HILLSBOROUGH COUNTY AVIATION AUTHORITY

SUPPLEMENTAL CONTRACT B

FOR SERVICES

BETWEEN

HILLSBOROUGH COUNTY AVIATION AUTHORITY

AND

ALSTOM TRANSPORT USA INC
F/K/A BOMBARDIER TRANSPORTATION (HOLDINGS) USA INC.

PROJECT NOS. 8420 21, 8500 23 & 8910 23

AIRSIDE A AND C SHUTTLE CAR AND CONTROL SYSTEM REPLACEMENT – PHASE 2, AIRSIDE D DEVELOPMENT & AIRSIDE E SHUTTLE CARS

DATED MARCH 7, 2024

SUPPLEMENTAL CONTRACT BETWEEN
OWNER AND CONTRACTOR

TABLE OF ARTICLES

SUPPLEMENTAL CONTRACT B

SUPPLEMENTAL CONTRACT B

This Supplemental Contract B (Contract) for services is made and entered into this 7th day of March 2024 by and between the Hillsborough County Aviation Authority, a public body corporate under the laws of the State of Florida, hereinafter referred to as the "Owner," and Alstom Transport USA Inc., a Delaware Corporation, authorized to do business in the State of Florida, hereinafter referred to as the “Contractor”.

For the following Program: Airside A and C Shuttle Car and Control System Replacement – Phase 2, Airside D Development & Airside E Shuttle Cars

Authority Project Nos. Authority Nos. 8420 21, 8500 23 & 8910 23

(Project No. 8420 21 – Airside A and C Shuttle Car and Control System Replacement – Phase 2, 8500 23 Airside D Development & 8910 23 Airside E Shuttle Cars)

The Owner and Contractor agree as set forth below.

As part of the Contract Between Owner and Contractor, dated November 4, 2021, for services for Airside A and C Shuttle Car and Control System Replacement – Phase 2, Project No. 8420 21, the Owner and Contractor established a GMP Contract Sum of $50,882,858.00 and Substantial Completion date of March 26, 2025.

As part of the Supplemental Contract A Between Owner and Contractor, dated November 3, 2022, for services for Airside A and C Shuttle Car and Control System Replacement – Phase 2, Airside D Development & Airside E Shuttle Cars, the Owner and Contractor established a GMP Contract Sum of $79,838,344.00 and Substantial Completion date for the Supplemental Contract A Work of August 30, 2025.

As part of the Change Order No. 1 Between Owner and Contractor, dated September 7, 2023, for services for Airside A and C Shuttle Car and Control System Replacement – Phase 2, Airside D Development & Airside E Shuttle Cars, the Owner and Contractor established a GMP Contract Sum of $79,910,334.00.

ARTICLE 1
GENERAL PROVISIONS

The existing Contract, Supplemental Contract A, Change Order No. 1, and all attachments, dated November 4, 2021, November 3, 2022, and September 7, 2023, between Owner and Contractor, as described above, are incorporated by reference herein to the extent not modified by this Supplemental Contract B.

ARTICLE 2
BASIS OF COMPENSATION

The Owner will compensate the Contractor for services rendered under the Contract, Supplemental Contract A, Change Order No. 1, and this Supplemental Contract B, as described below.

For the Contractor's successful performance of the Work, as described in Article 1 of the Contract and Contractor's GMP Proposals and including any other services listed in said Contract as part of the Work, the Owner will pay to the Contractor the GMP Contract Sum of One Hundred Forty-Four Million Five Thousand Eight Hundred Eighty-Four and No One-Hundredth Dollars ($144,005,884.00) subject to additions and deductions by changes in the Work as provided in the Contract Documents. Invoiced amounts will be based upon actual work completed and supported by monthly progress reports submitted to the Owner in accordance with Article 4 of the Contract.

The GMP amount is for the performance of the Work in accordance with the Contract, Supplemental Contract A, Change Order No.1, as if fully contained herein, and Design-Builder's GMP proposal for Supplemental Contract B ($64,095,550.00), marked Attachment 1, as follows:

Attachment 1 - Supplemental Contract B GMP proposal dated February 28, 2024, entitled "Fixed Offer for Airside D APM Wayside System and Airside E APM Upgrade."

ARTICLE 3
GUARANTEED COMPLETION DATE

23.1 The Contractor will commence the Work within 10 days of the date set by the Owner in a written Notice to Proceed. The Contractor will achieve Substantial Completion of the Contract Work for the Work included in the Contract dated November 4, 2021, for Project No. 8420 21 – Airside A and C Shuttle Car and Control System Replacement – Phase 2 no later than the Guaranteed Completion Date of March 26, 2025, subject to authorized adjustments and in accordance with the Contract Documents.

23.2 The Contractor will commence the Work within 10 days of the date set by the Owner in a written Notice to Proceed. The Contractor will achieve Substantial

Completion of the Supplemental Contract A Work for Project Nos. 8500 23 Airside D Development & 8910 23 Airside E Shuttle Cars (Cars only) no later than the Guaranteed Completion Date of August 30, 2025, subject to authorized adjustments and in accordance with the Contract Documents.

23.3 The Contractor will commence the Work within 10 days of the date set by the Owner in a written Notice to Proceed. The Contractor will achieve Substantial Completion of the Supplemental Contract B Work included in Attachment 1 for Project No. 8500 23 Airside D Development (Non-car work) no later than the Guaranteed Completion Date of December 31, 2027, subject to authorized adjustments and in accordance with the Contract Documents.

23.4 The Contractor will commence the Work within 10 days of the date set by the Owner in a written Notice to Proceed. The Contractor will achieve Substantial Completion of the Supplemental Contract B Work included in Attachment 1 for Project No. 8910 23 Airside E Shuttle Cars (Non-car work) no later than the Guaranteed Completion Date of July 31, 2026, subject to authorized adjustments and in accordance with the Contract Documents.

23.5 It is mutually agreed between the parties hereto that time is of the essence of this Contract and in the event the Contract Work for Project No. 8420 21 – Airside A and C Shuttle Car and Control System Replacement – Phase 2 has not achieved Substantial Completion by the Guaranteed Completion Date herein specified, it is agreed that from any money due or to become due the Contractor or the Contractor's Surety, the Owner may retain the sum of Five Hundred Dollars ($500.00) per day, for each day thereafter, Sundays and holidays included, until the Contract Work is substantially completed, not as a penalty but as liquidation of a reasonable portion of loss that will be incurred by the Owner if the Contract Work is not completed on or before the Guaranteed Completion Date. Multiple Substantial Completion Dates may be defined as part of this Contract. In addition, the Owner may retain different sums as liquidated damages if Work is not completed on or before the Substantial Completion Dates. The maximum amount of liquidated damages shall not exceed 10% of the Contract Sum.

23.6 It is mutually agreed between the parties hereto that time is of the essence of this Contract and in the event the Supplemental Contract A Work for Project Nos. 8500 23 Airside D Development & 8910 23 Airside E Shuttle Cars (Cars only) has not achieved Substantial Completion by the Guaranteed Completion Date herein specified, it is agreed that from any money due or to become due the Contractor or the Contractor's Surety, the Owner may retain the sum of Five Hundred Dollars ($500.00) per day, for each day thereafter, Sundays and holidays included, until the Supplemental Contract A Work is substantially completed, not as a penalty but as liquidation of a reasonable portion of loss that will be incurred by the Owner if the Supplemental Contract A Work is not completed on or before the Guaranteed

Completion Date. Multiple Substantial Completion Dates may be defined as part of this Contract. In addition, the Owner may retain different sums as liquidated damages if Work is not completed on or before the Substantial Completion Dates. The maximum amount of liquidated damages shall not exceed 10% of the Supplemental Contract A Sum for Project Nos. 8500 23 Airside D Development & 8910 23 Airside E Shuttle Cars (Cars only).

