

# Reliable signal protection in railroad joints



The robust NIJ-6 "Hercules" insulated joints play an essential role in current railroad circuit based signal systems by dividing the track into segments that detect train presence and activate trackside signals.

*A new and innovative insulated joint (IJ) from Canadian company NorFast Inc. is helping to enhance railroad signal reliability in North America. The modular kit doubles the operational lifetime of the rail joint, reduces stress within the joint by over 60 percent and reduces the cost and time required for its installation – performance benefits which are largely attributable to the company's selection of flexible and resilient DuPont™ Hytrel® thermoplastic polyester elastomer for key insulating components.*

*By Helga Plishka, DuPont Engineering Polymers, Canada*

Insulated joints (IJs) play an essential role in current railroad circuit-based signal systems by dividing the track into short, electrically isolated segments or 'blocks', usually 2 to 5 miles (approximately 3 to 8 kilometers) in length, that detect train presence and activate trackside signals, as well as assisting railroad operators in the discovery of broken rails. Yet while IJs are essential to the delay-free operation of the track, they

also introduce weak points which can cause increased maintenance and service disruptions, thus constituting a potential derailment risk.

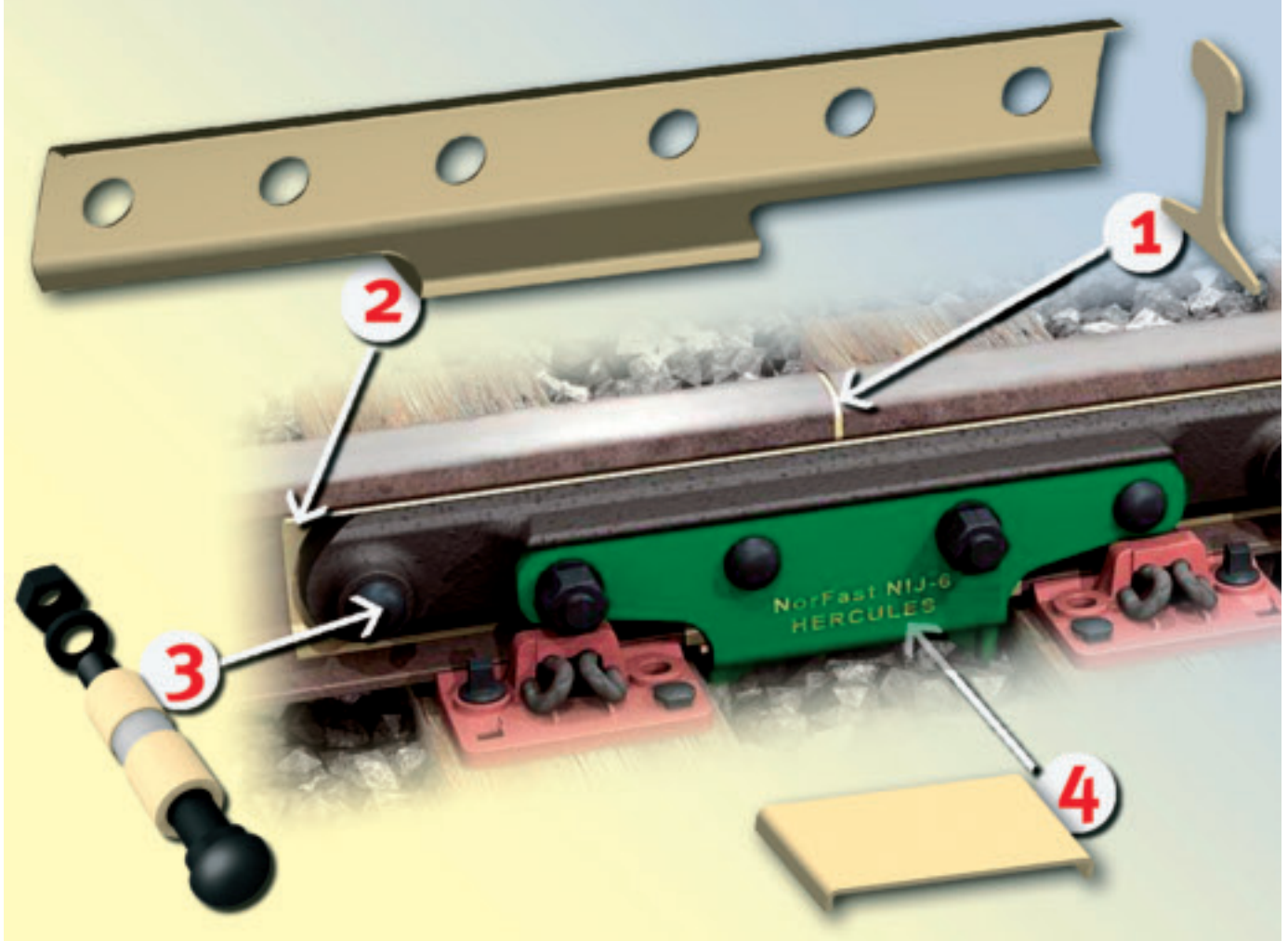
#### **Epoxy bonding weaknesses**

This was also the conclusion of Canadian railroad fastener-system manufacturer NorFast Inc., which resolved to provide its own innovative solution. Dr. Jude Igwemezie, president of ARRT Inc, NorFast's sister design company, explains: "It

