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Mr John Hall
Chief Executive
Queensland Competition Authority
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RE: QR Network's Electric Traction DAAU – Request for Comment on Draft Decision

General Electric welcomes the opportunity to comment on your October 8, 2012 letter to QR Network Pty Ltd Chief Executive Officer Mr Michael Carter which invites QR Network and other stakeholders to make submissions on its Electric Traction Services (AT₅) draft amending access undertaking (DAAU) and QCA's Draft Decision.

GE does not intend to comment on the merits, structure or imposition of the AT₅ tariff.

Rather, GE confines its comments on the *"additional matters"*¹ you refer to as raised with the QCA in its response to its Draft Decision and whether *"they have been addressed in sufficient detail in the material....[or] sufficient to support or contradict the proposition made by some stakeholders that electric traction is more efficient than diesel"*².

Specifically, GE will focus on the technology responses available and under development relevant to the *"particular issues about the implications of electrification"*³ you referred to:

1. Performance
2. Fuel Saving Technologies
3. Headways and Cycle Times

In reference to my letter dated November 23 2012, I can now confirm the information on GE technologies that are providing continuous improvement for the performance, fuel savings, headways and cycle times does not include material that GE would regard as commercial-in confidence or that GE would seek to be deemed as "confidential information" as per Section 187 of the *Queensland Competition Authority Act 1997*.

¹ E.J. Hall, "Issues for further comment: Letter to QR Network Pty Ltd CEO Mr Michael Carter", October 8 2012, p 1

² Ibid, p 2

³ Ibid

Background:

GE's Rail Technology Leadership

For more than a century, GE Transportation has been a leader in the rail industry, providing freight and passenger locomotives, signalling and communications systems as well as rail services to help solve the world's toughest rail challenges.

As a principal manufacturer of diesel-electric locomotives, GE Transportation has produced a succession of world-class models and developed advanced rail technology that reduces operating costs, decreases fuel use, minimizes downtime and complies with stringent emissions standards. Today, more than 17,000 GE locomotives operate in 50 countries.

As a global company, GE has a localized focus with products and services that adapt to regional needs across the world. Manufacturing is local, too, as GE and its partner facilities design and build rail products in locations worldwide.

GE's technology leadership in the rail industry goes well beyond locomotives to help move people and goods safely and efficiently with signalling, communications products, traffic-control and dispatch services. Additionally, GE keeps locomotives in reliable revenue service with service sites and distribution centres throughout the world.

GE's Environmental Investment

Ecomagination™ is a GE initiative to bring to market new technologies that will help customers meet their most pressing environmental challenges. GE has committed to invest US\$10 billion in ecomagination™ projects over the five years to 2015 after investing US\$5 billion between 2005 and 2010.

Those GE products with the ecomagination™ designation undergo a rigorous independent certification process to prove they measurably help customers' business and bottom lines while improving their environmental performance.

Some key products of ecomagination™ include:

- Evolution Series Locomotive: Uses up to 5% less fuel while reducing emissions by approximately 40% compared to previous GE models
- PowerHaul Series Locomotive: Reduces fuel use and CO₂ (greenhouse gas) by up to 9% compared to current operating fleet averages
- Trip Optimizer: Minimizes fuel consumption and reduces emissions by approximately 10%
- LOCOTROL® Distributed Power: Reduces NO_x production by up to 10% on a variety of locomotives and train configurations

GE comments on “particular issues about the implications of electrification”:

1. Performance

The QCA Draft Decision concluded that: *“there has been significant technological change that has apparently reduced the performance gap between diesel and electric trains. While technological change could be expected to continue into the future for both diesel and electric locomotive technologies, stakeholders have argued that this is most likely to occur for diesel locomotives.”*⁴

GE can support this finding with comments on the significant technological change in our own diesel-electric locomotives, our investment in future advances, including the development dual-fuel engines incorporating natural gas.

