The First GE F414 Engine (but probably not the last…) in the Saab GRIPEN a/c

Madeleine Schmidt, Saab Aeronautics, Sweden
Flight Test Safety Workshop, New Orleans
23-25 April 2013
At the morning Briefing…

Do you really feel as YOU actually have a “No Vote”? or does it feel as you in fact…have “no Vote at ALL”…

Do YOU have the courage to stand up and use your “No Vote”? 
Outline

- Gripen Demonstrator Program - "a new way of working"
- GE F414G Engine Installation
- My Flight Test Engineer Responsibility
- Conditions and Challenges
- Performed Engine Integration Tests
- Lessons Learned
- GRIPEN NG - the Integration of GE F414 continues…
GRIPEN Demonstrator Program

Purpose
The main purpose with the Demonstrator Program was to show the development capabilities of the GRIPEN aircraft.

Mission
“... the challenge to please the Project/Market demands, with a very tough time schedule, without compromising the Flight Safety...”
GRIPEN Demonstrator Program

- Some degree of "Skunk Works"
- Small organization
- Low profile until official "Roll Out"
- Communicate progress vs pressure on Env. Exp. Team

- Rebuilt a/c:
  - Engine
  - Fuel tank
  - Landing gear
  - Radar, etc

- GRIPEN Demo first flight may 2008

Project Goal
GRIPEN Demonstrator Program

- Adapting existing methods and processes
- Aggressive budget and Project goals
- "Good enough" technical solutions
- Project pressure = High priority ➞ Easy to work
- Fast design/project decisions
- Marketing interests and customer focus
The GRIPEN aircraft

- 4:th generation fighter
- Single engine
- Multi-role capability
- NATO compatibility
- Single seat and twin seat version

Length: 14.1 m
Height overall: 4.5 m
Span: 8.4 m
Empty weight: 6.8 tonnes
Max take-off weight: 14 tonnes
GE F414G Single Engine Installation

- Replacement of GE F404 engine
- “Single engine modified” by VAC, Sweden (GE F404)
- Cooperation with GE Aviation (GE F414)
- Similar to F414-GE-400 for F/A-18 Super Hornet
GE F414G Single Engine Installation

- Single engine modifications
- Air intake modules
- Engine mounts/physical interfaces
- Power take off shaft lowered
- Engine bay ventilation
- S/W and Avionics
  - FADEC s/w logic and functionality
  - Bus traffic to/from a/c (two channel FADEC)
  - Functional Monitoring alerts (Pilot warnings)
  - A/C and FADEC start up check (SC)
- Cockpit integration
  - FADEC channel shift
  - Emergency throttle control
  - Activation of Anti Ice
  - Throttle handling
  - Presentation
My Flight Test Engineer Responsibility

- Flight Test Engineer 2007-2009
- Integration of General Electric F414 engine in **GRIPEN** aircraft
- Plan, perform and report the tests
- Represent/submit the engine integration standpoint
- Enormous focus

Should I really dare to use my ”No Vote” if needed?
My Flight Test Engineer Responsibility

Program Manager Gripen Demonstrator Program

Test and Evaluation Board (TEB)

Envelope Expansion Team
GRIPEN Demo A/C

Engine Test Team
Flight Dynamic Test Team
Fuel System Test Team

Budget
Time Schedule
Marketing

Flight Safety
Team Work

Team…
Conditions and Challenges

”Failure is not an option”

- one a/c of this unique configuration

Successful Env. Expansion called for extended possibilities

- Higher workrate
- More shortcuts
- More customer evaluations
- One mistake is enough
- Stay focused
Performed Engine Integration Tests

- System Simulator Test  Will the new s/w be integrated correct?
- Engine Integration Test Will FADEC/aircraft communicate?
- Engine Installation  Will it really fit?
- GRIPEN Demo Power on  A very important Milestone!
- Engine/Aircraft Run-up  Will the engine start?
- Ground Roll  Will the airflow/thrust be as expected?
- GRIPEN Demo First Flight An even more important Milestone!
- Initial Flight Tests  Will the engine perform as expected?
- Envelope Expansion  Will the engine integration be successfull?
We can do this!

…with a high level of Flight Safety Awareness… despite the tough time schedule?

…?

Is this really possible?
System Simulator Test

*Will the new s/w be integrated correct?*

- Real time s/w model of the FADEC h/w
- Team with s/w-, design- and test engineers
- Focus on airworthiness tests

FADEC = Full Authority Digital Engine Control
Flight Safety Awareness in all Decisions

- Official "Roll out" 4th December 2007
- "Problems" with the pyrotechnics
- Ashes on the GRIPEN Demo a/c
- Engine impact?
- Flight Safety awareness in all decisions

*This is also an aspect of Flight safety, but not as obvious as build-up procedures during envelope expansion…*
Engine Integration and Engine Installation Test

Will it really fit?
Will FADEC/aircraft communicate?

- Final installation 12th January 2008
- Small distances between engine/aircraft
- "A little bit up, a little bit forward, a little"…
- Special made installation equipment
- Risk reduction test FADEC/aircraft
Engine/Aircraft Run-up

Will the engine start?
Will the integration work?

- The first engine start 4th February 2008
- Engine run < 5 months after the first System Simulator test session
- **Project:** Start testing with one new air intake modul…?
- An important Project Milestone
- Engine started and integration worked as expected
Envelope Expansion

Will the engine perform as expected?
Will the engine integration be successful?

- Customer Evaluations, Photo flights etc
- Envelope Expansion strategy rewritten (… again and again…)
- Constantly changed envelope limits and restrictions
- Good teamwork, high discipline and flight simulations

- I decided to use my “No Vote”
And the Answer is…

- Will it really fit?
- Will FADEC/aircraft communicate?
- Will power on be successful?
- Will the engine start?
- Will the airflow/thrust be as expected?
- Will First Flight be on schedule?
- Will the engine perform as expected?
- Will the engine integration be successful?

YES
Lessons Learned

Successful Program and Engine Integration due to:

- Hard work
- Rational decisions
- Good strategy and planning
- Exceptional teamwork
- Dedicated working methods
- Educated personnel
- High priority
- and finally…

Everyday Focus on Flight Safety
Lessons Learned

An assigned Flight Safety Engineer:

- Available
- Broad flight safety perspective
- Mentor/Expert in the area
- Everyday flight safety questions (brainstorm etc)
- Support the Envelope Expansion Team
- Information, workshops etc
- Complement to TEB and Chief Test Engineer
- Discuss "stupid" questions - is this an issue?

TEB = Test and Evaluation Board
Lessons Learned

The "No Vote": a combination of several conditions:

- Knowledge
- Experience
- Courage
- Company/National Culture
- Understanding of what "No Vote" really means

Work active with the organization/company culture

No "shortcuts" allowed, even with a tough time schedule!
GRIPEN NG
The Integration of GE F414 continues…

- Gripen Demo a/c is still a flying test rig
- GRIPEN Next Generation (GRIPEN E version)
- Reuse Gripen Demonstrator lessons learned
I used my "No Vote"…
and if neccessary I will do it again…
That’s my Promise!

This was the first,
but most likely not the last, GE F414 engine installation
in the Saab GRIPEN aircraft.