Additional Emergency Exit for Flight Tests

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EMBRAER Flight Test
FTSW, Seattle, 05.02.2012

Summary

- Introduction;
- Requirements for acft. exits;
- Emergency Exit: 80s and 90s;
- Aditional Emergency Exit: 21th century;
- New products
- Lessons Learned
- Q&A

Aditional Emergency Exit for Flight Tests

This presentation covers historical events, the last 20 years learning results on additional emergency exits for EMBRAER flight test prototypes, submitted to a civil certification process (ANAC, FAA, EASA), and the latest features added to the Legacy 500 (001 and 002 prototypes), with its test results.

FAR for Exits

- 25.561

(a) acft. must be designed to protect each occupant.
(b) designed to give chance of escaping in a minor crash landing;
(d) Seats and items of mass must not deform, that would impede evacuation of occupants.

- 25.562

Restraint sys: proper use, performance, Head Impact Criteria...

FAR for Exits

- 25.807

Type of exits (I, II, III, IV, A, B, C...) size, ground clearance....

- 29.783

Doors: latches, locks, access, strenght....

- 29.809

Emergency Exits: works, functions and slides

But...

Identified High Risk Situations

- Ground Egress:
  - Vmcg, Vmu, Brake Efficiency, Max.Kinectic Energy, Quick Tourn Around, Landing Perf., Steep Approach, Take Off Perf., Water ingestion;
- Stabilized Flight Bail-out:
  - Deep Stall, Flat spin;
- Uncontroled Flight Bail-out:
  - Structural failure.

FAR for Exits

- FAR 21.35 (d) provision is made for the flight test crew for emergency egress and the use of parachutes.

- Passenger doors, emergency doors or windows commonly supplied for passenger usage are not meant to be used in motion, nor on situations encountered on envelope opening of the compliance demonstration process.

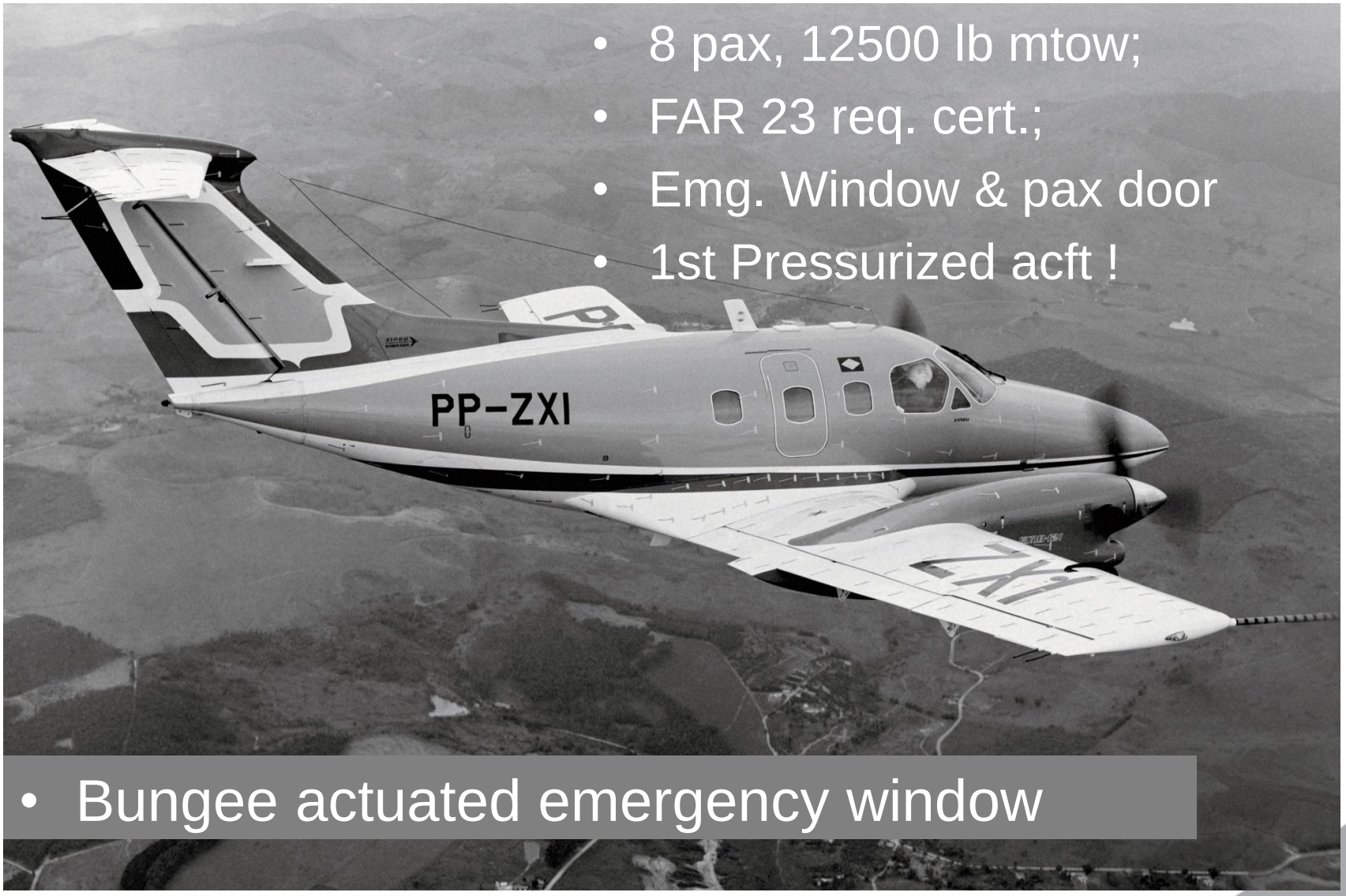
- Regarding the above listed requirements our team asked for additional safety features to be installed on the flight test articles

"The additional exit for flight test"

EMBRAER history: EMB-110 – Bandeirante

- Early 70s
- FAR 23 req. cert.;
- 18 pax, 13000 lb mtow;
- Emg. Window & pax door
- No additional exit features !

EMBRAER history: EMB-121 – Xingu



- 8 pax, 12500 lb mtow;
- FAR 23 req. cert.;
- Emg. Window & pax door
- 1st Pressurized acft !

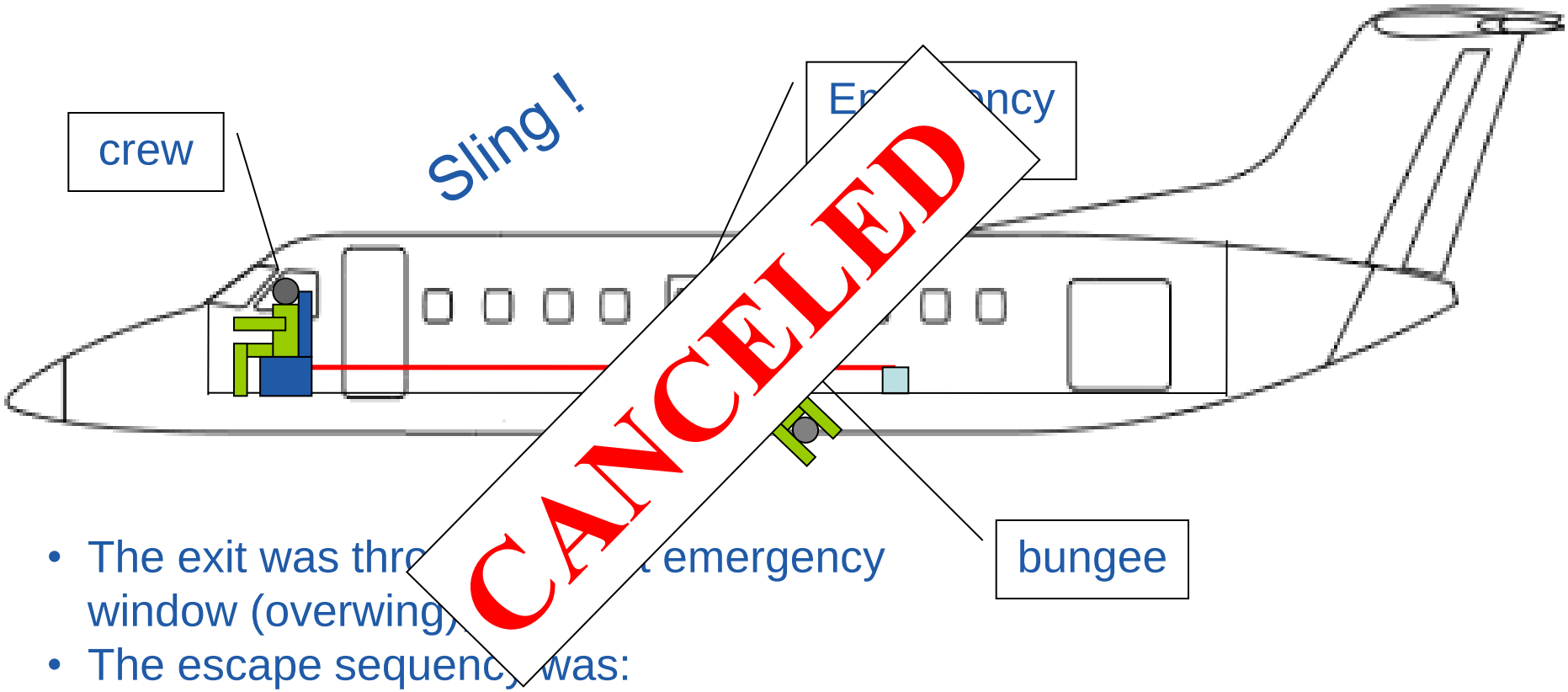
- Bungee actuated emergency window

EMBRAER history: EMB-120 – Brasilia

- Late 80s;
- 30 pax, 25300 lb mtow;
- FAR 25 req. cert.;
- One pax door;
- 2 emg. windows, one right emg. door;

