Le Prove in Volo

Uno strumento per la verifica del progetto
e
la certificazione di un velivolo

(G.Verde)

Le Prove di Volo per la verifica di rispondenza ai requisiti

GENESI DELLE PROVE DI VOLO

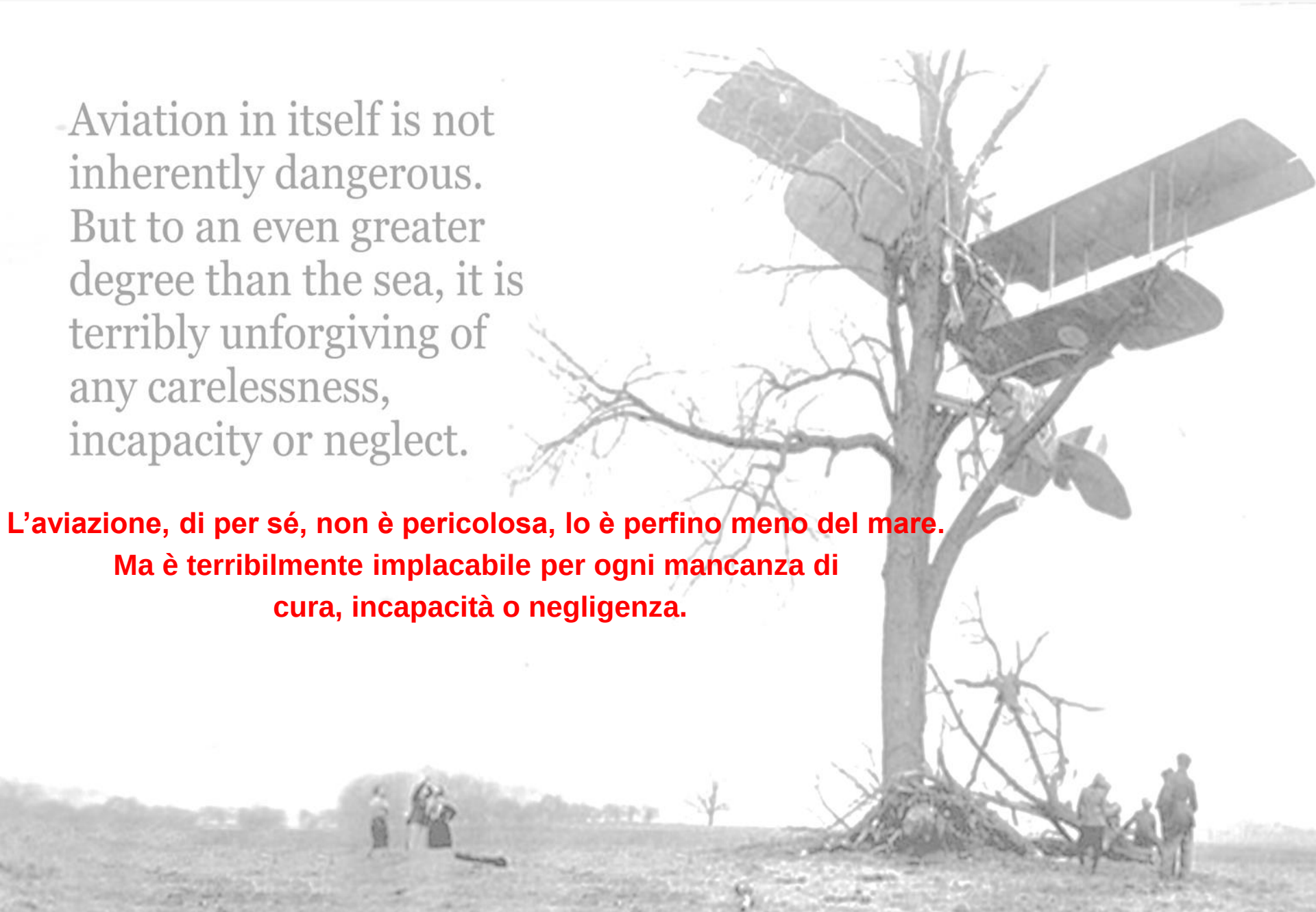
SVILUPPO DELLA CAMPAGNA DI FLIGHT TESTING

GESTIONE DELL'ATTIVITÀ DI TEST

L'ORGANIZZAZIONE DELLE PROVE DI VOLO

METODI DI ACQUISIZIONE E DI ANALISI DEI DATI (FTI)

CASI DI STUDIO



L'aviazione, di per sé, non è pericolosa, lo è perfino meno del mare.
Ma è terribilmente implacabile per ogni mancanza di cura, incapacità o negligenza.

Genesi Delle Prove Di Volo

GENESI DELLE PROVE DI VOLO

SVILUPPO DELL'ATTIVITÀ DI PROVA

GESTIONE DELL'ATTIVITÀ DI TEST

L'ORGANIZZAZIONE DELLE PROVE DI VOLO

METODI DI ACQUISIZIONE E DI ANALISI DEI DATI (FTI)

CASI DI STUDIO

REQUISITI → PROGETTO → FABBRICAZIONE → FLIGHT TESTING

Messa a punto velivolo

Verifiche progettuali
Ottimizzazione modelli
Validità delle ipotesi

Verifica rispondenza ai requisiti

Rispondenza ai requisiti :

- Normativi
- di Progetto
- di Sicurezza

→ **Flight Testing**

Obiettivi di una campagna di Flight Testing

- Dimostrazione della validità delle ipotesi di progetto
- Convalida dei modelli analitici di progetto
- Determinazione più accurata dei margini di sicurezza
- Messa a punto del velivolo (Flying Qualities,Sistemi,…..)
- Ottimizzazione delle prestazioni
- Investigazioni relative a deficienze post certificazione
- Sviluppo di nuove apparecchiature e sistemi di bordo
- Voli sperimentali oggetto di ricerche specifiche

- **Demonstration of compliance with regulations or certification specifications**

What kind of flights could fall under the definition of a flight test, according to Part 21?

- The GM to 21.A.701 provides useful information for identifying what is a flight test.
- Not all the cases listed in this GM should be qualified as a flight test. We are interested in 2 of these cases:

Development:

- Testing of new aircraft or modifications
- Testing of new concepts of airframe, engine, propeller and equipment
- Testing of new operating techniques

Demonstration of compliance with regulations or certification specifications:

- Certification flight testing for type certification, supplemental type certificates, changes to type certificates or ETSO authorisation

Requisiti Normativi

What existing requirements are actually related to the flight test activity?

PART 21.A.35

a) Flight testing for the purpose of obtaining a type-certificate shall be conducted in accordance with conditions for such flight testing specified by the Agency.

b) The Applicant must make all flight tests that the Authority finds necessary.

Part 21

- 21A.4(a), 21A.20, 21A.33, 21A.35(a), 21A.35(b), 21A.55, 21A.239, 21A.243, 21A.245, 21A.251, 21A.257(a), 21A.257(b), 21A.263(c), 21A.265, 21A.701, 21A.707, 21A.708, 21A.709, 21A.710, 21A.711, 21A.713, 21A.723, 21A.725, 21A.727, 21A.729 and related GMs and AMCs

Part FCL

- FCL.820 (Opt-out until 08/05/15)

CS-23 Amnd.5 (ed.29/03/2017)

Categorie di velivoli: Normal, Utility, Acrobatic, Commuter

SUBPART B: Flight

SUBPART C: Structure

SUBPART D: Design & Construction

SUBPART E: Powerplant Installation

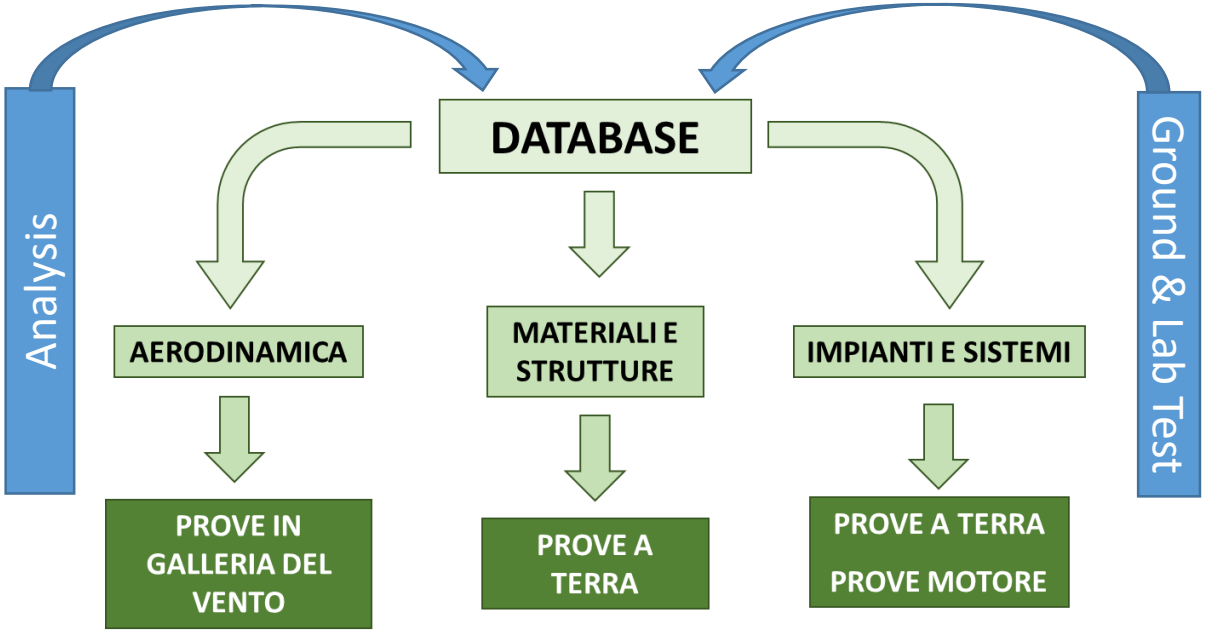
SUBPART F: Systems and Equipment

SUBPART G: Flight Crew Interface and Other Information

ICAO – Annex 16

Aircraft Noise

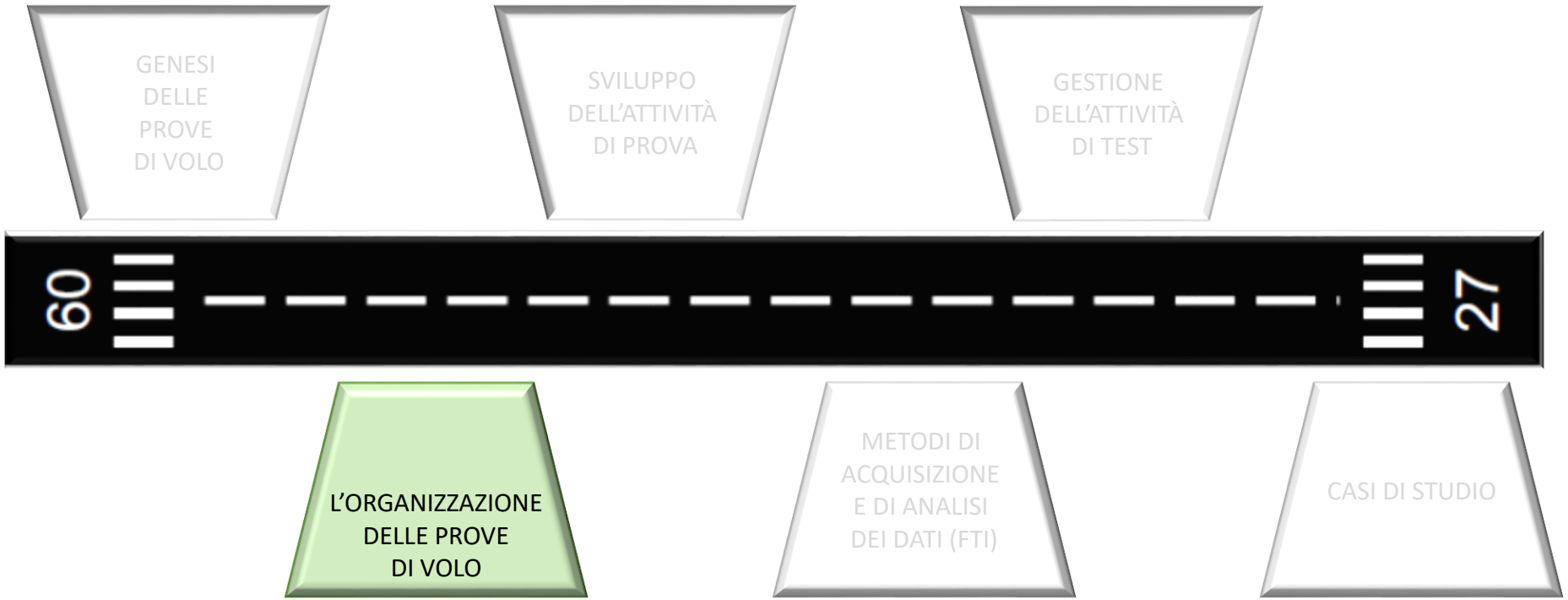
Investigazione di un nuovo prodotto



Necessità dell'attività di Flight Testing

- Impossibilità di replica a terra delle condizioni di volo (es. accelerazioni per gli impianti e le strutture)
- Impossibilità di simulare a terra particolari condizioni di volo (es. difficoltà di modellazione del flusso intorno all'aeroplano)
- Verifiche del comportamento in volo dell'aeromobile e su ciò che era stato predetto da calcoli e/o ground test
- Certificazione Velivolo – Part 21 A.35; Cerification Specification (CS , Aer P, Mil,…); ICAO Annex 16,…..

