

# A train for the 21st century

*Operating at speeds of 240 km/h, the 'Acela Express', the fastest train in North America, will soon revive 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' this autumn will be an equally historic event. It is the first high-speed train to enter service in the United States and will reduce journey times between

New York and Boston to just under 3 hours and between New York and Washington to 2 hours and 45 minutes.

Passengers will embark for their 240 km/h journey at the venerable Grand Central Station, in the centre of Manhattan, and will enjoy standards of safety, comfort and quality of service, which will, according to Barbara

Richardson, Amtrak's vice-president for marketing and communications, "convey a brand new experience in rail travel."

## Unparalleled comfort and service

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

Each seat will have its own electrical socket and audio system, whilst first-class passengers will also benefit from individual

video facilities, sockets for portable computers with modem connection and a sit-down dining service. The cars, which are designed to be accessible to persons with limited mobility, will have wide corridors, toilet facilities, plenty of room for passengers, pay-phones and generously-sized lockable luggage compartments. Each train will also include 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 Amer-

ican high-speed train is making its appearance on the North-east Corridor network, from Boston in the north to Washington in the south, since this region is the most densely populated in the United States and has the most heavily congested transportation system.

As we approach the next 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 kilometres (125-320 miles). For these distances, overall travelling 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 North-east 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 travelling 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 travelling time of Paris.



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.



When it enters into service later this year, the 'Acela Express' will bring high-speed rail travel to the United States.

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 will soon 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 is benefiting from the experience acquired over almost two decades of high-speed rail travel. For, while the 20 'Acela Express' trains ordered from the consortium are mostly being 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 are of the 'tilting' type, so that they can 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 manages 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

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performance materials, such as DuPont Nomex® paper and pressboard."

As the transformer is the heaviest component in the drive system, weighing about 11.5 tonnes, 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 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, DuPont 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 per cent, while optimising the volume and considerably improving long-term reliability.

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

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 tonnes. And, since they are virtually free from ageing, Nomex® paper and pressboard contribute directly to the transformers' 25 to 30-year lifespan and to easier maintenance.

International technology transfer 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, whilst 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 specialising in the precision cutting and machining of high-performance plastic materials, produces



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.

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 optimise the cutting of pressboard sticks in Nomex®, emphasises 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."

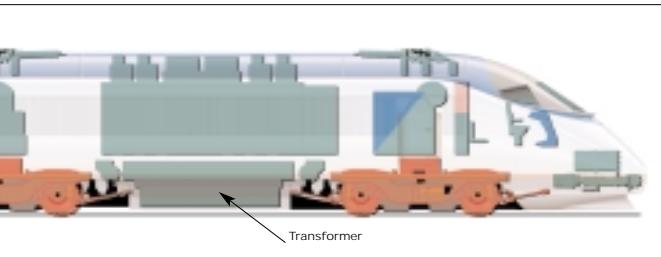
As a part of the technology transfer to the United States, Roger Wicks, DuPont market segment leader for Nomex® paper for immersed transformers, and Jean-Claude Duart, his European technical counterpart, worked

closely with Alstom engineers in the United States and France to help provide technical support for this application.

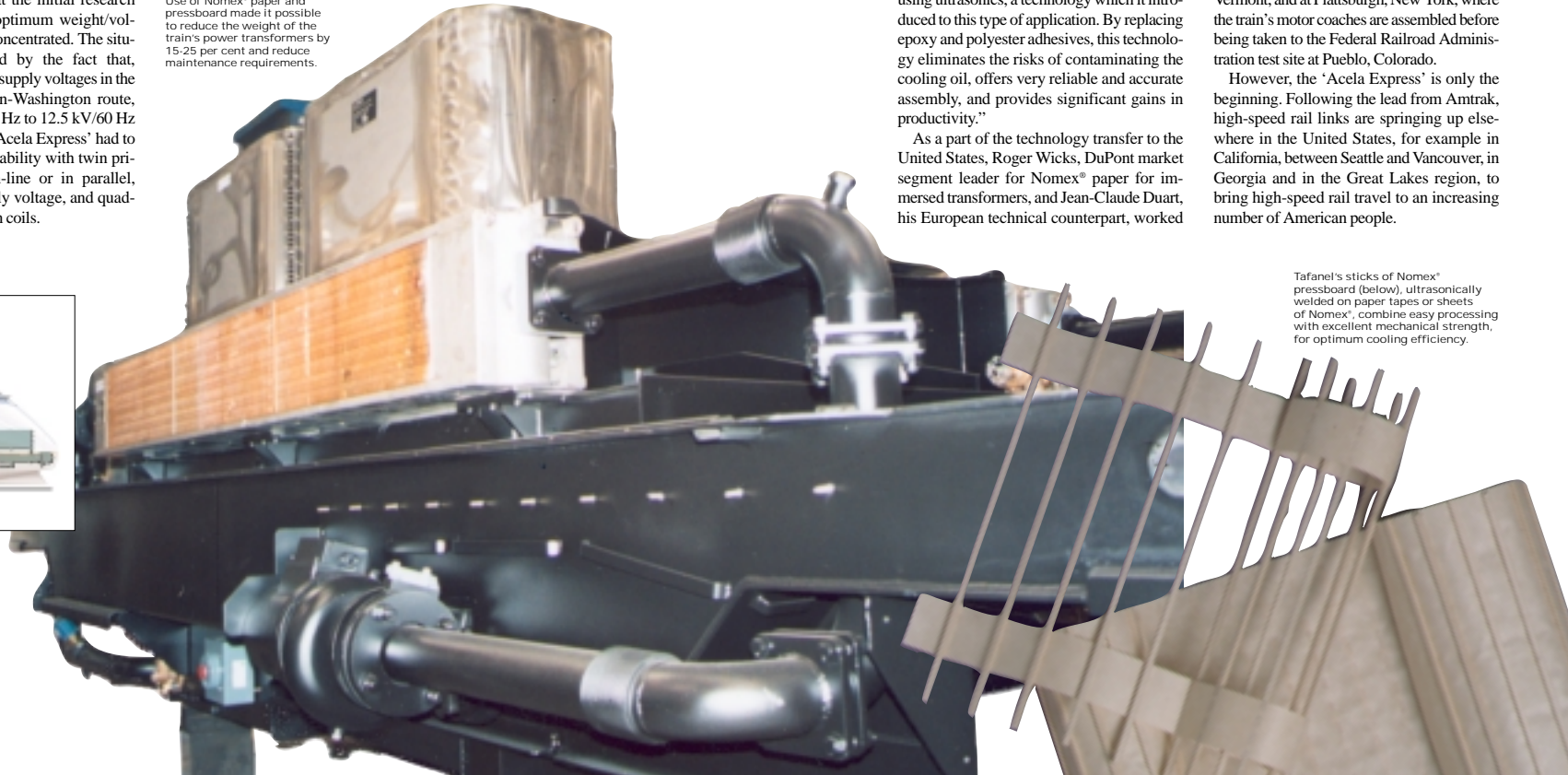
The assembly of the most powerful traction transformers, weight-for-weight, ever built in the United States is being undertaken at Alstom's state-of-the-art facility in Medford, Oregon. This business has manufactured distribution and measurement transformers since 1969, but this job is a totally new experience. According to Pat Barry, who is in charge of the Amtrak project at the Medford plant, the American Alstom engineers and technicians are proud to be taking part in this project with the support of their European colleagues. For, 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.

Today, the countdown to the introduction of the 'Acela Express' is well under way. Of the 61 firm orders due to be delivered by the year 2000, 12 transformers have already been 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.



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



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.