of the requirements for equipment to be used for commercial aircraft assembly either as part of a final assembly line or as a field repair capability.
- The applicant should also demonstrate a good track record of innovation in the development of new manufacturing techniques and assembly solutions.
- The applicant shall provide evidence of their track record in meeting tight time schedules and delivering a quality product on time and at cost.

3. Major deliverables and schedule

Del. Ref. Nr.	Title	Description (if applicable)	Due
1	Review of potential design solutions	Report	M2
2	Results from flat plate coupon tests	Report	M6
3	Final design solution	Report	M7
4	Results from final double curved coupon tests	Report	M11
5	Prototype device	Hardware	M13

4. Topic value (€)

The total value of this work package shall not exceed:

550,000.-- €
[five hundred and fifty thousand euro]

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

5. Remarks

As a general guide, it is anticipated that the maximum length of proposals will be approximately 40 pages. In this context, please note also the instructions on minimum font and margin sizes and other matters in the document “Rules for Participation and Rules for Submission of Proposals and the related Evaluation, Selection and Award Procedures”.

Where it is proposed to subcontract certain elements of the work to be carried out, the following conditions must be fulfilled and explained in the applicant’s proposal:

- Proposed subcontracts may only cover the execution of a limited part of the proposal
- Recourse to the award of subcontracts must be duly justified in the proposal having regard to the nature of the project and what is necessary for its implementation
- The proposal should indicate the tasks to be subcontracted and an estimation of the costs

All proposals shall comply with “Rules for Participation” and “Rules for Submission of Proposals” and the related “Evaluation, Selection and Award Procedures” that are available from the CORDIS website.

Topic Description

CfP topic number	Title		
JTI-CS-2012-01-SFWA-02-022	**Design and manufacturing of an innovative cryogenic wind tunnel model with motorized empennage**	**End date**	*Dec2013*
		Start date	*Jan 2013*

1. Topic Description

General Description

The subject of this topic is the design and manufacturing of a full aircraft model for high speed high Reynolds wind tunnel test (WTT) in a cryogenic facility.

Both the configuration and testing techniques are innovative. The model will be used for an ambitious WTT of a high speed business jet at flight Reynolds number. The evaluation of the overall gain of laminarity on a representative aircraft configuration is to be done in a cryogenic facility to ensure the potential of the technology and to consolidate the choices in terms of:

- Cruise flight design point (Mach, altitude);
- Airfoil design.

This WTT is therefore the most important milestone in pushing forward the design of a future jet based on Natural Laminar Flow (NLF) technology.

A large number of steady and unsteady measurement probes are to be integrated in the wing with special care of the final model surface quality. The design options and the ways to manufacture the wings (waviness, parts interchangeability) and to integrate the pressure probes have to be driven by the need of strong shape tolerance constraints to ensure laminarity at flight Reynolds number (about 10 million based on the Mean Aerodynamic Chord). The applicant shall provide innovative and robust solutions to match the high level of instrumentation density and laminar shape tolerance constraints.

The model will include:

- 2 sets of wings (low sweep, high aspect ratio, laminar airfoils) and adapted Karman shape for each type of wing;
- A motorized empennage (probably U-shaped);
- A fuselage for mating the empennage and both sets of wings;
- A set of flow through nacelles and pylons representative of a twin engine bizjet configuration.

The wings will be equipped with pressure probes and pressure transducers for buffeting and performance analysis purposes (steady and unsteady measurements).

Model and Test description

1 - WTT description

The objective of the WT campaigns is to test a highly efficient configuration studied in the scope of SFWA. Focus is put on the design to improve the environmental footprint of such an aircraft. In terms of aerodynamics, the design of the current project has been driven by:

- Efficient Low Sweep High Aspect-Ratio wing with an extensive laminar flow region on upper and lower sides and adaptive trailing edge (TE) camber. Two sets of wings are to be tested to explore NLF design for different Mach cruise conditions and wing sweep.

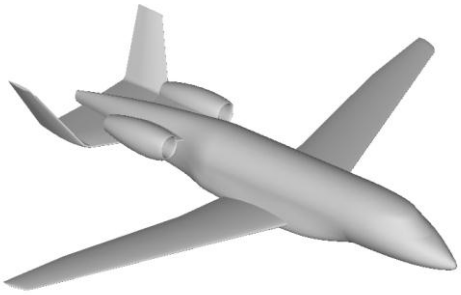

Figure 1: General View of the model preliminary design with its high aspect ratio wing

- Innovative Horizontal Tail (HT) configuration designed as engine noise shield (for both jet noise and turbomachinery noise). The stabilizing capabilities of the empennage at high speed and its own drag have to be evaluated during the test to consolidate the overall drag of the configuration.

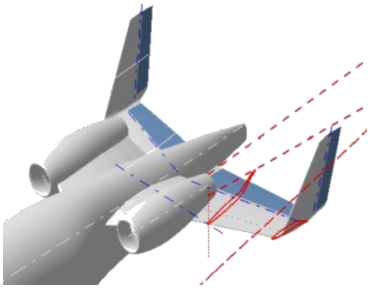

Figure 2: U-Fit Masking Tail (Jet above HT)

Therefore, the primary goal of the WTT planned with the model specified in this topic is to check the efficiency and viability of design choices in terms of:

- Laminar extension on the wing at different cruise conditions (Reynolds, Mach);
- Drag decrease due to the effective laminar flow extension;
- Buffet onset at different cruise flight points with laminar airfoils;
- Drag and longitudinal stability of the innovative empennage.

The model will be tested in the (Pressure, Temperature) range below:

- Pressure from 115kPa to 300kPa;
- Temperature from 110 K to 313 K.

The maximum loads expected on the model are presented below (static loads only):

- Fz = + 25kN;
- Fx = -100 / +900 N;
- My = ± 1350N/m.

These approximate loads are given only for costs estimates. Updated data will be provided with the final external shape.

2 - Model description

The model scale is approximately 1/15th, leading to a maximum full span of about 1600mm for a fuselage length of about 1300mm.

The different parts of the model are:

- 2 sets of wings with one set allowing some TE interchangeability to achieve camber effects. The shape of both wings (airfoil definition, plan view, sets of TE camber shapes, fairing and

other control surfaces) will be specified by the SFWA partner to the applicant. Two different Karman shapes will also be designed to adapt the two sets of wing on a common fuselage.
- a motorized empennage (probably U-shaped) with trim deflection capability. The shape (airfoil definition, plan view) will be specified by the SFWA partner to the applicant.
- a fuselage mounted to an existing z-sting.
- a set of Through-Flow nacelles/pylons mounted on the aft fuselage.

2.1 – Wings

The first wing set has a 15°-20° quarter-chord line sweep with modular TE and a high aspect ratio (9 to 12). Airfoil shape is driven by the pressure distribution required to achieve NLF at cruise condition. Typical relative thickness for such airfoils is 9-15%.

The second wing set has a 20°-25° quarter-chord line sweep and a high aspect ratio (9 to 12) with thinner airfoils, without any control surface, the other wing characteristics being the same as the first wing set.

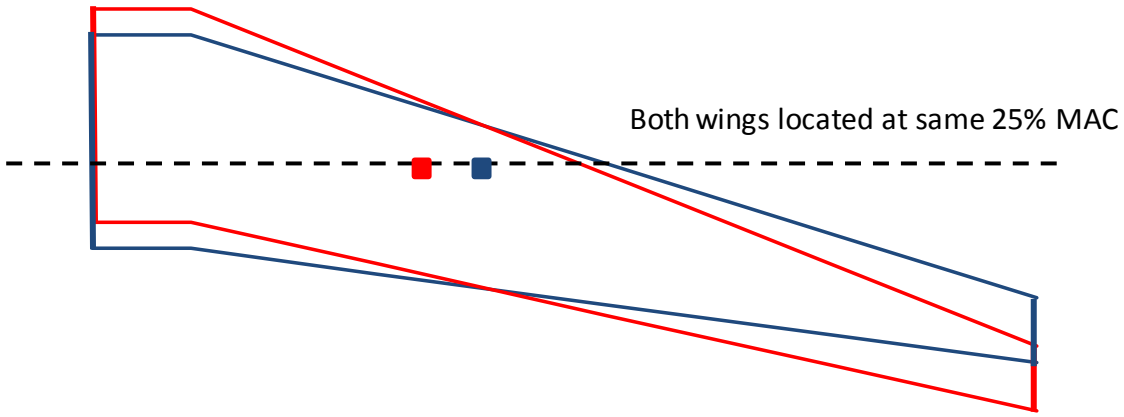

Figure 3: Generic Plan view of the two sets of wings with different leading edge sweep angle

Both sets of wing will be located at the same 25% MAC position in X leading to a different root footprint. Therefore two different Karman shapes will be designed and manufactured within this proposal to ensure an acceptable aerodynamic external shape.

Required modularity on wings is as follows:

- Interchangeable TE with different cambers. The TE camber angles (taken at 75% chord) will be [-2°, 0° and +2°]. The TE will be divided in at least 3 different parts in span to enable the combination of different TE cambers. One therefore can count 3x3 different TEs on each wing (port and starboard) which means 18 total parts. This will be done on only one set of wings (choice on the exact set will be done at the beginning of the project). The maximum proportion of chord for the removable parts is 35%.
- Removable wingtip. The wingtips of both sets of wings will be removable. This will allow the model to be fitted with different wingtips/winglets if needed.
- Winglet: one winglet will be designed and manufactured for the WTT for each set of wings. Their external shapes will be provided by the SFWA partner to the applicant.

2.2 – Empennage

The planned configuration for this model is a U-shaped tail that is composed of a horizontal tail plane and two symmetrically-placed vertical tips (see Figure 2). The empennage has to be removable from the model to achieve a ‘no empennage configuration’ test.

To optimize WTT costs, a motorized empennage is requested in order to achieve discrete trim deflection angles of -4°, -2°, 0° and +2° while the tunnel is in operation. No control surfaces are needed on the HTP/VTP. This is a challenging but realistic request. The following specifications are to be taken into account by the applicant:

- The accuracy of the trim angle will be to within +/- 0.05°.
- The exact trim angle is to be known during the test (with wind on) with the same accuracy (less than 0.05°). Therefore a dedicated transducer is to be integrated in the model to provide this information.
- A locking system is to be integrated in the model to ensure that the trim angle will not change during a given alpha sweep polar.
- The motorized empennage shall work at low temperature (about 110K) and high pressure (up to 300kPa). No trim angle modification will be done with wind on (only with low dynamic pressure but inside the WT under cryogenic and pressurized conditions).
- An “emergency” actuation mode has to be defined in order to manually change the trim angle (outside the WT and at atmospheric conditions) in case of engine malfunction during the test. At the same time a manual mode has also to be defined for the locking system.
- The system has to be validated, by the applicant before the tests, under the thermal, loads and vibration conditions that the model will encounter during the WTT. The different validations (thermal, vibration and loads) can be managed separately but a combined (thermal and vibrations) test is highly recommended.
- An independent remote control unit has to be provided together with the model to ensure the possibility to use it in different facilities.

2.3 – Pylons and nacelles

The pylons and flow-through nacelles are mounted on the aft fuselage just ahead of the empennage.

2.4 – Fuselage

The model will be mounted in the WT with an existing Z-sting and the sting geometry will be provided by the Topic Manager to the successful applicant. The fuselage will therefore include the balance integration attached to the sting. The motor for empennage trim control will be embedded inside the aft fuselage.

The fuselage is common to both wing sets but should include a Karman fairing interchangeability and two different Karman parts to restrict the leakage of the model with the two different sets of wings.

3 - Model Specification

All shape and interface definitions of the model are defined and will be provided by the SFWA partner to the successful applicant. Final geometry will be supplied in CATIA software definition in the Model Requirements Document to be issued in Q4 2012.

4 - Model Tolerances

Due to the extension of laminarity expected on the wings, special care is asked for the surface shape tolerances. In addition to the general roughness requirement, it is asked for a mirror finish on both sets of wings (upper and lower panel). The applicant shall consider the following tolerances for cost estimates:

- Surface roughness:
  - Wings: 0.08µm with mirror finish
  - Other parts: 0.08µm
- Steps :
  - Wings and winglet upper surface :
    - x/c<0.6:

        - no Forward Facing Step (FFS)
        - Backward Facing Step (BFS): ≤ 5µm
      - x/c>0.6 :
        - no FFS
        - BFS: ≤ 10µm
    - Wings and winglet lower surface :
      - x/c<0.5 :
        - no FFS
        - BFS: ≤ 5µm
      - x/c>0.5 :
        - no FFS
        - (BFS: ≤ 10µm
    - Other parts:
        - no FFS
        - BFS: ≤ 15µm
- Gaps: ± 5µm
- Surface Profile limit:
    - For x/c < 0.2: ±30µm
    - For x/c > 0.2: ±30µm

5 - Model equipment

Laminar extension will be detected on both wing sets using Temperature Sensitive Paint (TSP) techniques. Therefore, the starboard wing may be “clean” of instrumentation for TSP testing while the port wing will be equipped with pressure transducers. The TSP will be put for a specific rotation and therefore no thickness allocation is asked for on the wings. The TSP will be deposited on the current external aerodynamic shape.

