Annual Implementation Plan 2010
Annex 1c - Green Rotorcraft ITD (GRC)
Summary Project Description for Period P3: Jan-Dec. 2010

Revision Table

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GRC0 – ITD Management Package

Objective

The GRC management structure and procedures aim at ensuring timely achievement of high quality technical demonstrations, and at providing proficient contractual and budgetary support and coordination of the projects. It also intends to ensure that knowledge management and other innovation-related activities are coordinated at ITD level.

GRC0 Active tasks

All tasks of the management package will be active in Period 3 and will consist in implementing and improving the GRC management procedures and tools in compliance with Clean Sky JU common rules.

GRC0.1- Management operations

GRC0.1.1 - Committees

Regular activity of the Steering Committee and Management Committee, especially quarterly progress meetings.

GRC0.1.2 - Reporting & Planning

Compilation of management reports for the current period and preparation of implementation plan for the next periods.

GRC0.1.3 - Governing Board sessions

Preparation and participation to JU Governing Board meetings and decisions, for the Members representing the GRC ITD.

GRC0.1.4 - Coordination with TE and other ITDs

The coordination of work programmes which was initiated in Periods 1 and 2. Even after full completion of the cross-ITD coordination, it will be necessary to respond to the need for some further adaptation or new orientation, depending on results or unplanned events occurring either in GRC, in the TE or in any ITD having some cross-dependencies with GRC.

GRC0.1.5 - Collaboration with external participants

Panels for selection of Partners will be active in this period. It is assuming that four Calls for Proposals will be conducted in Period 3.

GRC0.2- Management tools

GRC0.2.1 - Rules & Procedures

The Management & Quality Plan (including templates, directories, guidance material, etc) will be updated as required.

GRC0.2.2 - Shared Information Repository

The GRC repository will be maintained and further developped, as required.

GRC0.3- Management of results

GRC0.3.1 - Confidentiality and Dissemination Policy

Updating of the Consortium Agreement, as needed. Some dissemination activity might start in Period 3, depending available results.

GRC0.3.2 - IP Protection and Exploitation Policy

Up keeping of IPR lists (including access to background, in the Consortium Agreement), as needed.

GRC1 – Innovative rotor blades

Objective

Assess the potential for active and passive rotor technologies to achieve a commercially viable solution that enables reduced rotor power consumption and reduced rotor acoustic signature.

Continue development of the active twist concept from Friendcopter.

Initiate parametric study of active and passive blade lay-out for global rotor benefits.

Continue development of methods necessary for the optimisation of blade design, actuation system integration, sensory data transmission, power transfer and control algorithms.

Initiate development of open loop control algorithms to manage the active system behaviour.

GRC1 Active tasks

GRC1.1. - Technology Evaluation and Basic Development

Review the current state-of-the-art in active technology for rotors. This work package will continue in Period 3 and beyond.

GRC1.1.2- Detailed Technology Development of Full Scale Active Twist

Transfer technology to full scale by detailed development of actuation, structure dynamics leading to detailed design for test segment manufacturing.

The transfer of the active twist technology to full scale will be continued in Period 3, including the detailed development of actuation and structure dynamics.

GRC1.1.4- Detailed Technology Development of Reviewed GRC Technology:

Detailed development of technologies selected from GRC1.1.1 for bench and/or 2D wind tunnel testing in GRC1.1.5 will continue in Period 3.

GRC1.1.7- Performance Assessment of Advanced Rotor Configurations:

Study advanced rotor configuration for maximum impact on green rotorcraft objectives. Parametric study of active and passive blade lay-out for global rotor benefits. Detail investigation on rotor speed variation. Task to continue throughout Period 3 and beyond.

GRC1.1.8- Method development:

Development of numerical methods for rotor platform, active device and control system design, including specific enhancement of numerical models to simulate GRC technologies. Methods to be developed range from computational fluid dynamics and computational structural modelling to rotor aero-acoustics and comprehensive rotor analysis codes, where required to achieve project objectives. Task to continue throughout Period 3 and beyond.

GRC1.2 - Model Rotor Design and Testing

This work package purses the following final results :

- Passive Model Rotor Test (new passive concept);
- Active Model Rotor Test (new active concept);
- Assessment of benefits provided by innovative rotor blades.

It will continue throughout Period 3 and beyond.

GRC1.2.1- Variation of design parameters for innovative model rotor blades:

Design parameter variation for passive model rotor blades to identify the most promising parameters to meet the GRC goals using state-of-the-art numerical technologies and methods. This task includes passive elements of the subsequent active blade design.

