community specific development

Our Vehicles

Metro

A rapid transit, subway or metro system is an electric public rail transportation system in an urban area with high capacity and frequency. Metros operate on dedicated right-of-way using underground, elevated or at-grade railway. Metros operate as multi-car trainsets or electric multiple units (EMU) with train length passenger access between cars. Modern metros are fully automated and driverless.

Features:
- High Passenger Capacity
- Grade Separation from Other traffic
- Fully Automated Driverless

Benefits:
- Meets Large Urban Area Transport Demands
- Higher Speeds, Faster Travel Times
- Safer, More Reliable; Lower Overhead Costs

Streetcar

A streetcar is a railcar of lighter weight and construction and slower top speed than an LRT Vehicle. It is designed exclusively for the transport of passengers within towns or cities, on tracks running primarily on streets. It is a 100% Low Floor configuration for exceptional passenger loading and unloading limiting dwell time in stations. Streetcars are most suitable for mixed traffic operations because of their size and speed.

Features:
- Full Width Cabs
- DOT Lighting
- 100% Low Floor Boarding
- Single Car Unit
- Light Weight and Smaller Size

Benefits:
- Designed For Mixed Traffic in City Streets
- Safe Design For Integration with Auto Traffic
- Very Rapid Passenger Loading & Unloading
- High Frequency Operations
- Low Power Consumption

A Vehicle Comparison: Metro • Streetcar • Light Rail






Light Rail Vehicle (LRV)

Light Rail is an electric rail transit system in an urban and suburban area that generally has capacity and speed between metro and streetcar systems. Light Rail is a versatile mode of rail transit suited for both dedicated right-of-way and mixed with traffic in city streets. LRVs are articulated units with low floor boarding areas for rapid loading and unloading of passengers at street level. LRVs are configured to operate as single units or up to four car trains.

Features:
- Highway Speed Capability
- DOT Lighting
- Low Floor Boarding
- Single or Multiple Units

Benefits:
- Right-Of-Way Versatility
- Safe Operation in Mixed Traffic
- Rapid Passenger Loading and Unloading
- Easily Adjustable Train Size for Peak Periods

The ameriTRAM™ Streetcar & DART Super Light Rail Vehicle

continuous improvement

Kaizen Approach

Vehicle Maintenance

When we come to a city, we hire and train a local workforce. We always aim to assemble the light rail vehicles locally, investing in the local economy and supporting regional growth. The same trained workers who built the vehicles then apply their accumulated expertise to servicing the cars and maintaining fleet performance.

At KINKISHARYO, we only maintain vehicles that we've designed and manufactured. For us, maintenance isn't just a service, but a product that compliments our core business, vehicle manufacturing. We focus on the big picture: the entire process, not just specific results. It's an approach called "Kaizen."

Kaizen and the Art of Vehicle Maintenance

"Kaizen" roughly translates to "continuous improvement in every respect." Our comprehensive approach to vehicle maintenance implements the Kaizen principle that no matter how well you're doing, you can always do better. We focus on improving the entire process, not just achieving certain results. We ensure continual improvement by applying innovation and analyzing all aspects of performance through management, engineering and quality perspectives.

Our approach to Kaizen has earned accolades from Federal Transit Administration auditors and peer groups for performance far above transit industry standards.

Process

KINKISHARYO provides our customers with a complete maintenance product including:

Features	Benefits
Engineered Maintenance Enhancements	Reduces repetitive labor costs and extends component service life
Failure Review Management	Analyze the effects of service failures for passenger impact, vehicle down-time, parts costs and fleet performance
Comprehensive Preventive Maintenance Programs: OEM requirements vs. actual in-service experience	Maximize Fleet Reliability & Availability
On-site Component Management	In-house repair, overhaul and functional testing
Progressively expanding planned maintenance	Reduces costs and vehicle down-time during major overhaul
Fully Integrated Maintenance Management Information System (MMIS)	Customized reporting of performance benchmarks and indicators
Use of bio-degradable cleaning products	Responsibly Green

Performance

Reliability & availability are the measures of a quality vehicle fleet and superior fleet maintenance operations. KINKISHARYO understands how to achieve both as the only manufacturer to design build and maintain fleets of LRVs in North America.

Notes:

Contact Us

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Business Opportunities

We are always looking for talented manufacturers to deliver the quality products our vehicle designs demand. We look forward to developing relationships with companies that share the same commitment to superior product quality and 100% on-time delivery. We strongly encourage participation of all Disadvantaged Business Enterprises.

KINKISHARYO is an equal opportunity employer.

KINKISHARYO

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2012

Wireless Streetcar Systems Estimated Cost Savings

20 April 2011

Russo & Redd Consulting Group LLC
Innovative Program Management Solutions

Wireless Streetcar Systems

The age of wireless streetcars has arrived. Recent advancements in battery technology have made the dream of wireless systems a reality. Storage devices are smaller, smarter and more efficient than ever before. They fit easily into modern streetcar shells and work seamlessly with the car's other systems. Car frames, trucks, motors, doors, heating and air conditioning systems remain unchanged. Pantographs and power routing systems can be totally eliminated in small systems and optimized in larger systems. And the only new addition is the battery management system. This seamless evolution in power supply provides a number of improvements while preserving the proven performance of time tested systems.

Wireless technology is most suitable for streetcar systems up to 5 miles in length, or where constraints like historic district restrictions must be considered. They are safer, cheaper to build, cheaper to operate, aesthetically more pleasing and have less environmental impact. And construction is faster and less disruptive. Wireless systems minimize property requirements, nearly eliminate the cost of electrical infrastructure, reduce the cost of bridges and tunnels, shorten construction schedules, reduce construction impacts, reduce maintenance costs, improve safety, and improve yard and shop operations. The result is a system that delivers all of the advantages of a modern streetcar without the complications and traditional clutter of poles and wires. Some of the advantages of wireless streetcar systems are:

Property: Assembling the right of way for new streetcar system is a difficult proposition. Property is always at a premium. New lines are often built in abandoned or underused freight rail corridors that were originally constructed with narrow track centers and little, if any, room for expansion. Squeezing in a modern streetcar line, complete with catenary poles and duct banks for power distribution, becomes problematic and expensive. It is not uncommon for the right of way to cost more than $2M per mile.

Pole & wire clutter in urban environment

Urban environments are even more difficult, especially in older, densely developed neighborhoods where the streets and sidewalks are narrow. Catenary poles must either occupy space between the tracks, adding as much as 3' to the width of the track system, or they must be located on narrow sidewalks where they take up precious pedestrian space and add to the urban clutter of poles. Eliminating wires and poles enhances the prospects of neighborhood acceptance and reduces the cost and time required for environmental clearance. Catenary systems also require power distribution cables and negative return cables. That means a considerable amount of street excavation to build the duct banks, and it adds significant cost, time, and construction impacts to already expensive projects.

Traction power substation

Locating substations is a particularly difficult property issue. Streetcar systems need substations about every mile. Typically, the substation footprint is about 1,000 SF. In an urban setting, that means finding an empty lot, locating them in a park, or purchasing existing commercial or residential property and converting it to an industrial application. Needless to say, this is a difficult and expensive proposition and generally meets with considerable resistance from the neighborhood, especially in a residential area. Even in an ideal setting, the underlying substation property could cost more than $500K. Substations also need power from the local electric utility. These are generally new underground cables that also add to the cost and impact of construction.

Power Infrastructure: The savings associated with wireless technology are substantial. Overhead catenary systems are expensive. Wireless technology eliminates all of the infrastructure and hardware associated with the distribution of power. It also eliminates the long term problems of stray current, and the cost of cathodic protection for underground utilities. At a minimum, wireless streetcar technology will eliminate:

- Overhead wires
- Line poles
- Tie offs and guy wires at curves
- Tensioning devices
- Sectionalizing switches and associated hardware
- Substations and substation feeds
- Power distribution and negative return cables
- Cathodic protection for buried utilities
- Utility relocation associated with underground construction
- Electrical isolation of the rail

Duct bank construction

The cost of catenary systems in an urban environment is typically about $2.5M per mile. That includes the poles, pole foundations, wires, and hardware. Tie-offs, guy wires, tensioning devices and sectionalizing switches adds another 10%, or $250,000 per mile. The average cost of a substation is approximately $1.25M and they are located about every mile. And the average cost of a utility feed to each substation can be taken as $500,000. The excavation and duct bank construction associated with the power distribution will cost, on average, $300,000 per mile. A major problem with "wired" systems is stray current and the resulting damage to buried utilities. Controlling stray current requires that the rails are wrapped in a special insulating material called a "boot". This is a laborious and costly element of work that is necessary to control stray currents. Wireless technology eliminates the need to "boot" the rail. Eliminating this element of work will save approximately $250,000 per mile. Stray current is also controlled through cathodic protection. Cathodic protection employs a suite of electrical devices attached to adjacent utilities and structures to counteract the effects of stray current. It is difficult to assign a cost to cathodic protection as it varies greatly from project to project. However, the cost can be substantial and it is reasonable to assign an average cost of $200,000 per mile. Lastly, utility relocation associated with the construction of the power distribution duct banks, substations, and catenary pole foundations will add another $500,000 per mile. Taken together, the capital cost savings of wireless technology is approximately $5.75M per mile. For a short urban circulator approximately 5 miles long, the total savings in capital costs is nearly $29M. These savings are substantial, and could offset nearly 100% of the cost of the vehicle fleet.

Wireless Streetcar Cost Savings:

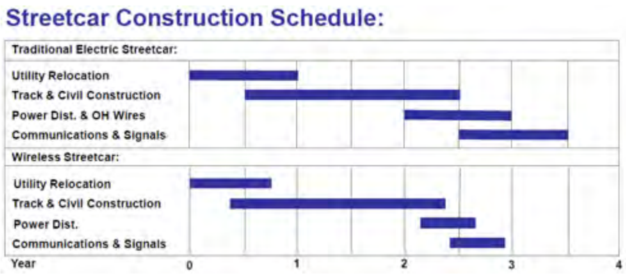
	Cost per Mile
Poles & wires	2,500,000
Special hardware	250,000
Substations	1,250,000
Utility power feeds	500,000
Duct banks	300,000
Special rail isolation	250,000
Cathodic protection	200,000
Utility relocation	500,000
Savings per mile:	**$5,750,000**

Bridge and Tunnel Costs: There are other savings in systems with bridges and tunnels. These savings can only be quantified on a project specific basis, but they are easy to identify. Bridge widths can be reduced by 3 to 4 feet simply by eliminating the poles and wires. And accommodations for the power distribution cables are eliminated. At nearly $500 per square foot, bridge costs may be reduced by nearly $2,000 per linear foot. A wireless system also means less overhead clearance, which could eliminate the need to raise existing overhead bridges and the need for additional bridge safety and maintenance considerations.