23.7 It is mutually agreed between the parties hereto that time is of the essence of this Contract and in the event the Supplemental Contract B Work for Project No. 8500 23 Airside D Development (Non-Car Work) has not achieved Substantial Completion by the Guaranteed Completion Date herein specified, it is agreed that from any money due or to become due the Contractor or the Contractor's Surety, the Owner may retain the sum of Five Thousand Dollars ($5000.00) per day, for each day thereafter, Sundays and holidays included, until the Supplemental Contract B Work is substantially completed, not as a penalty but as liquidation of a reasonable portion of loss that will be incurred by the Owner if the Supplemental Contract B Work is not completed on or before the Guaranteed Completion Date. Multiple Substantial Completion Dates may be defined as part of this Contract. In addition, the Owner may retain different sums as liquidated damages if Work is not completed on or before the Substantial Completion Dates. The maximum amount of liquidated damages shall not exceed 10% of the Supplemental Contract B Sum for Project No. 8500 23 Airside D Development (Non-Car Work).

23.8 It is mutually agreed between the parties hereto that time is of the essence of this Contract and in the event the Supplemental Contract B Work for Project No. 8910 23 Airside E Shuttle Cars (Non-Car Work) has not achieved Substantial Completion by the Guaranteed Completion Date herein specified, it is agreed that from any money due or to become due the Contractor or the Contractor's Surety, the Owner may retain the sum of Five Hundred Dollars ($500.00) per day, for each day thereafter, Sundays and holidays included, until the Supplemental Contract B Work is substantially completed, not as a penalty but as liquidation of a reasonable portion of loss that will be incurred by the Owner if the Supplemental Contract B Work is not completed on or before the Guaranteed Completion Date. Multiple Substantial Completion Dates may be defined as part of this Contract. In addition, the Owner may retain different sums as liquidated damages if Work is not completed on or before the Substantial Completion Dates. The maximum amount of liquidated damages shall not exceed 10% of the Supplemental Contract B Sum for Project No. 8910 23 Airside E Shuttle Cars (Non-Car Work).

ARTICLE 4
LIMITATION OF LIABILITY

Contractor's overall liability to the Owner under this Contract shall be limited to each individual amount included in the GMP Contract Sum as detailed below, except for (i) fraud, willful misconduct, or gross negligence, (ii) third-party personal injury and property damage claim indemnity, and (iii) indemnity relating to intellectual property rights.

Each individual amount is defined as the following:

Project No. 8420 21 – Airside A and C Shuttle Car and Control System Replacement – Phase 2 - $50,882,858.00.

Project No. 8500 23 Airside D Development (Cars and Non-Car Work) - $66,419,733.00.

Project No. 8910 23 Airside E Shuttle Cars (Cars and Non-Car Work) - $26,703,293.00.

ARTICLE 5
TERMS AND CONDITIONS

All other terms and conditions contained in the Contract remain in full force and effect and are hereby ratified and confirmed.

ARTICLE 6
CONTRACT

This Contract is entered into as of the day and year first written above.

IN WITNESS WHEREOF, the parties hereto have set their hands and corporate seals by their proper officers, duly authorized to do so;

By the Contractor this ___________ day of ________________________, 2024.

ATTEST: **Alstom Transport USA Inc.**

________________________ By: ____________________________________

Title: ____________________________________

Print Name

____

Print Address

____

____

Signed, sealed, and delivered
in the presence of:

____
Witness

____
Print Name

____
Witness

____
Print Name

<u>Notary for Alstom Transport USA Inc.</u>
STATE OF ______________________________
COUNTY OF ____________________________

The foregoing instrument was acknowledged before me by means of □ physical presence or □ online notarization, this ____ day of ____________, 2024, by ____ as
(Name of person)

_________________________________, for ____.
(type of authority) (name of party on behalf of whom contract was executed)

____
Signature of Notary

____
Print, Type, or Stamp Commissioned Name of Notary

Personally Known OR Produced Identification
Type of Identification Produced

By the Owner this ___ day of _____, 2024.

HILLSBOROUGH COUNTY AVIATION AUTHORITY

(*Affix Corporate Seal*)

By: ____

Gary Harrod, Vice Chairman

ATTEST:

____

Jane Castor, Secretary

Signed, sealed, and delivered
in the presence of:

____

Witness

____

Print Name

____

Witness

____

Print Name

APPROVED AS TO FORM FOR LEGAL SUFFICIENCY:

By: ____

Michael Kamprath, Assistant General Counsel

<u>Notary for Hillsborough County Aviation Authority</u>
STATE OF ________________________________
COUNTY OF ______________________________

The foregoing instrument was acknowledged before me by means of □ physical presence or □ online notarization, this ____ day of ____________, 2024, by ____ as
(Name of person)
________________________________, for ____.
(type of authority) (name of party on behalf of whom contract was executed)

____
Signature of Notary

____
Print, Type, or Stamp Commissioned Name of Notary

Personally Known OR Produced Identification
Type of Identification Produced

ATTACHMENT 1

ALSTOM
• mobility by nature •

1251 Waterfront Place
Pittsburgh, PA 15222, United States
Tel +1 412-803-8200
Fax +1 412-803-8201
www.alstom.com

February 28, 2024

Mr. Tom Thalheimer
Director, Procurement, Capital Programs
Hillsborough County Aviation Authority (HCAA)

Dear Mr. Thalheimer,

Subject: Fixed Offer for Airside D APM Wayside System and Airside E APM Upgrade

Following our meeting on February 12, 2024, Alstom Transport USA Inc. ("Alstom") is pleased to present you with our best and final offer for Fixed pricing of $ 64,095,550, as further broken out in Appendix D and subject to CPA adjustments as described in Appendix E. This best and final offer takes into consideration the requested scope change on the platform screen doors and an additional effort made considering our long-standing, fruitful relationship, and desire to keep working with Tampa Airport as your preferred technological partner on Airsides A, C, D, E and future development works on Airside F.

