Annual Implementation Plan 2010

Annex 1a

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Description of work for year 2010

1 SFWA 0 – ITD Management

1.1 SFWA-ITD Management - General

The SFWA –ITD is set up through the management bodies Coordinator, Management Committee, and Steering Committee, in agreement with the general rules and procedures of the Joint Technology Initiative CleanSky. The SFWA Steering Committee, which is in fact a body of the CleanSky Joint Undertaking, is functioning as interface between JU and the SFWA-ITD technical management. Underneath the Management Committee the management activities are further down cascaded down by Work Package Management Teams, which provide the coordination through work package levels 1, 2 and 3. In addition, an SFWA-ITD "airframers forum" monitors the orientation of work towards the end product with respect to the aircraft target concepts, which are the drivers for the SFWA-technologies.
The SFWA-ITD management is aligned to the overall work break down structure which comprises three main work packages WP1 "Smart Wing Technologies", WP2 "New Configuration" and WP3 "Flight Demonstrators".
The set up of the SFWA-ITD management structure is made to ensure timely achievement of the deliverables along technology development technology integration and testing in large ground tests but specifically in large flight test demonstrations.
To achieve a focussed progress of work along priority key SFWA target technologies towards a maturing up to Technology Readiness Level 6 (TRL 6), a scheme of eight principle "SFWA Aircraft Concepts" have been settled and established during the year 2009:

1. High Speed Demonstrator Passive (HSDP)
2. Low Speed Demonstrator (LSD)
3. Short Range Aircraft Concept (SRA)
4. Low Sweep Bizjet Concept (LSBJ)
5. High Speed Demonstrator Active (HSDA)
6. Long Range Aircraft Concept (LRA)
7. High Sweep Bizjet Concept (HSBJ)
8. CROR Engine Demo FTB

Each of the aircraft concepts has an own dedicated roadmap and is virtually connected with the work packages that are required to provide the specific deliverables to pursue the progressive development of the SFWA target technology. There is a dedicated position of a SFWA aircraft concept manager assigned to each of the eight. The Aircraft concepts HSDP, LSD and CROR engine demo FTB have an explicit focus to be matured through large scale ground and flight test demonstration. The HSDA has an option for demonstration, the roadmap of the other aircraft concepts are merely based to progress along numerical studies and paper studies.

To ensure a proper operation of the project along the aircraft concepts, in particular a cautious planning, conduct and handover of the deliverables, a matched deliverable matrix is a core element of the project.

The management will also ensure a proper interfacing to other CleanSky ITD´s, the Joint Undertaking and the Technology Evaluator.

1.2 Work Programme 2010

The year 2010 work program is dominated by the preparation of different elements for ground and flight test demonstration for the HSDP, the continuation of the feasibility study for the CROR demo-FTB and a number of configuration studies related to the integration of innovative engine concepts for large transport aircraft and for Bizjets. A further down selection of concepts for high performance high-lift concepts that can be integrated into a laminar wing design will take place in the first half of 2010. An increase of active loads control activities to support the concept of a smart laminar wing is considered. Emerging in particular from activities in work package WP1.2 “active loads control” in 2009, additional needs for demonstration are under investigation.

Due to the pending definition of the detailed outline of the large scale flight demonstrator, in particular the High Speed Demonstrator Passive HSDP, some of the work packages WP1.3 dealing with advanced sensors, actuators could not fully ramp up their work. This ramp up is planned to be made in the first half of 2010.

With respect to the overall management operations, the Management Committee, the Project Management Teams and the Steering Committee are in place and working. With the CleanSky Joint Undertaking having reached autonomy in November 2009, a transition to regular operation is expected in 2010 in particular with respect to the launch of Call for Proposal (CfP) activities. Within 2010, a number of 45 topics are scheduled to be published and finally taken by new partners to the SFWA-ITD. A wide range of subjects is related to the manufacturing, treatment, repair and testing of surfaces for laminar wing panels, the design and development of innovative sensors and actuators for control surfaces in laminar wings. Year 2010 calls will also include major work packages to attribute to the design and build parts of the laminar wing flight test articles.

Cross cutting coordination in particular with the SAGE –ITD and to some extend with the SGO-ITD and the EcoDesign-ITD will be established in 2010.