GE Evolution Series Locomotive

The Evolution Series is the most technologically advanced, diesel-electric heavy-haul locomotive in the world. This product of ecomagination™ delivers an incredible combination of power, performance and efficiency, using up to 5% less fuel while reducing emissions by approximately 40% compared to previous GE models.

Features

- 16-cylinder power with 12-cylinder economy
- Hybrid air-to-air cooling system
- Consolidated Control Architecture (CCA)
- Heavy duty traction motors
- High capacity dynamic braking
- Available with AC or DC traction systems
- Computer-controlled auxiliary devices
- Common Rail technology was introduced in early 2012 (~2% fuel benefit)

Benefits & Value

- 40% reduction in NOx and PM emissions over predecessor operating at Tier 1
- Engineered to deliver lower life cycle costs
- 30% longer engine overhaul interval compared to the 7FDL™ engine
- 184-day running maintenance

On August 24, 2012 GE Transportation unveiled the prototype for its next generation Evolution® Series Locomotive that will decrease key emissions by more than 70% and save railroad operators more than \$1.5 billion in infrastructure and operational costs. GE expects that the locomotive will be the first in the industry to meet the US Environmental Protection Agency’s (EPA) stringent “Tier 4” emission standards, which call for the single-largest emission

⁴ Queensland Competition Authority, “Draft Decision: QR Network Electric Traction Services Draft Amending Access Undertaking”, July 2012, p 11

reduction in the tiered program's timeline. The new locomotive will meet this standard with technological advancements versus costly alternatives, which require additional exhaust additives and infrastructure investments.

This new locomotive is the extension of GE's ecomagination™- proven Evolution Series Locomotive family – the best-selling global locomotive platform. Today, more than 5,000 Evolution Series Locomotives operate in the US, allowing railroads to move one ton of freight more than 480 miles on a single gallon of fuel. This new engine technology is the result of an initial six-year, \$400 million investment, followed by a two-year, US\$200 million investment to hone the research, design and engineering to meet Tier 4 standards.

Natural Gas Engine Locomotives

GE Transportation is developing dual-fuel engine kits that can be installed on new, or retrofitted to, Evolution Locomotives. This system can provide up to 80% substitution of diesel for natural gas and as well 100% diesel without sacrificing power and efficiency.

The use of natural gas not only reduces the emissions on a locomotive but also offers savings based on the substitution rate and price differential between the Diesel and Natural Gas. GE aims to conduct test runs on the first demonstration locomotive in 2013 with a target for production units by 2016.

GE Transportation is investing in emerging hybrid locomotive technology underpinned by our investment in the energy storage business.

GE PowerHaul Series Locomotive

GE Transportation and its local partner UGL are ready to deliver the next generation of narrow gauge locomotives to the Australian market with the introduction of the PowerHaul Series model PH37ACmai.

This locomotive is designed to be the most technologically advanced, fuel-efficient and emissions capable diesel-electric freight locomotive available.

At the heart of the PowerHaul Series is the P616 engine, the major driver in PowerHaul's ability to deliver better operational and environmental performance. The P616 diesel engine was born out of GE Transportation's development of the compact Jenbacher engine with its high power to weight ratio. Large numbers of these engines were produced for static power generation. The PowerHaul engine is a further advancement, taking it from gas to diesel using proven technology from GE's Evolution Series engine. This produced the 3750GHP PowerHaul P616 engine with its twin-turbocharger and high pressure common fuel rail.

The GE PowerHaul locomotive also uses regenerated energy from dynamic braking to power auxiliary system invertors that controls radiator fans, traction motor blowers, air compressor and some other devices. This inverter technology optimises the control of auxiliary loads whilst minimizing fuel consumption by using electrical braking energy that would otherwise be lost as heat.

