The Acela Express brought high-speed rail travel to the United States.

A train for the 21st century

Operating at speeds of 240 km/h, the Acela Express, the fastest train in North America, revived a link with the epic railroad days on the new continent, using Nomex® brand paper for electrical insulation

On the 10th of May, 1869, in Promontory, a tiny settlement in Utah, the Union Pacific and the Central Pacific Railroad lines were joined to complete the very first transcontinental rail link between the east and west coasts of the United States. The railroad thus came to represent nothing less than the unity of the American nation and would become the backbone of a new 'conquest of the West', just as the covered wagons of the pioneers had before it.

The introduction of the Acela Express was an equally historic event. It was the first high-speed train to enter service in the United States and reduced journey times between New York and Boston to just under 3 hours and between New York and Washington, DC, to 2 hours and 45 minutes.

Passengers embark for their 240 km/h journey at the venerable Grand Central Station, in the center of Manhattan, and enjoy standards of safety, comfort and quality of service, which, according to Barbara Richardson, Amtrak's vice-president for marketing and communications, "conveys a brand new experience in rail travel."


The joining of the Union Pacific and Central Pacific Railroad lines in 1869 created the first rail link between the east and west coasts of the United States.

Unparalleled comfort and service

Apart from speed, Amtrak, operator of the Northeast Corridor network, sought to place the emphasis on passenger comfort and convenience, so that families, tourists and especially business travelers, who are the main clients on this line, come to regard the train as their preferred means of city-center to city-center transport.

Each seat has its own electrical socket and audio system, while first-class passengers also benefit from individual video facilities, sockets for laptops with internet connection and a sit-down dining service. The cars, which are designed to be accessible to persons with limited mobility, have wide corridors, toilet facilities, plenty of room for passengers, pay phones and generously sized lockable luggage compartments. Each train also includes a 34-seat dining car, offering a selection of meals.

In a society which has been dominated in recent times by car and air travel, this is a true renaissance. Admittedly, things have come a long way since the trains first arrived at Promontory. Today, the railroad has a very different image and fulfills quite different needs. Indeed, it is no coincidence that the first American high-speed train made its appearance on the Northeast Corridor network, from Boston in the north to Washington, DC, in the south, since this region is the most densely populated in the United States and has the most heavily congested transportation system.

At the beginning of this century, the train has been transformed from a powerful transcontinental link—as it was at the end of last century—into a preferred means of transport for passengers wishing to travel over short to medium distances of 200 to 500 kilometers (125-320 miles). For these distances, overall traveling times by train are usually shorter than by plane, due to the location of main-line stations in downtown areas, simplified check-in procedures, quicker boarding times and immediate luggage availability.

Rail travel is also more comfortable, more economical, less energy intensive and virtually pollution-free. Indeed, the success of the European and Japanese high-speed trains shows that over these distances, which are similar to the distances involved in the Northeast Corridor, the train is the most rational form of transport and can carry a lot more people.

The experience of the TGV

In Europe, high-speed rail travel already forms part of everyday life for millions of passengers, and traveling at 300 km/h is no longer a source of wonderment. The French TGV, the fastest passenger train in service, showed the way as early as 1981. Since then, high-speed rail tracks have multiplied, putting French cities such as Lyon, Rennes and Nantes within 2 hours traveling time of Paris.

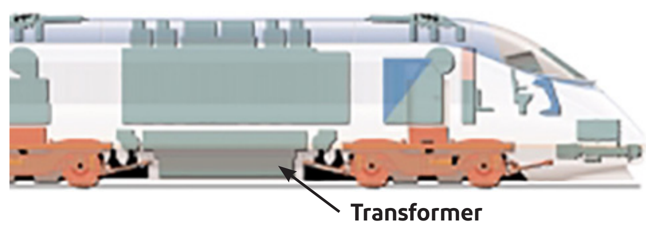
The German Inter-city Express (ICE) now links many of Germany's major cities, while Sweden's X2000 high-speed train operates a high-speed service between Stockholm and Gothenburg.

Elsewhere, Brussels is now just one-and-a-half hours from Paris, thanks to the Thalys, and the Eurostar looked to cut rail journey times between London and Paris to two-and-a-half hours.

By entrusting the building of the Acela Express to a consortium composed of Bombardier, the leading North American train manufacturer, and Alstom, the designer and manufacturer of the TGV, Amtrak benefited from the experience acquired over almost two decades of high-speed rail travel. For, while the 20 Acela Express trains ordered from the consortium were mostly built in the United States, they use some of the world's best technology.

Because of the sinuous nature of the terrain between New York and Boston, and the large number of relatively sharp bends, the Acela Express trains ordered were of the 'tilting' type, so that they could use the existing track, thus saving Amtrak the huge investment of building a dedicated high-speed line. The active tilting technology employed allows the carriages to tilt at an angle of 8 to 10 degrees relative to the bogies. This compensates for the centrifugal force and allows the train to travel at 240 km/h through bends that would limit a conventional train to 160 km/h, without affecting either passenger comfort or the stability of the train.

