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Kimberley Driscoll, Lieutenant Governor
Monica Tibbitts-Nutt, Secretary & CEO
Phillip Eng, General Manager & CEO



MEMORANDUM

TO: File

FROM: Bruce Shand
Senior Project manager
Vehicle Engineering

DATE: April 29, 2024

SUBJECT: MBTA Red Line Conditional Assessment Program & Life Extension Project

Vehicle Engineering Department through the Heavy Rail Conditional Assessment and Red Line Life Extension project have developed recommendations based on the assessment findings. A scope of work was developed for an in-house, targeted investment, life extension program for the Red Line No. 1, No. 2, and No. 3 vehicle types.

The Red Line Life Extension Assessment identified several major systems, sub-systems and components, across the three fleets, that are approaching or are past the date for overhaul and replacement. Additionally, the assessment has focused on identifying and replacing components on vehicle systems which have a limited availability of replacement parts or that are becoming obsolete and difficult to repair.

On March 28th, 2024, the MBTA Board of Directors approved a negotiated contract with CRRC. This contract included a boosted delivery schedule of New Red Line Vehicles. The Conditional Assessment project based the scope of work for the life extension on a proven historical delivery rate of CRRC replacement vehicles, with contingencies added, and not the boosted CRRC negotiated schedule. The recommendations outlined in the report were developed over the past 16 months and reflects the original assessment scope of extending service life for the Red Line fleet as follows:

- Red Line No.1: 2-3 years
- Red Line No.2: 3-5 years
- Red Line No.3: 4-6 years

The Vehicle Engineering Department will continue to work with all necessary MBTA stakeholders and various departments to update the scope of work for the life extension and determine appropriate strategies in order to get the vehicles to the end of life with the new CRRC boost schedule in-mind. These alternative recommendations will be submitted under a separate cover.



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Massachusetts Bay Transportation Authority

Red Line Conditional Assessment Program & Life Extension Project

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Project Objective:

The MBTA has performed a vehicle condition assessment for all three Red Line fleets. Based on the assessment findings, the project has developed a scope of work for an in-house, targeted investment, life extension program for the Red Line No. 1, No. 2, and No. 3 vehicle types. These fleets entered revenue service in 1969, 1989 and 1994, respectively. The Life Extension Project aims to balance the need for safety and reliability with the understanding that the vehicles only have a limited operating life remaining. The ongoing CRRC No. 4 Car Red Line Fleet Procurement program is expected to fully replace all current Red Line vehicles. Now 30-50 years old, all three current fleets are close to or have surpassed their initial planned service lives and will require targeted investments to ensure safe and reliable operation going forward.

The Red Line Life Extension Assessment has identified several major systems, sub-systems and components that are approaching or are past the date for overhaul and replacement. Additionally, the assessment has focused on identifying and replacing components on vehicle systems which have a limited availability of replacement parts or that are becoming obsolete and difficult to repair. The project has prioritized systems critical to safe and reliable operations (propulsion, batteries, trucks, carbody, pneumatic systems, communication, etc.), while addressing service life and obsolescence concerns.

The MBTA has developed a joint project team comprising of both Vehicle Engineering and Vehicle Maintenance staff to oversee and complete the Life Extension. Upon the project kickoff, Vehicle Maintenance will manage the day-to-day activities at the carhouse, including but not limited to managing the maintenance staff (forepersons, repairers, engineers, etc.) as well as Professional Services. Vehicle Engineering will ensure that all the required resources (Material, MBTA Personnel, and Professional Services) are in place for the successful kickoff and handoff of the Life Extension Project. Vehicle Engineering will perform Monthly Audits of the project and will be available to assist Vehicle Maintenance in any capacity as necessary to ensure the success and efficiency for the duration of this task.

The project team has identified timelines for the life extension, of each fleet, based on the CRRC delivery schedule outlined below:



Fleet	QTY in Service	No. Car 4 Replacement By ¹
Red Line No. 1	66	October 2025
Red Line No. 2	56	December 2026
Red Line No. 3	82	September 2028
Total ²	206	December 2028 ³

Table 1: MBTA Red Line - CRRC No. 4 Car Estimated Replacement Schedule

The project team has contingencies in place to ensure that the Red Line fleet is safe and reliable for passenger service if there is a delay in the CRRC delivery schedule for any reason. Many of the items identified in the scope of work, for all three current fleets, are necessary for reliability purposes in the immediate future. As such, the tasks listed are to be completed (up to a point) regardless of the CRRC delivery schedule. As a potential “worst case” predictive scenario for Red Line deliveries the project has operated with an assumed production rate of two-Married Pair (MP) or four-Cars per month from CRRC for the duration of the contract. This “worst case” scenario prediction assumes the published CRRC schedule is accurate until October of 2025 which is when the Orange Line procurement is expected to be completed. The worst-case prediction diverges from the published schedule to assume 2-MP per month delivery rate from October 2025 to a full delivery of 206 cars in September of 2028. Appendix 1 of this document shows the published CRRC schedule and anticipated fleet retirement dates that the project is assuming. The Project has identified that from January 2024 the Red Line fleet’s life will need to be extended (with contingency):

- Red Line No. 1 Fleet
 - 1-2 year life extension
- Red Line No. 2 Fleet
 - 2-4 year life extension
- Red Line No. 3 Fleet
 - 4-6 year life extension

The scope of work identified in the subsequent sections is based on the remaining time necessary in service for the fleets. Additional scoping and PO status can be seen in Appendix 2.