5.1 – Pressure probes

Three chord wise sections of around 40 pressure probes are to be instrumented on each port wing (on lower and upper surface). The psi external hole on the model skin will be 200µm. Some pressure tappings will be located on the removable TE parts. One shall assume around 10 probes per TE part for the port wings. Therefore a maximum number of 180 pressure probes are needed on each set on wings.

To ensure the reliability of the pressure probes and efficient configuration changes, a quick mounting and dismounting system is asked for the probes located on the removable TEs.

4 pressure probes are to be integrated in one Through-Flow nacelle together with one total pressure probe.

3 pressure probes are to be installed inside the fuselage for reference purposes.

5.2 – Kulites

For buffet-onset prediction, unsteady pressure transducers are needed on the model. On the wings, the Kulites will be located between 35% and 90% of chord.

The pressure transducers types are: LL-1-072-2.5 BAR A_cryo (surface mount Kulite).

Each wing will be equipped with 40 Kulites at a time. 5 Kulites will be mounted on each removable TE part. One wing will therefore count 40 Kulites while the second set will be equipped with a total of 70 Kulites (25 on wing box and 3x3x5 Kulites on the interchangeable TEs). A maximum total of 110

pressure transducers have to be purchased and integrated within this proposal.

To ensure the reliability of the pressure probes and efficient configuration changes, a quick mounting and dismounting system is asked for the pressure transducers located on the removable TEs.

The instrumented wings have to be tested before the reception of the model under thermal, loads and vibration conditions that the model will encounter during the WTT. The different validations (thermal, vibration and loads) can be managed separately but a combined (thermal and vibrations) test is highly recommended

The applicant shall propose a suitable and innovative way to integrate the probes (psi, Kulites) with minimal flow disturbance to prevent turbulent wedges on the wings.

Exact probe locations will be specified in the Model Requirements Document to be issued in Q4 2012.

The model balance will be provided by the WT operator.

6 – Other items

The applicant is responsible of the shipment of the model from his facility to the WT location.

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

- The applicant shall have significant experience in designing and manufacturing High Speed Wind Tunnel Models for the aeronautical industry.
- The applicant shall comply with the SFWA partner's procedures concerning WT model design and manufacturing. These procedures will be provided in the model requirement document to be issued in Q4 2012.
- The applicant will be required to have confidential agreement(s) with all partners participating in the High Speed Platform.
- The applicant shall be proficient in using the SFWA partner's CATIA V5 Software.

3. Major deliverables and schedule

Del. Ref. Nr.	Title	Description (if applicable)	Due
D2.1.3-D-01	Design and stress description of the model	According to detailed technical requirements	01.05.2013
D2.1.3-D-02	Complete model including instrumentation	According to detailed technical requirements	01.12.2013
D2.1.3-D-03	Geometric inspection	According to the tolerance requirements	Before 01.01.2014
D2.1.3-D-04	Instrumentation inspection	According to the technical requirements	Before 01.01.2014

4. Topic value (€)

The total value of this work package shall not exceed:

1,800,000.-- €
[one million eight hundred thousand euro]

Please note that VAT is not applicable in the frame of the Clean-Sky program.

5. Remarks

None

Clean Sky Joint Undertaking
JTI-CS-2012-01-SFWA-02-024

Topic Description

CfP topic number	Title		
JTI-CS-2012-01-SFWA-02-024	**Laminar Wing Optimisation using Adjoint Methods**	**Start date**	*1st Sep 2012*
		End date	*31st Dec 2013*

1. Topic Description

Introduction

Laminar wing optimisation relies on accurate flow calculations, transition modelling and optimisation methods. Applying this technique to industrial wing design with a large number of design parameters requires an efficient method.

Many of the methods for laminar wing design used in the industry today are based on the Euler and boundary layer equations. If these are used as part of an optimization procedure, finite difference gradients or response surface methods are often applied. This drastically limits the accuracy and the number of design parameters.

The efficiency and the number of design parameters can however be increased by using gradients computed by means of the Navier-Stokes (NS) equations and their adjoint instead.

Description of the CfP topic

The objective of this CfP topic is to develop and mature an optimisation method based on the Reynolds-Averaged Navier-Stokes (RANS) flow equations together with an accurate transition model using e.g. a robust Problem Solving Environment (PSE) method, for laminar wing design. Corresponding adjoint equations to the RANS and PSE, or equivalent, will provide the optimisation gradients of the total drag at a computation cost which is not dependent on the number of design parameters and which is accurate enough for use in gradient-based optimisation. The wing shape optimisation procedure must demonstrate the capability to carry out design in a realistic industrial context, e.g. dealing with realistic aircraft wing geometry including constraints.

Scope of the work of the applicant

Task 1: Development of software for computation of total drag gradients based on RANS equations and their adjoint.

The aim of this task is to develop a Natural Laminar Flow (NLF) wing design software package based on the NS equations and their adjoint. The NS-solver and its adjoint should include turbulence models in order to compute the turbulent drag and its gradient correctly. The software package should include advanced and accurate transition prediction tools (e.g. PSE). For the sake of accurate transition prediction, computation of disturbance growth and its gradient should be based on the solution of boundary layer equations and their adjoint.

Task 2: Efficient geometry parameterisation and mesh deformation

The efficiency in the optimisation procedure can be enhanced by the proper choice of design parameters. In this task a study of different parameterisations shall be performed. It is also important to have an accurate and efficient technique for deforming the volume mesh based on deformed surface mesh. The development of such a method is included in this task.

Task 3: Robust initialisation procedure for the PSE equations

In this task an automatic and efficient tool for estimation of frequencies, spanwise and streamwise wave numbers, corresponding to unstable modes, shall be developed. This data is necessary for the rapid initialization of transition prediction tools (e.g. PSE codes) and robust design software based on

such tools. A substantial decrease in computing time is hence expected.

Task 4: Demonstration of the laminar wing design

A test case, a generic wing body geometry representing a realistic civil Short Range Aircraft (SRA), with flight conditions and constraints, will be provided to the successful applicant. The purpose is to demonstrate the capability of their optimisation procedure to reduce the total drag of a wing at transonic speed in an industrial context.

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

- Long term experience in NS computations and transition prediction.
- Experience in Aerodynamic Shape Optimisation, in particular adjoint methods for NS equations.
- Access to high performance computers.

3. Major deliverables and schedule

Del. Ref. Nr.	Title	Description (if applicable)	Due
1	Review and approval of feasibility for proposed algorithms to be implemented in code	Milestone	31.12.2012
2	Report on Task 2 consisting of a short summary of the work and results	Report	31.6.2013
3	Report on Task 3 consisting of a short summary of the work and results	Report	31.6.2013
4	Final report on the validation of the Laminar Wing optimisation method based on RANS equations, including the test case in Task 4	Report	31.12.2013
5	Source code for Laminar Wing optimisation based on adjoint method for NS equation, integrated with present available EDGE code		31.12.2013

4. Topic value (K€)

The total value of the proposed package is

250,000.-- €
[two hundred and fifty thousand euro]

Please note that VAT is not applicable in the frame of the Clean-Sky program.

5. Remarks

None

Topic Description

CfP topic number	Title		
JTI-CS-2012-01-SFWA-02-025	**Development of ice fracture criteria for different ice cases**	**Start date**	*T0*
		End date	*T0+18 M*

1. Topic Description

The subject of this CfP topic is the development of fracture criteria for ice, used in an ElectroMechanical Expulsion Deicing System (EMEDS). The criteria should be implemented and validated in a commercial Finite Element (FE) code.

Description of a typical electromechanical deicing application

It is sometimes necessary to keep metallic or composite skins free from ice. One solution is to apply mechanical pulses to the skin, which will create deflections/forces that will break the ice into pieces. The pulses will introduce stresses in the skin, however, and will therefore have an impact on fatigue life (many pulses and locally high stresses), for example. For this reason, it is necessary to minimize the pulse energy and thereby improve the fatigue life whilst keeping full deicing capabilities. The number of pulses is typically comprised between 3 and 6 per sequence. Pulses may vary in amplitude.

Simulation of deicing

The ice accretion and break-up behaviour is typically validated via an Ice Wind Tunnel (IWT) test, but in this case the ambition is to conduct simulations on a given profile and to analyse the data using an FE program (for example LS-DYNA, an explicit FE program) in order to better understand the dynamic behaviour and mechanical stresses in the ice and the adhesive interface between ice and skin. With ice fracture/ice adhesive criteria it is possible to predict the amount of pulse energy needed in order to remove the ice to given requirement. This energy has to be minimized.

Ice properties

From IWT tests it seems that a good approximation is that the ice removing capability is dependent mainly on temperature, ice thickness and ice distribution. Of course stiffness properties in the skin (thickness, geometry and boundary conditions) are also important, but this shall not be handled by the ice model.

Work to be conducted by the applicant

The applicant shall have to conduct the work outlined in the Task description below. Tests for the validation of theoretical work shall have to be conducted under the applicant's own responsibility.

Parameters to be included

In order to be able to formulate the criteria above, the following parameters have to be tested and analysed:

1. Two ice temperatures
    a. Cold case Temp=TBD
    b. Warm case Temp=TBD
2. One ice quality
    a. Clear ice
3. Two skin materials
    a. Aluminium
        i. Thickness typically 1.0 - 2.0 mm

   b. Carbon fibre reinforced plastic TBD
      i. Thickness typically 1.0 - 2.5 mm
4. Two surface treatments
   a. Reference, polished surface
   b. Advanced surface TBD
5. Two geometries, including boundaries (given)
   a. Flat
   b. Half-circular R=150 mm
6. Ice thickness
   a. 1-10 mm
7. Mechanical model (LS-DYNA model, which includes load pulse) of an actuator, to be supplied by SFWA.

Task description

There are many combinations, not all of which have to be carried out, but it is important to design a well-defined and motivated test matrix.

The main task is to formulate:

1. Ice fracture criteria
2. Ice adhesive criteria

The sub-tasks are:

1. Formulate a work plan
   a. Define and motivate parameter combinations which will be carried out
      i. Preliminary results
      ii. Final results
   b. Description of test program
   c. Description of LS-DYNA analyses
   d. Description of theoretical fracture model
   e. Description of final report
   f. Time schedule
2. Formulate preliminary criteria for cold ice case, both ice and adhesive
   a. Based on tests and FE analyses for a few parameter combinations
3. Formulate preliminary criteria for warm ice case, both ice and adhesive
   a. Based on tests and FE analyses for a few parameters combinations
4. Formulate final criteria for both cases

The result from the CfP topic is a well documented report with results from all tests together with fracture and adhesive criteria for all ice cases.

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

- Experience in, and good knowledge of an FE program (for example LS-DYNA).
- Experience in, and good knowledge of material physics, especially ice.
- Experience in and good knowledge of material testing.
- The applicant has to have their own test facilities or easy access to a suitable facility.

3. Major deliverables and schedule

Del. Ref. Nr.	Title	Description (if applicable)	Due
1	Development plan	A detailed description in a work plan	T0 + 4 M
2	Preliminary criteria for cold ice case	Report including preliminary model description	T0 + 8 M
3	Preliminary criteria for warm ice case	Report including preliminary model description	T0 + 12 M
4	Final and validated criteria	Includes the user subroutine	T0 + 16 M
5	Final Report	Includes all test results, a complete and validated ice fracture and adhesive model description, including established model parameters	T0 + 18 M

4. Topic value (K€)

The total value of the proposed package is

300,000.-- €
[three hundred thousand euro]

Please note that VAT is not applicable in the frame of the Clean-Sky program.

5. Remarks

None

Clean Sky Joint Undertaking
JTI-CS-2012-01-SFWA-02-026

Topic Description

CfP topic number	Title		
JTI-CS-2012-01-SFWA-02-026	**Experimental and numerical investigation of Turbulent Boundary Layer (TBL) effects on noise propagation in high speed conditions**	**End date**	*June 2014*
		Start date	*June 2012*

1. Topic Description

Within the SFWA Integrated Technology Demonstrator, a specific Work Package is addressing the problems raised by the integration of the Counter Rotating Open Rotor Engine (CROR) to the aircraft in terms of aerodynamic performance and acoustic signature. The CROR noise transmission into the aircraft cabin in cruise conditions encompasses several complex phenomena, including some refraction due to the fuselage Turbulent Boundary Layer (TBL).