High-speed rail travel is all about speed, stability and safety, so anything that can be done to reduce the weight of the carriages and bogies, and particularly the drive system, including the motors and transformers, pays dividends. Says Stéphane Renaud, who managed the Amtrak project for Alstom's Traction Transformers division, "Since the first TGVs, Alstom has introduced major design improvements to the drive units to reduce their size and volume, notably through the use of high-performance materials, such as DuPont™ Nomex® paper and pressboard."



Schematic showing the location of the power transformers in the motor coaches of the Acela Express.

As the transformer is the heaviest component in the drive system, weighing about 11.5 tons, it was here that the initial research effort to achieve the optimum weight/volume/power ratio was concentrated. The situation was complicated by the fact that, because of the different supply voltages in the states along the Boston-Washington, DC, route, ranging from 25 kV/60 Hz to 12.5 kV/60 Hz and 12 kV/25 Hz, the Acela Express had to have triple-voltage capability with twin primary coils for use in-line or in parallel, depending on the supply voltage, and quadruple secondary traction coils.

In order to deliver the 5.745 MVA power required and to reduce the volume of the transformers so that they would fit beneath the two 6000 hp motor coaches of each train, the mass and cross-section of the copper conductors had to be reduced, raising the continuous operating temperature of the transformer to 160°C, with a peak temperature of 180 °C. As conventional materials are unable to provide the required safety margin of 220°C, Nomex® paper was the obvious choice.

By virtue of its unique ability to withstand electrical loads, and because of its mechanical strength, thermal stability, chemical compatibility, longevity and flame resistance, Nomex® is used as paper and pressboard in a large number of critical high-voltage insulation applications. In particular, this high-performance material makes it possible to reduce the weight of power transformers by between 15 and 25 percent, while optimizing the volume and considerably improving long-term reliability.

By decreasing the mass of the windings, all the transformer components, including the magnetic core, the tank and the volume of cooling oil, can be made smaller, saving not just a few kilos of insulation material, but several tons. And, since they are virtually free from aging, Nomex® paper and pressboard contribute directly to the transformers' 25- to 30-year lifespan and to easier maintenance.

International technology transfer

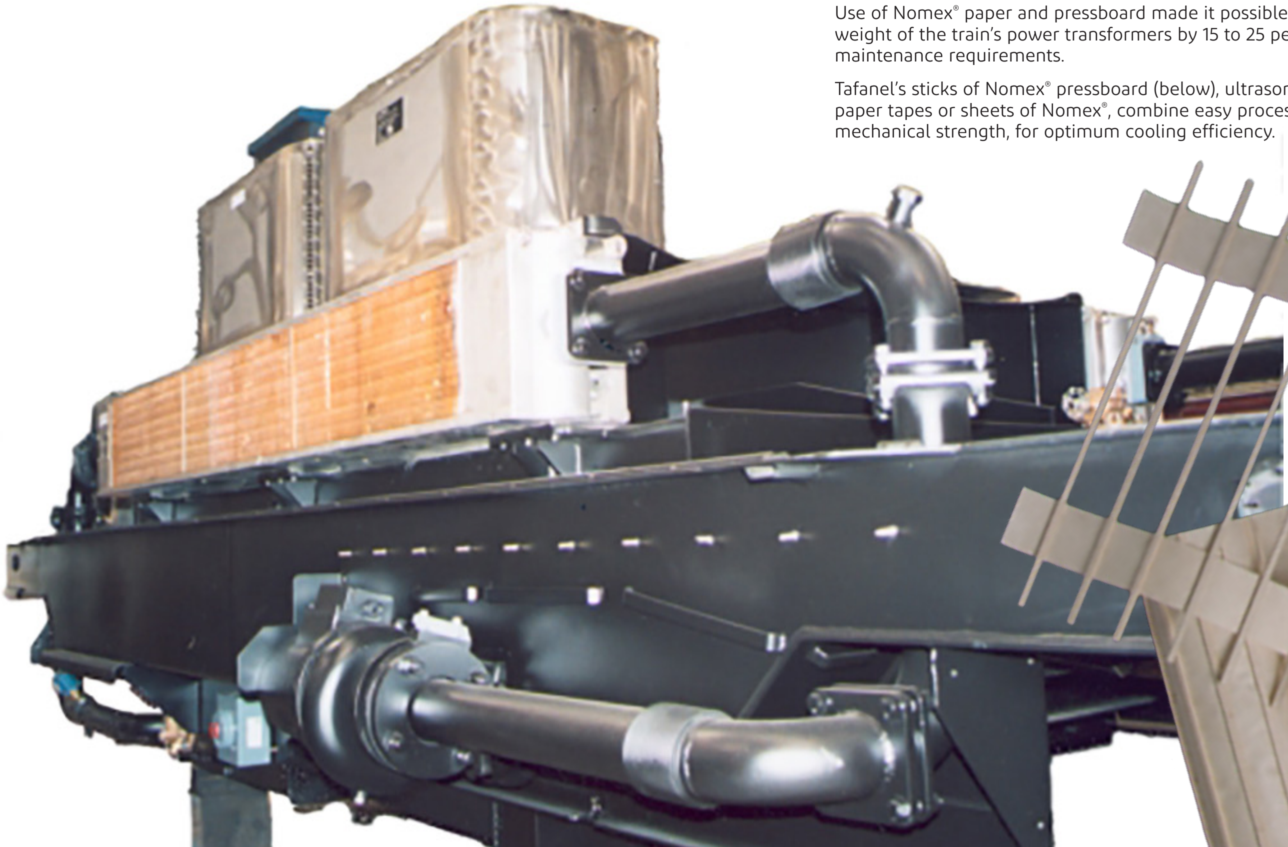
Manufacture of transformer coils at Alstom's Medford plant. Nomex® paper and pressboard are used for the ultrasonically welded cooling ducts and Nomex® paper for the conductor insulation.

