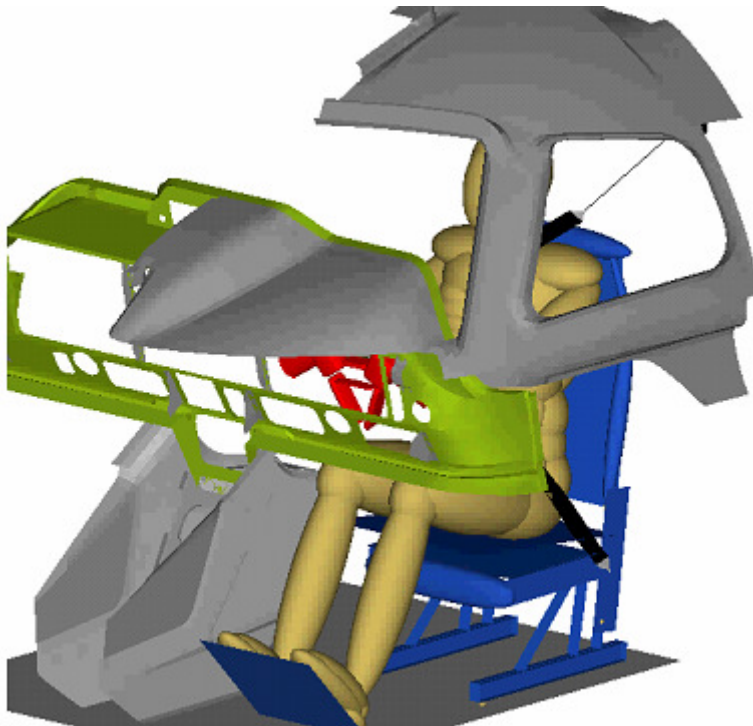


---

## USE OF DYNAMIC SIMULATION FOR CERTIFICATION AND DEVELOPMENT.



---

*August, 2012*

**Embraer offers several different interior configurations for the ERJ170/190 family of regional jets.**

**A large amount of time and money would be needed to approve all interior configurations using HIC dynamic testing.**

**And no seat dynamic test labs are available in Brasil...**

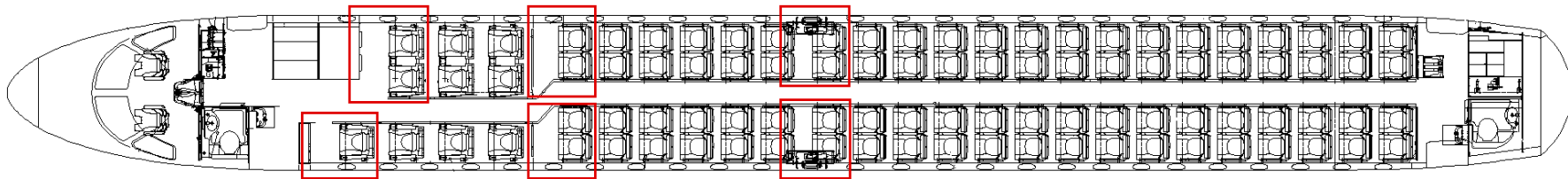
# EMBRAER USE OF CERTIFICATION BY ANALYSIS



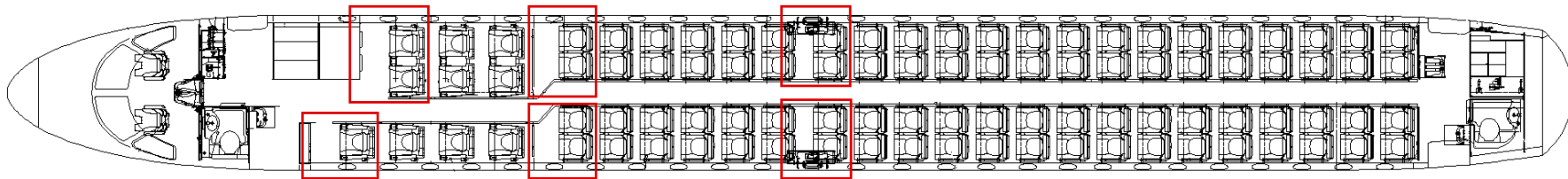
- HIC is a destructive test for all seats and the monuments.

- HIC is a destructive test for all seats and the monuments.
- HIC costs, especially for front row, represent 35% average of a new interior configuration development and certification cost for ERJ170/190.

- HIC is a destructive test for all seats and the monuments.
- HIC costs, especially for front row, represent 35% average of a new interior configuration development and certification cost for ERJ170/190.
- In an extreme case, a new interior configuration may add HIC testing costs up to US\$ 500k!...



- HIC is a destructive test for all seats and the monuments.
- HIC costs, especially for front row, represent 35% average of a new interior configuration development and certification cost for ERJ170/190.
- In an extreme case, a new interior configuration may add HIC testing costs up to US\$ 500k!...



- This cost added to a new interior configuration compromises ERJ170/190 competitiveness...

In 2004-2005 Embraer used **AC 20-146** to approve a methodology with ANAC (the Brazilian Civil Aviation Authority), including the use of dynamic simulation through validated models.

This methodology provided additional competitiveness for ERJ170/190 by drastically reducing the need for HIC dynamic testing and therefore reducing costs and time-to-certification of new interior configurations.

The Embraer use of HIC dynamic simulation approved by ANAC and used also in Part 23 / Part 25 FAA and EASA certifications comprise:

- Selection of critical HIC scenarios for certification testing
- HIC compliance demonstration ( $HIC < 700$ ).

