Dedicated to innovation in aerospace

Flight Test Safety Management in a small test group

Arun Karwal and Martine Hakkeling

Dedicated to innovation in aerospace

History


Fokker F II
H-NABC


Fokker F VII
H-NACC


Siebel


Fokker S14


Queen Air
PH-NLR


Hawker Hunter


Swearingen Metro

Current fleet

Cessna Citation II

Pipistrel Velis Electro SW 128

Research Topics





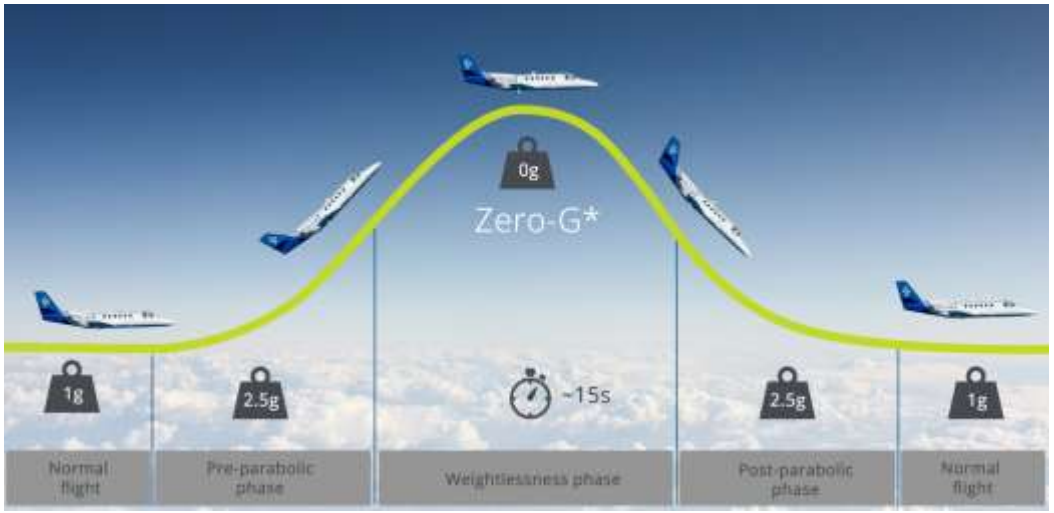
- ATM procedures (green profiles)
- Alternative fuels (biofuel, SAF)
- Avionics testbed
- Communication/datalink (VHF/SAT)
- Navaid calibration / procedure validation

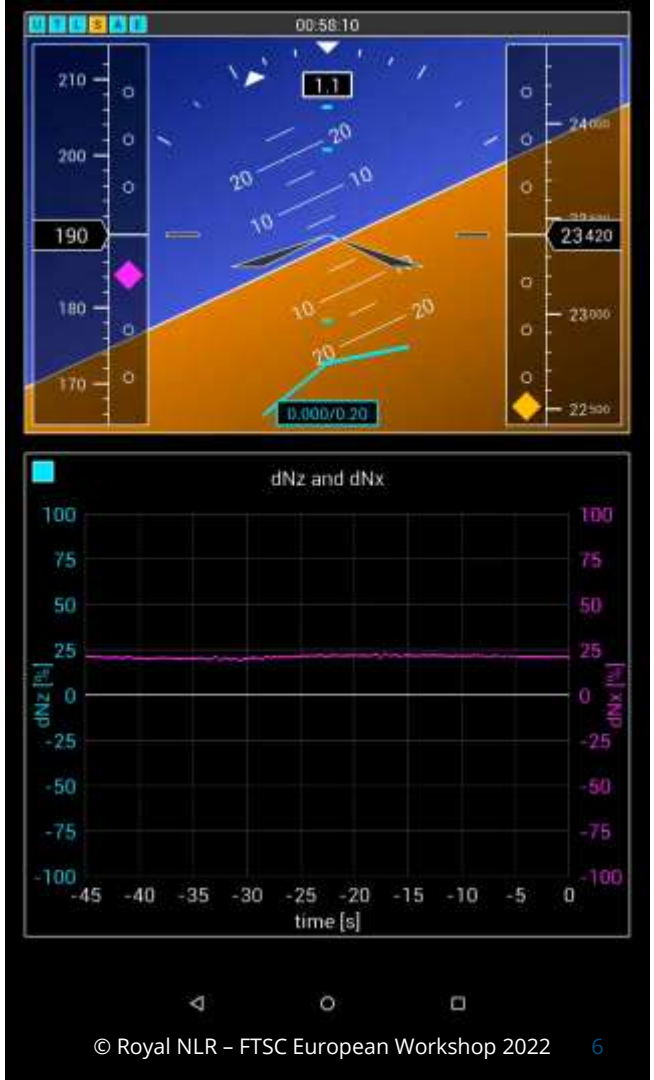
- Flight test methods
- Flying Classroom (Delft University Flight Dynamics)
- Remote sensing (external pods)
- Zero/partial-gravity