- Bungee actuated emergency window
- Bungee actuated seat rail

EMB-120: Bungee actuated seat rail



- The exit was thro emergency window (overwing),
- The escape sequenc was:

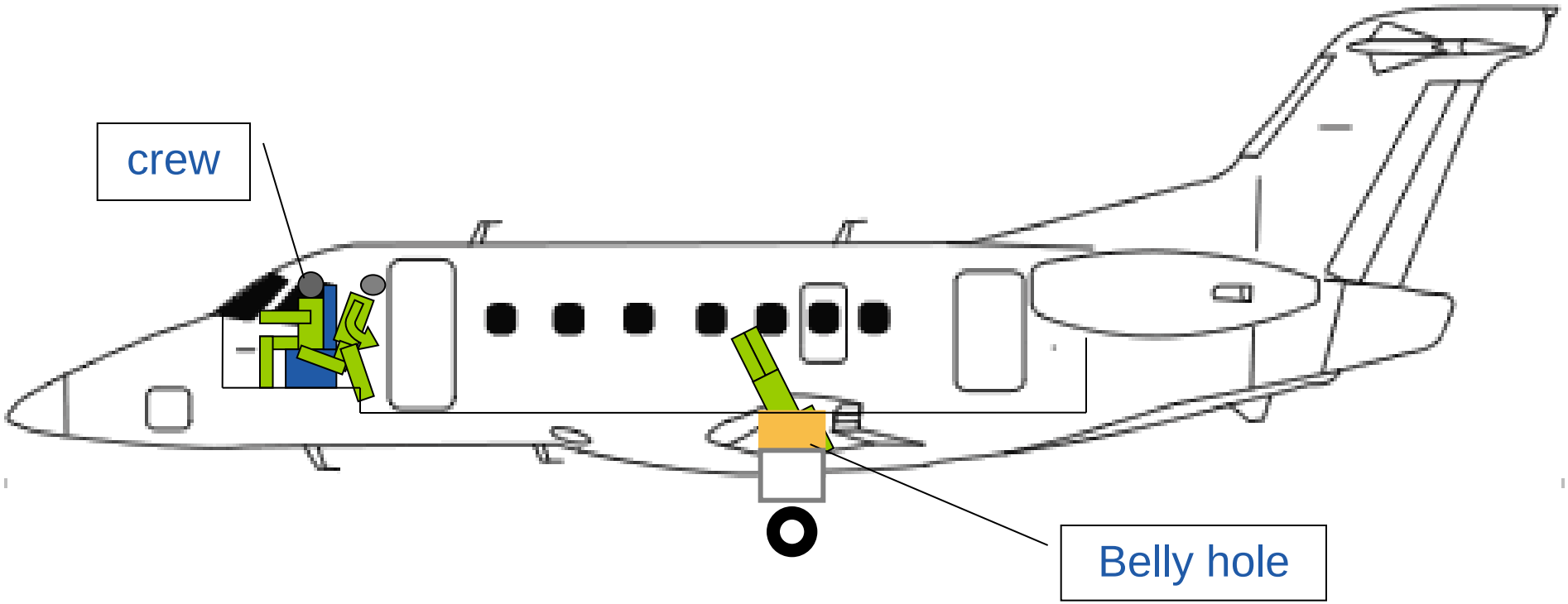
depressurize acft., trigger bungee, open window and jump through window

EMBRAER history: CBA-123 – Vector

- Early 90s;
- 19 pax, 17000 lb mtow;
- FAR 25 req. cert.;
- One pax door;
- 2 emg. windows, 1 pax. door;
- Pusher fans

- Ventral Exit

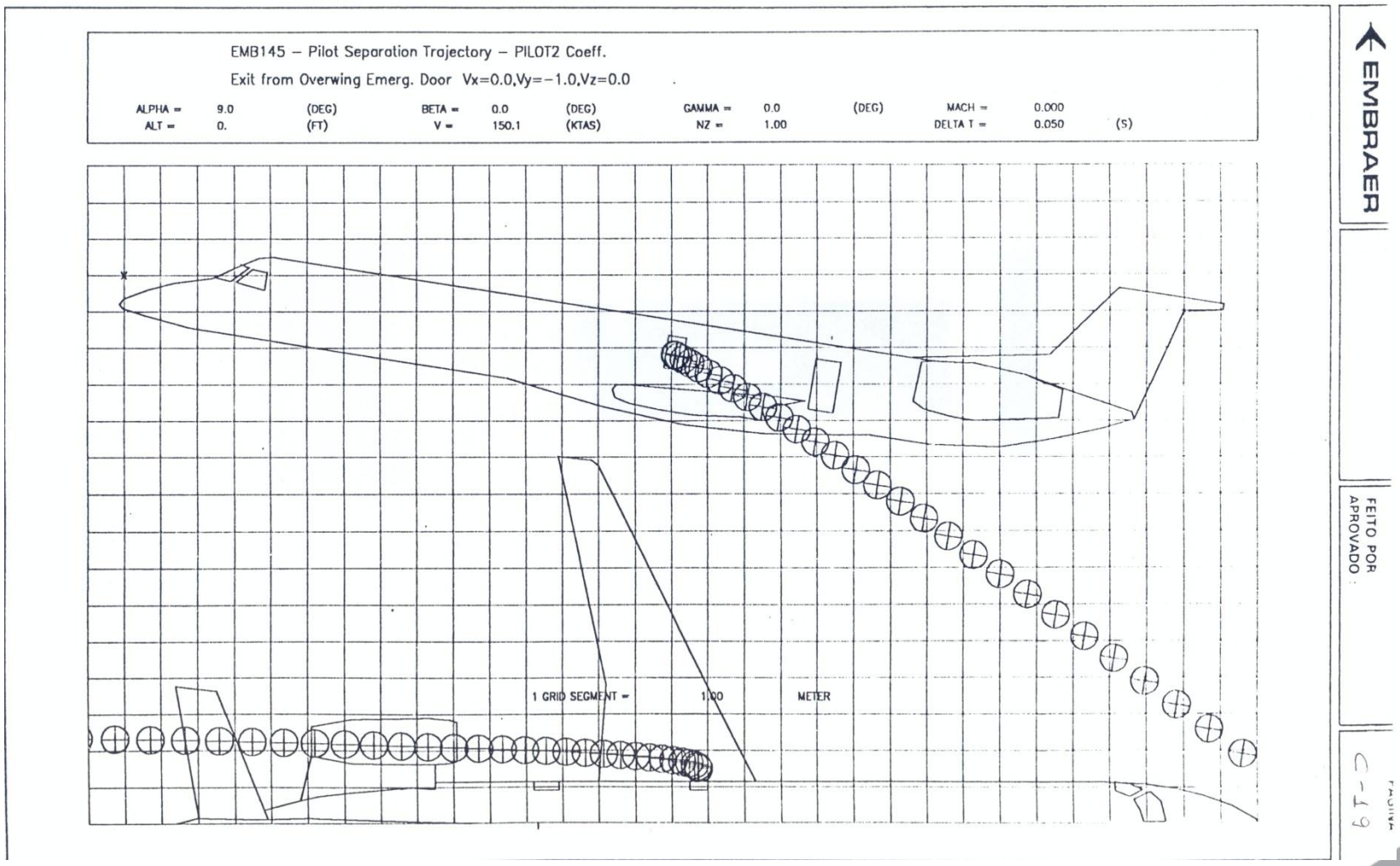
CBA-124: Ventral Exit



- The exit was through the right ldg enclosure;
- The escape sequency was:
  lower ldg, depressurize acft., run to the back, jump through hole

