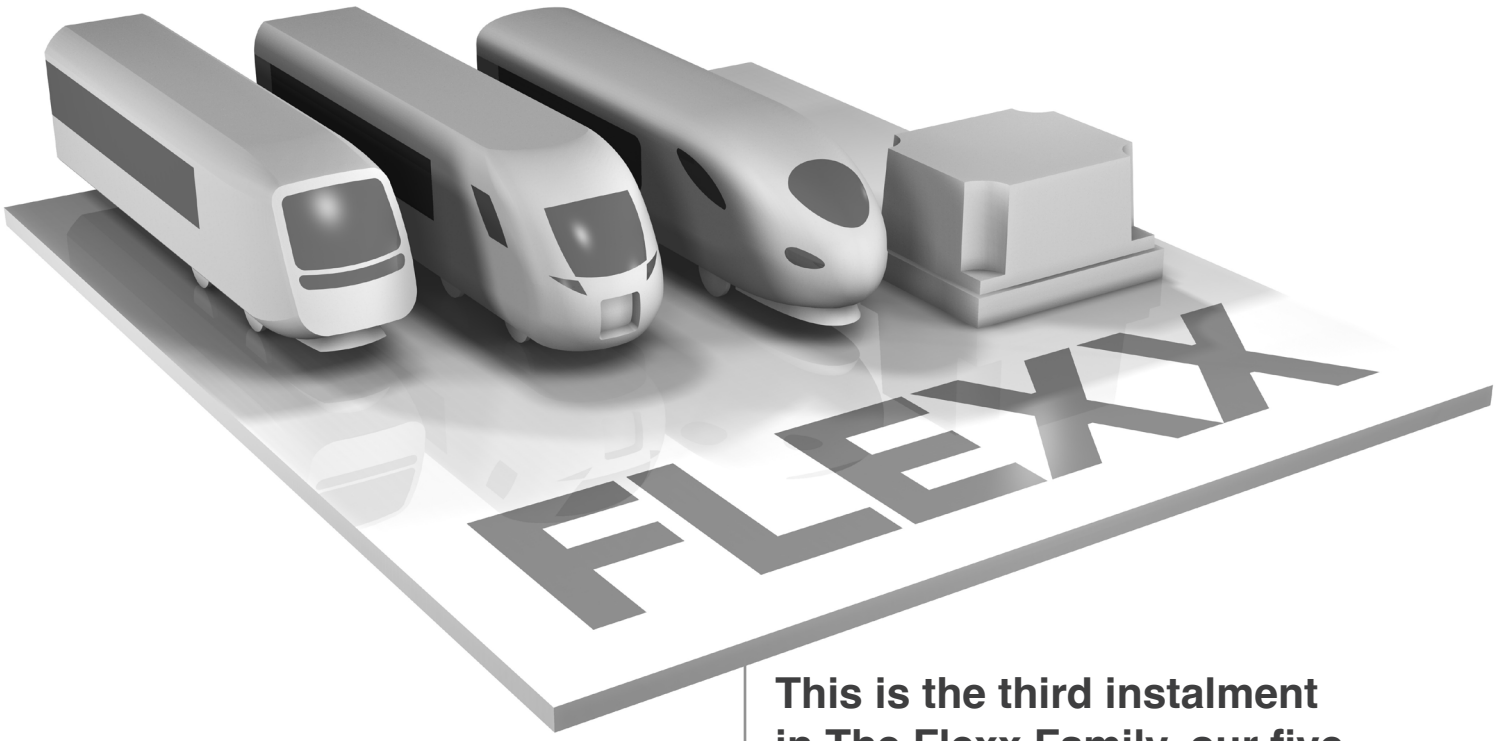
The Flexx Family: A maintenance break-through