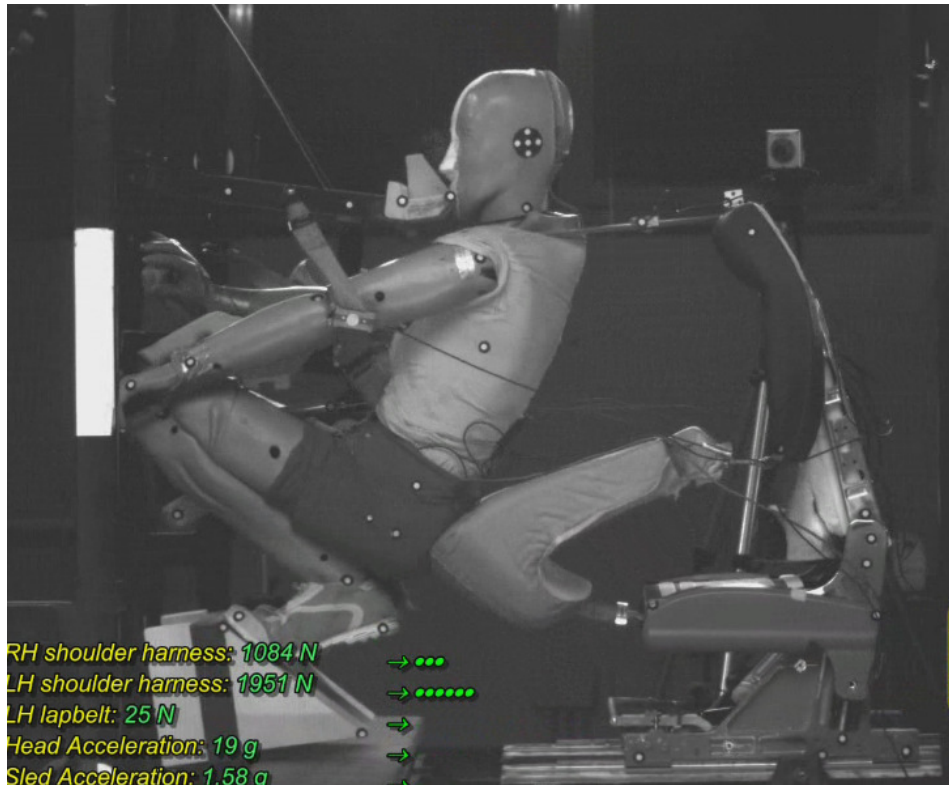
Embraer has also used HIC dynamic simulation for the development of new interior configurations and to support market/sales strategies.

A few examples are presented in the next slides...



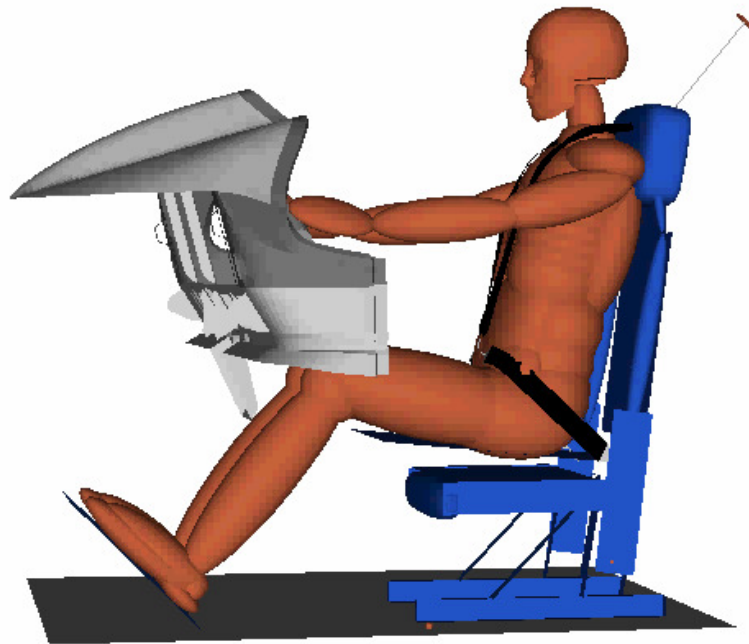
EMB-500 “Phenom 100” – Very Light Jet:

Around 100 models/variations developed from conception to certification.



Pilot HIC down from:  
10,000 in early stages (picture)  
to  
524 at certification.