¹ 16 cars delivered to date (1/15/2024), 20 cars expected in 2024, 44 cars expected in 2025, and stabilization of 2MP/month rate in 2026 (after OL deliveries are completed). Two (2) weeks required for commissioning testing / conditional acceptance

² Additional cars (252 total Type 4) to be delivered by September 2029 and conditionally accepted by October 2029 in the worst-case scenario.

³ December 2028 allows for all cars delivered to be tested and accepted. 4-6 year life extension includes a contingency in-case of schedule slippage and unforeseen circumstances.



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Project Funding:

To date the MBTA has committed approximately fifty-four million dollars for the Red Line fleet life extension initiative. Beginning in 2023, twelve-million dollars of funding was made available to solicit professional services and to begin the procurement of immediate action items i.e. material, repairs, etc. This was generated under MBTA CIP #P1151 and Grant #R23A41.

The remaining balance of funds (forty-two million dollars) for the project was intended to be available in Fiscal Year (FY) 2025 (July 2024) for the project kickoff. This funding plan aligned with the timelines associated with material procurement and for resources at Everett Main Repair Facility (EMRF) and Cabot Carhouse becoming available for dedicated work on this project. Due to the industry standard lead times for materials, material procurements must be placed six-months to one-year prior to the anticipated start date of work. This prompted the project to request that the remaining balance of funding be made available as early as possible for additional material procurements to be placed. This remaining 42-million dollars was released in January 2024. MBTA leadership has also authorized approximately 2.5-million dollars of Reliability Vehicle Centered Maintenance (RVCM) funding to be released in an expedited manner, some of this funding will be spent on life extension activities.

The project team has created a budget estimate of approximately ninety-five million dollars to complete a full-extended scope of work identified on the Red Line Fleets. This budget estimate accounts for workforce payroll, materials, professional services, and contingency funding. The final dollar amount is fluid as the need to complete all tasks is subject to the scheduled delivery of the No. 4 Car fleet from CRRC.

The labor breakdown for the full scope of work identified during the Conditional Assessment phase of the project for each fiscal year is shown in Table 2 (Appendix 3):

Cost Breakdown by Fiscal Year							
Expenses	FY24	FY25	FY26	FY27	FY28	FY29	FY24-29 Total
VE Personnel	\$ 1,375,694	\$ 1,430,722	\$ 1,480,797	\$ 1,532,625	\$ 1,578,603	\$ 1,625,962	\$ 9,024,402
Carhouse Personnel	\$ 720,658	\$ 4,817,471	\$ 4,986,083	\$ 5,160,595	\$ 5,315,413	\$ 5,474,876	\$ 26,475,096
Operations	\$ -	\$ 144,019	\$ 149,059	\$ 154,276	\$ 158,905	\$ 163,672	\$ 769,930
EMRF Personnel	\$ 140,239	\$ 1,973,239	\$ 1,989,393	\$ 2,059,021	\$ 2,047,058	\$ 1,956,577	\$ 10,165,526
Labor	\$ 2,236,591	\$ 8,365,450	\$ 8,605,331	\$ 8,906,518	\$ 9,099,979	\$ 9,221,086	\$ 46,434,955
Professional Services	\$ 2,019,624	\$ 2,080,213	\$ 2,142,619	\$ 2,206,898	\$ 2,273,105	\$ 2,341,298	\$ 13,063,756
Materials	\$ 2,600,000	\$ 12,000,000	\$ 12,000,000	\$ 8,738,153	\$ -	\$ -	\$ 35,338,153
FY24-29 Capital Total	\$ 6,856,215	\$ 22,445,663	\$ 22,747,950	\$ 19,851,569	\$ 11,373,084	\$ 11,562,383	\$ 94,836,864

Table 2: FY24-FY29 Cost Breakdown – Full Scope Financial Estimate

The costs shown in Table 2 include all overhead and indirect costs associated with labor as well as a contingency of 20% on labor to account for uncertainty in future pricing. The material costs in this



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breakdown were generated from vendor quotes, independent cost estimates from professional services, and placeholder estimates used where the scope of work required further defining. This estimate assumes that materials will be quoted in FY24 and payments will be released as materials are delivered in FY24-FY27.

The MBTA has submitted CIP requests which account for the full ninety-five million dollar scope of work. The project team has developed separate critical paths and schedules which account for the amount of funding made available to the project. The fifty-four million dollar reduced scope of work would account for the most critical items requiring replacement on the Red Line fleets but would not allow for all tasks identified during the assessment phase to be completed. Table 3 below as well as Appendix 4 shows a high-level breakdown for this reduced scope. As of February 2024, the MBTA expects the full ninety-four million dollars requested to be made available for this project. It is not known if or when this anticipated remaining funding will be made available to the project.