Even before the announcement of the Australian Government's Clean Energy Future package and the introduction of a carbon price, meeting the emissions requirements was a critical consideration in the design process and was driven as a result of the increasing focus of emissions and new regulatory requirements from other areas of the world. The PH37ACmai has been designed to meet the emission requirements stipulated by EU Stage IIIA and can be adapted to meet Stage IIIB. The PowerHaul Series reduces CO₂ (GHG) by up to 9% compared to current operating fleet averages. The locomotive can also deliver an impressive 6% - 10% reduction in fuel consumption compared to current operating fleet averages in its class.

2. Fuel Saving Technologies

GE notes the QCA Draft Decision acknowledges the comments of other stakeholders that *"the actual cycle time difference between electric and diesel trains was minimal due to network and operational issues such as signalling, scheduling and queuing"*.⁵

Furthermore, there are a range of technologies detailed below improve cycle times, through automatic start-up and fuel efficiencies, and these technologies are commercially available and being deployed in railways including in Queensland.

Auto Engine Start Stop (AESS)

The average locomotive spends 50% of its run-time in idle. AESS automatically shuts down an idling diesel engine, while keeping the locomotive ready to start on demand.

Installed on over 3000 locomotives worldwide and over 120 GE locomotives in Australia, AESS's patented algorithms continuously evaluate critical parameters, whether the engine is running or stopped. The system monitors locomotive speed, ambient temperature, battery voltage, and brake system air to safely and automatically stop and start your idle locomotive, as conditions warrant.

AESS was designed to be part of the integrated locomotive control system. The system monitors vital parameters. Specific conditions must be met prior to initiating shutdown. Start-up can be triggered either automatically, via the control system algorithms, or through operator-induced actions. Standard system features provide engine and shutdown status to the operator.

Consist Manager

Reallocating power among the lead and trail units in a locomotive consist can save fuel. GE's Consist Manager computer control system is the first product to make it happen by continuously monitoring and selecting the optimal notches across a consist. The driver chooses the throttle notch as normal. The changes in power notches are smoothly transitioned, minimizing fuel demand.

⁵ Ibid, page 8

Features

- Needed on lead unit only, although economies gained across the consist
- No need for unit insulation
- Capable of operating with units from both GE in trail

Benefits & Value

- Minimizes middle-notch (N3-N6) fuel inefficiencies without compromising total power
- 1-3% fuel savings for each locomotive depending on consist configuration
- Can be used in combination with other fuel savings solutions
- Lowers NOx emissions by up to 3%

Distributed Power

With GE LOCOTROL distributed power, railroads can optimise the distribution of power and braking control over the entire length of a train. Installed on more than 8500 locomotives across the world, the systems provide control of remote locomotives by command signals sensed at the lead locomotive and transmitted over a radio data link to the remote units.

LOCOTROL is designed to operate safely if radio communication is lost and will interface with almost every type of braking and train line control system.

Features

- Message repeaters (for improved radio coverage in critical areas)
- Tower control (for unmanned loading or dumping)
- Slow speed/plug mode (for loading and dumping control of heavy trains)
- Operates in mixed fleets of electric and diesel locomotives (China)

Benefits & Value

- 30% faster and smoother starting and stopping distances
- 22% faster and smoother starting and stopping times
- Brake pipe charging times reduced by 60%
- Improved fuel efficiency, depending on territory
- System throughput increases
- Operating cost reductions averaging 10%
- Reduced rail wear
- Reduced in-train forces

3. Headways and Cycle Time

The QCA Draft Decision reported the comment that:

"[B]ecause the density of electric trains in an electric system was a function of the capacity of each feeder station, which might limit the headways and the number of trains within an electrified feeder section. In contrast, train density in a diesel locomotive system was limited only by the headways imposed by the signalling system. Therefore, reducing headways in an electric system would require increasing the number of feeder sections, with the additional infrastructure costs."⁶

GE has a range of technologies such as the Trip Optimizer, RailEdge Movement Planner and Train Control Systems that help keep trains on schedule, minimise fuel use and reduce life-cycle cost.

