CLEAN SKY - *Green Rotorcraft ITD (GRC)*

Periodic Report P8 –

Publishable Summary

(January 1st to December 31st, 2015)

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Revision Table

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1	26/4/2016	First Issue

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Acronyms

A/C	Aircraft
ABC	Airborne Composite
ACARE	Advisory Council for Aeronautics Research in Europe
AGF	Active Gurney Flap
AH-D	(AHD) Airbus Helicopters Germany
AH-E	(AHE) Airbus Helicopters Spain
AHg	(AH) Airbus Helicopters Group
AHsas	Airbus Helicopters France sas
APP	Approach
ARM	Annual Review Meeting
AT(B)	Active Twist (Blade)
ATM	Air Traffic Management
ATS	Air Transport System
AW	Group AgustaWestland
AWL	AgustaWestland Ltd - UK
AWS	AgustaWestland SpA - Italy
CA	Consortium Agreement
CC	Consortium Committee
CDR	Critical Design Review
CFD	Computational Fluid Dynamics
CfP,	CFP Call for Proposal. Also project coming from a CfP
CS	Clean Sky
CSJU	Clean Sky Joint Undertaking
CSMM	Clean Sky Management Manual
ED	Eco Design Clean Sky ITD
EDA	Eco-Design for Airframe (upper level WP in Eco Design ITD)
EDS	Eco-Design for Systems (upper level WP in Eco Design ITD)
EFFP	Environment Friendly Flight Path
EHOC	European Helicopter Operators Committee
EMA	Electro Mechanical Actuator
ERF	European Rotorcraft Forum
ETR	Electrical Tail Rotor
EU	European Union
EUROPA	EUropean ROtorcraft Perfomance Analysis
FHD	Finmeccanica Helicopter Division (before was AWS)
FMS	Flight Management System
GA	Grant Agreement (for Members)
GA(M)	Grant Agreement (for Members)
GMT	Grant Management Tool
GRC	Green Rotorcraft (Integrated Technology Demonstrator)
GRCi	Subproject i of project GRC
GSP	Gas-turbine Simulation Program
H/C	Helicopter

HCE	High Compression Engine
HELENA	HELicopter Environmental Noise Analysis),
HEMAS	Helicopter Electro-Mechanical Actuation System
HMD	Helmet Mounted Device
HMI	Human Machine Interface
IFR	Instrument Flight Rule
IGOR	Cluster of GRC Associates
IO	(Project) Internal Output
ITD	Integrated Technology Demonstrator (Main Platforms within Clean Sky)
JTI	Joint Technology Initiative
JU	(Clean Sky) Joint Undertaking
KPI	Key Performance (Progress) Indicator
LCA	Life Cycle Assessment
LLI	Liebherr-Aerospace Lindenberg
LNA	Low Noise Algorithm
LPS	Labinal Power System
MC(M)	Management Committee (Meeting)
MICFL	Microflown Technologies
NDT	Non Destructive Test
NLR	Nationaal Lucht-en Ruimtevaartlaboratorium
P7	Period 7 (2014)
PDR	Preliminary Design Review
PDR	Preliminary Design Review
PHOENIX	Platform Hosting Operational Environmental Investigations for Rotorcraft
PITL	Pilot In The Loop
PIV	Particle Image Velocimetry
PM	Person Month
PO(B)	Passive Optimised (Blade)
Qi	Quarter i
R/C	Rotorcraft
RTD	Research and Technology development
SAGE	Smart And Green Engines ITD
SAR	Search And Rescue
SC(M)	Steering Committee (Meeting)
SEL	Single Engine Light
SEL-B,-R,-C	Single Engine Light – Baseline, Reference and Conceptual
SGO	Systems for Green Operations ITD
SNI	Simultaneous Non Interfering
SW	Software
T/R	Tilt-rotor
TAES	Thales Avionics Electrical Systems
TE	Technology Evaluator
TEH	Twin Engine Heavy (helicopter)
TEH-B,-R,-C	Twin Engine Heavy– Baseline, Reference and Conceptual
TEL	Twin Engine Light (helicopter)
TEL-B,-R,-C	Twin Engine Light– Baseline, Reference and Conceptual

TEM	Twin Engine Medium (helicopter)
TEM-B,-R,-C	Twin Engine Medium– Baseline, Reference and Conceptual
TM	Turbomeca
TP	Technology Project
TRL	Technology Readiness Level
TUD	Technische Universiteit Delft
VFR	Visual Flight Rule
WBS	Work Breakdown Structure
WP	Work Package
WT	Wind Tunnel