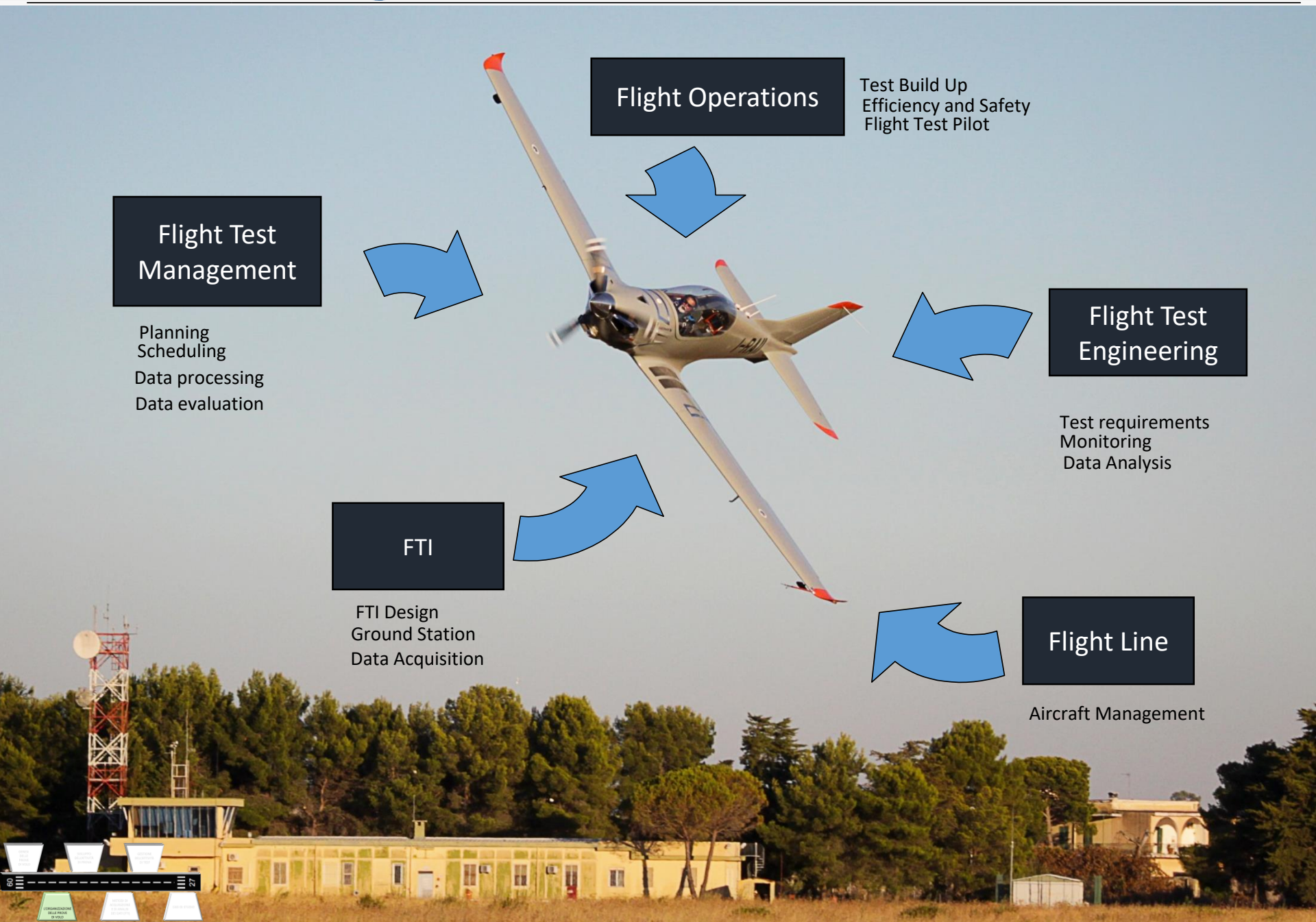
L'Organizzazione delle Prove Di Volo



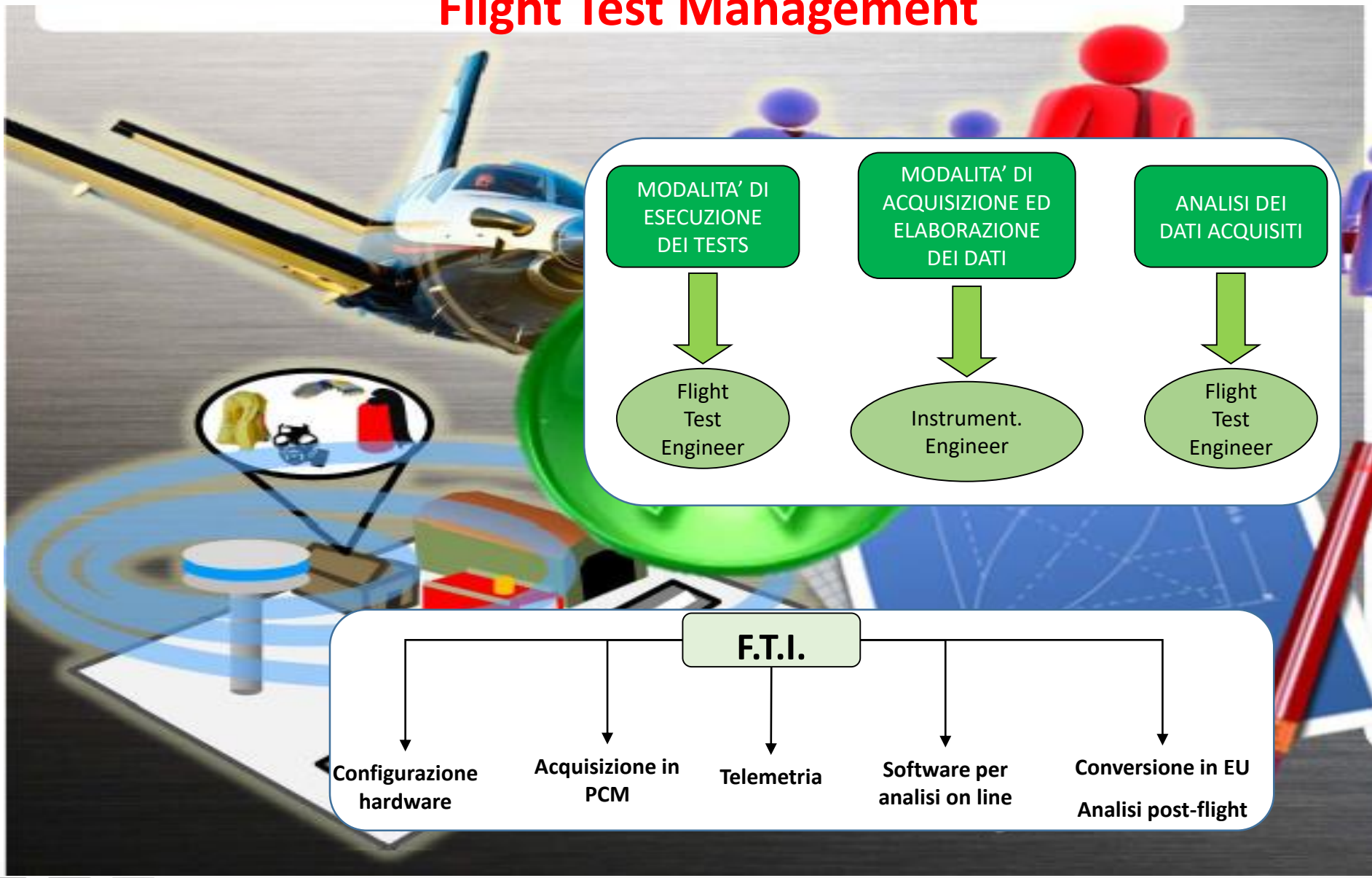
L'Organizzazione delle Prove Di Volo

Who are the people required in a flight test organisation?

- Test pilots
- Flight Test Engineers
- Designers
- Mechanics
- Certifying staff
- Safety officer


Flight Operations
Test Build Up
Efficiency and Safety
Flight Test Pilot
Flight Test Management
Planning
Scheduling
Data processing
Data evaluation
Flight Test Engineering
Test requirements
Monitoring
Data Analysis
FTI
FTI Design
Ground Station
Data Acquisition
Flight Line
Aircraft Management

Flight Test Management



Flight Test Engineering

"Parte dell'ingegneria associata alle prove in volo di un aeromobile o dell'equipaggiamento dello stesso."

The Flight Test Engineering unit performs the following activities:

- Taking into account the information provided by the design expertise unit in terms of instrumentation and test points needed for test, to define the test plan;
- To process the documents prior to accomplish the flight tests, indicating the technical execution of each test in accordance with applicable requirements;
- To process and analyze data gathered during the flight tests through the FTI
- To prepare the Technical Notes and Flight Test Report
- To process the Flight Cards

Flight Test Engineer (FTE)

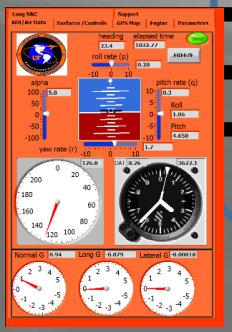
"Persona responsabile del coordinamento e della gestione di tutte le diverse attività coinvolte in un'attività di test."

- Specialisti tecnici
- Ingegneri della strumentazione
- Team di piloti collaudatori
- Specialisti dell'elaborazione e dell'analisi dei dati
- Ingegneri della manutenzione

Flight Test Instrumentation

The Flight Test Instrumentation unit performs the following activities:

- FTI system design
- Verify the correct installation and operation of the FTI equipment
- Ensure the efficiency of the installed equipment and compatibility with the type of flight to be performed



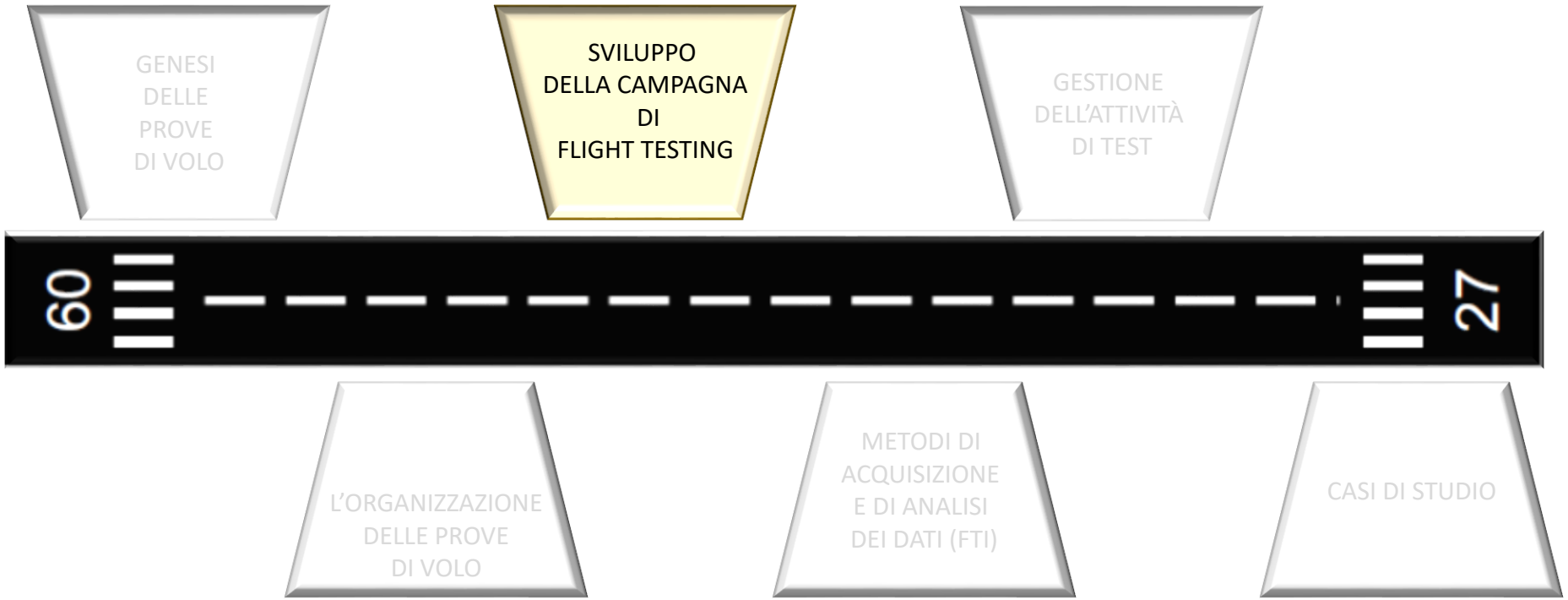
Flight Line

As part of the Flight Test Team, the Flight Line managing the following activities:

- ✓ Transferring the A/C to the airfield (and vice-versa)
- ✓ Handling the aircraft
- ✓ Preparation of the aircraft for the on-going test flight in terms of weight, balance, FTI installation …

- ✓ Closing discrepancies
- ✓ Performing general maintenance activities, such as refueling, rigging and any specified maintenance tasks on the prototype
- ✓ Securing the aircraft after the signature of the test readiness sheet

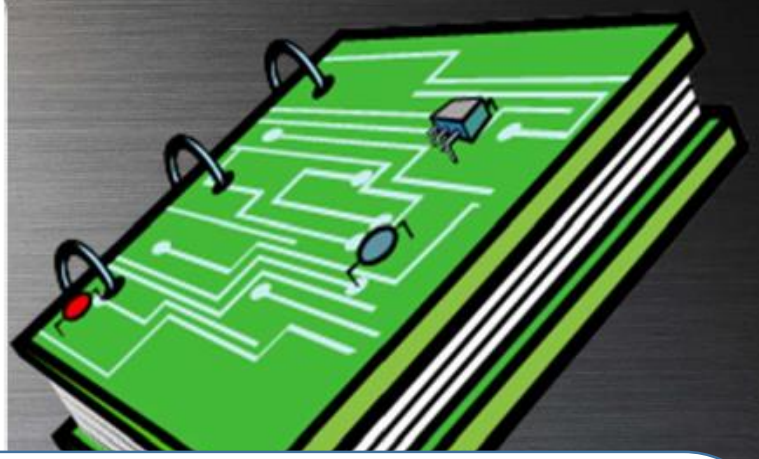
Sviluppo della campagna di Flight Testing



Manuale della Organizzazione delle Prove di Volo

Organisations performing flight tests in order to demonstrate regulatory compliance are required to document all activity in a **Flight Test Organisation Manual (FTOM)**

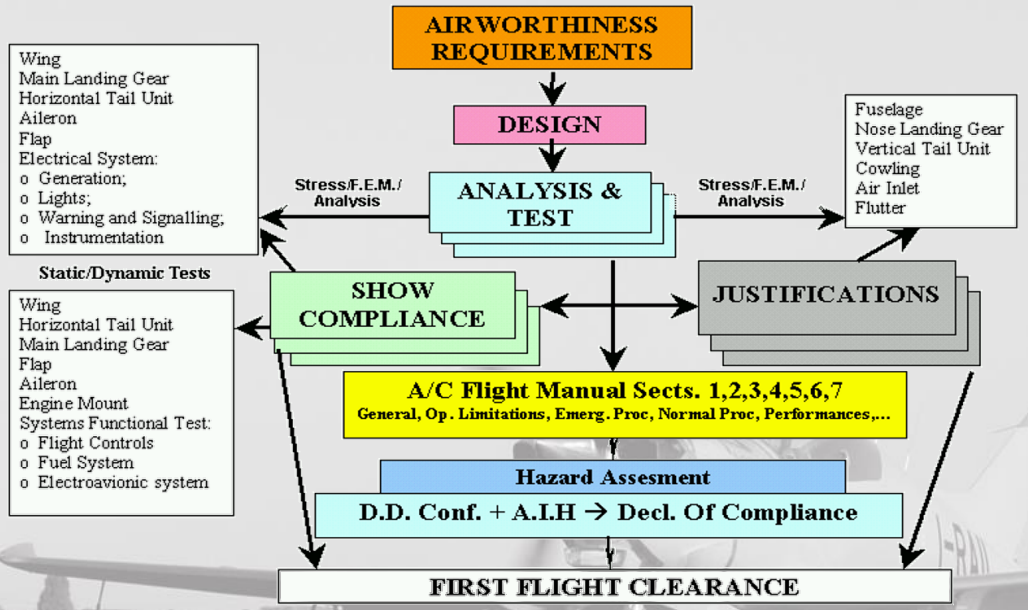
The FTOM should provide **general information** about principles adopted by the organisation and the management of the flight test activity.