Trip Optimizer

GE's Trip Optimizer, automatically controls a locomotive's throttle and dynamic brakes, helping keep trains on schedule while minimizing fuel use. This makes the process of delivering locomotive freight more fuel-efficient and less costly. Trip Optimizer can also be complementary to GE's RailEdge Movement Planner. This allows a railway to provide an efficient system wide utilization of the locomotives.

Trip Optimizer creates an optimal trip profile that can minimize braking by automatically learning a train's characteristics. The system calculates the most efficient way of running by considering such factors as train length, weight, grade, track conditions, weather and locomotive performance characteristics.

During the trip, an integrated network of on-board computers and GPS systems update the profile continuously, adjusting for changes so the train can arrive on time and with minimum fuel use.

Proven Fuel Savings

- 10% energy savings
- 10% emissions reduction
- 11% mean shift
- Reduced standard deviation between drivers
- Removes variations in driver response seen in coaching system

Trip Optimizer (Auto Control) Speed Regulation

- 90% vs. 65% on target
- 10% vs. 19% under speed
- No over speeds
- Reduced variability

⁶ Ibid, p 9

Greater efficiency achieved through a new advance in technology



Figure 1: GE Trip Optimizer (as seen by the locomotive driver)

RailEdge Movement Planner

This system delivers real-time overviews of network operation from a single, sophisticated string-line display, giving you the information you need to make optimal decisions.

With RailEdge Movement Planner, an operator can monitor trains in both signalled and non-signalled territories using global positioning systems, track-circuits, automatic equipment identification readers, and time-based tracking. RailEdge monitors and controls all kinds of wayside devices. Built-in traffic management applications, such as train sheets, restrictions, blocks, automatic train regulation, and route setting give you the ability to effectively manage train schedules and swiftly respond to unexpected events.

The rail network can improve its operational efficiency by taking advantage of RailEdge Movement Planner's data-rich environment and built-in analytical tools. With this ability to retrieve historical data into customizable reports, you can gain insight into optimizing train schedules and balancing staff workloads.

The RailEdge architecture is highly scalable allowing control of passenger and freight operations ranging from small branch lines to strategic national corridors. With RailEdge's track database management tool, updating the network layout is as simple as clicking a button. There's no need to "take down the network" or request vendor assistance.

Features

- Automatic train supervision (ATS)
- Centralized traffic control (CTC)
- Automatic route setting (ARS)
- Stacked and stored route management
- Train Information and tracking

- Network visibility console
- Direct traffic and track warrant control
- Track bulletins

Movement Planner is a faster, smarter way to gain network efficiency and the technology has been adapted by some of the world's leading railways including Norfolk Southern and Canadian Pacific.

Automatic Train Operation

With over 50 years of experience in automating heavy haul railways, GE understands the requirements around controlling and stopping long heavy trains in remote environments. Implementing GE's In-Cab signalling system and applying GE's Trip Optimizer technology will give the customer ability to provide a significant level of driving automation without large capital costs.

The operational and cost benefits of implementing these technologies would deliver significant dividends over entire life of the business. Further, GE has combined Trip Optimizer technology with RailEdge movement planner to produce a platform that optimizes fuel, energy, locomotive usage and staff to maximize the overall efficiency of the rail network.

Train Control Systems

(i) Integrated Train Control System – ITCS

ITCS is one of the few fully functional vital communication-based train control systems currently in operation today and requires the least amount of wayside hardware as transponders are not required for operation. ITCS provides safe train separation and positive train speed and authority enforcement.

