



ITD - G R A

Activity report

Period Covered: from 01/01/2013 to 31/12/2013

GRA-012-DL(DO.1.2-28)-ALA-MGMT-214140 A



## 1 Executive Summary (Publishable)

### 1.1 The Green Regional Aircraft ITD

The Regional Aviation is a key factor for creating resources and an efficient air transport system that respects the environment, ensuring safe and seamless mobility, building industrial leadership in Europe. Regional carriers typically operate aircraft, such as regional jets and turboprops, with fewer than 120 seats, on short to medium-haul routes. The regional aircraft market continues to be a key growth sector of the airline industry and taking into consideration traffic developed by regional aircraft in the last year more than 660000 millions ASK (Available Seat Kilometer) were offered worldwide. Only in Europe regional carriers were able to offer more than 120000 millions ASK to passengers, with average distance of 320NM (about 600 km), slight less than 200 mln people in the last year flew on regional A/C within European network. The regional traffic is expected to triplicate in the next 20 years, with a forecast of about 9300 new regional aircraft to be delivered in the next 20 years (about € 280 Billions, avg. € 14Billions per year).

A substantial contribution to the “Clean Sky” shall then come from the Regional Air Transport that, to drastically reduce the environmental impact all around, has to adopt innovative solutions in several technology domains.

Specific consideration of regional transport requirements will lead to products more optimised for the specific needs of this market segment. Environmental impact reduction will be a very important factor in shaping the technology content of future products, along with the fuel cost increase that pushes towards more efficient aircraft solutions.

According to ACARE strategic research roadmap, a large portion of the environmental goals achievement should come from the airframe. Considering the fields directly under the responsibility of the aircraft manufacturer, step changes to improve the impact on the environment deriving from the operation of regional aircraft are expected from weight and noise reduction technologies, as well as from the integration of advanced technologies belonging to other domains.

The resulting products for the regional market segment of the 2020“s will need to be substantially different from today“s offer, using a large share of technologies non conventional by current standards, and possibly with an overall configuration quite different from aircraft flying today.

The key green technologies demonstrated in Clean Sky, once integrated in a future advanced regional aircraft, will allow the full return of Europe as world leader also in the regional segment of the air-transport system, currently dominated by non-European actors, with the only exception of the ATR turboprop.

Main objectives of the Green Regional Aircraft ITD is to mature, validate and demonstrate the technologies best fitting the environmental goals set for the regional aircraft entering the market in the years 2015 - 2020.

Proprietary information: ITD Leaders and affiliates: AleniaAermacchi – Eads Casa – Fraunhofer Gesellschaft – Liebherr Aerospace – Rolls Royce – Thales, Snecma, Hispano-Suiza, Messier-Dowty; Associates: Air Green – ATR – Cira Plus – HAI – Onera

The Green Regional Aircraft Demonstration is the fundamental asset of the GRA ITD. It will constitute on one side the physical evidence of the degree of achievement of the ACARE environmental targets at aircraft level, and on the other will deliver the final assessment of the relevant technologies allowing the European industry to gather technical information that will be fundamental for the definition of environmental friendly future regional aircraft. It will be a cost effective mix of ground and flight tests covering the aspects of integration of airframe, systems and engines technical solutions at the aircraft level.