- Organizational structure and position within the DO
- Competences requirement and nomination process versus Categories of flights
- Facilities requirements
- Management and calibration of test equipment
- Configuration management of the test aircraft
- Maintenance of test aircraft (arrangements with CAMO and Part 145)
- Arrangements with suppliers (e.g. pilots, flight test engineers, and suppliers of flight test instrumentation) Flight Test Procedure

Certification Scheme of work before 1st Flight

Substantiation that aircraft can safely perform a flight



Safety analysis
- Functional hazard assessment
- Fault tree analysis
- Zonal safety analysis
- Failure mode and effect analysis
- System safety assessment

Operational Limitations
- Operating procedures
- Weight and balance
- Flight envelop
- Weather conditions
- Facilities, runway
- Passengers
- Other operational aspects...

Calculations
- Structural analysis
- Weight and balance
- …

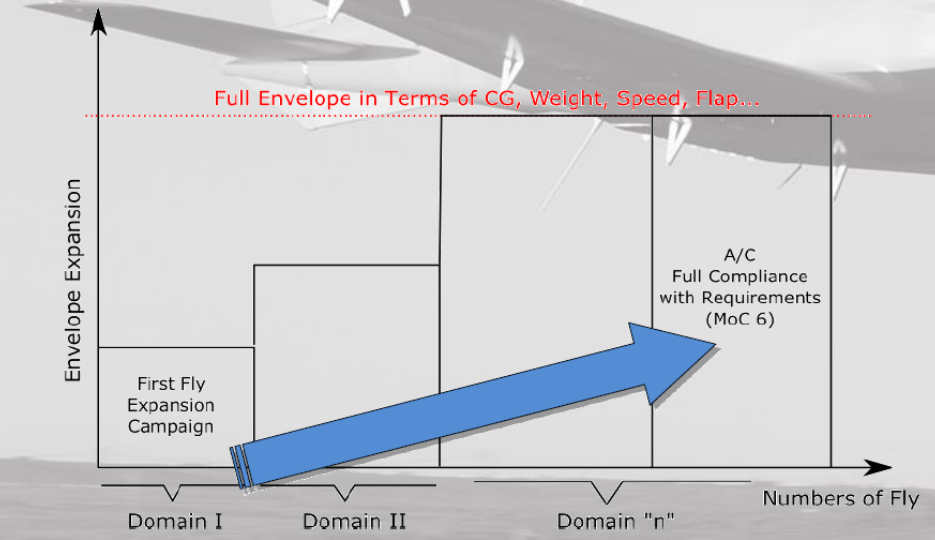
Ground tests Examples:
- Static test
- Flutter analysis
- System functional test
- Simulation
- FTI test
- Emergency system

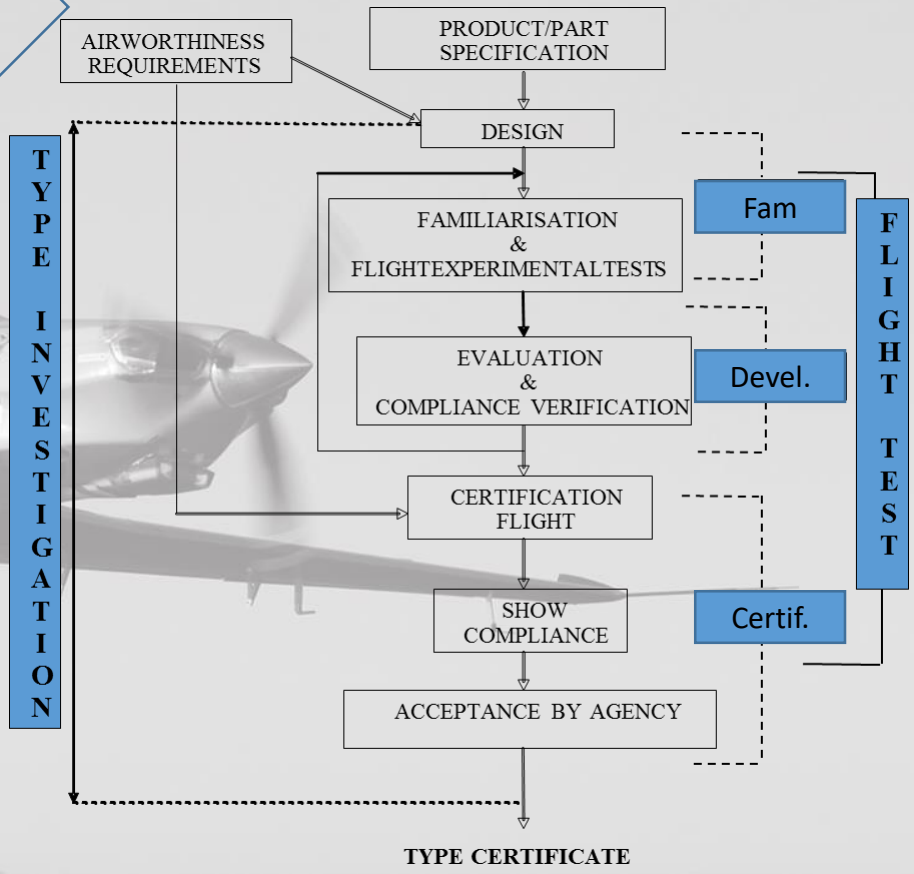
Maintenance instructions
- Reference to existing applicable maintenance programme
- Supplemental maintenance data (IPC, AMM, MPD…)
- Test installation maintenance data

Development of Flight Test Campaign & Envelope Expansion

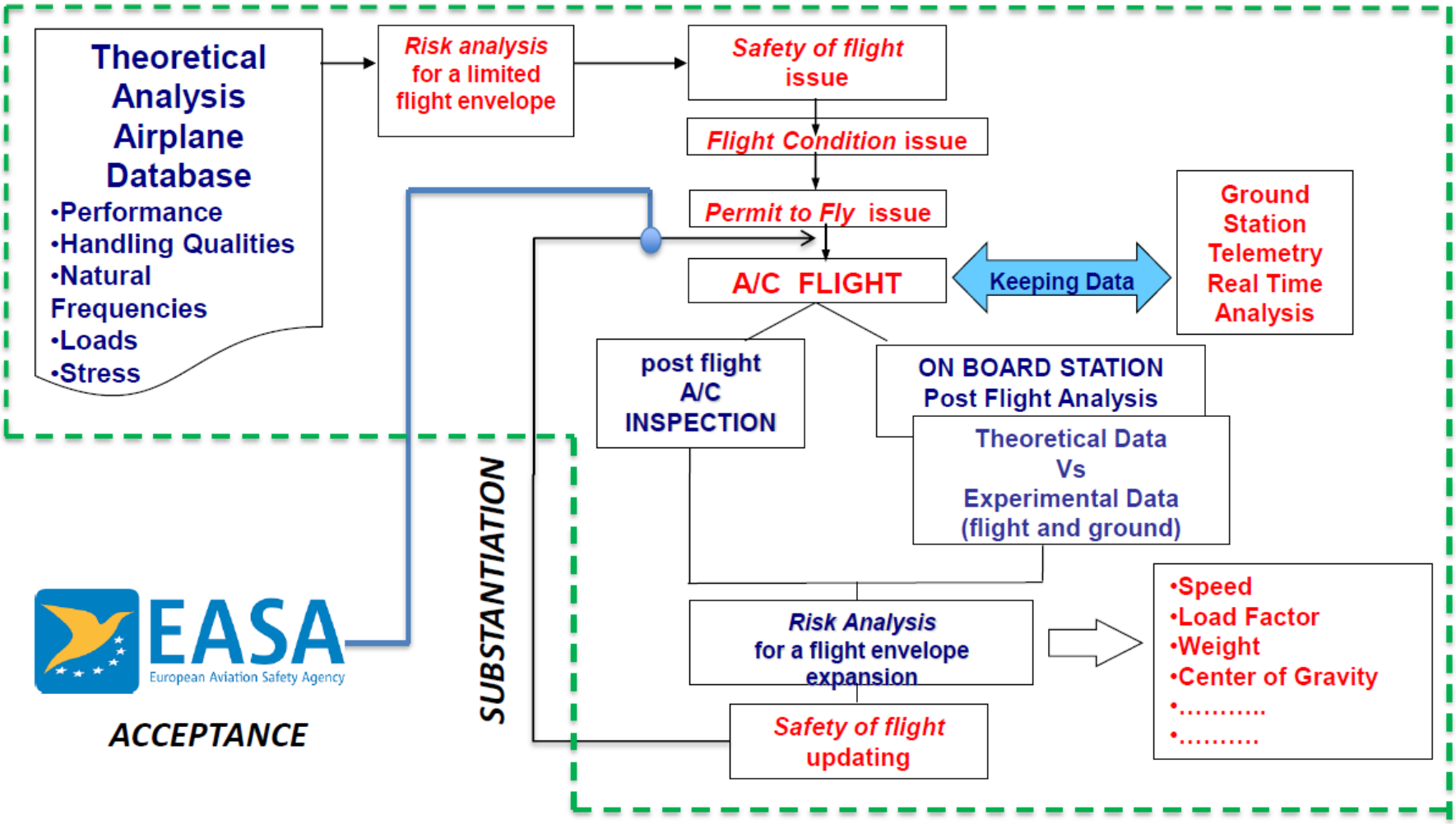
Flight conditions issue 1	Flight conditions issue 2	Flight conditions issue 3	Flight conditions issue 4
Phase 1: Initial flights	**Phase 2 :** Flight envelop opening	**Phase 3:** Flight qualities	**Phase 4:** Performances

Permit to fly making reference to Approved Flight Conditions at latest issue

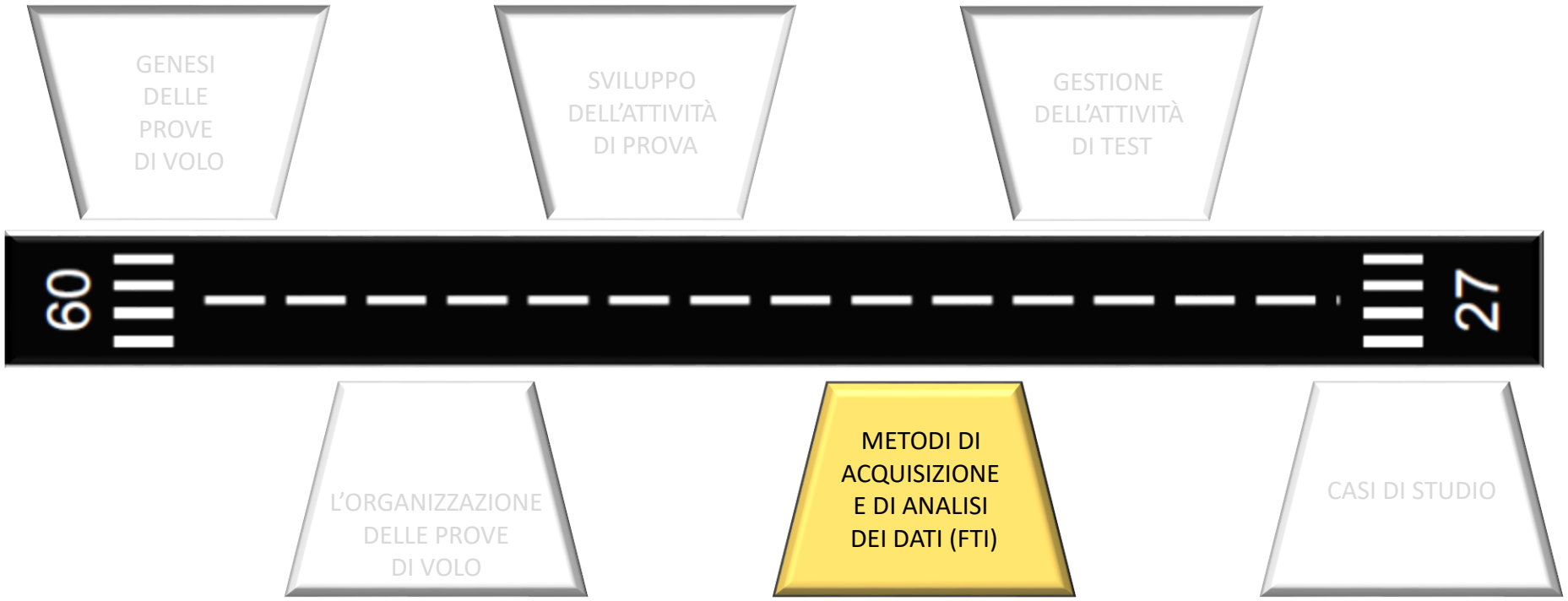




Flight Condition Management



Metodi di Acquisizione e di Analisi dei Dati (FTI)