EMBRAER history: ERJ-145

ERJ-145: Bailout Ballistic

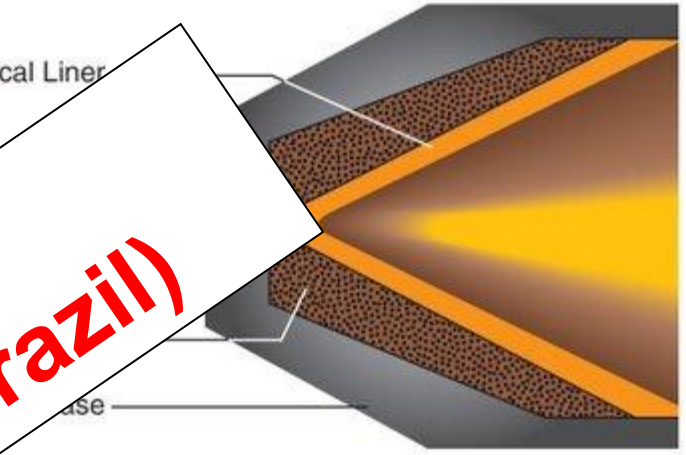


ERJ-145: Explosive windows

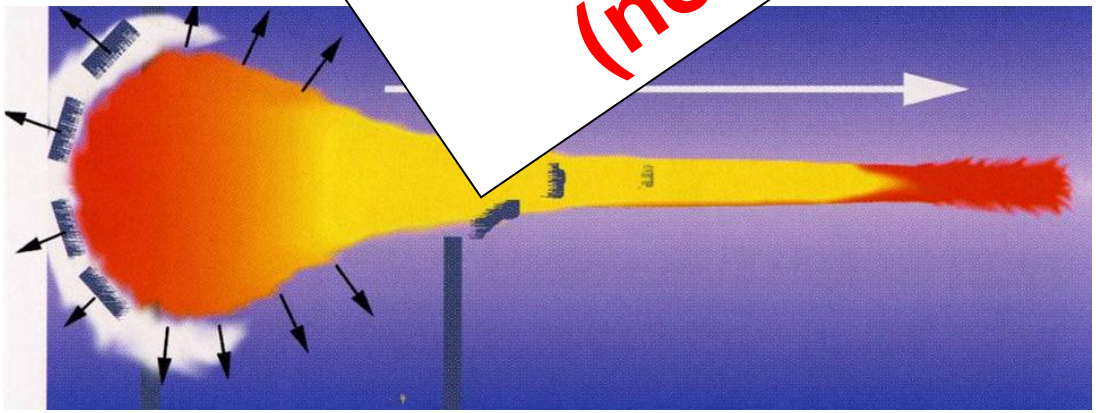
- The exit was through the cockpit windows and a blown up hole on the right side of the fuselage.
- The escape sequency was:
  Push trigger, jump out.

Hollow Charge

V or U chaped explosive chord, that focus the explosive energy into a single narrow point, producing a predictive and controled cut.



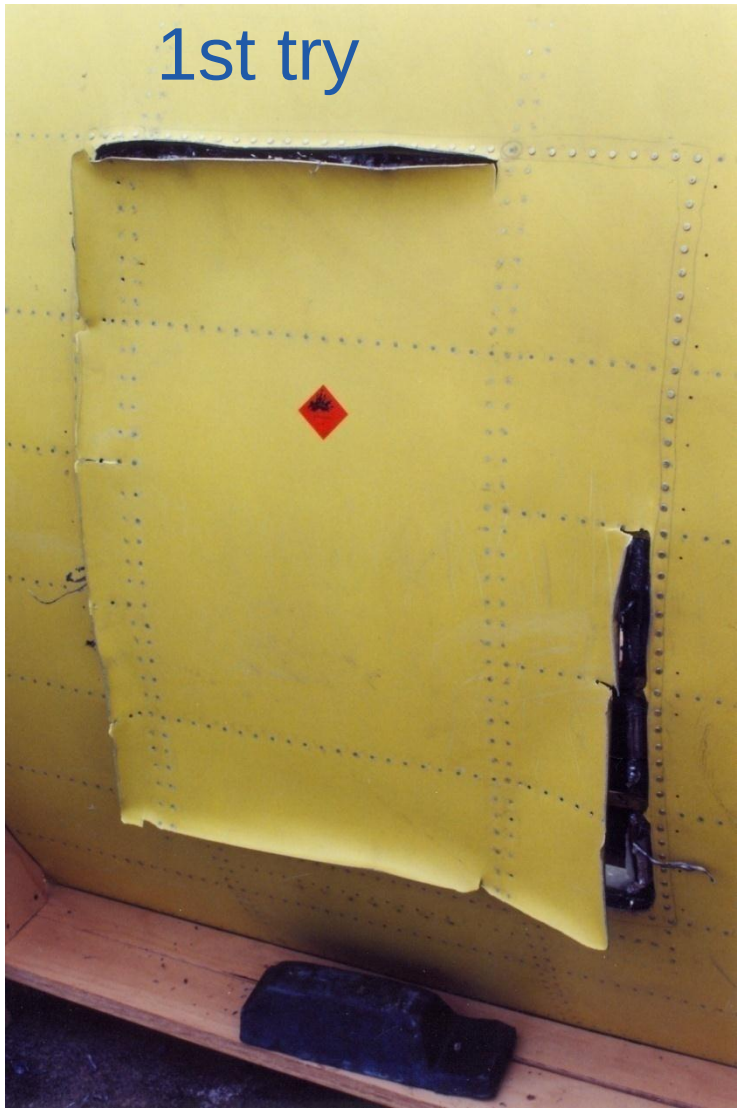
IMPORTED
(not made in Brazil)

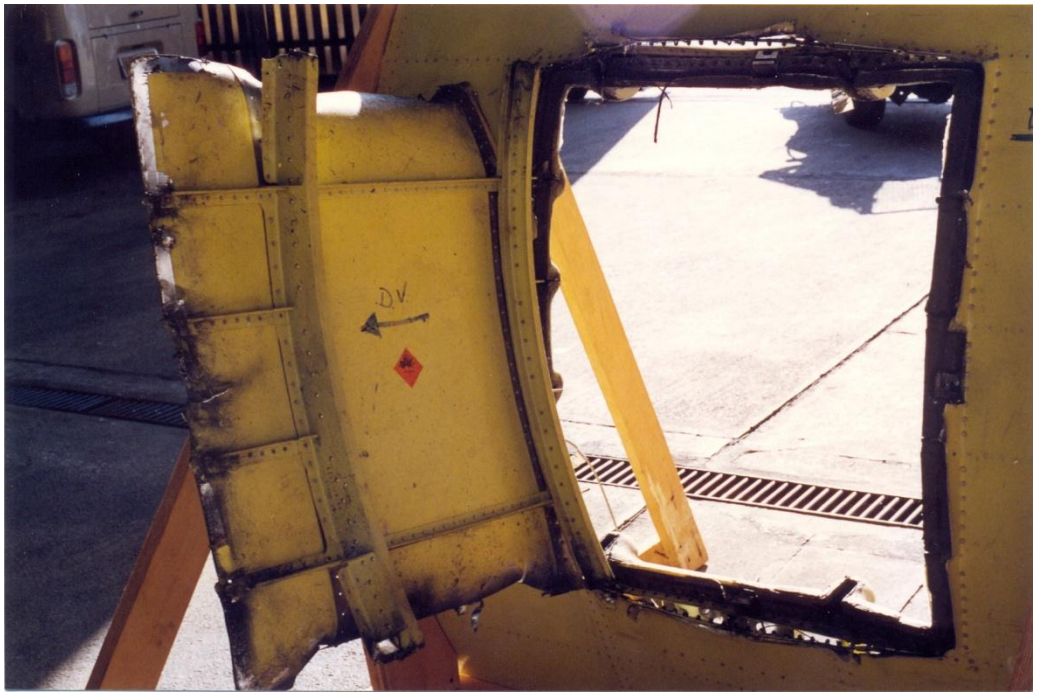


Munroe effect
or
Neumann effect

ERJ-145: Explosive windows

1st try





2nd try

ERJ-145: Explosive windows

Final conf.

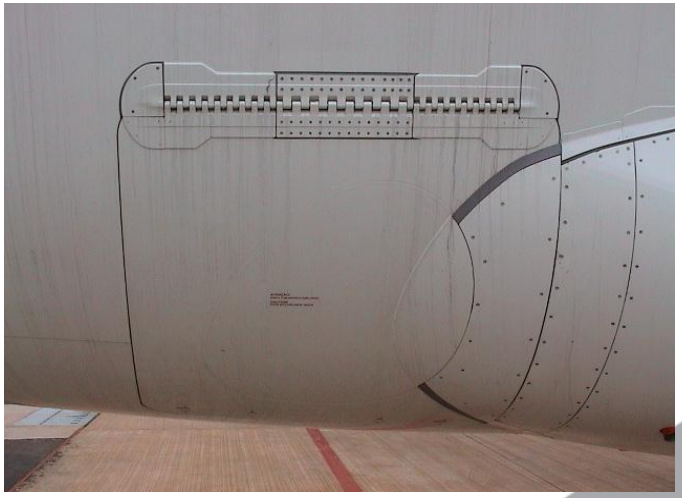
EMBRAER flightline today: E170/ E175

- 70+ pob, 74800lb mtow;
- FAR 25 req. cert.;
- FBW;
- Under cabin Cargo.