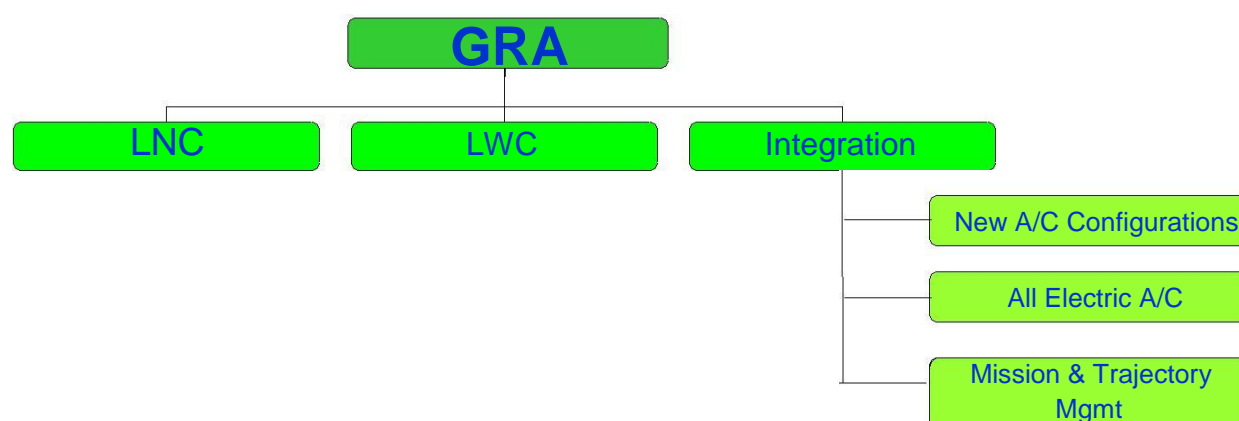
The general approach is functional to the step change in environmental impact that is sought for the regional products of the future. It is necessary to concentrate on some very promising “mainstream” technologies, but also draw the benefits of other technologies in an integrated view of their cumulative and reciprocal effects.

This very productive new research approach is made possible by Clean Sky: take the benefit of multidisciplinary integration while gathering the results of several basic technologies.

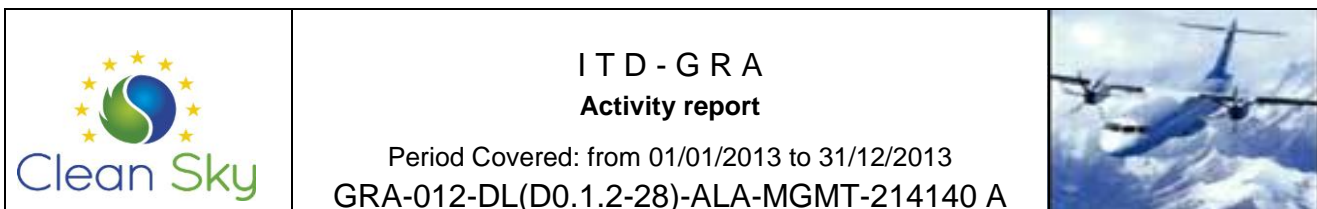
The activities of the ITD are organised so as to:

1. develop the most promising “mainstream” technologies (Low Weight and Low Noise Configurations) best fitting the requirement of greening the regional aircraft;
2. integrate technical solutions from the mainstream technologies and from other technology domains (Energy Management, Mission & Trajectory Management, Advanced Engines, Eco Design, New Configurations) in the Demonstrators of the Green Regional Aircraft, using a multidisciplinary approach.

The following schematic is the high level WBS of the GRA Project.



The Green Regional Aircraft (GRA) ITD of Clean Sky was one of the six ITD’s of Clean Sky to achieve a Grant Agreement on 28<sup>th</sup> November 2008. Accession to the Grant Agreement by the other thirty-two ITD beneficiaries was achieved on 30<sup>th</sup> January 2009.



According to the Amendment N° 7 & 8 to Grant Agreement No CSJU-GAM-GRA-2008-01 in the following modification were applied:

- **Modification of Annex 1A:** General Description of Work Programme (*GRA-012-DL(D.0.1.2-17)-ALA-MGMT-211074 B*);
- **Addition of a new Annex 1B:** a new Annex 1B (*GRA-012-DL(D0.1.2-16)-ALA-MGMT-211073 B*) related to the description of the annual Project, version B dated September 2012
- **Modification of duration:** new duration from 1<sup>st</sup> January 2012 until 31<sup>st</sup> December 2012

**Termination of a Beneficiary's participation:** Alenia SIA, Alenia Aermacchi have been merged by incorporation into Alenia Aeronautica consequently we notify a take over all rights and obligations of Alenia Aermacchi and Alenia SIA, the so called universal transfer of rights and obligations (UTRO).

- **Addition of a Third Party:** a new Party was added in the Consortium;
- **Modification of the legal entity details:** two members legal representatives were modified.