In twin bore (single track) tunnels, the tunnel diameter is generally determined by the combined height of the track, vehicle, and the overhead wire system. Eliminating the overhead wires, and the operating clearance for a raised pantograph, may allow for a smaller tunnel bore. Large bore (double track) tunnel diameters are generally dictated by the width of the track system, so tunnel bores for a wireless system may be nearly identical to a system with wires. But space in a tunnel is always at a premium and construction and maintenance in a tunnel is expensive, so eliminating the wires and power distribution cables may still result in significant savings. And locating substations in a tunnel is also expensive. They must either be housed in the passenger facilities or somewhere along the tunnel. Either way, the amount of cavern excavation required for their construction and maintenance is significant.

Construction Impacts: Wireless technology reduces construction impacts. It improves access to homes and reduces disruptions to businesses. The most disruptive elements of streetcar construction are the pole foundations, construction of the duct banks, and the relocation of utilities. All of these require excavation. The work is time consuming, noisy, and creates a considerable amount dirt and dust. It often requires detours, including pedestrian barriers, and sometimes the work is immediately in front of homes or commercial establishments. This work is greatly reduced with wireless technology, and the quality of life within the construction corridor is easier to maintain.

Urban construction



Construction durations are also reduced. In general, "stringing" the wire, powering the substations, and testing the electrical systems are among the last elements of work. This work requires specialized equipment and unencumbered access to the work site. Consequently, these tasks are only started when construction of the track and stations is nearly complete. Eliminating the electrical systems would reduce construction durations, and just as importantly, greatly simplify start up and commissioning of the Streetcar. A typical streetcar construction project that normally takes more than 3 years to complete could easily be reduced by more than 6 months. This also lowers costs by reducing the expenses related to overhead and financing.

Vehicle Costs: The addition of battery equipment will result in added weight to the vehicle, resulting in added power costs. These costs, however, will be more than offset by using regenerative braking to directly recharge the batteries. Based on a fleet size of 7 cars, operating at an average of 20 hours per day and running 50,000 car miles per year, an annual savings of about $150,000 in power consumption could be realized.

e-Brid Streetcar

The lithium-ion batteries and associated equipment used in Kinkisharyo's e-Brid system have proven to be very reliable and require no regular maintenance. Current life expectancy is conservatively estimated to be about 8 years. But battery technology is improving daily and batteries with a 20 year life are expected in the near future. The current cost of battery sets is approximately $240,000. If we assume changing the batteries twice in 30 years, then the annualized maintenance costs would be about $55,000 for a fleet of 7 vehicles.

A new 5 mile wireless system would require two charging stations at $500,000 each and the initial cost per vehicle will be increased by about $350,000, resulting in an added capital cost of $3,450,000.

Operations & Maintenance: Wireless technology simplifies operations and maintenance, especially in climates with inclement weather. Winter storms play havoc with overhead wire systems. Ice accumulation can cause "arcing" which damages the pantographs, and can even go as far as to cause "snags" which rip the pantograph off the roof of the car or pull down the wire. It is not uncommon for operators to schedule non-revenue "ice runs" ahead of normal service just to clear the catenary system of dangerous accumulations of ice and snow. These non-revenue runs are costly, complicate service schedules, and are not an efficient use of the revenue fleet. In older "constant length" catenary systems another problem is loose wires in the summer and wire breaks in the winter as the system tries to expand and contract with the temperature change. Even in ideal climates, catenary systems are expensive to maintain. Both the wires and the substations require regular inspection and maintenance. Substations and power feeds also require a level of security, including protective fencing and intrusion alarms, which must be inspected, tested and maintained. Wireless systems also eliminate the need for overhead wire maintenance trucks…specialized non-revenue maintenance units that are expensive to buy and can only be used efficiently on large systems. They also eliminate the spare parts and material stores of wire and catenary hardware. Even vehicle maintenance is reduced, as smooth and safe operation is dependent on the regular inspection and maintenance of the pantograph system. Wire maintenance crews are eliminated; the traditional job of "power dispatcher" is eliminated; critical safety and proficiency training associated with overhead wires is eliminated; and substation maintenance is limited to the charging station, usually located in the shop and yard area. On a small streetcar system, these improvements and efficiencies will result in operating cost savings of approximately $600,000 per year.

Overhead wire maintenance

Operating Cost Savings:	
Wire & substation maintenance	460,000
Material, parts & supplies	55,000
Special equipment & tools	15,000
Operating efficiencies	30,000
3rd party support	40,000
Annual savings:	**$600,000**

Safety: Passenger and worker safety are improved with a wireless system. In the event of a loss of power, the need for a "rescue" vehicle to ferry passengers to the nearest station is eliminated; this is especially important if power is lost to vehicles in a tunnel.

Worker safety is improved, especially in the shop and yard area where employees routinely work above the roof line of the vehicles. The vehicle maintenance shop is the most dangerous area on the system. Moving vehicles in and out of the shop can only be accomplished by powering the vehicle through overhead wires, using a "hot stick", or moving vehicles using winches or a motorized tow. Overhead wires in the shop expose employees working above the roof line to dangerous electrical

Exposed wires in shop

equipment. "Hot sticks" are even more dangerous, requiring employees to handle tools with exposed electrical contacts. Winches and tow motors are much safer, but highly inefficient. Wireless technology overcomes all of those problems safely and efficiently; improving safety for employees and reducing maintenance costs.

Wireless technology also improves safety for 3rd parties working along the line. Streetcar operators must routinely provide protective services for contractors working along the right of way. Protection is required to ensure the safety of 3rd party employees performing inspection or maintenance of bridges which cross above the wires, or to ensure the safe operation of cranes and other high mast construction equipment operating near the wires. Most of the time, this protection includes a review of the contractor's operations and equipment before work is started, and an inspector at the site to ensure compliance with safety procedures. Occasionally, contractors must work very close to the overhead wires. On those occasions the wires must be de-energized and grounds applied to protect the workers. Wireless technology will not eliminate the need to protect all work above the tracks, but it will eliminate the specialized protective services for electrical safety.

Another consideration is emergency response along the transit corridor. Responding to fires along the right of way often requires the deployment of ladders and other rescue equipment in close proximity to the wires. This requires closely coordinated and diligently rehearsed emergency procedures to ensure the safety of the emergency crews. Emergency response may also require de-energizing the wires and applying grounds, which can delay response time and further threaten life and property. Wireless technology eliminates the coordination of emergency response related to the electrified systems, and eliminates the need for rescue vehicles in the event of a total loss of traction power.

Yard Operations and Storage Tracks: The yard and shop area can also be designed more effectively, without regard to pole locations or power feeds. And track geometry can be developed independent of the complications of overhead wire geometry. Storage tracks can be closer together and save space. Yard and shop construction is easier and cheaper, and yard operations are more reliable. All of the storage is available all of the time, because shut downs for wire inspection and maintenance are eliminated.

Poles in storage yard

Summary: The advantages of a wireless system include significant savings in both the capital and operating cost, as well as potential savings associated with reduced rights of way, savings associated with civil works (especially bridges and tunnels), and with improved construction schedules. The disadvantages are limited to small increases in vehicle cost and battery maintenance.

Not accounting for the cost savings associated with right of way, shorter implementation schedules or civil works benefits associated with smaller bridges and smaller bore tunnels (which can only be evaluated on a project specific basis), the system-wide savings for a 5 mile wireless streetcar system could easily be as much as:

- Project Capital Cost Savings **$25,300,000**
- Annual Operating Cost Savings **$695,000**

E-Brid System Cost Saving Summary:

Capital Cost Savings (5 mile system)	28,750,000
Additional Vehicle Cost & Charging Stations	-3,450,000
Total Capital Cost Savings:	25,300,000
Vehicle Cost Savings (per year)	95,000
Maintenance Cost Savings (per year)	600,000
Total O&M Cost Savings (per year):	695,000
Present Value of O&M Savings:	10,700,000
Present Value - Total Savings: (5 mile system, 7 vehicles, 30 years)	$36,000,000

For a 5 mile streetcar system utilizing a fleet of 7 e-Brid vehicles, the estimated annual operating cost savings could be capitalized (at 5%) as $10.7 Million, and when combined on a present worth basis the total cost savings could be about $36 Million over the 30 year life of the system.

The advantages of wireless streetcars will continue to expand. Existing battery technology limits a completely wireless system to about 5 miles. But battery storage systems will get smaller and lighter even as their capacity grows, and the range of wireless systems will be extended. Construction schedule savings together with capital and operating cost savings will make streetcar systems financially more attractive, and eliminating wires and substations will make them aesthetically and environmentally more acceptable. The improvements in electrical and passenger safety are priceless, especially when they come at no cost.

Even longer streetcar lines can benefit from wireless technology. Wireless streetcars can be especially useful in cities with historic districts that prohibit the introduction of wires. They can "bridge the gap" by running conventionally outside the historic district, then lower the pantograph and operate without wires within the district. They may also be able to lower the cost of systems with tunnels by lowering the cost of tunnel construction and maintenance.

Wireless technology is no longer experimental. It is ready for commercial use now and will quickly become the preferred solution for shorter streetcar lines and downtown circulators in an urban environment. And wireless systems offer benefits that may provide value even for longer systems. Most importantly, they are faster and cheaper to build, easier and less expensive to maintain, and they result in a more aesthetically pleasing product.

Note: The information in this report was based on typical project data and from manufacturer's data provided by Kinkisharyo. Costs for a specific project may vary depending on specific project conditions.