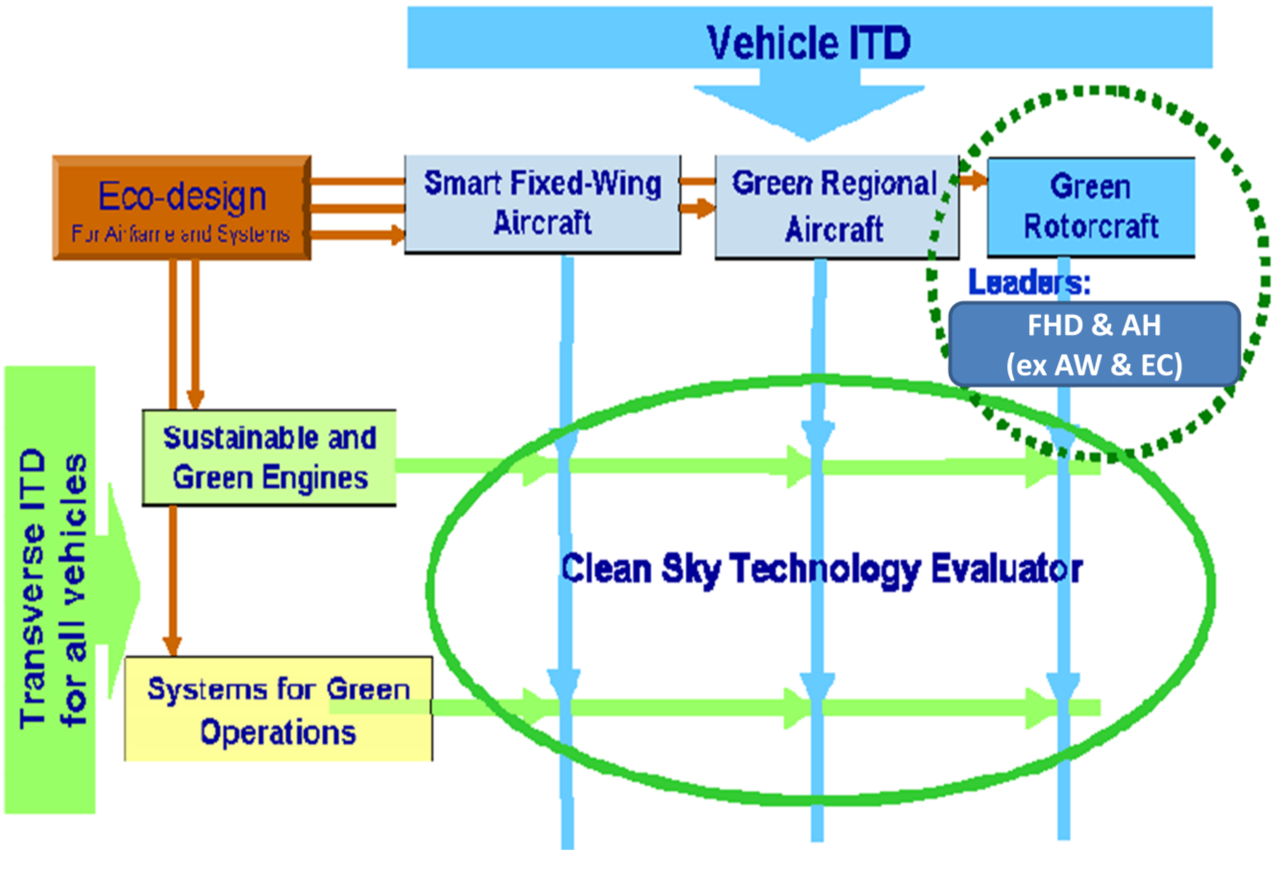
1 Publishable summary

Context

The Green Rotorcraft Integrated Technology Demonstrator (GRC ITD) addresses environmental issues in relation to rotorcraft vehicle usage, as part of a wider Air Transport System considered in the Clean Sky Joint Technology Initiative (CS JTI).

Clean Sky aims to create a radically innovative Air Transport System based on the integration of advanced technologies and full scale demonstrators, with the target of reducing the environmental impact of air transport through reduction of noise and gaseous emissions, and improvement of the fuel economy of aircraft. The activity covers all main flying segments of the Air Transport System and the associated underlying technologies identified in the Strategic Research Agenda for Aeronautics developed by ACARE.

Clean Sky is built upon 6 different technical areas called Integrated Technology Demonstrators (ITDs), where preliminary studies and down-selection of work will be performed, followed by large scale demonstrations on ground or in-flight, in order to bring innovative technologies to a maturity level where they can be applicable to new generation “green aircraft”.



The Green Rotorcraft ITD gathers and structures all activities specifically concerned with the integration of technologies and demonstration on rotorcraft platforms (helicopters, tilt-rotor) which cannot be performed in platform-generic ITDs. There are however technical links with activities conducted within the EcoDesign ITD, the Sustainable Green Engines ITD, the Systems for Green Operations ITD and with the Technology Evaluator.