Airside D

- Cityflo™ 650 CBTC train control system
- Command and control systems
- Guidance equipment
- Power distribution system including traction power substation
- Platform screen doors for two-car berthing in two stations
- Fit out of the M&SF
- Integrate the new APM system's operation and management into the existing Central Control Facility, backup Central Control
- Installation of the new Innovia™ 300R vehicles already procured separately for Airside D under Airside A and C Shuttle Car and Control System Replacement – Phase 2 Contract ("Airside D Vehicles")
- Incorporate the testing, commissioning and integration of the Airside D Vehicles

Airside E

- Upgrade to Cityflo^{TM} 650 CBTC train control system
- Power rail replacement
- Integrate the new APM system's operation and management into the existing Central Control Facility, backup Central Control
- Installation of the new Innovia^{TM} 300R vehicles already procured separately for Airside E under Airside A and C Shuttle Car and Control System Replacement – Phase 2 Contract ("Airside E Vehicles)"
- Incorporate the testing, commissioning and integration of the Airside E Vehicles

Detailed Airside D Scope of Work as follows:

Description
Signaling: One region of CBTC system, with the associated central control functionalities utilizing the existing central control
Power Distribution System: One Traction Power Substation, new power rail and associated electrical installation
Platform Screen Door System: Provision system for two-car berthing with operating doors good for the current two-car berthing scenario
Wayside APM Civil Components: include guidance system, buffers and MSF fit out
System Engineering and Integration: include overall system integration of the subsystems, alignment design, system performance analysis
Special Tools and Portable test equipment are included
Spare parts are included to the end of the warranty period
Delivery to site – Delivery will be FOB Tampa airport. Alstom to offload the new APM 300R vehicles (Procured separately, not included in this offer) with crane, and vehicles will be installed on running surfaces
Airside D Vehicle Installation on guideway + Crane + lifting devices + lifting Beam + Supervision by Alstom all included
Testing and Commissioning
- Routine & Qualification Testing – at Alstom's Pittsburgh APM Design and Manufacturing Facility
- Qualification Testing – at Tampa Airport
- Commissioning of Airside D Vehicles – at Tampa Airport
Manuals & Training
- Operation manuals
- Maintenance manuals
Documentation/Training included
- Operation manuals
- Maintenance manuals
- Maximum of 40 Training hours of HCAA employees have been allocated – HCAA and Alstom to agree on the number of training sessions to achieve this
CPA: escalation adjustment as provided in Appendix E

Detailed Airside E Scope of Work as follows:

Description
Signaling: One region of CBTC system, with the associated central control functionalities utilizing the existing central control
Power Distribution System: Power rail removal and replacement on Leg E
Analysis of the current PDS (Power Distribution System) equipment
Wayside APM Civil Components: Buffer replacement.
Buffer support analysis, reinforcement and/or rehabilitation to be determined by HCAA structural consultants.
System Engineering and Integration: include overall system integration of the subsystems, alignment design, system performance analysis
Special Tools and Portable test equipment are included. Bench test equipment is NOT included in this offer.
Spare parts are included to the end of the warranty period
Delivery to site – Delivery will be FOB Tampa airport. Alstom to offload the Airside E Vehicles with crane, and Airside E Vehicles will be installed on running surfaces
Airside E Vehicle Installation on guideway + Crane + lifting devices + lifting Beam + Supervision by Alstom all included
Removing old CX100 vehicles – Alstom to salvage some critical spares from old vehicles, remove them from the guideway, and then transport vehicles to a recycling facility located near Tampa airport. Residual value, if any, owned by Alstom. (Note that historically, residual value has been insignificant).
Testing and Commissioning
- Routine & Qualification Testing – at Alstom's Pittsburgh APM Design and Manufacturing Facility
- Qualification Testing – at Tampa Airport
- Commissioning of Airside E Vehicles – at Tampa Airport
Manuals & Training
- Operation manuals
- Maintenance manuals
Documentation/Training included
- Operation manuals
- Maintenance manuals
- Maximum of 40 Training hours of HCAA employees have been allocated – HCAA and Alstom to agree on the number of training sessions to achieve this
CPA: escalation adjustment as provided in Appendix E

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Project Schedule Assumptions:

In collaboration with the HCAA Project Team, Alstom is proposing a project schedule provided in Appendix C based on conditions known as of the time of this offer and the schedule previously provided by HCAA. Alstom's pricing is based on this proposed schedule including the efficiencies found by targeting continuous effort for the project team from Legs A&C to Leg E, then finally to Leg D. The parties agree to continue to meet to refine a mutually acceptable schedule as project coordination efforts continue. It is understood that the project schedule is not frozen and may be adjusted during the detailed design integration with the APM Fixed Facilities Design-Build Contractor, therefore, Alstom reserves the right to present any resulting impacts to our price estimate and schedule.

Conditions specific to this offer:

- Pricing is in USD, Fixed, subject to CPA adjustments and valid until March 15, 2024
- Pricing is based on receipt of an NTP by March 20, 2024 and on the condition that Alstom receives the 25% down payment for both Airsides D&E (as shown in Appendix D) no later than March 27, 2024.
- Pricing is based on Cityflo™ 650, and the wayside elements per the Technical Proposal provided in Appendix A for Airside D and in Appendix B for Airside E
- As it is intended that this is a supplement to the AIRSIDE A AND C SHUTTLE CAR AND CONTROL SYSTEM REPLACEMENT – PHASE 2 contract between the parties dated 4 November 2021.
- To optimize the execution, relevant on-site installation and testing activities pertaining to the scope included in this proposal have been assumed to be incorporated with those of the AIRSIDE A AND C SHUTTLE CAR AND CONTROL SYSTEM REPLACEMENT – PHASE 2 contract and are to be executed in series with the contract to eliminate the need for demobilization and remobilization of the Project Team. It is understood and agreed that the award of Airside D and Airside E as described in this proposal will be made together as Supplemental Contract B to the Airside A and C Shuttle Car and Control System Replacement – Phase2 Contract so that the pricing and the continuity of on-site works are in accord with this condition
- Pricing assumes:
  - Standard technical documentation and manuals will be provided and where appropriate, as revision updates to documentation and manuals already submitted under the Airside A+C project.
  - Suppliers' quality assurance will be managed by Alstom's robust internal QA process, thus no involvement required by HCAA at Alstom's supplier locations.
  - All necessary testing, including qualification, will be performed by Alstom.
  - NTP date no later than March 20, 2024.
  - A 45-month overall project schedule adjusting site activities that are preceded by the substantial completion of Airsides A and C upgrades, accommodating high traffic months and dependent on the handover dates from the APM Fixed Facilities Design-Build Contractor.
    - Expected Substantial Completion dates for each Airside are;
      - Airside E: July 31, 2026
      - Airside D: December 31, 2027