The aim of this CfP topic is (i) the acquisition of an experimental database and (ii) the development and assessment of numerical aero-acoustics methods able to predict TBL refraction and scattering effects on noise reaching an aircraft fuselage in high speed conditions.

Method validation / assessment will have to be done vs to be measured experimental data over a simplified problem (simple tonal source, simple aircraft fuselage shape).

This refraction effect can be split into two main physical phenomena:

- The hereafter called “pure TBL refraction effect”, due to steady velocity gradients in the TBLs which “curve” the sound waves.
- The hereafter called “scattering TBL refraction effect”, due to the interaction (weak or strong) between the sound waves and the turbulent unsteady structure present in the TBL.

The high speed wind tunnel tests to be carried out by the applicant shall include measurements performed on the skin under the TBL (rms pressure levels & phases) at source frequency and in free field, which will enable the characterisation of the refraction effects. The tonal source (1000, 2000 & 3000Hz) is to be placed within the flow during the measurements. This source and its support, which fits well into a tunnel > 1,5m square, can be provided by Airbus. Different source locations will have to be tested, preferably over TBLs with different characteristics (thickness, etc).

Regarding computations, the two described effects will have to be addressed using steady and unsteady CFD (Computational Fluid Dynamics) and CAA (Computational Aero-Acoustics) codes. A final demonstration case will be performed on an experimental configuration using more realistic sources coming from CFD/CAA simulations, to be provided by Airbus. Depending on dominating physical mechanisms, recommendation/guidelines for simulations of TBL effects on surface rms pressure and phase will have to be drawn, including a cost estimate for the application to a representative case (part of an aircraft) to be provided by Airbus.

The work to be performed by the applicant consists of three work packages:

WP1:

- Suggested planning: before October 2012 (or M0 + 3 M): Definition of tests: agreement on test set up & measurements, test matrix and so on.
- Mandatory milestone: before January 2013 (or M0 + 7 M): Completion of the High Speed Wind Tunnel Testing of the simplified configuration (tonal source, simplified fuselage).

WP2:

- Suggested planning: before Dec 2012 (or M0 + 6 M): Development & tests of the aeroacoustic methods able to deal with the pure TBL refraction effect.
- Mandatory milestone: before June 2013 (or M0 + 12 M): Comparison between experimental results and numerical prediction for the pure refraction effect. Analysis of the results and

physical understanding, recommendations for further modelling activities.

WP3:

- Suggested planning: before June 2013 (or M0 + 12 M): Development & tests of aero acoustics methods able to deal with scattering TBL refraction effect.
- Mandatory milestone: before December 2013 (or M0 + 24 M): Comparison between experimental results and numerical predictions for the scattering TBL effect. Final demonstration case using more realistic noise sources. Analysis of the results and physical understanding, recommendation for further modelling activities.

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

Due to the wide range of skills required for the execution of this topic, it is suggested that the applicant prepare a joint proposal with other party(ies), e.g. one for the experimental side / one or two for the aeroacoustic modelling part.

Mandatory skills:

- Recognized skills in external aerodynamic and aeroacoustic numerical modelling;
- Model manufacturing capability & Wind tunnel facility equipped for transonic flows tests.

3. Major deliverables and schedule

Del. Ref. Nr.	Title	Description (if applicable)	Due
1	Report & Database	Tests Results & Analysis	M0 + 8 M
2	Report	Comparison between experimental results and numerical predictions for the pure refraction effect	M0 + 12 M
3	Report	Comparison between experimental results and numerical predictions for the scattering TBL effect. Final demonstration case using more realistic noise sources and guidelines/recommendations for the application of the most adapted method to a representative aircraft case	M0 + 24 M

4. Topic value (K€)

The total value of the proposed package, is

750,000.-- €
[seven hundred and fifty thousand euro]

Please note that VAT is not applicable in the frame of the Clean-Sky program.

5. Remarks

None

Clean Sky Joint Undertaking
JTI-CS-2012-01-SFWA-02-027

Topic Description

CfP topic number	Title		
JTI-CS-2012-01-SFWA-02-027	**Transonic High Reynolds Number Testing of a Large Laminar Wing Half Model**	**End date**	*Dec2012*
		Start date	*June 2012*

1. Topic Description

Introduction

Natural Laminar Flow (NLF) is established as a key Technology Stream within the Smart Fixed Wing Aircraft (SFWA) programme. As part of the process to mature that technology to a Technology Readiness Level of 6, that includes flight test and ground based demonstrators, it is intended to perform high Reynolds number experiments in a Wind Tunnel (WT). These WT-based experiments will be addressing issues associated with the impact of surface quality e.g. waves and steps, on the robustness of the region of laminar flow.

A large half model with a span of 1.6m is presently being constructed and includes a fuselage and peniche section, see Figure 1 below.

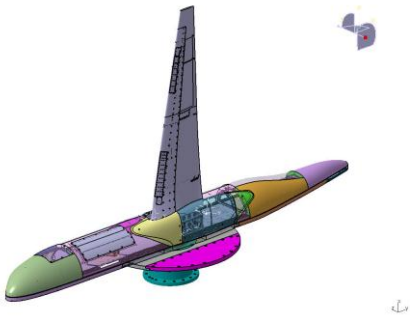

Figure 1: Large half model construction

It is the intention of the SFWA team to seek a WT site that is capable of accommodating this model and performing experiments up to M0.85.

In addition, the model is equipped with simulations of a variety of surface imperfections. The WT facility should be capable of providing and controlling inert gases at steady pressures up to 30 bar.

Objectives of WT experiment:

At high Reynolds number the experiment should:

- Provide transition data with respect to allowable manufacturing tolerances for surface steps and surface waviness over a range of Mach number and angles of attack.
- Provide data to validate CFD predictions on NLF wing designs.
- Provide the necessary information to assess the feasibility of using large half models for transition studies applicable to NLF configurations.

Model Description

- Overall span ~1.6m, overall length ~ 2m.
- Low sweep NLF wing.
- Wing design point M 0.75, Re 25E6.
- Peniche ~30 mm in height.
- The model will require a separate pressure control system and internal pressure

measurement.
- The model includes a variety of planned surface imperfections.
- Instrumentation includes:
  - Conventional pressure tappings on both the wing and the half fuselage;
  - Internal pressure measurements;
  - Temperature Sensitive Paint (TSP) regions on both top and bottom wing surfaces;
  - Internal space and attachments to accommodate a 6-component WT balance;
  - Accelerometers;
  - Assessment of static deflections under load.

The applicant will be required to demonstrate the capability to monitor all these methods and to provide appropriate optical access to the upper and lower wing surfaces for the TSP evaluation. Interpretation of the results will be the responsibility of the relevant SFWA team.

Design of the model has been completed and manufacture is underway in Germany.

Test Programme

The test shall take place during the middle of 2012.

The test shall consist of:
- Initial continuous traverse polars at M 0.73 up to M 0.77 in 0.01 increments to gather pressure data and check lift curve behaviour.
- TSP images taken at 3 CLs for various Mach numbers to verify predicted wing behaviour.
- Matrix of data points populated with TSP images for prescribed Mach and CL conditions over a range of surface quality conditions;
- Check on alternative Reynolds numbers.
- Preliminary evaluation of buffet boundaries.

Scope for Innovation
The applicant is required to identify innovative approaches to developing the test matrix and/or data acquisition to minimise the test duration or maximise the volume and quality of data. Real time processing of data could be an advantage.

Concluding Remarks
- A large half model has been designed to test allowable surface tolerance requirements for manufacture.
- Additionally it will provide validation data for NLF design techniques and CFD performance predictions.
- The test programme will concentrate on gathering TSP images for transition behaviour in the presence of various surface imperfections.
- Design of the model has been completed and manufacture is underway.

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

- Appropriate Certificates and ISO standards.
- Proof/Evidence of capability from former test campaigns including experimental accuracy, repeatability etc.
- Fit to requirements and any specific model handling or mounting requirements.
- Ability to meet both test objectives and test dates.

All applicants should provide recent data on the levels of freestream turbulence, noise and particulate contamination for the proposed facility at or near the expected test conditions of Mach and Reynolds number. Previous test data on critical N-factor performance of the facility would also be an advantage. Previous experience of testing laminar wings should be reported.

3. Major deliverables and schedule

Ref. Nr.	Title	Description (if applicable)	Due

1	Test Readiness Report	A document that shows that all infrastructure and preparatory tests are completed and in place ready for test. Statements of accuracy and proposed test schedule.	M0 + 1 M
2	Final data report	A full compilation of all data acquired	M0 + 6 M

4. Topic value (€)

The total value of the proposed package, is

1,200,000.-- €
[one million two hundred thousandeuro]

Please note that VAT is not applicable in the frame of the Clean-Sky program.

5. Remarks

None

Clean Sky Joint Undertaking
JTI-CS-2012-01-SFWA-02-028

Topic Description

CfP topic number	Title		
JTI-CS-2012-01-SFWA-02-028	**Low speed aerodynamic test of large CROR aircraft model in a closed test section**	**End date**	*Dec2012*
		Start date	*Aug 2012*

1. Topic Description

Clean Sky is investigating the potential of Counter Rotating Open Rotor (CROR) engines. In the Smart Fixed Wing Aircraft (SFWA) technology demonstrator there is a dedicated Technology Stream addressing the aerodynamic performance and acoustic signature of such engines. In this framework a low speed aerodynamic Wind Tunnel (WT) Test has to be conducted with an existing model.

Specifications of the model, which is to be equipped with two engines, are as follows:

- 5.11m full span;
- Two 170kW per shaft counter rotating engines, one on each side of the fuselage, each requiring pressurized air with a maximum mass flow of 7.2kg/s at 80 bar pressure;
- The model is mounted on a ventral sting with feed and return air for the two engines;
- The maximum model dead weight is 17,000 N.

The applicant shall develop optimised engine feed and return lines (minimized pressure losses) to assure availability of maximum engine power.

The applicant shall test the model in a large low speed WT of their choice. This must be able to cover the following conditions:

- Mach number ≥ 0.22;
- Closed test section with a suitable wall correction methodology;
- The test section should be larger than 8m of width by 6m of height;
- The test section should allow the coverage of a full range of incidences up to deep stall and sideslip;
- The model support shall allow full incidence and yawing angles at associated loads;
- The applicant shall apply advanced steady and unsteady aerodynamic measurement methods.

An innovative approach is requested in setting-up and operating a fast data acquisition system able to record all unsteady pressures and balance data at high sampling rates with at least one day of storage capacity on the facilities local data acquisition system.

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

Mandatory skills:
- Recognized skills in external aerodynamic experimental characterization;
- Recognized skills in aerodynamic steady and unsteady measurements, and in the storing and processing of acoustic data;
- Availability of experienced tunnel staff ensuring high productivity testing, including model changes and operation of the pressurized engine simulators.

Mandatory equipment:
- Large low speed closed WT capable of Mach 0.22, with a test section exceeding 154% of model span;
- Advanced steady and unsteady acquisition and storage systems.