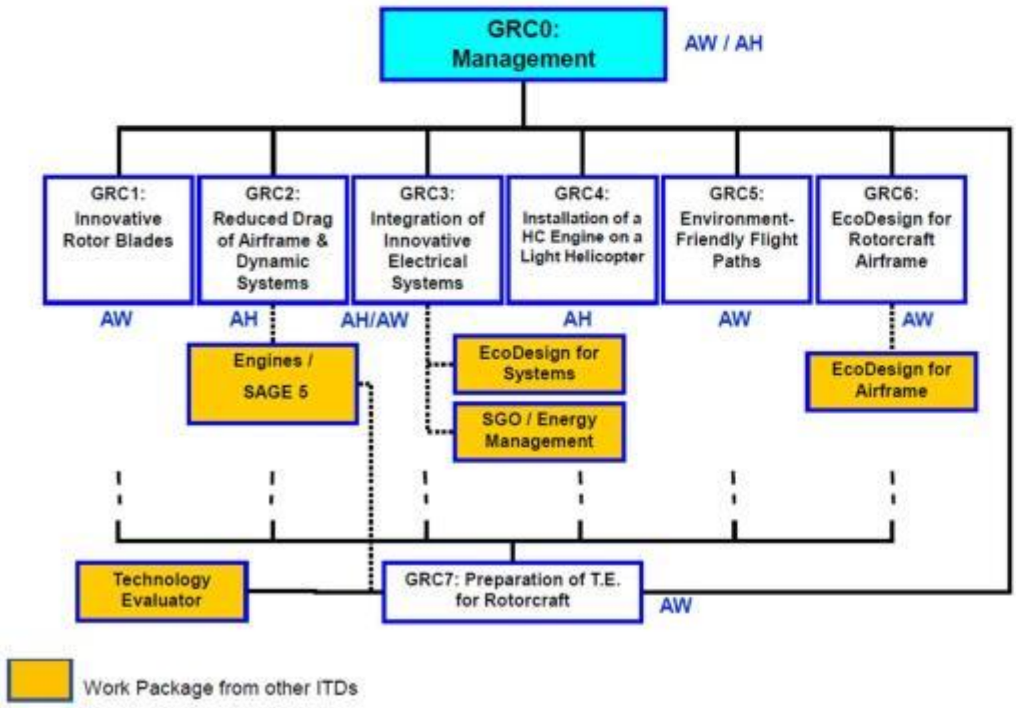
Objectives

The Green Rotorcraft ITD addresses the challenge of minimising the impact of the sharply Increasing rotorcraft traffic expected in the future - including the introduction of tilt-rotors – through a more efficient usage of energy and through a drastic reduction of greenhouse gas emissions and noise footprints throughout the whole mission spectrum. With the goal to contribute to the overall objective of coming back within 20 years to the present global level of environmental impact while sustaining the expected growth of rotorcraft services, the Clean Sky initiative aims to reduce by half before year 2020, the specific impact of rotorcraft operations on the environment. In detail, taking into account year 2000 as baseline, the objectives of the GRC ITD and concurrent activities in other Clean Sky ITDs are to reduce CO_2 emissions by 26-40% and NO_x emissions by 53-65%, according to vehicle and technologies used, and to reduce average noise level by 10 dB.

Organisation

In order to contribute to the achievement of these global objectives, the project will develop a new high compression power plant, innovative rotor blades and new aircraft configurations. The project is organised along six technological streams dedicated to key topics and one stream dedicated to technology evaluation:

- Innovative rotor blades (GRC1)
- Reduced drag of airframe and dynamic systems (GRC2)
- Integration of innovative electrical systems (GRC3)
- Installation of a high compression engine on a light helicopter (GRC4)
- Environment friendly flight paths (GRC5)
- Eco-design demonstrator (rotorcraft) (GRC6)
- Technology evaluator for rotorcraft (GRC7)



The project includes also a management subproject (GRC0). It is scheduled to run over an eight year period starting on July 1st, 2008; it is jointly coordinated by Finmeccanica (FHD) and Airbus Helicopters (AH).

1.1 Overview of work performed and results achieved

Main milestones achieved in 2015

1) Innovative Rotors GRC1: Completion of the AGF model rotor test programme (design, manufacture, test and analysis). AGF main rotor blade CDR, tooling and start of blade build. Electrical systems provisioned. Passive optimised blade CDR, start of blade build.
2) For airframe drag reduction GRC2: Flight tests of the optimised airframe and hub fairings of the Bluecopter of AHD have been completed (TRL6), it still remains though to test in flight the new side intake already measured at full scale in wind tunnel (TRL4). Flight tests of the new beanie for the AW169 have also been conducted (TRL6). The remaining wind tunnel tests about passive shape optimisation and active means on the fuselage and rotor head are completed (TRL4). Concerning the remaining optimised hub fairings aerodynamic design freeze achieved (TRL3) and wind tunnel tests partly achieved (TRL4).
3) For Innovative Electrical Systems, GRC3: the final report deliverable for the Brushless Starter Generator technology and the GRC3 benefits assessment at H/C level for TEM configurations were issued. The milestone for the Electric Tail Demonstrator Motor CDR was achieved early and the TRL5 assessments for the Power Converter and Energy Storage systems completed.
4) For the High Compression Engine (HCE)-powered helicopter GRC4: Two main milestones have been achieved in 2015: Ground runs completed in March, and Maiden Flight achieved on November 6th, after Partners finished the Powerpack endurance needed to flight-clear the engine.
5) For environment-friendly flight paths (GRC5): VFR procedures for helicopter validated by PITL (pilot in the loop) simulations in laboratory environment; low-noise trajectories for Tiltrotor IFR procedures defined; report on Pilot-in-the-loop tests of helicopter FMS with run-time low-noise planning.
6) For Eco-design for rotorcraft airframe (GRC6): during period 8, two of three thermoplastic demonstrators have been manufactured and assembled, the cross tube fairing and the tail boom demonstrator. A third demonstrator of a thermoplastic roof panel has been achieved only at element level, allowing the “go” decision for the co-melt technology to be taken to TRL6 through flight test of the final demonstrator. Significant challenges have been faced causing delays for the final full scale demonstrator.

   Moreover, eco-sustainable REACH compliant and ECO efficient treatments for metallic transmission components were also demonstrated on the following two demonstrators: Intermediate Gear Box (IGB) and associated shaft and a main helicopter mast and tail gear box.
7) Concerning the GRC7 contribution to TE (Technology Evaluator): second update of the Twin Engine Heavy (TEHU2) in the first quarter with updates of the TEM and SELU1 to include GRC5 low noise trajectories for the first time. Trade-off studies for the Single Engine Light (SEL) and High Compression Engine HCE reported.

The following extract from the Reviewers' Report issued after the Interim Review of 21st November 2015 gives some ideas about the GRC ITD status.

"All technical presentations reflect a significant progress sustained by the clear willing to achieve TRL 6 in most of work packages. This ambition is illustrated by the confirmation of flight evaluation of 3 demonstrators (possibly 4 under option):

- Active Gurney Flap
- Aerodynamic drag reduction devices on EC135
- High Compression Engine
- Passive Optimised Blade (optional)
- Validation on ground in a dedicated test rig of the "Electrical tail rotor drive".

These visible contributions to concrete GRC ITD outcomes will become from now the "flagships" of Clean Sky Programme and will deserve high priority in work plan carrying out.

A positive result is also secured by the excellent coordination between GRC5 and GRC7 about the cumulated effect of noise emission targets (GRC1) and noise footprint reduction obtained from optimised trajectories. The probability to fulfil the ambitious noise reduction of the Clean Sky programme seems now very high."

Activities performed in 2015 are summarised here after for each GRC ITD subprojects.