Vehicle Specification

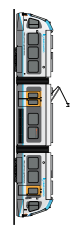
ameri*TRAM*™

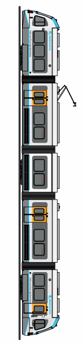
The 100% Low-Floor Streetcar Engineered for North America

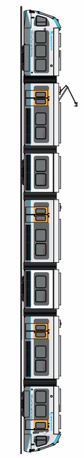
ameri*TRAM*™

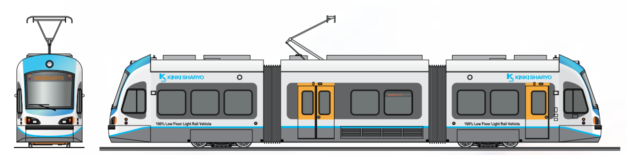
		300	500	700
	Empty Weight with e-Brid ™	**32 mt** (70.5 klbs)	**48 mt** (105.5 klbs)	**64 mt** (141 klbs)
	Passengers (4/m2)	**115** (28 seats)	**150** (62 seats)	**190** (96 seats)
Primary Dimensions	Length over Anticlimbers	**20m** (65 ft 7.4 in)	**30m** (98 ft 5 in)	**40m** (131ft 2.8 in)
	Width of Carbody *	**2.65m/2.46m** (8 ft 8.3 in/8 ft 1 in)		
	Width of Thresholds *	**2.71m/2.52m** (8 ft 10.7 in/8 ft 3.2 in)		
	Height of Carbody	**3.8m** (12 ft 5.6 in)		
	Boarding Height	**350mm** (13.75 in)		
	Ceiling Height	**2472mm** (8 ft. 1.3 in.)		
	Clear door opening Double Door:	**1220mm** (4 ft.)		
	Single Door:	**815mm** (2 ft. 8.1 in.)		
Trucks	Truck Centers	**10.8m** (35 ft. 5.2 in.)		
	Wheel Diameter	**600mm** (23.6 in.)		
	Wheel Base	**1800mm** (70.9 in.)		
Operating Parameters	Maximum Grade **	**9%**		
	Minimum Horizontal Curve	**18m** (60 ft.)		
	Minimum Vertical Curve (+/-)	**350mm** (1150 ft.)		
	OCS Voltage (DC)	**750 nominal** (525-900 range)		
Performance	Maximum Service Speed	**80 kph** (50 mph)		
	Acceleration **	**1.3m/s²** (3.0 mphps)		
	Service Brake	**1.3m/s²** (3.0 mphps)		
	Emergency Brake	**2.3m/s²** (4.5 mphps)		
Primary Systems	Propulsion	**IGBT Inverter with VVVF Controls**		
	Friction Brake	**Hydraulic Disc**		
	Auxilary Power	**208vAC - 3phase - 60hz**		
	LVPS	**24vDC**		

*Available in wide (LRV) or narrow (Streetcar) versions
**All axles powered

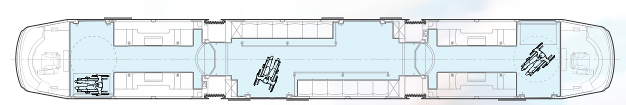








ameri*TRAM*™ Streetcar, exterior



ameri*TRAM*™ Streetcar, interior

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For more information please visit
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www.ameritram.com

KINKISHARYO
Engineering Sustainable Urban Transit

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ameriTRAM™

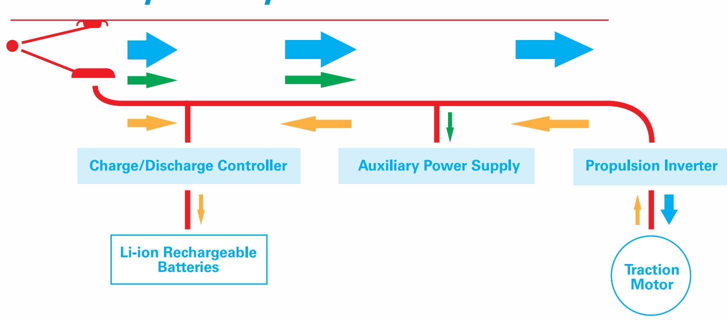
North America's 100% Low-Floor Streetcar

e-Brid™

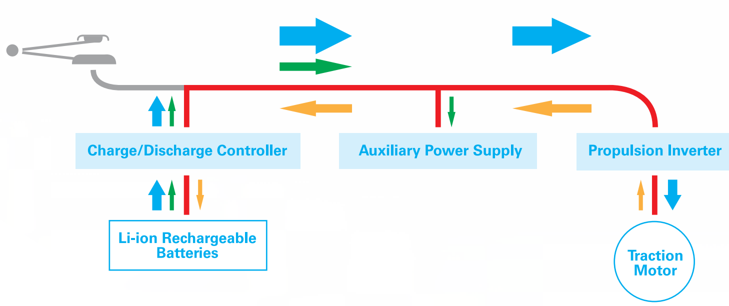
Electro-Hybrid Li-ion Battery Power Propulsion Technology

Through unique e-Brid™ technology, *ameriTRAM™* is propelled by overhead catenary or on-board lithium-ion batteries. e-Brid™ charges the batteries while running on catenary power; and, when in battery mode, uses electricity stored from regenerative braking.

Powered by Catenary



Powered by Li-ion Batteries



Through e-Brid™ technology *ameriTRAM™* provides:

+ **Superior Versatility**
  Achieve propulsion where overhead contact wire cannot be installed

+ **Historic Preservation**
  Free downtown and historic areas of overhead wires

+ **Improved Aesthetics**
  Minimize environmental impact and improve visual aesthetics through wireless sections

+ **Reduced Energy Usage**
  Realize immediate savings though lower power consumption via "peak-shaving"

+ **Greater Value**
  Save millions in capital investment and operational costs with less electrification equipment and maintenance

+ **Enhanced Public Safety**
  Ensure safety of passengers in power outages or inclement weather

+ **Environmental Responsibility**
  Realize fewer greenhouse gas concerns through zero emissions and lower energy usage

Engineered For North America

ameriTRAM™ is the only streetcar in North America that is compliant with ADA, Buy America, NFPA-130 and ASME RT-1

100% Low-Floor

With its 100% Low-Floor, *ameriTRAM™* offers:

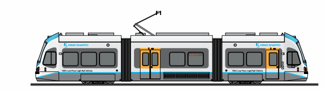
+ **Improved Passenger Safety**
  100% low-floor with no interior steps or ramps

+ **Superior Access**
  ameriTRAM™ provides easier access and complies with all ADA requirements throughout the passenger area

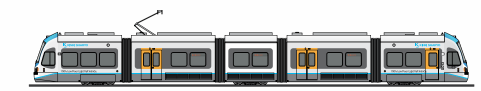
+ **Greater Efficiency**
  Faster boarding means less dwell time at stations

Flexible Modularity

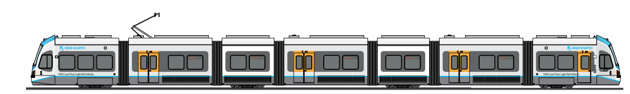
Expandable design allows for future system growth without increasing fleet size



ameriTRAM™ 300



ameriTRAM™ 500



ameriTRAM™ 700

KINKISHARYO International, L.L.C. is the #1 supplier of low-floor light rail vehicles in North America.

With the introduction of *ameriTRAM™*, Kinkisharyo is the only light rail manufacturer to supply North America with a 100% low-floor, electro-hybrid, zero-emission streetcar powered by either overhead electric catenary or on-board lithium-ion batteries. Headquartered in Westwood, MA, KINKISHARYO has been redefining urban light rail transit systems throughout the U.S. for nearly three decades.

For more information on *ameriTRAM™*
www.ameritram.com

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TELEPHONE: (781) 320-1220 FACSIMILE: (781) 320-1201

April 5, 2013

Mr. Jose R. Bustamante, PE
Director of Transit & Rail
RK&K
81 Mosher Street
Baltimore, MD 21217

Subject: Union Station – Georgetown Alternatives Analysis

Dear Mr. Bustamante:

Thank you for the opportunity to contribute to the study your firm is performing for the Georgetown Waterfront to Union Station Alternatives Analysis. Set out below are responses to the Supplier Questionnaire regarding streetcar vehicle and alternative propulsion technologies.

Question #1

The District will consider designs which allow for the use of an in-street conductor which supplies power to the vehicle continuously while operating, a system with long gaps in the overhead supply and wired areas for recharging while operating (batteries), or a system which charges an on-board storage system only when stopped at station platforms (supercapacitors or flywheels). Which of these types of systems have you supplied vehicles (rail, bus, or other transport) for? Or, are in the process of supplying? Do you have any comments on the advantages or disadvantages concerning the three system types?

Response:

Kinkisharyo has developed a LiIon battery 100% Low Floor vehicle that has off wire capabilities. This vehicle was demonstrated in the US at Charlotte, Dallas, and Phoenix where dynamic performance was demonstrated. It was also displayed statically at several locations. This vehicle can be seen at www.ameritram.com

The ameriTRAM as presently configured can be charged via an Overhead Contact System through a pantograph. This gives it the flexibility to operate over existing non-proprietary infrastructure. The vehicle can also be configured for inductive charging at fixed locations or a combination of both.

Flywheels are unproven. Supercapacitors are limited by the energy density which limits the distance that can be traveled. In street conductors are proprietary and limit the source of supply, especially for future expansions.

Question #2

A traditional streetcar is designed to operate from an overhead supply system operating continuously at either 600 or 750 Vdc. Would your company's offering place any special or additional requirements concerning integration of the electrification system? Would your technology operate with a pantograph when not on a wireless section?

Response:

Yes. Our technology uses a pantograph for wired right of ways. We prefer 750 Vdc but can configure to operate at the lower voltage.

Question #3 - In Street Conductors

Has the in-street conductor been utilized in areas which normally experience snow and ice in the winter? What material would you use for fabricating in-street conductors? Would the material show corrosion for the application of de-icing road salt? What provisions are made to prevent snow plow blades from damaging the rail?

Response:

Kinksharyo studied this type of operation but chose to develop a system that would operate on non-proprietary OCS systems due to the requirements for heaters, drains (flooding) and road damage.

Question #4 – In Street Conductors

Has the in-street conductor been installed in mixed use traffic lanes? Has it been installed in reserved lanes with normal traffic operating at right angles across it? Have there been any issues related to cleanliness resulting from contamination with rubber tire, oils, or autumn leaves?

Response:

Not applicable to Kinkisharyo ameriTRAM.

Question #5 – In Street Conductors

How is the conductor installed in the street? Are there any restrictions on horizontal or vertical curvature of the pavement? How are crossings or turnouts implemented with the

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conductor rail? What clearances are required for other structures such as manholes and metallic covers?