According to the Amendment N° 9 to Grant Agreement No CSJU-GAM-GRA-2008-01 in the following modification were applied:

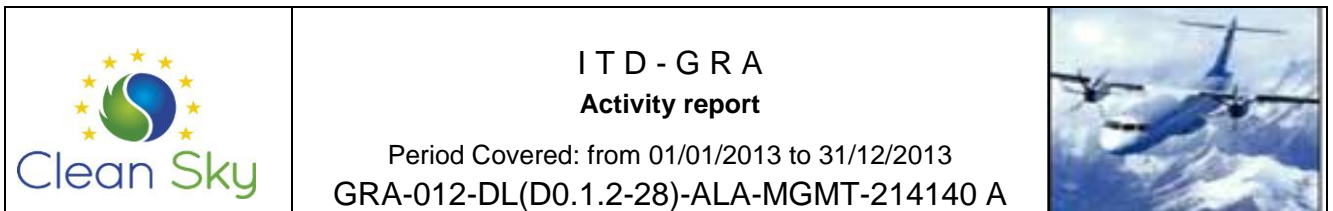
- **Modification of Annex 1A:** General Description of Work Programme *GA 2013 GRA Annex 1A (GRA-012-DL(D0.1.2-22)-ALA-MGMT-212100 A)*.
- **Addition of a new Annex 1B:** a new Annex 1B (*GA 2013 GRA Annex 1B (GRA-012-DL(D0.1.2-21)-ALA-MGMT-212099 B*) related to the description of the annual project for the period from 01/01/2013 to 31/12/2013, dated April 2013
- **Modification of duration:** new duration from 1<sup>st</sup> January 2013 until 31<sup>st</sup> December 2013
- **Modification of the legal entity details:** seven members modified their Points of Contact.

Alenia Aermacchi is the coordinator of GRA, Eads-Casa is the ITD co-leader, chairs the GRA Steering Committee. In addition to the Steering Committee meetings, the full consortium had several meetings (Consortium Management Committees, Project Managements Committees for each of the five domains, Work Packages Management Committees) using teleconference and web meeting facilities.

Year 2013 was the fifth full year of the Green Regional Aircraft (GRA) programme in which all five Technical & Demonstrations domains have been worked.

The GRA Steering Committee met six times, adopting the new issue of GRA Risk Management Plan, supporting the Coordinator in budgeting, preparing and delivering the 2013 work programme, approving the Contents and the Evaluation Ranking list of Call for Proposal topics, approving annexes of AIP and GA.

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All five Domains carried on towards their objectives during 2013.

Planning and budgeting for future activities has been refined: four (in the first batch), seven (in the second batch), zero (in the third batch) Call for Proposal Topics were launched. Of these, in the first batch four were awarded, six were awarded in the second batch: activities relating to the topic not awarded in the second batch will be developed internally to GRA.

No further topics were prepared to launch for third batch of 2013 and for 2014, consistent with the programme planning.

The following sections will provide more information on the progress achieved by each of the demonstrator projects during 2013.

Overall, the programme has achieved about 60,0% of deliverables declared in GA 2013 annex1b (on overall of 95 deliverables 57 have been delivered).

Besides, almost all deliverables (25) pending in 2012, have been delivered in year 2013: only 2 deliverables are still pending.

Total deliverables issued in year 2013 are : 80 (57+23) respect to 120 (95+25) planned, about 66,7 %, having used about 91% of the planned Men-Months.

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## Major achievements during the reporting period

The GRA work plan in 2013 was focused on the following activities:

LWC - Ground Demonstration and In-Flight Demonstration CDRs (Critical Design Reviews) as major events of Low Weight Domain.

Detailed design of the tools and demonstrators (Fuselage Barrel, Cockpit, Wing Box) to be tested on ground.

Detailed design of the tools and demonstrator to be tested in flight.

Realization of the first tools for manufacturing and components of Ground Demonstrators and of In-flight Demonstrator.

Design and manufacturing of components, subcomponents and elements for experimental activities needed for permit to flight. Completion of static, fatigue or other functional tests on large panels.

LNC - Further CFD assessment of GTF A/C transonic NLF wing aerodynamic performance in cruise condition (Mach 0.74) and (*recovery from GA 2012*) completion of the wing aero-elastic modelling.

Completion (*recovery from GA 2012*) of technological studies for the development of highly-efficient / low-noise High-Lift Devices architectures.

Completion (*partial recovery from GA 2012*) of technological studies for the development of low-noise concepts for main and nose landing gears of TP 90-seat A/C and down-selection of relevant solutions for subsequent WT tests.