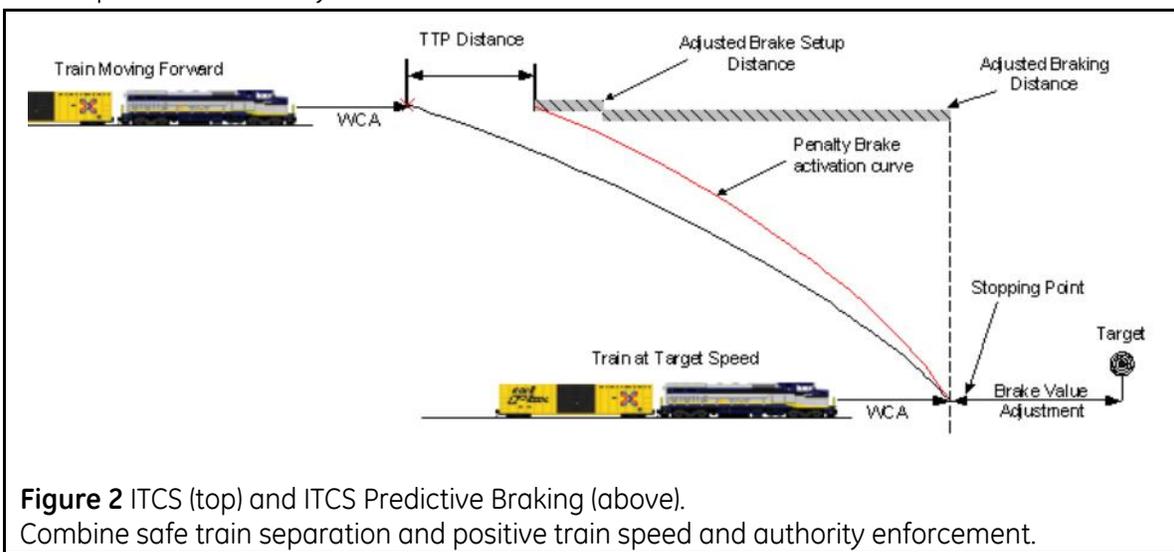


Figure 2 ITCS (top) and ITCS Predictive Braking (above).
Combine safe train separation and positive train speed and authority enforcement.

Features

- Wireless Train movement communication
- Replaces or augments existing wayside signalling
- Standalone capability for new installations and non-signalled territories
- Dynamic on-board map containing temporary, civil and signalled speed limits
- Commuter, freight and passenger applications

Benefits & Value

- Safety: Improves safety through full continuous ATP and on-board displays
- Reliability: reduces/eliminates the need for track and wayside devices (signals, train detection)
- Efficiency: reduced headway leads to increased train speed and line capacity

Cost Savings/Avoidance

- Greenfield projects: a cost effective CBTC solution with significantly reduced maintenance cost compared to conventional signalling
- Overlay: cost effective and quick to deploy to increase capacity, speed and safety
- Significant operational expense cost savings over traditional signalling Systems
- Building railway track in Queensland is a significant capital outlay and ITCS is a cost effective solution to get increased throughput

ITCS is currently in operation at the following railways:

Railway	Operation
Amtrak Michigan Line	Performing enforcement of CTC and safe train separation for trains exceeding 90 Miles / Hour and allow for higher capacity
China Ministry of Railways	Performing 100% radio-based CTC and safe train separation in high altitude and extreme cold climates
Fortesque Metals Group Australia	Currently in design and installation. Will perform safe train separation and speed enforcement for heavy haul mining operation
Union Pacific Illinois	High-speed project currently in design

(ii) Wayside Signalling (Computer based Interlocking)

ElectroLogIXS products are well proven in service around the world. The current generation train control product originally carrying the brand EC5 was introduced in 2000 as a train control product capable of being populated with up to 4 Vital Logic Control (VLC) modules. In 2004 GE introduced 1 slot, 4 slot and 9 slot chassis to house the same processor and IO cards, allowing our customers options that optimize space and cost.

In 2010 GE introduced the VPM-3 Processor module that added Ethernet communication capability to the already incredibly flexible platform. The ElectroLogIXS platform to date has shipped over 13,000 systems to customers worldwide.

ElectroLogICS is widely used throughout Australia, servicing customers including Fortescue Metals Group, BHP Billiton, V/Line, Brookfield Rail and ARTC.



Figure 3 ElectroLogIXS 9-Slot System
Designed to optimize available space at an affordable cost.