TYPES OF FLIGHT TESTS:

- ROUTINE/LOW/MEDIUM risk categories (HIGH excluded)
- Part 21 category I/II/III/IV
- In- and out of certified flight envelope

Zero-g


0g
Zero-G*
1g
2.5g
~15s
2.5g
1g
Normal flight
Pre-parabolic phase
Weightlessness phase
Post-parabolic phase
Normal flight


00:58:10
210
200
190
180
170
1.1
20
10
10
20
10
20
20
0.000/0.20
24000
23420
23000
22500
dNz and dNx
100
75
50
25
0
-25
-50
-75
-100
dNz [%]
dNx [%]
-45 -40 -35 -30 -25 -20 -15 -10 -5 0
time [s]

A lot of work …

Design organisation

- Modification design and approval

CAMO and maintenance

- Modification and config changes (on a weekly basis)
- Paperwork

Flight operation

- RFT / FTP / TCs
- Operational approvals
- Execution of flights
- Calendar is very full

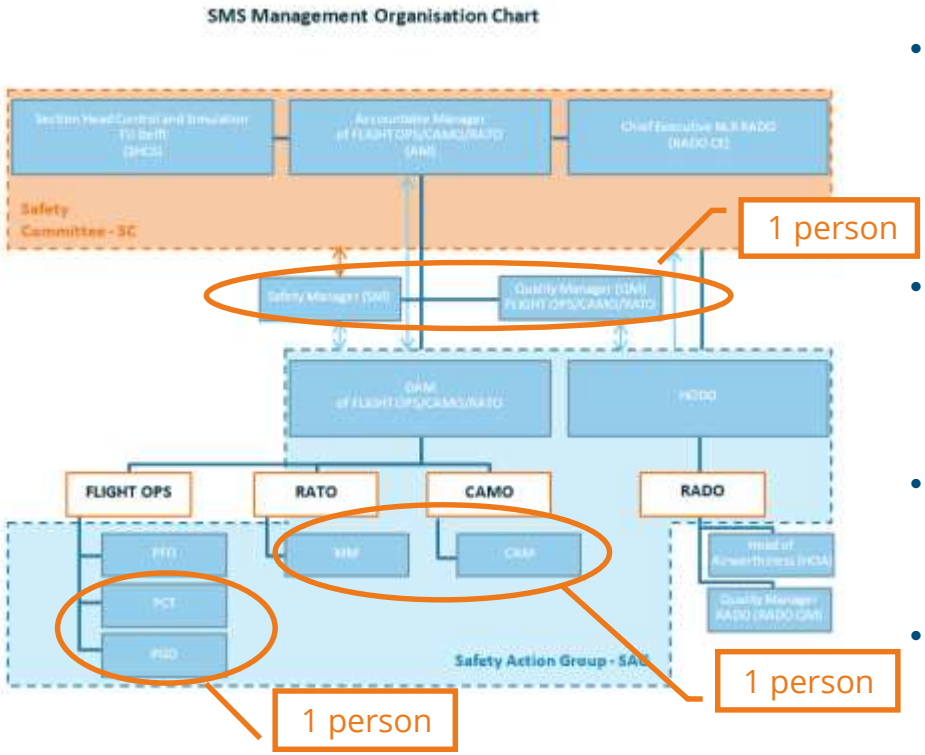
Project example: ITARO (Integration of TMA, Airport and Runway Operations)