Cost Breakdown by Fiscal Year							
Expenses	FY24	FY25	FY26	FY27	FY28	FY29	FY24-29 Total
VE Personnel	\$ 535,855.74	\$ 557,289.97	\$ 576,795.12	\$ 596,982.94	\$ 614,892.43	\$ 633,339.21	\$ 3,515,155
Carhouse Personnel	\$ 866,377	\$ 3,361,354	\$ 3,479,002	\$ 3,600,767	\$ 3,708,790	\$ 3,820,054	\$ 18,836,343
Operations	\$ -	\$ 73,927	\$ 76,514	\$ 79,192	\$ 81,568	\$ 84,015	\$ 395,215
EMRF Personnel	\$ -	\$ 1,387,302	\$ 1,435,857	\$ 1,486,112	\$ 1,530,696	\$ 1,576,617	\$ 7,416,584
Labor	\$ 1,402,232	\$ 5,379,873	\$ 5,568,168	\$ 5,763,054	\$ 5,935,946	\$ 6,114,024	\$ 30,163,297
Professional Services	\$ 543,000	\$ 1,064,196	\$ 1,096,122	\$ 1,129,006	\$ 1,162,876	\$ 1,197,762	\$ 6,192,961
Materials	\$ 2,600,000	\$ 7,000,000	\$ 7,000,000	\$ 2,154,180	\$ -	\$ -	\$ 18,754,180
FY24-29 Capital Total	\$ 4,545,232	\$ 13,444,069	\$ 13,664,290	\$ 9,046,240	\$ 7,098,821	\$ 7,311,786	\$ 55,110,438

Table 3: FY24-FY29 Cost Breakdown – Reduced Scope Financial Estimate

It is anticipated that the conditional assessment phase of the Life Extension Project will be complete in 2024. Material procurements and specification packages generated during this assessment will be posted and contractors will be selected to perform services for a majority of the work identified. Material lead times and specification design review periods are anticipated to account for a large portion of 2024. The project will begin receiving materials in July of 2024 which were ordered as part of the initial twelve million dollars released to the project. The remaining material procurements will be placed when the balance of funds is made available, and engineering is complete to determine the most effective solution. This July 2024 kickoff date will represent the first project activities to take place within Cabot Carhouse and EMRF. It is anticipated in July 2024 that the labor associated with project activities in the Carhouse and at Everett Main Repair will begin to be charged to the Life Extension Project. The Project will take on additional capital employees once their current project activities are completed.



MBTA Staffing Plan:

To complete the life extension of the Red Line fleet, the project team and maintenance operations have determined that additional staffing will need to be hired to complete the anticipated scope of work. These new employees will aid in completion of planned activities at Cabot Carhouse and Everett Main Repair Facility. This includes additional engineering staff from Vehicle Engineering and Vehicle Maintenance.

The following positions have been posted to support the service life extension activities:

- EMRF Machinist (5)
- EMRF Blacksmith (1)

The MBTA has also completed an internal effort over the course of FY23 to increase the staffing levels at Cabot Carhouse to support capital projects like the life extension project. It is anticipated that the additional staff hired in FY23 will be available to support the life extension effort.

Cabot Carhouse Staffing:

Upon completion of the active No. 3 Car SSRP (Selective System Reliability Program) propulsion project, carhouse repairers will be reassigned to the Life Extension Project. This staffing plan aligns with the estimated kickoff date in July 2024. On an as-needed or when-available basis the carhouse will assign additional staffing to complete tasks.

The Life Extension Project had initially identified the need for fifteen (15) repairers to be assigned to the project to complete the full-extended scope of work at Cabot Carhouse across all three Red Line fleets. The Project has agreed to take on the labor charges of the No. 3 Car SSRP door program which increases this labor request to twenty (20) repairers be made available to complete the project scope. The project also accounts for three (3) forepersons support (door program included) and carhouse engineering support on an as-needed basis. It is anticipated that this staff will be available to begin supporting the life extension activities in July of 2024 and will continue to support the project until completion. It is anticipated that personnel for this project will be a combination of full time capital staffing along with supplemental operating employees. Newly hired employees beginning at the MBTA in early 2024 will make-up a portion of the planned staff allocated to project work. Carhouse staffing will consist of:

- Repairers
 - Twenty (20) - Assuming No. 3 Car Door Program is absorbed.
- Foreperson



- Three (3) - Assuming No. 3 Car Door Program is absorbed.

Vehicle Engineering & Vehicle Maintenance Staffing:

The project management team for the Life Extension Project will be comprised of a joint staff of Vehicle Engineering and Vehicle Maintenance employees. It is anticipated that two senior project managers, a technical project manager, engineering support, and project administrators from the MBTA will all be assigned to the Life Extension Program. The role of these positions will be the overall management of the project along with the engineering oversight required to complete tasks. These employees will also aid in engineering review, development of work procedures, and test plans when determined to be necessary for the various activities and material purchases for the project. Staffing from Vehicle Engineering and Vehicle Maintenance is anticipated to consist of:

- Senior Technical Project Manager
 - Vehicle Engineering (1)
 - Vehicle Maintenance (1)
- Technical Project Manager
 - Vehicle Engineering (1)
- Project Coordinator
 - Vehicle Engineering (1)
- Engineer
 - Vehicle Engineering (1 full-time, 1 half-time)

EMRF Staffing:

The project is estimating that support from EMRF will be necessary to complete the identified scope of work. The project has identified and accounted for costs associated with Machinists, Blacksmiths, Motor Room Support, and Carpenters which will all be required to support the Life Extension Project. Staffing from Everett Main Repair Facility is anticipated to consist of:

- Machinist
 - Five (5)
- Blacksmith
 - One (1)
- Motor Room (Motor Overhaul)
 - As needed
- Carpenter (Seat Upgrade)
 - As needed



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Operations Staffing:

Due to the requirement to test many of the upgrades being completed to the Red Line fleets, funding for operations personnel has been incorporated into the budget. Operations and testing accounts for an Instructor and an Engineer to be present for mainline functional testing of equipment during the trial phase of many upgrades and at completion of work to return the cars to service. These tests are to ensure that cars are functional and meet necessary requirements prior to returning to service. Operations staffing is anticipated to consist of:

- Instructor
 - As needed
- Engineer
 - As needed

Professional Services:

Professional Services support has been identified as necessary to supplement the engineering staffs and assist in oversight staff of the MBTA. Professional Services will work as directed by Vehicle Engineering and Vehicle Maintenance staff to aid in completion of the project. Professional Services staffing is anticipated to consist of:

- Project Manager
- Engineer
- Subject Matter Expert
- On-site Resident Engineering Support
- Admin

Project Schedule:

The Project has developed several high-level schedules to aid in the completion of work at Cabot Carhouse. These schedules include approximate locations for work to be completed, duration to complete each task, and labor requirements for each assignment.

It is assumed that a majority of the Red Line No. 3 Car work will be completed while the car is out of service for the HVAC upgrade activity. This out of service time is estimated to be between four (4) to six (6) weeks to complete the HVAC scope. During this period additional tasks will be completed on the car. Work will mimic the format of the current SSRP program and take place on Track One South of Cabot Carhouse.



Tasks generated for the other Red Line fleets and a small portion of the No. 3 Car tasks are anticipated to be completed with much shorter duration out of service periods. The project anticipates that the cars will receive a system or component replacement while in the shop for routine maintenance tasks and returned to service following this replacement or upgrade. These tasks will be tracked using multi-unit-projects and carried out until the fleet is complete or the upgrades are no longer necessary.

An example of the proposed program work for one month in 2024 is shown in Figure 1:

Location	Task	Labor-Hours	Notes
Track 1 North	No. 1 Car Truck Overhaul	120 hrs/truck	60 trucks total, 4 weeks per MP
Track 1 North	No. 3 Car Truck Overhaul	160 hrs/truck	164 trucks total, assessment and overhaul
Track 1 South	No. 3 Car HVAC R-407C Upgrade	640 hrs/MP	4 weeks per MP, 41 MP's total
Track 1 South	No. 3 Car Lighting Upgrade	Unknown	1 weeks per MP, 41 MP's total
Track 1 South	No. 3 Car Trainline Cable Upgrade	Unknown	1 weeks per MP, 41 MP's total
Track 1 South	No. 3 Car Seat Wrapping Program	32 hrs/MP	1 weeks per MP, 41 MP's total
Track 2 Middle	No. 2 Car Battery Replacement	32 hrs/MP	52 Batteries total, 2 MP per month completed
Track 2 Middle	No. 2 Car D4 Changeout	48 hrs/MP	52 D4's total, 1 MP per month completed, based on material availability
Track 2 Middle	No. 2 Car E2S & Valving Upgrade	48 hrs/MP	52 E2S stands total, 1 MP per month completed
Track 2 Middle	No. 3 Car Battery Replacement	16 hrs/MP	2-MP per month, NOT FULL TIME RESOURCES
OTHER	No. 3 Car Door Program	-	1-MP per Month

Figure 1: Example of Planned Work Activities 2024

For all planned work at Cabot Carhouse, the location where the work is to be performed will be subject to review and collaboration between the carhouse and the project team. All activities for this project require time studies to ensure estimates for duration of work activities and allocated resources are appropriate.

Red Line No. 1 Car Fleet Scope of Work:

The MBTA Red Line No. 1 Car fleet currently has 54-years in revenue service. It is expected that a one-to-two-year life extension is necessary to operate the fleet until the replacement Red Line No.4 Cars arrive. Due to the short remaining life of the fleet, the scope of work for the No. 1 Car fleet targets key safety systems.

Truck Frame & Bolster Assessment & Repair Program:

A portion of the cast GSI truck frames and bolsters on the No. 1 car have been assessed by the Life Extension Project and a third-party firm non-destructive testing firm. The results of the assessment along with results from past assessment programs have been reviewed by Professional Services to determine the scope of an overhaul and repair program.

A truck frame repair program has been implemented at an outside vendor's facility (TTA Systems LLC). The MBTA has an active PO with TTA for approximately the first twenty (20) frames to be overhauled as part of this program. It is anticipated that an additional twenty-two (22) No. 1 truck frames will be



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required to complete the full fleet following the completion of the first twenty (20). The MBTA has scrapped approximately thirty (30) No. 1 cars and has previously repaired thirty (30) frames at an outside vendor.

Following the completion of the first twenty frame overhauls, the MBTA will assess the situation of scrapping the Red Line No.1 Cars and determine the need for additional in-service frames to be put through the repair program. The allocated funds will be adjusted based on the number of in-service vehicles following the scrapping program.

Red Line No. 2 Car Fleet Scope of Work:

The MBTA Red Line No. 2 Car fleet currently has 35-years in revenue service. It is expected that a two-to-four-year life extension is necessary for the fleet until they can be completely retired. The scope of work for the No. 2 Car fleet targets key safety systems and components approaching the age for replacement and or overhaul. The Red Line No. 2 Car fleet had a mid-life overhaul performed beginning in 2011 and ending in 2016. Some of the components addressed during that previous program are now in-need of additional work.

Carbody Structural Assessment:

The MBTA plans to solicit Professional Services to perform a fitness for service assessment of the Red Line No. 2 Car carbody structure. The goal of this assessment is to quantify the remaining life of the carbody and attachments. Based on the result of this assessment, the project will develop a scope of work and action plan for any repairs deemed necessary.