Response:

Not applicable to Kinkisharyo ameriTRAM.

Question #6 – Batteries

Which battery type do you have experience in applying, Lithium (Li) or Nickel Metal Hydride (NiMH)? What is the maximum acceleration rate and maximum speed normally used in these applications?

Response:

Kinkisharyo's ameriTRAM uses Lithium Ion Batteries. Kinkisharyo limits acceleration in battery operation mode to increase battery life. Acceleration in battery mode is limited to 0.9m/s^2(2mphps). Speed is limited to 40 mph. Acceleration in wired mode is 1.34 m/s^2 (3mphps).

Question #7 – Batteries

What are the design limits and emergency limits for charge/discharge levels of the batteries on your vehicles? Is the battery management system provided by the battery manufacturer, third-party specialized supplier, or incorporated into the propulsion system? Are the individual cells monitored?

Response:

The limit of charge/discharge is defined by our battery supplier dependent upon the battery chosen for this application. The charge / discharge capabilities are very high approaching 600 amperes. See link below for battery data sheet. The battery management system is provided by the battery supplier. Individual cells are monitored.
http://www.gsyuasa-lp.com/LIM30-lithium-battery

Question #8 – Batteries

The operating environment in DC has a temperature range of -15^0 F to 106^0 F. What will be used for the cold temperatures to ensure proper operation of the system? Do the high temperatures with added solar heat gain prove detrimental to the batteries? Is a heating and cooling system typically provided for the batteries?

Response:

These temperatures do not cause a concern for the Kinkisharyo battery system. The cells are cooled via fans that are part of the battery trays.

Question #9 – Batteries

There is a concern with impacts damaging Li batteries with fires resulting days later. This was observed during crash testing of the Chevy Volt. Are the batteries located in an area susceptible to impacts in traffic accidents? Have you established criteria for maximum impact shocks and have the criteria been validated by the battery manufacturer?

Response:

In the ameriTRAM the batteries are mounted low on the side of the vehicle and protected by side frame bars that act to reduce damage if a traffic mishap occurs. The battery mounting location is no more vulnerable than a side door entry.
If batteries are damaged in any way they should be removed from the vehicle and discharged.

The batteries have been qualified to the UN testing criteria for the transport of dangerous goods. UN 38.3 includes Tests 1-8 of this specification:
T1 – Altitude Simulation (Primary and Secondary Cells and Batteries)
T2 – Thermal Test (Primary and Secondary Cells and Batteries)
T3 – Vibration (Primary and Secondary Cells and Batteries)
T4 – Shock (Primary and Secondary Cells and Batteries)
T5 – External Short Circuit (Primary and Secondary Cells and Batteries)
T6 – Impact (Primary and Secondary Cells)
T7 – Overcharge (Secondary

Question #10 – Batteries

Batteries will be discharged during overhead gaps and recharged while operating in wired sections. As a “ball-park” approximation, if a streetcar traveled three miles off wire with 6 stops on an average 2% grade how long would the vehicle need to travel on wire to fully recharge? What would be the maximum current draw for battery recharging?

Response:

In order to accurately determine the battery performance a simulation of the route profile would have to be performed. This profile would include regeneration charging in braking and loading from acceleration, grades, and auxiliaries. The simulation would take into account a discharge of the batteries at the start of the

simulation to approximately 90% of battery charge and discharge down to about 40% SOC. After performing the simulations Kinkisharyo would work with the wayside designer to optimize placement of charging wire sections. This iterative design approach is the best way to optimize the systems design.

The battery charging current while stopped is limited to 200 amps. The charging current while braking is higher to optimize regeneration energy recovery. For a 50% discharge as described above it takes approximately 16 minutes to recharge back to the 90% level.

Question #11 – Batteries

If a stationary vehicle draws the maximum current for battery recharging in addition to the vehicle's maximum auxiliary power requirement on a 106^{0} F day in full sun with no wind, is it possible to heat a 350 kcmil overhead contact wire to the 160^{0} F annealing temperature of the copper? If so, what measures may be taken to mitigate this concern?

Response:

Charging currents are limited. KI uses a 4 carbon pantograph to spread the charging current density. Additionally, for areas where the vehicle will be stopped for a long time on a consistent basis charging bars can be added to the overhead to spread demand and reduce charging density. The stationary current for charging with full auxiliary loads will be approximately 300 amps.

Question #12 – Supercapacitors

What is the time required to recharge fully depleted supercapitors at a stop? What level of current and voltage is this time based on?

Response:

Not applicable to Kinkisharyo ameriTRAM.

Question #13 – Supercapacitors

For a discrete charging system, would your firm recommend a traditional supply system with distribution via underground conduit or smaller discrete chargers at predetermined locations? If discrete chargers are possible, what is the range of AC supply voltages that could be accommodated? Can a one-line diagram of such a discrete charger be provided?

Response:

Not applicable to Kinkisharyo ameriTRAM.

Question #14 – Supercapacitors

If station spacing of one-half mile (800 m) on a 2% grade and the streetcars stops for traffic signals every 500 ft (150 m) is used, would your standard vehicle be capable of passing a stop without charging while operating with the maximum auxiliary load, including HVAC? What would be the anticipated charge level remaining at the second stop?

Response:

Not applicable to Kinkisharyo ameriTRAM.

Question #15 – Batteries & Supercapacitors

Under lane-sharing scenarios, a Streetcar could be delayed considerably in traffic resulting in insufficient remaining charge to reach the next charging area. What is your strategy for minimizing this risk? Would additional storage capacity or capacity monitoring and load shedding (HVAC) be used? What is the possibility of recharging the vehicle in the street and what equipment would be recommended?

Response:

Kinkisharyo's ameriTRAM can be configured to load shed and have performance limits imposed based on the battery state of charge. We recommend traffic light preemption to limit stopping.

A rescue vehicle could be developed that would be used for recharging the vehicle in the street or could power the vehicle until it reaches a wired segment.

Question #16 – Vehicle Design Criteria

The District currently owns three T12 streetcars manufactured by Inekon and has three American-built versions of the Skoda T10 streetcars on order. These vehicles use the standard Czech width of 8 ft (2.46 m). What are the implications of continuing to use such European dimensions? Would you be interested in proposing on a small order of 8-10 cars with this width requirement? If no, what is the minimum order size you would be interested in? Would you prefer using the typical US width of 8 ft 8.3 in (2.65 m)?

Response:

These are Czech widths. European widths are different. Refer to the street car guidelines being prepared by APTA for standard widths. Kinkisharyo recommends the 2650mm width to increase passenger loading and provide interoperability with LRV systems, but can build to the narrow width if the quantities of vehicles are significant.

Question #17 – Vehicle Design Criteria

The District's current vehicle design criteria limit the length of the vehicles to 72.2 ft (22 m). Does this length permit sufficient space to mount energy storage devices on your standard vehicles? If not, what is the minimum length of vehicle your firm would be interested in providing?

Response:

The Kinkisharyo ameriTRAM vehicle is 20m over the anticlimbers and accommodates the energy storage equipment.

Question #18 – Retrofit of Existing Vehicles

The District currently has vehicles with lengths of 66 ft (20 m) and width of 8 ft (2.46 m). If these vehicles are to be operated on lines with wireless sections they will need to be retrofitted. What would be the approximate space requirements if your technology were to be retrofitted? Are there any proprietary components that would be required? Do you have any experience retrofitting the system to older vehicles manufactured by you or others? Would you be interested in performing the retrofit work as part of a new procurement?

Response:

Kinkisharyo recommends that these vehicles be sold to authorities that are operating similar vehicles with similar widths. Portland, Seattle, Tacoma, and possibly Tucson would be candidates. These vehicles should be replaced as part of the procurement to keep the fleet and its maintenance practices/ parts common and to have state of the art wireless operation.

Question #19 – Specialized Equipment

What specialized equipment will be required to maintain your proposed energy storage and/or enhanced propulsion technology options? Will additional shop equipment or storage/charging rooms be required? Will test and troubleshooting procedures be

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impacted, particularly for high voltage storage devices on the vehicles? Please elaborate on the specific function and purpose of such equipment.

Response:

The Kinkisharyo ameriTRAM does not require specialized equipment over that found in modern vehicle maintenance facilities. High voltages exist on any streetcar. Testing and troubleshooting practices will have to take into account procedures to deal with LiIon batteries and high voltage in the form of batteries.

Question #20 – Training and Education

Will additional specialized training for vehicle maintainers, wayside maintainers, or vehicle operators be required? Will specialized personnel in any of these areas be required or would a typical maintainer/operator with a high school diploma and standard maintainer/operator training be sufficient?

Response:

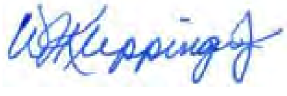
The Kinkisharyo ameriTRAM is designed to be maintained by personnel who maintain electrically power railcars. No advanced training is required other than maintainer / operator training for the battery systems which would be included for a vehicle of this type. The vehicle has the batteries, battery monitor system, and the charge discharge controller that are in addition to typical electrical equipment found on electrically powered railcars.

Also included with this letter are the following materials:

- Kinkisharyo International brochure
- ameriTRAM brochure
- Wireless Streetcar Savings

I will contact you early next week to discuss arrangements for a technical interview including the possibility of a telephone conference call. If this is feasible, we can furnish a call-in number for the call.