This task will continue throughout Period 3 and beyond.

Calls for Proposals

The following CFP topics will be prepared and published during Period 3:

GRC-01-004	Performance assessment: Performance/benefit assessment of advanced rotor configurations including active and passive blades
GRC-01-005	Design of scaled systems representing the GRC1 technologies to be tested at wind tunnel facilities
GRC-01-006	Design of innovative power transfer system to power active system on whirling full scale blade
GRC-01-007	Design of innovative data transfer system to provide feedback from the active system on a whirling full scale blade

Some further topics may be published at the end of Period 3 for negotiation and funding in the next Period.

GRC2 – Drag reduction of airframe and non lifting rotating systems

Objective

Reduction of various rotorcraft (Helicopter and Tilt Rotor A/C) components drag, aimed at increasing airframe and non lifting rotating systems efficiency. Innovative techniques, both passive and active are being developed for drag abatement of helicopter rotor hub, helicopter and tilt rotor fuselage and empennage, tilt rotor wings, and engine installation architectures.

GRC2 Active tasks

GRC2.1. – Helicopter Hub Drag Reduction

GRC2.1.1- Technology Review:

To review different helicopter rotor hub technologies and to review methodologies for minimisation of the drag produced by the rotor.

Task to be completed beginning of Period 3.

GRC2.1.2- Analysis of hub drag reduction:

Using CFD techniques, to analyse the breakdown of drag per component, to identify areas of improvement and to predict drag reduction potential and impact on helicopter stability.

Task to start beginning of Period 3 and to extent throughout Period 3 and beyond.

GRC2.1.3- Confirmation of benefits by wind tunnel tests

The improvements implemented by each partner in GRC 2.1.2 on the hub geometries selected in GRC 2.1.1 will be tested.

Task to start beginning of Period 3 and to extent throughout Period 3 and beyond.

GRC2.2. – Fuselage Drag Reduction

GRC2.2.1- Technology Review:

To review different drag reduction technologies applicable to blunt fuselage cabins of Helicopters in the light, medium and heavy class. To review key technologies aiming at improving the efficiency of Helicopter tails. To review solutions used to reduce the fuselage drag (e.g. shape optimisation) and to increase the efficiency of the lifting surfaces of small airplanes and Tiltrotors.

Task to be completed beginning of Period 3.

GRC 2.2.2 Helicopter blunt fuselage and tail optimisation

Aerodynamic study of a H/R fuselage cabin & tail, and specific study of the empennage including control surfaces using CFD techniques and study of active devices for drag minimisation.

Task to start beginning of Period 3 and to extent throughout Period 3 and beyond.

GRC 2.2.3 Tilt Rotor body component optimisation

Shape design-optimisation of the wing-fuselage and wing-nacelle junctions, of nose and landing gear fairings, and of lifting surfaces for the ERICA tilt rotor, using CFD techniques.

Task to start beginning of Period 3 and to extent throughout Period 3 and beyond.

GRC2.2.4- Confirmation of benefits by wind tunnel tests

The solutions studied on blunt helicopter fuselages (including empennages) in GRC2.2.2 and on the common tiltrotor in GRC2.2.3 will be tested in the wind tunnel in order to validate numerical simulations and verify whether numerically predicted improvements have been achieved.

Task to start beginning of Period 3 and to extent throughout Period 3 and beyond.

GRC 2.2.6 Implementation Study of synthetic jets or pulsed jets.

To perform an implementation study of synthetic or pulsed jets, including the simulation of system performance.

Task to continue in Period 3 and beyond.

GRC 2.2.7 Common Platform Helicopter Empennage

Design, modelling manufacturing and testing an empennage with movable control surfaces.

Task to continue in Period 3 and beyond.

GRC2.3 – Engine installation

This WP aims at improving the installation of turboshaft engines on rotorcraft with respect to installation losses and noise emission, investigating in depth the technical feasibility of solutions.This work package addresses both rotorcraft configurations i.e. helicopter and tilt rotor.

GRC 2.3.1 Technology Review

Review the different technical solutions available on both configurations regarding air intake and exhausts configurations, and engine compartments

Task to be completed beginning of Period 3.

GRC 2.3.2 Analysis of Installation Efficiency, Pressure-losses and Noise Emission

Analysis of several intake and exhaust geometries using CFD techniques, including impact on fire extinguishing system.

Task to start beginning of Period 3 and to extent throughout Period 3 and beyond.

