



New Train Design for Sleeper Comfort, Efficiency and Safety

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16 November 2010

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Introduction

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Content

- **Zefiro family**
- **ECO4**
- **Challenges**
 - **Comfort**
 - **Efficiency**
 - **Safety**

ZEFIRO Very High Speed trains

The ZEFIRO products will cover a wide range of products:

ZEFIRO products

ZEFIRO250

- Coaches
- **Sleeper**
- 8 car train
- 16 car train

V300ZEFIRO*

- UIC coaches
- 8 car train
- 16 car train

*In cooperation with AnsaldoBreda for selected markets.

ZEFIRO350+

- Wide carbody coaches
- 8 car train
- 16 car train

Focus for this presentation

3

ZEFIRO. Very high experience. Very high speed.

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ECO4 – Energy Saving Solutions

- **ECO4** is a suite of solutions, services, products and technologies, offering the best in class environmental performance, by providing future-oriented technology for the rail industry of the 21st century today.
- **ECO4** is balancing the four “E”-cornerstones (Energy, Efficiency, Economy, Ecology) within convincing and reliable solutions, services and products.
- **ECO4** “

Now, more than ever: The Climate is Right for Trains

Welcome to the World of **eco**⁴



ZEFIRO. Very high experience. Very high speed.

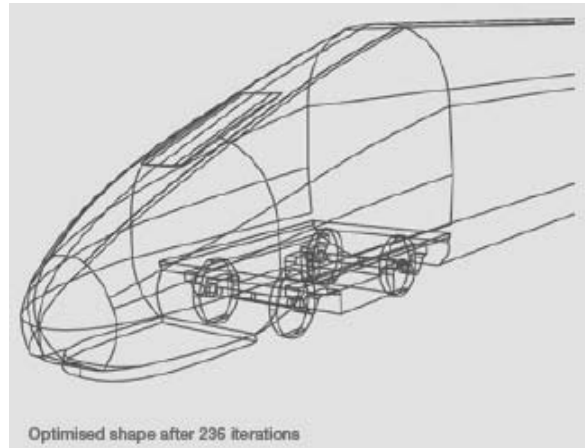
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ECO4 technology in ZEFIRO Sleeper

AeroEfficient Optimized Train Shaping

AeroEfficient is a new way of optimizing the complete configuration (e.g. head/tail, bogie, pantographs, equipment) for lowest wind resistance, cross wind stability, bow pressure wave and effects on noise.



From a well proven 200 kph CRH1A train to a Sleeper train



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Challenges in Sleeper design

■ **Comfort**

- The requirement set for passengers is to provide low noise level such that you can enjoy an overnight trip.

■ **Efficiency**

- In addition to standard approaches in modern train such as Electro Dynamic braking maximization, this new Sleeper trains should provide advantages to the Operator:
 - Energy efficiency with a new high speed nose (focus in this presentation)
 - Commonality of parts/components for maintenance
 - Commonality for the driver's desk to reduce training

■ **Safety**

- In addition to the inherent level of safety required for 250 km/hr operation, the design shall ensures the optimal fire safety protection for a Sleeper train

CRH1A to CRH1E sleeper version

Main changes

- **Vehicle level**
 - 250 km/h, 16-car configuration, Sleeper cars
- **Vehicle systems**
 - Center split gangway car 8 & 9, exterior door and steps, Pneumatic Line breaker, Kitchen increased capacity, Pantograph up to 250 km/h, On board Video entertainment system,...etc
- **Vehicle interiors**
 - Sleeping modules, lounge area, crew compartments
- **Electrical and control**
 - TCMS software modified, components re-arranged in cubicles and lockers
- **Exterior design**
 - High speed nose
- **Bogie**
 - 250 km/hr operation



