Annual Implementation Plan 2011

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Description of work for year 2011

1 SFWA 0 – ITD Management

1.1 SFWA-ITD Management - General

The SFWA-ITD is structured through Work packages which are reflecting either the organisation by technical topics as well as the progressive maturing defined by either a subsequent down selection and increase of the Technology Readiness level of the SFWA-Technologies (see details in the following text). The SFWA-ITD management, coordination and decisions are handled by the Consortium Bodies "Coordinator" and the "Management Committee"
In addition the work packages at levels 1, 2 and level 3 are carrying a strong role and responsibility of the technical management, i.e. push the technical progress along the SFWA work plan, manage and ensure the time cost quality in the progress of the individual work packages and the coordination of interfaces and transfer of data through the WBS. This role has to be taken by the individual Work Package Leader.
The management responsibility is cascaded top down from the Coordinator to the Work package leaders level one further down to the WP-leaders level two and level three respectively. The SFWA Management Committee, chaired by the SFWA-ITD coordinator is carrying the major role in managing the project and is acting, with strong support of all work package leaders at all levels, on the day to day business of the program. The SFWA-Coordinator is holding the overall responsibility for the SFWA-ITD.
The Steering Committee is the main decision and governing body of the SFWA-ITD, which is by definition the interface function between the straight technical management of the SFWA-ITD and the administrative body of the CleanSky Joint Undertaking. It is chaired by a representative of the Coordinator or the by the Coordinator himself. These management principles and the application rules will be fully developed in the SFWA Consortium Agreement, in compliance and complementary with all Clean Sky statutes and procedures.
The principle organisation of the SFWA-ITD is based on a generic work break down structure with three main pillars, which reflects the core elements of SFWA-ITD, namely the development of *smart wing technologies*, their integration into *new aircraft configurations* which also includes dedicated work packages which includes the integration of innovative engine concepts, and technology validation through *flight demonstration*.
The SFWA-ITD organisation incorporates the processes and ways of working as outlined in the actual issue of the CleanSky Management Manual and in the SFWA-ITD Reference Guide.

In order to improve the technical coherence and alignment in SFWA towards the ultimate goal, which is to mature the SFWA key technologies toward a readiness level of TRL6, an additional layer of "SFWA-ITD Technology Streams" has been established in 2010. The Technology Streams are defining the technology roadmaps for the respective technologies which serve as pacemakers for the work packages. In other words, the technology streams are the "internal customer" of SFWA, providing the guiding master plans and the technical requests to the work packages.

The objective of the Technology Streams is to advance the key technologies towards a TRL of 6 (in some cases 5) within the life time of CleanSky, by providing all relevant milestones, reviews, gates as part of the master plan.

Following an iterative process with the SFWA-ITD members, the list of technology streams were frozen in mid 2010.

- Natural Laminar Flow Smart Wing (NLF SW)
- Hybrid Laminar Flow Smart Wing (HLF SW)
- Innovative Control Surfaces (ICS)
- Fluidic Control Surfaces (FCS)
- Load Control Functions and Architectures (LCFA)
- Buffet Control (BC)
- CROR engine integration (CROR-EI)
- Integration of Innovative Turbofan Engines to Bizjets (IITE)
- Advanced Flight Test Instrumentation (FTI)

The technology roadmaps of the technology streams were defined in the second half of 2010 by senior engineers. The activities required for achieving progress in each technology stream are entirely embedded in the planning of the work packages. To manage the interactions, i.e. the inputs and outputs between the work packages, all of these are coordinated through the "SFWA-ITD Correlation Matrix". This correlation matrix does contain all major project outputs (deliverables) including all relevant details such as dates, ownership, etc. and the interfaces with other CleanSky ITD´s and the CleanSky Technology Evaluator.

1.2 Work Programme 2011

The year 2011 work program includes a continuation of the declared strategy for the ground and flight test demonstration for the HSDP, further maturation of concepts chosen for the CROR demo-FTB and a number of concepts related to the integration of innovative engine concepts for large transport aircraft and for Business Jets.

Preliminary design activities will continue, on several high performance high-lift concepts chosen to be integrated into a laminar wing. As well as maturation of active loads control concepts to support the concept of a smart laminar wing.

Within 2011, a number of Call for Proposal - topics (CfP-topics) are scheduled to be published and finally taken by new partners to the SFWA-ITD. A wide range of subjects is expected related to the manufacturing, treatment, and 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 2011 calls will also include major work packages to attribute to the design and build parts of the laminar wing flight test articles.