Completion (*recovery from GA 2012*) of technological studies relevant to Load Control & Alleviation functions tailored to Open Rotor 130-seat A/C (with NLF wing).

First part of Application Studies to implement down-selected HLD and LC&A technologies to the GTF 130-seat A/C (with NLF wing) including: i) steady/unsteady high-fidelity computational aero-elastic analyses; ii) modelling of the LC&A system architecture; iii) part of conceptual mechanical design of wing movables (high-lift and LC&A devices); iv) part of mechanical design of the morphing flap (SACM architecture) prototype; v) manufacturing of a 1:6 half-wing WT model to assess the droop nose aerodynamic performances; vi) realization of a mechanical prototype of the droop nose to assess the functionality of the relevant smart architecture and actuation system.

Support, in terms of relevant tests definition and WT models specification, to the activities in the frame of projects under CfP (in progress or going to start) concerning Wind Tunnel demonstrations of: i) GTF 130-seat A/C NLF wing aerodynamic/ aero-elastic design integrated with LC&A devices; ii) GTF 130-seat A/C LC&A strategy; iii) GTF 130-seat and TP 90-seat A/C low-speed aerodynamic and acoustic performances; iv) 90-seat A/C MLG low-noise configuration.

Preliminary definition of ground demonstration of LC&A control system architecture on a suitable test rig.

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AEA – to Complete the prototype version of the Shared Simulation Environment (SSE) to be industrialised by CfP Partner. To perform E-ECS and EPGDS TRL4 review. To complete the analysis of function and performance of the on board systems for 130 Pax All Electrical future regional A/C as well as the definition of the modifications to be implemented on the A/C demonstrator in order to integrate and to in-flight test the innovative technologies for selected on-board systems. To develop the Saber Simulation model of the Electrical Power Generation and Distribution of the Demo Electrical channel of the A/C demonstrator and define a single channel RIG to support the Saber simulation Model activities. Complete preparation of the Verification and Validation Plan for the Flight Test activities. To proceed with the design drawings, the ICD upgrade of Systems and structural modifications to be implemented on the A/C demonstrator (E-ECS, E-EM, EPG, EMA"s, FTI). Support activities for development of Equipment delivered by CfPs such as: EMA LGS, EMA FCS, Electrical Power Center, Simulated Resistive Electrical Load.

MTM - Development of green FMS has been continued: a second release (including a subset of MTM functionalities) of green FMS was finalized and related tests were performed on GRA flight simulator (WP4.3).

The following main activities have been continued according to GRA MTM planning:

- preparation of upgraded prototyping tool
- development of ATM scenario model
- development of Advanced communication interface model

The third release of the Green FMS planned for December „13 was postponed to June „14 for development issues encountered during the process.

NC – Third set of power plant requirements for all Green A/C configuration (GTF, ATF and TP).

Third loop of preliminary sizing, performance estimation and configuration definition (CAD file), performed using the engines data set sent by Rolls Royce and Snecma, for five different Green A/Cs configurations.

GTF rear engine installation : final aerodynamic database

Upgrading of the Aircraft Simulation Model (ASM) tool development, able to estimate the green aircrafts features.

Alenia provided to Technology Evaluator four ASMs for the following aircrafts: Reference Turboprop, Green Low Speed Turboprop 90pax, Reference Turbofan and Green Geared Turbofan rear mounted aircraft configuration 130pax.



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### The main technical achievements in 2013 have concerned:



#### For LWC

- Static, fatigue and other functional tests conducted on Large Panels.
- NDI / SHM system readings correlation conducted on panel in Composite with SHM for wing.
- Assessment of technical solutions for cockpit and nacelles from different technical perspectives and support to future ground testing.
- Drawings of the stiffened panel to be integrated on test A/C for flight demonstration for CDR.
- Justifications for flight clearance for Crown Panel modification (first issue). Drawings of the ground demonstrators for CDR.
- IML and OML tools for manufacturing and assembly of fuselage barrel ground demonstrator.
- Fuselage barrel ground demonstrator Pre-Production Manufacturing (PPM).
- Preliminary general layout of test rig for ground demonstrations.