GRC1: Innovative rotor blades

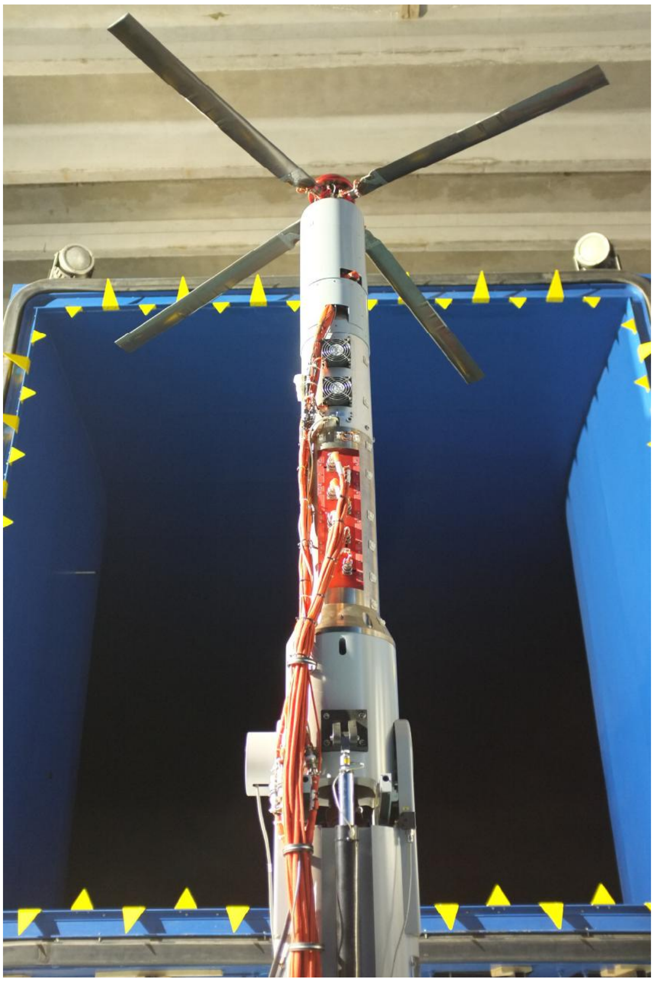
Helicopter rotor blade technology has been progressively 'fine-tuned' to extract the maximum efficiency from the rotor system. Increasingly sophisticated and more powerful computational tools are used for each development of a modern rotor system in order to gain increasingly smaller rewards. Inevitably, all helicopter rotor blade designs are a compromise, contending with the conflicting requirements of hover performance versus the needs of fast forward flight. For the latter, they contend with the difference of needs between the forward moving helicopter's lift generating *advancing* blade and the onset of stall on the *retreating* side of the rotor disc.

For this reason, helicopter manufacturers have turned their attention to the potential benefits of 'Innovative Rotors' being either a) 'Active' rotor systems, incorporating deployable (movable) components or surfaces within the blade which are capable of allowing the blade to adapt to its ever changing environment and demands or b) the design of conventional passive rotor technology that is optimised (hence Passive Optimised or PO blades), using latest design capabilities, to better meet all operational conditions.

GRC1 is thus split between 'Active' and 'Passive Optimised' blade developments as outlined below;

Blade Technology	Prime	Contributors	End Objective	TRL Objective
Active Twist (AT)	Airbus Helicopter	DRL	Acoustic Signature benefits	TRL 4 Laboratory demonstration
Passive optimised (PO) Rotor	Airbus Helicopter	Onera, DRL, others	Overall blade optimisation	TRL5 Ground "whirl tower" (Objective for TRL6 Flight demonstration assuming funding)
Active Gurney Flap (AGF)	AgustaWestland ltd	University Twente, NLR, Airborne Composites, Siemens, others	Rotor performance (= reduced engine emissions) for loaded rotor	TRL6 Flight Demonstration

In the period P8 of the CleanSky project, GRC1 reports that major elements of the programme, such as the Active Gurney Flap Model Rotor Test, were completed on schedule and cost. Major advances have also been made with respect to advancing the two larger demonstrator programmes (AGF flight demonstration and PO blade whirl tower demonstration). Out of the six due deliverables, four were achieved. Technical difficulties meant that the two milestones were transferred to 2016.



Active Gurney Flap Model Rotor Test

The 'Call for Proposal' ('GAP') activities across GRC 1 programme remained on schedule despite technical challenges. GAP partners formed a very significant part of one of the major elements of the AGF programme this year (AGF Model Rotor test). The performance of these GAP partners was outstanding, and provided a very real contribution to the overall success of those activities.

GRC2: Drag reduction of airframe and non-lifting rotating systems

The GRC2 subproject (Drag reduction of airframe and non-lifting rotating systems), deals with the aerodynamic optimisation of rotor hub and fuselage, and with the improvement of engine installation. The reduction of pressure drag generated by the fuselage and rotor head goes towards a reduction of the rotorcraft required power, whereas an improvement of the engine installation aims at increasing the available power of the installed engine.

Several helicopter weight classes, from light to heavy, different rotor-head architectures, from fully articulated to bearing less, are addressed. Moreover, active and passive methodologies are used to reduce the fuselage drag.

After having conducted a technology review in the field of rotorcraft drag reduction, a number of Technology Products (TP) have been identified by the GRC2 members. Pre-design activities were initiated for each TP with the objective of selecting the most promising ones. These TPs have been subjected to an aerodynamic and structural detailed design normally leading to a Critical Design Review (CDR). Manufacturing of down-scale or full-scale components of the selected technology product is being carried out, depending whether the benefits assessment shall be conducted in wind tunnel, thus reaching TRL 4 (Technology Readiness Level), or in flight, leading to TRL6.

All numerical activities towards aerodynamic optimisation of the selected helicopter weight classes have been concluded reaching TRL3. All wind tunnel measurements activities to assess the benefits of the various technologies have been conducted. The last challenging phase of testing selected technologies in flight started.