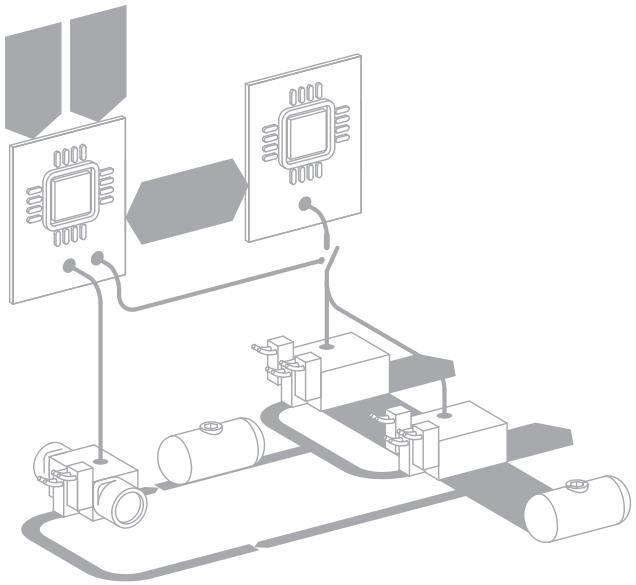
This is the third instalment in The Flexx Family, our five-part series of white papers on our Metroflexx and Regioflexx brake control solutions.

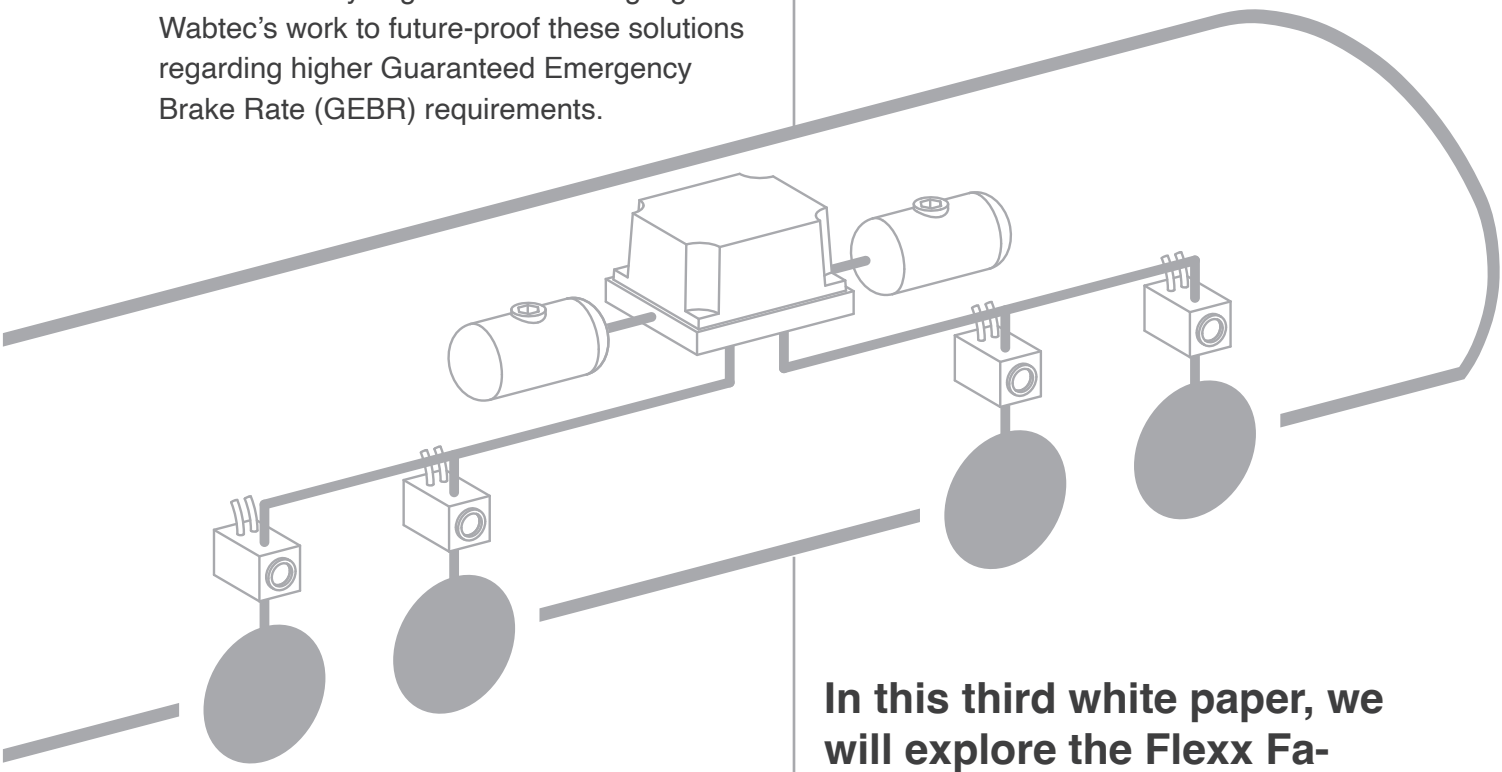
- Pushing boundaries with integrated solutions
- Achieving more through unrivaled modularity
- **A maintenance break-through**
- New functionalities thanks to SIL4 architecture
- Converging on the future of brake architecture

Wabtec

We began this series by explaining some of the Flexx Family's underlying design concepts and objectives: simplified installation and maintenance, and a robust safety and interoperability certification process.