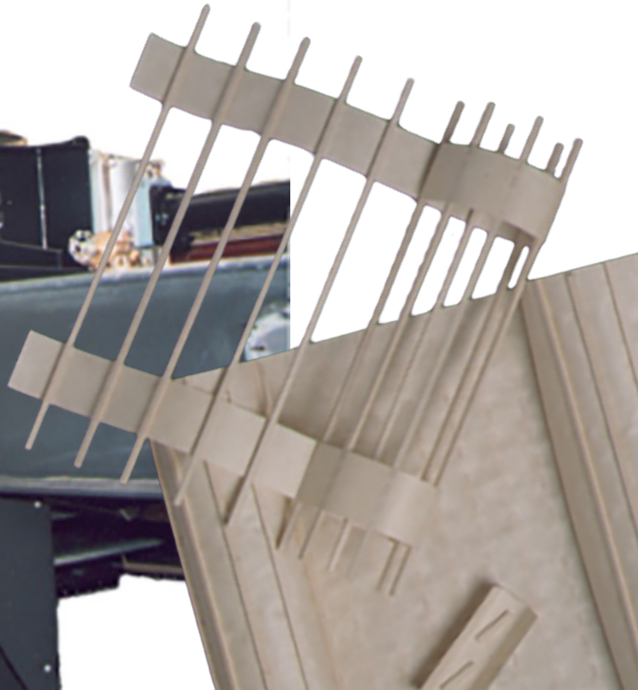
On the H Class transformers designed and manufactured by Alstom for the Acela Express, Nomex® paper is used to cover the copper windings on the coils, while Nomex® pressboard is used for the spacers that separate the coil layers and act as guides for the silicone cooling oil in which the internal transformer components are immersed.

Tafanel S.A., a French company specializing in the precision cutting and machining of high-performance plastic materials, produces these spacers for Alstom's plant at Medford, Oregon, where the transformers are assembled. Jacques Vaillant, general manager of Tafanel, which has developed an exclusive tool to optimize the cutting of pressboard sticks in Nomex®, emphasizes that his firm is "one of just two companies in the world to master the technique of welding material using ultrasonics, a technology which it introduced to this type of application. By replacing epoxy and polyester adhesives, this technology eliminates the risks of contaminating the cooling oil, offers very reliable and accurate assembly, and provides significant gains in productivity."

Use of Nomex® paper and pressboard made it possible to reduce the weight of the train's power transformers by 15 to 25 percent and reduce maintenance requirements.

Tafanel's sticks of Nomex® pressboard (below), ultrasonically welded on paper tapes or sheets of Nomex®, combine easy processing with excellent mechanical strength, for optimum cooling efficiency.





As a part of the technology transfer to the United States, Roger Wicks, DuPont market segment leader for Nomex® paper for immersed transformers, and Jean-Claude Duart, his European technical counterpart, worked closely with Alstom engineers in the United States and France to help provide technical support for this application.

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The assembly of the most powerful traction transformers, weight-for-weight, ever built in the United States takes place at Alstom's state-of-the-art facility in Medford, Oregon. This business has manufactured distribution and measurement transformers since 1969, but this job was a totally new experience. According to Pat Barry, who is in charge of the Amtrak project at the Medford plant, the American Alstom engineers and technicians were proud to take part in this project with the support of their European colleagues. The Acela Express venture is a story of successful technology transfer by the leader in high-speed electric traction and an opportunity for Alstom to establish itself firmly in the traction transformer market in the United States, in cooperation with DuPont and Tafanel.

The introduction of the Acela Express led to 61 firm orders delivered in the year 2000. A total of 12 transformers were delivered to the Bombardier factories at Barre, Vermont, and at Plattsburgh, New York, where the train's motor coaches are assembled before being taken to the Federal Railroad Administration test site at Pueblo, Colorado.

However, the Acela Express is only the beginning. Following the lead from Amtrak, high-speed rail links are springing up elsewhere in the United States, for example in California, between Seattle and Vancouver, in Georgia and in the Great Lakes region, to bring high-speed rail travel to an increasing number of American people.