- HCAA to allow full 24-hr shutdown of lanes on Airside E to allow installation of signaling equipment and testing of new APM vehicles. Work is to be performed as sequenced in Appendix C.
- Vehicle storage costs are not included for the Airside D Vehicles or Airside E Vehicles. As executed in Supplemental Contract A, any storage, maintenance, and related costs for vehicles completed (i.e.. Ex-works) for Airsides D&E are not included in the price above. It is Alstom's understanding that the Authority will issue a change order for the storage by Alstom until such time that the vehicles can be loaded, delivered, and lifted onto their respective Airside lane according to the schedule in Appendix C.
- One-year warranty period per lane starting from respective date of Substantial Completion.
- HCAA is exempt from sales and use tax. Sales and use tax apply only to items purchased for Alstom's own consumption. (HCAA to provide tax exemption certificate).
- 30-day payment terms and a positive cashflow for Alstom as per the Milestone Payment Schedule provided in Appendix D, subject to applicable Prompt Pay Laws.
- Alstom will leverage existing Airside A&C documents and submittals; updating as necessary to incorporate Airsides D&E and/or submitting additional documents where applicable for added scope.
- Reasonable involvement of an HCAA third-party consultant or Independent Safety Assessor. It is understood that reasonable involvement will mean that any Third-Party Consultant will review documents with Owner without direct interaction with Alstom and with a minimal number of iterations (2-3) and expeditiously (within 10 business days after receipt), based on a quality submittal by Alstom, so as not to delay Alstom's work.
- Sufficient O&M site personnel support, including Environment, Health and Safety (EHS), Field Service Engineer (FSE) and a Technician – any engagement of O&M personnel does not relieve Alstom of maintenance obligations and responsibilities under the current O&M contract unless specifically agreed in writing by HCAA. As specified in the current O&M Contract, Alstom and HCAA will negotiate adjustments to the maintenance price when these new vehicles, systems and elements are added to the system.
- Alstom assumed an Airside D preliminary alignment as shown in the Technical Proposal in Appendix A reflecting limited horizontal curves and no vertical curves. This alignment is the basis for civil works pricing, system architecture and system operating criteria. It is understood that the alignment is not frozen and may be adjusted during the detailed design integration with the APM Fixed Facilities Design-Build Contractor; therefore, Alstom reserves the right to present any resulting impacts to our price estimate, architecture and system operating criteria accordingly.
- On Airside D, HCAA will provide a cable-restraint fall-protection system and HCAA's design-builder will construct an engineered, temporary work platform, intended to facilitate both the construction of the guideway as well as the installation of Alstom's scope. Alstom's requirements for the design of this platform, as well as their needs for unencumbered access to it, will be coordinated with the design-builder during design. HCAA's design-builder will remove the temporary work platform when all work is complete. Should this assumption prove to be incorrect, Alstom reserves the right to revisit our price estimate and schedule accordingly.
- Alstom will provide recommendations, technical specifications, interface requirements and review support, but will have no technical or oversight responsibility for the civil works (including the running surface) which are under the APM Fixed Facilities Design-Build Contractor's scope of works (for both Airside D and Airside E). Alstom will provide timely review and advise HCAA if anything is found to be inaccurate , or acceptance of the running surfaces and other facilities as defined in Alstom's DCID; however this review, advice or acceptance does not transfer ownership or responsibility to Alstom from HCAA and their Contractor.

- Any necessary modifications to the Airside E superstructure to accommodate this scope will be identified and performed by HCAA, including for example running surface replacement, rehabilitation and verification.
- Alstom has excluded the running surface design, installation, and verification for Airside D. HCAA has assumed all scope responsibility for the running surface in accordance with Alstom's Guideway Design Criteria. Alstom will provide timely review and advise HCAA if anything is found to be inaccurate, or acceptance of the running surfaces and other facilities as defined in Alstom's DCID; however this review, advice or acceptance does not transfer ownership or responsibility to Alstom from HCAA and their Contractor.
- As requested by HCAA on February 12, 2024, Alstom will provide platform screen doors on Airside D for the two-car berth scenario only. The size and length of the station tunnel shall not change (including on the new Airside station) such that the buffer locations are unchanged. As indicated in our Technical Proposal for Airside D in Appendix A, Alstom will coordinate the locations of the two-car berths with HCAA's design-builder. HCAA has assumed all scope responsibility for the third-berth area of the station barrier walls.
- HCAA to provide site access, parking spaces and room for Alstom employees during project execution and delivery.
- Similar to the scope split on Airside A&C, Alstom pricing for Airside E does not include providing project office spaces. Alstom pricing for project office spaces on Airside D starts in July 2026 after the expected Substantial Completion of Airside E upgrade.
- Alstom pricing does not include providing Division 1-specification construction signage during project execution.
- HCAA will pay for out of the Owner Allowance the following items:
    - Following the same scope split and agreement on Airside A&C, reimbursement for project office spaces through June 2026, allowing for a continuous project office space from Airside A&C
    - Division 1-specification signage during project execution should HCAA require the signage
    - As requested by HCAA, the Owner Allowance shall be increased from $500,000 to $1,000,000 with this proposal
- Policies meeting the requirements of the Contract for insurance coverage for the 45-month project duration are included. An additional $50,000 must be added to the contract price if Terrorism Risk Insurance Act (TRIA) coverage is required.
- The 1% transaction fee for MyFloridaMarketPlace is not applicable to HCAA and therefore is not included.
- Performance and Payment Bond in the amount of 100% of the Contract Value (exclusive of insurance price) in place for 45 months.
- Required duties on material coming from outside the USA.
- Buy America not relevant and not part of terms.
- No Building Information Modeling (BIM) required.
- Internal Safety Assessment acceptable by the Customer.
- Preliminary and Final design reviews as envisioned in Appendix C. Authorization for operation to be done separately for each Leg.
- No availability or reliability analysis required. The System Demonstration will verify that System service availability complies with the existing Maintenance Contract Service Availability (CSA).
- Similar to the scope split on Airside A&C, Alstom has assumed no Cybersecurity scope requirements.
- Similar to the scope split on Airside A&C, Alstom has assumed no electricity costs for running the trains or operating equipment during installation, testing and commissioning.
- All Airside E guideway superstructure structural analysis and repair by the Customer.

- Onboard Operational Radio System (ORS) will function the same as the existing legs.
- No ORS software changes required for the existing fleet or Central Control.
- No vehicle sign control from Central Control.
- 5.8 Ghz frequency for *CITYFLO*650 operation is acceptable to the Customer.
- Alstom will strive to meet the existing operational characteristics (dwell times, round trip times, passenger flow rates, etc) as the current system on Airside E based on the new equipment.
- No changes to the mechanical portion of the Airside E existing platform doors or platform dynamic signs as part of the Airside E upgrade.
- Upgrades to Airside F are not part of this contract.
- No existing traction power distribution system or utility interface modifications.

Alstom is pleased to be able to provide this proposal consistent with the ROM for Airside E offered a year ago. Though the price provided herein is broken down separately for Airside D and Airside E, as indicated in the Conditions above, the Airside D and Airside E work must be awarded together. We also look forward to eventually providing a proposal for future Leg F work but must caution that the pricing in this offer cannot be used as the basis for Alstom's pricing of such future work as it will be a fresh quote based on conditions existing at the relevant time.

The contents of this proposal are intended for the exclusive use of HCAA for the purposes of a Contract with Alstom for the supply of the scope described herein.

Should you have any questions regarding the information or wish to further discuss any aspect of this offer, please do not hesitate to contact me at +1 (347) 301-3954.

Sincerely,

Jean Germain
MD Turnkey NAM
ALSTOM

cc: Jeff Siddle, Tom Thalheimer – HCAA

Appendix A

Airside D Technical Proposal

Request for Proposal

TPA Tampa APM Wayside Upgrade - Leg D

HCAA Project No. 8500 23

26 February 2024

Presented to: Hillsborough County Aviation Authority
Presented by: Alstom Transportation Inc. (ATI)

ALSTOM

TABLE OF CONTENTS

Contents

1. INTRODUCTION

The Alstom Transportation Team is pleased to continue the long-standing relationship with Hillsborough County Aviation Authority (HCAA) for the continued expansions and improvement at the Tampa International Airport. Since the installation of the first automated transit system in the early 1970s as Westinghouse Electric Corporation and through our various transitions up to the present, the Alstom Turnkey and APM Teams have been proud to be a part of the Tampa International Airport history.

This offer is for the greenfield design and installation of the new Tampa D Leg Automated People Mover (APM) shuttle system. This new APM shuttle system will be similar in design and functionality to the ongoing upgrades and signaling improvements underway on the Tampa A and C concourse APM legs. The contents of this package will provide an overview of the planned design direction, installation activities, performance, and commissioning of the greenfield Tampa Leg D shuttle APM system.