Comfort Noise

- **Contractual requirements on noise**

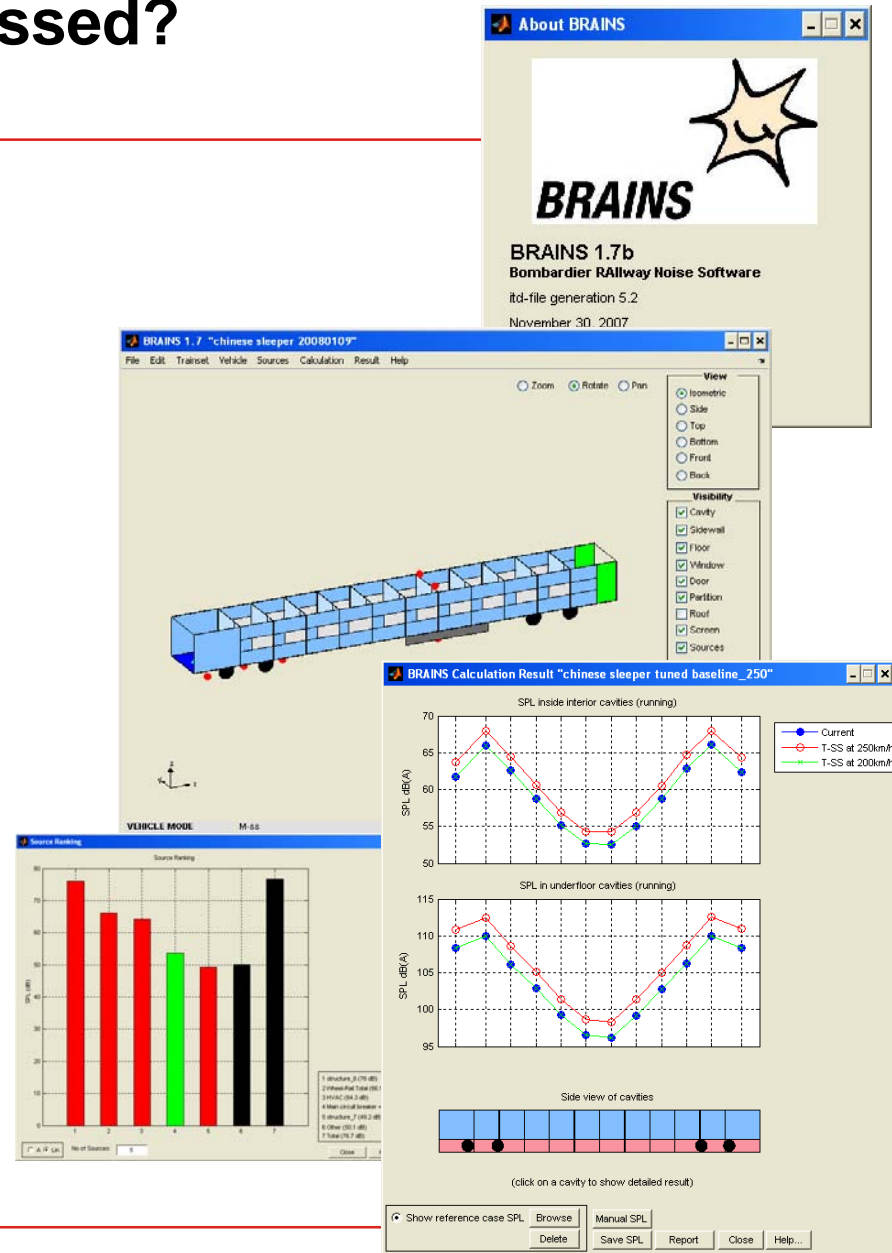
- When running at 250 km/hr in open country, the noise level in the sleeper room shall not exceed the following level: 65 dB(A) in the sleeper room.
- When sounding the warning horn, the following maximum level of 95 dB(A) in the drivers cab

- **Improvements to reduce noise**

- Main circuit breaker
- Floor
- Front design, horns and cab interior
- Sleeper module attachment to carbody
- HVAC
- Propulsion equipment

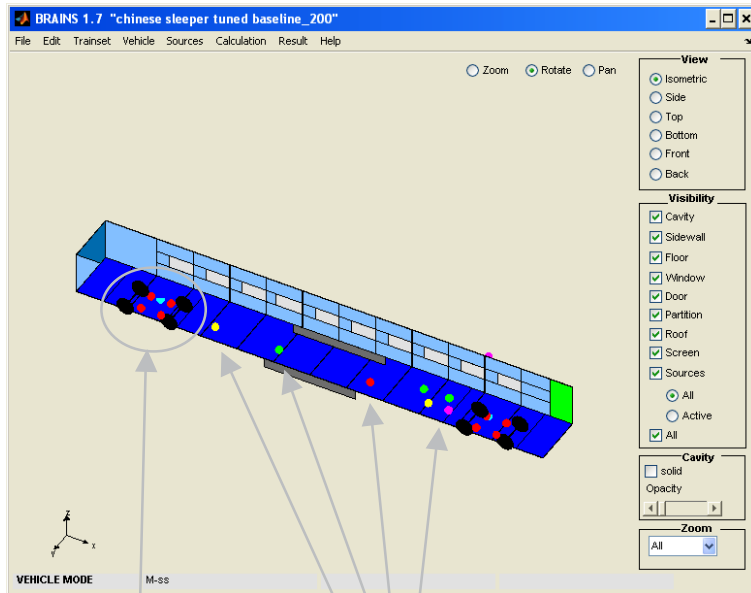
How is the Performance Assessed?