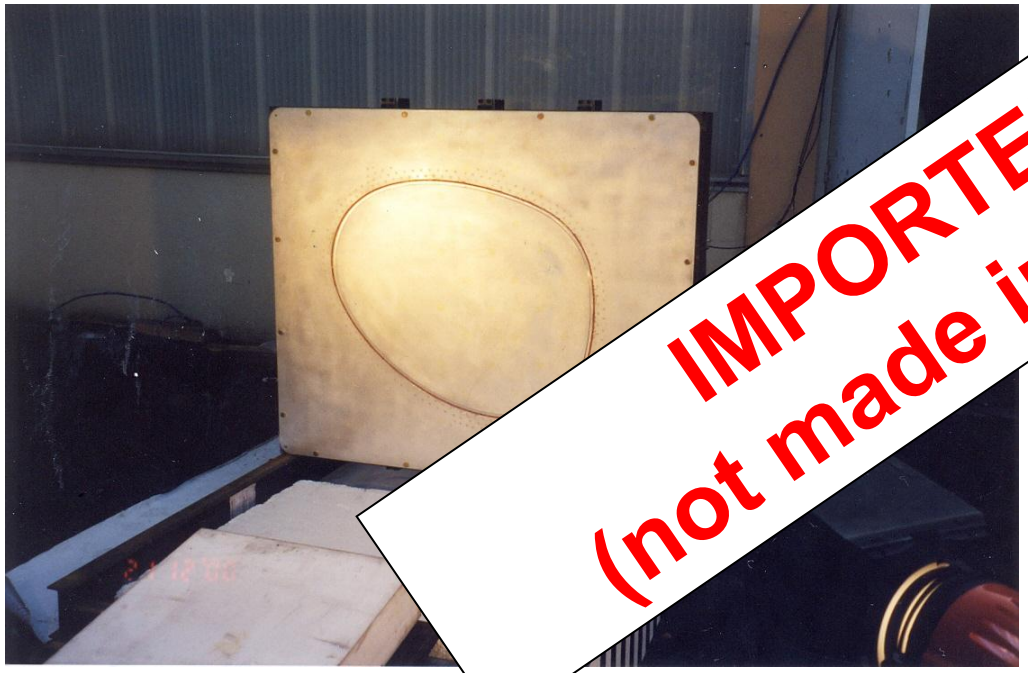
Additional exit (BAC-111 2nd prototype)

E170, E190: Escape Hatch

“Potty”



E170, E190: Escape Hatch



IMPORTED (not made in Brazil)

- Subcontracted to European Supplier

E-170: “Potty” hole

- The exit was through the aft hatch;
- The escape sequency was:
  depressurize acft., run all the way to the back, blow the door, jump through hole

E-175, E-195

"Fast" opening door for pressurized situations.

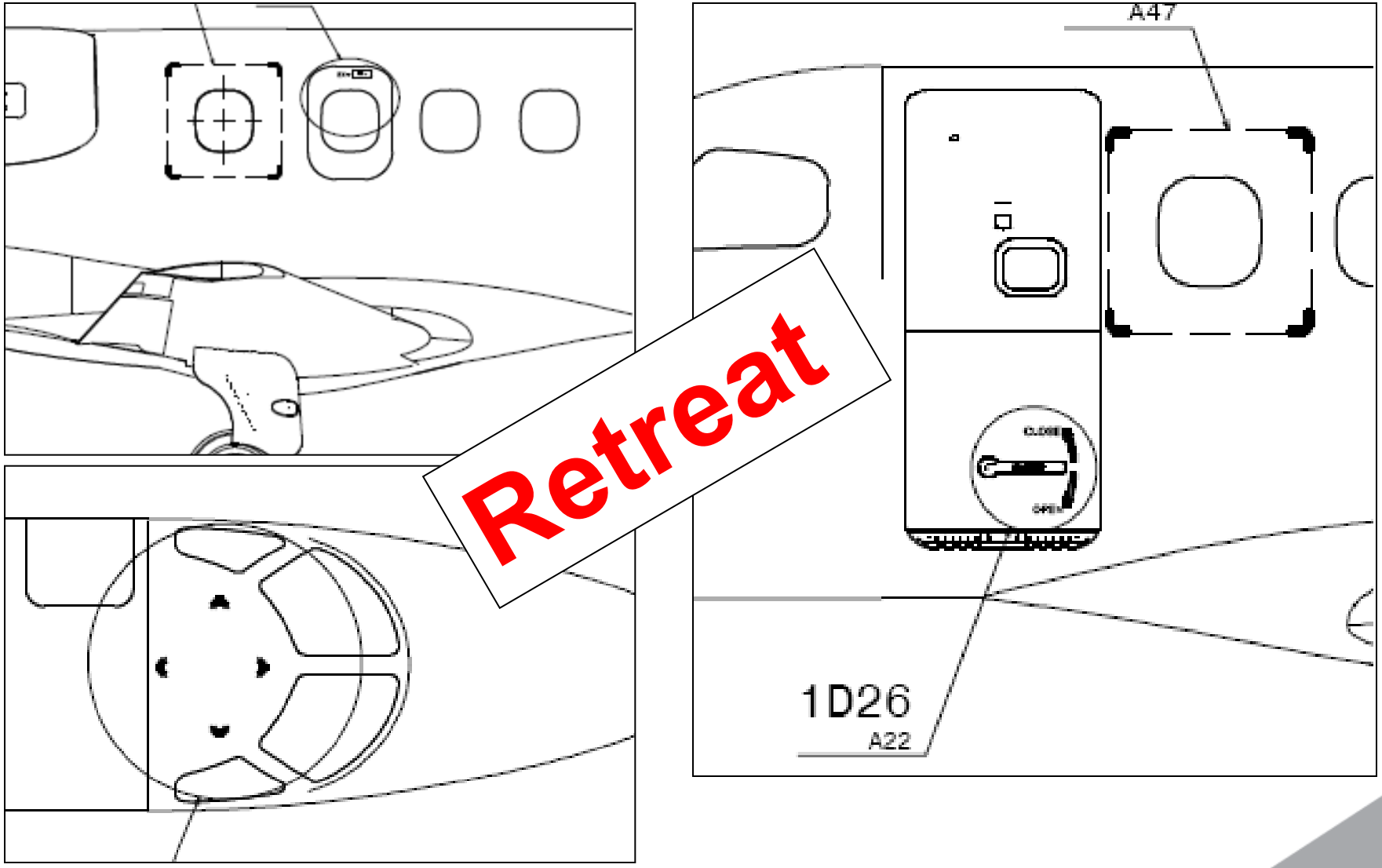
Phenom 100 / 300

- 6+ pob, 17500 lb mtow
- FAR 23 req. cert.
- Pax door, emg. window

Extraction Markings

Phenom 300: Extraction Markings

Phenom 100 / 300: extraction markings

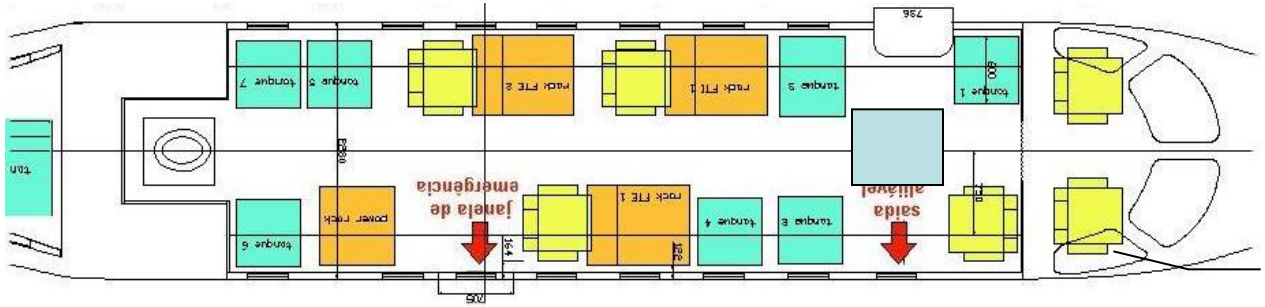


Upcoming EMBRAER Flightline

Identified High Risk Test Situations

- Ground Egress:
  - Vmcg, Vmu, Brake Efficiency, Max.Kinectic Energy, Quick Tourn Around, Landing Perf., Steep Approach, Take Off Perf., Water ingestion;
- Stabilized Flight Bail-out:
  - Deep Stall, Flat spin; Flight controls malfunction,
- Uncontroled Flight Bail-out:
  - Structural failure; Flight Controls Departure, Flight Controls Inop.