3. Major Deliverables and Schedule

Ref. Nr.	Title	Description (if applicable)	Due
1	WT Test campaign description	Complete description of the WT test campaign, including all activities related to model installation, shake down, testing and model de-rig for 160 hours of productive testing	M0 + 1M
2	Preliminary test data	Delivery of complete preliminary test database, including raw data, steady state data & dynamic data	M0 + 1M
3	Final test data	Delivery of complete final test database, including raw data, steady state data & dynamic data	M0 + 2M
4	WT Test Report	Test report to include full description of the experimental setup including a detailed run log and validated data description	M0 + 4M

4. Topic value

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

2,000,000.-- €
[two million euro]

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

5. Remarks

None

Clean Sky –Systems for Green Operations

Identification	ITD - AREA - TOPIC	topics	VALUE	MAX FUND
JTI-CS-SGO	**Clean Sky - Systems for Green Operations**	**14**	**6.540.000**	**4.905.000**
JTI-CS-SGO-01	*Area-01 - Definition of Aircraft Solutions and explotation strategies*			
JTI-CS-SGO-02	*Area-02 - Management of Aircraft Energy*		**4.700.000**	
JTI-CS-2012-1-SGO-02-021	Development of key technology components for high power-density power converters for rotorcraft swashplate actuator		350.000	
JTI-CS-2012-1-SGO-02-035	Disconnect device for jam tolerant linear actuators		800.000	
JTI-CS-2012-1-SGO-02-038	Passive cooling solution validation		300.000	
JTI-CS-2012-1-SGO-02-039	Optimisation of heat pipe to cool high speed motorised turbo-machine		300.000	
JTI-CS-2012-1-SGO-02-040	Compressor air inlet protection for electrical ECS		600.000	
JTI-CS-2012-1-SGO-02-041	Identification of a fluid for diphasic cooling adapted to aircraft applications		550.000	
JTI-CS-2012-1-SGO-02-042	Study and development of a carbon sleeve made by filament winding and directly wound on an electric motor rotor		200.000	
JTI-CS-2012-1-SGO-02-043	Aerospace housing for extreme environment		300.000	
JTI-CS-2012-1-SGO-02-044	Bus system housing for extreme environment		300.000	
JTI-CS-2012-1-SGO-02-045	Regenerative Snubber & innovative control algorithm		400.000	
JTI-CS-2012-1-SGO-02-046	High Dense Smart Power Capacitor (HDSPC) for next generation Aircraft converters		600.000	
JTI-CS-SGO-03	*Area-03 - Management of Trajectory and Mission*		**1.590.000**	
JTI-CS-2012-1-SGO-03-014	Smart Operations on Ground (SOG) power electronics with energy recycling system		1.390.000	
JTI-CS-2012-1-SGO-03-017	Real time optimiser for continuous descent approaches		200.000	
JTI-CS-SGO-04	*Area-04 - Aircraft Demonstrators*		**250.000**	
JTI-CS-2012-1-SGO-04-003	Solid State Power Controllers test benches		250.000	

Topic description

CfPNbr	Title		
JTI-CS-2012-01-SGO-02-021	**Development of key technology components for high power-density power converters for rotorcraft swashplate actuators**	**End date**	August 2014
		Start date	September 2012

6. Background

Within the JTI "Clean Sky" SGO a team are developing electro-mechanical actuation systems for rotor aircraft control surfaces. The potential benefits of moving away from an all hydraulically actuated rotorcraft to an electrical system are expected to be:

- Lower system weight,
- Increased reliability
- Lower maintenance costs.

This call for proposals (CfP) deals with the development and manufacturing of high performance power electronic converters which will need to be able to control the electrical machines used to actuate the main rotor swashplate of a medium-sized rotorcraft. The power converters will form an integral part of the fault tolerant actuation system designed by the project team. The selected partner will work closely with the team to develop, manufacture and test a set of power converters. Reliability/availability and weight are key elements of this project. The unit will be expected to operate using passive air cooling in an ambient temperature of 70C. Each power converter will be required to drive three independent, three phase motors with a peak current < 15A, be supplied from DC bus with a nominal voltage of 540V. The integration of diagnostic techniques to enable the detection of failures within the power circuit is also necessary.

7. Scope of work

The partner will contribute in the following ways:

1) Provide technical input as part of the project team during the power converter design process.
2) Demonstrate the rapid detection of faults within the power converter circuit.
3) Construct seven power converters for use in the demonstration system.

The partner will be responsible for:

- Manufacturing the prototype converters for a laboratory based demonstrator
- Support the hardware during the system test phase in either England or Germany. A small provision could be made for continued support continued system testing to the end of 2015 if this is felt necessary

8. Type of work

Applicants should be able identify the key skills and capabilities needed in the development and manufacturing of power converters and demonstrate their track record in manufacturing to a laboratory based demonstration level.

The partner will be expected to manufacture and test the final power converters with a high degree of quality in sufficient quantities to allow the system to be fully demonstrated. A minimum of seven triple output converters will be required (plus spares).

Suitable heat transfer / heat-sinking technologies should be used to minimise weight whilst maximising reliability. Natural, passive cooling techniques will be used in the design. The heat sinks will need to be manufactured or sourced by the partner.

If there is enough time available within the budget of this CfP the partner could propose to perform device trade studies based on devices which may be available within the next 5 years and also consider innovative converter topologies which could bring advantages to the application in the future. It would be expected that such studies would be conducted in parallel with the power converter construction phase of the project

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

The successful partner will have:

1. Experience in design, manufacture and integration of power converters at least to a demonstration level at the required power and voltage levels.
2. Flexible manufacturing facilities to enable alternative power converter topologies and design concepts to be considered as part of the project..

10. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Preliminary design review of: power converter design including thermal management and fault detection.		February 2013
D2	Production of 2 prototype power converters for initial system testing.		September 2013
D3	Critical design review of final power converter design.		December 2013
D4	Delivery of remaining Power Converter Units.		April 2014
D5	Completion of the initial testing of the final Power Converters as part of the complete system		August 2014

11. Topic value (€)

The **maximum value** for this topic is
350,000 €
Three hundred thousand Euro

Topic description

CfPNbr	Title		
JTI-CS-2012-01-SGO-02-035	**Disconnect device for jam tolerant linear actuators**	**End date**	Jun-2015
		Start date	Aug-2012

1. Background

The “Systems for Green Operations – Management of Aircraft Energy” research consortium investigates new system technologies for more environmentally friendly aircraft. One approach towards this target is the “electrification” of aircraft systems under the headline of the More Electric Aircraft. This includes improvement/development of individual new electrical systems with high power/weight ratio. Envisioned benefits are:

- better energy efficiency of electrically powered systems

- increased safety due to elimination of poisonous and flammable hydraulic fluids

- reduced weight and complexity of power transmission paths,weight benefit on a/c level

- easier and reduced maintenance due to elimination of hydraulic leaks and better diagnosability.

One of these systems under consideration is the swash plate actuation system of a helicopter. Here EMAs are being developed to replace the hydraulic actuators presently used.It is the target to deliver full scale demonstration hardware, validate it in aircraft relevant environment and thus shorten significantly the time to market of the solutions developed.

The swashplate system of a helicopter provides lift, pitch and roll control. The loss of any of these control functions is classified catastrophic mandating a very robust and fault-tolerant design of the 3-degree-of-freedom swashplate actuation system. The conventional hydraulic swash plate actuation system to be replaced consists of three hydraulic linear actuators arranged around the helicopter main gear box with lower attachment points to this gearbox and upper attachment points to the static swash plate.

In the described context one peculiarity of electromechanical actuators (EMAs) compared to well established and field proven hydraulic actuators is that the mechanical jamof an electromechanical actuator has to be considered as a credible failure with a probability of occurrence of larger than 10^{-9} per flight hour. In the conventional swashplate actuation arrangement comprising three actuators, the jamming of any one of those actuators would be catastrophic.The approach to this problem investigated here, is to design jam-tolerant actuators and provide additional actuators for redundancy.

One key component of such EMAs are disconnection means providing failure detection and neutralization in case of the jamming of drive train components. These disconnect devices (DDs) shall disconnect the actuator output from the main drive train elements, i.e. transform the jamming of an actuator into a free-wheel failure or in other words, allow linear motion of the actuator output with respect to its input after activation of the DD. This allows redundant actuators to take over the function of failed ones. It is one design constraint, that these DDs should be placed “close” to the actuator output to be able to neutralize a high fraction of all possible failure modes that would lead to an actuator jamming (ball or roller screw jam, gearbox jam…).

In previous work an initial study into possible implementations of disconnect devices has already been performed and an evaluation of the options is ongoing.

Quite generally the solution space can be divided into two groups of solutions:

1) Reversible and fully testable DDs

This class of solutions offers a high level of safety as the DD would be fully testable in a built in test procedure and dormant failure modes can largely be excluded. However this probably comes at the cost of quite complex designs which may translate into larger envelope, weight, failure rate and cost.

Such disconnect devices could be based on state-of-the-art clutches and brakes using well-established machine elements with only limited application specific modifications. This would be beneficial to keep development risk to a manageable level. However envelope and weight might be prohibitive.

Examples for more innovative approaches are development of customized, compact, weight optimized coupling means from state-of-the-art basic components, DD mechanisms using the torque of the drive motor to trigger the DD (avoiding dedicated drives and power stages) or full integration of the DD

within the screw drive mechanism. Other approaches that have not yet been analyzed in detail consider application of smart materials. Reversibility/testability combined with a robust still lightweight design is expected from these innovative approaches.

2) “Single-shot” or manually reversible DDs

This class of solutions can not routinely be tested in fully automatic built-in test procedures or the test coverage is quite limited. Thus over the operational life of the DD the probability that certain components have failed and would not operate properly when required accumulates. This has to be addressed by a very low and proven failure rate of these components. However, such solutions promise to be less complex and more compact and light-weight compared to the above mentioned approach.

Examples of “single-shot” DDs are pyrotechnical devices, which arewidely applied in safety devices in general and offer a very fast activation and compact, relatively simple and lightweight design. However this study shall not be limited to pyrotechnical approaches. Electromagnetic or smart material actuation of the DD mechanism is also conceivable. For some space applications, actuators based on shape memory alloys (SMA) replace pyrotechnical actuators. However, with respect to the requirements for the DD for helicopter primary flight control actuators, specificially the required temperature range, the feasibility with available SMA materials seems questionable and in case SMAs are considered, this issue shall be properly addressed in the proposal.

Given the very broad area of research pointed out above the work programme of the CfP has been partitioned into two distinct phases of work. The first phase (not to exceed 12 months) comprises a broad concept study into different implementation options of such DD and an evaluation of their respective advantages and disadvantages, technological viability and associated development risks. This phase could beneficially be structured in two parallel threads of work addressing reversible and “single-shot” devices. Concepts to be evaluated will be nominated by the caller and proposed by the applicant(s). Based upon the results of this first phase, the detailed programme of the second phase will be defined in consultations with the caller. The second phase of the programme will comprise detailed design, implementation and validation testing of two selected implementation options and the corresponding documentation. It is intended to launch this phase immediately after the conclusion of the first phase. Its expected duration is about 22 months. More details about the expected project schedule are provided in chapter 5 “Major deliverables and schedule” of this topic description. Other delivery dates of D1 to D6 may be proposed by the applicants with good justification. However D1 corresponds to the conclusion of phase 1 and shall not be moved beyond project month 12. Also the D5 delivery date shall not be postponed.

Organisations or consortia wishing to bid for this programme are advised to provide a single proposal covering both phases. This should comprise a detailed proposal for the first phase of the work and an outline proposal covering the second phase. It is essential that the applicant(s) have the full range of skills necessary to carry out the complete programme of work and this shall be credibly demonstrated in the proposal. For phase one of the programme a structured approach to establish, categorize and evaluate concept designs vs. the requirements shall be described and a selection of possible technological approaches for the DD shall be outlined. It is important that the applicant(s) clearly specify the budget and if applicable split of budget within the consortium for the different activities during phase one of the programme and the balance of budget between phase one and phase two. It is expected that phase one will require between 20% and 30% of the total budget. Any deviation shall be duly justified. For phase two, budget provisions for prototype manufacturing activities and provisioning of required test means (if not readily available at the applicant(s)) shall be clearly indicated. It is anticipated that there will be some flexibility to adapt the budget split within the consortium (if more than one organization) for phase two of the programme after the selection of the concept designs for prototype implementation.

As indicated above, the caller does not expect to receive fully evaluated design proposals for phase one or a detailed proposal covering the activities associated with detailed design, implementation and validation testing in phase two. The main reasons being, that a full set of requirements and definition of main geometries and interfaces with the actuator will be defined in cooperation between the caller and the selected applicant(s) early in phase one and that a definition of the solution concept for the prototype systems will not be available before the end of this first phase of the programme. Rather the caller is looking for a strong consortium of partners who can demonstrate – ideally through recent related activity – that they have the necessary knowledge, skills and understanding of the task outlined above and described in more detail in the following section.

2. Scope of work

The scope of the work under this call can be structured by three work packages (WP1 covering phase one of the programme and WPs 2 and 3 covering phase two. However the applicant(s) may propose a different work structure as long as phases one and two can be clearly identified.)

1) **Study and evaluation of DD concepts**

This study shall cover DD concept development (includingelectrical interfaces and the interfaces with the neighbouring mechanical parts) and concept evaluation against specifications provided by the caller. To provide a rough order of magnitude, the DDs shall operate under applied axial forces in the range of 20-50kN. Activation time should not exceed 50ms. Their weight should be in the lower single digit kg range. Ambient temperatures are between -45 and +110°C. Robustness is required under oscillating external loads (including load reversal), vibrations and limited exposure to temperatures of about 250-300°C. The axial backlash should be below 0.05mm at end of life, ideally zero backlash.

The applicants shall develop and propose their preferred approaches. About five concepts will also be defined for evaluation by the caller. A hydraulic or pneumatic “infrastructure” will not be available to supply the DD. In case such solutions are considered, they need to be “self-contained”.

One important milestone of this work package is a concept design review which aims to identify two concepts for implementation – one reversible DD and one “single shot” DD, the latter preferably based on pyrotechnical activation. Concept evaluation shall be prepared by the applicant(s). Concept selection shall be performed in cooperation and consultations with the caller.