In our second white paper, we focused on these brake control solutions' unrivaled modularity. We showed how Metroflexx and Regioflexx can adapt to all brake control architectures for any segment. And we highlighted Wabtec's work to future-proof these solutions regarding higher Guaranteed Emergency Brake Rate (GEBR) requirements.





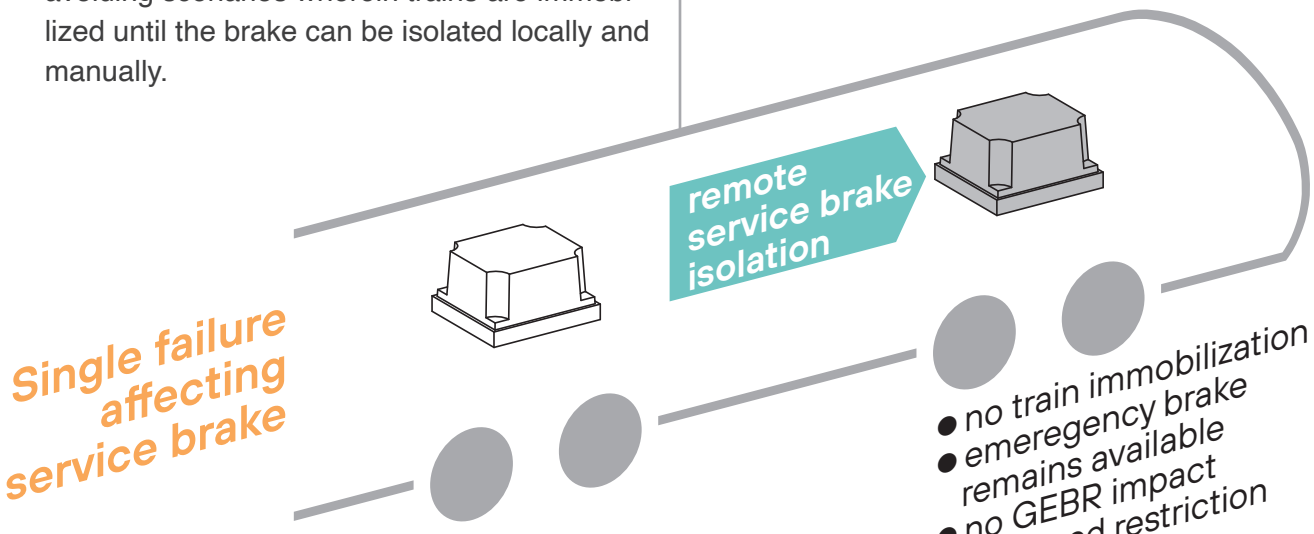
In this third white paper, we will explore the Flexx Family's revolutionary impact on brake control maintenance. Let's dive into our R&D teams list of priorities to address, and explore their successes that made these game-changing products possible.

