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## High Speed Trainset Velaro E for Spanish National Railways RENFE

In July 2001, RENFE placed an order with Siemens to deliver 16 high speed trains for the Madrid-Barcelona-French border line. Then, in December 2005, another 10 trains were ordered. This fleet will reduce the travel time for the distance of 625 km from Barcelona via Zaragoza to Madrid to less than 2 1/2 hours.

The Velaro® for Spain (Velaro E) train is based on the advanced ICE® 3 train of German Rail (DB AG), and it is currently the world's fastest series-production multiple unit train in commercial service.

The trainset develops 8,800 kW traction power for a maximum operating speed of 350 km/h. It offers the highest degree of comfort and, with its four onboard galleys, highquality catering for 405 passengers in three classes. Comfort and safety are guaranteed by the proven running gear technology from Siemens, while entertainment is provided by the audio and video programs. The advanced European ETCS Level 2 signaling system based on the GSM-R standard, as well as the proven LZB – both systems from Siemens – protect train operations.

### Technical Data

Maximum speed	350 km/h
Train length	200 m
Track gauge	1,435 mm
Voltage	25 kV / 50 Hz
Traction power	8,800 kW
Brake systems	Regenerative, rheostatic, pneumatic
Number of axles	32 (16 driven)
Wheel arrangement	Bo'Bo'+2'2'+Bo'Bo'+2'2'+2'2'+Bo'Bo'+2'2'+Bo'Bo'
Number of bogies	16
Max. axle load	17 t
Number of cars per train	8 (1 Club, 2 Preferente, 1 Cafeteria, 4 Turista)
Number of seats	405 (38 / 103 / 264) (Club / Preferente / Turista)
Operating temperature range	-20°C to +50°C
Signaling systems	ASFA, LZB, ETCS



### **Trainset: A proven concept**

The Velaro E is a multiple-unit trainset in which the traction and all technical modules are distributed under floor over the length of the train. This means that the full length above floor of the train is available to the passengers, offering 20% more room than conventional trains of the same train length.

### **The clear advantage: Optimized performance**

The trainset concept results in overall operating advantages:

- Improved leverage of the adhesion coefficient during acceleration because 50% of the axles are driven
- Ability to travel on sections with steep gradients up to 40‰
- Due to the evenly distributed weight across the entire trainset, the load for the individual wheelset is reduced. This reduces stress on the track as well as the maintenance requirements on the running gear. The load per wheelset is lower than the international standard of 17 metric tons.

### **Additional benefits: Ultra-smooth ride**

The evenly distributed weight also improves the running characteristics and thus comfort.

- The train length of 200 m is ideal with the requirements of the Technical Specification of Interoperability (TSI). It means that the train can run in double traction – with a total length of 400 m. This means that the Velaro E can run with two coupled trainsets on a section of the track and then be divided into two trains for different final destinations.

### **Impressive traction**

The Velaro E has four identical, independent traction units. This principle provides clear advantages in continuous service:

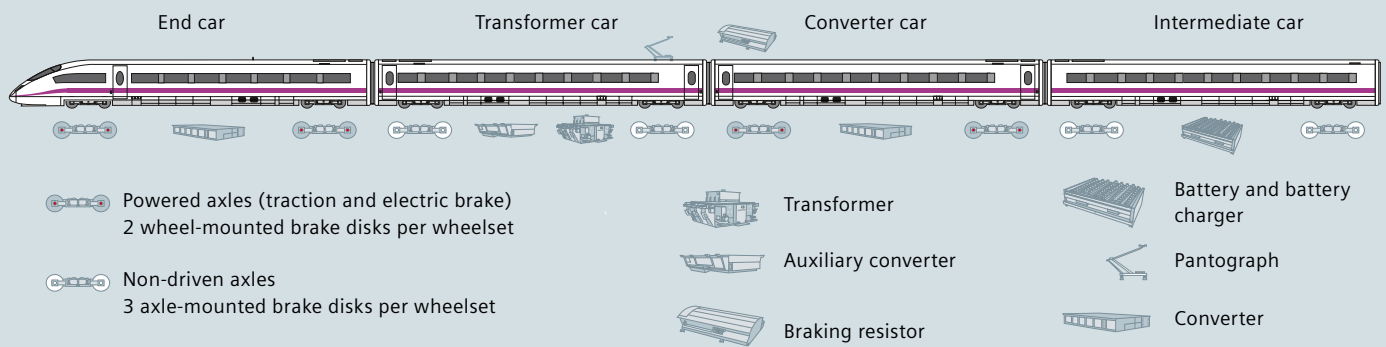
- If one traction unit fails, it can be disabled without affecting the remaining units. This enables the train to safely reach its destination with 75% of its maximum rated traction and braking power.
- Low-maintenance three-phase asynchronous motors with cage rotors ensure high availability for productive service.

### **One train. Three classes. Comfort times eight.**

The front section of the train houses an end car of the Club class, with premium service plus its own galley. The generous use of leather as well as large video screens and a unique forward view of the track characterize the special ambience of this class.

Next comes the Preferente class. Here, too, passengers can find a high-quality ambience and personal service at the business class level.

The transition between the two top classes and the Turista area is formed by the cafeteria car. It accommodates additional services: The customer service desk as well as spaces for the train personnel and for check-in luggage. Adjacent to this are the cars of the Turista class. Of course, they also feature special areas and equipment for passengers in wheelchairs. Here again, the highlight is the lounge that provides an unobstructed view of the track.