# EMBRAER USE OF CERTIFICATION BY ANALYSIS



EMB-500 “Phenom 100” – Very Light Jet: pilot seats

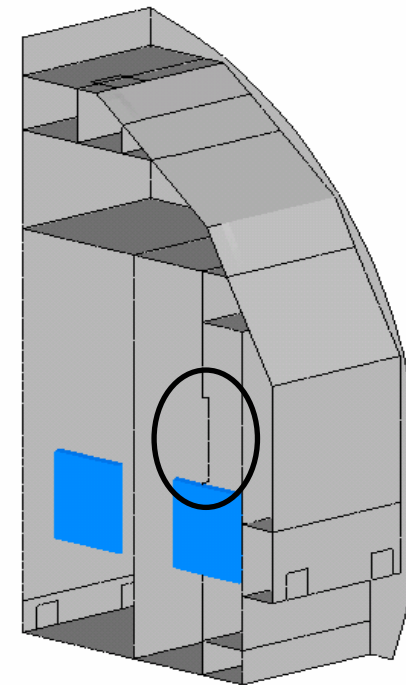
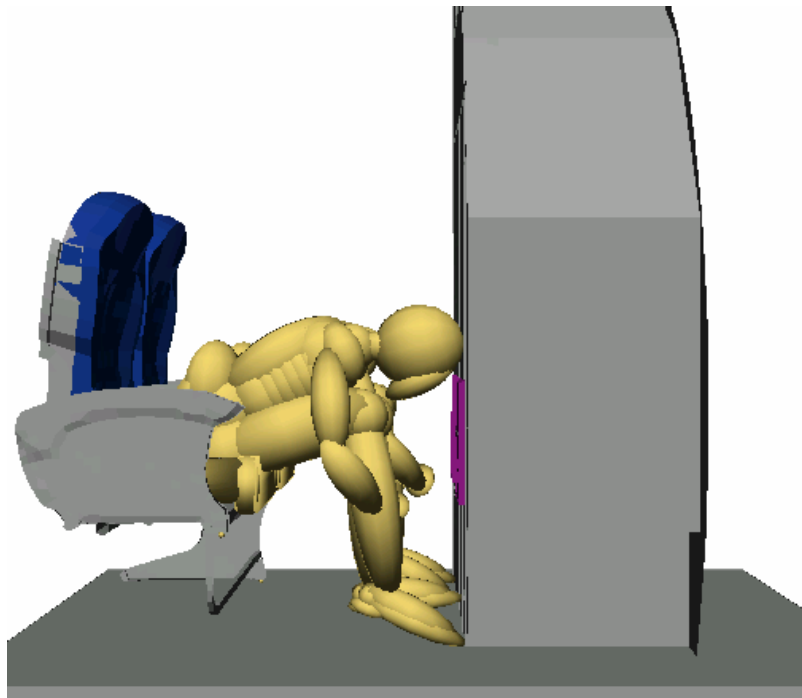
# EMBRAER USE OF CERTIFICATION BY ANALYSIS



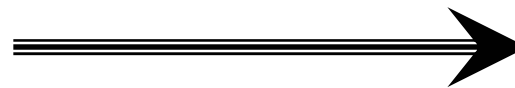
ERJ190-100 Finnair, 2006:

Original Galley Design Test

Final Galley Design Test

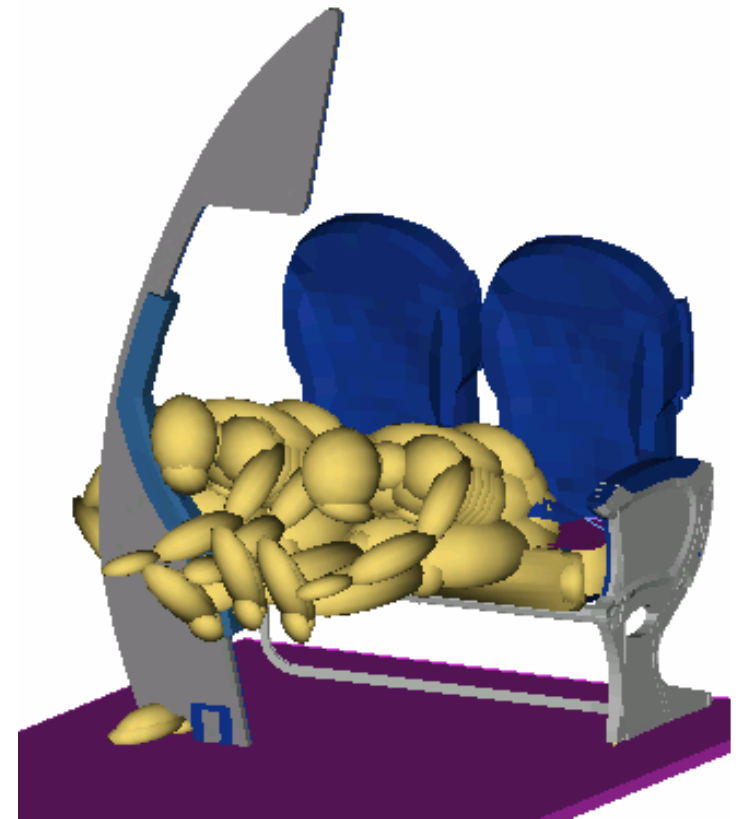
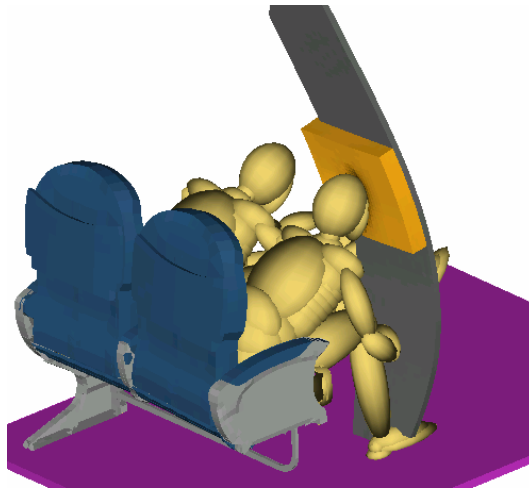
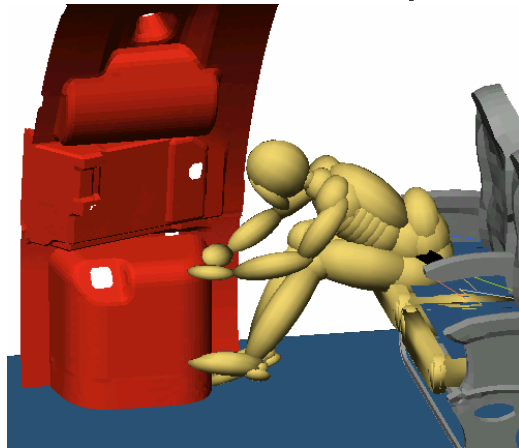