Pneumatic Valve & E2S Stand Overhaul:

The MBTA has reviewed the recommended maintenance intervals for the pneumatic system and valves on the No. 2 Car. The MBTA solicited the services of Wabtec (OEM) for a variety of valve rebuild kits, valve body replacements, and a full kit to rebuild the E2S manifold valves. Wabtec is the OEM supplier of the braking equipment on the No. 2 Car, so a sole-source procurement for this equipment was submitted for these components. It is anticipated that EMRF staff will overhaul E2S manifolds and brake valve assemblies. A unit exchange program will then be conducted at Cabot Carhouse using the overhauled pneumatic parts. It is anticipated that this procurement will be funded through RVCM project funding that was released to support the Life Extension Project.

Tread Brake Unit (TBU) Overhaul:

The MBTA maintains the TBU's on the Red Line No.2 Car by rebuilding the units at the Everett Main Repair Facility with rebuild kits supplied by Wabtec. TBU rebuild kits (032-96-811) have become increasingly difficult to source, suffering from long lead times. The project plans to support MBTA



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Vehicle Maintenance's on-going brake package unit exchange program by procuring additional kits. The Project will be procuring 200 brake kits as part of the initial order with Wabtec. With a production and minimum installation rate of 8-kits per month for the No. 2 Car. This represents roughly half of the No. 2 Car fleet of available brake kits for installation on the Cars. Upon exhaustion of these kits the project will evaluate the need to purchase additional kits for continued installation. This effort will be tracked at the truck level with a multi-unit project (MUP).

D4 Air Compressor Overhaul:

The MBTA currently overhauls D4 air compressor and motor assemblies at the EMRF to support running maintenance. For the Life Extension project the MBTA will purchase overhaul kits for the compressor and air dryer assemblies from Wabtec (OEM). The overhauls will be completed at EMRF until the entire No. 2 Car fleet has been completed. This effort will be tracked at the car level with a multi-unit project (MUP).

The project has also allocated funding for armature replacement on the No. 2 Car compressors. Replacement of armatures will be tracked separately by the Project. Any compressor receiving a project purchased armature will be considered part of the life extension multi-unit project. Armatures will be purchased as new assemblies from Wabtec (OEM).

Exterior Side Mounted Lights:

The exterior side mounted lights on the Red Line No. 2 Car are white lights with cone shaped colored glass lens. This lens is becoming increasingly difficult to procure due to the material type, unique shape and color. The project has purchased a prototype car-set of TDG Inc. LED replacement side mounted lights to trial. Additionally, the Project has procured LED bulbs from Cooper Trading. This is an COF product that can be installed on the vehicle. Following successful testing of these trial units the project will decide on the best solution for a procurement of replacement lights.

Battery Replacement:

The OEM SAFT battery assemblies on the Red Line No. 2 Car were replaced as part of the No. 2 Car overhaul project in 2011. The batteries have a recommended service life of 10-years. The Life Extension Project has received pricing to replace the No. 2 Car batteries from the OEM vendor SAFT. The project will procure battery assemblies with a delivery date of July 2024. This sequence aligns with procurement times, carhouse space, and staff availability for fleet-wide replacement.

Red Line No. 3 Car Fleet Scope of Work



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The MBTA Red Line No. 3 Car fleet currently has 30-years in revenue service. It is expected that a four-to-six-year life extension is necessary for the fleet until they can be completely retired. The scope of work for the No. 3 Car fleet targets key safety systems and components approaching the age for replacement and overhaul. The Red Line No. 3 Car is in the process of completing a Selective System Overhaul Project. The Life Extension Project aims to identify additional activities outside the selective system overhaul for completion to extend the No. 3 vehicle life.

Carbody Structural Assessment:

The MBTA plans to solicit Professional Services to perform a fitness for service assessment of the Red Line No. 3 Car carbody structure. The goal of the assessment is to quantify the remaining life of the carbody and attachments. Based on the result of this assessment the project will develop a scope of work and action plan for any repairs deemed necessary.

Truck Frame & Bolster Assessment & Repair Program:

A portion of the cast Buckeye Steel truck frames and bolsters on the No. 3 Car will be assessed using non-destructive testing. The results of the assessment along with results from past assessment programs will be used to determine the scope of work for an overhaul and repair program.

A truck frame repair program (if necessary) will begin following the assessment of the No. 3 Car truck frames and bolsters. Due to the lack of available spare of No. 3 Car truck components the project team has identified Amsted Rail (OEM vendor) as a vendor to complete the assessment and potential repair of the first batch of No. 3 Car truck frames. This selection allows for the trucks being sent off-property to be returned to the MBTA in a condition suitable for service. The project team currently has four-million dollars assigned to No. 3 Car truck work which will be allocated to truck related tasks as the engineering assessment is completed.

The MBTA project team is working to finalize a bill of materials for potential components which should be procured as part of the truck component replacement program. All components related to the suspension system (primary & secondary suspension) should be replaced as part of a life extension. ATO wiring and additional high voltage wiring should also be replaced due to age and to increase reliability.