### The result

A concept that makes the most economic use of the available space while offering passengers a comfortable ride and maximum mobility, consistent across all three service classes.

### Excellent climate

Spain is a sunny country. This is reflected in the design of the Velaro E:

- Redundant air conditioning system, upgraded by about 25% for operation at outside temperatures up to 50 °C
- Separate air conditioning for driver's cab

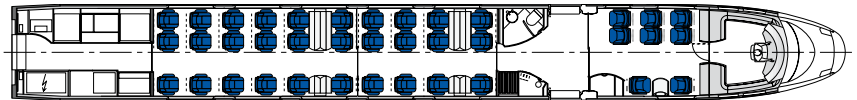
### Exciting entertainment

The passenger information system builds on previous experience and incorporates advanced technologies.

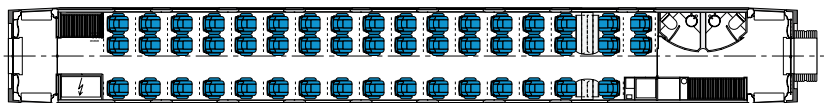
- In all car classes, large video screens that are clearly visible from every seat provide exciting entertainment. The program can be assembled by the train attendants, selecting from different video channels for each car.
- The compatibility with advanced media and formats – such as DVD and MP3 – makes sure that passengers have access to the latest productions in top quality.
- Seven different stereo audio programs can be received at every seat.

### The latest news

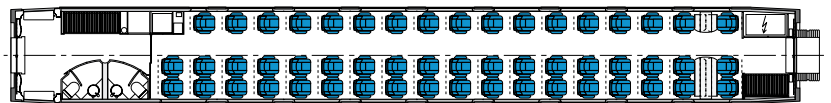
- The central announcements for all passengers are coordinated from the customer service office via a computer with GSM interface.
- Announcements and internal communication can be made from 12 fixed intercom stations. The system offers the possibility of group selective announcements (e.g. for individual cars, classes)
- Passengers receive information via interior and exterior LED displays. Owing to the expected international audience, the information can be provided in English, Spanish, French and Catalan.



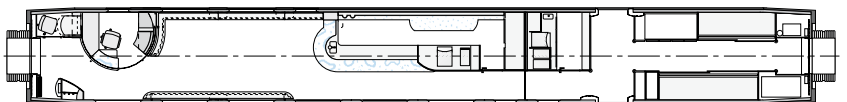
End car Club



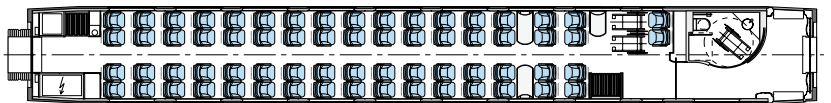
Transformer car Preferente



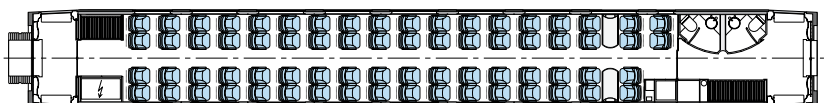
Converter car Preferente



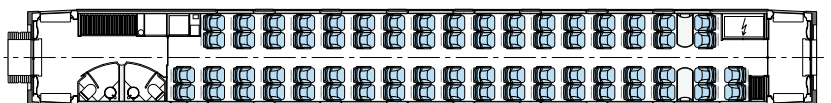
Intermediate car Cafeteria



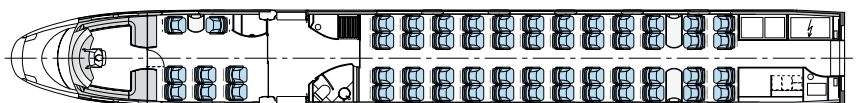
Intermediate car Turista



Converter car Turista



Transformer car Turista



End car Turista





### Perfect control

The Train Communication Network (TCN), consisting of the train bus (WTB) and the vehicle bus (MVB), ensures a smooth and reliable data transfer. Both between the two 4-car traction units of the 8-car train and between two coupled trainsets.

The consistently redundant design of the TCN system provides additional clear advantages:

- Significant improvement of the availability of the communications paths
- Savings in terms of hardware, installation volume, weight, and lifecycle costs
- Increased data transparency and shorter data propagation delays through the reduced number of interfaces and subsystems

### Sophisticated onboard power supply system

Providing maximum comfort for the passengers requires an especially efficient electrical system. Continuous busbars ensure the reliable supply of these electrical loads, including:

- Heating, ventilation and air conditioning
- Fans and pumps
- Microwave ovens
- Lighting
- Coffee machines
- 230 V sockets
- Communication system

### Proven safety

The bogies are proven in worldwide operation and contribute to the exemplary lateral guidance performance of the Velaro E. They also maximize stability for excellent running comfort. Even more important than a rapid acceleration is a rapid deceleration. On the Velaro E, the electric brake allows automatic switchover and braking in regenerative and rheostatic mode.

Braking in regenerative mode is used preferentially in routine service, which prevents unnecessary wear on the mechanical brakes. Only when the network is no longer able to absorb the electric braking energy of the traction motors is the rheostatic brake used.

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The information in this document contains general descriptions of the technical options available, which do not always have to be present in individual cases. The required features should therefore be specified in each individual case at the time of closing the contract.