Legacy 500: Additional Exit Options

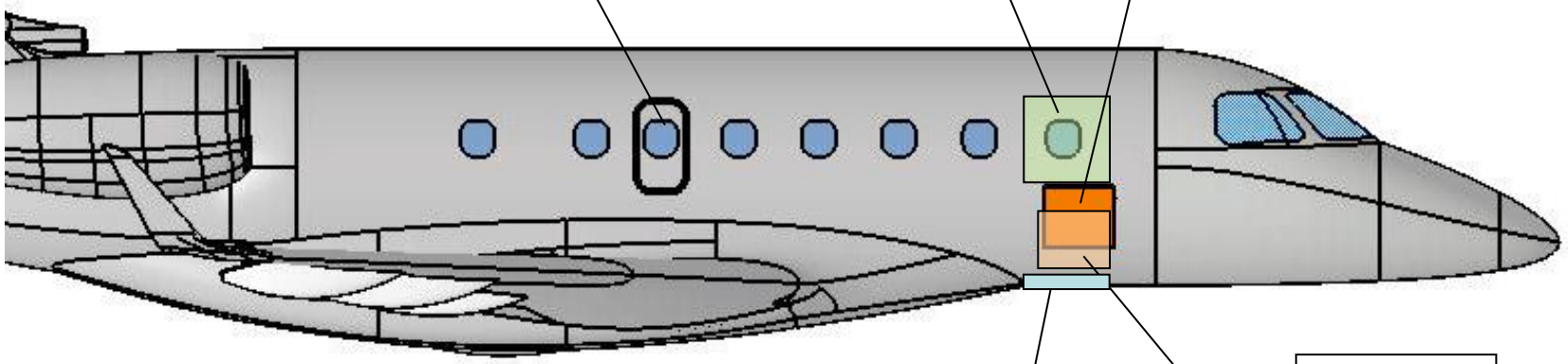


Cockpit side window

Overwing Emergency window

position 2

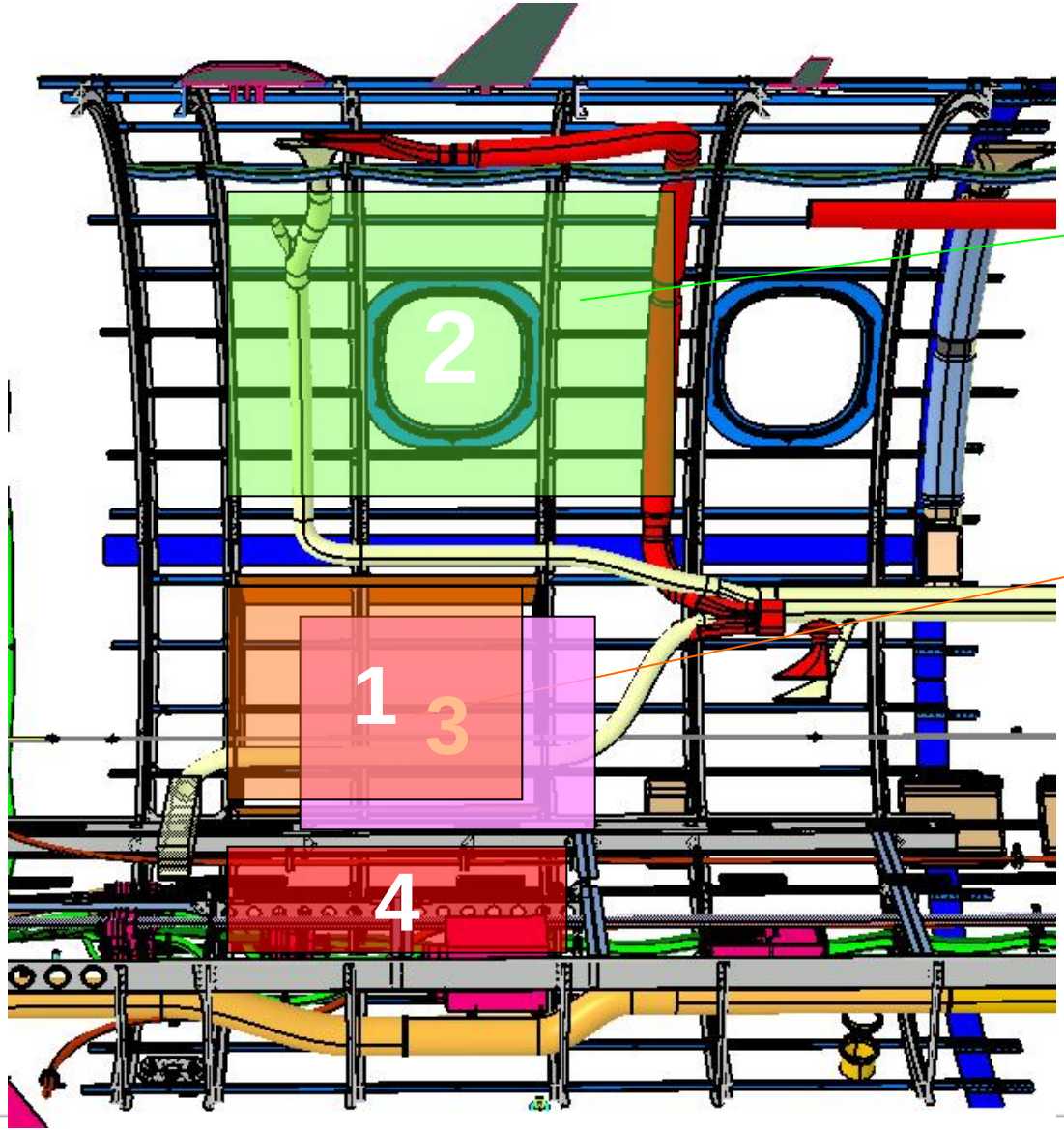
position 1



position 3

position 4

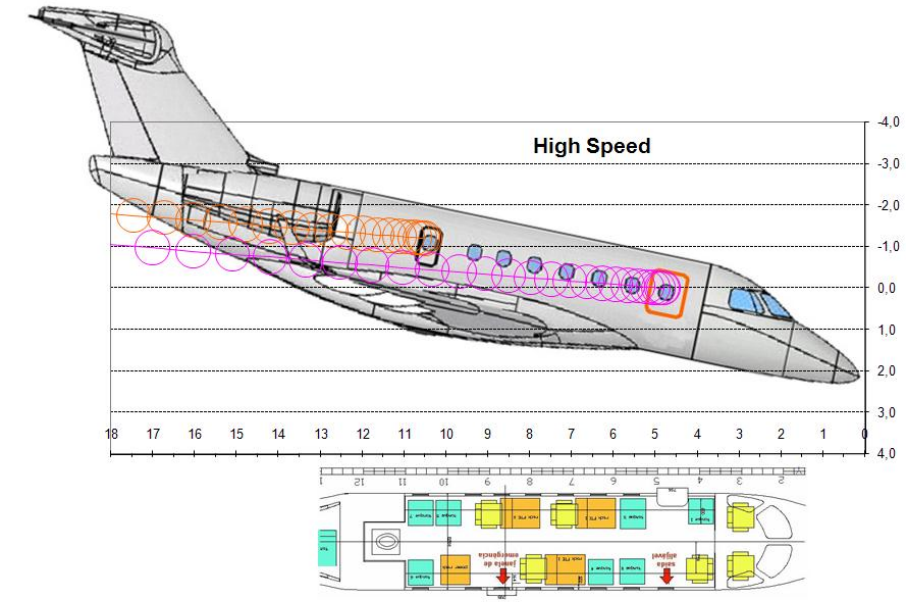
Legacy 500: Additional Exit Options

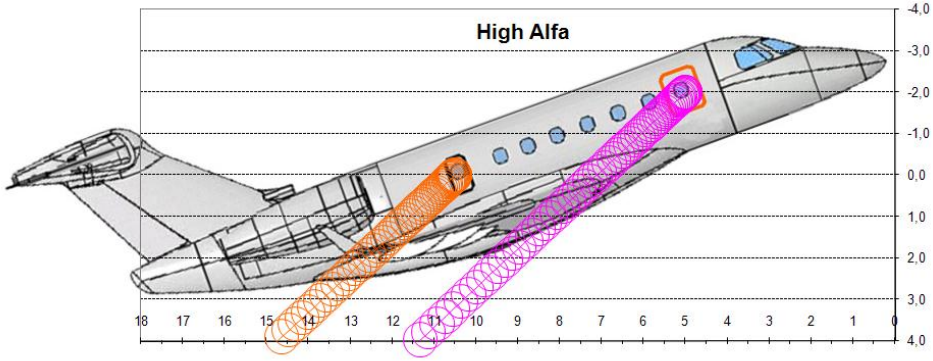


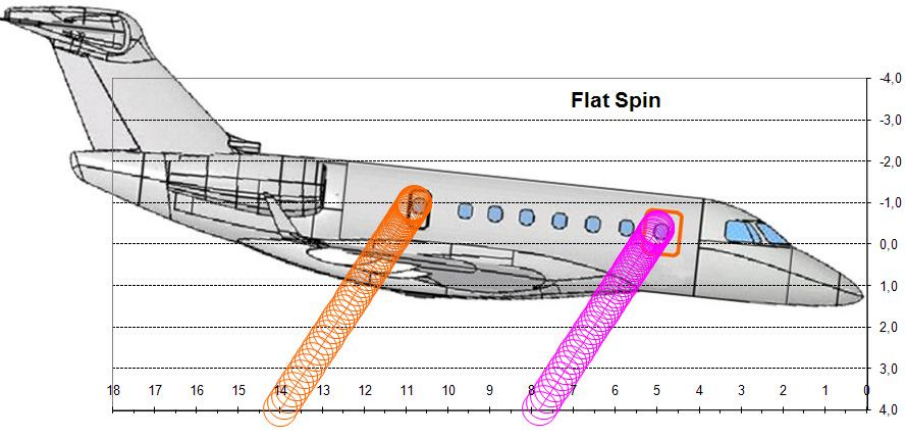
-2 frames
-5 stringers

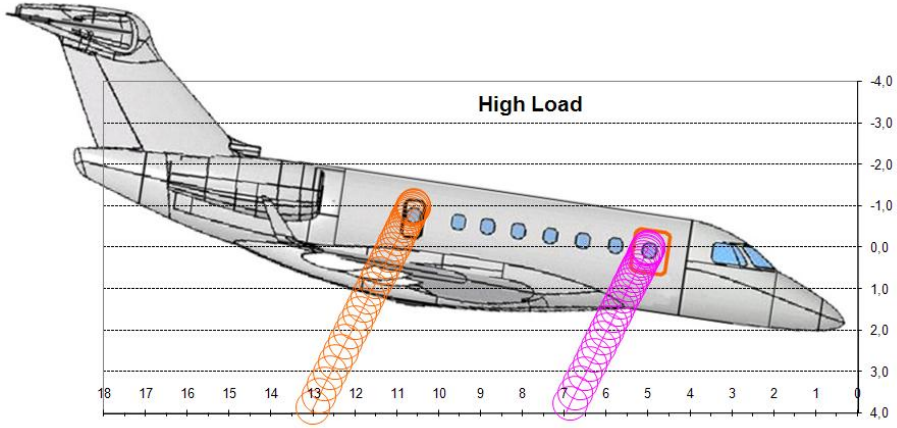
-1 frames
-3 stringers

Legacy 500: Bailout Ballistic





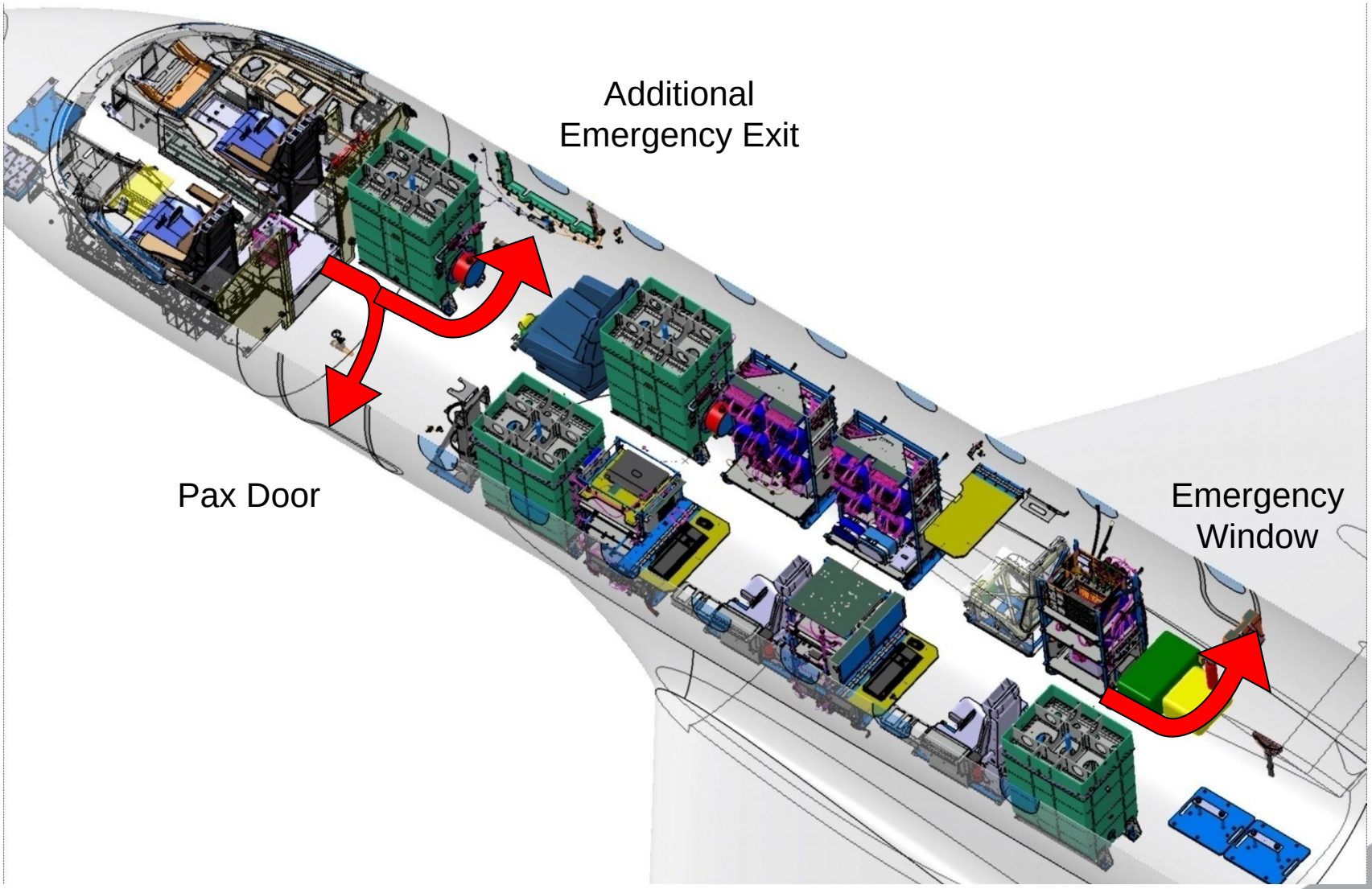




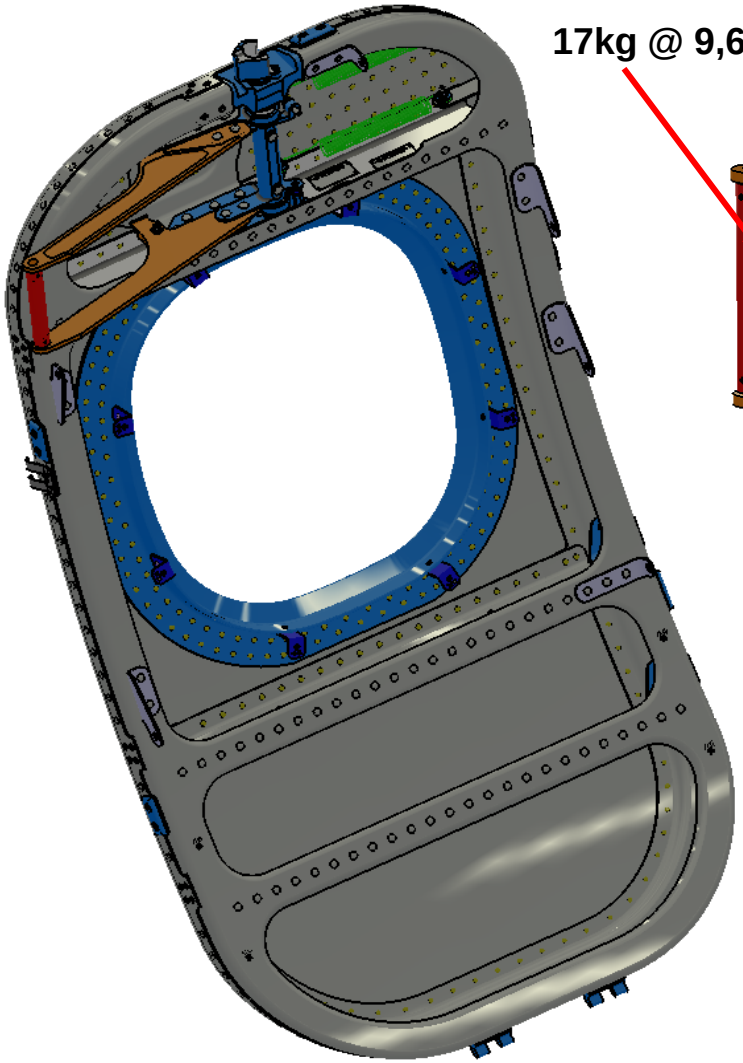
Legacy 500: Additional Exit Options

position	description	ground egress	stabilized flight bail out				project and implementation
			high speed	flat spin	high alfa	high load	
1	rh lateral 4h	may be obstructed in ground	possible wing hit	possible engine hit	possible engine hit	clear bail out	feasible
2	rh lateral 3h	not obstructed in ground	clear bail out	possible tail hit	possible tail hit	clear bail out	feasible: more explosives than pos 1
3	rh lateral 5h	obstructed on ground	possible wing hit	possible engine hit	possible engine hit	clear bail out	feasible: more explosives than pos 2; cable and system changes
4	front floor	obstructed in ground	possible belly hit	possible belly hit	possible belly hit	clear bail out	feasible: more explosives than pos 3; cable and system changes
5	cabin door (lh)	obstructed on ground	clear bail out	possible tail hit	possible tail hit	clear bail out	Need 10 explosive pins. Difficult operation, installation and removal.
6	rh lateral emerg. window	not obstructed on ground	clear bail out	possible engine hit	possible engine hit	possible wing hit	must include long opening handle
7	cockpit side window	not obstructed on ground	not enough space to bail out with parachute				Must explode wider area than available