- Direct comparison with measured levels on CRH1 A vehicle (adjusted for higher speed operation)
- Bombardier in-house developed prediction tool for acoustics – BRAINS
 - Exterior noise and interior noise calculated
 - A model of the vehicle is built up by acoustic cavities, panels, partitions and sources
 - Noise measurements from CRH1A used to tune the model
 - Model updated with new data from suppliers when available



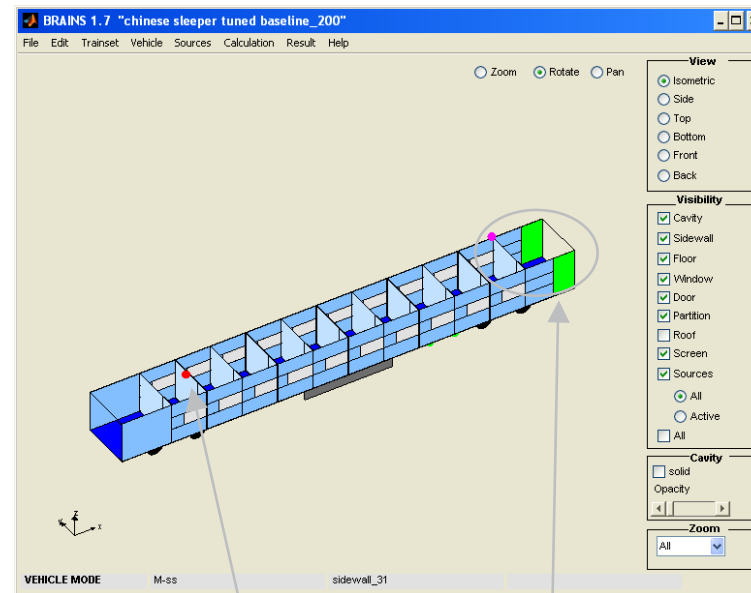
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Noise predictions



Sources in underframe

Sources in bogie
(Traction Motor
+gear box)



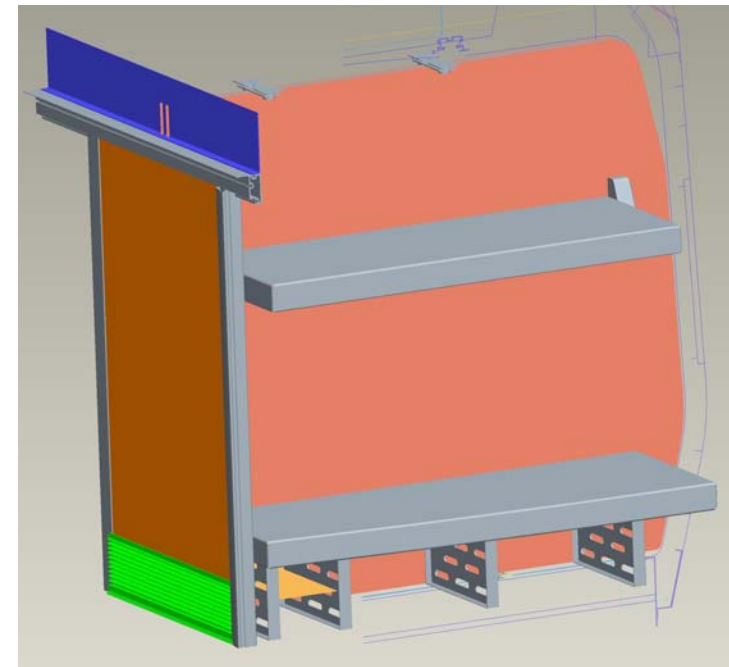
HVAC

Entrance area

- Calculations show that 3 dB reduction compared to CRH1A design must be achieved to reach 65 dB(A) inside (particularly low frequency structure-borne noise need to be reduced)

1st example HVAC

- **Return air intake**
 - A 1 m long silencer integrated
- **Transfer air between sleeper rooms and aisle**
 - A noise trap integrated at the air opening (green area) in the sleeper room to insure privacy