was our belief that current bonded IJ designs, whereby a steel joint is bolted and glued into the middle of the rails using an epoxy, were inappropriate for today's high tonnage lines. A key issue was the use of the epoxy resin as an insulating material for isolating rail sections. It is brittle and responds poorly to the high tensile and flexural forces exerted on the rails.

As a result the epoxy would start to de-bond, causing the bars or bolts used in the joint to make contact with the rails and short out the signal in each block, which in turn would falsely indicate the presence of the train in the rail section."

As a direct result of the material deficiencies in bonded joints, the expected lifetime of the IJs was only 12 to 18 months on high tonnage



The NIJ-6 "Hercules" consists of seven principle parts, four of which are made from DuPont™ Hytrel® thermoplastic polyester elastomer: (1) for the insulating end post between the two adjacent rails; (2) as a liner between the bar and the rails; (3) in the patented thimble design that isolates and strengthens the six fixing bolts; (4) and as an insulating pad between the rail and integral saddle.

lines, with direct costs of thousands of dollars per mile per year for their maintenance. Furthermore, the installation of repairs required two welds in the track to incorporate a replacement joint, which in turn introduced new weak points in the rail and lengthened track-closure time.

**Hytrel®: a tailor-made solution**

It was against this background that NorFast developed the NIJ-6 "Hercules", a stronger, more resilient mechanical IJ designed to eliminate the need for in-track welding and thus reduce installation times. Fundamental to its two-year development project was the selection of an insulating material able to withstand the severe load environments of modern high tonnage lines, and to reduce stress within the joint's components.

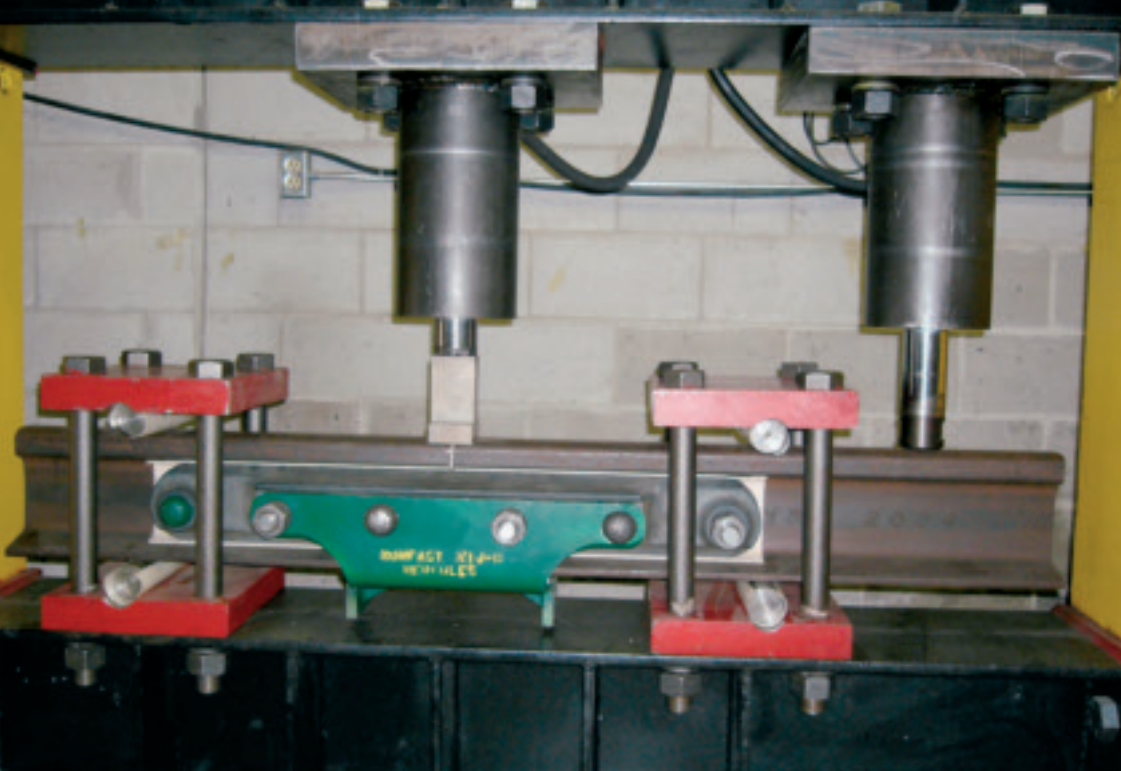
"Following the advice of Canadian polymer distributor CCC Plastics, we briefed DuPont of our requirements and DuPont™ Hytrel® thermoplastic polyester elastomer emerged as the tailor-made solution," says Dr. Igwemezie of the material selection process. A particularly flexible and durable grade of Hytrel® with high resistance to creep, impact and fatigue is used for four parts of the new NIJ-6 kit: for the insulating end post between the two adjacent rails; as a liner between the bar and the rails; in the patented thimble design that isolates and strengthens the six fixing bolts; and as an insulating pad between the rail and integral saddle.