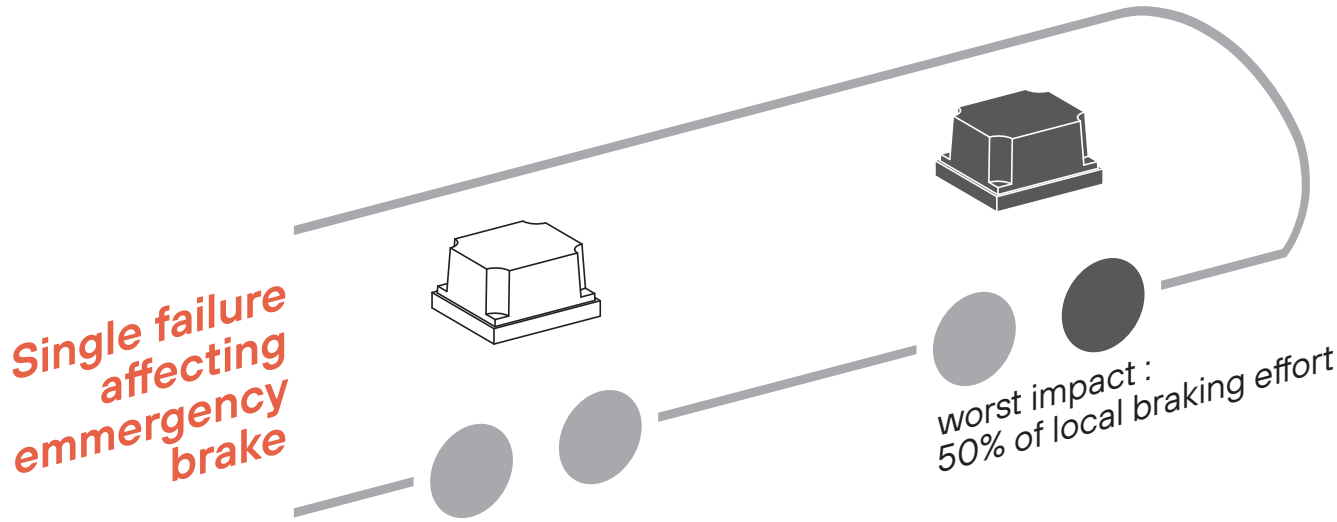
Minimizing the operational impact of single failures

As all engineers know, there is no such thing as absolute reliability. But the next best thing is ensuring single failures have minimal impact on train operation – if any.

This therefore became our focus, assisted by several advantages of the unique Flexx Family architecture:

- Single failures that affect service brakes can be isolated via the train control and management system (TCMS) or remotely by the train driver. They have no impact on train operation, avoiding scenarios wherein trains are immobilized until the brake can be isolated locally and manually.
- In case of forced service brake isolation, emergency brakes remain available. Such failures, therefore, do not compromise the GEBR, nor the train's ability to operate without speed restrictions.
- Finally, a single failure affecting emergency brakes cannot compromise more than 50% of the local braking effort.
Simply put, the Flexx Family architecture reduces the impact of a single failure by half compared to conventional systems.

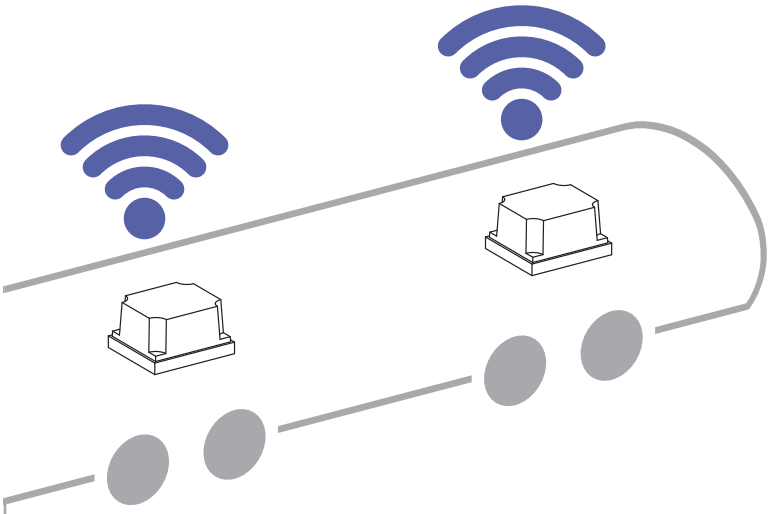




Designed for condition-based maintenance

To maximize train availability, Metroflexx and Regioflexx go beyond sharing standard fault messages with train drivers and maintenance crews. Their embedded algorithms also generate predictive maintenance messages (e.g., time remaining before overhaul) to help crews plan ahead.

The Flexx Family products also measure performance drift in real time and generate inspection requests to flag and manage latent failures before they occur. Each Metroflexx or Regioflexx unit can share this information through the TCMS, or through an independent transmission device installed in the unit cover.



Quick and easy replacement

From the outset, the Flexx Family products were designed as line-replaceable units (LRUs) for easy on-train replacement. As a result, installing Metroflexx and Regioflexx units only requires two or three electrical connectors and four bolts; local settings are applied automatically. In total, on-train replacement takes less than 20 minutes for a single operator – including time for tests before service resumes.
Weight reduction is a key factor in this quick turnaround. By using additive manufacturing processes for the base plate, we have been able to reduce the weight of each unit to under 15kg. This makes for easy handling, with no additional dedicated handling equipment required

Minimizing asset immobilization

On most trains, the uneven car body weight distribution may require different emergency brake settings for different bogies. When using conventional brake systems, train operators need different part numbers for different components, and are forced to have a high number of spares on hand to ensure fleet availability.