SESAR2020-PJ.37-W3 co-funded by SESAR3 JU under grant no 10107622

All photos credits: Royal NLR

See www.sesarju.eu/projects/itaro

Small organisation, limited human resources



- Small group, ~ 10 FTE
  - 2 FTE Management (AM, Q, S, Projects)
  - 4 FTE pilots (7 pilots, 5 with FTR)
  - 4 FTE CS
- Many part-time functionaries, people have other assignments in NLR or elsewhere
- A person may have several functions within the organisation
- Various positions throughout a project
  (the pressure stays on)

Legal compliance

Organisation	Compliance	Manu
Design	National design approval, based on EASA Part 21	DOE
CAMO	Part CAMO and national approval	CAME
Maintenance	Part 145 and national approval	MOE
Operations	• ICAO Annex 6 compliant (declaration) • Part SPO compliant where possible • ICAO Doc 8071 Radio Nav Aids testing	OM Part A – D, X FI Manual
SMS	• ICAO Annex 19 • Part CAMO • EC and national occurrence reporting regulations	SMS Manual
FPD	Part FPD (Flight Validation)	OM Part FPD
Drones	UAS and U-space regulation	TBD

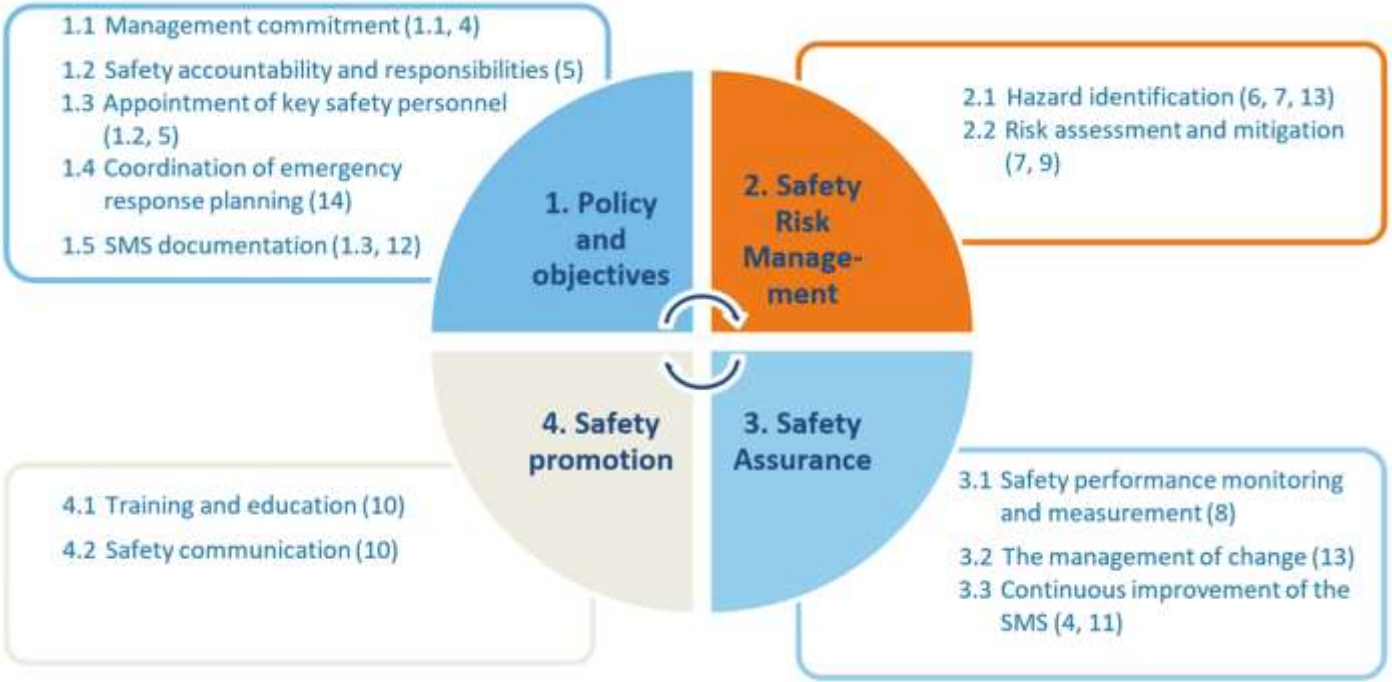
- CS-25
- CS-LSA
- CS-ANCS

- Part M
- Part 66
- Part 26
- CS-STAN
- Dutch AIC-Bs
- Dutch Maintenance Directives