Calls for Proposals

The following CFP topics will be prepared and published during Period 3:

GRC-02-004	Contribution to design optimisation of tiltrotor for drag (fuselage/wing junction, nose, landing gear, empennage)
GRC-02-005	Contribution to the aerodynamic design optimisation of a helicopter fuselage including its rotating rotor head. Focus will be put on wind tunnel testing, including model manufacturing, and CFD analysis.

GRC3 – Integration of Innovative Electrical Systems

Objective

The programme has two major technical objectives:

- The eventual replacement of "non-green" hydraulic systems on rotorcraft by electrically-powered systems.
- Improvement of overall rotorcraft efficiency that will reduce carbon (and other undesirable) emissions through new electrical system technologies.

GRC3 Active tasks

GRC3.1. – Reference Helicopter

The definition of a reference helicopter will be used as the baseline for all of the programme activities. The reference helicopter has been selected as a medium weight (7-9 tons) and of conventional configuration. Based on this level of definition, a "current technology" electrical system is defined as the "baseline system" that will be used to assess the improvements and advantages of the technologies developed in later stages of the programme.

In Period 3, the description of interfaces with GRC7 and TE will be completed and this WP will be closed.

GRC3.2. – Power Management

This work package defines a high level electrical power system that will eliminate hydraulics from the helicopter. The high level definition of requirements developed in GRC 3.1 is used as the starting point for the development of a lower level set of requirements that can be used as the basis for scheming new architectures for the on board power management system. A number of architecture options will be identified and assessed using the tools and models developed in the ED ITD.

This WP will continue in Period 3.

GRC3.3. – Electrical Network

Building on the requirements defined in GRC 3.1, a more detailed specification for the helicopter electrical network will be prepared in this work package, covering such aspects as the voltage levels and redundancy required in the network. A number of candidate network architectures will be defined, for assessment. Leading candidate options, or a single option, will be selected as the basis for defining the technologies that should be addressed and demonstrated in the later programme activities.

This WP will continue in Period 3.

GRC3.4. – Electrical Technologies

This work package aims at developing and demonstrating the key technology developments that are needed to deliver the programme objectives. The technology categories to be addressed are: Electrical Generation; Electrical Power conversion; Energy Storage ; Energy Distribution ; Consumer Systems. For each category if technologies, the first steps to be undertaken are first to conduct an initial review of technology options and trade off studies to

identify leading candidate technologies to be demonstrated and then to specify the requirements for sub-systems and components identified as demonstration candidates.

GRC3.4.1 - 28VDC brushless starter generator

This task will continue throughout Period 3 and beyond.

GRC3.4.2 - Power converters

This task will continue throughout Period 3 and beyond.

GRC3.4.3 - Energy storage

This task will continue throughout Period 3 and beyond.

GRC3.4.4 - Energy distribution

This task will start in Period 3.

GRC3.4.5 - Consumer systems

This task will continue throughout Period 3 and beyond.

GRC3.5. – Electromechanical Actuators

This work package addresses the replacement of hydraulic actuators with electromechanical actuation (EMA). The Period 3 activity encompasses two main areas:

GRC3.5.1 - EMA for light helicopter

EMA for flight controls for a light helicopter application, with the possibility of mechanical back up.

GRC3.5.2 - EMA for medium helicopter

EMA for flight controls of the reference helicopter application.

Both tasks will continue throughout Period 3 and beyond.

GRC3.6. – Electrical Tail Rotor

This work package will evaluate the potential benefits of an electrical tail rotor drive system. The initial work will concentrate on requirements analysis and capture, identifying requirements in areas such as performance, integrity and reliability/maintainability. Configuration options will be reviewed and leading candidates identified.

This WP will continue throughout Period 3 and beyond.

GRC3.7. – Energy for Piezo Actuators

This package aims at developing a power supply system for a helicopter piezoelectric actuation system :

To capitalise on higher on-board voltage (270 V) of onboard power network

To use latest generation semiconductors for the amplifier

To ensure compatibility between amplification and power supply system

To ensure redundancy of the system.

This WP will continue throughout Period 3 and beyond.

GRC3.8. – Ground demonstration

Some preparatory work for the Copper Rig demonstration will start in Period 3.

Calls for Proposals

The following CFP topics will be prepared and published during Period 3:

GRC-03-003	Innovative technologies for storage & conversion of electrical power(2nd batch)
GRC-03-004	Piezo Power Supply Module
GRC-03-005	Contribution to other EMAs for helicopter (different from flight control)

GRC4 – Integration of a Diesel engine on a light helicopter

Objective

To take advantage of the extremely low specific fuel consumption which can be obtained thanks to turbocharged Diesel engine technology developed in the automotive industry in order to integrate this technology on helicopters and drastically reduce their gas emission level.