AHD tested in flight new landing skid fairings, a new designed aft body and new hub fairings (full fairing) on its Bluecopter demonstrator unveiled to the public on July 7th, 2015 in Donauwörth (Germany). The flight demonstrator underwent a lay-up phase at the end of 2015 to have a new side intake and plenum installed; flight tests for this new technology product are foreseen in the first quarter of 2016. The new side intake was successfully tested at full scale in wind tunnel at TUM-AER in the context of the ATHENAI partner project.

Bluecopter demonstrator of Airbus Helicopters in flight

New optimised beanie installed on the AW169 of AgustaWestland

GRC3: Integration of Innovative Electrical Systems for Rotorcraft

In GRC3 (Integration of innovative electrical systems activities), analysis reports covering technologies across differing helicopter types were delivered and data from the CfPs regarding system mass and future electrical power requirements provided to GRC7. Deliverables for this period included data for TEM, SEL & TEH configurations.

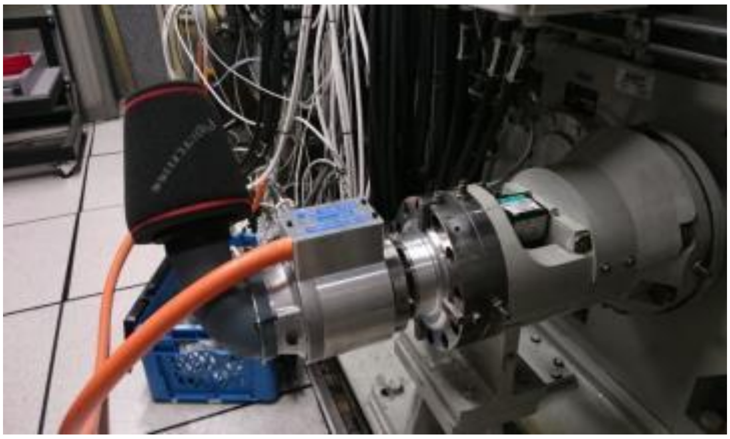
System power management strategies continued to be refined and principles aligned with the evolving CfP technology developments and leading power supply technologies.

Optimised electrical architectures were further refined in electrical network simulations utilising software models.

The technologies for improved electrical system efficiency were further developed, with all major projects progressed with CfP partners.

The Starter Generator, concluded prototype testing, analysis, final reporting and TRL analysis.

Starter Generator Prototype



Starter Generator Rig Tests

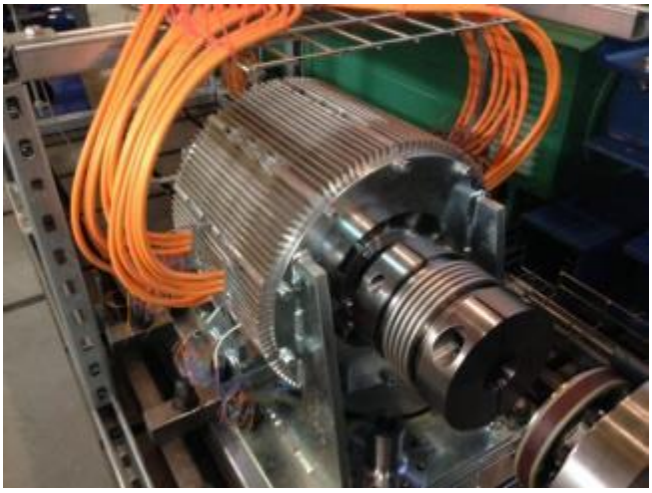
The Power Converter and Energy Storage CfPs were successfully completed following partner test and reporting. Hardware was transferred to AW Yeovil for concluding integrated analysis, and will provide a final reporting in 2016.

Energy Recovery technologies were appraised in 2015, and the decision taken were not to proceed to test. This resulted in the preparation and delivery of a closure document.

The EMA for Rotor Brake provided a test prototype machine and analysis. So as to fully explore the technical capabilities of the technology, further tests beyond the CfP closure date were agreed, and these will be formally reported in 2016.

Electrical tail rotor drive for conventional tail rotors has provided innovative concepts. The open rotor solution has created two prototype motor designs, which have initiated test bench and on-going analysis. This technology has also progressed towards provision of a tail demonstrator in 2016, by the preparatory design and provisioning of electrical test facilities and agreed supply of an airframe tail ground test rig at AW.

Electric Tail Drive ELETAD Prototype Radial Motor



ELETAD Axial Motor Rig Tests

The HEMAS system assessment planned in 2015 on the Electrical Test Bench/Copper Bird did not occur. Prototypes have been manufactured and assembled ready for the re-planned Integration. Test now to be conducted in Cascina Costa from Jan-Jun 2016.

No significant deviations regarding the Technical Annex plan were necessary.

GRC4: Light Helicopter Demonstrator with High Compression Engine

Purpose of GRC4 is to install a High Compression Engine (reciprocating engine using Kerosene) in a Light Helicopter Demonstrator in order to contribute to the fuel consumption and CO_2 emissions reduction in the frame of ACARE. Target within GRC4 is a fuel consumption of -30% based only on the engine modification.

In that context, Airbus Helicopters has teamed with a Consortium led by TEOS Powertrain Engineering and including AustroEngine in order to develop, manufacture and test the engine needed for the demonstration. The engine started testing in March 2013 with calibration tests, reaching the max power target of 330kW with a mass-to-power ratio lower than 0.9kg/kW. Airbus Helicopters on its side successfully passed:

- Iron Bird tests between November 2013 and February 2014,
- Ground tests with the H120 HCE Demonstrator between February and March 2015,
- Maiden flight of the Demonstrator on November 6th 2015.