2. EXECUTIVE SUMMARY

The Tampa D Leg APM system is a relatively short APM shuttle system of approximately 770-foot length that will reside on a dual lane elevated guideway structure similar to the existing Tampa A and C Leg configurations. Key differences in this D Leg Greenfield project include the short length of the system and the relatively tangent nature of the alignment. In support of the traveling passenger exchange between landside and airside areas of concourse D there will be two passenger stations, one at each end of the alignment. Like the prior APM designs in Tampa and other shuttle systems there will be an online Maintenance and Storage Facility (M&SF) located under the Airside passenger station serving the D Leg facilities. Station platforms will be configured for the Innovia™ APM 300R technology and will be designed around the planned maximum 2-car shuttle consist. There will be no provisioning in the initial installation or this project execution for the operation of a 3-car married consist configuration.

In addition to the new vehicles procured under a prior contract, the Alstom team will support and coordinate the design supply and installation of the signaling and control system required by the Tampa D Leg specification as well as the communications subsystems identified and the M&SF APM System maintenance functions, tools, and equipment. Alstom will coordinate and integrate APM with Fixed Facilities Contractor during design, construction and implementation and will initiate the support for the interface requirements in advance of the award per the engineering services agreement established. The final step will be to integrate/Test Innovia™ APM 300R Cars provided under prior contract (4-cars as 2 married pairs) planned for the Tampa D Leg APM greenfield system design. Including the design, supply, install, test, and commissioning of the following key elements:

- Guidance equipment;
- Cityflo™ 650 Communication Based Train Control (CBTC) train control system;
- Communications, Command and control systems;
- Power distribution system including traction power substation and uninterrupted Power Supply (UPS);
- Platform screen doors for two stations;
- Fit out of the M&SF, Maintenance Facility/Depot Equipment;
- Integrate the new APM system's operation and management into the existing Central Control Facility, backup Central Control;
- Installation of the new Innovia™ 300R vehicles (provided under prior contract).

3. SYSTEM DESCRIPTION

3.1 Project Overview

Alstom, in support of Hillsborough County Aviation Authority (HCAA, the Owner), will design, supply, and install a new Automated People Mover (APM) to link the Main Terminal to a new Airside D terminal. The APM project being procured by the HCAA Team will include the following high-level scope, among other elements:

- Automatic train control / command and control systems;
- Guidebeam system;
- Platform screen doors;
- Power distribution system.

The above high-level categories of scope identified will be implemented in concert with and into/onto the HCAA designed and supplied fixed facilities by the HCAA and their subcontractors and will include:

- Guideway structure and drainage systems;
- Guidebeam and cross drainage systems
- Emergency Walkway
- Stations, equipment rooms and facilities for M&SF;
- Designed to accommodate up to two 2-car trains;
- Central Control Facility (including backup Central Control).

Additional details and information regarding the project are provided in the balance of this Technical Proposal and will highlight the Alstom compliance and agreements to the HCAA Tampa International Airport Airside D Program Automated People Mover Technology Provisions. In addition to the design, supply, install, and testing of the Alstom scope of supply the Alstom's team will also work closely prior to and during the project execution with the HCAA designers and consultant to ensure the correct interface and integration information.

3.2 System Configuration

The 770-foot of elevated guideway (dual-lane) will be configured to reside on top of the clients provided guideway deck. All elements for the interface requirements will be provided during the pre-project and project design integration and interfaces with the HCAA design and construction team. Via the use of the HCAA Teams interface team and the Alstom Design

Construction Interface Document (D/CID) as well as the collaborative meetings and site effort therein, the guideway System configuration will be implemented.

Design and construction of the D Leg infrastructure and systems will be centered around the integration of the vehicle fleet procured separately under Airside A and C Shuttle Car and Control System Replacement – Phase 2 Supplemental Contract A. The guideway running surface, guidebeam, emergency walkway, PDS, and other interfaces between the APM 300R vehicles and the HCAA Team's stations, infrastructure, maintenance facilities, power distributions systems and related components will be closely aligned with the HCAA Team(s) providing the fixed facilities, running surface, emergency walkway and related civil scope.

Based on the preliminary alignment provided in the Tampa D Leg RFP documentation, the Alstom Team has prepared the following preliminary system alignment included in Figure 1.

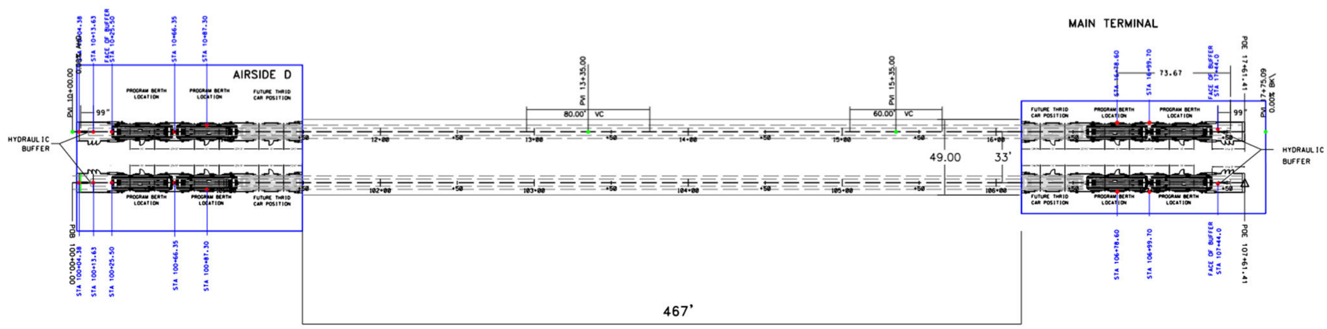


Figure 1: Tampa D Leg Preliminary System Alignment

Not highlighted on the alignment geometry above is the emergency walkway that will be designed supplied and installed by the HCAA Team along with the running surfaces. As part of the integration of the HCAA and Alstom Team's, the design of the cable trays, conduits, and related interfaces between the emergency walkway as well as the deck and guidebeam elements will be coordinated.

3.3 Service Proven System Technology

The design of the power distribution, signaling/communications, and station platform door subsystems to be applied in the Tampa D Leg design comply with the service proven system technology requirements. In all cases for these subsystems the proposed technologies have been operating in daily year-round passenger service for more than two years.

Table 1: Major Subsystem Service Proven Compliance

Major Subsystem	Description	Reference Location	Approx. Years in Service
Power Distribution	3 Phase, 600 VAC Traction power	Tampa International Airport	More than 50 years
Automatic Train Control	Cityflo™°650 Moving Block Train Control	San Francisco International Airport	More Than 10 Years

Major Subsystem	Description	Reference Location	Approx. Years in Service
Power Rail	Aluminum Power Rails with Stainless conductor surface 3 Phase AC	Tampa International Airport	More than 50 years
Automatic Station Platform Doors	Automatic Bi-Parting Platform Doors	Tampa International Airport	More than 50 years

There have been no radical design changes in the configuration or operation of these elements to be utilized in the Tampa D Leg Program. Table 1 highlights the four major subsystems identified in the Tampa D Leg technical specification and identifies Alstom's compliance of those subsystems. Additionally, Table 1 highlights the locations and the approximate years of service where they have been in passenger operation.