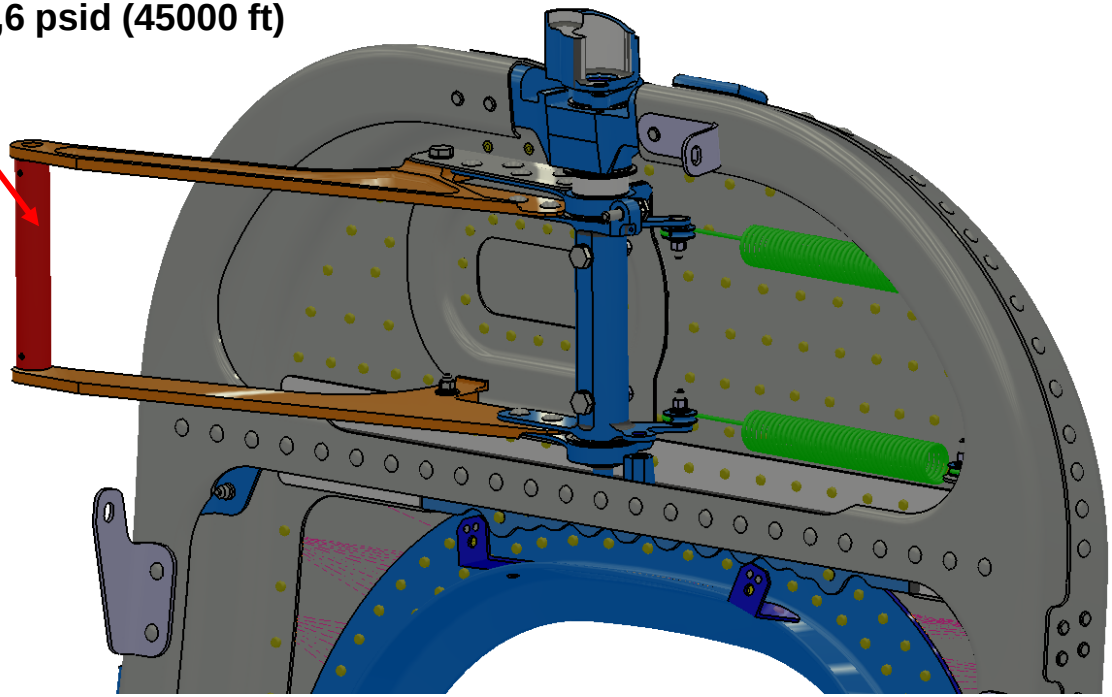
Legacy 500: Additional Exit Options



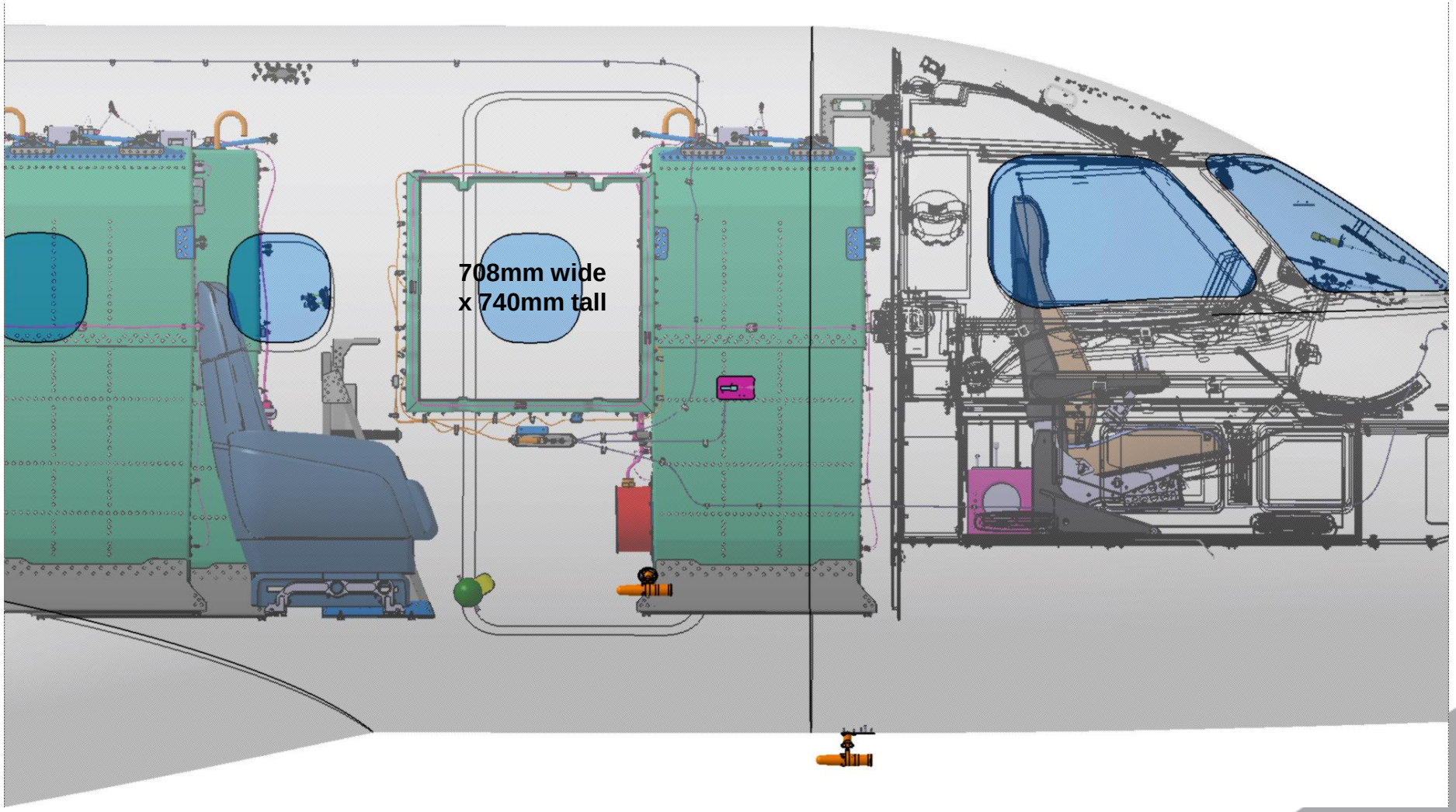
Legacy 500: Emerg. Window Handle



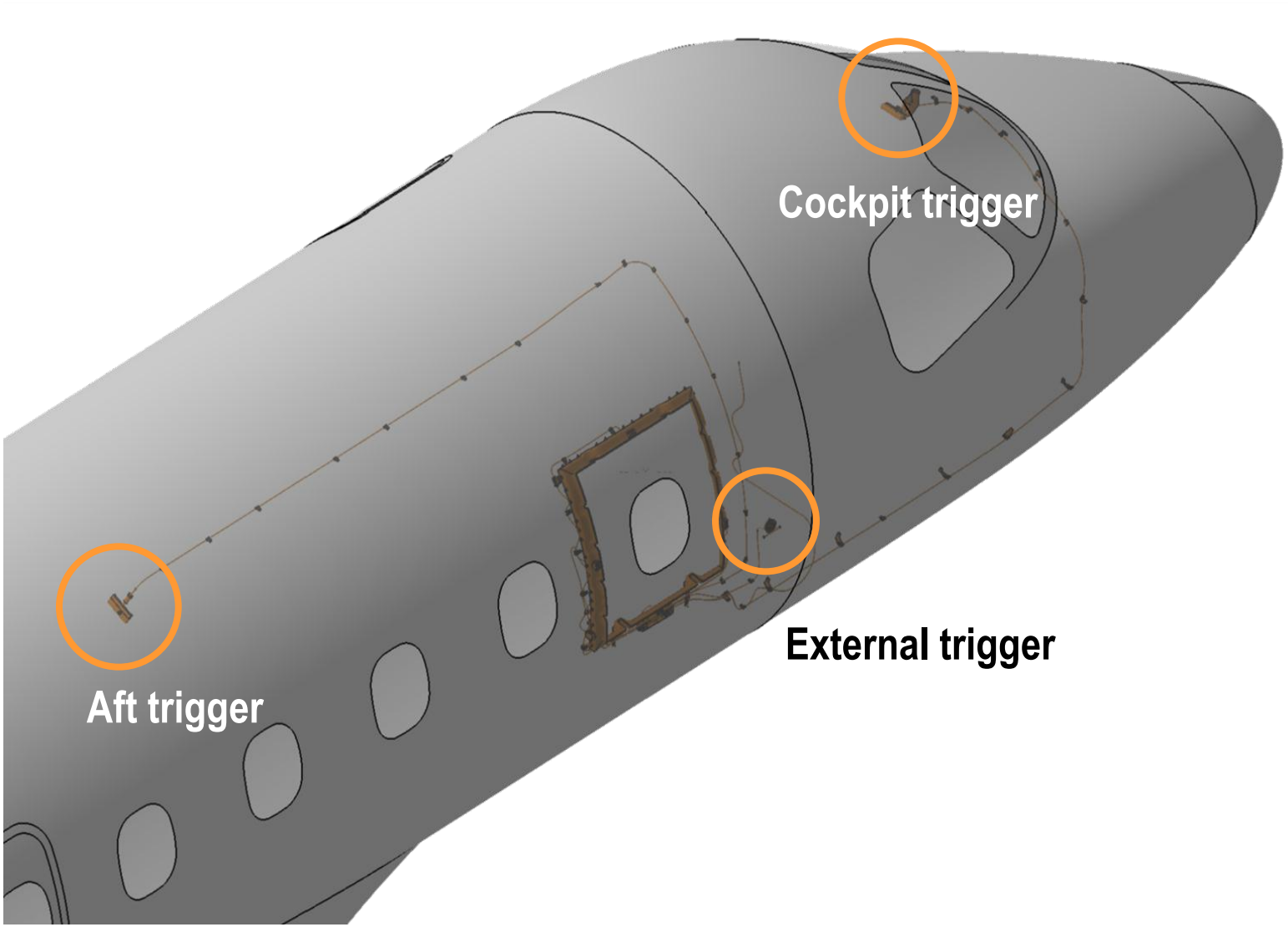
17kg @ 9,6 psid (45000 ft)