Fase di sviluppo di un sistema di acquisizione dati

DEFINIZIONE

- Obiettivi generali
- Tipo e numero di parametri da acquisire
- Caratteristiche dei parametri
- Presentazione dei dati
- Limiti di spazio e di peso
- Requisiti particolari

LISTA PARAMETRI

PROGETTO

- Scelta delle apparecchiature
- Schemi elettrici
- Schemi meccanici
- Specifiche tecniche
- Valutazione impatto sul velivolo

ELABORATI GRAFICI E DESCRITTIVI

INSTALLAZIONE E TEST

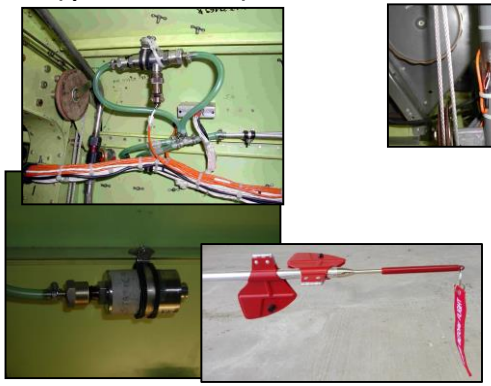
- Costruzione rack installativo
- Configurazione software
- Test di funzionamento
- Calibrazione trasduttori

Trasduttori

Conversione delle *grandezze fisiche* in *segnali elettrici*

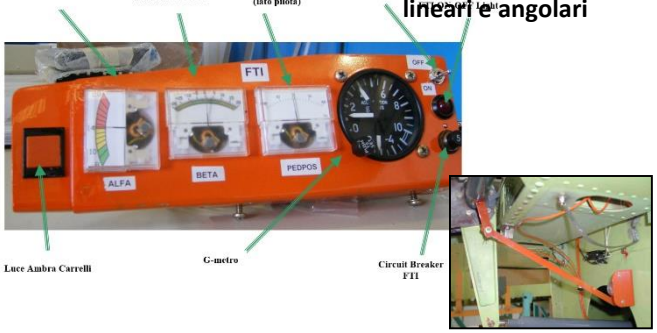
Tipologie

- **CAPSULE DI PRESSIONE** → Misura di pressioni e di grandezze barometriche (quota e velocità)



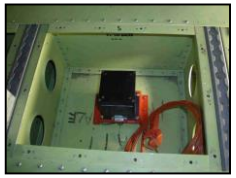
- **ESTENSIMETRI** → Misura di deformazioni e di carichi di forza

- **TERMOCOPPIE** → Misura di temperature

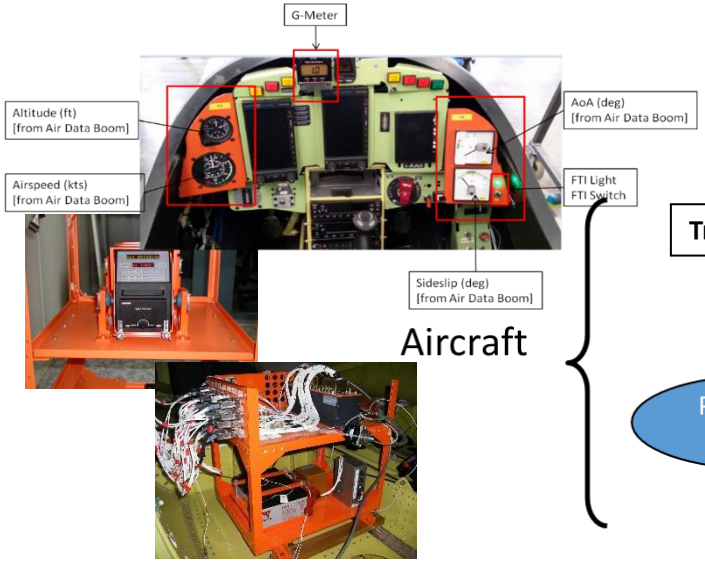


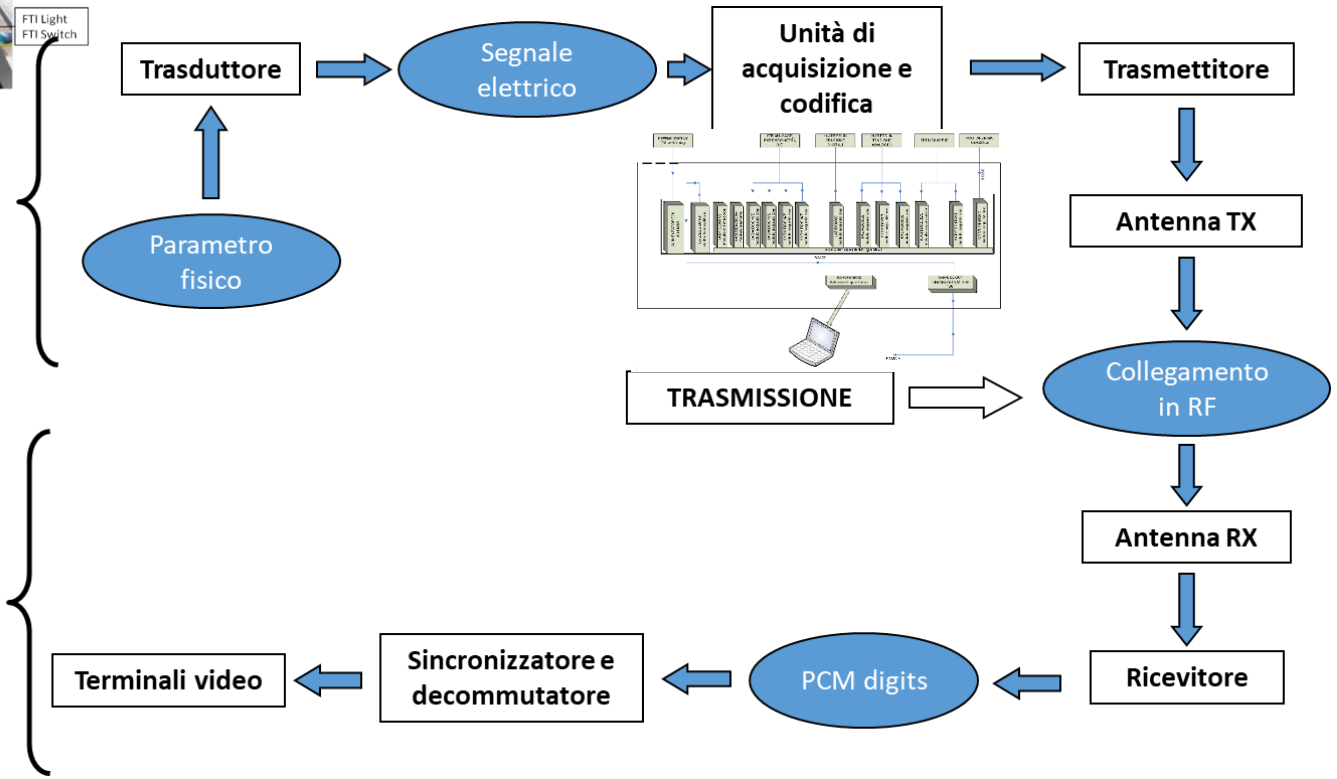
- **POTENZIOMETRI** → Misura di spostamenti lineari e angolari

- **PIATTAFORMA INERZIALE** → Misura di heading, degli angoli di pitch, roll e relative velocità angolari

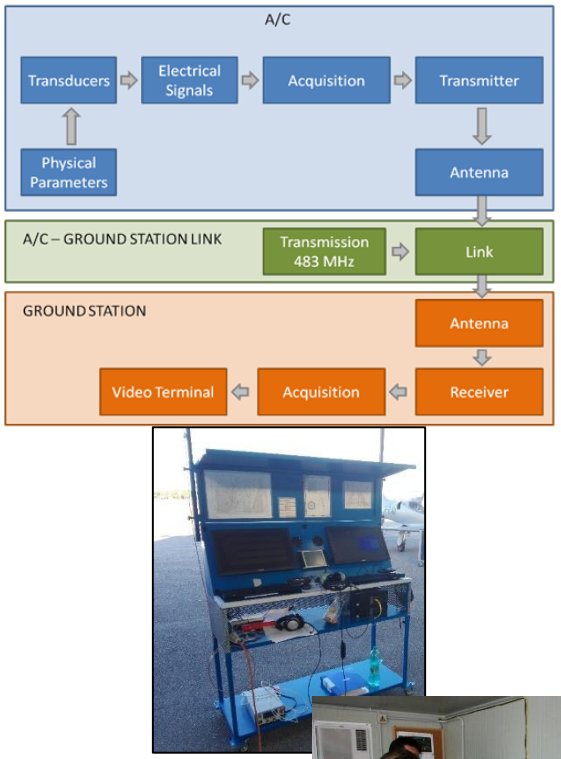


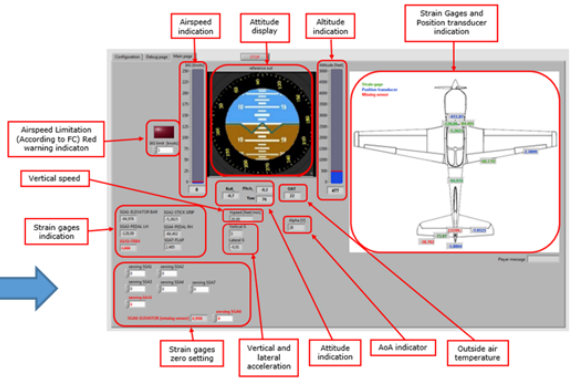
Catena di misura e trasmissione [1/2]

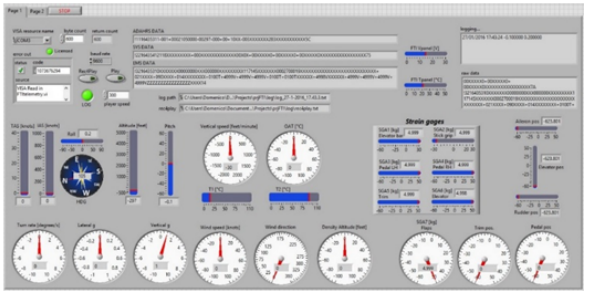


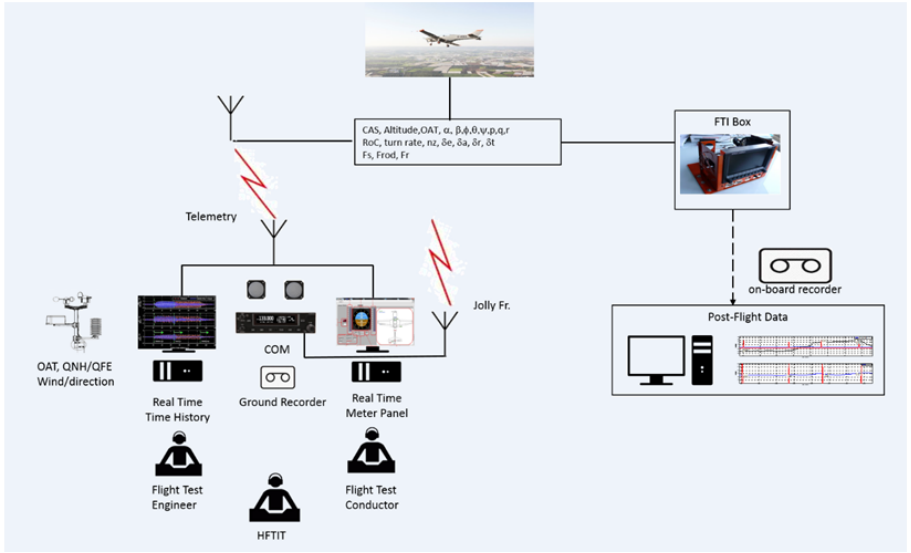


Catena di misura e trasmissione [2/2]







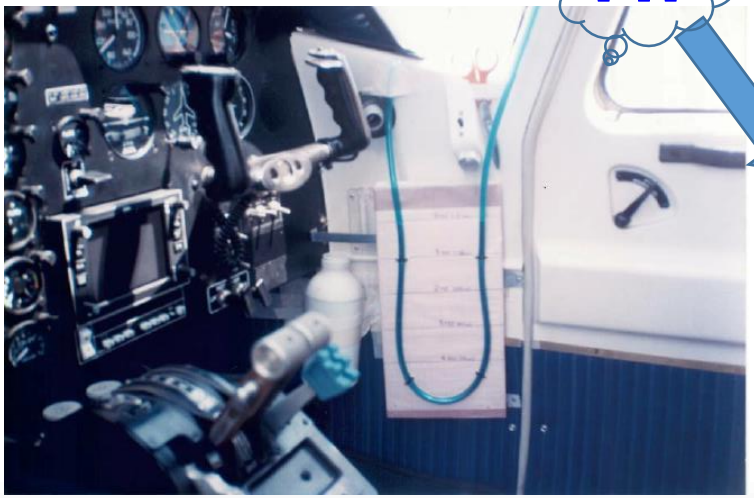


In the absence of *:.....Arrange yourself by giving you freedom to fantasy for the achievement of the objective*

Bangalore-India a/c AP68TP Viator
Wing Box collapsed : Descent @1600 FPM – Fuel Vent obstructed

