



**Massachusetts Bay  
Transportation Authority**

# Electric Multiple Units RFI Update

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Fiscal and Management Control Board

June 15, 2020

Bill Wolfgang

# Agenda

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- Request for Information (RFI) Overview
- Summary of Responses
- Alternative Concepts
- Continuing Efforts



# Request for Information (RFI) Overview

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- RFI Goal: solicit the input and experience of the industry relative to existing Electric Multiple Unit (EMU) designs and their applicability to the MBTA Commuter Rail system of the future
  - Contained 27 questions covering 13 topics
  - Encouraged respondents to submit additional information
- Publicly advertised on the MBTA's Business Center on January 15, 2020
- Original response date of April 15, 2020 was extended to May 21, 2020



# Summary of Responses

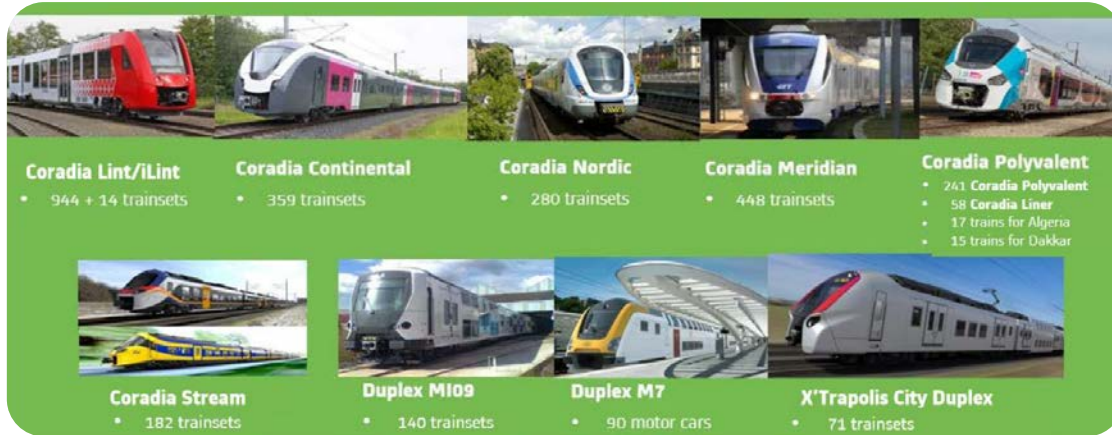
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- Respondents: Alstom, Bombardier, CRRC, Hitachi Rail, Hyundai Rotem, and Stadler
  - All respondents indicated a willingness to discuss their submittals.
- Responses were also received from equipment suppliers Wabtec and Harting and the advocacy group TransitMatters.
- Respondents answered the questions posed to industry and provided technical information about existing EMU designs.
  - Some respondents provided commentary about the Commuter Rail transformation vision that extended beyond vehicle technology.
- A final report synthesizing all RFI responses and other available information will be completed in summer 2020.

*Note: Submittals varied greatly in the level of detail provided.*



# Alstom



## • Suggested:

- 3 or 6 car semi-permanently coupled units
- A mix of single-level power and multi-level trailer cars
- One of three cars powered
- Low-level boarding at select doors

## • Alternatives:

- 3 to 10 car semi-permanently coupled units
- Entirely single-level or multi-level train sets
- Additional powered cars or trucks
- Articulated train sets
- Hydrogen fuel cell powered train sets
- Hybrid electric + battery train sets
- Hybrid electric + diesel train sets



# Alstom Coradia Concept for MBTA



Image source: <https://groupe.cfl.lu/en-gb/amenities/detail/automotrice-serie-2200>

- Alstom's suggested concept is a variant of the CFL 2200 provided to the national railroad of Luxembourg
- Fixed train sets with multiples of three cars: 1 power car and 2 trailer cars
- Mix of single-level and multi-level cars

Powered



Powered



Powered

*These images represent two of several possible configurations*



# Bombardier



Image source: <https://www.bombardier.com/en/media/newsList/details.bt-20190109-bombardier-to-supply-new-generation-of-passenger-rail-cars-for-new-jersey.bombardiercom.html>

- Suggested:
  - A comprehensive transition plan featuring:
    - Multilevel EMUs
    - Dual-power electric + diesel locomotives
    - Continued use of the MBTA's existing coaches
- Alternatives:
  - Hybrid electric + battery train sets



