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Background Information

Siemens Mobility GmbH

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The ICE celebrates its 30th birthday

On May 29, 1991, six ICE 1 trains converged in Kassel-Wilhelmshöhe from different directions and officially inaugurated the era of high-speed rail travel in Germany. The path to this event was paved by a comprehensive phase of research and development dating back to the 1970s conducted by the Federal Ministries for Transportation and for Research and Technology, Deutsche Bundesbahn (today Deutsche Bahn (DB)), and a consortium of companies. The goal of the project, in addition to the systematic research for a suitable wheel-rail system, was the development of a high-speed trainset comprised of two locomotives-like power cars and passenger cars that could reach speeds between 300 and 350 km/h. The power cars were developed by an industrial consortium, led by Krupp Industrietechnik, with Krauss-Maffei and Thyssen Henschel. AEG, BBC and Siemens were responsible for developing the electrical equipment. The Krauss-Maffei locomotive business was acquired by Siemens in 2001.

1985: InterCityExperimental (ICE/V) – Class 410

In March 1985, the aerodynamic power cars of the InterCityExperimental, class 410, were turned over to DB. Together with a measurement car and two demonstration passenger cars, the experimental train began practical testing in 1986. Some of the components were taken over from class 120 locomotives. A new pantograph was developed for the top speeds of 350 km/h. Power cars and passenger cars were braked for the first time with wear-free eddy current brakes and disk brakes, and the power cars were also equipped with regenerative brakes to recuperate braking energy and feed it back into the power line.

Test runs were conducted beginning in 1986 on a section of the new high-speed line from Hanover to Würzburg. On May 1, 1986, the train set a new speed record of 406.9 km/h between Würzburg and Mottgers, surpassing the previous record of the French TGV by 26.5 km/h.

Siemens Mobility GmbH
Communications

Otto-Hahn-Ring 6
81739 München
Deutschland

1991: Intercity Express ICE 1 – Class 401

The successful tests of the Intercity Experimental led in mid-1987 to the signing of 13 principal contracts between Deutsche Bundesbahn and the manufacturers of the experimental train and other component suppliers. Siemens, together with AEG and BBC, was responsible for the electrical equipment of the power cars. Experience gathered from the comprehensive test runs was incorporated in the construction of the ICE 1.

DB ordered 60 trainsets in a number of tranches: Each trainset comprised two 280-km/h power cars with two double-axle bogies and 9,600 kW output, together with twelve passenger cars in first- and second-class configuration, and a dining car with a raised roof. The pressure-tight trains, so designed because of the many tunnels on the high-speed lines, are 358 meters long and have currently 703 seats. Siemens equipped the power cars 401 051 to 401 090 and 401 551 to 401 590 with GTO inverters, each with an output of 2,400 kW. By employing GTOs rather than thyristors, the number of semiconductors could be reduced by 90% and the power car weight was reduced by roughly two tons. The first power car, numbered 401 001, was handed over to DB on September 26, 1989 at the Krauss-Maffei factory in Munich-Allach, today Siemens' locomotive factory.

Duewag, acquired by Siemens in 1989, produced around one-quarter of the comfortable passenger cars – 168 out of a total of 694 – at its Krefeld factory. They offered a completely new level of travel comfort, with music and radio programs available at every seat and a passenger information system on LCD displays.

On June 2, 1991, DB inaugurated regularly scheduled high-speed service with the first 19 ICE 1 trains. The new high-speed lines Hanover-Würzburg (324 km) and Mannheim-Stuttgart (99 km) shortened travel time on north-south connections by one to two hours. The highly comfortable trains were so popular with the public that a thirteenth passenger car sometimes had to be added.

1996/1998: ICE 2 – Class 402

For economic reasons, DB decided in favor of operating so-called half-trains on the newly planned ICE lines Berlin-Hanover-Cologne, and Berlin-Hanover-Bremen; this enabled DB to revive the practice of splitting trains when needed. The practice has continued to this day, where, for example, two ICE 2 trains from Berlin are

separated in Hamm and continue as split trains via the Ruhr Region to Düsseldorf or via Wuppertal to Cologne.

The 44 trainsets of this ICE generation are comprised of a power car, six passenger cars and a cab car. The power cars of the class 402 trainset generally correspond to those of class 401, but have an automatic coupling behind the nose hatch which allows the half-trains to be uncoupled or coupled without manual assistance. The bodies of the power cars were built at ABB in Kassel and Krauss-Maffei in Munich and completed by Siemens in Essen. Krupp Verkehrstechnik in Essen has been owned by Siemens since 1996.

Part of the passenger cars – a total of 121 1st and 2nd class open plan cars in the class 806 – were produced at Siemens' subsidiary Duewag in Krefeld. The newly developed cab cars were built by ARG in Nuremberg. The ICE 2 trains, only 205 meters long, have a new dining car without a raised roof. The first trainsets were put into operation beginning on September 29, 1996 on the Frankfurt/Main-Bremen line. Since 1998, the ICE 2 has dominated the growing high-speed network that since also includes the Hanover – Berlin line.

1999 – 2001: ICE 3, Class 403 and Class 406

Requirements for the new high-speed line between Cologne and Rhine/Main – with inclines of up to 4 percent, a desired top speed of 330 km/h, and an axle loading gauge limited to 17 tons to meet international standards – led to a completely new concept for the ICE 3: a high-speed trainset with traction motors distributed underneath the whole train.