With the autonomy of the CleanSky Joint Undertaking, the policy and means of dissemination and public communication will be in the hands of the JU, thus in joint coordination of the CleanSky ITD-leaders.

The envisioned major achievements / milestones for 2010 are:

- Complete the work for a laminar wing design definition, complete the work to propose and approve structural laminar wing concepts
- Conduct of tests for cleaning, maintenance and repair of surfaces and surface coating for laminar wing panels
- Design and development of sensors and actuators for the use in laminar wing concepts
- Continue the feasibility phase for the CROR-engine integration and CROR demo-FTB including numerical simulation, and subscale ground and wind tunnel testing.
- Continue to investigate and evaluate concepts for the integration of innovative engines in Bizjets through dedicated subscale wind tunnel tests.
- Continue definition and selection of high performance high lift concepts for laminar wings.
- Pass the gate decision to launch the design and manufacturing of the High Speed Demonstrator Passive flight test articles.
- Conduct of a large scale wind tunnel test to prepare the laminar wing flight tests onboard the modified Airbus A340-300 flight test vehicle.
- Complete the first laminar wing “feature” ground demonstrator, launch activities for further feature demonstrators

- Evaluate, select and contract new partners for work packages published in subsequent CleanSky call for proposals.
- Establish a set of reference aircraft models for evaluation of SFWA technologies
- Conduct of a major SFWA-ITD Annual Progress Review
- Preparation of a detailed follow-on year 2011 work and budget plan to be issued s a Consortium Plan 2011 at the end of this year
- *Proceed along the SFWA Consortium Plan 2010 and achieve the planned milestones and deliverables sketched in the following chapters*

2 SFWA 1 – Smart Wing Technology

2.1 Overview

In this major work package SFWA1 all passive and active flow and load control technologies required to design and develop an all new Smart Wing are being reviewed, further developed to a technology readiness level of 4 and then down selected for further integration. The rationale is to make use of all appropriate technologies that have a sufficiently status of maturity to be integrated into a large scale demonstrator article to be tested in a flight test under fully operational condition. These technologies have typically emerged as results from other funded R&T projects like those funded in European Commission funded frame program level 1 or level 2 projects or national funded programs.
The work launched in 2008 will include elements for the more passive flow and load control oriented first phase of SFWA as well as some advanced active flow and load control technologies for the prospected second phase of SFWA

Major Elements of SFWA1 and work program 2010

2.2 SFWA 1.1: Flow Control

Work package 1.1 contains four level-three work packages covering passive and active flow control technologies for drag reduction and separation control. The aim is to bring these technologies to a sufficiently high readiness level so that they can be progressed within in work package 2 and flight tested within work package 3.

SFWA 1.1.1 “Passive Technologies for Flow Control” covers the technologies needed for the application of natural laminar flow (NLF). These technologies were already considered between 1985 and 1995 within several national and European research programmes leading to the test flights with a natural laminar vertical fin of a Falcon 50 and with a natural laminar flow glove mounted on a Fokker F100 aircraft.

Main objectives of work in 2010:

- Mature NLF concepts applicable for a Smart Wing
- Develop high performance high lift elements for laminar wings
- Qualification of transition criteria on cumulative shape defects
- Manufacturing requirements and tolerances
- Ground tests

SFWA 1.1.2 "Active Technologies for Laminar Flow Control" is related to the investigation of active technologies or concepts devoted to flow control, either transition from laminar to turbulent flows or buffet for turbulent flows. The activities that are be considered in this task cover mainly aerodynamics aspects and also aspects of control and maintenance issues. Initialisation of the work package has been delayed to mid 2009 and low level activity is scheduled in 2010 due to resource conflicts with priority NLF activities.