The concepts shall be evaluated at least against the following criteria:

- mass, envelope
- reversibility/testability (built in test)
- safety/availability by means of a safety analysis, specifically addressing failure to disconnect and unintentional disconnection
- coverage of possible root causes for actuator jamming
- ease of integration with the drive train
- development risk
- complexity of the design
- effort associated with DD activation (control and power electronics)

Final deliverable for this work package shall be a report summarizing the principal DD concepts and the evaluation results.

This work package may be structured by two sub-packages, one covering the reversible DDs and one covering the single-shot or manually reversible designs.

2) **DD detailed design**

This work package covers the detailed design and required development testing for the selected DD concepts. Simulations as well as analytical calculations may be used to establish a good design confidence. This should be combined with physical testing of critical design elements or load cases where required (e.g. disconnection under limit load). Along with this a validation test plan shall be established in cooperation with the caller. Required test means shall be defined and designed/procured if not available. The purpose of the validation testing is to validate a TRL of 5 for at least one of the selected design concepts (TRL4 for the second one).

The final milestone of this WP is a critical design review which will clear the designs for prototype manufacturing.

This work package may be structured by two sub-packages addressing the two selected design concepts.

3) **DD manufacturing and validation testing**

This work package covers the manufacturing and validation testing of the developed DD designs. Eight prototypes of each design shall be manufactured and delivered to the caller. Depending on the solution concept, the integration of the disconnect device and the corresponding tests may already be performed in work package 2 described above.

Validation testing shall specifically address the following aspects:

- Disconnection capability under applied load
- Reconnection capability (load free, only for reversible mechanisms)

- Activation time
- Backlash
- Robustness of the mechanism (vibrations, oscillating loads, temperature… as considered critical)

Final deliverable to this work package is the delivery of the validated prototypes to the caller for the integration into full-scale actuators.

This work package may be structured by two sub-packages addressing the two selected design concepts.

After completion of the project the applicant(s) shall provide assistance for the developed disconnect device(s) for additional 1 year. As far as necessary maintenance shall be performed and minor fixes/updates shall be developed. Of course, the exact scope of this “maintenance” will be defined together with the applicant(s), but the applicants should be prepared to assign several man-days for these activities.

It is anticipated that after the end of the project the disconnect deviceand related IPR will be co-owned by the applicant(s) and the caller, i.e. the caller will have access to all IPR required for the application of the developed technology.

3. Type of work

The selected applicant(s) shall

- perform a product development analysis for a disconnect device as outlined above
- develop solution concepts and support the down-selection process of design options
- design the selected concept(s) to CDR (critical design review) level
- perform analysis, simulation and development tests to establish good confidence in specification compliance of the designs
- manufacture demonstrators of the disconnect devices
- perform validation testing of the demonstrators
- deliver 8 items of each demonstrator to the caller
- provide detailed documentation of all steps described above

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

The selected applicant(s) should have industrially relevant experience in design/application of machine elements and pyrotechnical elements and should ideally be familiar to design according to RTCA DO-160F.

A background in methodical product development starting at the level of basic machine elements and specifically in development of fast switching actuators/couplings is beneficial.

The applicant(s) should provide all necessary resources (expertise, machines, tooling, materials, test means, etc.) required to perform the tasks described above. If not available, the development/sourcing of such resources, specifically machines, tooling and test means, shall be part of the proposal.

The consortium of applicants should include:

- Manufacturers of couplings and/or machine elements
- Universities or research institutions with experience in the field and in methodical product development
- Expert company in the field of pyrotechnical elements

Aerospace experience is desirable.

5. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Concepts developed and evaluated. Solution concept(s) selected.	Concept design review prepared and held together with caller. Corresponding documentation available.	Jul-2013
D2	Solution concept validated by analysis, simulation and/or development tests	Specification compliance matrix established, means of compliance and design confidence indicated. Corresponding documentation deli-	Jan-2014

		vered.	
D3	First prototypes available for validation testing		Jul-2014
D4	Validation testing completed	Validation testing completed and test reports delivered to caller.	Jan-2015
D5	Prototypes delivered to caller		Mar-2015
D6	Documentation completed and delivered	All documentation available including design trade studies, prototypes documentation, test analysis and derived design recommendations.	May-2015

6. Topic value (€)

The **maximum value** for this topic is

800,000 €

Eight hundred thousand Euro.

7. Remarks

The expected length of the proposal Part B is about 50 pages (Arial, font size 10).

Based on the results of the first phase of this project, two concept designs will be selected for further development and a decision will be made as to how to proceed towards the experimental validation of technology demonstrators. The work programme of the second phase will be updated accordingly. This may require some limited adjustment of the budget split and an amendment to the Grant Agreement between Clean Sky JU and the selected applicant(s) to reflect the revised/updated work programme. The total budget for the whole project and the maximum JU contribution shall not be increased by this amendment.

Topic description

CfPNbr	Title		
JTI-CS-2012-01-SGO-02-038	**Passive cooling solution validation**	**End date**	T0 + 36 M
		Start date	T0 (S2 2012)

1. Background

"More electric" aircraft requires more power electronics integration. Cooling systems may reach their maximal performances because of too high thermal dissipation density of these components. A need of heat spreading is clearly identified. Thanks to their heat transport capacity and their passive pumping, two-phase fluid capillary pumped heat transfer systems appear among efficient alternative solutions: vapour chamber, Pulsating Heat Pipe (PHP), … However, the demonstration of their functioning in avionic application, by modelling and experimental tests, is required before being equipped on an airplane.

2. Scope of work

The aim of this work is to develop a two-phase fluid heat spreading solution for avionic application which maturity level is TRL6 (Technology Readiness Level).

The format of this equipment is close to an A4 format.

One hundred of watts are dissipated over several localized area with heat flux density around 30 W/cm². The equipment is located in a harsh environment characterized by an ambient temperature of 160°C and a low heat exchange coefficient. Despite, its maximal temperature should not exceed 200°C.

3. Type of work

The scope of this work is:

- Bibliography review
- Technology selection
- Fluid selection
- Sizing / modelling
- Prototype construction
- Experimental validation

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

The applicant should have knowledge in two-phase fluid flow and heat transfer. The capability of experimental validation (thermal performance, vibration response, …) is required (internal or external).

5. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Synthesis of bibliography and justification of technology and fluid selection		T0 + 6 m
D2	Modelling results: justification of design		T0 + 18m
D3	Prototype definition		T0 + 24m
D4	Experimental characterization		T0 + 36m

6. Topic value (€)

The **maximum value** for this topic is
300,000€
Three hundred thousand Euro

Topic description

CfPNbr	Title		
JTI-CS-2012-01-SGO-02-039	**Optimisation of heat pipe to cool high speed motorised turbomachine**	**End date**	T0 + 36 months
		Start date	T0

1. Background

To achieve a high reliability, the air cycle machine must be cooled (bearings). Fresh air (turbine) is used: a dedicated air circuit is defined inside the air cycle machine (thrust and bearings).

Today, the member investigates new solutions to cool the machine. This new solution must be able to accept high rotational speed (> 60 000 rpm).

A first study has been realized (University) to evaluate the possibility to integrate a heat pipe inside the rotor. First tests have been performed at 60 000 rpm.

2. Scope of work

This call for proposal aims to select a partner (laboratory) that will be in charge of the development of air cycle machine including a rotational heat pipe inside the rotor. During this work, the partner will be able to develop a model, representative of heat pipe functioning.

To complete the first study lead on this subject, we can propose the following research axis:

- Heat pipe geometry optimisation (cylindrical, conical, …)
- Fluid optimisation (type, filling ratio, …)
- Negative temperature (if water)
- Transient phenomena
- Rotational heat pipe or revolution heat pipe
- Modeling (nodal)

The partner will be able to design a special closure system of the heat pipe, compatible with high rotational speed (negligible effects on rotor dynamic).

All the tests will be performed at high rotational speed (from 0 to 60 000 rpm). For this reason, the laboratory will be able to integrate this test bench in a special secured space (in case of air cycle machine failure).

At the end of this study, thermal demonstrator on Air Cycle Machine will be used to validate laboratory results.

3. Type of work

This study is mainly based on experimental work. The test bench must include heater and cooling systems (evaporator and condenser) on the rotor.

The test bench must include special instrumentations to measure the heat flux and temperatures on rotational parts of the machine.

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

Laboratory of University having significant experience in:

- Heat pipes
- High rotational speed (60 000 rpm)
- Infra red camera (thermography)
- Air cycle machine
- Thermal Nodal Models
- Model performances validation through experimental tests

5. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Test Bench definition and Installation	Specification Test bench installation First tests performed	T0 + 12 months
D2	First Tests Campaign	First results Modelisation	T0 + 18 months
D3	Final Tests Campaign	End of Thesis Final results Design and Manufacturing recommendations	T0 + 30 months
D4	Integration and Tests on Real Air Cycle Machine	Design Manufacturing Tests and Validation	T0 + 36 months

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.

Clean Sky Joint Undertaking

JTI-CS-2012-01-SGO-02-040

Topic description

CfPNbr	Title		
JTI-CS-2012-01-SGO-02-040	**Compressor air inlet protection for electrical ECS**	**End date**	December 31st, 2013
		Start date	July 1st, 2012

1. Background

On an electrical ECS pack (MSP), the outside air is injected directly into the compressor via a scoop air inlet located on the belly fairing of the aircraft. Contrarily to a bleed pack where air bled from the engine is guaranteed a certain level of filtration because of its high temperature associated to the fact it has gone through several stages of the engine compressor, external air at ambient temperature goes directly into the compressor without prior passage through other components.

Depending on aircraft altitude, debris and contaminants may be mixed with the external air and ingested by the turbo-compressor. These debris and contaminants may be of various sizes andnatures: stones, runaway debris, hail, water, sand, birds, etc. Ingestion of such particles by the compressor may result in premature wear of the blades which in turn gradually impacts the turbomachine's performances. It may also result in complete failure of the compressor if the FOD is of significant size. Other potential consequences are as follows (non-exhaustive list): blockage of compressor air inlet, impact marks on compressor blades which result in a decreased efficiency, water ingestion by the pack.

In order to protect the turbo-compressor and electrical pack against such debris and consequently prevent degraded performances or even failure of these components, the outside air shall be cleaned.

Today's state of the art on the subject is unknown. The Boeing 787 aircraft is equipped with an electrical ECS pack but the use of an outside air filtration system for such applications appears to be a new issue not addressed by conventional solutions. On rotorcrafts exposed to harsh environments, filtration companies have developed inertial particle separation devices which could be of interest for electrical pack applications but which would need further investigation and analysis.
At last, it has to be noticed that safety of the system can be impacted by any device implemented in the compressor air inlet. Therefore, solutions envisaged will have to consider this issue in order to guarantee that the probability of loss of fresh air supply to the cabin stays in a relevant range according to ECS safety.

2. Scope of work

The proposed work package can be separated into four sub-topics:

1) Elaboration of a specification defining the debris and pollution ingested together with outside air at scoop air inlet: characterization of the particles (nature, size, weight, concentration, orientation upon entry into scoop, energy, energy restitution coefficient function of the surface material and type, etc.). This characterization may be based on experimental measures to be performed or already done, biographic search or any other adequate method.

2) Airflow modelling from entrance of scoop air inlet to compressor. To be based upon previous pollution specification and for various aircraft attitudes and speeds. Results of this modelling shall show the airflow and particle trajectory occurring in the channel in presence of the specified debris and contaminants.

3) Review of existing technologies on similar or comparable applications, including brainstorming for new concepts, trade-off to allow choice of one technology and preliminary design/sizing of the selected solution. Modelling of the various concepts, simulation of the polluted airflow within these filtration devices and pollution removal efficiency shall be part of the trade-off step. LTS will support the final assessment by providing the evaluation of the impact of the solution on the complete ECS perimeter (performance, safety, etc.).

4) Detailed design of the selected filtration device and manufacturing of a demonstrator.

3. Type of work

The type of work is a function of each sub-topic:

1) Bibliographic search and analysis, measurement campaign if judged necessary.

2) Modelling of inlet air scoop and ducting up to compressor, simulation of polluted airflows within this routing.

3) Bibliographic search, brainstorming and creative work, preliminary technical design of a filtration component which may involve mechanical and electrical features, modelling of filtration devices and simulation of polluted airflows up to device exit .

4) Detailed design of filtration component, demonstrator manufacturing.

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

SME and/or laboratory having a significant experience on::

1) Engineering and knowledge of particle behaviour and/or filtration for aerospace applications.

2) CFD modelling and simulation (using Star-CCM+ by CD-adapco or software to be discussed with Liebherr).

3) Engineering, CFD modelling and simulation (using Star-CCM+ by CD-adapco or software to be discussed).

4) Engineering and demonstrator production experience.

5. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1.1	Technical characterization and specification of debris and pollution at scoop air inlet	Issued from sub-topic 1. Shall include measures if applicable.	October 30th, 2012
D2.1	Scoop air inlet and channel CFD simulation report	Issued from sub-topic 3. Including model assumptions, meshing, input parameters, simulation results and analysis (document format).	January 31st, 2013
D2.2	Scoop air inlet and channel CFD model	Issued from sub-topic 3. Star-CCM+ compatible model.	January 31st, 2013
D3.1	Bibliographic search	Issued from sub-topic 3. Including new concepts.	March 31st, 2013
D3.2	Filtration solution trade-off	Issued from sub-topic 3. CFD modelling and simulation to be used as one of the criteria for selection. Activity performed in partnership with Liebherr Aerospace Toulouse for impact on electrical ECS. Results in one designated solution.	June 15th, 2013
D3.2a	Scoop air inlet, channel and filtration device CFD simulation report	Issued from sub-topic 3 and trade-off step. Including model assumptions, meshing, input parameters, simulation results and analysis (document format).	June 15th, 2013
D3.2b	Scoop air inlet and channel CFD model	Issued from sub-topic 3 and trade-off step. Star-CCM+ compatible model.	June 15th, 2013
D3.3	Preliminary design/sizing of chosen filtration solution	Issued from sub-topic 3.	June 15th, 2013
D4.1	Detailed design of chosen filtration device	Issued from sub-topic 4.	September 15th, 2013
D4.2	Filtration device demonstrator	Issued from sub-topic 4. Actual hardware shall be delivered to Liebherr Aerospace Toulouse (quantity to be defined).	December 31st, 2013

6. Topic value (€)

The **maximum value** for this topic is

600,000 €

Six hundred thousand Euro

Please note any proposal above this value will be NOT be eligible.

7. Remarks

Each of the four sub-topics may be considered as separate work packages, to be attributed to a single or different partners.

Following relevance of proposed technical solution and evaluation of its efficiency by the partner, Liebherr Aerospace Toulouse may eventually test the filtration device in a representative environment using an electrical pack.

Topic description

CfPNbr	Title		
JTI-CS-2012-01-SGO-02-041	**Identification of a fluid for diphasic cooling adapted to aircraft applications**	**End date**	T0 + 36 M
		Start date	T0 (Assumed S2 2012)

1. Background

"More electric" aircraft requires more power electronics integration.

Traditional cooling systems reach their maximal performances because of too high thermal dissipation of these components. Thanks to their heat transport capacity and their passive pumping, two-phase fluid capillary pumped heat transfer systems appear among identified alternative solutions.

Fluid choice is of primary importance.

Firstly, its properties have to be compliant with thermal objectives over the full temperature range [-55°C;150°C]. Moreover, it has to be compliant to REACH, RTCA DO 160, avionic and electrical constraints.

2. Scope of work

Because of the high degree of severity of constraint, no fluid is fully compliant. As a consequence, the synthesis of a new fluid is required. Its properties must be as follow:

Latent heat of vaporization as high as possible: at least higher than 500 kJ/kg.

Dynamic viscosity of vapour as low as possible: at least lower than 140.10^{-7} kg/m/s.

Surface tension as high as possible: at least higher than 11.10^{-3} N/m.

Density of vapour: at least higher than 1kg/m^3 at 80°C.

These levels for the following properties would be an advantage:

Dynamic viscosity of liquid as low as possible: at least lower than $0.12\ 10^{-3}$ kg/m/s.

Specific heat of liquid as high as possible: at least higher than 2000 W/kg/K.

Specific heat of vapour as high as possible: at least higher than 1300 W/m/K.

Thermal conductivity of liquid as high as possible: at least higher than 0.150 W/m/K.

Thermal conductivity of vapour as high as possible: at least higher than 0.015 W/m/K.

Density of liquid as high as possible: at least higher than 700 kg/$m^{3.}$

Saturation vapour pressure must be lower than 7 Bars over the temperature range.

These specifications are required over the whole temperature range.

Moreover its ignition temperature must be higher than 400°C and this fluid has to be compliant with REACH. To be compliant to electrical constraint, a high dielectric constant is required.

3. Type of work

The study begins with an exhaustive review of existing fluids that are partially compliant with the previously defined specification. This phase aims at identifying nature and properties of potential fluid to prepare the second phase.

This second step consists in synthesis of the new fluid.

To finish, an experimental characterization of the synthesized fluid is required. The goal of this step is to demonstrate the compliance to each point of the specification.

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

The applicant should have skills in chemistry, particularly in synthesis of fluids. It should have equipment required to characterize the fluid.

5. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Review of potential existing fluid		T0 + 2M
D2	Fluid synthesis plan		T0 + 6M
D3	Experimental characterization of the synthesized fluid – intermediate results		T0 + 18 M
D4	Experimental characterization of the synthesized fluid – final report		T0 + 36 M: End of project

6. Topic value (€)

The **maximum value** for this topic is

550,000 €

Five hundred fifty thousand Euro.

Clean Sky Joint Undertaking

JTI-CS-2012-01-SGO-02-042

Topic description

CfPNbr	Title		
JTI-CS-2012-01-SGO-02-042	**Development of acarbonsleeve made by filament winding andwounddirectly onanelectric rotor.**	**End date**	30.12.2013
		Start date	01.06.2012

1. Background

In the frame of SGO ITD the topic manager aims to develop an electrical driven air conditioning system for aircraft application. Such air system requires high speed moto-compressor based on permanent magnet rotor technology.

The rotor consists of a stainless steel shaft. This shaft supportstiles magnet of samarium-cobalt, locked axially by Titanium flanges. The sleeve is the part covering the rotor magnet tiles. Its function is to hold them at high speed and high temperature.

An innovative approach would consist in the replacement of current metallic sleeve by composite ones.

The Member has already worked on composite sleeves for rotor applications up to 55 000 rpm and maximum temperature up to 240°C. This study resulted in the development of a carbon sleeve shrunk on the rotor. However, this technology needs small tolerances on the sleeve inner diameter and expensive shrink tooling.

The aim of this call is to develop a direct filament winding process on a mandrel such that the filament has enough tensile strength to apply a preload on the mandrel.

The second objective of the call is to find the best system resin/fibre that could withstand the operational conditions (Temperature, Humidity) and suitable for filament winding process.

2. Scope of work

Scope 1: process development

- To develop a direct filament winding process on a mandrel such that the filament has enough tensile strength to apply a preload on the mandrel of 75MPa of radial tress at the mandrel and sleeve junction.

The composite layer material shall be composed of:

* High thermal capability resin with a Tg> 300°C. A Cyanate Ester resin shall be used (type to be discuss with topic manager).

* Carbon fibres of IMS (intermediary modulus) type (T800 standard or equivalent).

The mandrel used shall be a cylinder representative of the electrical rotor made of stainless steel on which strain gauges can give the deformation of the mandrel after and/or during the winding and curing process.

For this stack, the partner shall have composite calculation capability. The topic member will give the electrical rotor mechanical characteristics (equivalent stiffness) for mandrel design and calculation.

The goal is to make a sleeve, at least, equivalent of the current one (shrunk) used on the electrical rotor chosen.

- To manufacture 5 prototypes of electrical rotors able to be tested comparatively to the current ones on a real turbomachine. For this, the topic manager gives 4 rotors without the sleeve. The winding process is the responsibility of the partner company.

A cost analysis shall be done in order to compare the actual rotor to the direct wound one.

Scope 2: Technology improvement

- To find the best system (fibre + resin) to withstand 220°C in normal operation, using a winding process. Optimization on the curing and post curing cycles?

- To Compare with the system proposed in step 1

- Characterization of new systems: Tg measurements, Interlaminar Shearing Stress (ILSS) measurements after thermal ageing (up to 250°C), after cycles humidity/temperature. The whole

protocol will be given by the topic manager at the beginning of the project.

- Manufacture 5 prototypes of electrical rotors able to be tested comparatively to the current ones on a real turbomachine. For this, the topic manager gives 4 rotors without the sleeve. The winding process is the responsibility of the partner company.

A cost analysis shall be done in order to compare the actual rotor to the direct wound one.

3. Type of work

The Partner will be responsible of :

- the direct winding process concept and the validation. Test conditions have to be discussing with the topic manager
- delivering 5 electrical rotor wound directly with cyanate Ester resin used.
- The development and characterization of new composite (resin/fibre)
- delivering 5 electrical rotor wound directly with new composite (resin/fibre) used.

- a cost analysis (RC / NRC) of this industrial process for the LTS serial quantities.

The topic manager will be responsible of :

- the furniture of 10 prototypes rotors without carbon sleeve
- comparative development tests to valid the electrical rotor wound directly.

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

The applicant (company, university, SME) should have :

- extensive experience on composite winding machine.

- composite calculation to define the comparative mandrel to the final rotor in order to get the same preload on both case.
- strain gauge experience on composite application in order to validate calculation results.
- strain gauge measurement tooling for instrumentation.

5. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Process development period with the initial system resin/fibre (given by the topic manager)	• Report: process description + stress calculation and results on samples • 5 wound samples of stainless steel	T0 + 6 months
D2	electrical rotor prototypes manufacturing (Cyanater Ester resin used)	• Report: process + stress result. • 4 rotor prototypes (topic manager gives the magnet rotors' S/A)	T0+12 months
D3	High temperature Carbon composite material (fiber& resin) for filament winding process	• Report. • 50 specimens for LTS analysis	T0+12 months
D4	electrical rotor prototypes manufacturing (optimized matrix)	• Report: process + stress result. • 4 rotor prototypes (topic manager gives the magnet rotors' S/A)	T0+18 months

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 project duration is 1 year and half:

- 6 months of development to adapt a carbon filament winding machine to this type of process.
- 12 months of development to manufacture firstly rotor sample to prove the radial stress is well obtained and secondly rotor prototypes of winding sleeve with good mechanical characteristics. Those last prototypes shall be able to be test on turbomachine in real life conditions.
- 18 months to analyse the best couple of composite material (fibre + resin) to withstand 220°C in normal operation using a winding process and manufacture rotor prototypes with optimized composite sleeve. Those last prototypes shall be able to be test on turbomachine in real life conditions.

Topic description

CfPNbr	Title		
JTI-CS-2012-01-SGO-02-043	**Aerospace housing for extreme environment**	**End date**	12.2013
		Start date	06.2012

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 reach higher power density and lower costs the optimisation of the housing is a must.

The proper housing protects the electronics against the environment, ensures EMC and supports the thermal management. Two main streams are followed in order to fulfil these requirements: one is the “open box” and the other is the “hermetic sealed housing”.

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). The optimisation for the housing also comprises subjects as

- Connectors and their bonding
- Sealing (withstand salt spray, humidity levels according to DO 160)
- Fixation technologies for PCBs, chokes, power modules etc. regarding relevant vibration levels
- cooling concepts

After the conceptual design prototype housings should be implemented for an example application

3. Type of work

- Bibliography / concepts of materials and construction technologies and their evaluation against the state of art
- Risk mitigation: setting up samples and tests for critical issues
- Construction of housing for example application
- Verification tests

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

SME and/or laboratory having a significant experience on:

- Experience with hermetic sealed (aerospace) housing for electronics
- Ability to perform structural, thermal and fatigue analysis
- Advantage would be 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 (fixation), corrosion, sealing, cooling. Furthermore the weight reduction and the cost saving potential should be outlined	December, 15th, 2012
D2	Risk mitigation report	Report on solutions and tests for critical issues	March 31st, 2013
D3	Housing for example application	Hardware (application data will be provided to the applicant)	June 30th, 2013
D4	Verification and test report		December, 15th, 2013

6. Topic value (€)

The **maximum value** for this topic is

300,000 €

Three hundred thousand Euro

Please note any proposal above this value will be NOT be eligible.

Topic description

CfPNbr	Title		
JTI-CS-2012-01-SGO-02-044	**Bus system housing for extreme environment**	**End date**	12.2013
		Start date	06.2012

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 reach higher power density and lower costs the optimisation of the housing is a must.

The proper housing protects the electronics against the environment, ensures EMC and supports the thermal management. Two main streams are followed in order to fulfil these requirements: one is the “open box” and the other is the “hermetic sealed housing”.

2. Scope of work

Aim of the proposed work package is an “open box” ARINC-housing (ARINC-standard) for vibration levels C/C1. It should be a light weight and low cost solution. The design should consider the effective area for the PCBs, which ideally should not suffer from the constructional constrains due to the high vibration level.

The design also should consider bonding requirements, corrosion, thermal management, fixation technologies, high voltage protection and connector requirements.