Truck Control Unit (TCU) & Brake Pipe Control Unit (BPCU) Overhaul:

The MBTA has identified the need to rebuild the truck control units, the brake pipe control unit, and the associated manifold components. The MBTA has procured both kits from Knorr Brake for the overhaul of these units. The MBTA will complete the valve overhaul in-house at either EMRF or at Cabot Carhouse. The objective of this overhaul is to target the pneumatic system on the No. 3 Cars. Both of these components affect the safety and reliability of the Red Line No. 3 Car fleet. The majority of failures in the winter on the No. 3 Car are attributed to an issue with freezing up of pneumatic systems.



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As result of these known failures, and the safety critical nature of this system, the Life Extension Project is targeting funds around this system.

Friction Brake Electronic Control Unit (FBECU):

Knorr Brake has obsoleted the current Red Line No. 3 Car friction brake electronic control unit and no longer supports the Z-80 control system installed on the cars. Knorr Brake (OEM vendor) indicated to the MBTA in early 2024 that the upgrade of the FBECU system is estimated to be a multi-year minimum project with extensive design review and testing. This system has been used on airport trolleys but never passenger heavy rail vehicles. Knorr's recommendation to the MBTA was to move away from the upgrade of the FBECU to a component repair program to keep the existing system operational until end of life.

The MBTA and project team are exploring the repair of boards on the current Z-80 system as an alternative option. The project team is working to set up a repair and return system of the braking system boards with Knorr in an attempt to keep the Z-80 system in a state of good repair.. The MBTA is also working with Knorr to extract the necessary source code data from the current Z-80 system in order to keep the system operational for as long as possible.

Tread Brake Unit (TBU) Overhaul:

The MBTA maintains the TBUs on the Red Line No. 3 car by rebuilding the units at the EMRF with rebuild kits supplied by Knorr Brake. EMRF will continue to provide resources to overhaul the TBUs. If additional funding is obtained the project intends to procure additional TBU rebuild kits for EMRF.

The MBTA requested Knorr Brake provide a quote to cast new TBUs to increase available float, stock, supply, back-ups. Knorr Brake has expressed that there are obsolescence issues with the handbrake portion of the No. 3 Car TBU and is currently engineering a solution to supply a commercial offer.

The project will be procuring 250 brake kits as part of the initial order with Knorr. This represents roughly one third of the No. 3 Car fleet of available brake kits for installation on the Cars. Upon exhaustion of these kits the project will evaluate the need to purchase additional kits for continued installation. This effort will be tracked at the truck level with a multi-unit project (MUP).

Air Supply Unit (ASU) Overhaul & Procurement:

The air supply unit installed on the Red Line No. 3 Car is obsolete and no longer supported by Knorr Brake. The MBTA purchased a last and final offer of 50 heavy repair overhaul kits for the ASU. The MBTA has begun an ASU heavy overhaul project at EMRF. The heavy overhauls of the compressors and air dryer kits are anticipated to generate increased reliability up to approximately five years after the ASU is overhauled. The life of the vehicle may be extended beyond this period where additional



Maura Healey, Governor
Kimberley Driscoll, Lieutenant Governor
Monica Tibbitts-Nutt, Secretary & CEO
Phillip Eng, General Manager & CEO



light overhaul kits may be necessary, or heavy overhauls for failures that occur in service. The project team has developed a list of additional components which are required to be in-stock and will look to receive quotes from Knorr Brake to purchase additional overhaul components. The MBTA will procure and store these additional components for future repair as a risk mitigation/reduction measure

The project team has a procurement for the design, testing and supply of new air supply units for the No. 3 Car to ensure the air supply unit is supported until the end of vehicle life. This procurement will allow for options to procure additional units, up to 50, if the MBTA deems it necessary to upgrade the ASU. Wabtec has been awarded a contract to trial a D4 Compressor which is the same model and frame as the new CRRC Red/Orange vehicles. This unit will have a modified auxiliary bracket to allow for plug-and-play installation on the No. 3 Car's existing mounting hardware. The MBTA project team will trial this D4 application including the design review and engineering required in the event that the components for the Knorr compressor overhaul is no longer available.

Propulsion System Upgrade/Material Support:

The propulsion system on the Red Line No. 3 Car was overhauled by the current ongoing Selective System Overhaul Project. The scope of work on the propulsion system by the SSRP program targeted key components identified to aid in extending the life of the vehicle. The Life Extension Project determined that additional components outside of the SSRP scope should be targeted to further reduce risk to service and aid in getting the vehicle to the newly established end of life. The Life Extension project found that repair or replacement of certain boards within the Car Control Unit (CCU) and inverter are necessary to support continued operations of the car. The project team has developed a list of additional propulsion components necessary to support maintenance activities.

The MBTA has contacted Wabtec who is now the OEM of the GE propulsion system on the No. 3 Car. Wabtec has supplied a quote for a fleetwide replacement of the CCU backplane assemblies. Wabtec has expressed that three of the propulsion boards on the GE system can be replaced with new (41C666382G6, 17FB128A4S, 17FB120A2S). For the remainder of these boards, Wabtec has expressed that there is a potential to begin a Repair and Return program with the OEM vendor, with the exception of the 17FB129A3S boards.

O.E.M. G.E. P/N	Wabtec- Revision P/N
17FB113A3	17FB113A5S
17FB116B4	17FB116B5S
17FB120A1	17FB120A2S
17FB122B2	17FB122B3S
17FB124B1	17FB124C2S
17FB125A1	17FB125A3S
17FB12BA2	17FB128A4S
17FB129A2	17FB129A3S



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Phillip Eng, General Manager & CEO



Table 4: MBTA Propulsion System CCU & Inverter Boards

The project team has also contacted vendors regarding the possibility of replacing the connectors on the boards. With the backplanes and connectors being a point of failure, it was determined to replace these components as well.