(iii) Level Crossing Protection

The ElectroLogIXS XP4 is not just any crossing predictor. Its proven HXP technology that performs through the most difficult AC-induced noise and delivers continued reliability in poor ballast conditions. The XP4 supports a range of highway-rail grade crossing applications, incorporating constant warning time and motion detection control, crossing island train detection, vital input monitoring, vital relay drive output control, and ground fault detection.

Features

- Provides crossing prediction functions in a streamlined platform
- Broadens crossing capabilities to four-track normal/standby monitoring
- Adds flexibility in crossing prediction for four quadrant gate and quiet zone crossing

Benefits & Value

- Highest noise immunity in the industry
- Compatible with high-current cab signals
- Easy installation and maintenance

Our ElectroLogIXS family of wayside electronics is designed to simplify the way you control your railroad. This versatile platform can be used to integrate crossing prediction (ElectroLogIXS XP4), intermediate signalling (ElectroLogIXS EC5) and interlocking control (ElectroLogIXS VLC).

Train Detection

GE's Axle Counter System (ACS) is a multi-point axle detection and track occupancy system that performs within a wide range of rail applications. The system uses an axle counter unit in a wayside enclosure and one or more axle detection points at track section boundaries. The versatile ACS can be configured for point-to-point or multipoint track sections, counting the number of axles on a specific train or total axles present within one or more track sections.



Figure 3 GE ACS-3 Axle Counter.

Versatile configuration for point-to-point or multi-point track sections.

Features

- Extremely reliable axle and track occupancy detection
- Integrates electronic wheel detectors using magnetic field technology
- Built-in event recording and diagnostic capabilities
- Supports vital data for bi-directional operation via wire, fibre optics or radio

Benefits & Value

- No external logic interface needed
- Can link directly with signalling to indicate track occupancy or clearance
- Alternatively, can link with a vital serial message to interlocking modules
- Capability for remotely clearing track from a control office

CTS-2 In-Track Switch Machine

Through an innovative modular design and minimal moving parts, the CTS-2 Point Machine from GE is extremely reliable, resulting in fewer late trains and a reduced life-cycle cost.



Figure 4 CTS-2 Point Machine.

Achieve a faster return on investment by eliminating the need for scheduled lubrication and regular adjustments.

The CTS-2 integrates all the traditional point machine components into a single in-sleeper unit. The system consists of modular subsystems including a metallic sleeper, a motor unit with a supplemental hand crank for dual control, and a locking detection unit. The modular design permits the replacement of individual components without removing the sleeper. Installation of the CTS-2 is simple and straightforward.

The CTS-2 eliminates the need for scheduled lubrication and regular adjustments resulting in faster return on investment. A universal symmetrical design reduces spare parts inventory. The central feature of the CTS-2 is a patented locking and detection system. The mechanism locks when it has moved to the correct position and meets the required force against the stock rail. This superior design reduces the number of moving parts and dramatically improves reliability over current models.

Office Systems Integration

RailEdge was designed with modularity and scalability in mind to ensure that the investment in a new train control system is protected. The system architecture facilitates a complete mine to port solution allowing mine, rail, and port operators to share information in real-time. The level of integration helps the operators to make the right decisions at the right time.

Built on proven, mission-critical control technologies have been perfected over more than a decade, GE's RailEdge platform brings together six applications that are essential to the efficient operation of rail businesses:

- Traffic Control
- Scheduling & Planning
- Supervisory Control
- Passenger Information
- Security & Safety
- Advanced Communications

Conclusion:

GE has provided locomotive technologies for Queensland railways over the last 60 years. With this experience, our global expertise, broad technology offering and commitment to innovation, GE is well-placed to comment on the capability and development of rail technologies.

Therefore, GE would welcome the opportunity to participate in any further discussions, such as a workshop of interested parties, on these issues.

Please contact GE Government Affairs and Policy Director (Australia and New Zealand) Mr Kirby Anderson on (07) 3001 4339 or Kirby.Anderson@ge.com if QCA requires additional information or clarification.



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