A two stream approach is implemented : firstly, the study of the ideal Diesel engine and optimisation of the helicopter to be powered; secondly, the integration of flying helicopter demonstrator based the adaptation to helicopter specifications of an aeronautical Diesel engine and transformation of a turbine powered light helicopter. The synthesis of both parallel streams will allow to define the way forward for future helicopter products.

GRC4 Active tasks

GRC4.1. – Pre-design for Engine Concept Selection

A survey of the diesel engines for aeronautical applications was performed to define diesel engine selection guidelines and to study the principles of the integration of a diesel engine on a helicopter.

This WP has not been fully completed in Period 2 owing to some missing elements needed to deliver a an engine proposal for flight worthy demonstrator (EC120 class). This work requires the participation of an engine manufacturer to be selected as Partner through the Call for Proposal procedure (see GRC4.6). The first call and selection performed in Period 2 was unsuccessful and did not allow to select an appropriate engine manufacturer. Consequently this WP was suspended and will be restarted at the end of Period 3 following a new Call which topic is to be redefined..

GRC 4.2 – Definition of optimal helicopter architecture for Diesel Engine

This WP aims at defining a concept helicopter on the base of the selected engine and selected mission profile, in terms of architecture and general sizing. The process is conducted iteratively considering in turns design mission and preliminary sizing (task 4.2.1),

general configuration & layout (task 4.2.2) and performance analysis in the full flight domain (task 4.2.3). It will continue throughout Period 3 and the next period.

GRC 4.3 – Integration studies for optimal diesel helicopter configuration

This WP is to carry out the necessary studies to integrate a diesel engine on the optimal helicopter configuration and to define the engine and sub-systems technical specifications.

This WP will start in Period 3, with general lay-out of airframe, avionic/rotors/electrical systems/hydraulic systems/starting/transmission, design load definition.

This task will start in Period 3 with the participation of a new Partner to be selected following a Call for Proposal launched in this period.

GRC4.4. – Flight loads and general sizing of the demonstrator

This WP will ultimately allow to derive the possible flight envelope and the flight loads due to the new engine integration. The steps are firstto compute the flight envelope, then the airframe and transmission loads.

This WP is suspended at the end of Period 1 due to lack of engine data. It will resume after successful selection of the engine manufacturer (see GRC4.6), presumably at the end of Period 3.

GRC4.5. – Pre design vehicle architecture and configuration

This WP will determine the integration concepts, the new components to be designed and pre-sized, select and describe the optimized configuration.

This WP was suspended after initial work performed in Period 1 as it is dependent on WP4.1 results and on activity of the engine manufacturer. It will resume after successful selection of the engine manufacturer (see GRC4.6), presumably at the end of Period 3.

GRC4.6. – Powerplant development & integration design for demonstrator

This WP will ultimately deliver the complete engine specification, define the engine/vehicle interfaces, design the engine installation and manufacturing including the fuel system.

Activity in this WP will be limited to the re-definition of work expected from the engine manufacturer and to the activity needed to follow the new CfP process.

All other WP concerning the development of the demonstrator in Period 3 are postponed until the engine manufacturer is selected and actually starts collaboration.

Calls for Proposals

The following CFP topic will be prepared and published during Period 3:

GRC-04-002	Participation to the definition of optimal helicopter architecture for Diesel engine

The redefined CFP topic for provision of the Diesel powerpack of the demonstrator (GRC-04-003) shall also be prepared and published in Period 3, for selection, negotiation and funding in the next Period.

GRC5 – Environment-friendly flight paths

GRC5 Active tasks

GRC5.1 - Requirement Analysis & Specifications Definition

The aim of the work package is to define the specifications for Environment-Friendly Flight Paths and Low Noise Procedures after a review of the existing requirements applicable to the H/C flight.

GRC5.1.3- Air Navigation Requirements (PANS-OPS) for IFR

GRC5.1.4- Piloting and Guidance Systems (FMS, Navigation Means)

Both tasks 5.1.3 and 5.1.4 to be completed in Period 3.

GRC5.1.5- Airport/Heliport Constraints

GRC5.1.6- Specific Tilt Rotor Aspects

Both tasks 5.1.5 and 5.1.6 to start in Period 3 and be completed in the next period.