Sincerely,



W. J. Kleppinger
Business Development / Program Management
KINKISHARYO International, LLC

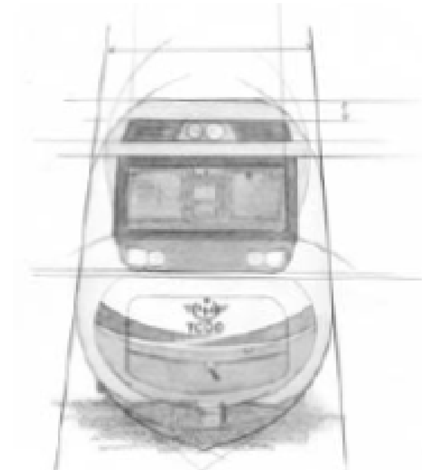
CAF

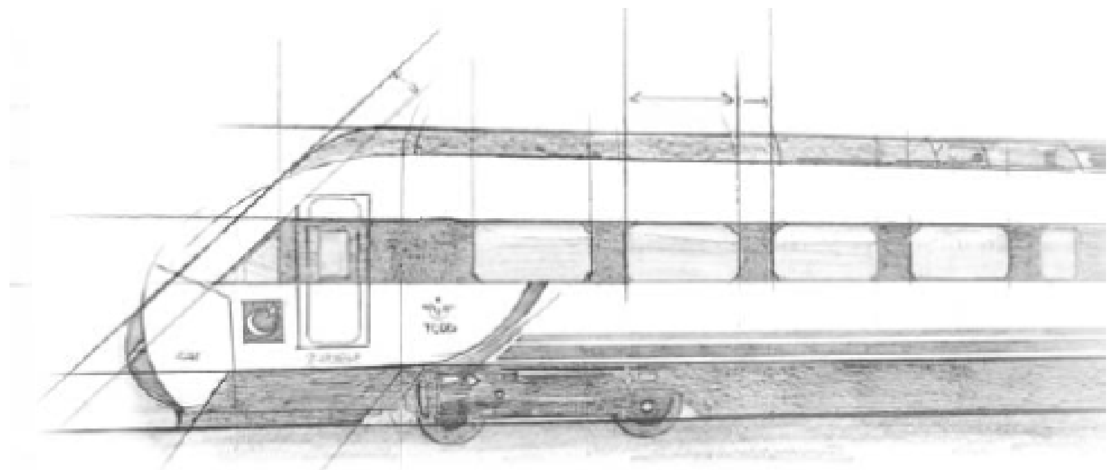
CONSTRUCCIONES Y AUXILIAR DE FERROCARRILES, S.A.

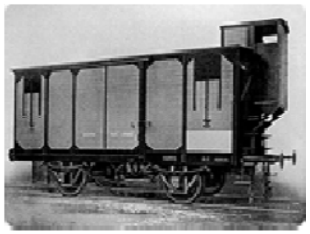
Presentation Index

- History
- Products and services
- Production facilities
- CAF Group
- International presence
- CAF in figures





History



1860–1906: Industrial workshops for the repair and assembly of wagons

1897: Zaragoza: Establishment of "Carde y Escoriaza" First tram manufactured in Zaragoza.

1917: Establishment of the company "Compañía Auxiliar de Ferrocarriles, S.A." with headquarters in Beasain Main activity: manufacture of freight wagons.

1969: Creation of the R&D unit strengthening technological development

1992-2000: International consolidation of the company

History

2006: Commissioning of the variable gauge BRAVA system for High-Speed Rail

2008: Start of the commercial Operation of suburban Train in Mexico, 30 year concession contract. DBOT Project

2010: Oaris, very high-speed train (350 km/h)

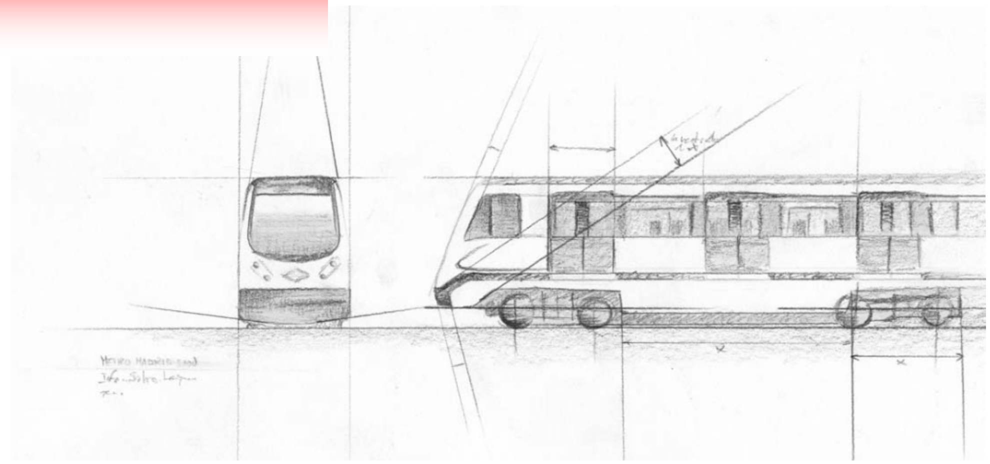
Products and Services

ROLLING STOCK

• Design and manufacture of all types of rolling stock

TURNKEY PROJECTS

• Turnkey
• Concessions



FINANCING

• Project financing
• Leasing/Renting
• Made to measure solutions

SUBSYSTEMS

• Component Manufacture (wheels, axles, couplings, etc.)
• Equipment Supply (Trucks, Cosmos, Traction…)

ENGINEERING SERVICES

• Integration of Systems
• R&D
• Reliability Study
• Simulators
• Documentation
• Testing

AFTER-SALES SERVICES

• Maintenance
• Spare Parts Supply
• Repair
• Maintenance depot construction and equipment

Rolling stock

Wide range of products

High-speed trains

Regional trains

Suburban trains

Coaches

Subways

Airport shuttles

Trams

Articulated units

Locomotives

Facilities

➢ CAF BEASAIN

Total Surface Area:	446,000 m2
Staff:	2,432

Activities:
- Manufacture of Components
- Manufacture of Bogies
- Manufacture of Steel Car Bodies
- Manufacture of Aluminum Car Bodies
- Static testing of Car Bodies
- Painting
- Final Finishing and Testing

4. Facilities in Spain

- **CAF ZARAGOZA**

- **CAF IRUN**

- **CAF TRENASA - CASTEJON**

- **CAF SANTANA - LINARES**

4. Facilities outside Spain

➢ CAF BRAZIL (HORTOLANDIA)

➢ CAF FRANCE (CFD BAGNÈRES DE BIGORRE)

4. Facilities outside Spain

➢ CAF USA (ELMIRA)

➢ CAF MEXICO (HUEHUETOCA)

CAF Group

CAF Group comprises more than 70 companies that work together to offer global railway solutions.

-**CAF Transport Engineering:** engineering and system electrification and integration.
-**CAF Signalling:** energy remote control and signaling
-**CETEST:** comprehensive testing and test management
-**Lander:** simulation systems
-**Danobat Rail:** depot equipment
-**CAF Power and Automation:** design and manufacture of electrical traction equipment for all types of trains, information and communication systems in the railway sector
-**Ennera:** renewable energy supply systems
-**Geminys:** integrated document management
-**NEM:** intelligent maintenance management systems.

CAF Power & Automation

CAF Signalling

CAF Transport Engineering

cetest CENTRO DE ENSAYOS Y ANÁLISIS

NEM solutions

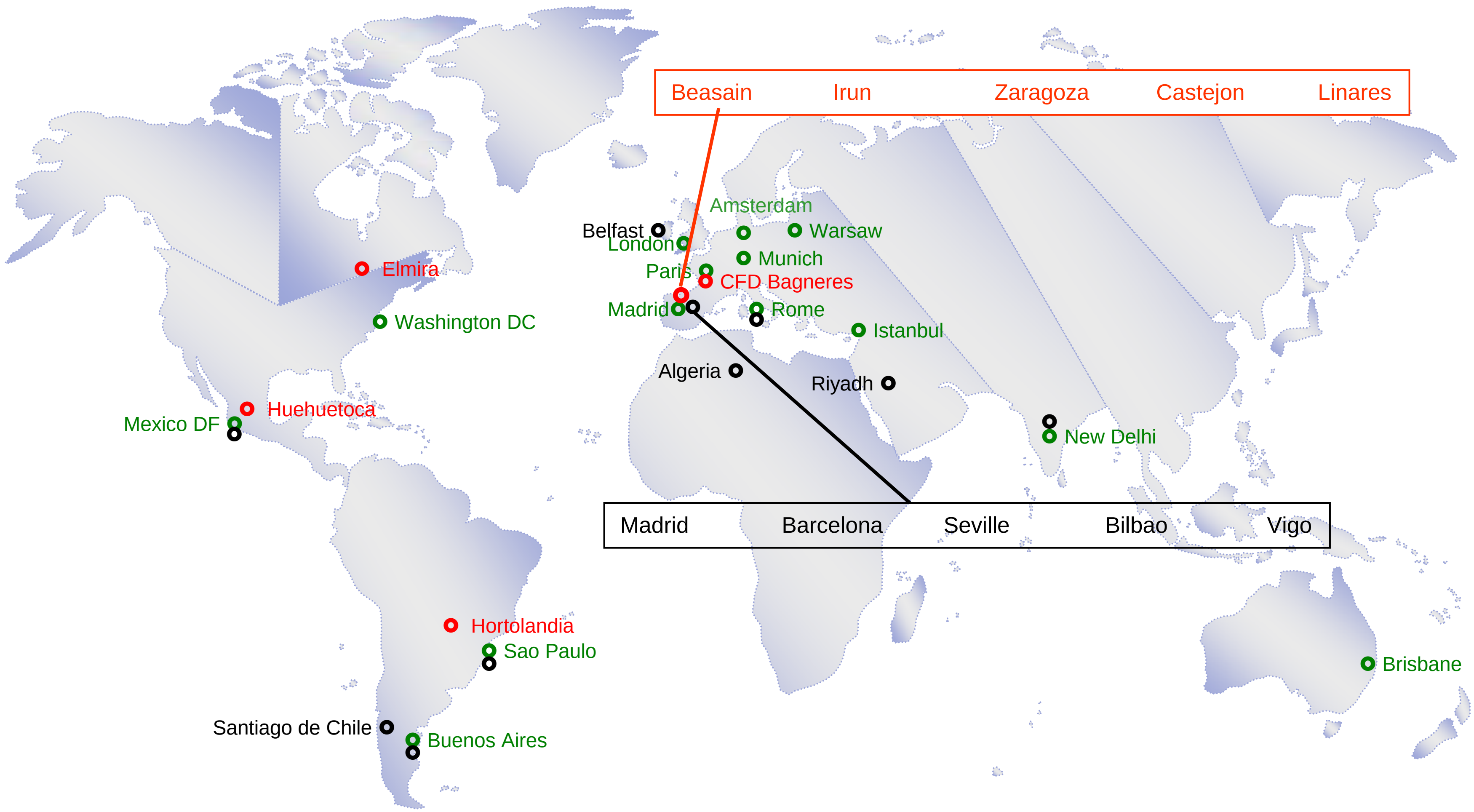
ennera energy for a new era

LANDER SIMULATION & TRAINING SOLUTIONS

Geminys gestión de manuales industriales e ingeniería

CAF

International Presence



OFFICES **FACTORIES** **DEPOTS**

International Operations

- 30 COUNTRIES
- 67 PROJECTS
- $2 Billion

Capital and Investments

- CAF is a private corporation with 100% of its shares listed on the stock market
- 29.56% employee participation
- 19.06% savings bank participation