With the Flexx Family, we made things simpler. Our software stores all the brake settings required for a given fleet. Upon installation, an SIL4 optical reader equipped on each unit scans the barcode on the bracket to load the corresponding setting for its position on the train. As a result, our customers only need to store one part number for Metroflexx or Regioflexx products in their stock, making spare parts management that much simpler and cost-effective.

Extending MTBO to 15 years

To increase mean time between overhauls (MTBO), our R&D teams have prioritized heavily used components that can impact these intervals. They quickly identified one key driver in this area: the regulation of build-ups in brake cylinder pressure. In response, we developed algorithms to optimize – and minimize – the way magnet valves operate to reach a target pressure.

Understanding regulation

Usually, regulation involves the magnet valve creating a certain number of pulsations to reach the targeted pressure:

1 To fill the relay valve pilot chamber
2 To compensate for the thermo-dynamic effects of pressure variation
3 To compensate for relay valve hysteresis
4 To fill up brake cylinders

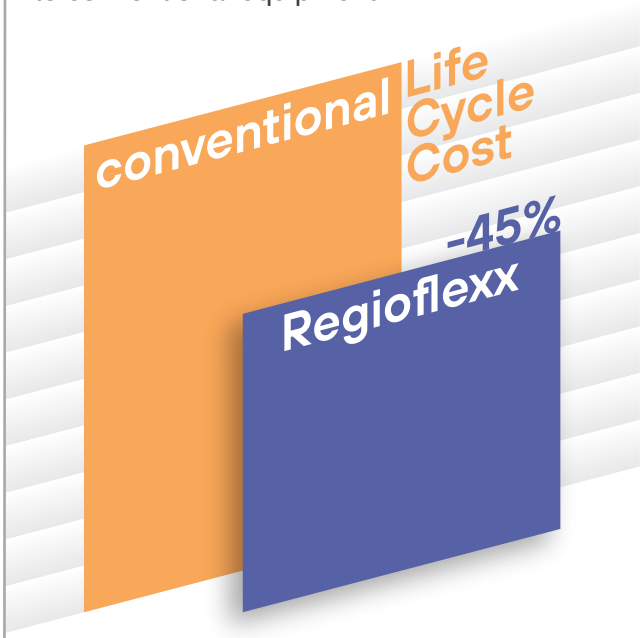
Deploying algorithms and reducing weight

The algorithms we developed learn how much time is needed to reach target pressure from the first application of the brake. After a few applications, it becomes possible to minimize the number of pulsations undergone by electro-pneumatic and pneumatic components. As a result, we can divide the number of valve applications by five for a given operation on average.

Moreover, we included new material into our components – especially relay valves – to reduce piston weight, while improving mobility (i.e., reaction time) and air flow. This ensures the best performance in all brake control configurations while reducing hysteresis.

Major MTBO gains

By combining algorithms and new material, we have pushed the MTBO for our Flexx Family products up to 10-12 years in urban applications (Metroflexx), and up to 15 years in mainline applications (Regioflexx). This means mainline brake control systems only require a single overhaul during their 30-year lifecycle, and offers a 45% reduction in cost compared to conventional equipment.



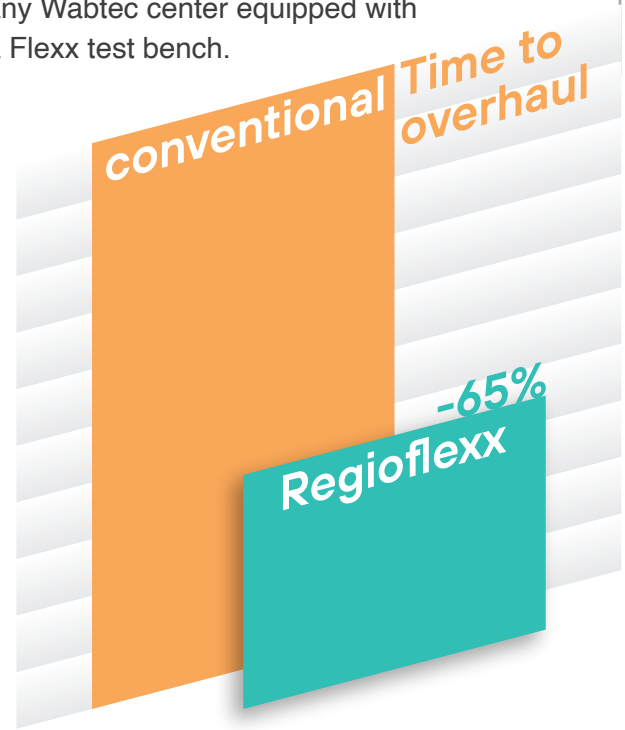
Making in-house maintenance easier than ever