3. Type of work

- Bibliography / concepts of materials and construction technologies and their evaluation against the state of art
- Risk mitigation: setting up samples and tests for critical issues
- Construction of housing for example application
- Verification tests

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

SME and/or laboratory having a significant experience on:

- Experience with open box (aerospace) housing for signal electronics
- Ability to perform structural, thermal and fatigue analysis
- Advantage would be knowledge of bonding, corrosion protection, thermal management, screw fixation technologies, 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 (fixation), corrosion, cooling. Furthermore the weight reduction and the cost saving potential should be outlined	December, 15th, 2012
D2	Risk mitigation report	Report on solutions and tests for critical issues	March 31st, 2013
D3	Housing for example application	Hardware (application data will be provided to the applicant)	June 30th, 2013
D4	Verification and test report		December, 15th, 2013

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.

Clean Sky Joint Undertaking

JTI-CS-2012-01-SGO-02-045

Topic description

CfPNbr	Title		
JTI-CS-2012-01-SGO-02-045	**Regenerative Snubber and Innovative control algorithm for high efficient aircraft converter**	**End date**	T0 + 36M
		Start date	T0 (Assumed Sept. 2012)

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 challenges 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 built 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 oftrade 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
D4	Report delivery of simulation study of selected solutions	• Simulation tool to be defined during specification phase	T0+15M

Deliverable	Title	Description (if applicable)	Due date
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

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Please note any proposal above this value will be NOT be eligible.

Clean Sky Joint Undertaking

JTI-CS-2012-01-SGO-02-046

Topic description

CfPNbr	Title		
JTI-CS-2012-01-SGO-02-046	**High Dense Smart Power Capacitor (HDSPC) for next generation Aircraft converters**	**End date**	T0 + 36M
		Start date	T0 (Assumed Sept 2012

1. Background and context

Power electronics for next generation aircraft needs a drastic reduction of weight, size and shall operates 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 built 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

Deliverable	Title	Description (if applicable)	Due date
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 k€

Six hundred thousand Euro

Please note any proposal above this value will be NOT be eligible.

Clean Sky Joint Undertaking
JTI-CS-2012-01-SGO-03-014

Topic description

CfPNbr	Title		
JTI-CS-2012-01-SGO-03-014	**SOG power electronic with energy recycling system**	**End date**	November 2013
		Start date	July 2012

1. Background

The **Smart Operation on Ground (SOG)** concept has appeared at the end of the 60's. It was consisting in adding an hydraulic motor within the wheel of the nose landing gear of an aircraft. This concept was not integrated on an existing aircraft, maybe due to the fact that these systems were too heavy and not enough efficient.

Since few years, due to significant evolution in electrical technologies, some activities have been carried out on this concept using electrical devices.

Basics functions of SOG system are forward and backward motions. Since, economical and environmental benefits can be done if aircraft braking is performed thanks to this system, a more complex and sophisticated architecture for this system shall be developed. This requires the development of a sub-system which will be able to manage regenerative power during braking phases.

The integration of this sub-system gives the opportunity, on first hand, to get extra functions such as cruise control and braking, and, on the other hand to optimised systems integration at aircraft level with, for example, emergency braking or emergency Landing Gear Extension Retraction System (LGERS) directly supplied with regenerative power stored in local storage devices.

2. Scope of work

System overview:

This system should be divided into two main parts :

- A Power Electronic Unit (PEU) which drives the wheel actuator motors
- A Power Supply Unit (PSU) which manages both power coming from the aircraft network and power provided to other aircraft systems

The PEU interfaces with the SOG wheel Actuators. It is mainly composed of Power Drive Units (including inverters, filters, …) and a Control Unit (CU) which manages the wheel actuator sensors acquisition and which embedded the wheel actuator control laws. The Control Unit will also acquire orders coming from the high-level controller of the SOG system.

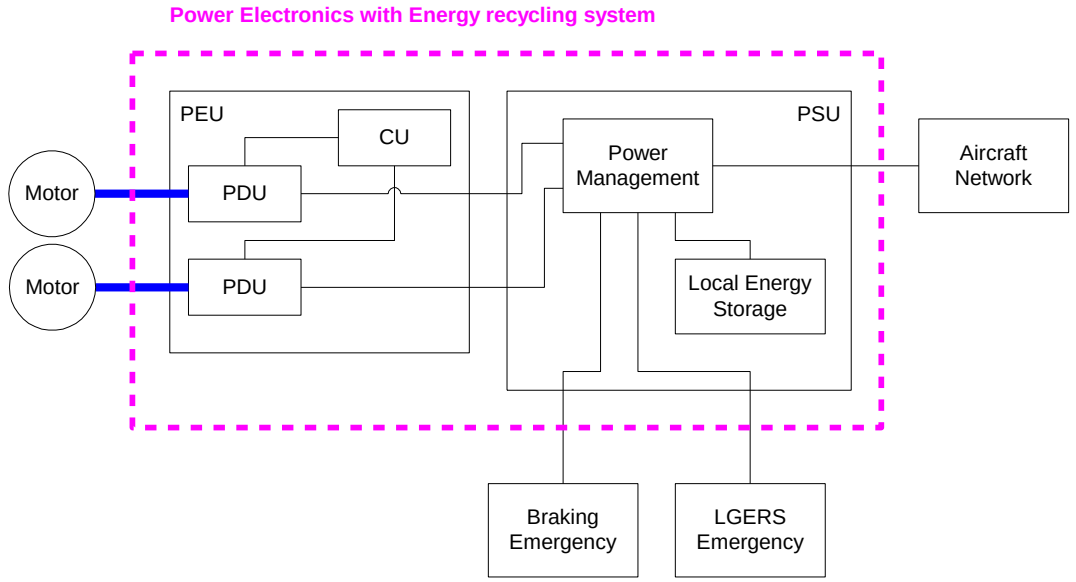
During acceleration phases, the PSU is providing power to the PEU in order to provide the needed motion torque to the aircraft thanks to the wheel actuators. This power may come from aircraft network or local energy storage device.

During braking phase, some regenerative power is transmitted from the Wheel Actuator Motors to the PEU and then, From the PEU to the PSU. Depending of the system status and configuration, the power may be :

- Stored in the local Energy storage device
- Transmitted to the aircraft network to supply other aircraft systems
- Burned in dedicated device (resistances, …)

During aircraft landing or landing gear Extension phases, the power embedded in the Local Energy Storage Device may be used to supply if needed the braking or the LGERS emergency systems.

An overview of the system is provided on the figure below.



Purpose of the CFP:

This CfP is aimed to design, manufacture and test the PEERS before its integration at SOG system level.

As this system shall be developed for a long term aircraft application, technologies breakthrough are allowed since they will provide significant gain in terms of performances, weight and safety.

3. Type of work

1. Design of a power electronic with energy recycling system (PEERS)
   - Architecture and technology study and choice
   - Joined integration studies with SOG Members (plateau Phase)
   - Preliminary and detailed design
2. Manufacturing of a power electronic with energy recycling system
3. Test of the power electronic with energy recycling system
   - Acceptance Test
   - Performance Tests
4. Technical support to SOG Member Team during power system integration at SOG system level

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

Expert skill in power electronics design, manufacturing and test

Knowledge of aeronautical regulations and rules

Industrial applicant

5. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	PEERS Architecture		T0 + 5 months
D2	Conformity matrix vs. Specification		T0 + 5 months
D3	PEERS ICD	Interface Control Document	T0 + 5 months
D4	PEERS DJP	Definition Justification Plan	T0 + 5 months
D5	PEERS Components Specification		T0 + 8 months
D6	Tests programs, Acceptance Test Procedure		T0 + 12 months

D7	PEERS Prototype		T0 + 15 months
D8	DJD	Definition Justification Dossier	T0 + 17 months
D9	Tests reports		T0 + 17 months

6. Topic value (€)

The **maximum value** for this topic is

1,390,000 €

One million three hundred ninety thousand Euro.

7. Remarks

A technical specification for the SOG power electronics with energy recycling system is provided into the reference document: DR40763 issue 2, which can be downloaded from the Additional Documents section of the Call Web site.

Applicant proposal shall include prototype property transfer to SOG Member

Clean Sky Joint Undertaking
JTI-CS-2012-01-SGO-03-017

Topic description

CfP topic number	Title		
JTI-CS-2012-01-SGO-03-017	**Fast optimiser for continuous descent approaches**	**Start date**	01/09/2012
		End date	01/10/2013

1. Background

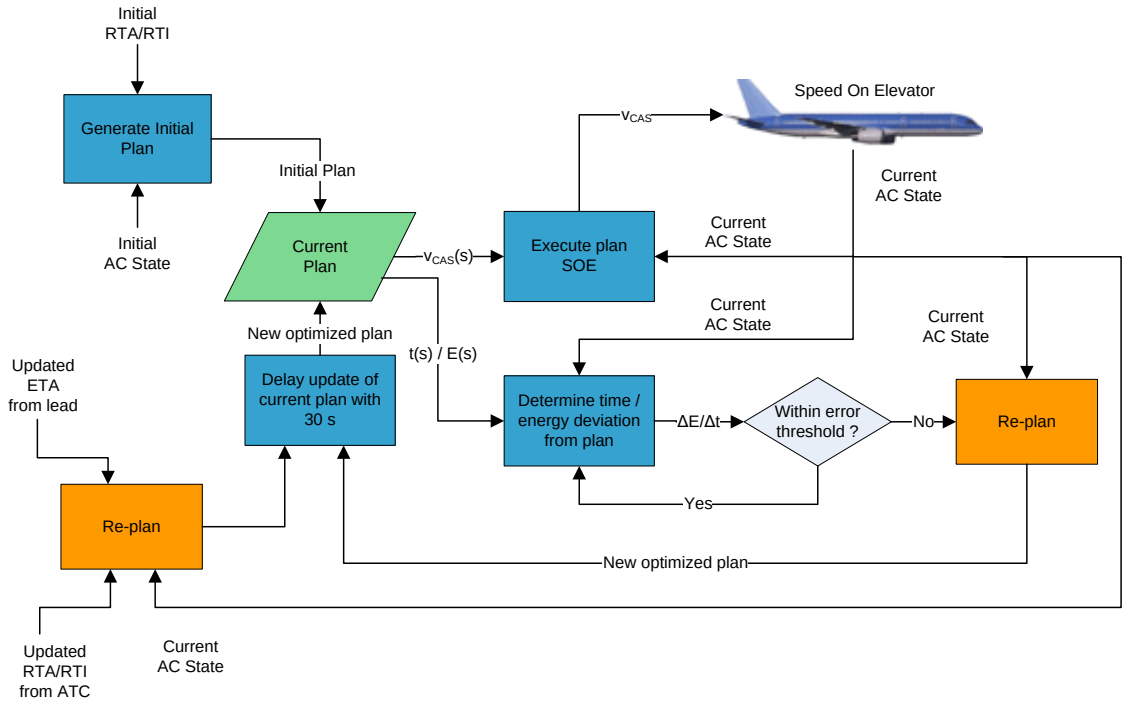
To accommodate the increase in air traffic movements and public demand for environmentally friendly air traffic, a new planning and guidance algorithm is developed which optimizes the vertical trajectory to achieve a continuous engine-idle descent. The new approach, named **TEMO (Time and Energy Managed Operations),** achieves maximum noise, emission and fuel reduction while maintaining airport landing capacity. ATC issues time requirements to aircraft to meet (in succession) at the Initial Approach Fix (IAF) and the runway threshold. This technique yields two control points for flow management and arrival separation. The optimization routine onboard the aircraft calculates a new profile (minimizing the use of engine thrust and speed brakes) which complies with the given ATC time requirements. The autopilot guides the aircraft along the speed profile by applying speed-to-elevator control, while monitoring the aircraft time and energy state. Modeling and flight technical errors result in a deviation from the intended time and energy trajectory. When the deviation exceeds the allowable error margin, a new optimal profile is generated, based upon current aircraft state and applicable time constraint. Simulations show that aircraft are capable of flying engine-idle approaches whilst adhering to time constraints and reducing the environmental impact of air traffic.

Part of the guidance algorithm is an optimization routine which calculates new optimal profiles (named re-planning). Re-planning is described as an Optimal Control Problem and uses MATLAB-based numerical optimization methods. The TEMO algorithm uses an open-source toolbox named “General Pseudo-spectral Optimal Control Software” (GPOPS) available for MATLAB. This toolbox translates the high-level optimal control problem to the input definition required by the SNOPT optimizer, which is provided as a MEX-file executable. The GPOPS toolbox is merely a tool which translates a mathematical description to the defined input required for SNOPT. Moreover, it determines mesh points and collocations points and can optimize the location of these points based on the returned defects from SNOPT. As SNOPT requires derivatives (amongst others, state and control variables, but also derivatives of path and event constraints), the MATLAB toolbox INTLAB is used as an Automatic Differentiation tool to calculate these derivatives of all parameters in the optimization problem.