The trainsets, developed in a consortium with Adtranz (ABB Daimler Benz Transportation) led by Siemens, have many advantages compared to their predecessors. The ICE 1 as well as the ICE 2 were driven by one or two power cars with four axles each. Since the four axles of every second ICE 3 car are driven, the trainset can accelerate faster with less power and, during generative braking when all eight traction motors function as generators, feed power back into the overhead line. Another advantage is the higher number of seats for the same train length.

DB's ICE 3 is the first European high-speed train in which the traction motors, transformers and inverters are all installed underneath the train. A powered end car with driver compartment, an unpowered transformer car and a powered inverter car comprise a functional unit. The symmetrical train halves are each supplemented by a passenger car. The roughly 200-meter-long trainset has a top speed of 330 km/h.

Along with the currently 49 single-system trains in class 403 developed for the 15 kV/16.66 Hz overhead power system used in Germany, Switzerland and Austria, DB also operates 13 multisystem trains in international service with the Netherlands, Belgium and initially also France. In addition, Nederlandse Spoorwegen (NS) has three trains from the same class in service.

For the first time in Europe, the unpowered cars of these high-speed trainsets are equipped with eddy current brakes. And for the first time, the trains have environmentally friendly air conditioning systems that operate without chemical coolants. The trains have a passenger information system. The lounge in the first-class end car offers an open view of the rail line through the driver's compartment as well as space for additional seats.

1999 – 2000, 2004: Tilting ICE-T, Class 411 and Class 415

Parallel to the ICE 3, the IC NeiTech consortium, led by Bombardier DWA, with Duewag, Fiat and Siemens, developed tilting electric multiple-unit trains. They are similar in design to the ICE 3 and are used on older and especially curvy rail lines in order to shorten travel times by ten to 20 percent. Higher speeds on curves are achieved by using a tilting technology developed by Fiat that tilts the train at an angle of up to eight degrees toward the inside of the curve. The system enables the train to tilt like a motorcycle rider in a curve and thus compensate for higher centrifugal forces on the passengers. As with the ICE 3, the traction units of the 230-km/h ICE-T are installed beneath the train. To ensure an even distribution of mass in the train, the end cars contain the transformers and pantograph. In curves, the pantographs don't tilt with the car, but flexibly move to remain parallel to the overhead line. The motorized cars have two traction motors: each drives one axle per bogie via cardan shafts. The middle car with bistro or restaurant is unpowered.

DB initially ordered 32 seven-car and eleven five-car tilting ICE-Ts, and later introduced them to ICE service on curvy routes beginning in 1999. DB received 28 additional class 411 trainsets, also designed for top speeds of 230 km/h, beginning in 2004.

2013: ICE 3, Class 407

For its international high-speed traffic, DB ordered the Velaro D, a new generation of multisystem trainsets designed for speeds up to 320 km/h, from Siemens in 2009. The train is based on the concept and experience of the ICE 3 and the variants that are successfully operating in Spain, China and Russia.

The 17 ordered ICE class 407 trains have end cars with a distinctive, sleek nose and a higher roof for optimized aerodynamics that reduces energy consumption and offers other advantages. The trainsets have 30 more seats than in the multisystem ICE 3, making it more economical to operate. The body shells are aluminum.

The configuration of the seats and tables can be freely arranged according to need along wall and floor tracks in the 18-meter long available space in the cars. The flexible interior design of the new ICE 3 class 407 makes the train future-proof, since the seating requirements and interior design will certainly change a number of times over the train’s minimum service life of 30 years.

2016: ICE 4, Class 412/812

When DB ordered 137 ICE 4 trainsets since 2011, the primary requirement for the design was to ensure the greatest possible flexibility in train configuration and performance. The trains, initially given the working name ICx, differ from the previous ICE models through their new traction concept.

So-called power cars provide traction, and these units can be located in the ICE 4 trainset according to the power needed and the train’s length. About half of the trainset can be comprised of power cars that have two powered double-axle bogies and also contain nearly the complete traction equipment with transformers and inverters. Only the pantograph is located on one of the passenger cars. In addition, the ICE 4 has end cars with driver compartments, a restaurant and a service car. The cars are to be delivered in part by Bombardier (now part of the Alstom Group).

The ICE 4 variants include, for example, a seven-car train with three power cars and a top speed of 250 km/h, as well as a twelve-car configuration with six power cars and a thirteen-car train with seven power cars both capable of reaching up to 265 km/h in the future. With a total of 918 seats, the thirteen-car ICE 4 offers more seats than any other ICE before.

A new ICE 4 is currently being added to DB's long-distance fleet every three weeks. To date, Siemens Mobility has delivered 75 of the ICE 4 trains ordered by Deutsche Bahn. The first ICE 4 trains have been in passenger service since 2016.

2022: ICE 3 Neo

Beginning in 2022, 30 new high-speed trains will strengthen DB's long-distance fleet. In July 2020, Deutsche Bahn awarded Siemens Mobility a contract worth about one billion euros for the trains. Technically, the new train is based on the proven Velaro platform of the ICE 3. It has 439 seats and a top speed of 320 km/h. Features like frequency-permeable windowpanes for stable cellphone reception and spaces for bicycles on every train offer greater convenience. The first trains are to be delivered end of 2022.

Contact for journalists:
Eva Haupenthal, Tel.: + 49 152 01654597
E-mail: eva.haupenthal@siemens.com

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