# Bombardier Multilevel III Concept for MBTA



Unpowered with Cab  
Could be existing MBTA Coach

Powered  
Bombardier Coach

Unpowered with Cab  
Could be existing MBTA Coach

- Bombardier's suggested concept EMU is the NJT Multilevel III
- EMU trains in multiples of three cars:
  - One of three cars powered
  - The trailer cars could be existing MBTA multi-level coaches
    - Would impose compatibility requirements between new and existing equipment
- Can be used in a push-pull train

- 3 cars (Cab - Power Car - Cab) - this represents the minimum trainset



- 6 cars (Cab - Power Car - Trailer - Trailer - Power car - Cab)



- 9 cars (Cab - Power Car - Trailer - Trailer - Power car - Trailer - Trailer - Power car - Cab)



- 2 x 6 cars units (Cab - Power Car - Trailer - Trailer - Power car - Cab - Cab - Power car - Trailer - Trailer - Power car - Cab)



- 10 cars with Loco (Loco - Trailer - Trailer - Trailer - Trailer - Trailer - Trailer - Trailer - Cab - Power car - Cab)



*These images represent five of several possible configurations*



# CRRC



- Suggested:
  - 3 or 4 cars semi-permanently coupled
  - The merits of stainless steel and aluminum carbodies
  - The merits of a shaped nose with emergency exit door vs a flat front with end door
- Alternatives:
  - Hybrid electric + diesel train sets
  - Hybrid electric + battery train sets



# Hitachi Rail



Image source: <http://www.hitachirail-eu.com/products/our-trains/at200-commuter>



Image source: [https://www.hitachi-rail.com/delivery/rail\\_vehicles/commuter/index.html#S\\_100](https://www.hitachi-rail.com/delivery/rail_vehicles/commuter/index.html#S_100)

- Suggested:
  - 6 to 9 car semi-permanently coupled units
  - Single-level cars
  - A mix of powered and unpowered cars
  - Shaped nose on cab ends
- Alternatives:
  - Multiple configurations possible once service requirements defined
  - Hybrid electric + diesel train sets
  - Hybrid electric + battery train sets



# Hyundai Rotem



Image source: [https://www.hyundai-rotem.co.kr/Eng/Business/Rail/Business\\_sub.asp?d1=1&d2=1&d3=1](https://www.hyundai-rotem.co.kr/Eng/Business/Rail/Business_sub.asp?d1=1&d2=1&d3=1)

- Suggested:
  - 2 cars semi-permanently coupled (married pairs)
  - Single-level vehicles
  - 100% powered trucks
  - Cab end doors
- Alternatives:
  - Hybrid electric + battery train sets





# Hyundai Rotem Silverliner-V Concept for MBTA



Image source: Famartin / CC BY-SA (<https://creativecommons.org/licenses/by-sa/4.0>)

- Hyundai Rotem's suggested concept is the Silverliner-V
- Currently used by SEPTA and RTD (Denver)
- Married pairs and single cars
- 100% powered trucks
- Current variants do not have toilets
- Low platform boarding at select doors only



# Stadler



- Suggested:
  - 2 to 8 car semi-permanently coupled units
  - Multi-level vehicles
  - A mix of powered and unpowered trucks
  - Dedicated doors for high-level and low-level boarding
  - Use of 2 x 2 seating to improve boarding and alighting
  - Shaped nose on cab ends
- Alternatives:
  - Single-level vehicles
  - Articulated train sets
  - Hybrid electric + battery train sets
  - Hybrid electric + diesel train sets



# Stadler KISS Concept for MBTA



- Stadler provided a concept drawing of a four-car KISS multilevel EMU
- Stadler indicated that the Caltrain version of their KISS vehicle is not compatible with MBTA's existing standard high-level platform dimensions





# Industry Consensus and Variations

## Consensus

OCS: 25 kV, 60 Hz	Onboard energy storage not suggested
A carbon fiber carbody structure is not suggested	An exclusively steel carbody is not suggested
Compatibility with legacy fleets adds cost per vehicle	Low platform boarding at select doors only

## Variations

Single-level or multi-level vehicles	Stainless steel or aluminum carbody
Married pairs vs longer semi-permanent units	Ratio of powered to unpowered cars or trucks
Shaped nose vs end door on cab end	Standard or alternative compliance to FRA structural standards