ATO/TPU System Upgrade/Material Support:

The MBTA has identified that the ATO and TPU systems installed on the No. 3 Car require additional material support to extend the service life. The MBTA has contacted Hitachi who is now the licensed vendor for US&S equipment. It was determined that upgrading the existing ATO system was not feasible within the project budget or timelines. The project team has established a Repair and Return program with Hitachi for the boards in the ATO and TPU systems. In this program Hitachi repairs, tests, and upgrades the boards to the latest revision level. The project has also purchased vital relays from Hitachi which were identified as being materials which fail frequently and should be stocked and available for installation on cars.

Component Description	O.E.M. US&S P/N
TPU Card File	US&S part # N451812-0701
ATP Card File	US&S part # N451812-0601
ATP Relay Panel - Vital Relay	US&S part # N436788

Table 5: MBTA ATO/TPU System Hitachi Rail Requests

HVAC System Overhaul:

The MBTA has completed several R407C HVAC conversions as part of the selective system overhaul project. The Life Extension Project plans to continue with this work until the entire fleet has been upgraded with R407C refrigerant and associated components have been upgraded.

The MBTA and consultant staff have prepared a procurement with Westcode to have the compressor/condenser assemblies overhauled off-property. This procurement also includes a new controller upgrade portion with associated sensors. The MBTA will complete all work at Cabot to reinstall the overhauled compressor/condenser units and work associated with the R407C upgrade. At the time of the HVAC work, the overhead evaporator units will be subject to a cleaning program.

Additional HVAC work includes replacement of contactors in the HVAC undercar compartment.

Communications System Upgrade:



Maura Healey, Governor
Kimberley Driscoll, Lieutenant Governor
Monica Tibbitts-Nutt, Secretary & CEO
Phillip Eng, General Manager & CEO



The MBTA project team identified several components within the communications system scope which would be beneficial to replace as part of the Life Extension Project.

- MTU (Monitor Terminal Unit)
- AAS (automatic announcement)
- TMS (train monitoring)
- CMU
- PA System
- PEI System

The OEM suppliers for this equipment (Pocotec and Primetec) have both been acquired by other companies since the No. 3 Car was put into service. The MBTA project team has contacted both OEM vendors. Luminator who acquired Pocotec has indicated that the communications system is obsolete and is no longer supported for replacement or repair. One option identified for the communications system would be to procure an upgraded system or find additional vendors to repair the existing equipment. The project team is working with the OEM carbuilder (Alstom) and various other vendors on potential board repairs to increase the available floats, back-up stock, and spares of communications boards. The MTU specifically has been a focus of efforts with other vendors as this has been deemed by the project to be a critical path item. These efforts will determine if it is feasible to continue operating this system until the end of life of the car.

Lighting System & Destination Signage Upgrade:

The MBTA has developed a specification to replace the No. 3 Car lighting system with new LED interior and exterior lighting. The replacement LEDs should require no significant modifications to the train and be a direct replacement for the florescent lighting currently installed.

TDG has been contracted to supply the upgraded lighting for the No. 3 Car. This scope involves all lighting on the train besides the headlights and side mounted lights. For the interior lights specifically, the solution presented is a stick-on application of the same PCB LED strips which are installed on the new CRRC Red/Orange Line cars. This will allow for fleet consistency in ordered spares. The replacement LED's installed on the No. 3 car are anticipated to have a life expectancy which exceeds the life of the car making replacements unnecessary.

Coupler Heads and Draft Gear Replacement

The project has purchased coupler head overhaul kits from Dellner as an extension of the SSRP program. The SSRP program has entered into a repair and exchange program for draft gear assemblies for the No. 3 car fleet. The Life Extension project has agreed, if necessary, that capital funding be made available to aid in the draft gear program and coupler head overhaul program. This will be tracked using a multi-unit project on the married-pair level.

Trainline Wire Harness Assemblies:



Maura Healey, Governor
Kimberley Driscoll, Lieutenant Governor
Monica Tibbitts-Nutt, Secretary & CEO
Phillip Eng, General Manager & CEO



Trainline wire harness assemblies have been identified as components which may be approaching the end of their life. The project has submitted a PO to have new harnesses procured ensuring there are available spares in the event of multiple failures in service. The new harnesses will serve as the First Article Inspection (FAI) units for a full fleetwide replacement of the No. 1 and No. 2 end inter-car trainline cables. This represents six (6) individual cables which will be procured for each car. It is anticipated that the FAI units for the #2 end cables on the No. 3 Car, along with a small order of twenty (20) of each cable type, will be purchased with project funding. The remainder of the trainline cables are predicted to be purchased with RVCM funding. This will include the remainder of the No. 2 end cables as well as the replacement for the No. 1 end cables. There is a potential to have the selected vendor terminate the No. 2 end cables for the cables ordered after the initial quantity of twenty (20).

Battery Replacement:

The OEM Hoppecke battery assemblies on the Red Line No. 3 Car were last replaced in 2016. The batteries have a recommended service life of 10-years. The Life Extension Project has received pricing to replace the No. 3 Car batteries. The project will procure battery assemblies to align with the battery recommended lifespan. This procurement will include replacement of over temperature sensors as well as battery filling equipment. It is anticipated that batteries for the No. 3 Car will be purchased with RVCM funding.