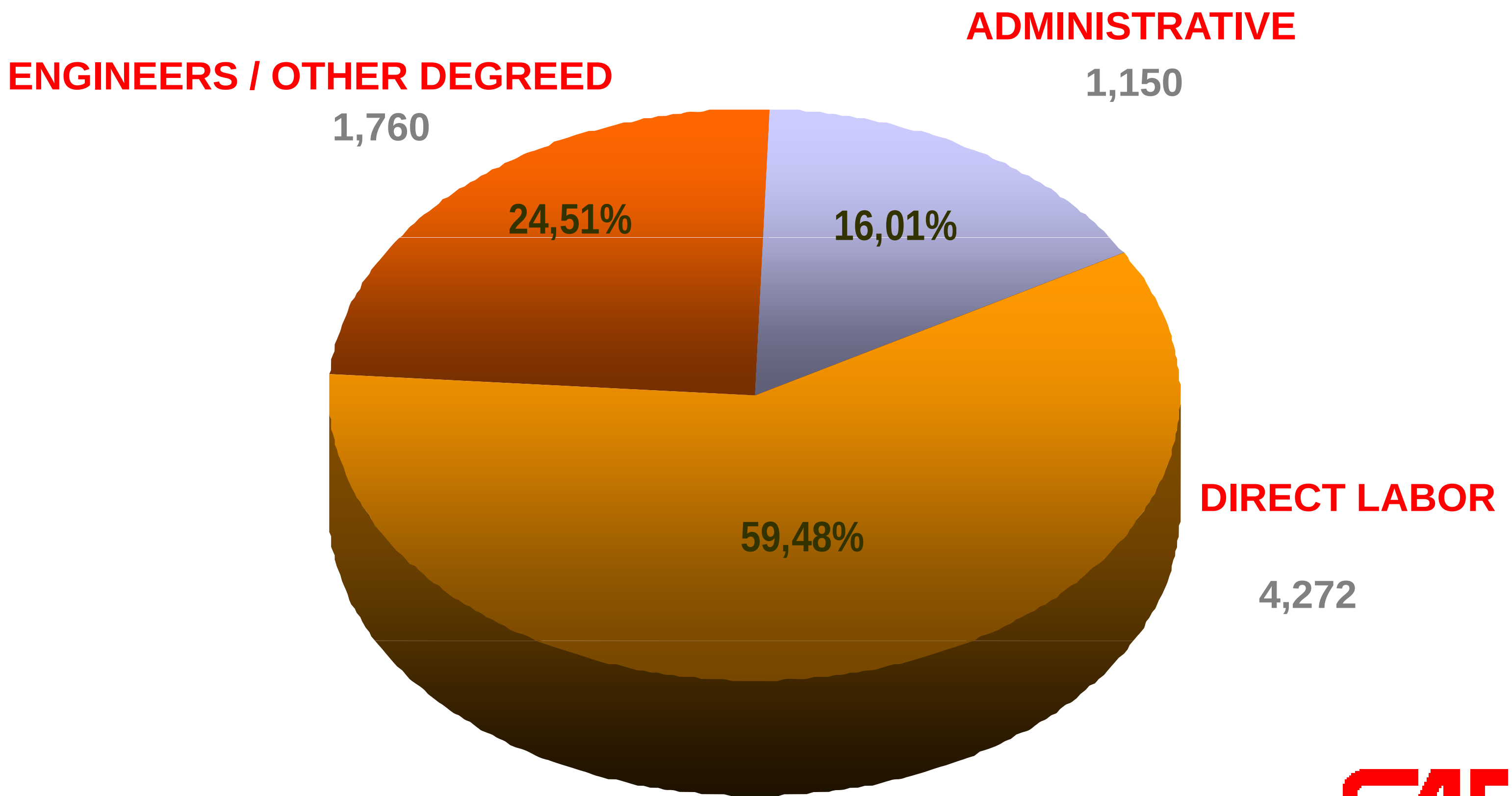
The investment figure since 1995 has reached more than 417 million €

Workforce

30/09/2012:

CAF Group's total no. of employees 7,182

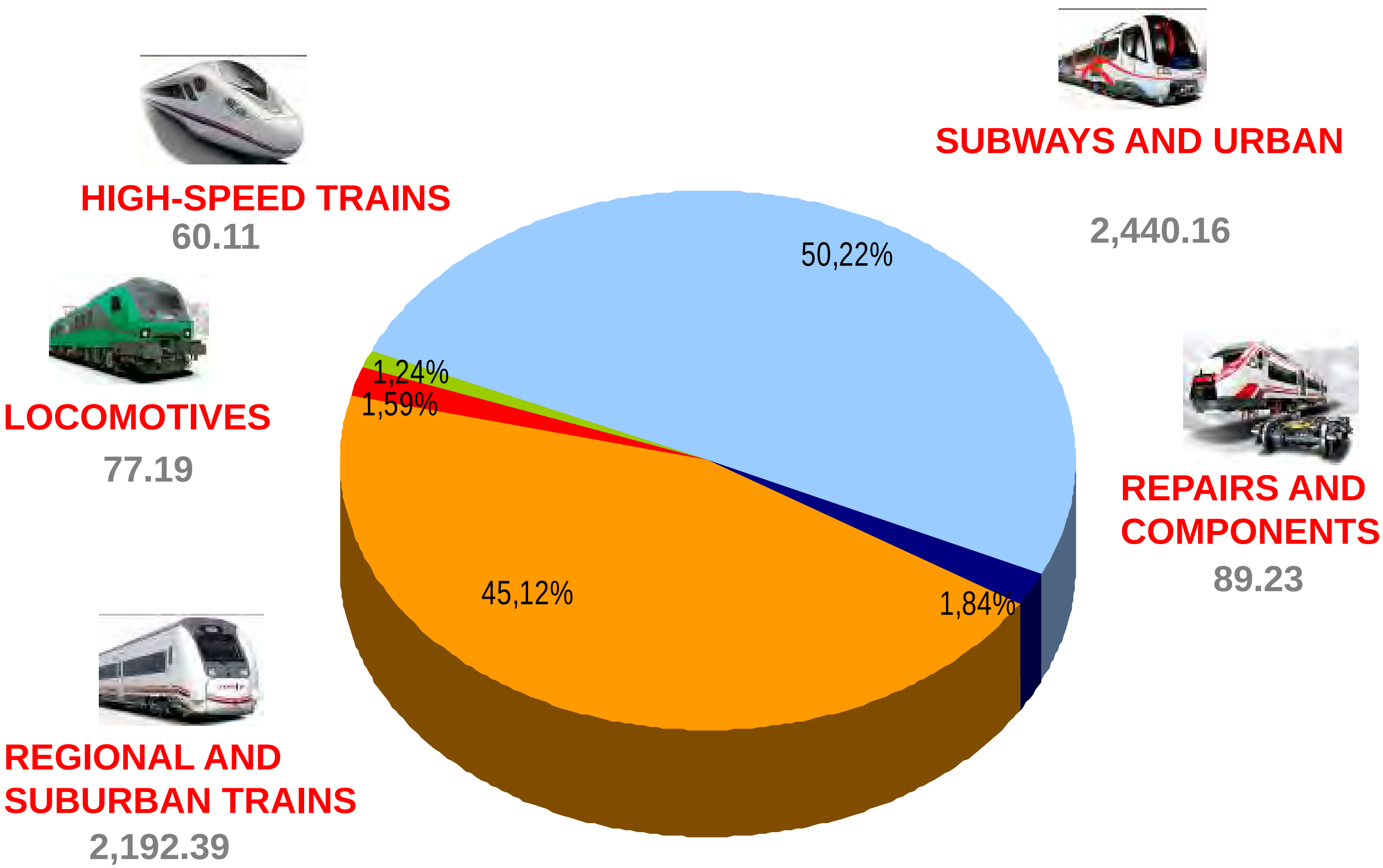
- CAF S.A.: 3,778
- Subsidiaries: 3,404



BACKLOG

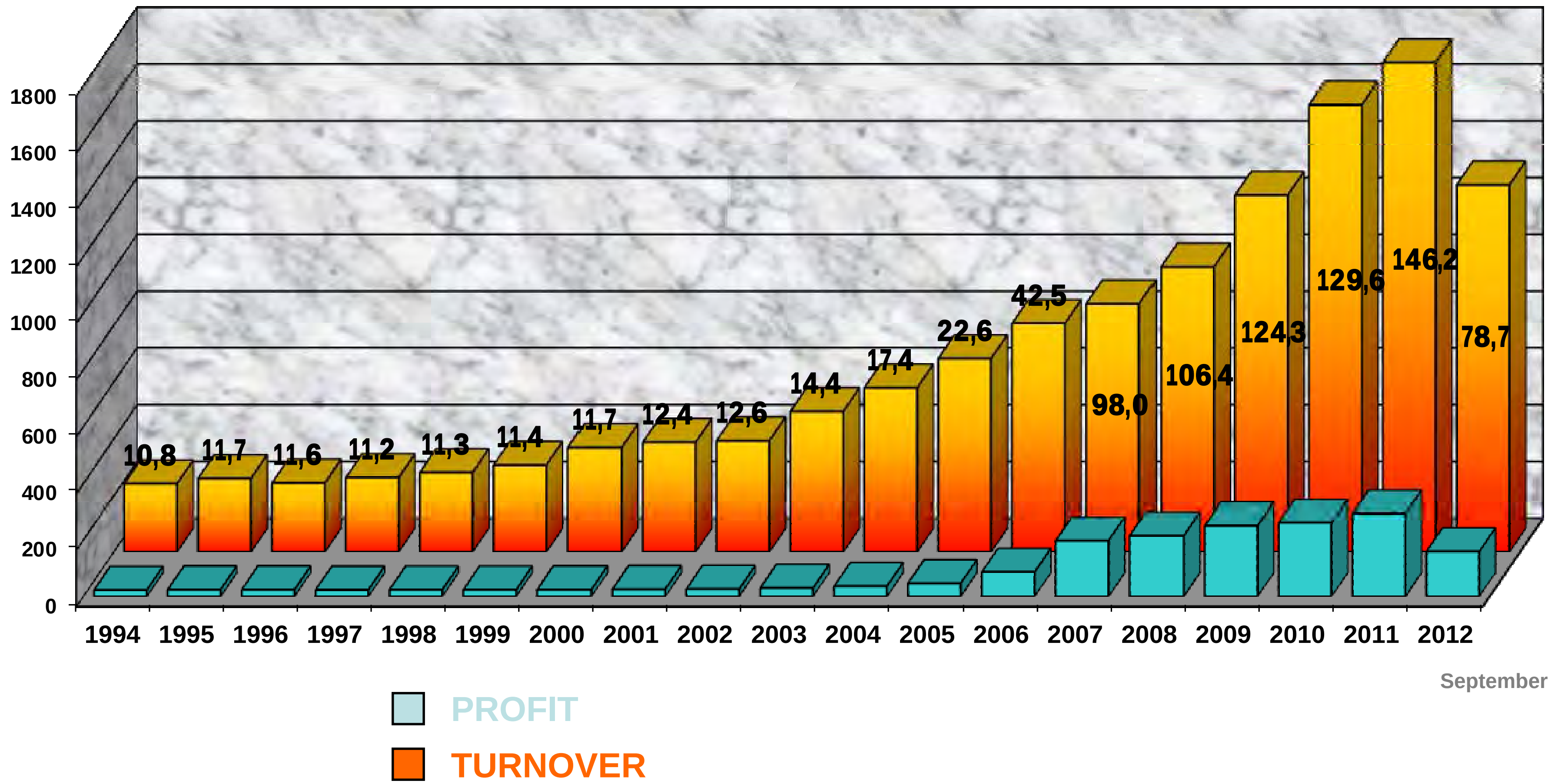
30/09/2012:

Order portfolio: €4,859.09 Million



Turnover and Profit

On the 30/09/2012, CAF is in a good position with respect to turnover and profit.



September 2012

We create railway solutions

March 22, 2013

CAF URBOS PLATFORM

Urbos 100% Platform

- Modularity and flexibility:
  - Uni-directional ⇔ Bi-directional
  - Multiple Configurations
  - Dimensions: length and width
  - Different Voltages: 650 Vdc, 750 Vdc and 1,500 Vdc
- Accessibility:
  - 100% Low Floor
  - ADA Compliant
- Optional Energy Storage System (Supercapacitors - ACR):
  - Energy Saving
  - Catenary-less Service
- Ease of Repair and Mantainability ➔ Modular Construction

Urbos 100% Platform

- 100% Low Floor
- Different Configurations: 3, 5, 7 and 9 modules

M- Motor Truck Module

T- Trailer Truck Module

3 Module

M M

5 Module

M T M

7 Module

M M T M

9 Module

M M M T M

Track and Wayside Parameters

- Supply Voltages: 650 Vdc, 750 Vdc and 1,500 Vdc
- Track Gauge: 1,000 mm ⇔ 1,435 mm
- Floor Height (TOR) 14”
- Floor Height in Access (TOR to Threshold) 12-14”
- Minimum Horizontal Curve Radius: 15 m for 1,000 mm gauge ⇔ 18 m for 1,435 mm gauge
- Minimum Vertical Curvature: 1,150 ft
- Maximum Gradient: 8-10% (3M-5M)
- Minimum and Maximum Operating Heights:
  - (w/o Supercapacitors – ACR) 11.48 – 22.22 ft
  - (w/ Supercapacitors – ACR) 12.38 – 22.22 ft

Technical Characteristics. Dimensions

- **Standard Car Length:**
  - 3 Modules — 69.29 ft to 77.50 ft
  - 5 Modules* — 106.19 ft to 124.56 ft
  - 7 Modules — 143.08 ft
  - 9 Modules — 179.97 ft

*Flexible Length of the Vehicle

- **Carbody Width**

Zaragoza Tram → Sevilla Tram → Belgrado Tram

Technical Characteristics. Doorway Dimensions

- Floor Height (TOR) — 14”
- Floor Height in Access (TOR to Threshold) — 12-14”
- Single door opening width: — 32”
- Double door opening width: — 51.2”
- Door Configuration per side:
  - 3 Modules — 2 double leaf + 2 single
  - 5 Modules — 4 double leaf + 2 single
  - 7 Modules — 6 double leaf + 2 single
  - 9 Modules — 8 double leaf + single

Technical Characteristics. Capacities and Weights

- Capacity (2,650 mm width vehicles)

LRV Configuration	Seats	Passengers (4p/m2)	Total capacity
3 Modules	24	124	148
5 Modules	48	180	228
7 Modules	68	249	317
9 Modules	80	317	397

- Tare Weights
  - 3M Vehicle 76,850 lbs
- Maximum Axle Load 132 kN

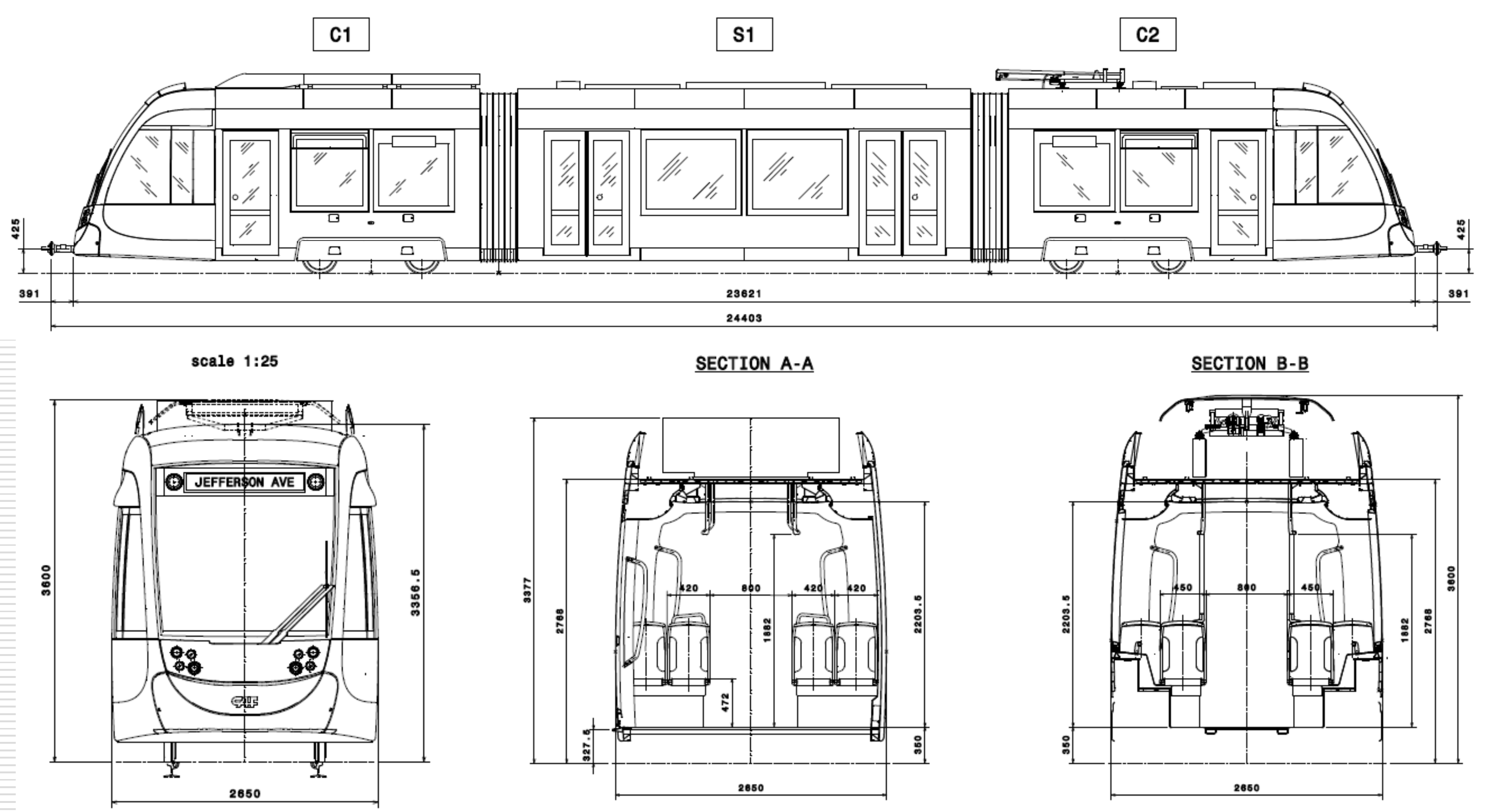
Technical Characteristics. Vehicle Performance

- Supply Voltage — 750 Vdc
- Maximum Speed: — 45mph
- Nominal Power: — 560kW (70kW per motor)
- Acceleration: — 3.0 mphps (1.34 m/s2) from AW0 to AW2
- Deceleration rate (full service): — 3.0 mphps (1.34 m/s2) from entry speed to zero
- Deceleration rate (emergency): — 5.0 mphps (2.23 m/s2) For 42 mph > entry speeds > 15 mph and it shall not exceed by more than 30%
- Parking Brake — 8%

Technical Characteristics. Base Configuration (3M USA)