3.3 System Equipment and Operations

System operations will be in accordance with the technical provisions requirements. The system will operate in a dual lane shuttle mode of operation between the Tampa Airport's main core terminal area to the new Tampa Leg D terminal. The operational modes and failure management operations will be similar in design and concept to the Tampa A&C legs currently in operation and under refurbishment. The train movements, controls, synchronization, and other operational criteria of the system as defined in the specification will be satisfied in the same manner that the Tampa A&C Leg operations where satisfied.

All train movements will be automatically controlled and synchronized in the same manner and from the same central control facility as the currently operating and upgraded leg at Tampa Airport central control. The new APM legs operations will be controlled via the Cityflo™ 650 Automatic Train Supervisory system and will provide for the same route and operational flexibility currently know to the passenger. For further details on the automatic train control system reference Section 9 of this proposal.

Breakaway panels will be provided by the Alstom Team in accordance with the scope split documentation provided by the HCAA Team. The breakaway panels (or Emergency Egress Doors (EED)) that are located within the berthing position of the individual cars will be provided by Alstom, however, the EEDs outside the berthing positions between the vehicles as well as prior to and beyond the berthing position to the end of the station platform will be provided by the HCAA Team. The normal automatic operational doors will also act as emergency doors and can be opened manually in the event the car berth improperly or the automatic doors do not open.

The Automatic Train Control (ATC), Communications, Central Control Operator (CCO) interfaces, Power distribution, communication networks, and related passenger information and subsystems will be provided and will operate in accordance with the HCAA and Alstom agreed upon scope. The basis for the scope of work will be the detailed work scope identified in Appendix A and the reference drawings to the HCAA Tampa D Leg specification and as modified by all applicable and agreed upon changes to the specification through the proposal clarification process between HCAA and Alstom. Spare parts and equipment including equipment for maintenance of the APM system in the new Airside D Maintenance facility will be assessed and provided in accordance with the operation and maintenance teams requirements to maintain the availability of the new D Leg alignment. The finish out and fixed facilities provided by the Owner will be completed by Alstom in accordance with the Technical Provisions requirements as well as the Alstom Operations and Maintenance Team's performance requirements.

3.4 System Expansion Requirements

All systems and subsystem provided for the Tampa Leg D program will be designed, supplied, and installed for the operation of a 2-car married consist per lane on the Tampa Leg D. In accordance with the HCAA direction there will be no future expansion of the Tampa D Leg system for the operation of a 3-car married consist during this project execution.

3.5 Accessibility

The Alstom proposed APM system design for Tampa Leg D will be equivalent to the designs of the existing APM system in Tampa and will be modelled after the design upgrades and modification ongoing for the Tampa A and C Legs. There will be no designs or configuration that will hinder accessibility to the system for all guests to the Tampa International Airport. The designs will comply with the accessibility requirements for the Tampa D Leg specifications and the applicable Americans with Disability Act (ADA) requirements identified therein.

3.6 Design Lives

The design supply and installation of the APM products proposed for the Tampa D Leg will comply with the design life requirements as identified in section 3.7 of the Tampa D Leg Technical provisions.

4. SYSTEM INTERFACES AND COORDINATION

4.1 Related Work

The Alstom team will work closely with the HCAA contractors prior to and during the design and development of the new Tampa D Leg APM solution. The interfaces between Alstom provided elements of the APM system will be managed closely with the owner's design and construction teams. As part of this ongoing commitment the Alstom design engineering team will interface with the HCAA Design and Construction team during the pre-bid activities under a separate agreement developed for these design construction interfaces. Alstom will support the HCAA designers and constructors with the necessary interface information such and but not limited to live and dead load weights, structural interface requirements, cable and conduit interfaces, automatic door and wayside equipment interfaces, power distribution equipment sizes and interfaces, cable tray and conduit interfaces as well as emergency walkway clearances and interfaces and other related interface designs and requirements.

Alstom is honored to continue the relationship with HCAA and will work closely to maintain this relationship and provide the necessary interface data requirements to keep the project moving in a positive direction. Any installation measure required to anchor fasten or install equipment provided by the Alstom team will be coordinated with the Tampa Airport construction team to ascertain the best team member to design and install the element.

4.2 System Fixed Facilities

In accordance with the technical specification requirements, the general fixed facilities will be design and installed by the HCAA design and construction team. However, Alstom acknowledges the critical importance of the definition of the fixed facility interfaces to the Alstom provided subsystems and equipment. The Alstom design, construction, and installation and testing team will work closely with the HCAA Team to ensure that the interfaces and details required to complete the installation of the Alstom components are accurately represented in the documentation provided to the Owners Fixed Facility design team. These elements will be provided to address the subsections of the System Fixed Facilities section in the Technical Provisions as briefly described in the next section.

4.3 Design/Construction Interface Document

In accordance with the Tampa D Leg Technical Provisions, the Alstom design team will provide documentation via a Design Construction Interface Document (D/CID) that will provide the level of details necessary to identify and design the interfaces between the HCAA provided fixed facilities and the Alstom provided operating equipment and facilities. Per the technical provisions, the following typical information will be prepared for each interface item along with appropriate drawings illustrating interface details and requirements:

A. Type of interface;

B. Description of the interface;

C. Interface identification code;

D. Location of associated equipment or components;

E. Design, performance and operational constraints;

F. Responsibility for interface design and implementation;

G. Related drawing numbers and issues.

Via the Alstom Teams expertise and guideway design criteria manual the various items identified above will be developed into a project specific design construction interface package. The package will identify and highlight the necessary structural, electrical, penetration, and related interfaces to make the integration of the APM system to the Owner design fixed facilities a success. The planned D/CID package developed in concert with the

HCAA design team members will include but not be limited to the following subjects related to the necessary interface packages and as described in the Tampa D Leg Technical Provisions Section 4.3:

1. **Guideways and Guideway Equipment:** to define the interfaces between the HCAA guideway superstructure and running surface and the Alstom APM guidebeam, and related wayside equipment installations. Inclusive of reinforcement, attachment, loading, guideway geometry and related design elements needed for the appropriate levels of interface.
2. **Stations:** inclusive of the station barrier wall interfaces supplied by Alstom (vehicle berthing and EED system at the vehicles only), threshold information, rubstrip details, threshold ramps and related interfaces. Additionally, interfaces and space allocations for equipment rooms, PA systems, Uninterruptable Power Supplies (UPS) systems and similar station related subsystems.
3. **Power Distribution System:** definition of the sizes, space requirements, ratings, and interfaces for the various power subsystems such as the traction power transformers, circuit breakers automatic and manual bus tie breakers, UPS equipment, as well as low voltage equipment necessary for system operations such as switches and stations doors.
4. **Central Control Facility:** while the central control facility already exists, the Alstom Team will identify the appropriate changes necessary to integrate the new leg equipment in to and around the revisions require to the latest subsystem requirements.
5. **Maintenance and Storage Facility:** Alstom will define the room, spaces, utilities, equipment demands, and related requirements in the fixed facilities of the Maintenance and Storage Facility (MSF) areas that will be needed to house the Alstom APM maintenance equipment, tools, spare parts and related items to ensure the availability of the Tampa D Leg APM system.
6. **Vehicle Wash Platform:** as part of the Operations and Maintenance (O&M) contract the Alstom O&M Team will be cleaning and maintaining the new APM 300R vehicles. This will require a location for washing the vehicle to be supplied by the owner, Alstom will provide as part of the D/CID the information required to configure this location just outside the Airside maintenance area.
7. **Equipment Rooms:** there are a variety of equipment rooms needed for the operation of the APM train control, power distribution, and related subsystems. The D/CID will contain the required information to define the space needed in the room, the utilities required with in the room, as well as the heating, ventilation, and air conditioning requirements within the equipment rooms.
8. **Staging Areas:** during the construction and testing phases of the project the Alstom contractors and subcontractors will require area to stage equipment, personnel, and tools and other related construction and testing materials. The Alstom team will highlight as part of the D/CID the approximate area required for these staging areas.