**ATD LHS - HIC 592.4**  
**ATD RHS - HIC 1,737.1**

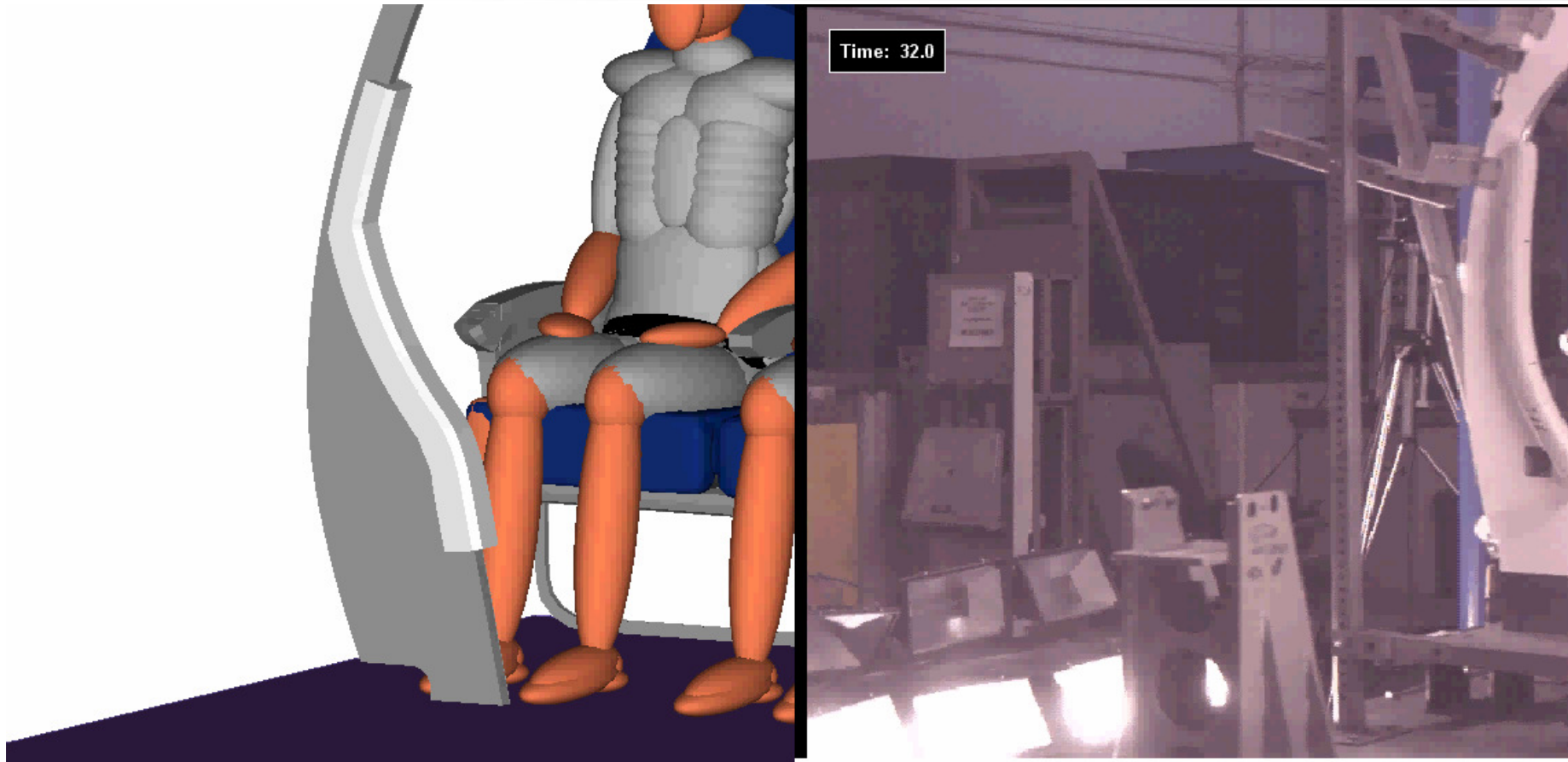


**ATD LHS - HIC 607.7**  
**ATD RHS - HIC 844.0**

ERJ170/190 High Density Configurations, 2006: development of a cabin divider to prevent occupant contact with escape slide bustle.