Simplified pneumatics to do more with less

In previous instalments of this series, we described the simplified components included in Flexx Family solutions: two EP modules that build up brake cylinder pressure, and a third to maintain load-controlled brake cylinder pressure regardless of failure. Compared to conventional brake control panels on mainline trains, we have divided the number, weight, and volume of pneumatic components by five.

Maintenance has never been so easy

Flexx Family products offer high performance, with nearly double the MTBO, and simplify maintenance, needing only a third of the time normally required for overhauls. Rather than shipping components to a maintenance center, trained operators can perform maintenance in-house using a certified test bench. The return on investment for a test bench and operator training will, of course, depend on the number of Flexx products involved. For customers unable or unwilling to take on these costs, our teams are available for servicing in any Wabtec center equipped with a Flexx test bench.



Simplified electronics and continuous safety

We have simplified electronic maintenance even further. The only preventive maintenance required is a replacement during overhaul of few electronic component subject to ageing, all on one electronic board. Should a Flexx test bench detect faults in any electronic boards, these must be shipped to Wabtec for repair or replacement. This ensures electronic systems maintain their continuity of certification, which is essential as they perform safety functions.

Flexx Family products feature an electronic architecture based on our in-house Gemini II platform, which manages both the hardware components and software library. Customers benefit from our long-standing development and maintenance expertise, and need not worry about obsolescence management. Wabtec guarantees that electronics remain up to date at the board level, and ensures the upward compatibility of upgrades at component obsolescence.

Full support for hardware and software maintenance

At Wabtec, we fully understand the specific issues operators must deal with when it comes to maintaining software-based systems across their entire lifecycle. As such, we offer solutions that support train maintenance teams each step of the way.

Vehicle and/or performance data modifications

Flexx Family software parameters are accessible through the software maintenance tool, which grants customers full access. Given the potential to affect overall system behavior, we advise our customers to contact the Wabtec team for assistance to avoid any negative impacts. This level of modification generally does not require a heavy validation process.

Functional modifications

At the functional level, modifications involving alterations to the software may impact certification. As such, we consider they must be managed at a Wabtec competence center, and guarantee our teams will be available to analyze and implement modifications during the product's full lifetime.

Core operating system updates

Should a software evolution be needed, we may update the Metroflexx or Regioflexx core operating system. Throughout the product's lifetime, we guarantee that our customers will be informed ahead of such modifications and involved in implementing software updates on a given fleet. It should also be noted that in such an eventuality, the software can be installed using the Flexx test bench. In the unlikely event that Wabtec is unable to fulfill this responsibility, our customers can still rest easy: our software source code, under conditions to be agreed, can be placed under escrow, guaranteeing operational continuity whatever the situation.

Takeaway: more than an improvement, the Flexx Family is a maintenance breakthrough

When it comes to maintenance, the Flexx Family's development has been grounded in our deep understanding of train operator's needs. With these brake control systems, we're giving our customers the products and the guarantees they need to maintain high performance and maximize availability over the whole service life. Not only do Metroflexx and Regioflexx offer major MTBO gains, they also enable condition-based maintenance, and the flexibility to conduct maintenance in-house. In short, we are answering our clients' challenges with a revolution in brake control maintenance.

Fabio Ferrara
Product Manager Brakes,
Transit Service Group,
WABTEC

At a glance: The Flexx Family's added value for train maintenance:

- Less hardware and smarter software: a winning formula for completely streamlined maintenance
- A unique architecture, resilient to single failures, to maximize train availability and reduce impact on GEBR
- Embedded condition-based maintenance to facilitate workload planning and increase fleet availability
- A unique part number in stocks for each product to minimize immobilization
- Extending MTBO to enable a single overhaul in the 30 years of a mainline train life