Main objectives of work in 2010:

- Review applicable solutions for buffet control for a Smart Wing
- Parametric studies of active flow and buffet control concepts with numerical methods (RANS)
- Definition of ground tests and instrumentation for ground tests
- Review solutions for active transition control with combinations of suction/ blowing
- Propose first control system, design, manufacture and maintenance concepts for Hybrid Laminar Flow Control (HLFC) for an all new Smart Wing

SFWA 1.1.3 "Surface Technologies and Repair Concepts" is aiming to provide two key elements to achieve an industrial Smart Wing concept with substantial drag reduction through the application of laminarity

Main objectives of work in 2010:

- Studies with model-materials in laboratory and ground tests
- Qualification tests in icing tunnel
- Analytical characterisation of typical surfaces and surface materials
- Review of actual repair concepts and transfer into concepts proposals for a laminar wing

SFWA 1.1.4 "Flow Control for Low Speed / High Lift" is aiming to provide progress in low speed performances, which have direct and indirect, through aircraft level trade-offs, benefit on noise and fuel consumption These progresses have to be compatible with a laminar type Smart Wing.

Main objectives of work in 2010:

- Numerical design of potential high lift solution for the concepts fixed leading edge, smart gapless droopnose and high performance flaps
- Testing in INCAS and Airbus wind tunnel facilitiesExploitation of relevant test results from other major recent R&T programs (e.g. Avert)
- System and structural analysis to identify contraints of the different high lift concept candidates.

Subcontracting in SFWA 1.1 in 2010 is planned to purchase sensors and parts for drive and control units to prepare wind tunnel experiments dedicated to flow control scheduled to start in 2010.

2.3 SFWA 1.2: Load Control

Work package 1.2 will address the following major topics to account for the requirements of the Smart Wing

- manoeuvre loads
- gust loads
- fatigue loads (mainly monitoring)
- extreme events loads (a/c protection functions)
- shape adaption for performance maximisation (primarily drag minimisation, also buffet minimisation) at each flight point
- Vibrations

All these functions will be investigated and enablers will be developed to try to satisfy the functional requirements. The enablers for these functions are the control devices (new aerodynamic control surfaces), the shape morphing of the wing through passive or active means, the logics and laws to uses these devices and the system devices (sensors and actuators).

The related objectives will be adressed in four work packages:

SFWA 1.2.1 “Innovative Devices for Loads Control”
SFWA 1.2.2 “Adaptive Wing”
SFWA 1.2.3 “Advanced Load Control Techniques”
SFWA 1.2.4 “Aircraft Loads Control Management and Optimization”

Main objectives of work in 2010:

- Requirements for new load control devices
- Review of concepts for adaptive wing and applicability to a laminar wing design
- Set up / definition of a generic aerodynamic model and definition of a standard reference
- Definition and launch of numerical tools for fully dynamic load simulation
- Design activities for passive and active aeroelastic wing tailoring
- Setup of the numerical design process
- Review of exisiting loads alleviation concepts
- Development of selected gust load and maneouvre load and vibration control concepts

2.4 SFWA 1.3: Integrated Flow and Load Control Systems

The overall objective of this WP is to provide a system solution to support the implementation of load & flow control concepts in a future aircraft.

SFWA 1.1 & 1.2 deal with the objective to develop technologies for load and flow control functions that could be integrated into the overall aircraft design. An enabler for implementation of such functions is the system architecture that could support these functions. SFWA 1.3 aim is to define the integrated flow & load control systems and to mature them in order to provide enough information so as to evaluate the overall benefit at aircraft level for load and flow control concepts.
To assess the benefits of the concepts at an aircraft level, following criteria will be studied very closed for each sub system:

- Weight
- Integration constraints
- Power & communication needs
- Maintainability
- Reliability

The objectives of SFWA 1.3 will be addressed through dedicated work packages

SFWA 1.3.1 Advanced Aircraft Control System Options
SFWA 1.3.2 Advanced Communication Networks and Field Buses
SFWA 1.3.3 Power Networks & Management
SFWA 1.3.5 Ground Demonstration
SFWA 1.3.6 Loads & Intertial Sensing Technologies
SFWA 1.3.7 Aerodynamic Sensing Technologies
SFWA 1.3.8 Fluidic Actuators
SFWA 1.3.9 Mechanical Actuators

Main objectives of work in 2010:

- Definition of a global system architecture for the first step of load & flow control concepts
- Preliminary definition of requirements for all sub systems(Communication & power networks, actuators & sensors)
- Definition of subsystem and system ground tests, requirements for system flight tests and system certification (first loop)
- Selection of technologies that will be evaluated to support the first set of load & flow control concepts for a smart wing
- Preliminary development of fluidic flow control devices

Subcontracting in SFWA 1.3 in 2010 is planned to purchase equipment to prepare wind tunnel experiments on flow control sensor techniques to start in 2010.