REPAIR

FTI



Flight Test

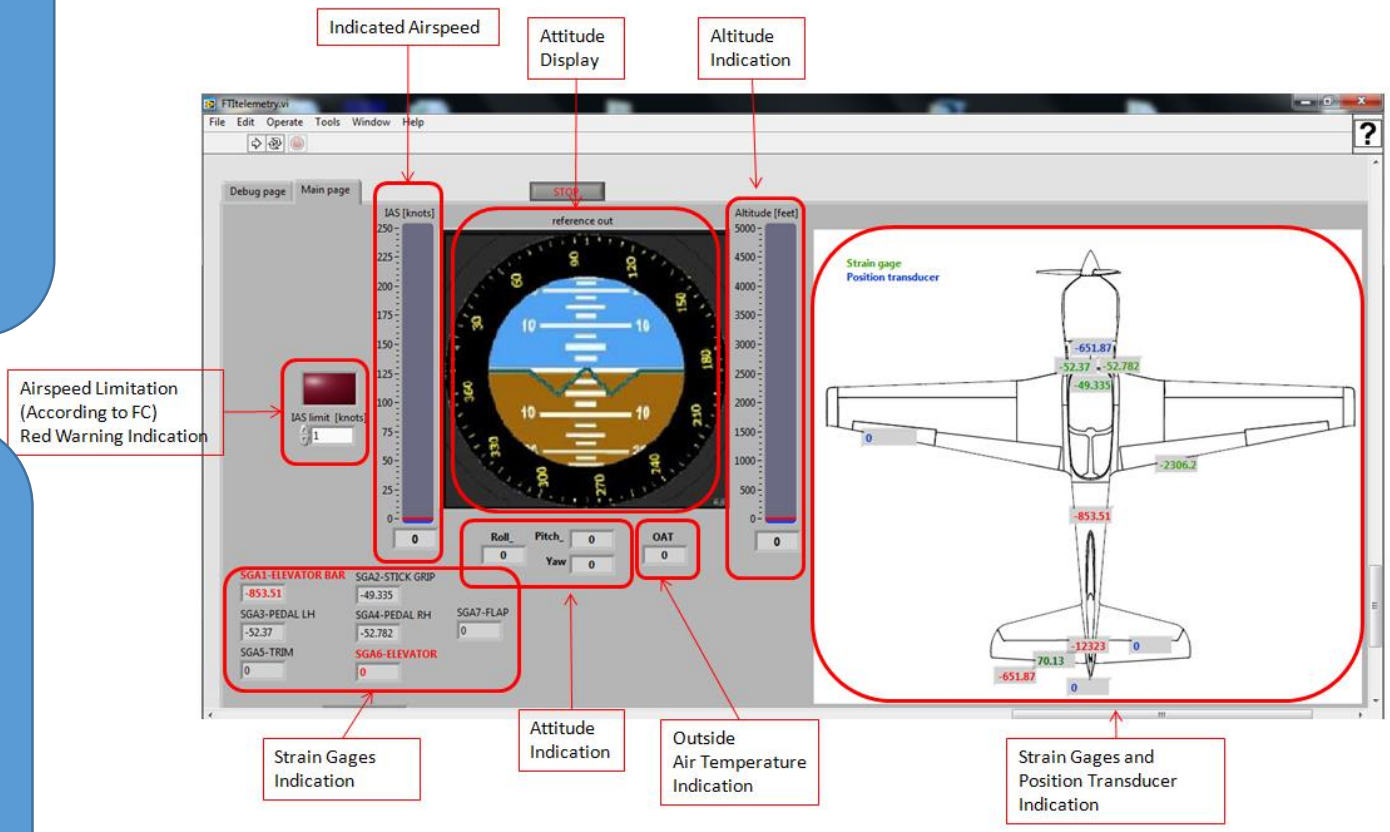
Software di elaborazione ed analisi quick look

FULL ANALYSIS

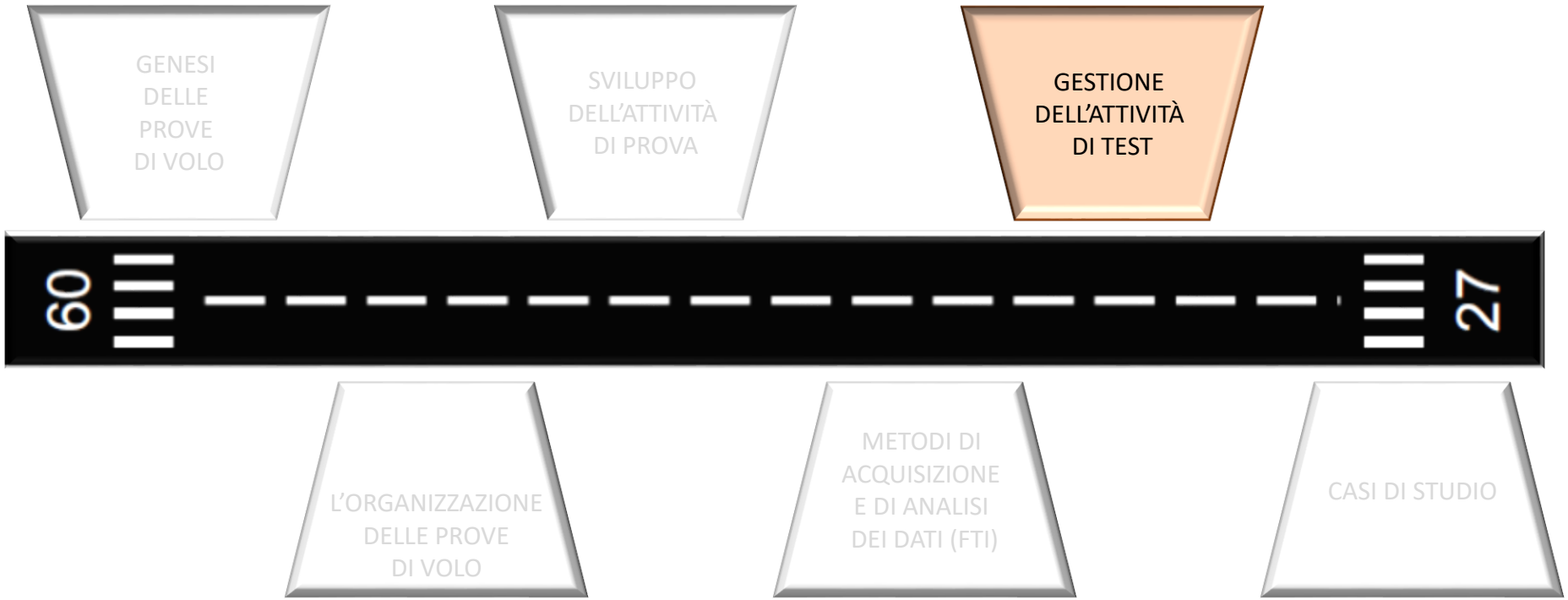
- Conversione dei dati off-line
- Generazione di file di testo contenenti le evoluzioni temporali dei singoli parametri

QUICK LOOK

- Visualizzazione in tempo reale dei parametri acquisiti
- Monitoraggio dei parametri di sicurezza
- Intrapendere azioni tempestive in caso di situazioni di pericolo



Gestione dell'Attività di Test



Definizione del programma di prove in volo

Flight test Programme
Specific to the **project**, shows **sequence of flights**

Flight test order
One **per flight**, show **sequence of test points**

Flight test Card
One per **test point**

Specific to the **project**, covering development and certification flights, the flight test Programme should document:

- Sequence and planning of flights (with phases if needed)
- Reference to the applicable requirements (certification flights)
- Method of test flight
- Safety provisions (analysis, emergency devices, airspace…)
- Design Limitations
- Ground and flight crew
- Facilities information
- Test aircraft configuration versus target configuration
- Flight test instrumentation
- Maintenance of the test aircraft

The flight test order is an **order** given by **someone having the appropriate authority** to the test pilot and flight test engineer to perform a predefined **sequence of tasks**, called "test points".

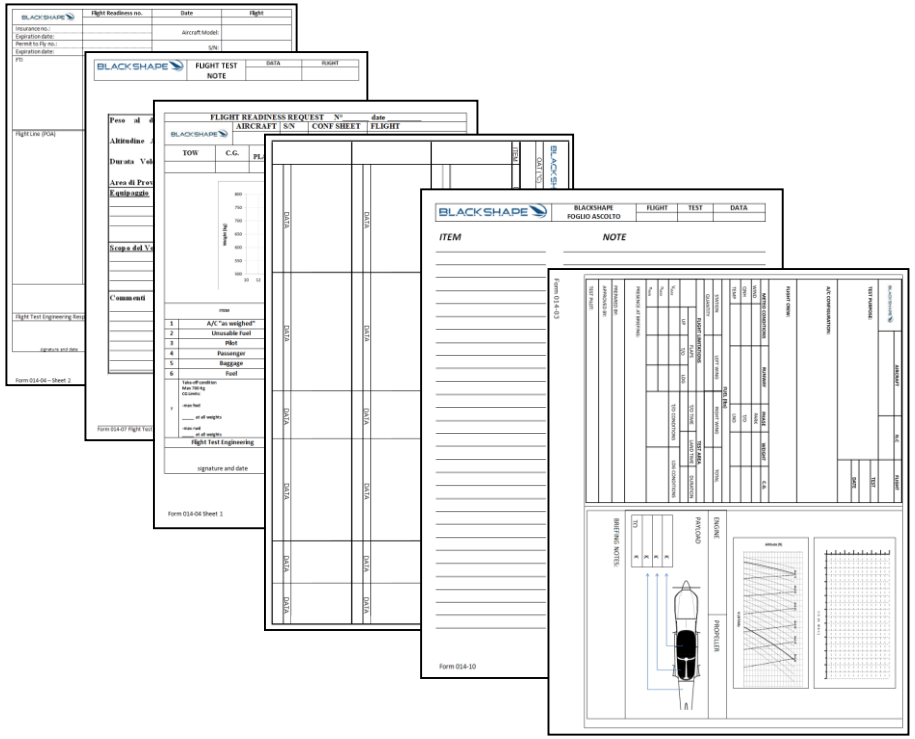
Who is able to issue the order should be defined in the Handbook

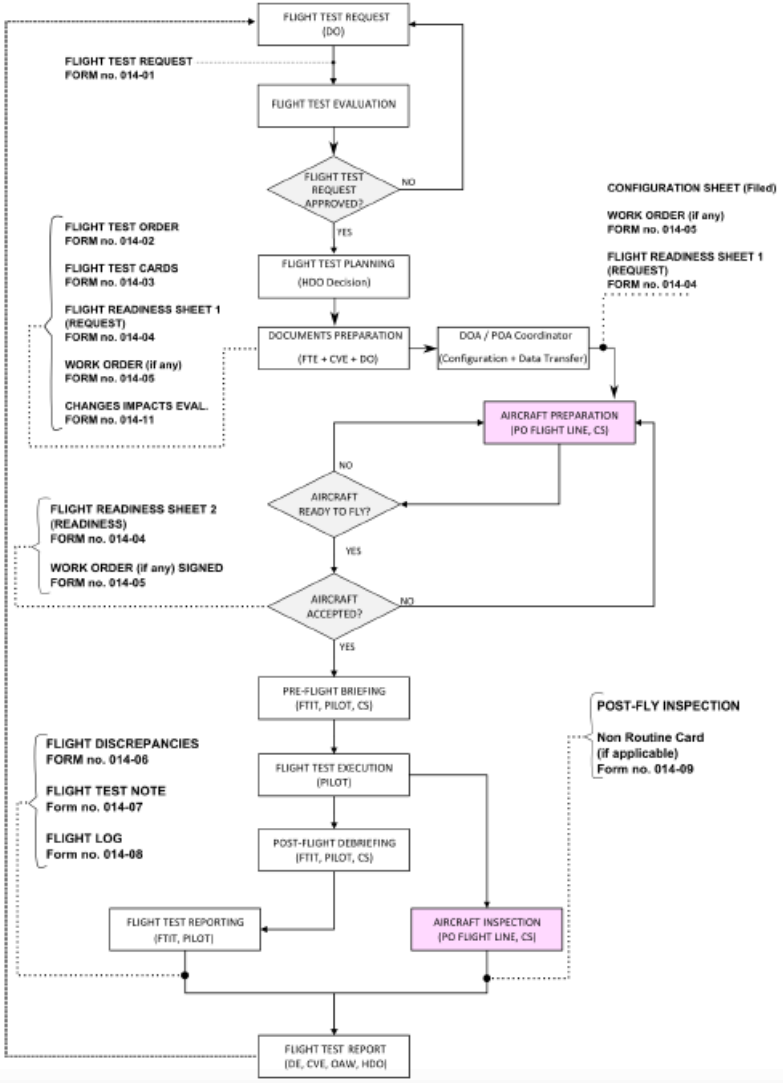
What is a flight test card?
Why can a flight test card not replace a flight test order?

- Flight Test cards can be used as input data, to prepare the Flight Test Order, and/or to record data, collected from the Flight Test Instrumentation or the notes recorded by the test pilot or the flight test engineer.
- Flight Test Cards, when used, are specific to a test point. They are standalone documents and cannot replace the Flight Test Order, which is defining the sequence of test points.
- A compilation of filled Flight Test Cards can be used to build a flight test report.

Svolgimento dell'attività di test

- Definizione del programma di prove in volo
- Esecuzione del programma di prove in volo
- Elaborazione dei risultati
- Attività di ispezione dell'aeromobile





Technical Logbook

The **technical logbook** is an essential deliverable for flight test operations. What should a **Techlog** be used for?

- Any change in aircraft configuration, like implementation of changes, installation or removal of flight test instrumentation, installation or change in ballast configuration…
- Maintenance tasks performed on the test aircraft
- Snags reported by the crew

Who should sign the Techlog?

- The maintenance or production certifying staff appointed by the DOA to attest the work performed on the aircraft.
- The FTE or/and test pilot for acceptance.

Safety And Risk Management

In the context of a test flight, operational risk management is a process leading to the establishment of operational limitations, mitigating the risk associated to each specific test point.
These operational limitations should be part of the flight conditions.
The flight test order should record the final risk level of each test point and the associated mitigation measures.