#### For LNC

- Further CFD assessment though more accurate methods of GTF A/C transonic NLF wing design (laminar flow extent and aerodynamic efficiency).
- GTF A/C NLF wing aero-elastic model based on adaptive (relaxed torsional stiffness) wing concept.
- CFD/CAA based design of acoustic liners inside the slat cove of a 3-component airfoil, sized to the HLD architecture of the ATF 130-seat A/C under-wing engine configuration; CFD/CAA based aerodynamic/aero-acoustic optimization of the slat setting of the 3-element airfoil above.
- Development, relying on computational studies (mainly CFD/CAA analyses) and basic aero-acoustic WT tests, of low-noise concepts for both main and nose landing gears. Down-selection of relevant most promising solutions by taking account, as main evaluation criteria, of respective noise reduction performance, weight penalty and integration feasibility/complexity, but also considering other issues like impact on A/C operation, safety, TRL, etc. Mechanical design of 1:2 MLG and 1:1 NLG WT models to experimentally assess down-selected low-noise concepts.







- Final assessment of performances of LC&A system tailored to the OR 130-seat A/C through aero-elastic static (LC function) and dynamic (LA function) simulations, respectively on flexible steady loads and aero-servo-elastic A/C models.
- In the frame of Application Studies to integrate down-selected technologies on the GTF 130-seat A/C: i) high-fidelity CFD/CSM aero-elastic analyses; ii) modelling of LC&A system architecture (sensors, load estimator, control laws and actuators); iii) preliminary mechanical concepts of wing movables (T/E flaps, T/E tabs, ailerons); iii) preliminary mechanical design of the morphing flap (SACM architecture) prototype; iv) design of a 1:6 half-wing WT model with droop nose and T/E flap; vi) mechanical design of the droop nose (3m span) prototype.
- In the frame of Technologies Demonstrations for GTF 130-seat A/C, definition of test requirements and specification of relevant WT models in support to projects ETRIOLLA and ESICAPIA (under CfP) dealing with D&M and testing respectively of: a) 1:3 half-wing NLF wing WT model (with LC&A devices) to assess transonic NLF wing design in cruise (Mach 0.74) and high-speed/off-design conditions; b) 1:7 complete A/C powered WT model to assess the A/C viability (S&C and high-lift performance) in low-speed (take-off, first climbing, approach/landing) conditions.

❖ For AEA

- Delivered the prototype version of the Shared Simulation Environment (SSE)
- Passed the EPGDS TRL4 review.
- Completed the analysis of function and performance of the on board systems for 130 Pax All Electrical future regional A/C
- Completed the definition of the modifications to be implemented on the A/C demonstrator
- Development of commons ITDs ( GRA, EDS, SGO) activities for ground test at COPPER Bird® peculiar to Future Regional Aircraft configuration
- Held the Preliminary Design review for development of Equipment delivered by CfPs such as: EMA LGS, EMA FCS, Electrical Power Center, Simulated Resistive Electrical Load.
- Developed the Saber Simulation model of the Electrical Power Generation and Distribution of the Demo Electrical channel of the A/C demonstrator
- Released the Demo Channel RIG specification
- Released the Verification and Validation Plan for the Flight Test activities.



- In progress the release of the design drawings and the ICD upgrade of Systems and structural modifications to be implemented on the A/C demonstrator (E-ECS, E-EM, EPG, EMA"s, FTI).
- Held the Preliminary Design review for development of Equipment delivered by CfPs such as: EMA LGS, EMA FCS, Electrical Power Center, Simulated Resistive Electrical Load.

❖ For MTM

- Preparation of Upgrade Prototyping tool;
- Finalization of upgraded ATM scenario model;
- Finalization of upgraded advance communication model;
- Provision of second release of Green FMS;
- Start of preparation of third release of Green FMS
- Closure of DARGOS and ADAVES CfPs

❖ For NC

- Green Power plant Requirements - 3<sup>rd</sup> loop
- Power plants definition (weight and dimensions, performance, pollution and noise levels data) - 3<sup>rd</sup> loop
- GRA aircraft simulation model reference aircraft (TP & ATF): new release;
- GRA aircraft simulation model green conceptual aircraft (TP & GTF rear installation) : new release;
- Green advanced turbofan configuration CAD file - 3<sup>rd</sup> loop
- OR aero-acoustic WTT activities (within WENEMOR project under CfP) completed