3 SFWA 2 – New Configuration

3.1 Overview

The objective of the SFWA 2 of the Smart Fixed Wing Aircraft ITD is to design “smart” wing concepts, innovative powerplant concepts and innovative after bodies concepts utilising the technology matured in SFWA1. The objective of SFWA2 is to mature these concepts up to a Technology Readiness Level of 6, assess and report achieved technology progress to the Technology Evaluator.

The work packages will study the following concepts:

- Paper study of a new Short Range Aircraft - Passive Flow and Load Control technology
- High Speed Demonstrator – Passive Flow and Load Control Technology
- Low Speed Demonstrator - High Lift Technology
- Paper study of a new Business Jet - Low Sweep, Low Speed
- High Speed Demonstrator – Active Flow and Load Control
- Paper study of a new Long Range Aircraft - passive and active flow and load control technology
- Paper study of a new Business Jet - High Sweep, High Speed
- Passive Nacelle Ground Based Demonstrator
- Active Nacelle Ground Based Demonstrator
- Paper study of innovative after bodies with CROR or turbofan
- Paper study of Innovative power plant integration

Major Elements of SFWA2 and work program 2010

3.2 SFWA 2.1: Integration of Smart Wing into the Overall Aircraft Design

This Work Package will deliver preliminary design solutions for a range of application concepts designed to exploit the capabilities in Flow and Load Control delivered from Work Package 1. The conceptual designs, reference aircraft and TLARs will be delivered from WP2.3 Interfaces and Technology Assessment along eight SFWA aircraft concepts which will provide the basis to study the potentials of the Smart Wing, the integration of Innovative Engine Concepts or the redesign of the afterbody.

The objectives are addressed in four related work packages

SFWA 2.1.1 Application of Smart Wing Technologies
SFWA 2.1.2 Structures and Systems Integration
SFWA 2.1.3 Concept Simulation & Ground Testing
SFWA 2.1.4 Overall Aircraft Design and Technology Integration

Main objectives of work in 2010:

- Definition and further maturation of wing concepts for new aircraft configurations
- Conceptual design of a large scale low speed, high lift demonstrator
- Tool development, tool support for aero- and design calculations
- Conceptual and preliminary design of a Ground Based Demonstrator
- Definition of wind tunnel models and tests
- Surface manufacture concepts for a laminar Smart Wing
- Definition of requirements for structure and system integration concepts

Subcontracting is planned in SFWA 2.1 in 2010 to contribute to the design and manufacturing of wind tunnel models and related measurement equipment for experiments. Further subcontracting is planned to support the build up and testing of a large scale ground demonstrator

3.3 SFWA 2.2: Integration of Other Smart Components into the Overall Aircraft Design

This work package deals with the integration and evaluation of new type of engines and after bodies (aft fuselage and empennages). The objective is to rethink the aircraft configuration to acquire the maximum potentials from both, the reconfigured aircraft and the innovative propulsion systems. This is including the environmental targets of the ACARE Vision 2020 but in particular constraints due to handling quality, aerodynamic features, loads and certification issues.

The objectives are addressed in five related work packages

WP 2.2.1: Innovative after bodies definition
WP 2.2.2: Innovative power plant integration
WP 2.2.3: Innovative after bodies design
WP 2.2.4: Detailed simulation and ground testing
WP 2.2.5: Synthesis, analysis, demo requirements

Main objectives of work in 2010:

- Specifications & after body objectives, review of potential and generic concepts
- Conceptual design studies of U -tail geometries and shapes for BizJets
- Definition of innovative after bodies with CROR or turbofan.
- Conceptual design studies for HBP engine integration
- Rear end design review from flight physics perspective, aerodynamic layout for BizJets
- Inovative engine technologies and integration issues analysis.
- Definition and detailed design data for engine / propeller/ empenage studies and reference configurations
- Definition of wind tunnel tests and instrumentation
- Manufacturing of wind tunnel models, in particular TPS
- Conduct of wind tunnel tests on noise and aero performance

Subcontracting in SFWA 2.2 in 2010 is planned to purchase support for the design and manufacturing of ground test related equipment and related services.