Severity classification		
Definition	**Meaning**	**Value**
Catastrophic	Destruction of equipment Fatalities	**A**
Hazardous	Very substantial degradation of aviation safety measurements; Physical danger or workload, when the operators might be unable to complete their tasks; Serious injuries occurring with multiple personnel; Major damage of equipment;	**B**
Major	Substantial degradation of aviation safety measurements; Degradation of operators' abilities to complete their tasks in an increasing workload environment Serious accident; Injuries;	**C**
Minor	Damage of equipment Operational limitations Applying emergency procedures Minor accidents	**D**
No safety effect	Minor consequences	**E**

Probability table		
Type	**Meaning**	**Value**
Frequent	Probably occurs frequently;	**5**
Probable	Probable sometimes occurs;	**4**
Occasional	Improbable, but may occur;	**3**
Remote	Very improbable to occur;	**2**
Improbable	Almost unimaginable to occur;	**1**

Avoid	Unacceptable;
High	Handling of risk demands decision;
Medium	Acceptable after review of operation;
Low	Acceptable;

Probability of occurrence		Severity of occurrence				
		Catastrophic A	**Hazardous B**	**Major C**	**Minor D**	**Negligible E**
5	**Frequent**	5A	5B	5C	5D	5E
4	**Probable**	4A	4B	4C	4D	4E
3	**Occasional**	3A	3B	3C	3D	3E
2	**Remote**	2A	2B	2C	2D	2E
1	**Improbable**	1A	1B	1C	1D	1E

Hazard #: **1**
Test Plan:
Flight Test Technique: **Fuel System Hot Weather Testing**
Hazard: **Uncommanded shutdown of test engine in flight**
Cause: **Vapor Formation, Detonation, Fuel Starvation**
Effect: **Engine Failure**

Risk Assessment

Severity / Probability	**Frequent**	**Probable**	**Occasional**	**Remote**	**Improbable**
Catastrophic	Avoid	High	High	Medium	Low
Hazardous	Avoid	High	Medium	Medium	Low
Major	High	High	Medium	**Medium**	Low
Minor	Medium	Medium	Medium	Low	Low
No Safety Effect	Low	Low	Low	Low	Low

Minimizing Procedure:
1. Pre-flight briefing to include in flight engine failure procedures, inflight engine restart procedure.
2. Flight crew experienced in flight test techniques

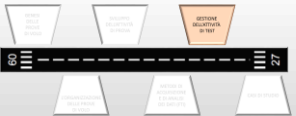
Emergency Procedures: Per the AFM:
Engine Failure, Restart, Engine Out Landing, Emergency Descent

Weather Requirement and/or Flight Conditions:
DAY VFR

Minimum Essential Aircrew: ☒YES ☐NO Parachutes Required: ☒YES ☐NO

Risk Level: LOW | **MEDIUM** | HIGH | AVOID

Example: Installation of an external pod on a CS23 aircraft with potential impact on stall characteristics;
Test point: assess low speed behavior;
Risk: Stall, Spin -> consequences: potentially catastrophic;
Mitigation: Step by step approach, altitude



Briefing & Debriefing

Briefing

- Review of the techlog (aircraft condition)
- Review of the flight test order (showing limitations)
- Weather condition
- Crew condition

Debriefing

- Snags recorded during the flights
- Configuration to be prepared before next flight

Briefing and debriefing are key activities during flight test operations. It is important to record evidence of these activities. What documents could be used for this purpose?

- Specific minutes
- Flight test order (if all participants identified)
- Techlog

Azioni durante il volo

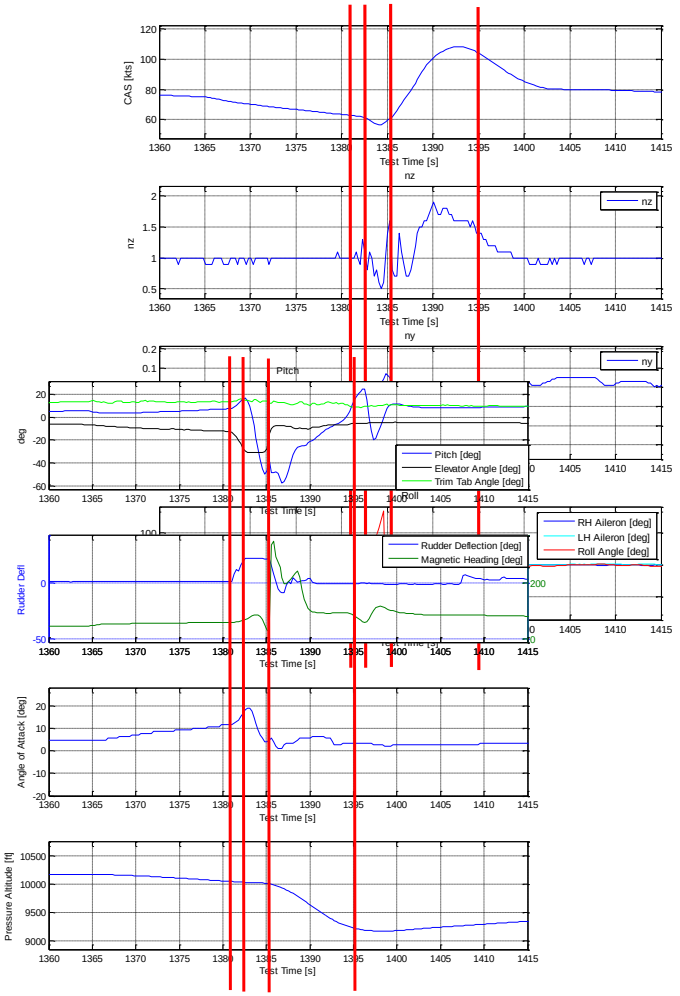
- *Risultati di prova*
  (annotazioni del conduttore della prova e commenti del pilota collaudatore)
- *Acquisizione real time dei parametri tramite la Ground Station*
- *Registrazione dei parametri tramite il dedicato sistema F.T.I.*

Azioni dopo il volo (debriefing)

- *Rapporto di volo*
- *Technical Log*
- *Discrepanze di volo*

Elaborazione dei risultati della prova

- Identificazione delle prove di volo eseguite, mediante l'ausilio della flight card, delle time histories e dei top pilota;
- Visualizzazione in forma grafica dei parametri ritenuti significativi per ciascun tipologia di prova;
- Analisi della time history per la valutazione della bontà del dato acquisito e della validità dell'esecuzione della prova, in conformità a quanto riportato sulla Flight Card;
- Elaborazione dei parametri per la sintesi dei risultati della prova.



Maintenance: Prototype Management

Configuration management process of the test article must be defined in the flight test programme or in dedicated procedures.

POST-FLIGHT INSPECTION

MAINTENANCE PROGRAMME

INSPECTIONS OF THE FLIGHT TESTED ITEMS

RECORD KEEPING

FLIGHT TEST

INSPECTIONS LIST PROCESSING

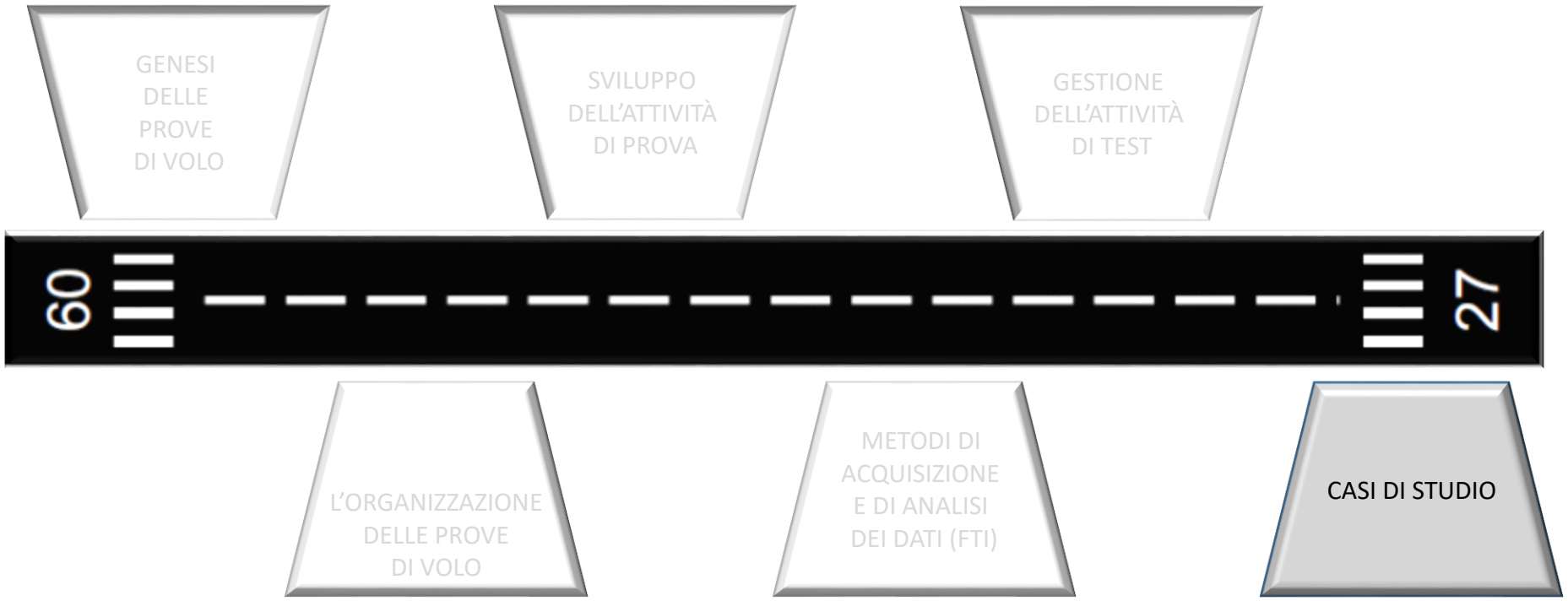
FTI DATA EVALUATION

STATIC TESTS

FEM ANALYSIS

PRE-FLIGHT INSPECTIONS

Casi di Studio



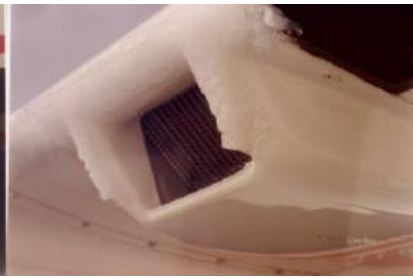
Caso Studio: Prove di Ghiaccio

CS 23.1419 Ice protection (See AMC 23.1419)

b) An analysis must be performed to establish, on the basis of the aeroplane's operational needs, the adequacy of the ice protection system for the various components of the aeroplane. In addition, tests of the ice protection system must be conducted to demonstrate that the aeroplane is capable of operating safely in continuous maximum and intermittent maximum icing conditions as described in AMC-1.

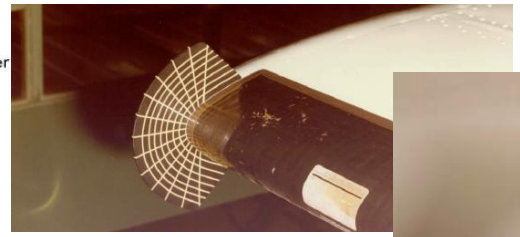
Icing Hazards

- Drag Increases
- Stall Speed Increases
- Weight Increases
- Thrust Decreases
- Controllability Degraded



LWC - Liquid Water Content, gm/m^3

$\beta = \frac{dy}{ds}$ - Catch Efficiency Parameter

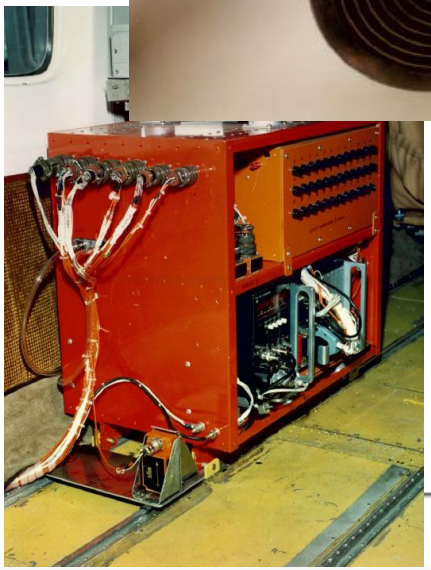


β is a function of:

- Droplet Size
- Air Density
- Airspeed
- Shape of Component
- Size of Component

Type of Ice is a Function of:

- Temperature, Droplet Size, Airspeed, LWC
- Clear (glaze)
- Rime

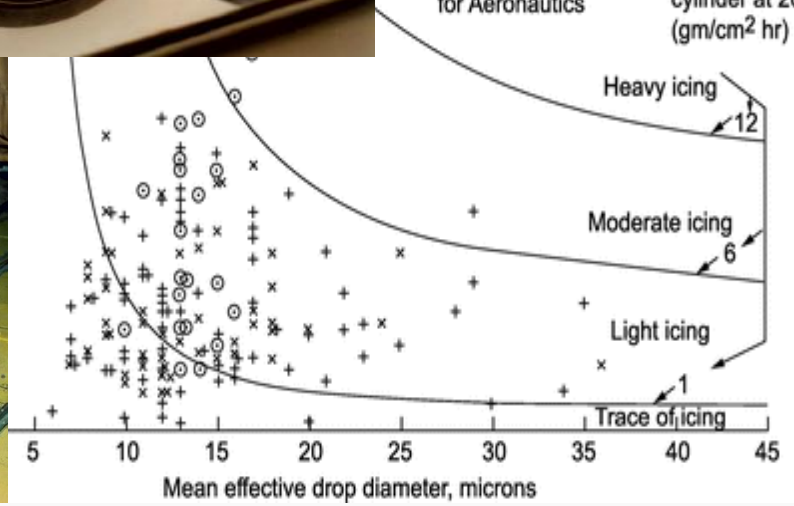


A.L. Winter 1946-47
Cumulus clouds observations
Layer clouds observations

R.L. Winter 1946-47
Layer clouds observations

National Advisory Committee for Aeronautics

Rate of accretion on a 3-in.-diam. cylinder at 200 mph (gm/cm^2 hr)



Caso Studio: Alta Incidenza - La Vite – Test Plan

CS-VLA 221 Spinning
CS 23.221 Spinning

NORMAL SPIN (x2 DIRECTION - RH/LH)										
Flight Condition			FLAPS			U/C		CG		PWR
Wing Level	Left Turn	Right Turn	UP	TO	LND	UP	DWN	FWD	AFT	ON	OFF
			x			x		x			x

ABNORMAL SPIN (x2 DIRECTION - RH/LH)										
Flight Condition			FLAPS			U/C		CG		TYPE
Wing Level	Left Turn	Right Turn	UP	TO	LND	UP	DWN	FWD	AFT	
x			x			x		x		
x										
x										
x										
x										

ABNORMAL SPIN (x2 DIRECTION - RH/LH)										
Spin N	Flight Condition		FLAPS			U/C		CG		TYPE
	Wing Level	Left Turn	Right Turn	UP	TO	LND	UP	DWN	FWD	AFT	
10	x										
11	x										
12	x										
13											
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57	x										
58	x										
59	x										
60	x										

MIL-F-83691 Definitions

Stalls	Maneuver Description and Departure Susceptibility Rating
Phase A	**Hold specified airspeed bleed rate until:** **a)** Definite g-break, or **b)** a rapid, un-commanded angular motion, or **c)** the aft stick stop has been reached and no other indication of stall has occurred, or **d)** sustained intolerable buffet. If a departure occurs during a Phase A stall, the aircraft is rated **"extremely susceptible"** to departure.
	Phase A stall with one/three second(s) aggravating rudder, respectively. If a *first* occurs during a Phase B stall, the aircraft is rated **ble"** to departure. If a departure *first* occurs during a Phase C stall, : is rated **"resistant"** to departure. If the aircraft does not depart Phase A-C stall, it is rated **"extremely resistant"** to departure.