5. SYSTEM OPERATING CRITIERIA

As with all automated people mover systems, there are specific criteria and passenger service requirements for frequency of passenger service and total passenger movements. Additionally, the APM systems must have provisions for operations during maintenance periods, off peak periods and failure management periods of service. This system operating criteria section provides a brief overview of the proposed operating criteria at a high level.

5.1 Passenger Service Characteristics

The Tampa D Leg APM system is a dual lane shuttle configuration and will have initial two 2-car married pair consists operating on the dual lane guideway. Since the application is a shuttle design like the Tampa A&C Legs, the trains will "normally" operate in a synchronized double shuttle mode. This operational configuration will result in the following system performance characteristics (the cases below represent different operating criteria from the specification defined criteria to other past reference operating criteria) reference Figure 2 and the assumptions identified below):

Case 0 – (Based on Current TP Dwell and acceleration requirements)

Round trip time ~ 204 seconds (using a 60 second dwell at each station)

Peak pphpd = 5576 pphpd (2 lanes, 2 car train)

Off-Peak pphpd = 2788 pphpd (1 lane, 2 car train)

Case 1 – (Based on Tampa A&C dwell designs)

Round trip time ~ 158 seconds

Peak pphpd = 7200 pphpd (2 lanes, 2 car train)

Off-Peak pphpd = 3600 pphpd (1 lane, 2 car train)

Case 2 – (Reduced Dwell, higher passenger on/off rate)

Round trip time ~ 138 seconds (shorter dwell based on above)

Peak pphpd = 8242 pphpd (2 lanes, 2 car train)

Off-Peak pphpd = 4121 pphpd (1 lane, 2 car train)

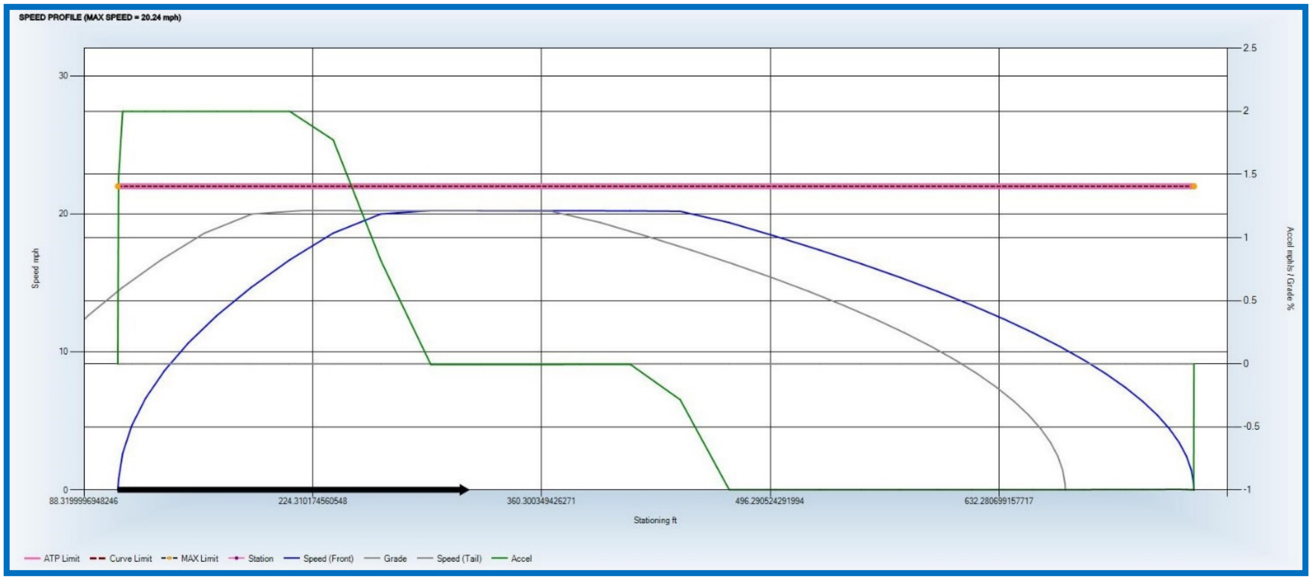


Figure 2: Sample Tampa D APM System Performance Curve

Assumptions:

A. Based on alignment discussed earlier in the presentation;

B. Vehicle 300R capacity = 79 pax normal load (as per Leg A and Leg C, same performance and loading used);

C. Dwell time Case 1 = 37 seconds based on what was used for Leg A and C (100 % on and 100% off using 1 side of the car 4 exit lanes per side at 1 sec per lane movement time, 10 second technical time, no passenger movement during door opening);

D. Dwell time Case 2 = 27 seconds based on (100 % on and 100% off using 2 side of the car (5 second stagger door side opening, 4 exit lanes per side at 1 sec per lane movement time, 10 second technical time, passenger movement during door opening);

E. Maximum ATP speed set at 22 mph (20 mph operating, see attached speed profile plot as reference to operations);

F. Brake rate = 1 mphps (due to close buffer location like Leg C);

G. Buffer Impact Speed = 5 mph impact speed on the buffer with the End of Line (EOL) set behind the buffer;

H. “Special” Station Map Segment = May be required, TBD with SIG Team but not applied to Date;

I. Modified VATO/VATO operations similar to other legs may be required.

J. Overrun distance extends approximately 7ft past the face of the buffer under worst-case stopping conditions and allows hitting the buffer at 5 mph in failures.

The summary of the results of the above information is that with the currently defined dwell requirements in the Technical Provisions the desired flow of the APM system cannot be achieved. However, if the dwell times and acceleration rates planned for the Tampa A&C Legs would be utilized the flow rate capacity requirements with the 2-car consist of TP Section 5.1.5 can be achieved. As part of the overall APM system design, the Alstom team will develop a System Performance and Failure Management Analysis package that will describe the appropriate calculations, flowrates, and many other performance requirements identified that effect the performance of the system to the specification.

The figure below shows the preliminary overrun distance as it relates to the stopping location and buffer location. This information will be updated during the Tampa D Leg program based upon the final stopping distance calculations and civil station design configuration.