However, the adoption of Hytrel® presented a steep learning curve for Dr. Igwemezie and his team, who had limited experience of polymer processing – an area where DuPont was able to provide invaluable assistance.

Further to support in initial prototype testing, DuPont helped source the material and manufacturing expertise to produce the first 1,000 insulating liners for field testing.

*The simple, in-field installation of the NIJ-6 "Hercules" saves two weld points while its modular construction means that worn components can be replaced quickly and with minimal disruption for a brand new joint.*





Fatigue testing of the joint at 60,000 pounds (27,000 kilograms) vertical loads for 3 million cycles showed no wear or damage to its parts, including those made of Hytrel®. Parts made with other polymers, and tested by NorFast on the same rig, were destroyed in under half a million cycles.

During the course of this work, injection molding was found to be the least economical option for part production due to the associated tooling costs. DuPont therefore investigated extrusion and thermoforming processes with several partner companies, before providing NorFast with data that enabled them to design their own thermoforming tool to produce the liner and pad. The spherical Hytrel® parts for the bolt thimbles were provided by a separate extrusion company.

#### Outstanding results

The performance of NorFast's NIJ-6 bears comparison with similar systems: the section modulus of the new IJ is greater than that of the rail, while fatigue testing of the joint at 60,000 pounds (27,000 kilograms) vertical loads for 3 million cycles showed no wear or damage to its parts, including those made of Hytrel®. Insulator stress within the joint is reduced by up to 65 percent compared with a standard joint, whereas thimble insulator stress is reduced by up to 75 percent.

Meanwhile, the integration of a saddle in the design provides structural redundancy in the unlikely event of bar failure and increases overall joint strength.

Its simple, in-field installation, which fits any type track and fastener without track modification, saves two weld points

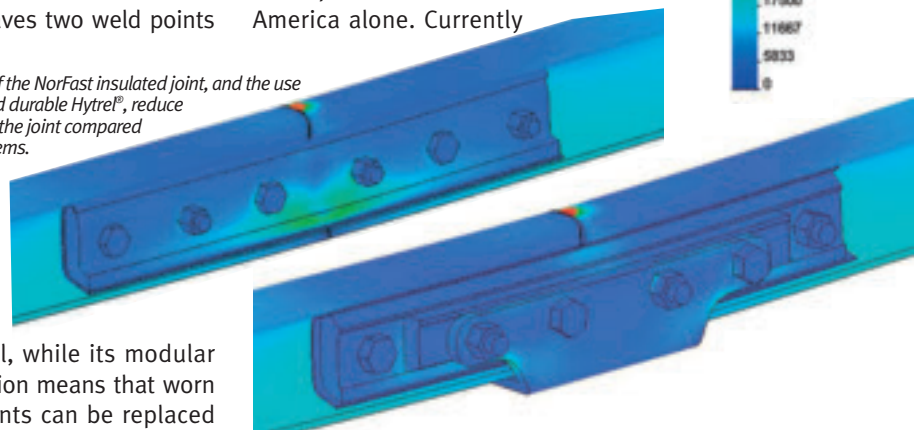
*The design of the NorFast insulated joint, and the use of flexible and durable Hytrel®, reduce stress within the joint compared to other systems.*

in the rail, while its modular construction means that worn components can be replaced quickly and with minimal disruption, creating a brand new joint.

Such is the confidence of NorFast in the longevity of its new system, the company intends to offer a 3-year or 400-million-gross-tons warranty on its continued operation.

The net result for passenger and freight railroad operators will be the availability of a new, innovative system that helps ensure track signal reliability and reduces train delays through IJ failures.

NorFast estimates the market potential of its new IJ at over US\$ 70 million in North America alone. Currently



over 100 NIJ-6 "Hercules" systems are being tested on passenger and haulage lines across the US and Canada before commercial availability.

The testing period will be defined to include twelve months of summer and winter conditions, whereby the NIJ-6 is expected to be exposed to seasonal temperature variances of between -40°C (-40°F) and 70°C (158°F). Yet Dr. Igwemezie remains confident in the success of the NorFast product, in no small way attributable to the company's cooperation with DuPont: "It would have been a lot more difficult for us to get where we are today, and as quickly as we did, without the

polymer engineering and manufacturing logistics of DuPont. It is a wonderful case of management and engineers from both sides working on the development of a railway track safety device."

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