BLACKSHAPE | N.C. | FLIGHT | TEST | PAG.

ITEM	DESCRIPTION	NOTE / LIMITS
	SPINNING – WING LEVEL – PWR OFF (CS-VLA 221) Hi: _____ (7000 ft) FLAP: UP U/C: UP V_{trim} = 80 kts (1.5 Vs) PWR: IDLE 1) ENTRY SPIN (RIGHT) – Vsi a) AILERON MAINTAIN NEUTRAL b) ELEVATOR FULL NOSE UP c) RUDDER FULL RIGHT **After 1 turn or 3 seconds** 2) RECOVERY SPIN a) RUDDER FULL LEFT b) CENTRALIZE STICK AND HOLD IT UNTIL SPIN STOPS	Vs=55 kts

BLACKSHAPE | N.C. | FLIGHT | TEST | PAG.

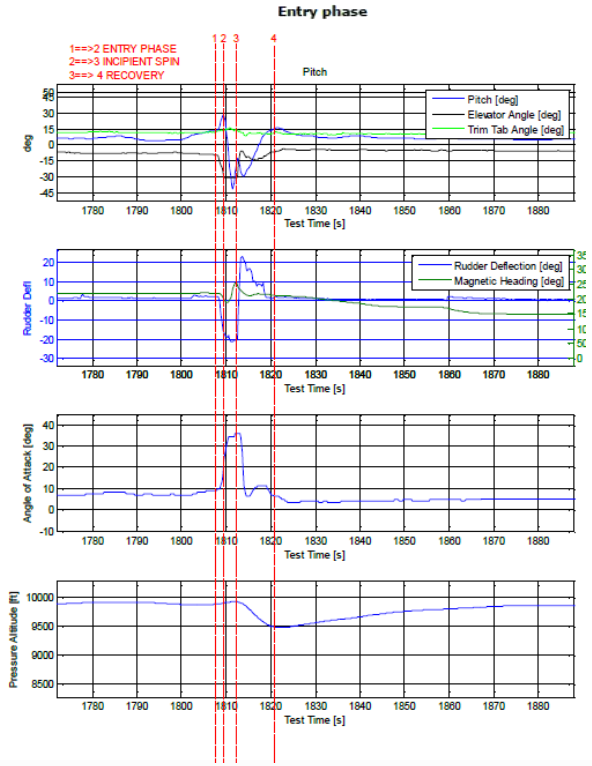
ITEM	DESCRIPTION	NOTE / LIMITS
	SPINNING – WING LEVEL – PWR OFF (CS-VLA 221) Hi: _____ (7000 ft) FLAP: UP U/C: UP V_{trim} = 80 kts (1.5 Vs) PWR: IDLE 1) ENTRY SPIN (LEFT) – VS1 a) AILERON MAINTAIN NEUTRAL b) ELEVATOR FULL NOSE UP c) RUDDER FULL LEFT **After 1 turn or 3 seconds** 2) RECOVERY SPIN a) RUDDER FULL RIGHT b) CENTRALIZE STICK AND HOLD IT UNTIL SPIN STOPS	Vs=55 kts

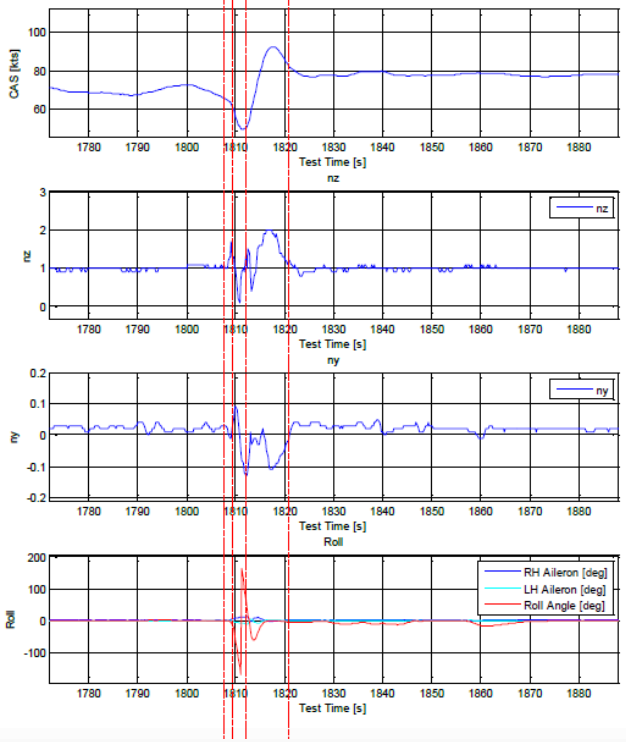
Caso Studio: Alta Incidenza - La Vite – Test Results

CS-VLA 221 Spinning

CS 23.221 Spinning

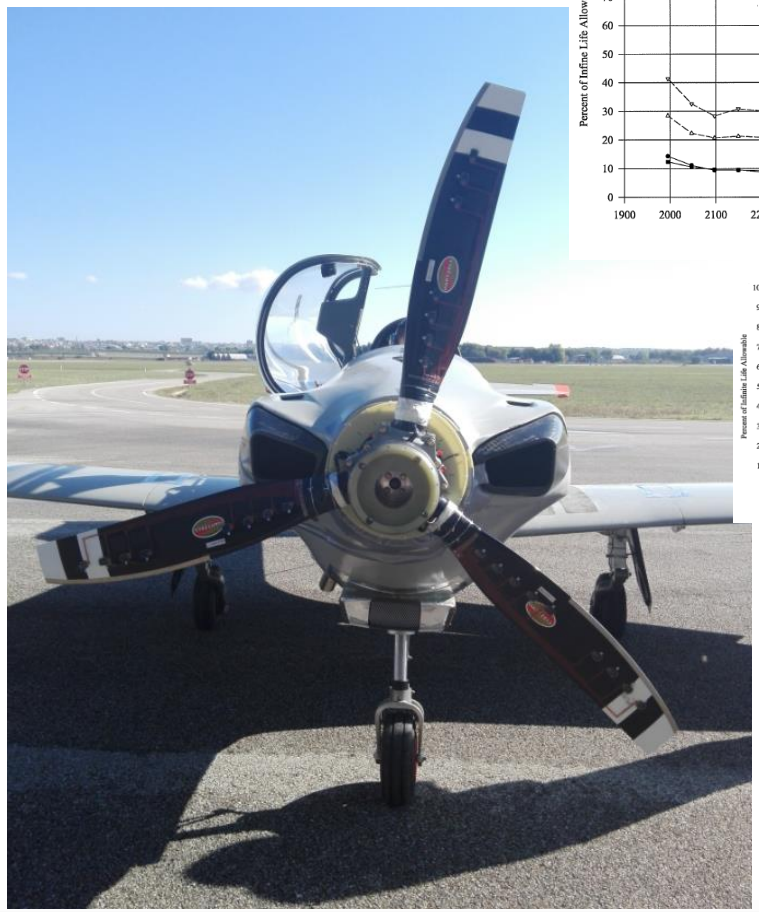
Flight #	Test point	TOW [kg]	C.G. [%MAC]	FLAP	U/C	PWR	SPIN DIRECTION	FLIGHT ATTITUDE
71	2	717.4	19.5%	UP	UP	IDLE	RH	WING LEVEL
	4			UP	UP	IDLE	LH	WING LEVEL
	5			UP	UP	IDLE	RH	20° RH BANK
	6			UP	UP	IDLE	LH	20° LH BANK
	7			UP	UP	50%MCP	RH	WING LEVEL
	8			UP	UP	50%MCP	LH	WING LEVEL
	9A			UP	UP	IDLE	RH	WING LEVEL
	9B			UP	UP	IDLE	LH	WING LEVEL
	10			TO	UP	IDLE	RH	WING LEVEL
	11			LND	DWN	IDLE	RH	WING LEVEL

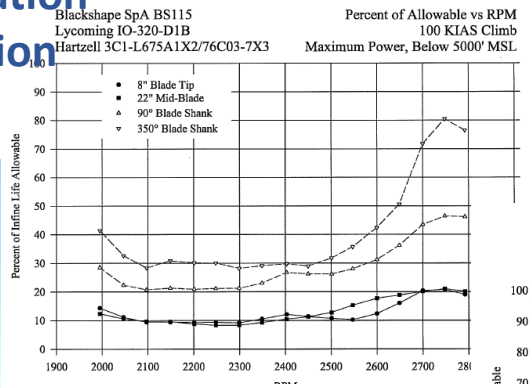


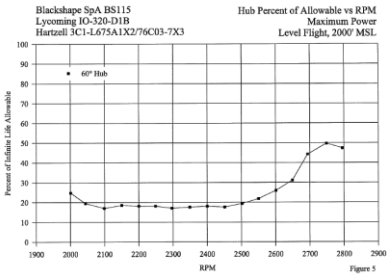


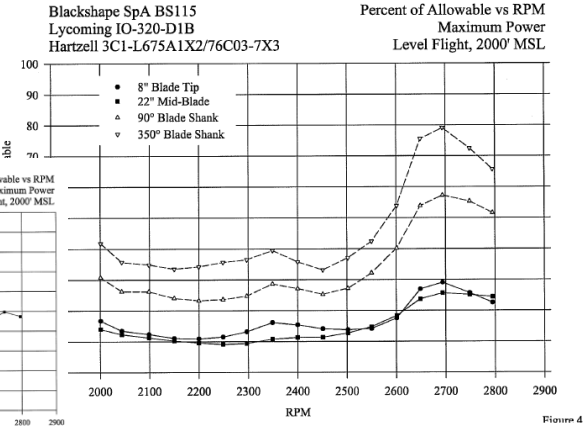
Caso Studio: Propeller Vibration Test

CS-VLA 907 Propeller vibration
CS 23.907 Propeller vibration
(See AMC 23.907 (a))