Interior Seating Upgrade:

The project team has explored several seat upgrade options with multiple vendors. It was deemed cost prohibitive to upgrade the current seat inserts to a new fiberglass material. A fiberglass insert option would require significant upfront costs for tooling and generating a mold of the existing seat. The seat inserts on the No. 3 Car will all be re-wrapped with fabric at the EMRF. The project team has developed options to create spares of seat inserts by repairing mounting studs on current inserts and by using cars with long out-of-service periods for the project. A fleetwide re-wrapping and replacement program will be completed by the project.

SSRP Door Overhaul Program:

The project team, at the request of MBTA leadership, will also absorb the continuation of the SSRP Red Line No. 3 Car door overhaul program. This program includes the replacement of the door actuators on the No. 3 car along with replacement of various additional components on the door system.

The addition of this program to the project will be for labor and additional materials as needed. It is expected that this capital project will account for five (5) full time repairers along with a dedicated foreperson. Justification and inter-department correspondence is included in Appendix 5 of this document.



Maura Healey, Governor
Kimberley Driscoll, Lieutenant Governor
Monica Tibbitts-Nutt, Secretary & CEO
Phillip Eng, General Manager & CEO



Appendices:

1. MBTA Red Line - CRRC Estimated Delivery Schedule Breakdown
2. MBTA Red Line CMS Breakdown, Scope & PO Status Breakdown
3. Red Line Heavy Rail Condition Assessment & Life Extension Program - Full Scope Financial Projections
4. Red Line Heavy Rail Condition Assessment & Life Extension Program - Reduced Scope Financial Projections
5. Inter-department Correspondence & Memorandums



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Kimberley Driscoll, Lieutenant Governor
Monica Tibbitts-Nutt, Secretary & CEO
Phillip Eng, General Manager & CEO



Appendix 1: MBTA Red Line - CRRC Estimated Delivery Schedule Breakdown

	Input: Cars delivered to date: Jan 2024	16				
Month	Orange Line MP's /Month	Red Line MP's / Month	Worst Case RL 2-MP / Month	Cars Delivered: CRRC Schedule	Cars Delivered: Worst Case 2-MP / Month	Notes: CRRC Schedule in red column matches board approved timeline Worst Case Scenario is 2-MP per month based on past performance
Feb-24	1	1	1	18	18	
Mar-24	2	0	0	18	18	
Apr-24	1	1	1	20	20	
May-24	2	0	0	20	20	
Jun-24	1	1	1	22	22	
Jul-24	1	1	1	24	24	
Aug-24	1	1	1	26	26	
Sep-24	1	1	1	28	28	
Oct-24	1	1	1	30	30	
Nov-24	1	1	1	32	32	
Dec-24	1	1	1	34	34	
Jan-25	1	1	1	36	36	
Feb-25	1	2	1	40	38	
Mar-25	1	1	1	42	40	
Apr-25	1	2	1	46	42	
May-25	1	1	1	48	44	
Jun-25	1	1	1	50	46	
Jul-25	1	2	1	54	48	
Aug-25	1	2	1	58	50	
Sep-25	0	2	2	62	54	
Oct-25	1	2	1	66	56	CRRC schedule No.1 fleet end of service
Nov-25	0	2	2	70	60	Anticipated Orange Line Completion
Dec-25	0	4	2	78	64	
Jan-26	0	3	2	84	68	No. 1 Car fleet retired - @ 2 MP per month
Feb-26	0	2	2	88	72	
Mar-26	0	5	2	98	76	
Apr-26	0	4	2	106	80	
May-26	0	4	2	114	84	
Jun-26	0	4	2	122	88	CRRC schedule No. 2 fleet end of service
Jul-26	0	4	2	130	92	
Aug-26	0	4	2	138	96	
Sep-26	0	3	2	144	100	
Oct-26	0	4	2	152	104	
Nov-26	0	4	2	160	108	
Dec-26	0	4	2	168	112	
Jan-27	0	4	2	176	116	
Feb-27	0	4	2	184	120	
Mar-27	0	4	2	192	124	No. 2 Car fleet retired - @ 2MP per month
Apr-27	0	4	2	200	128	
May-27	0	4	2	208	132	CRRC schedule No. 3 fleet end of service
Jun-27	0	4	2	216	136	
Jul-27	0	4	2	224	140	
Aug-27	0	4	2	232	144	
Sep-27	0	4	2	240	148	
Oct-27	0	2	2	244	152	
Nov-27	0	3	2	250	156	

Dec-27	0	1	2	252	160	CRRC anticipated Complete delivery
Jan-28			2		164	
Feb-28			2		168	
Mar-28			2		172	
Apr-28			2		176	
May-28			2		180	
Jun-28			2		184	
Jul-28			2		188	
Aug-28			2		192	
Sep-28			2		196	
Oct-28			2		200	
Nov-28			2		204	
Dec-28			2		208	No. 3 Car fleet retired @ 2MP per month
Jan-29			2		212	
Feb-29			2		216	
Mar-29			2		220	
Apr-29			2		224	
May-29			2		228	
Jun-29			2		232	
Jul-29			2		236	
Aug-29			2		240	
Sep-29			2		244	
Oct-29			2		248	
Nov-29			2		252	Last MP (252) delivered @ 2 MP per month based on past performance