## Carbon Reduction Suggestions

Driver advisory  
systems

Temperature  
control of traction  
system cooling

High-efficiency  
propulsion system

Intelligent HVAC  
recirculating/fresh  
air control

Passenger load  
dependent HVAC  
control

HVAC setpoint  
control for  
ambient  
temperature

Improved thermal  
insulation

Passenger  
requested door  
operation

Lightweight  
vehicle  
construction

Aerodynamics

Regenerative  
braking

Prefer electric  
actuation over  
pneumatic

HVAC sizing



# Alternative Concepts



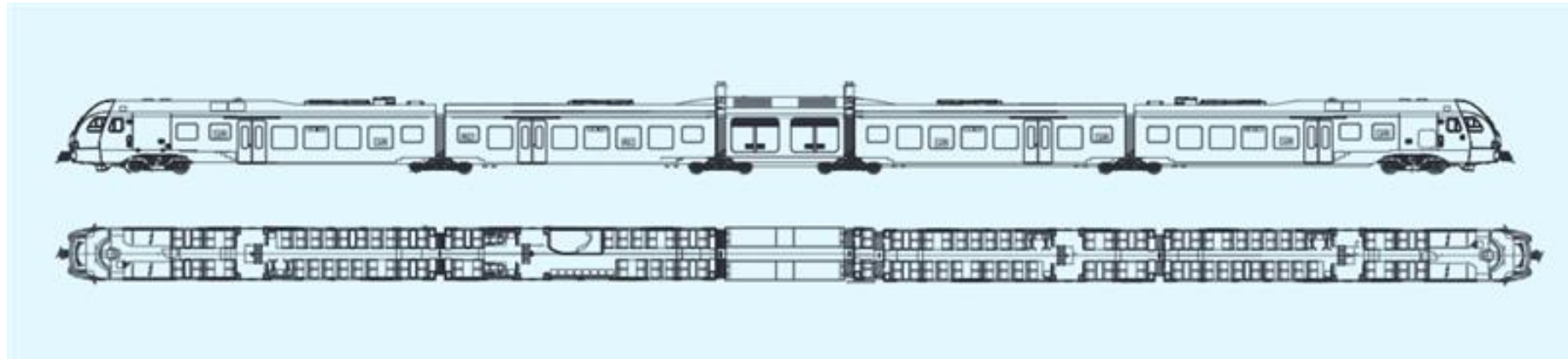
# Articulated Train Set

Alstom Coradia Continental



Image source: <https://www.alstom.com/our-solutions/rolling-stock/coradia-range-regional-trains-suit-all-operator-needs>

Stadler FLIRT



# Dual-Power or Electric Locomotives

- Bombardier suggested dual-power ALP-45DP locomotives to:
  - Extend the service life of existing MBTA coaches
  - Allow for electrification over time on a line-by-line basis
  - Replace aging MBTA locomotives
- The same train can operate as an electric train on an electrified inner core and transition to diesel on the less dense outer portion of the line



# Electric/Battery Hybrid

- Requires recharging after every use
  - Can charge when operating on OCS or at designated charging stations
  - 30-60 minute recharge time at charging stations
  - Limited operating range
- Batteries have finite life
  - High replacement cost
  - Complex disposal requirements
- The same train can operate as an electric train on an electrified inner core and transition to battery on the less dense outer portion of the line
  - Reduced performance when on battery
  - Trade performance vs. range when on battery



Image source:

[https://upload.wikimedia.org/wikipedia/commons/6/6b/J33\\_770\\_%C3%96BB\\_%C2%BBCityjet%C2%AB.jpg](https://upload.wikimedia.org/wikipedia/commons/6/6b/J33_770_%C3%96BB_%C2%BBCityjet%C2%AB.jpg)





# Electric/Diesel Hybrid

- Mentioned by 5 of 6 manufacturers
- The same train can operate as an electric train on an electrified inner core and transition to diesel on the less dense outer portion of the line
  - Reduced performance when on diesel
- Additional onboard energy storage required to recover brake energy
- Requires refueling for diesel operation



Image source:  
<https://www.stadlerrail.com/media/pdf/feabmu0916e.pdf>



# Hydrogen Fuel Cell

- Requires a hydrogen source for refueling
- Additional onboard energy storage required to recover brake energy
- Emerging technology for rail