- Part OPS (ORO, NCC)
- Part FCL
- CS-AWO
- Part SERA
- Part AUR
- …

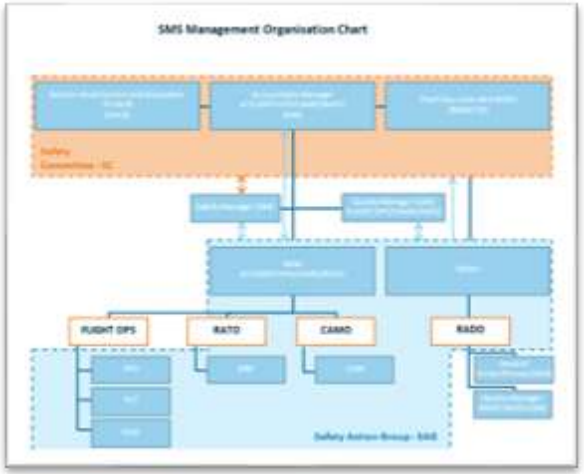
- AMC-20
- 996/2010
- 376/2014
- 2015/1018

SMS



Ref: STO AGARDograph STO-AG-300-V32 Flight Test Safety and Risk Management

SMS – 1. Policy and objectives



Management structure

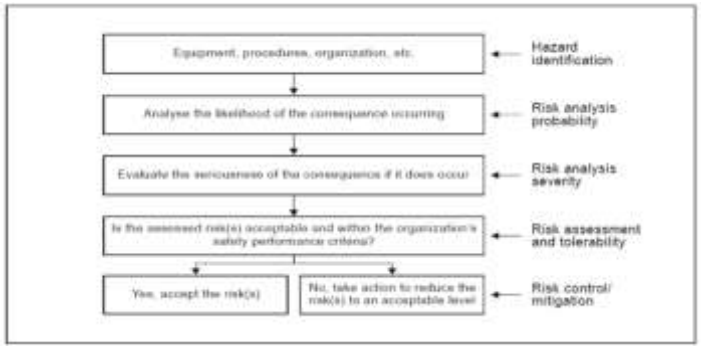
- Accountable Manager
- Safety Manager
- Safety Committee
- Safety Action Group


SAFETY POLICY STATEMENT

Safety policy

- Safety == responsibility of all personnel
- Just Culture applied

SMS – 2. Safety Risk Management



Probability	Severity				
	Catastrophic	Hazardous	Major	Minor	None
Frequent	HIGH	HIGH	MEDIUM	LOW	NEGLIGIBLE
Probable	HIGH	HIGH	MEDIUM	LOW	NEGLIGIBLE
Occasional	HIGH	MEDIUM	LOW	LOW	NEGLIGIBLE
Remote	MEDIUM	LOW	LOW	LOW	NEGLIGIBLE
Improbable	LOW	LOW	LOW	NEGLIGIBLE	NEGLIGIBLE

Hazard identification and Risk Management

- Flight Test Safety Assessments (FTP)
- Management of Change
- Occurrences

Occurrence reporting

- Small numbers (~10/year)
- Occurrences – pro-active reports – idea box
- Anonimity

SMS – 3. Safety Assurance

Safety Performance Indicators (SPI)

- ‘Safety profile’ => ‘area’s to be observed => SPI
- Little data
- How to look at these data?
  - Take average, compare with previous years (large fluctuations)
  - ‘Common sense’: understand and explain
  - Postholder view/assessment relevant

Yearly Safety Goal

2015	TCAS-RA’s (uncontrolled airspace)
2016	Promotion of Occurrence Reporting, stimulating pro-active reports
2017	Timely execution of SMS actions
2018/2019	Workload (prevention of too high workload situations)
2020/2021	Exposure/recency and lessons learned (communication and administration)
2022	Communication in a post-covid hybrid work situation

SMS – 4. Safety promotion (training and communication)

Communication

- MT/SAG meetings – monthly
- Management Review Safety Committee – once a year (MT/SAG twice)
- OPS meeting – monthly
- Operational planning meeting – monthly
- MX/CAMO – no scheduled meetings, daily contact (shared office)
- Design organisation – monthly
- Project related meetings – as required
- (Co-owners Citation – twice a year)

Training

- 2 yearly HF and SMS recurrent training (in-house)

Keeping up-to-date…

"Old School" Flight Test Risk Assessment

1. Identify hazards
2. Combine hazards into scenarios
3. Assess Severity
4. Assess Probability
5. Determine (unmitigated) risk
6. Define mitigating measures
7. Determine which measures can be implemented
8. Re-evaluate risk

+ Well known process
+ Embedded in legislation
- Not always practicable
- Not always complete?