3.4 SFWA 2.3: Technology Assessment and Interface to the Technology Evaluator

This work package is one of the core functions in the SFWA-ITD. It is providing reference aircraft concepts to trigger design and concept studies for the laminar wing end new configuration concepts and will support all kind off technology assesment whenever required in the work packages to provide an analysis and downselection of candidate technologies, in particlar in multidisciplinary studies.

Another function of this work package is to provide the interface to the CleanSky Technology Evaluator, by selecting the required data and information thruogh the workpackages in the SFWA-ITD.

Adressing these objectives is structured in following work packages:

SFWA 2.3.1 Specifications
SFWA 2.3.2 Technology Assessment
SFWA 2.3.3 Data Preparation for the Technology Evaluator

Main objectives of work in 2010:

- Defintion of reference aircraft configurations and concept aircraft configurations
- Support of smart wing and innovative afterbody and engine integration work packages to use reference models for the SFWA aircraft concepts
- Tool development & tool support
- Definition of data interface requirements to the TE

4 SFWA 3 – Flight Test Demonstration

4.1 Overview

The logic of the JTI "CleanSky" SFWA is ultimately connected with the test of innovative green technologies for future aircraft in large scale tests under operational conditions. Including novel technologies on large transport aircraft requires a very high level of maturity to guarantee the benefit in performance, while offer long endurance and stability as well as efficient maintenance and repair and of course a fully secure operation of the overall system. Environmental effects and benefits have to be judged and balanced on overall aircraft level against technological efforts, risks and different types of cost.

It is well agreed that this large scale flight demonstrator testing of novel technologies will provide the essential difference to other major R&T projects that has existed before. The substantial risks which are present when introducing step changing technologies into products at large industrial scales can be analysed and judged, and decisions for a new generation of greener technologies in aeronautics can finally be taken.

In the SFWA-ITD the major two subjects selected for an ultimate effort of R&T are the development of an all new "Smart Wing", and the integration of innovative engine concepts, with a prime candidate "Counter Rotating Open Rotor" CROR. There are five large flight demonstrator activities foreseen to cover the needs of the SFWA program:

1. An all new "Smart Wing" Laminar High Speed Flight Demonstrator (Work package SFWA3.1.). All key performance data of this Smart Wing, featuring a new set and combination of passive and active flow and loads control technologies shall be exploited under full operational conditions, at relevant Reynolds- and mach numbers, and at realistic c_L, and wing loading condition. In April 2009 it has been taken decided that the Airbus A340-300 test aircraft shall be used as flight test vehicel. On either side the datum wing will be removed outboard of the outboard engines and replaced by a full size passive laminar wing test article.

2. Smart Wing Low Speed Flight Demonstrator (Work package SFWA3.2.). The smart wing is envisioned to require a set of low speed devices and functionalities which may differ substantially from those used today fro conventional wings. A key feature of these high lift devices will be that they provide the low speed performance of the wing while protecting a foreseen level of laminarity at the entire wing at cruise condition. A number of dedicated high lift concepts have been proposed in 2009. A final down selection and a selection of a flight test vehicle is planned to be made in the first part of year 2010.

3. Flying Test Bed for the Innovative "CROR" –type Engine Demonstrator (Work package SFWA3.3.). This test bed will provide key information about the viability and performance of the CROR concept for future large transport aircraft application. The engine will be developed in the frame of the Sustainable and Green Engine (SAGE)-ITD as a ground demonstrator article, and is foreseen to receive experimental flight worthiness in an activity outside of CleanSky. The schedule to complete the feasibility study and the preparation and conduct of the engine demonstration flight test has been detailed through the year 2009 in close coordination with the engine manufacturers. In 2009, the Airbus A340-600 test aircraft has been selected as flight test vehicle.