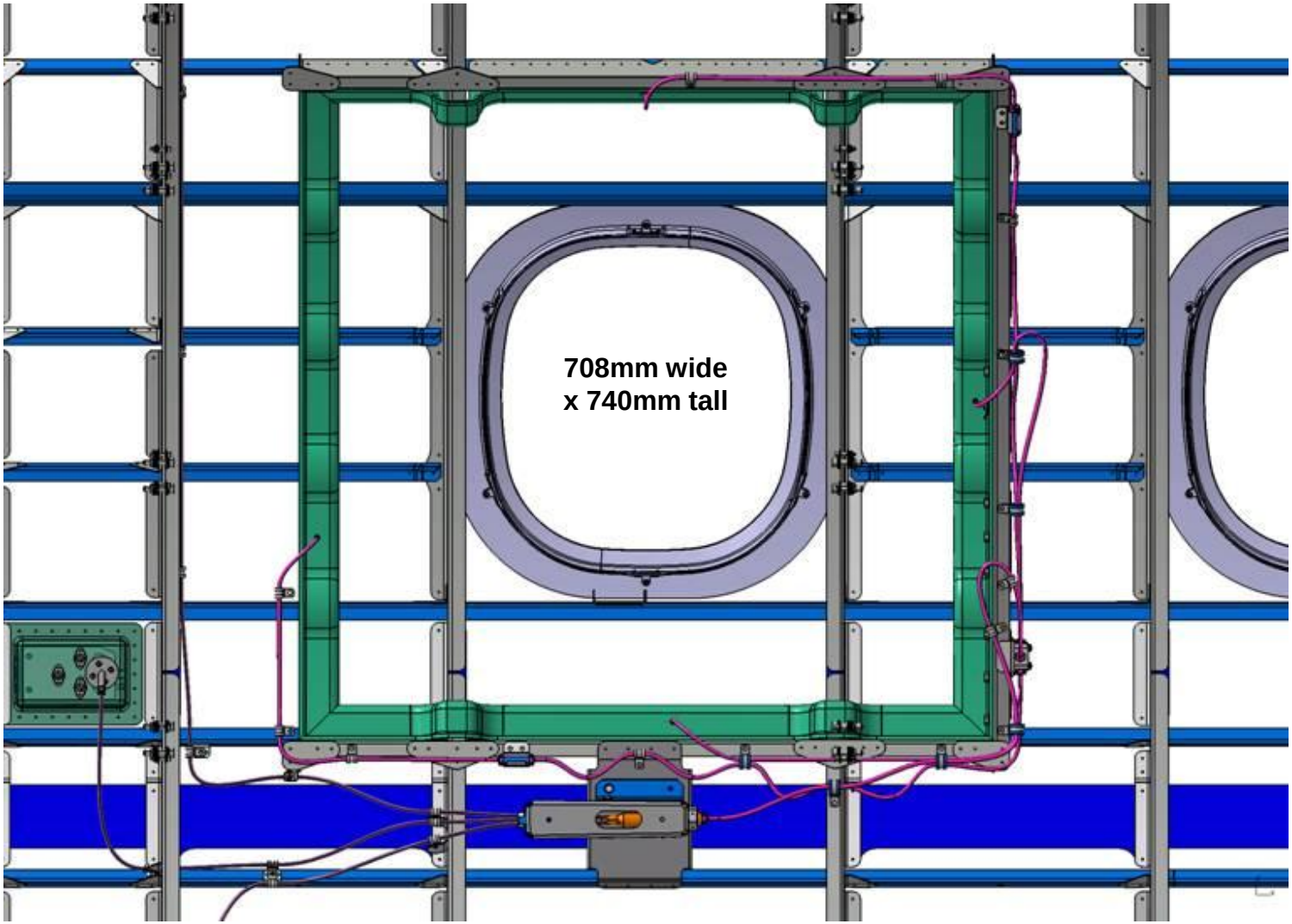
Legacy 500 Additional Emergency Exit



Legacy 500: Explosive Trigger Positions



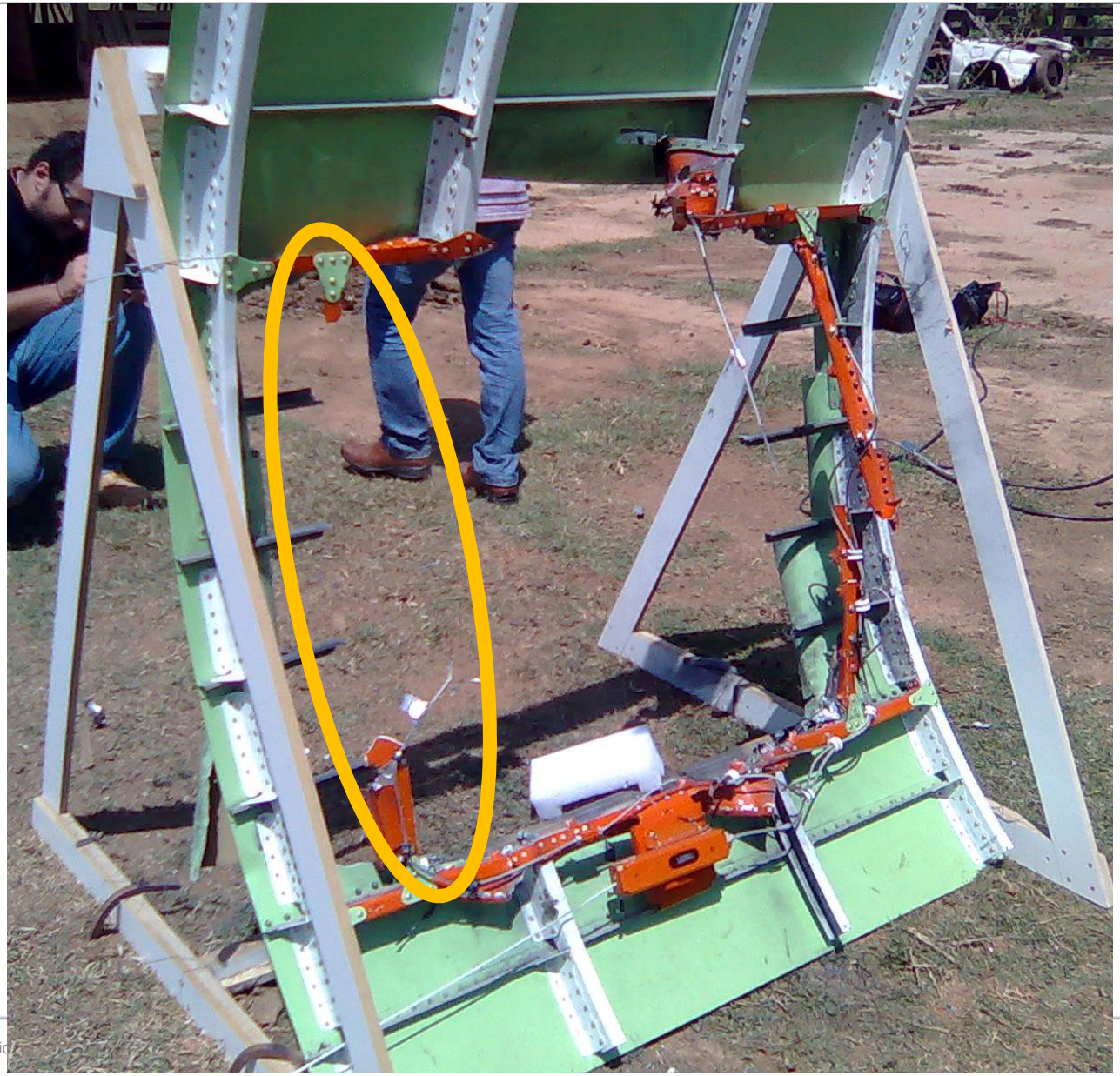
Legacy 500: Explosive frame



Explosive charge test #1 - before

Explosive charge test #1

Explosive charge test #1 - after



Explosive charge test #2 - before

Explosive charge test #2

Explosive charge test #2 - after

Lessons Learned

- Gvmt. (safety) requirements are not enough for envelope opening flight tests ;
- Extra safety devices may require structural changes;
- Extra safety devices may not interfere with tests and its conformity;
- Development Schedule and tight budget may easily push a Corporate No-Go decision;
- Almost the same recipe may turn out in almost a different cake;
- Do not produce a safety device that results in more danger than if you did not have it !

Questions ?

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Thank You !