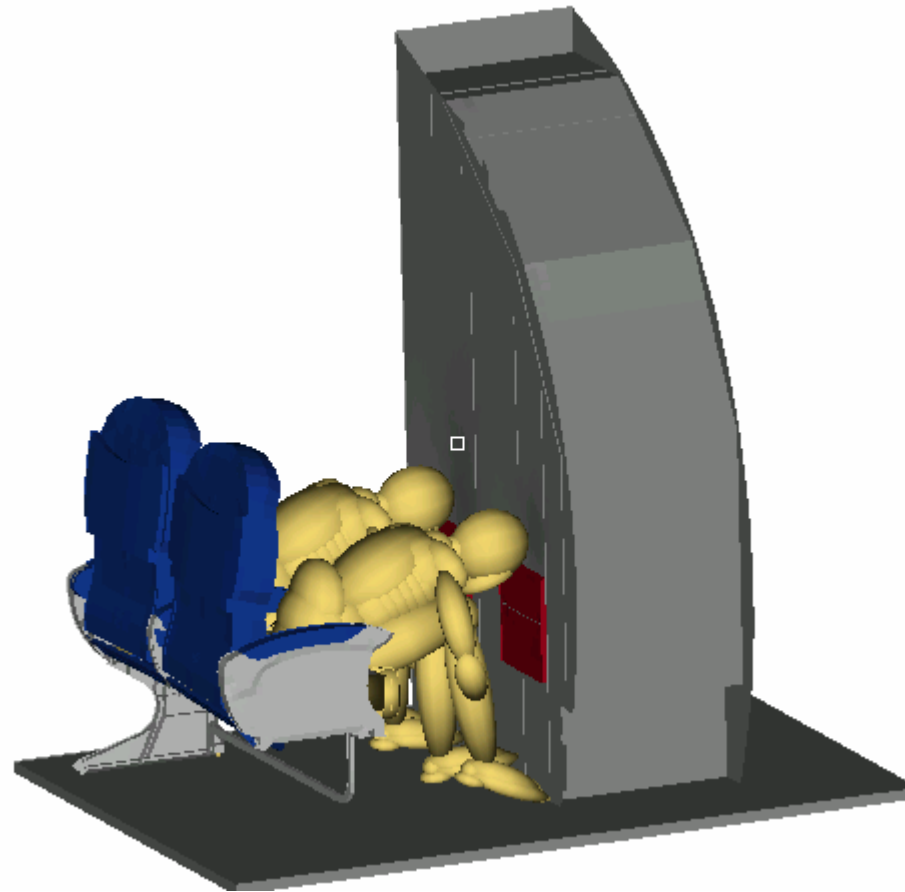


# EMBRAER USE OF CERTIFICATION BY ANALYSIS



## ERJ170/190 High Density Configurations

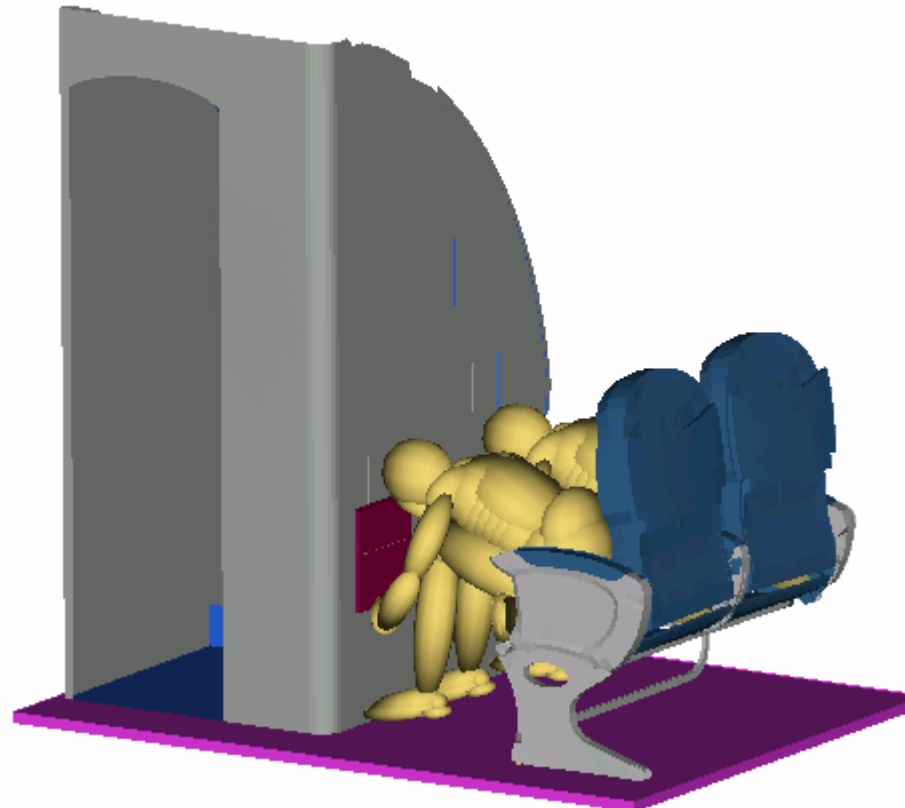
ERJ190-100 TAME, 2006: front row HIC (US\$80,000 saved)



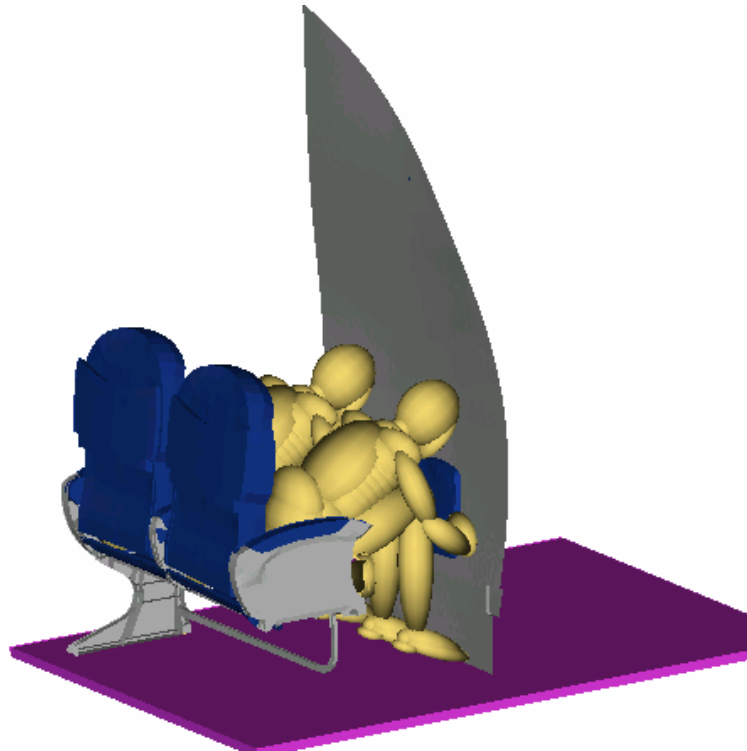
# EMBRAER USE OF CERTIFICATION BY ANALYSIS



ERJ190-200 FlyBe, 2006: front row HIC (US\$80,000 saved)