The envisioned major achievements / milestones for 2011 are:

- Prepare and conduct the Critical Design Review for the High Speed Demonstrator Passive (CDR) // *With status July 2011 this CDR may be delayed into early 2012*
- Continue with the detailed design work and initiate the manufacturing of key elements of the High Speed Demonstrator Passive flight test articles
- Define all wind tunnel tests and ground tests for the laminar smart wing technology

- Freeze the items of the flight test instrumentation to be developed for the major SFWA flight demonstrators
- Select the Low Speed Demonstrator, including a selection of complementary ground and wind tunnel tests
- Prepare and conduct the Preliminary Design Review of the SFWA "Short Range Aircraft" concept (PDR)
- Choice of the CROR Integration Concept to be continued for further SFWA development and demonstration, in coordination of the main stakeholders in CleanSky SAGE-ITD
- Define the loads control strategy for a technology stream technology roadmap with a demonstration plan with link to the development of the smart wing
- Accomplish an updated set of SFWA environmental targets aligned with other ITD´s and the CleanSky Technology Evaluator
- Achieve the delivery of an set of SFWA reference and concept aircraft for the first CleanSky technology assessment loop to the Technology Evaluator
- Conclude on an all CleanSky program runtime SFWA-ITD technology roadmap including a cost to completion planning
- Achieve a full transition of the SFWA-ITD technical management based on the Technology Stream roadmaps which are linked to the work package activities through the "Correlation Matrix"
- Prepare a detailed follow-on year 2012 work and budget plan to be issued s a Consortium Plan 2012 at the end of 2011
- Conduct of a major SFWA-ITD Annual Progress Review

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 2011

In 2011 more experimental results will be obtained to confirm the expected performances of the shorter term flow control concepts. Development of technologies for passive concepts should be close to complete for many of them , with subsystem integration tests defined for the next stages, partially to be conducted in the dedicated area of WP1.3.

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. These passive flow control technologies enjoy a renewed interest because of rising environmental concerns and increasing fuel prices.

<u>Main objectives of work in 2011:</u>

- Confirmation of boundaries of design criteria for attachment line transition, cross flow and Tollmien-Schlichting instabilities over a range of flight conditions and wing plan forms
- Review and advance maturity of the requisite technologies and design tools for the development of a passive laminar flow
- Development of NLF concepts for wing and engine nacelles
- Development of methods for managing the parasitic wave drag associated with passive laminar flow solutions and buffet control
- Establishing of design and manufacturing requirements for full scale applications.
- Preparation of ground tests and research type wind tunnel 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. As the initialisation of the work package has started in mid 2009 and activities in 2010 activities ramped up affected by a strong competition with priority NLF activities, some of these tasks rolled over from 2010.

Main objectives of work in 2011:

- Review applicable solutions for buffet control for a Smart Wing
- Develop active shock control concepts able to delay or tailor the onset of shock respectively buffeting at high speed.
- Continue parametric studies of active flow and buffet control concepts with numerical methods (RANS)
- Develop active transition control concepts by means of distributes roughness elements
- Definition of ground tests and instrumentation for related 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. Laminar flow depends on a smooth surface in particular in the leading edge area which requires a coating that provides anticontamination – anti-icing properties at high stability against erosion.
An important topic for laminar wing structures and surfaces is to ensure easy, quick and reasonably cheap repair. Develop the principle techniques in particular for CfRP structures is part this work package

Main objectives of work in 2011:

- Study of working mechanisms, degradation behaviour and lifetime of different functional coatings through analytical study of properties
- Model coatings with anti-contamination-, anti-icing- and anti-erosion behaviour shall be available for systematic further testing
- Evaluation of coatings in ground tests in lab scales
- Preparation and testing of active cleaning devices and icing tests in wind tunnels
- Development of concepts for manufacturing, repair for industrial type application
- Preparation of experimental investigations planned at the ONERA S3 Modane Avrieux Wind Tunnel to be performed in 2012, regarding the aerodynamic performance evaluation of structures surfaces.

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. A classical high lift solution with a slat leading edge device can not be used, alternative concepts with a seamless droop nose or Krueger concepts with a combined shielding / high lift capability are potential candiadates for a replacement. These concepts can be combined with active flow control high lift arrangements to provide extra lift, either at the leading edge and the trailing edge.

Main objectives of work in 2011:

- After a principle evaluation and selection phase in year 2010, three high lift concepts shall be studies and matured to a technology readiness level TRL 3 or beyond.
- Smart leading edge device for laminar wings, based on smart materials and morphing technologies. The work will include structurla and kinematic studies and optimization with respect to aerodynamic performace for take/off and landing
- Active flow control using continuous blowing and pulsed or mass/less jets through spanwise orifices at the leading edge without slat. Application of passive flow control by classical vortex generators shall be used as reference to be compared with candidate active solutions.
- Active flow control technologies at a high performance flow control trailing edge flap shall prepared for testing by numerical unsteady 3D numerical simulation

Subcontracting in SFWA 1.1 in 2011 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 2011.