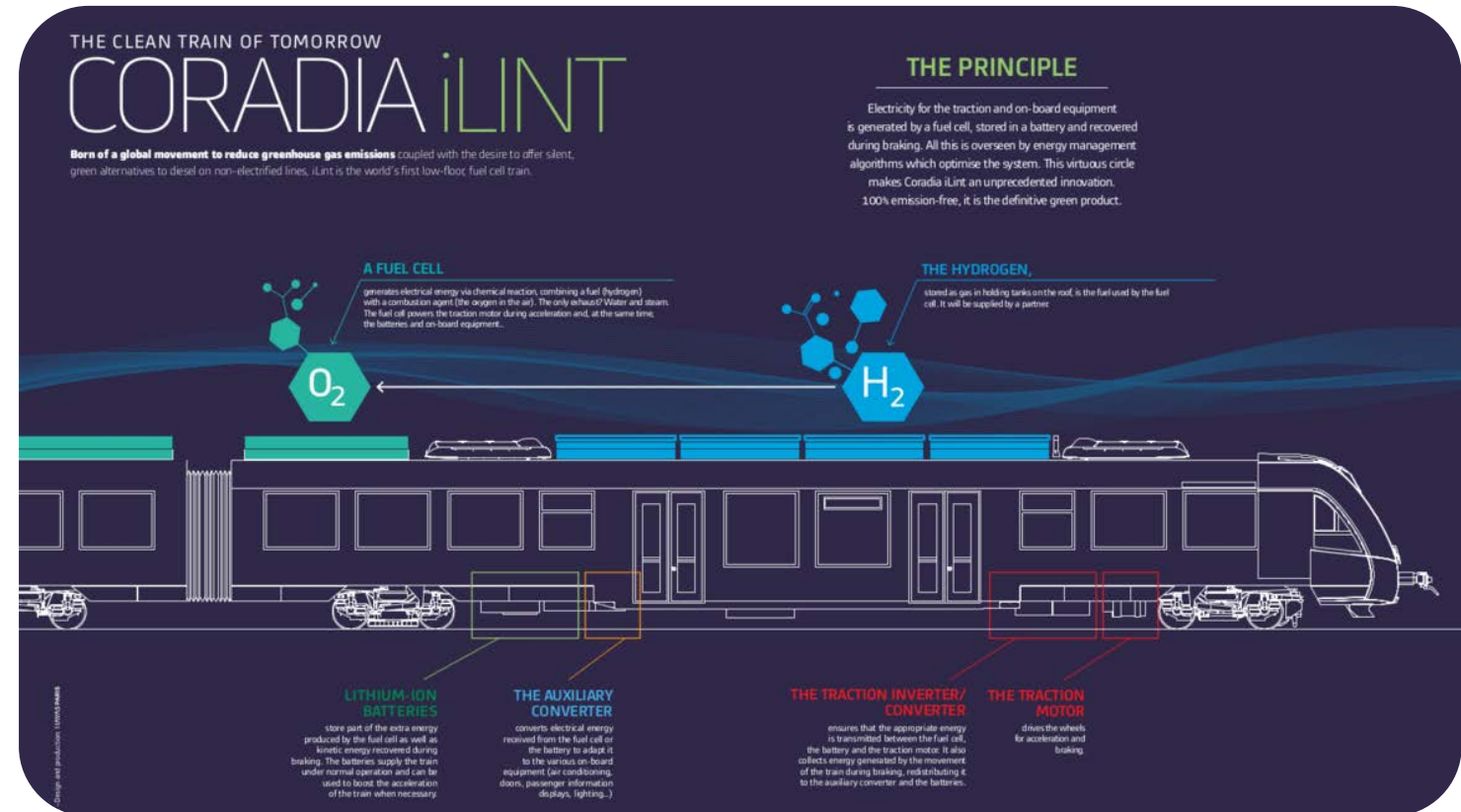


Image source: <https://www.alstom.com/our-solutions/rolling-stock/coradia-ilint-worlds-1st-hydrogen-powered-train>

# Continuing Efforts

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- There may not be one best solution for the Commuter Rail
  - A single “best compromise” fleet simplifies procurement and maintenance
  - Fleets tailored to the needs of each mission optimize passenger service
- Strategic Mission Decisions to determine how EMUs fit into the Commuter Rail Transformation
  - Schedule types, headways, capacity
  - Timeline for electrification, stations and platforms, maintenance facilities
  - Integrating EMU service into existing and planned Commuter Rail service
- Vehicle Engineering is ready to support the Office of Commuter Rail Transformation



# Next Steps

- Technical Specification and Contract Terms for new Bi-Level Coaches (single-level coach replacement) is in Final Development
  - Anticipated Summer 2020
- Strategic decisions need to be made in order to determine long-term fleet makeup
- Additional funding for long-term decisions needs to be identified
  - Current funding is limited to professional services for the bi-level coach procurement

*Once our strategic direction is chosen:*

- *Vehicle manufacturers responded that it will take approximately 36 to 42 months from notice to proceed to deliver the first trainset.*
- *Assuming an 18-month strategic decision-making process for Commuter Rail Transformation, we anticipate delivery for a new fleet would begin in 2025/2026.*
- *Additional funding for EMU procurement, wayside, and facility changes needs to be identified.*