	Severity			
Probability	Catastrophic	Hazardous	Major	Minor
Frequent	HIGH	HIGH	MEDIUM	LOW
Probable	HIGH	HIGH	MEDIUM	LOW
Occasional	HIGH	MEDIUM	LOW	LOW
Remote	MEDIUM	LOW	LOW	LOW
Improbable	LOW	LOW	LOW	ROUTINE

Keeping up-to-date… Changing processes is HARD!!

"Effectiveness of mitigating actions" replacing "Probability"

	Severity			
Effectiveness of mitigation measures	Catastrophic	Hazardous	Major	Minor
Not effective	HIGH	HIGH	MEDIUM	MEDIUM
Minimal	HIGH	MEDIUM	MEDIUM	LOW
Limited	MEDIUM	MEDIUM	LOW	LOW
Effective	LOW	LOW	LOW	ROUTINE

STPA applications
Look very promising…

Control action	Not providing causes hazard	Providing causes hazard	Too early, too late, out of order	Stopped too soon, applied too long

Challenges

PARTTIME FUNCTIONS / MULTIPLE RESPONSIBILITIES

STAYING COMPLIANT

LIMITED HUMAN RESOURCES

LIMITED TIME FOR REFLECTION

TIME PRESSURE

INSUFFICIENT PERFORMANCE DATA, FEW OCCURRENCES

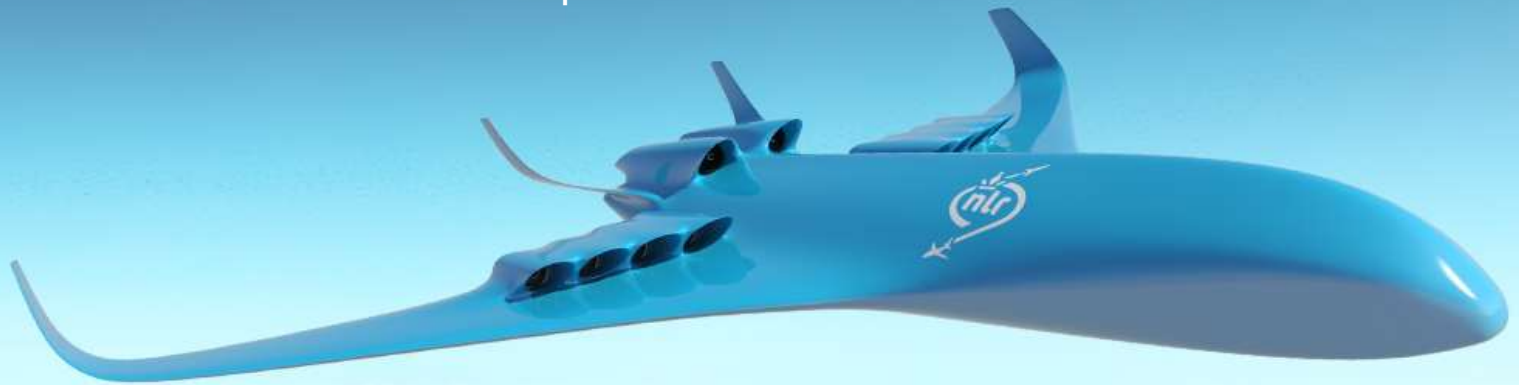
KEEPING UP TO DATE

KNOWLEDGE RETENTION

Dedicated to innovation in aerospace

Fully engaged

NLR - Netherlands Aerospace Centre



Anthony Fokkerweg 2
1059 CM Amsterdam
The Netherlands

p) +31 88 511 31 13
e) info@nlr.nl i) www.nlr.org

Voorsterweg 31
8316 PR Marknesse
The Netherlands

p) +31 88 511 44 44
e) info@nlr.nl i) www.nlr.org