ERJ190-100 AeroRepublica, 2006: front row HIC (US\$80,000 saved)





Cost balance for *1st year* of dynamic simulation use:

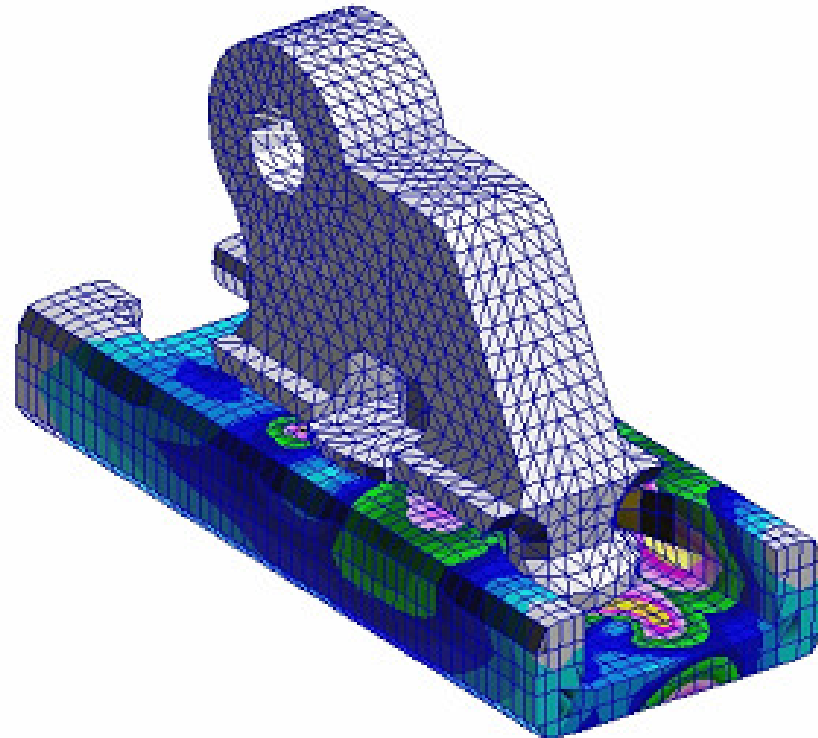
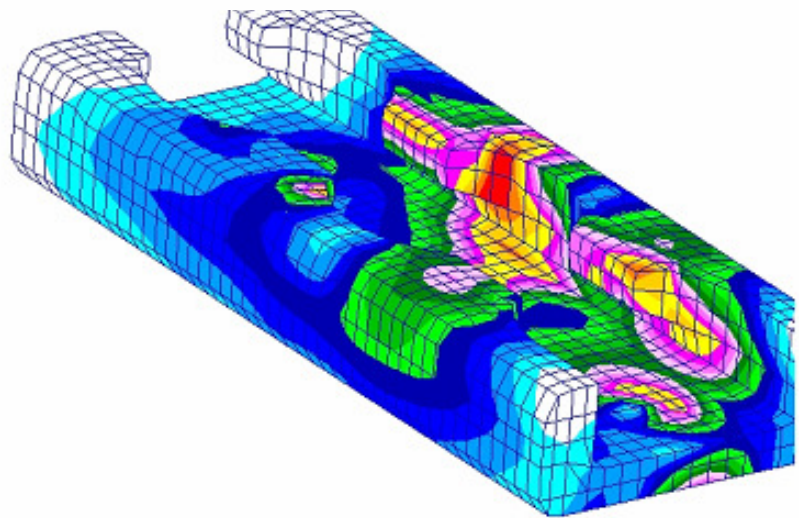
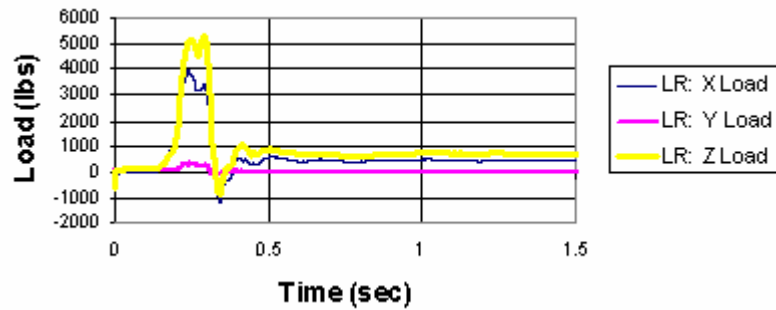
- Invested: US\$180,000 (TASS Madymo + Altair Hypermesh licences and training, etc.)
- Saved: US\$240,000 + €40,000

... and relevant new interior configurations certification and deliveries risk mitigation...