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, in particular in view of the aerodynamic and structural concept features of the smart, laminar wing. In the course of that cross feeding will be done with SFWA 1.1 and SFWA 2.1.
The enablers for the targeted load 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”

Following a revision process of the work package SFWA1.2 subjects in the course of the planning of the Technology Stream “Load Control Functions and Architectures” (LCFA) the objectives for 2011 may be updated during the year.

Main objectives of work in 2011:

- Update the requirements for new load control devices
- Set up / definition of a generic aerodynamic model and definition of a standard reference based on a benchmark 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 for a smart wing 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 closely 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

SFWA 1.3.1 and SFWA 1.3.2. The objective of WP 1.3.1 is to define system architectures for most promising combinations of flow control and load control technologies fora n application in a future smart wing. The control architecture for the complete system including sensors, networks, actuators and power management are being put together. After the merger of WP1.3.1 and 1.3.2, the second objective of 1.3.1 is to provide the architecture and specification of the Communication network sub system that will be further developed and used in the two system demonstrators (passive and active configuration).

Main objectives of work in 2011:

- Identify downselected of flow and load control and health monitoring
- Design of related system architecture candidates at concept level including sensitivity studies
- Functional design of subsystems for data communication and power network
- Design of common network concepts for all sensing and control, centralized and distributed
- Identification and analysis of control units
- Specification of communication data protocols, sensor and actuator performance

SFWA 1.3.3: This work package deals with the objective to define a power platform able to support technologies needed for load & flow control concepts integration into aircraft. From WP1.3.1 “Advanced Control Systems Options”, requirements will be translated into electrical terms in order to specify electrical functions that have to be performed to fulfil control systems

Main objectives of work in 2011:

- Definition of electrical requirements based on control system concept
- Definition of a validation and verification strategy plan
- Completion of preparation of electrical test means
- Selection of a communication standard
- Development of a data on power demonstrator
- Contribution to the design of a power network architecture for a leading edge or trailing edge segment
- Contribution to the integration of signal and power lines into a smart wing architecture

SFWA 1.3.5: Objectives in this work is to prepare and conduct ground demonstration for the evaluation of the TRL of selected candidate technologies based on dedicated test rigs, at relevant scale, for both flow control (two demonstrators) and load control selected technologies. Each test rig will have the capability to demonstrate at least 2 innovative technologies selected from WP 1.1 and WP 1.2 at TRL 4.

Main objectives of work in 2011:

- Support the preparation of a wind tunnel model for a test on buffet control using passive devices and synthetic jet actuators.
- Preparation of test instrumentation
- Conduct of the test in the second half of 2011
- Contribute to evaluate test data
- Contribute to define and prepare wind tunnel tests for 2012

SFWA 1.3.6: The overall aim of this work package is to develop inertial and load sensor technologies to support active flow and load control for SFWA with the requirements defined in WP 1.3.1 and to provide load and inertial technologies investigation results supporting TRL level 5 validation.

Main objectives of work in 2011:

- Development of down selected types of loads sensors, in particluar printed strain
- Test and evaluation of test articles
- Draft specification of target applications for wing measurements

SFWA 1.3.7: This work package is to provide means for measurements not available with today fuselage air data systems, suitable to control the wing devices. The necessary measurements can include static (<10Hz) and dynamic (>10Hz) local pressures. It can include direct or indirect detection of turbulence, and localisation of the separation line of the boundary layer. Remote sensing is basically included, e.g. by the LIDAR technology.

Main objectives of work in 2011:

- Specification of an sensing technology with WP1.3.1 for integration into a smart wing
- Development of static and dynamic loads sensors
- Development of sensors for flow separation control
- Delivery tof test sensor articles for tests in WP1.3.5

SFWA 1.3.8: The task of this work package is to develop fluidic actuators dedicated to flow control to be demonstrated in future aircraft wings.

Main objectives of work in 2011:

- Development of fluidic actuators for low speed, i.e. to augment the high lift performance of the main wing and high lift movables
- Perform trade-off studies for fluidic actuators in downselected configurations
- Qualify fluidic actuators with respect to maturity and performance for ground demonstration
- Prepere and conduct ground tests, deliver test articles for testing

SFWA 1.3.9: The task of this work package is to develop mechanical actuators dedicated to flow and load control technology and to be demonstrated in future aircraft wings and other components, in particular high lift. Work package 1.3.8 and 1.3.9 are planned to be merged in 2011

Main objectives of work in 2011:

- Definition adaptive movables for a smart wing, in particular for buffet and loads control

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 4-5, assess and report achieved technology progress to the Technology Evaluator. The typical role of work packages WP2.x to integrate technologies into an aircraft environment, either by providing an appropriate “paper study” aircraft concept, or by scaled ground demonstrations and wind tunnel tests.