Bluecopter Airbus Helicopter demonstrator

- The first flights confirmed the good results already shown in the previous test campaigns (Iron bird and ground tests). Fuel consumption is reduced by 40% for a flight including hovering and forward cruising up to 100kt. Furthermore the flights are validating the very satisfactory behaviour with respect to the other addressed crucial topics: torque oscillations, engine displacement and vibration, rotor speed control, cooling system. The flights are expecting to last until the end of H1/2016 in order to validate the concept in hot conditions.

GRC5: Environmentally friendly flight paths

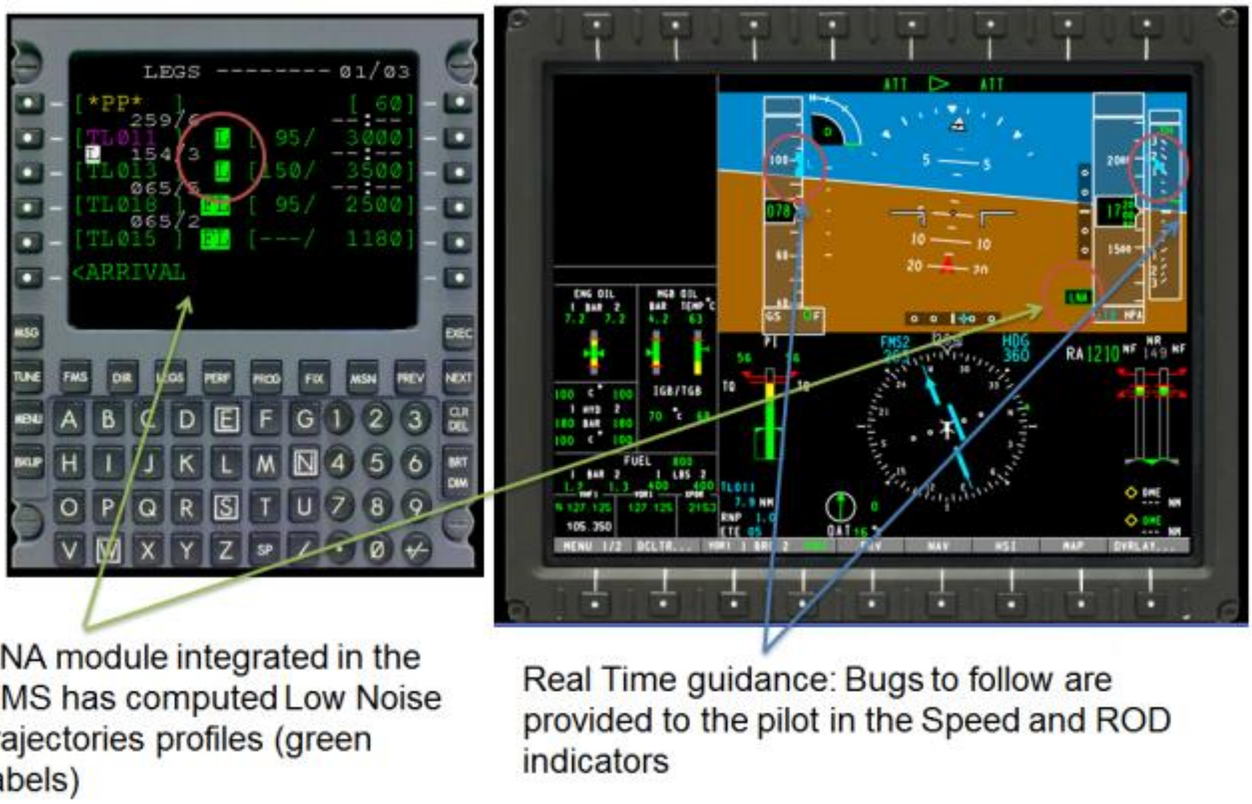
GRC5 is the CleanSky Green Rotorcraft subproject which aims at reducing noise and pollutant emissions for existing vehicle configurations, by innovating the flight procedures and mission profiles, and the pilot navigation and guidance systems necessary to implement them.

In 2015 the subproject GRC5 steadily progressed through on-ground and in-flight demonstrations towards its final objectives of several low-noise and low-pollutant technologies with Technology Readiness up to 6 (the highest expected in CleanSky). In the eco-Flight Procedures technology stream, innovative noise-abatement procedures for helicopters were tested by pilot in the loop simulations and are ready for in-flight demonstration in 2016. The T/R eco-IFR procedure final demonstration by pilot-in-the-loop test campaign has been successfully completed: the simulations have been performed connecting in remote the engineering vehicle simulator AWARE by Finmeccanica Helicopter Division (Former AgustaWestland spa) in Cascina Costa (Varese) with the Air Traffic System simulation platform by SICTA/ENAV in Capodichino (Napoli).

The Low Noise Simultaneous Non Interfering IFR Procedures at Toulouse airport have been demonstrated by a flight test campaign with the helicopter H175. Data analysis of in-flight recordings shows that Low Noise IFR procedures have been flown with very high accuracy.

Out of the window and landing site (top) and view of the engineering simulator (bottom) used for demonstrating T/R low noise IFR procedures in TP2B.

In the eco-Flight Guidance stream, most of the pilot indicators and guidance display systems were reviewed with high attention payed to their acceptability by the final users and operators. The concept of the so-called Blade-Vortex Interaction indicator was streamlined using short-term available functionalities in serial helicopters, and studying general but flexible recommendations to be implemented in the rotorcraft flight manual. Simulator flights (H145) with and without AFCS support have been conducted to verify the consistency of re-optimized noise abatement procedures. The VFR (Visual Flight Rule) guidance based on the tunnel-in-the-sky technology was extended and ported to the helmet-mounted-display that has been tested in piloted simulations and in-flight. The Low Noise Algorithm provided by CIRA was integrated in the AW139 FMS emulator and assessed by pilot-in-the-loop test in the flight dynamics handling qualities simulator AWARE.