4. Long Duration Flight Test Demonstrator (Work package SFWA3.4.). A number of technologies which will be elementary parts of the Smart Wing are expected to be prone to degradation under long lasting severe or frequently repeated operational condition. Testing and demonstration of these technologies may require the availability of operational conditions for a substantial period of time, with a larger number of repeated quality checks. The first of these tests will be related to experiments with measures to remove or avoid contamination of wing surfaces

5. New Empenage Demonstrator (Work package SFWA3.5.). This concept is in particular foreseen for large scale studies of novel empennage concepts, which might be necessary to accommodate unconventional innovative engines or conventional ones in the aircraft with reduced noise propagation. Major elements of the study will be related to structural design and manufacturing concepts to account for the specific loads and vibration scenarios coming along with the integration of those engines. At the issuing of this SFWA planning document, the empennage demonstrator is envisaged as one fall back solution in case the CROR concept should not be pursued for what ever reason.

Main objectives of work in 2010:

The major objectives of the year 2010 are related to the definition of requirements and detailed design work for the HSDP lamainar wing flight test onboard the Airbus A340-300 test aircraft, and detailed studies to integrate the CROR demo engine in the rear fuselage of the Airbus A340-600 test aircraft. Another main objective is to prepare and make a decission upon the low speed flight test demonstrator vehicle. Further work in 2010 are expected to yield a number a specific long duration flight tests, in particular on subjects related to technologies for the almainar wing.

- Freeze of the final design and manufacturing concepts for the HSDP flight test articles
- Conduct of large scale wind tunnel tests to confirm the A340-300 modified wing flight test vehicle
- Kick-off of the specific design and manufacturing of the laminar wing flight test articles
- Final definition of the laminar wing flight test instrumentation
- Launch of partner work shares to attribute to specific elements of the laminar wing design, manaufacture and assembly
- Start of the preparation of dedicated qualification tests for flight hardware
- Start of the CROR demo engine pylon design
- Preselection of a structural concept to integrate the CROR engine – pylon in the Airbus A340-600
- Down-selection of high-performance high lift concepts for a laminar wing
- Definition of a short list of candidate high lift concepts for ground and flight test demonstration
- Selection of a low speed demonstrator flight test vehicle

For work packages 3.2 to 3.5 year 2009 has been dedicated to the establishment of demonstration requirements and the definition and costing of possible demonstration paths (including selection of demonstration vehicle). Decisions on preferred paths will be taken early 2010, integrating the decision at the "CROR decision gate".

Year 2010 will be dedicated, for the first semester, to the more detailed planning of the selected demonstrations, in interaction with WP1 and WP2, and for the second semester to the preliminar development (prototyping) of the most urgent ones.

Subcontracting in SFWA3.1 in 2009 is planned to purchase support in the definition, manufacturing and servicing of equipment to prepare the large scale flight test. Additional support may have to be purchased for calculation of data required to certify flight test equipment or components.

5 Glossary

A/C	Aircraft
AEA	All Electrical Aircraft
ATRU	Auto Transformer Rectifier Unit
ATS	Air Transport System
ATU	Auto Transformer Unit
AW	AgustaWestland
BJ	Business Jet
CfP	Call for Proposal
CfP	Call for Proposal
CROR	Counter-Rotating Open Rotor engine
Ecg	Eurocopter Group
ED	Eco-Design ITD
FTI	Flight Tests Instrumentation
FTR	Flight Tests Request
G/T	Ground Test
GRA	Green Regional Aircraft ITD
GRC	Green Rotorcraft ITD
H/C	Helicopter
ITD	Integrated Technology Demonstration
ITD	Integrated Technology Demonstrator
IVV	Integration Validation Verification
L/G	Landing Gear
LN	Low Noise
LW	Low Weight

MTM	Mission and Trajectory Management
MTM	Management of Trajectories & Mission
NB	Nota Bene
OAD	Overall Aircraft Design
RRD	Rolls-Royce Deutschland
RRUK	Rolls-Royce UK
S/S	Subsystem
SAGE	Sustainable and green Engine ITD
SFW	Smart Fixed Wing
SFWA	Smart Fixed Wing Aircraft ITD
SFWA	Smart Fixed Wing Aircraft
SGO	Systems for Green Operations ITD
SGO	Systems for Green Operations
SOG	Smart Operations on Ground
TBC	To Be Confirmed
TBD	To Be Defined
TE	Technology Evaluator
TRA	Technology Readiness Assessment
TRL	Technology Readiness Level
V&V	Validation & Verification
V&V	Validation and Verification
W/T	Wind-tunnel
WP	Work Package

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