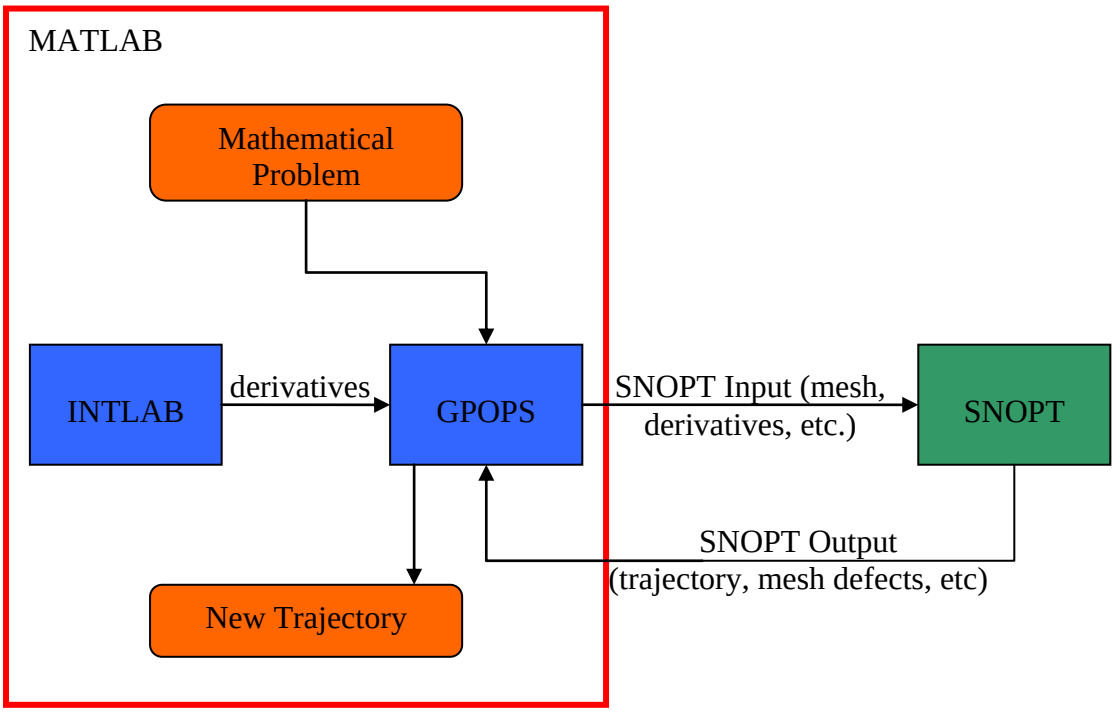
The major drawback of this MATLAB approach is MATLAB itself; MATLAB uses it’s own, interpreted, language which eases programming in MATLAB but comes at the cost of an increased computational time compared to programs coded in computer languages such as C/C++ or Fortran. The typical, average, calculation time of the current algorithm is typically approximately 30 seconds but with a large standard deviation. Both average and standard deviation values need to be reduced for improved aircraft guidance, and it is expected that the algorithm could benefit from a transition from MATLAB to C/C++.

Furthermore, to pass higher TRL level gates, implementation in simulators and/or real aircraft is required and the algorithm will possibly be integrated into onboard systems. The use of MATLAB in these systems is not possible, requiring a stand-alone program without the overhead and downsides of MATLAB. These experiments are scheduled for the second development cycle of TEMO, starting in November 2012. The updated algorithm is required by midway 2013.

A schematic overview of the TEMO guidance algorithm is shown below:



A schematic overview of the re-planning algorithm is shown below:



The topic task is to develop, as part of Management of Trajectory and Missions, Time- and Energy Managed Operations (TEMO), a dedicated calculation engine to generate trajectories in (near-) real time, optimized for time, path deviations, speed, (idle) thrust and potentially parameters like emissions (or fuel flow) and noise impact. The blue blocks in the re-planning algorithm diagram need to updated to C++ code and the TEMO problem formulation should be enhanced to reduced overhead an optimize the re-planning algorithm. Moreover, it must be investigated whether SNOPT is the fastest optimizer available and whether TEMO might benefit from a different optimizer.

A consortium of companies (public and private) can apply together to this topic Call for Proposal.

2. Scope of work

Description of work
In the current TEMO developments the optimisation routine used to calculate the optimized trajectory still takes a considerable amount of calculation time. With the foreseen inclusion of more advanced models, with weather (e.g. wind) aspects and/or using fewer assumptions this computation time may even increase further. To improve the calculation performance and accuracy of the trajectory solutions, as well as to bring TEMO to a higher TRL level in the next cycle, it is highly recommended to bring the calculation time to (near-) real time.

A dedicated calculation engine/optimiser needs to be developed to serve this purpose, requiring new model- and problem definitions and development.

The current problem definition has to be simplified and current constraints might be redefined such that the optimization problem becomes more efficient and solutions are found much faster. The current GPOPS (MATLAB tool) implementation could serve as a basis. Furthermore, the amount of "overhead calculations" should be minimal. Generic optimizers, such as GPOPS, etc., suffer from overhead which reduces the calculation time.

Current onboard optimization logics always have a predetermined solution available. As Non-Linear Programming (NLP)-solvers do not guarantee to find a solution implementation into real aircraft is prohibited. Therefore the algorithm to be developed needs to assure that certification is possible. Solutions to this problem should be proposed.

Finally, the new optimizer should be able to work in simulator and real-cockpit environments.

Validation of the optimizer algorithm
The new algorithm must be validated by verifying the solutions between current and new algorithm. The performance metrics are cost function value, amount of optimization variables, calculation time and predictable algorithm convergence.

Inputs from Clean Sky SGO ITD
- Performance requirements
- TEMO concept of operations document
- Current TEMO algorithm for benchmarking the developed algorithm

Software required to run current algorithm
- MATLAB
- INTLAB
- GPOPS
- SNOPT (included with GPOPS)

Technical Requirements and Constraints
- Programmed in a fast computer language such as C/C++
- Possibility of operation in simulators or laboratory aircraft
- Reduced computation time over reference algorithm. Calculation time close to real-time
- Consistent solutions from optimization routine are required
- Flexibility of using different aircraft models

Algorithm Inputs
- Current aircraft state at time of optimization start
- Simplified aircraft model of simulated aircraft
- Lateral trajectory, including ATM constraints
- Estimated wind profile along trajectory

Algorithm Outputs

- Newly generated trajectory, in terms of position x(t)) time t(x), velocity v(t) v(x), energy E(t) E(x), altitude h(x) h(t), thrust T(x) T(t), speed brakes SB(x) SB(t) and aircraft configuration Config(x) Config(t).
- Calculation time
- Mesh defects
- Cost function value

3. Type of work

Development of a TEMO optimizer (programming) in a computer language for use in simulator and real environments

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

The candidate organization shall have recognized experience and knowledge of Optimal Control theory, programming and aircraft performance.

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 knowhow.

5. Major deliverables and schedule

Deliverable	Title	Description (if applicable)	Due date
D1	Problem Definition (PD)	Definition of the TEMO concept, and optimization problem as described in this topic. Completing the imposed requirements and definition of constraints. The content of this document is defined and agreed in cooperation with the topic manager or his appointed representative, through technical workshops.	T0 + 3
D2	Mathematical Model (MM)	Description of the mathematical optimal control problem and solutions of solving the TEMO optimization problem	T0 + 5
D3	Software Description (SD)	Description of the proposed optimization software to solve the problem as described in Deliverable 2.	T0 + 5
D4	Software Package (SP)	Delivery of the software - source code - stand-alone executable - user manual	T0 + 12
D5	Validation Report (VR)	Comparison between developed and reference algorithm in terms of the performance metrics. Moreover, an overview of limitations of the developed algorithm must be listed	T0 + 12
D6	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.	T0 + 13

6. Topic value (€)

The **maximum value** for this topic is

€ 200.000.

[two hundred thousand euro]

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

7. Remarks

Reporting

Periodic progress reports – typically monthly - will be established including the following elements:

- Description of work performed
- (Preliminary) tests results
- Status of deliverables
- Updated planning
- Action items

Meeting and review policy

- A start-up meeting covering the TEMO concept, algorithm and interfacing is scheduled at the beginning of the project
- Management & progress meetings shall be periodically planned during all the project to evaluate activities
- Technical meetings shall take place on SGO Topic Manager request, in order to discuss in details specific technical points

Clean Sky Joint Undertaking
JTI-CS-2012-01-SGO-04-003

Topic description

CfPNbr	Title		
JTI-CS-2012-01-SGO-04-003	**Solid State Power Controllers test benches**	**End date**	31/06/2014
		Start date	01/06/2012

1. Background

The purpose of this call for proposal (CfP) is to design specific load test benches dedicated to the tests of Solid State Power Controllers (SSPC). These load test benches will be used to simulate a range of aircraft electrical loads in order to test different types of SSPCs.

The interest and the need of these specific test benches are to give more confidence on the advanced distribution systems design.

New SSPCs technologies drive to develop new tests benches technologies in order to be able to test the entire advanced distribution systems.

2. Scope of work

The system tested using these load test benches are the new technologies SSPCs developed in the frame of the More Electrical Aircraft.
The applicant shall be able to define specific benches test based on these characteristics.

The following main functions and features shall be considered:

1) Load profiles shall be programmable from a specific computer.
2) Each channel shall be able to support either +/- 270 VDC, 230 VAC, 115 VAC and 28 VDC.
3) Each channel shall allow to set up a current consumption from 0 up to 15 A, with an accuracy of 0,5 A and a slew rate of 1 ms.
4) A total of 80 channels are required, i.e. 80 physical inputs must be available.
5) The load bench shall be able to emulate A/C equipment power consumption on A/C electrical network: three-phase 115VAC, three-phase 230VAC, 540VDC or .28VDC.
6) The total consumption of the load benches will be around 100 kW.
7) A maximum of five cabinets shall cover the 100 kW total power.
8) Each cabinet shall be used in a laboratory controlled environment (25°c). The cabinets shall not require additional ventilation.
   The size of each cabinet shall not exceed the following dimensions: Height: 2000 mm, depth: 800 mm, width: 800 mm.
   The cabinet shall be moved inside buildings without specific tools.
9) The link between the cabinet and the monitoring & control computer shall be compatible with Ethernet network and with a distance between benches and monitoring & control of at least 30 m.

The applicant shall perform following main activities:

- Define adequate test benches technologies with the SGO member (end user),
- Design, manufacture and validate the test benches,
- Install the test benches at SGO member facilities,
- Validate the test benches at SGO member facilities,
- Training phase of SGO member technical user,
- Ensure the maintenance of the means during the test campaign.

3. Type of work

Planning and deliveries
A kick-off meeting, a progress meeting and final meeting will be scheduled at topic manager's site. This project is split into following tasks proposed for the applicant activities:

At **T0 (assumed 01.06.2012):**
Kick of meeting: review of generic specification and planning
Task 1: (T0+2M)
Review of final detailed specification
Task 2: (T0+5M)
Design Review of test benches
Task 3: (T0+12M)
Installation of test benches in SGO member facilities
Acceptance test report to validate the bench
Technical training phase from applicant to SGO member in order it can operate the test bench autonomously.
Task 4: (TO+25M)
Maintenance of the means during the test campaign on SGO member facilities
Task 5: (T0+26M)
Final meeting to close this project

Progress report will be requested every month.

Documentation for installation and maintenance shall be delivered by the applicant.

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

For this study, the applicant shall satisfy following criteria:

- Strong experience in the field of industrial test bench design and manufacturing is mandatory,
- ISO qualification for the design and manufacturing of industrial test benches is mandatory,
- Experience and knowledge of electronic components test bench is a key factor,
- Knowledge of RTCA-DO-160 standard and aeronautic environmental requirements is an advantage,
- Innovative components technologies are encouraged if minimum of maturity is demonstrated in equivalent test bench and if development risks are limited.
- Insurance shall be provided to manage this work in time without delay for study and development phases.
- 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	- Compliance Matrix with final technical specification. - Development plan.		September 2012
D2	- Design description and datasheet of test bench. - Preliminary Drawing		October 2012
D3	- Manufactured test bench		May 2013
D4	- Validation test report, - Delivery to SGO member facilities, - Installation and Acceptance test report of test bench		June 2013
D5	- Drawing (test bench plan), user and maintenance manual.		July 2013
D6	- Dissemination document	Short presentation of the project for dissemination purpose	December 2013

6. Topic value (€)

The **maximum value** for this topic is
250,000 €.*
(Two hundred fifty thousand Euros)
**Please note any proposal above this value will be NOT be eligible.*

No Technology Evaluator topics in this call.