# EMBRAER USE OF CERTIFICATION BY ANALYSIS



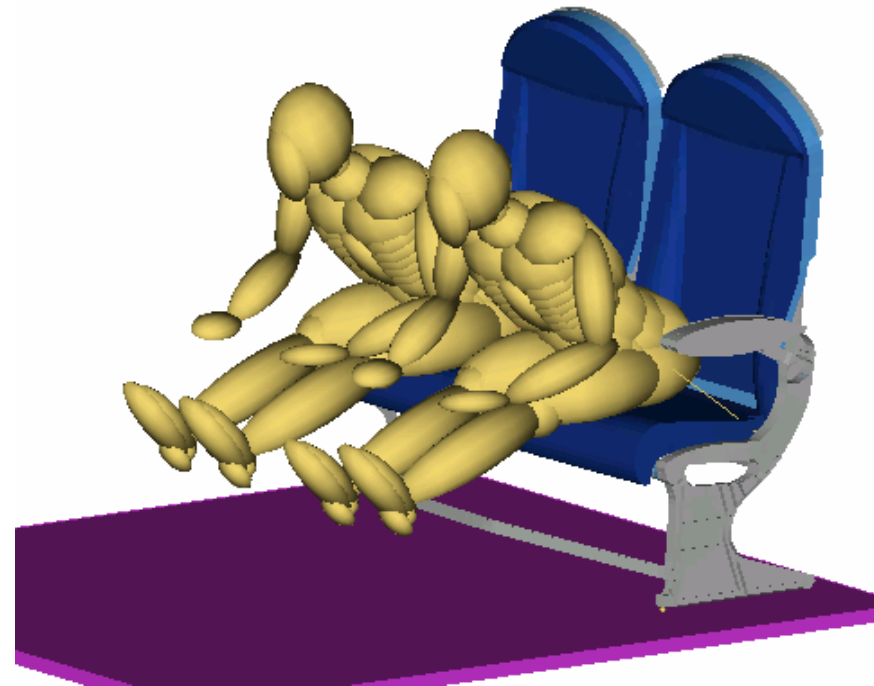
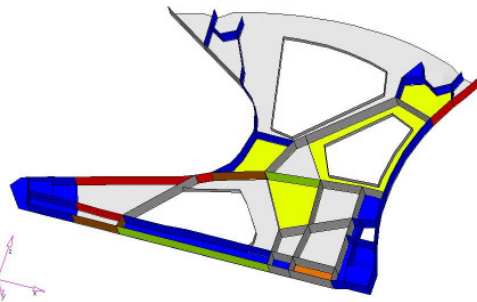
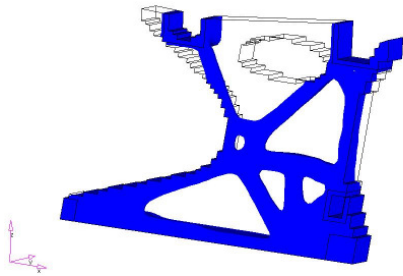
ERJ170/190, 2004: development and support to certification of a device to install seats at the track ends (flexibilization for interior configurations).



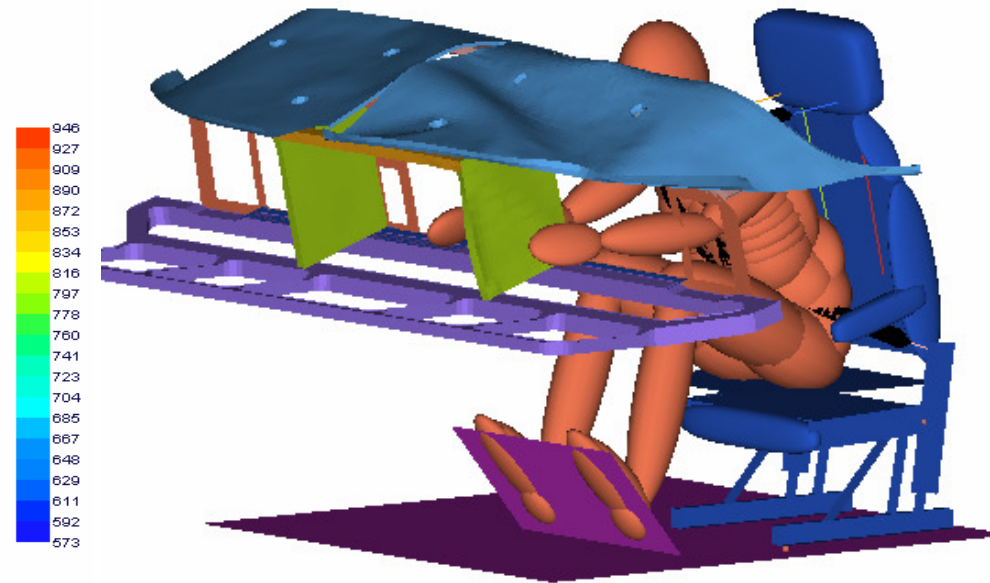
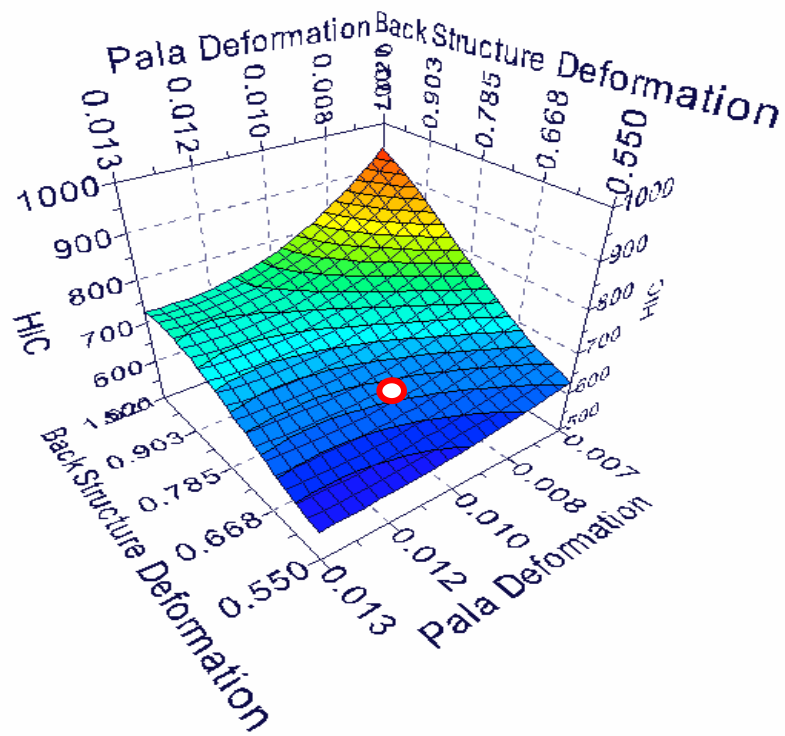
# EMBRAER USE OF CERTIFICATION BY ANALYSIS