WP5.2 - Analysis and development of specific methodologies to evaluate the engine emissions

The availability of a specific code for the prediction analysis of NOx and CO2 emissions will permit to define green mission profiles. The work package starts with a review of the existing knowledge of the NOx and CO2 emissions, then proceeds with the definition of the measurement and computational tools required and finally defines a standard methodology for the prediction analysis of the NOx and CO2 emissions :

GRC5.2.1- Review of state of the art

GRC5.2.2- Definition of tools required to perform the NOx & CO2 analysis

GRC5.2.3- Definition of a methodology evaluation

Tasks 5.2.1, 5.2.2, 5.2.3 will be completed in Period 3.

GRC5.2.4- Evaluation and development of specifics codes

This task will continue throughout Period 3 and beyond.

WP5.3- Green Mission Profiles

The definition of the database of the main parameters of the H/C flight (fuel consumption, NOX, CO2 vs speed, engine torque, etc.) will permit the choice of the optimised mission profiles minimising fuel consumption and gas emission.

GRC5.3.1- Generation of fuel consumption and gas emission data bases

Task to start in Period 3 and be completed in the next period.

WP5.4- Development and updating of optimisation tools and test methodologies for H/C noise

The aim of the work package is to provide appropriate Noise Impact tools to the H/C pilots in order to define low noise flight paths and to authorities, operators and airports in order to allow the prediction analysis of the noise footprint generated by the H/C flights.

The two tasks included in this work package will continue throughout Period 3 and beyond :

GRC5.4.1- Development of On Board Management of Low Noise Flight Paths

GRC5.4.2- Noise Impact Tools for authorities, operators and airports for Environmental Impact Studies

WP5.5- Low Noise Procedures

The aim of the work package is to define the best flight profiles minimising noise footprint during IFR & VFR approach, departures and low level flights. This work package is to start in Period 3, with the following tasks:

5.5.1 - Final Approach Profiles

5.5.2 - Initial and Intermediate Approach Profiles

5.5.3 - Low Noise Departures

5.5.4 - Low Level / Narrow IFR Routes

5.5.6 - Tools and Methods

Calls for Proposals

No CFP topic will be published, except possibly at the end of Period 3 for negotiation and funding in the next Period.

GRC6 – Eco Design Demonstrators for Rotorcraft Airframe

This activity will be launched in Period 4, as it is dependant on results from the Eco Design ITD not yet available. No activity planned in Period 3.

GRC7 – Technology Evaluator for Rotorcraft

Objective

This activity enables to provide rotorcraft specific inputs needed by the Clean Sly Technology Evaluator (TE) and will feedback the Green Rotorcraft ITD with TE results. The GRC7 work breakdown consequently mirrors the TE's one and GRC7 activity is driven by the needs of TE.

GRC7 Active tasks

The following work packages and tasks will continue throughout Period 3 and beyond.

GRC7.1 - TE requirements and architecture

GRC7.1.1- Definition of TE inputs

Definition of Technology Evaluator inputs, in relation with and to support TE task 1.1 leader and participants. This includes: specification of input selected and/or derived from ITD's set of sensitive parameters proposed for each relevant technology to be evaluated (technology deltas, system information/context); specification of reasonable association of multiple technologies for cross impact studies; specification of input data concerning technology reference systems from assigned partners.

GRC7.1.2- Models and data consistency study incl. with external projects

To perform a models and data consistency study, in relation with and to support TE task 1.4 leader and participants. This task is to provide input for TE WP2 "Models development and validation", with the objective to take advantage as much as possible of external projects results in order to avoid duplication and to give priority to tools rationalization. Also, complementarity with external projects will be emphasized.

GRC7.1.5- Definition of TE operations and architecture

Definition of Technology Evaluator Operation and Architecture, in relation with and to support TE task 1.5 leader and participants. This includes: review and listing of models resp. TE-modules; specification of architecture, i.e. definition of input/output of each TE-module and data flow between modules; specification of operation, i.e. procedure to be followed for technology evaluation; review and definition of specific procedures where needed.

GRC7.2 - Models development and validation

GRC7.2.1- Mission level

The objective of this task is to develop and validate the R/C model at mission level, composed of a rotorcraft/tiltrotor performance, an engine fuel burn, an emission and a noise black boxes elementary sub-models deliverable for TE WP2.1. Generic rotorcraft/tiltrotor and generic missions will be part of inputs for the model. This model will allow TE to perform the assessment of JTI technology at mission level in WP 4.3.

GRC7.3 - Simulation Framework Development + IVV

GRC7.3.1- TE input database structure definition

Identification of the rotorcraft input parameters to the TE simulation framework .

Calls for Proposals

No CfP topic are foreseen for GRC7.