Details of MCDU and Primary Flight Display bugs related to LNA implementation into FMS simulator.

For the eco-Technologies stream, which gathers other supporting innovations, all the planned eco-technologies (Acoustic Passive Radar, Sound Synthesis Approach and Pollutant Emission Assessment) have successfully completed their activities. Only the GRC7 interface is still open and will complete its activities in 2016.

GRC6: Eco-design demonstrators for rotorcraft

The Eco-design demonstrator project aim to the application of technologies developed within Eco-design ITD into rotary wing specific components. Based on this requirement, the technologies have been adapted to achieve the Clean Sky goals.

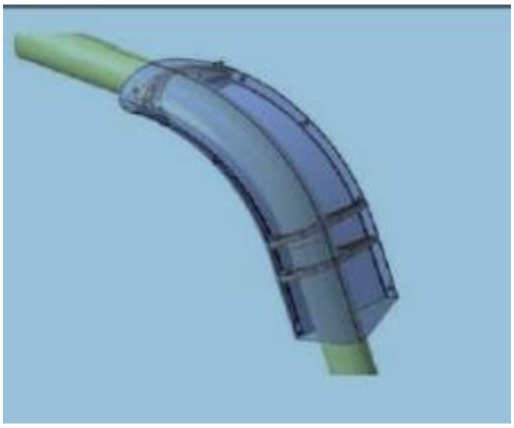
The GRC6 target was to design manufacture and test several demonstrators to prove applicability of thermoplastic composite solutions and metallic assemblies.

The aim of the programme is the demonstration of weight saving solution for helicopter primary and secondary structures as well as proves modern surface treatment which can provide REACH compliant solutions.

Most of the effort in previous periods addressed the design finalization and manufacturing trials and in general terms in 2015 most of the time has been spent in assembly and evaluation of the demonstrators. The manufacturing process of thermoplastic proved to be challenging thus causing delays. Most of the challenges have been overcome others resulted in acceptance of some of the technology limits.

In work package 6.1 a thermoplastic composite cross tube fairing demonstrator has been selected as a mean of exploitation for the following innovative thermoplastic composite technologies: fibre placement, stamp forming, welding and compression moulding of chopped fibres.

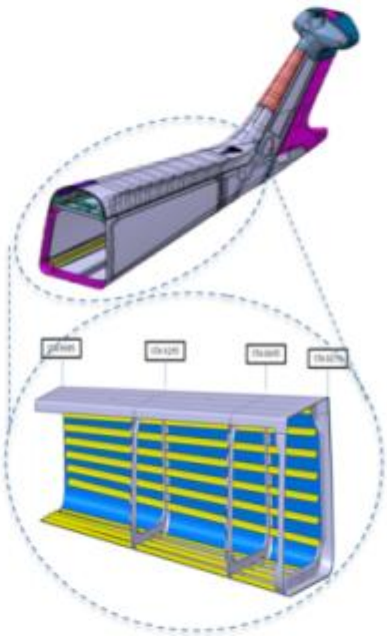
During the 2015 the assembly of sub-components (ribs and skins) has been completed and assembly on standard airframe executed.

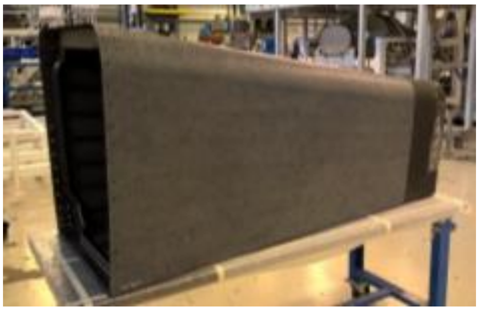


Design principle and manufacturing assembly of ribs on cross tube

In work package 6.2 there is the build of two thermoplastic demonstrators, one thermoplastic tail boom section and a roof panel demonstrator.

The first demonstrator hosts post-buckling design, press forming of complex shapes and induction welding of sub-assemblies as shown in the figures above; target technology maturity is TRL5. Most of the effort in 2015 has been focussed in completion of manufacturing of the components, with focus on induction welding and assembly. The test rig milestone has been also achieved.

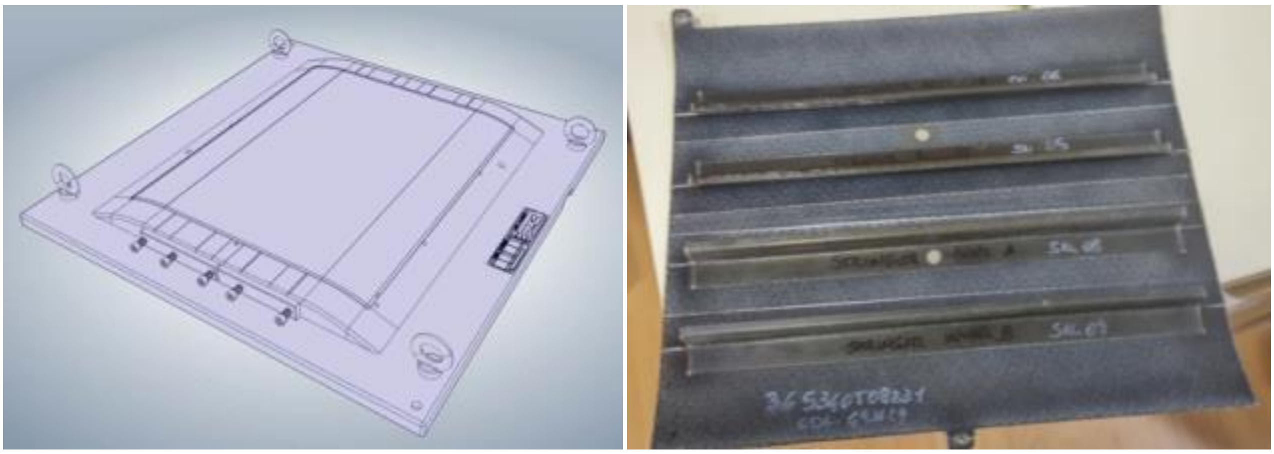




Tail boom demonstrator, from design to manufacturing

The second demonstrator hosts the co-melt technology and aims a maturity of TRL6 proven by an experimental flight. During this period most the main effort has been put in three areas:

