

## GKN Aerospace involvement in the Clean Sky engine demonstrators Robert Lundberg Director European Programmes

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### **Clean Sky-1**

- > 2007 2016
- > GKN Aerospace Sweden AB is an Associate Partner (i.e. Strategic partner for the full duration of the project with responsibility for significant parts of the engine demonstrators
- > GKN Aerospace UK is a partner in the laminar wing subproject.

### Clean Sky-2

- > 2014 2022
- SKN Aerospace Sweden AB is a Core Partner in the engine demonstrators (GKN Norway, GKN ACAB and GKN Aerospace UK participate as 3<sup>rd</sup> parties.
- > Fokker is a Core Partners in several airframe demonstrators





### **Engine demonstrators in Clean Sky-1**

#### Sustainable And Green Engines (SAGE)

- > SAGE 2 Open Rotor (engine test Q4 2016)
  - GKN responsible for rotating structures
- > SAGE 3 Large 3-shaft engine (engine test ongoing)
  - GKN responsible for the ICC (intermediate compressor case)
- > SAGE 4 Geared turbofan (engine test 2015)
  - GKN responsible for Turbine Exhaust Case







### **SAGE 2 - Open Rotor demonstrator**



- SAFRAN is engine integrator (OEM)
- GKN responsible for front- and aft rotating frames. A completly new type of critical rotating component with extreme quality requirements and unique load path design
- Substantial SME involvement (Brogren, Tooltec)
- GKN carried out subcomponent tests in 2013-2015
- Engine assembly is ongoing at SAFRAN
- Engine ground test planned Q4 2016



On-time delivery of first rotating frame 3/11 2015





### SAGE 3 compressor structure – new steel concept





Brogren (SME) machined sub-elements Laser welded at Innovatum

GKNs new concept is as light as a titanium structure , at a lower cost and with European material suppliers





Mechanical component test at GKN performed 2012



Validation of our stress and lifing methods





### SAGE 4 Turbine structure with separated functionality



Instrumented turbine structure before delivery to MTU for engine assembly

#### Concept

Load carrying inner structure Aerodynamic fairing/airfoil Acoustic panels (Creo (SME)) Cooling/ventilation **Technologies** Hydroforming (HDL (SME)) 3D-printing Aero/termo-validation (GKN, Lund Univ)



Engine assembly at MTU. Engine test november 2015



10110 Rev. 22





### **Demonstrator engines in Clean Sky-2**

#### **Engines ITD**

- > WP2 SAFRAN UHPE engine
  - GKN responsible TRF, ICF and shaft
- > WP4 MTU GTF-demo
  - GKN responsible for LPC and IC-duct + integrated exhaust
- > WP5 & WP6 Rolls-Royce UltraFan engine
  - GKN responsible for ICC

#### Large Passenger Aircraft AIDP

> Platform 1 – Open rotor flight test

UHPE

- GKN responsible for front- and aft rotating structures





SAFRAN Open Rotor

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#### **UHPE** - a geared turbofan



Intermediate Compressor Frame GKN SE, GKN ACAB, GKN UK Additive Manufacturing (Ti) HT Polymer Composite study

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### WP4 Compressor module with MTU



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### WP4 exhaust module with MTU

### Engine testing using a smaller engine. Technolgies developed for next generation GTF engine





#### TEC + exhaust





### WP5 & WP6 Rolls-Royce UltraFan engine







## LPA platform 1 – SAFRAN Open Rotor flight test

Engine ground test Q4 2016 (in Clean Sky-1) Post test evaluation Re-design? Flight test in Clean Sky-2







### **Involving SMEs and Research Centres**

### The open calls in Clean Sky has been extremely successful for SMEs

- simple to apply
- no consortia needed
- high TRL topics

# Examples of partners brought in through GKN topics in the open calls or as subcontractor:

**SME** – Brogren, Tooltec, Permanova, HB Mekaniska, Optoskand, A-teknik, Winkler, Rydverken, TPC Halstahammar, Creo Dynamics, Termospect, RD&T, TST

Industry - Trelleborg, Siemens (formerly Trestad Svets), Parker, Gestamp Hardtech, Zeiss

**Research Centres** - Swerea KIMAB, -SWECAST, -SICOMP, -MEFOS, -IVF, SP, University West, Innovatum/PTC, Luleå TU, Chalmers Univ, Lund Univ, KTH







### > Call 3

- Developing the investment casting process for titanium (AMRC Castings, Sheffield, UK)
- Call 4 call just closed
  - Hybrid machining for critical rotating parts
  - Castability and weldability of high temperature Ni-based alloys
- > Call 5 not yet finalized
  - Compressor duct aerodynamic rig test. Development and validation of improved CFD codes
  - Innovative machining and tooling concepts for slender shafts
- > Future plans, examples:
  - HT polymer composites manufacturing technology/preforming
  - Probabilistic lifing methods
  - New aluminium alloys for structural engine parts
  - Relationships between process parameters/microstructure and mechanical properties for Additive Manufacturing





### **SWE DEMO MOTOR**



SWE DEMO is a Vinnova funded program to support an increased participation in international demonstrator programmes

#### Industry

- > GKN Aerospace Engines Systems
- > GKN Aerospace Applied Composites

#### **Research centres**

- > Högskolan Väst
- > Innovatum
- > Swerea IVF
- > Swerea SICOMP
- > Chalmers
- > KTH

#### SME

- > Brogren Industries
- > Tooltec
- > Permanova
- > Midroc Automation
- > Tuvanium
- > Inpernova
- > MVG Kristinehamn









> Validation to TRL6 is difficult and very expensive

- > Can only be made in collaboration with an OEM
- > Positioning for future business
- > Relevant, high TRL topics for SMEs and Research Centres

> INNOVATION







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