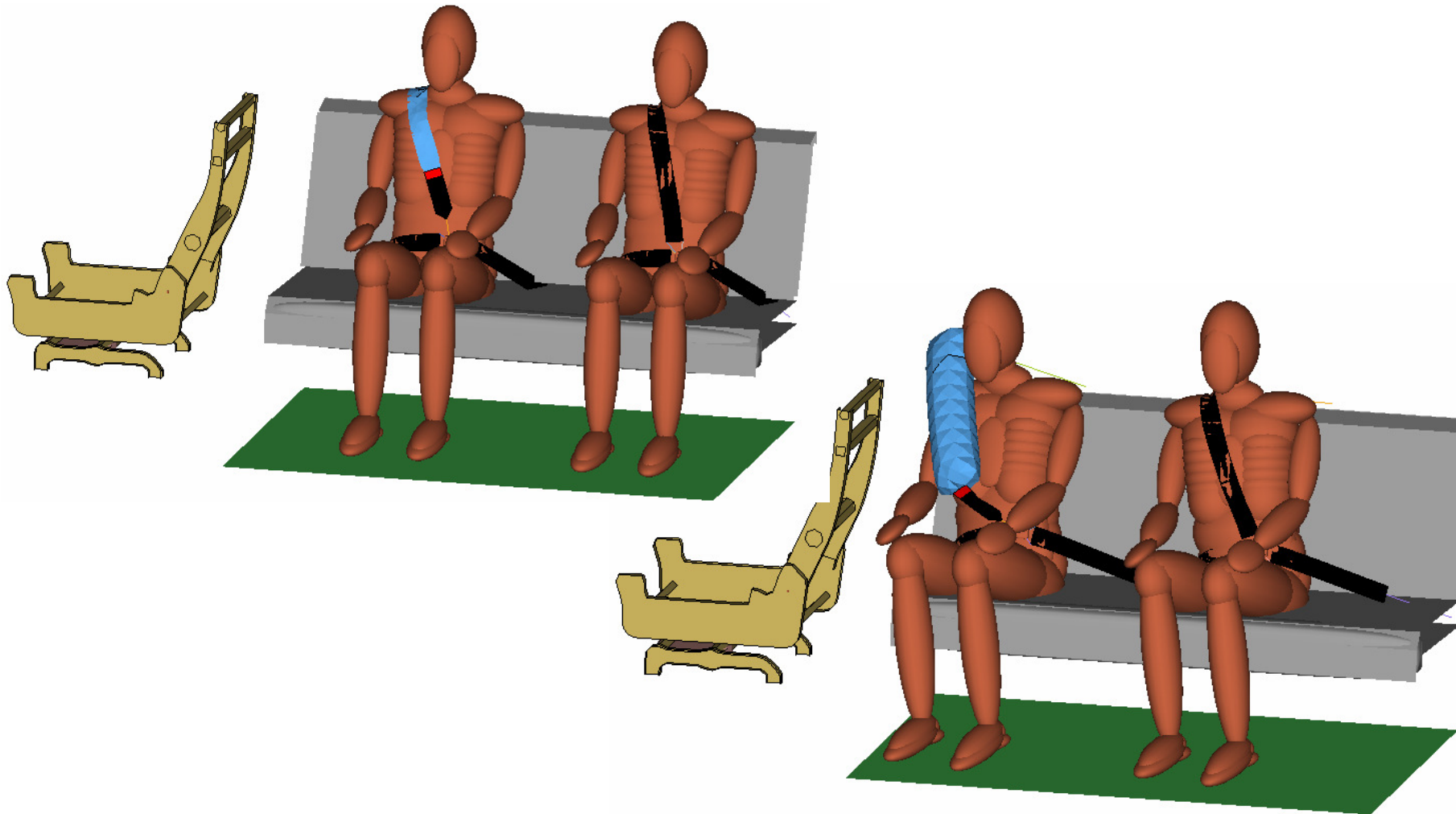
- ERJ170/190: Standard Passenger Seat Model Validation
- ERJ170/190: 1<sup>st</sup> Class Passenger Seat Model Validation
- ERJ170/190: Standard Passenger Seat weight reduction proposal



## HIC Sensitivity Study



## EMB-550 - Light Jet, 2010: investigation on inflatable shoulder restraints



Embraer use of CBA is:

- to compare similar installation scenarios for the same seat to determine the HIC-critical scenario for certification testing,
- to certify some configurations within the AC20-146 limitations.

Embraer developed and approved with ANAC a simple criteria for this determination and any scenario that is less critical than a tested and approved scenario (used for model validation) can be covered by similarity (no additional HIC test for the less critical new scenario).

Many regional jets front row HIC scenarios were tested to HIC values greater than current AC20-146 limitation of 700 (ref. section 7.1.1.4).

***Therefore, Embraer would like to suggest AC 20-146 HIC limit to be extended to 1000 (same limit for testing) once there is a good enough model-test correlation.***



*Thank you  
for your  
attention!*

Contact:

Luis C. Linzmaier, e-mail: [luis.linzmaier@embraer.com.br](mailto:luis.linzmaier@embraer.com.br), Phone 55 12 3927-6858

Sergio T. Soares, e-mail: [sergio.soares@embraer.com.br](mailto:sergio.soares@embraer.com.br), Phone 55 12 3927-3472