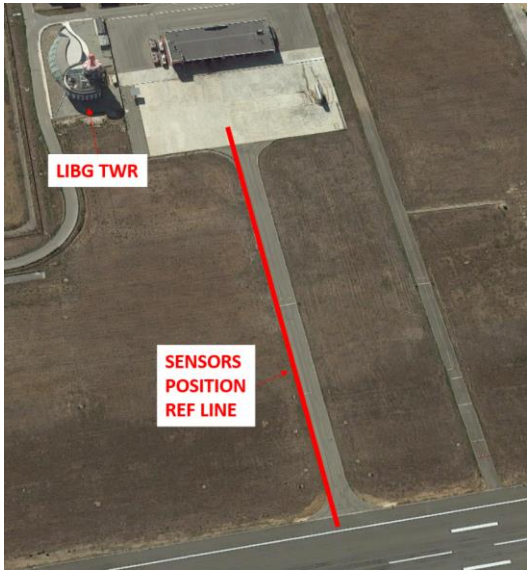


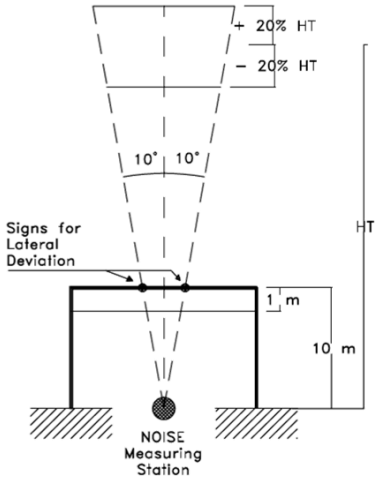


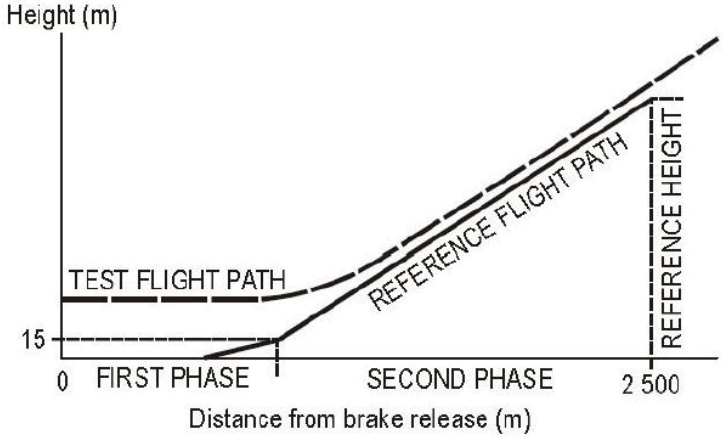


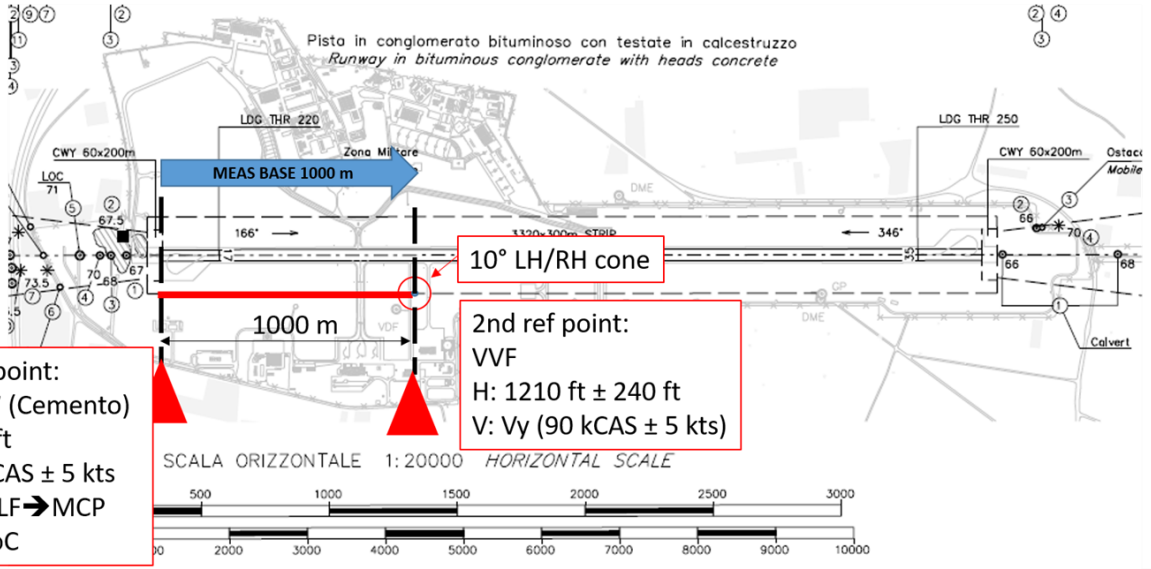
Caso Studio: Noise Flight Test Plan

CS-36
ICAO ANNEX 16



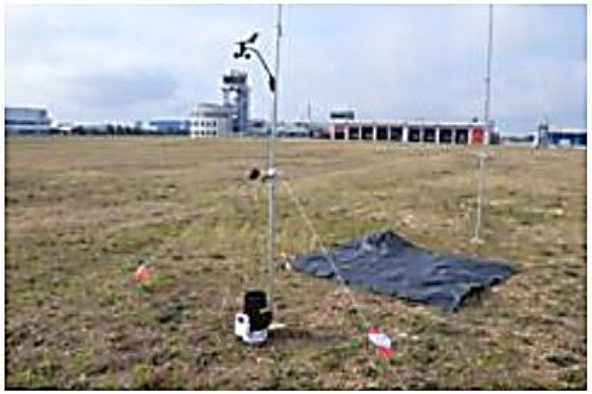


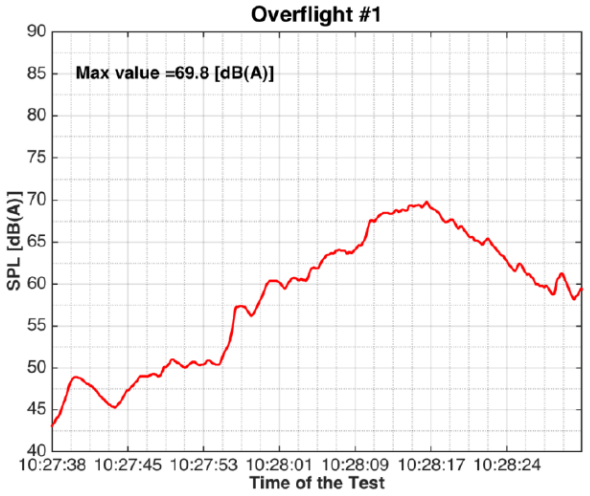


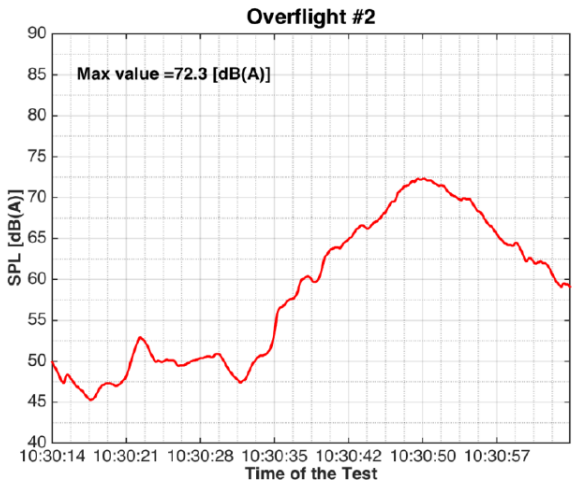


Caso Studio: Noise Flight Test Results

CS-36
ICAO ANNEX 16

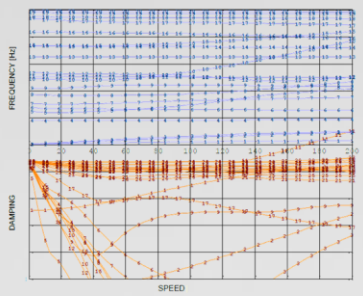


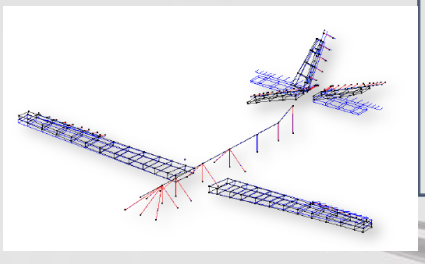


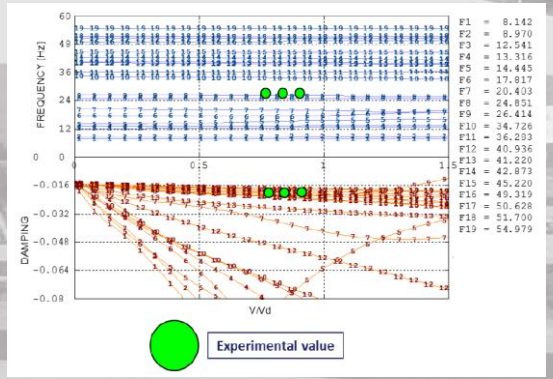


Caso Studio: Flutter

CS-VLA 629
CS 23.629







AIRCRAFT DYNAMIC MODEL

AIRCRAFT AERODYNAMIC MODEL

THEORETICAL MODES EVALUATION

MATCHING OF THEORETICAL MODES AND AERODYNAMIC LATTICE

PRELIMINARY FLUTTER ANALYSIS BASED ON THEORETICAL MODES

GROUND VIBRATION TESTS – EXPERIMENTAL MODES EVALUATION

DYNAMIC MODEL/THEORETICAL MODES CORRELATION WITH EXPERIMENTAL MODES

FLUTTER ANALYSIS BY MEANS OF EXPERIMENTAL AND/OR CORRELATED THEORETICAL MODES

FLIGHT FLUTTER TESTS

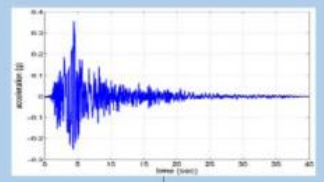
CS-VLA 629
CS 23.629

Flutter Flight Test Plan

IN FLIGHT ACTIVITIES

H: 10000 ft
V: 150 kCAS
160 kCAS
170 kCAS
Real Time Data Monitoring

FLIGHT #1



Step 1 In-flight excitation of flutter mode by means of impulsive rudder and aileron deflection due to pilot's actions on A/C pedals or stick

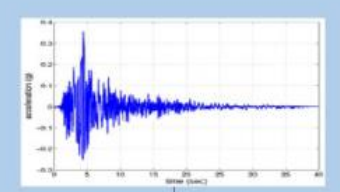
Step 2 Acquisition (@ 128 samples per second) of the time histories related to accelerations measured on the tail unit. Real Time monitoring of A/C response

Go to next speed

END OF FIRST FLUTTER FLIGHT

H: 10000 ft
V: 180 kCAS
191 kCAS (V_D)
Real Time Data Monitoring

FLIGHT #2



Step 1 In-flight excitation of flutter mode by means of impulsive rudder and aileron deflection due to pilot's actions on A/C pedals or stick

Step 2 Acquisition (@ 128 samples per second) of the time histories related to accelerations measured on the tail unit. Real Time monitoring of A/C response

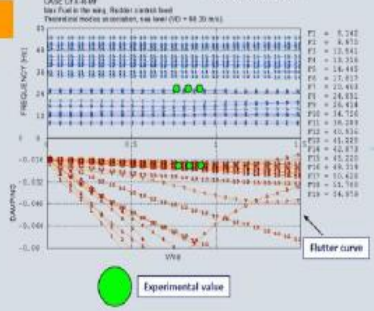
Go to next speed

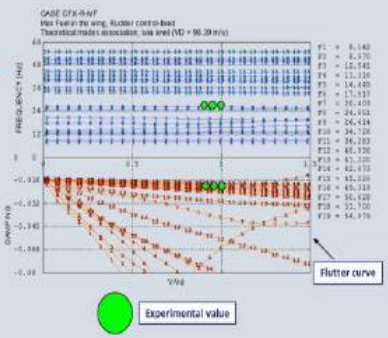
END OF SECOND FLUTTER FLIGHT

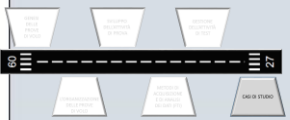
Step 3 Elaboration of accelerometric signals and identification of flutter mode's frequency and damping value

Experimental/ theoretical trends comparison

On Ground
Data Analysis



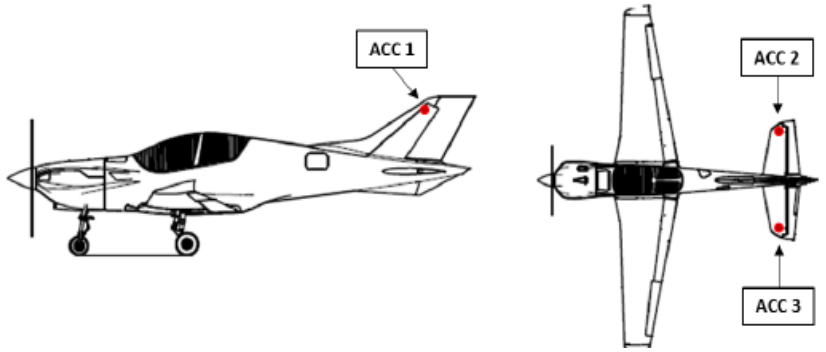


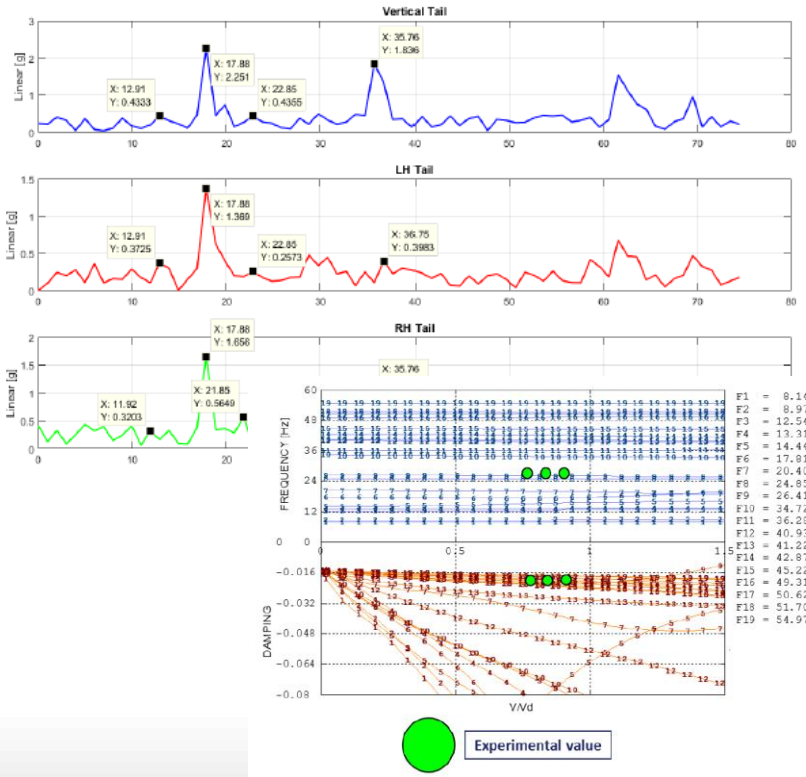


ON GROUND ACTIVITIES

Flutter Flight Test Results

CS-VLA 629
CS 23.629





"Flight Test Engineer" (per riderci su)

A Flight Test Engineer is a person who passes as an expert on the basis of being able to turn out, with prolific fortitude, indefinite strings of incomprehensible mathematical figures, calculated with mirromatic precision from vague assumptions which are based on debatable figures taken from inconclusive data, carried out through forms of problematical accuracy by persons of doubtful reliability and questionable mentality, for the avowed purpose of annoying and confounding a hopelessly befuddled group of key personnel who never read the damned reports anyway.

IL FLIGHT TEST ENGINEER E' UNA PERSONA CHE PASSA PER UN ESPERTO
GRAZIE ALLA SUA ABILITA' A MANIPOLARE, CON PROLIFICO CORAGGIO,
SEQUENZE INFINITE DI INCOMPRENSIBILI FIGURE MATEMATICHE,
CALCOLATE CON PRECISIONE CERTOSINA A PARTIRE DA VAGHE ASSUNZIONI
BASATE SU FIGURE OBIETTABILI RICAVATE DA DATI INUTILI,
CALCOLATI CON ACCURATEZZA APPROSSIMATIVA
DA PERSONE DI DUBBIA AFFIDABILITA' E CAPACITA' MENTALE,
CON L'UNICO SCOPO DI ANNOIARE E CONFONDERE
LE PERSONE CHE ASCOLTANO SENZA ALCUNA SPERANZA E CHE NON LEGGERANNO MAI QUEL
DANNATO DOCUMENTO.

1982

1983
AP68TP-100

1984
AP68TP-300
SPARTACUS

1985
AP68TP-RG

1986
AP68TP-600 VIATOR

1986
P86 Mosquito

1987
P68 OBSERVER 2

P68 &Spartacus
SPRAYER

1988
C27

1988
C27 ICING Test

1989
ATLANTIC

1993/95
TANEJA Aer

2001
ZOCHE Diesel engine

2003
VF600W Mission

2006
SKYCAR

2011
REDDBIRD

2016
BS100-ISP

2017
BS115

E' facile inventare una macchina volante: più difficile è costruirla; ma farla volare è tutto.

(Otto Lilienthal)

Grazie per l'attenzione!

and.....HAPPY LANDING