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2nd example

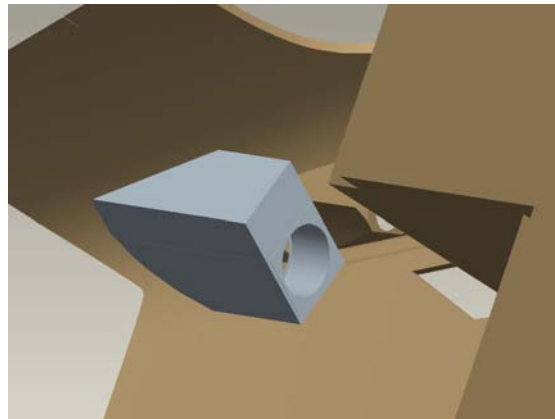
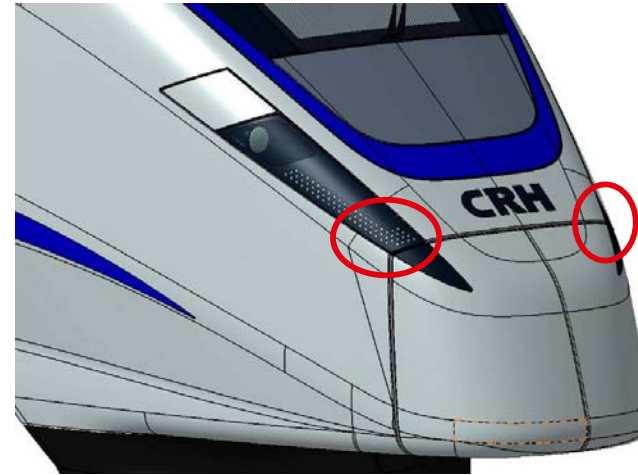
Front - Cab – Horns

- **Main issue has been to ensure that there are no acoustic leaks into the driver's cab**
- **Same floating floor proposed as in the sleeper cabins**
- **Horn position (sealed box in front)**
- **Outer surface as smooth as possible to avoid aero-acoustic noise (no protruding objects and cavities like handrails, HVAC, etc)**

Horns

2nd example

- Sealed box to avoid noise leakage from horn into cab
- Sufficient volume of box to ensure good function of horn



Efficiency

High speed nose



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New high speed nose developed specifically for the Zefiro 250 Sleeper.

Efficiency

High Speed nose

- Aerodynamic calculations (CFD) are carried out to primarily assess the effects of the **Nose** and **Tail**. Results are used to calculate the total running resistance.
- Improvement on the aerodynamic resistance due to new streamlined front-end of CRH-Sleeper is equivalent to the power of one traction motor on a 16 car trainset (40 TM/train)



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Fire Safety

Fire safety measures are:

- **Combustible material fire property**
- **Fire alarm (focus in this presentation)**
- **Fire fighting equipment**
- **Safety evacuation**

Fire Detection System tasks

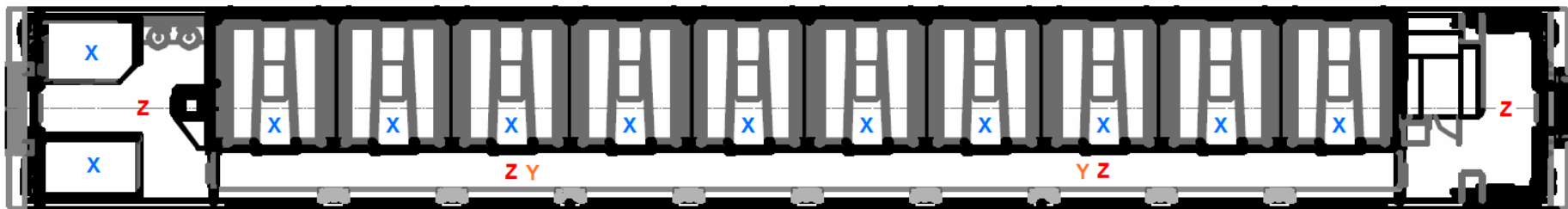
- **The train is equipped with a Fire Detection System, which detects smoke/heat in the driver's cab, crew cabin, toilettes, sleeping compartments and passenger areas.**
- **The purpose with the Fire Detection System will be in case of fire, to rapidly detect the smoke inside the train and thereby prevent spreading in other parts of the train.**
- **It will also announces and turn on the light in the sleeping compartment where fire is detected, the purpose of this is to wake up sleeping passengers and alert the surrounding area.**
- **A fire will both generate smoke and heat which the combined heat/smoke detector is able to detect.**

Soft sleepers cars

Location	Combined heat/smoke detector (X)	Aspirating smoke detectors (Z)	Audible alarm (80dB) (Y)
Toilet	2	-	-
Sleeping compartment	10	-	-
Vestibule/Hallway	-	4	2
HVAC control panel	-	-	-

A-END/A端

B-END/B端




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Key advantages of the *ZEFIRO* Sleeper

- ▶ Designed for highest operational speed (250 km/hr).
- ▶ Provides a comfortable, efficient and safe operation.
- ▶ Futuristic Design Concept beneficial of Bombardier knowledge and expertise in aerodynamics
- ▶ Ecological – incorporates Bombardier’s ECO⁴ feature

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A sleek, modern white train with a glowing blue light strip running along its side, viewed from a low angle. The train is positioned in a station with large glass windows in the background. The lighting is soft and blue-toned, highlighting the train's aerodynamic design.

Thank you for your attention !