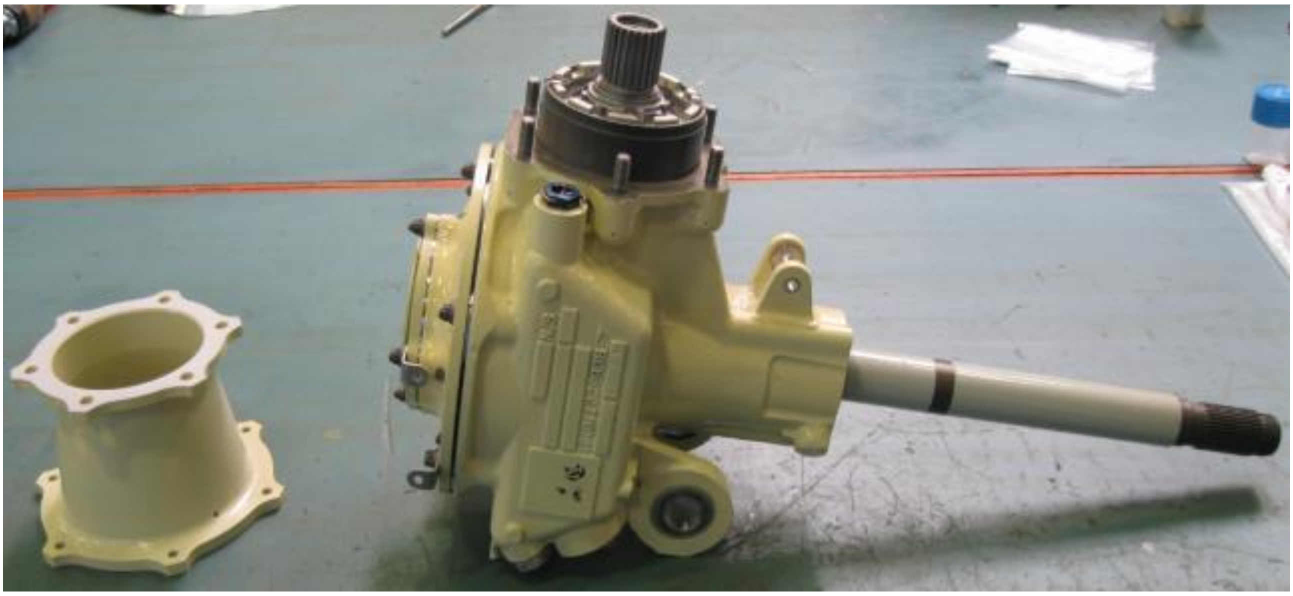
Design and manufacturing of a representative test panel including the same manufacturing challenges as the demonstrator component. This effort is inclusive of design manufacturing of the tooling mould, in which resides the main criticality of the technology. Positive results of evaluation of this test panel ended up in a go-ahead decision for scale up. The second main activity focussed on the completion of the design phase for the full demonstrator, with a big focus in finding solution for interferences with electrical, transmission and other systems. Finally, focus has been put in proving reproducibility of the test panel, to mitigate risks for the full scale manufacturing.



Tool for co-melt technology (left); co-melt test panel demonstrator (right).

The scope of work package 6.3 is to demonstrate the industrial applicability and technical functionality on helicopter power transmission components of corrosion protection treatments that are compliant to the REACh (Registration, Evaluation, Authorization of Chemicals) directive in terms of low environmental impact.

During the first half of 2015 the manufacturing activities were completed in terms of both machining activities and application of the surface treatments. Once all the finished parts were made available, the assembly and testing operation were performed in compliance with airworthiness standards. Moreover environmental aging followed by appropriate fatigue testing was performed to prove the target TRL maturity. Finally, the Recycling work package (GRC6.3.5) was completed.



Completed demonstrator of cone connector. All parts were painted with chromate free primer.

GRC7: Technology Evaluator for Rotorcraft

GRC7 had five external deliverables and milestones relating to the delivery of the Phoenix platform V5.1 and V6.1 for the Technology Evaluator's (TE)'s Fourth and Fifth Assessments respectively. The data and software packages deliverables for the Twin Engine Heavy (TEHU1) and High Compression Engine (HCE) for a light generic rotorcraft were delivered to the TE as planned. The Twin Engine Medium (TEM), Single Engine Light (SELU1) suffered minor delays due to the noise aspect of the model and first incorporation of the GRC5 benefits.

The TE completed their fourth assessment for the delivered (TEM), (TEHU1), (SELU1) and (HCE) with their results approved by all GRC(i) leads. (NLR) extended their trade-off analysis to maximise the GRC(i) technology potential benefits to include the models of (SELU1) and (TEHU1).

TELU2 deliverable and milestone due to industry resource availability has suffered major delay. The planned delivery date is September 2015, now forecast for the first quarter 2016. The rescheduled delivery of the (TELU2) has a minor impact on the TE's fifth assessment which is due to start in June 2016.

Good progress was made with the development of (TEMU1), (SELU2) and (HCEU1) due for update and delivery in 2016.

GRC7 milestones are based on the receipt and integration of the Phoenix V5.1 and V6.1 into the TE's platform and the generation of their assessment results.

1.2 Dissemination

GRC	Papers & Articles
General	1
GRC 1	2
GRC2	27
GRC3	1
GRC4	2
GRC5	20
GRC6	
GRC7	3
TOTAL	56

A total of 56 papers were been issued