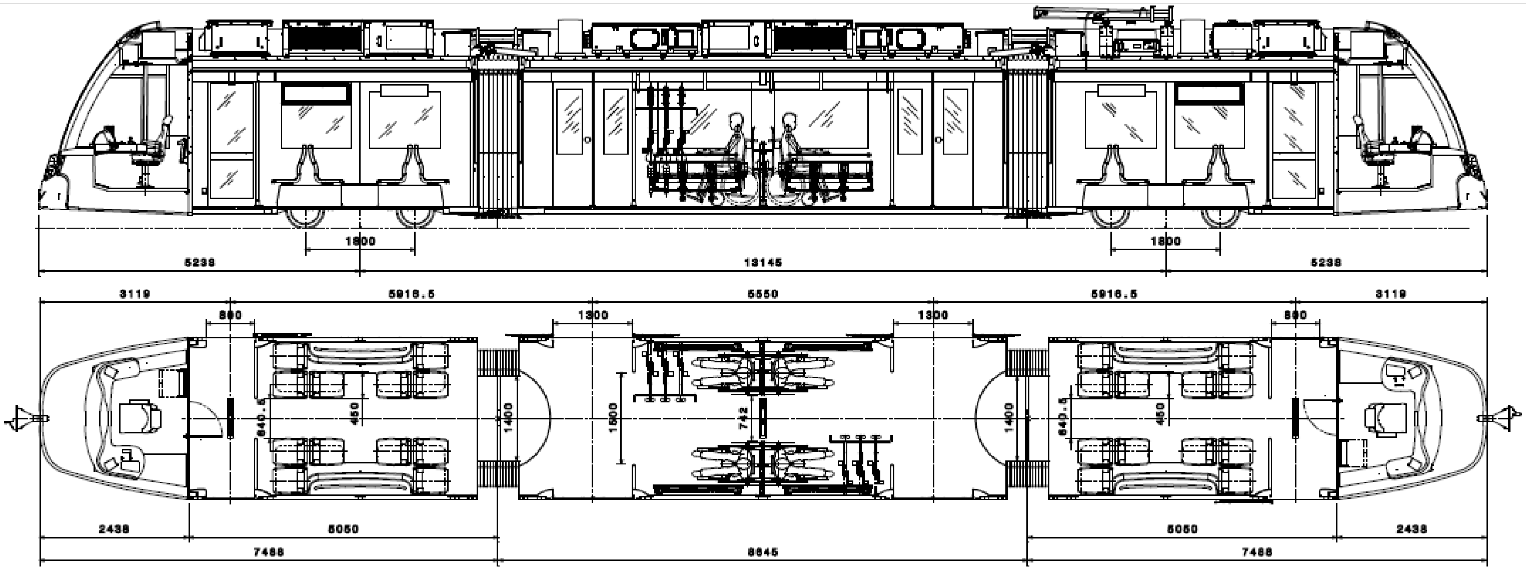
3 Modules:	C1-S1-C2
Body width:	8.69 ft
Unit height:	11.81 ft lowered panto
Floor height (TOR):	14”
Floor Height in Access (TOR to Threshold)	13.48”
Total length:	77.49 ft
Length between doors:	57.03 ft
Wheelbase:	70.87” motor truck
Bodybase:	43.12 ft
Wheel diameter:	23.22-20.07” (590-510 mm)
Vehicle capacity:	148 (24 seated -16%-, 148 @4p/m2)
Axle load:	132 kN EN 15663

Technical Characteristics. Cincinnati (3M)



URBOS PLATFORM

Technical Characteristics. Interior Layout. Cincinnati (3M)



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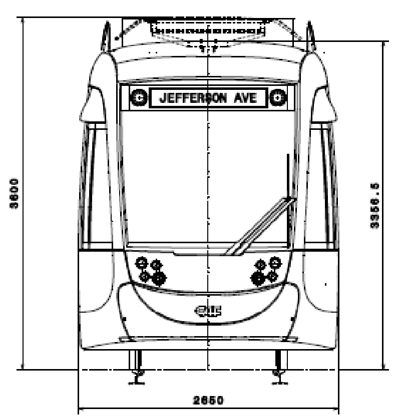
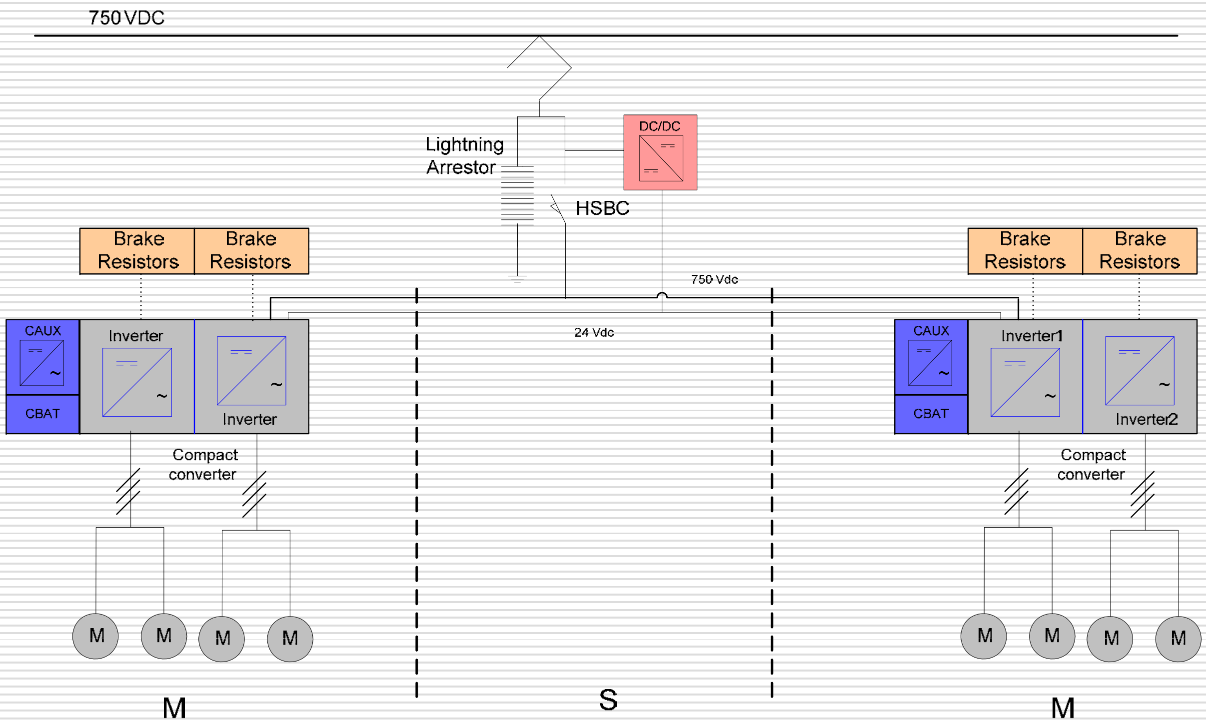


PASSENGER CAPACITY					
		C1	S1	C2	TOTAL
SEATED		12	(+12)	12	24 (+12)
AREA (m²)		5.64	20	5.64	31.28
STANDEED	4p/m²	22	80	22	124
	6p/m²	33	120	33	186
	8p/m²	45	160	45	250
TOTAL	4p/m²	34	80 (+12)	34	148 (+12)
	6p/m²	45	120 (+12)	45	210 (+12)
	8p/m²	57	160 (+12)	57	274 (+12)

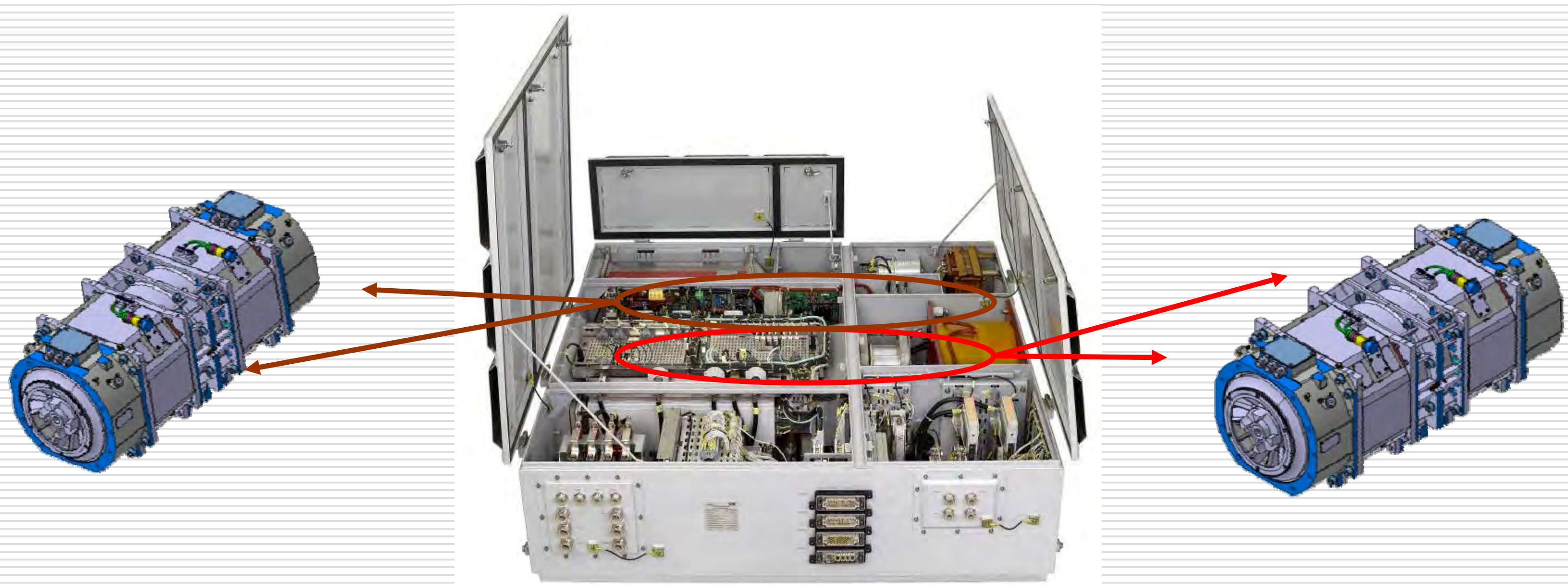
Main Equipment. Traction and APS (3M)

- Traction Inverter, Static Converter and Battery Charger consolidated in one Box
- Each Motor Truck has its own traction box, that consolidates 2 inverters



Main Equipment. Traction and APS

- Each Traction Unit is controlled by the Electronics integrated in the Inverter Box.
- Each Inverter controls 2 Traction Motors of one side in order to reduce flange and rail wear and optimize curve negotiation.
  - Nominal Power: 61kW per motor.
- Self-Ventilated Motors
- Forced Air Cooled Inverters
- Regenerative and Rehostatic braking



Main Equipment. Traction and APS

The Auxiliary Power Supply consists of the following elements:

- 1 Auxiliary Converter (208 Vac, 60 Hz) integrated in each Traction Box of 50kVA
- 1 Battery Charger (28Vdc) integrated in each Traction Box of 5.5 kW
- 1 Battery (24Vdc) de NiCd de 110Ah per tramway

The Auxiliary Converters feed all the train loads redundantly.

In case of 1 Converter failure, the other Converters will feed the HVAC Units with a reduced performance and the rest of the loads of the vehicle.