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 2011

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.

WP2 will perform the first evaluation of available SFWA ITD technologies. WP2 will also support the intermediate assessment of Clean Sky results, by providing Technology Evaluator (TE) with PANEM, a model capable of performing environmental assessment on noise and emissions for varies aircraft concepts. PANEM will consider input from SFWA ITD technologies, Engine ITD technologies and System ITD trajectories.

SFWA 2.1 contains 4 level-three work packages to investigate, via aircraft studies and large scale testing, the application of passive and active flow control technologies for drag reduction, load control and separation control. The aim is to bring those technologies to a sufficiently high readiness level so that they can be flight tested within work package 3 or matured via large ground tests, as appropriate.

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 2011:

- Definition and further maturation of wing concepts for new aircraft configurations
- Tool development, tool support for aero- and design calculations
- Detailed design of a Ground Based Demonstrator, start of work with CfP partners in dedicated CfP-topics
- Definition and preparation of wind tunnel models and tests, in particular for high speed tests
- Surface manufacture concepts for a laminar Smart Wing
- Definition of requirements for structure and system integration concepts (continued activity from 2010)
- Prepare and conduct concept Design reviewes for Low Speed Business Jet Concept (LSBJ) and High Swep Business Jet Concept (HSBJ)

Major subcontracting activities are planned in SFWA 2.1 in 2011 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 activities follow three major directions of improvements:

- Lower engine turbo machinery and jet noise (engine level, but also A/C manufacturer level) through shielding, by designing innovative aftbody shapes, while retaining or improving fuel savings brought by new technologies.
- Translate potential gains brought by innovative power plant into improved acoustic and carbon footprint characteristics on an integrated aircraft design
- Maximize the integrated platform efficiency

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 2011:

- Select the most promising concept for the LSBJ and HSBJ, based on the results of activities done in 2010
- Freeze of the external afterbody shape for the LSBJ
- Preparation of related wind tunnel tests for further detailed investigations
- Continue of a detailed feasibility study with different principle configurations with CROR engines, freeze of a target configuration for further detailed studies and tunnel tests.
- Rear end design review from flight physics perspective, aerodynamic layout for BizJets
- Detailed numerical studies with selected propeller and pylon designs
- Manufacturing of wind tunnel models, in particular TPS and dedicated high quality instrumentation
- Preparation and conduct of wind tunnel tests at different scales, in particular for aero, handling quality and noise

Subcontracting in SFWA 2.2 in 2011 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 through the workpackages in the SFWA-ITD.

Work package 2.3 contains 3 level-three work packages covering three main activities:

- Work package 2.3.1 is dedicated to the definition of the specifications: integration constraints and reference aircraft configuration.
- Work package 2.3.2 is in charge of the Technology Evaluation: after the data collection, reference aircraft configuration will be re-optimised with the SFWA ITD technologies and the Systems ITD trajectories, the evaluations will be performed on the optimised aircraft configurations.
- Finally technology evaluation results will be prepared and delivered to the Clean Sky Technology Evaluator by work package 2.3.3.

Main objectives of work in 2011:

- Definition 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
- Delivery of a reference aircraft models to the TE for a short and medium range large transport aircraft, Long range large transport aircraft as well as two classes of business jets
- Delivery of a first set of SFWA-ITD concept aircraft, i.e. an advanced, turbofan powered short and medium range large transport aircraft, and for two different types of business aircraft (LSBJ and HSBJ)

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 Empennage 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 2011:

The major objectives of the year 2011 are related to the kick off and conduct the detailed definition and design of the HSDP lamainar wing flight test onboard the Airbus A340-300 test aircraft based on the configuration frozen in the preliminary design, and to complete detailed studies to integrate the CROR demo engine in the rear fuselage of the Airbus A340-600 test aircraft. Updates may be due to results of the feasibility study in SFWA 2.2 during 2011.
Another main objective is to prepare and make a decission upon the low speed flight test demonstrator vehicle. Further work in 2011 are expected to yield a number a specific long duration flight tests, in particular on subjects related to technologies for the almainar wing.

- Kick-off detailed design work for the HSDP flight test articles based on the concept and outline frozen with status of the preliminary design. *Manufacturing of the test articles will start early 2012.*
- Preparation and conduct of different large scale wind tunnel tests to confirm the A340-300 modified wing flight test vehicle
- Final definition of the laminar wing flight test instrumentation
- Launch of partner work shares to attribute to specific elements of the laminar wing design, manufacture 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
- Preparation and conduct of flight tests with samples of surface coatings in operational conditions

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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