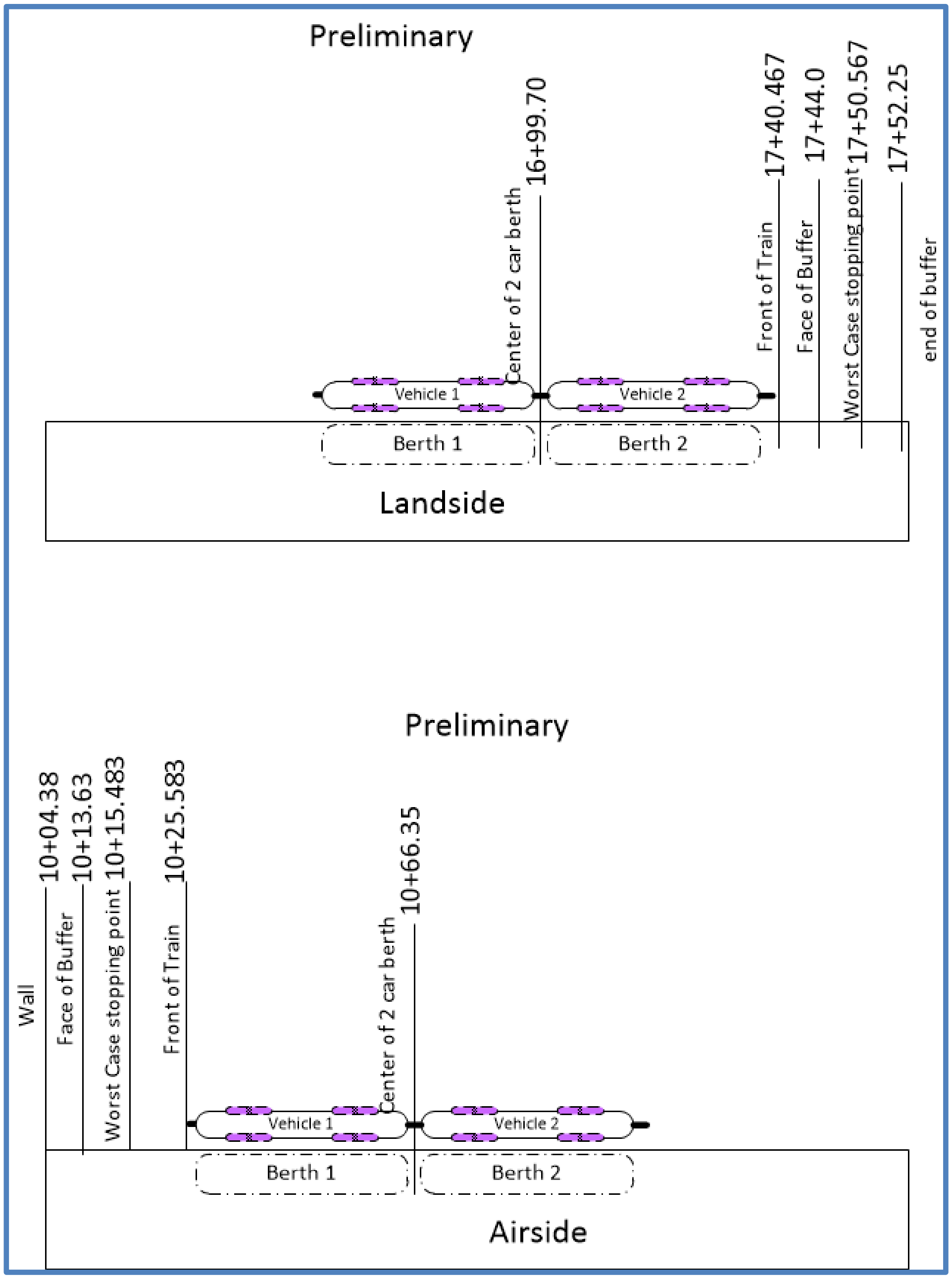


Figure 3 Preliminary Stopping locations showing overrun distance and buffer locations.

5.2 System Operating Modes

The Alstom APM 300R and Cityflo™ 650 train control package will offer all the prescribed modes of operation for the D Leg dual lane shuttle as prescribed by the HCAA Technical provisions. Via the central control console, the central control operators can select from the available modes of:

1. Full Synchronized Double Shuttle (make passenger flow rate).
2. Single Shuttle (approximately 50% of normal full-service operation).
3. On call shuttle (this flow rate cannot be defined as it is based on when a passenger requests service, like elevator lift operation).

Pending the final agreed upon dwell times and passenger loading rates, the flow rates for these various operational modes will vary as described in this Section.

All operating modes may be overridden, and adjustments made as required by the central control operator for any of the operational configurations.

5.3 Operations in Precipitation

In accordance with the Technical Provisions as well as operational experience in the Tampa operational environment, the new Tampa D Leg APM technology will be configured to operate in the environment conditions described in Section 6 inclusive of the level anticipated amount of rain.

6. SYSTEM ENVIRONMENTAL DESIGN REQUIREMENTS

The Alstom team has significant experience in the operation of Automated People Mover systems in a variety of environmental operating conditions. Alstom APM systems have been installed and operating in revenue service in environmental conditions from winter climates to hot climates, as well as high humidity and rain environments to desert like conditions. Additionally, the systems have been installed and operated in conditions of high EMC locations such as airport and city environments. Additionally, the APM Cityflo™ 650 train control and communications networks have shown operational capabilities in the same type of environmental conditions.

In accordance with the Technical Provisions as well as operational experience in the Tampa, Orlando, and Houston operational environment as early as 1971, the new Tampa D Leg APM technology will be configured to operate in the planned and defined environmental conditions identified in Section 6 of the Tampa D Leg Technical Provisions.

7. SAFETY AND SECURITY TECHNICAL REQUIREMENTS

Alstom designs, produces, supplies, and supports innovative, safe, reliable and sustainable rail transport solutions, which comfortably transport millions of passengers and a large quantity of goods around the world every day where quality and safety are at the heart of all Alstom's actions to ensure the safety of passengers and third parties.

- Alstom designs our products, systems, applications and services to achieve the required level of Safety based on applicable laws and regulations and internal processes compliant with applicable standards and codes of practices;
- Alstom ensures that Safety requirements are fully defined and fulfilled from development to delivery (including manufacturing and installation) of products, systems, applications and services;
- Alstom relies on robust Quality and Safety processes to ensure that Alstom, and our suppliers, deliver safe and compliant solutions to our customers in a sustainable manner.

7.1 Security Technical Requirements

Alstom ensures safety of the system by incorporation of high-reliability parts, selective redundancy, warning devices, and protective elements, Additionally, safety must be assured when system elements fail or malfunction. Alstom ensures that, in the event of failure, the system fails to a known and safe state. If a hazardous situation occurs, Alstom will ensure that human safety takes precedence over equipment safety.

Alstom's APM system conforms to ASCE 21 safety principles:

- When the system is operating normally there shall be no unacceptable or undesirable hazard conditions;
- The system design shall require positive actions to be taken in a prescribed manner to either begin system operation or continue system operation;
- The safety of the system in the normal automatic operating mode shall not depend on the correctness of actions or procedures used by operating personnel;
- There shall be no single-point failures in the system that can result in an unacceptable or undesirable hazard condition;
- If one failure combined with a second failure can cause an unacceptable or undesirable hazard condition, the first failure shall be detected, and the system shall achieve a known safe state before the second failure can occur;
- Software faults shall not cause an unacceptable or undesirable hazard condition.
- Unacceptable hazards shall be eliminated by design.

Maintenance activities required to preserve or achieve risk levels shall be prescribed to the individual responsible for the System Safety Program during the design phase. These maintenance activities shall be minimized in both the frequency and in the complexity of their implementation. The personnel qualifications required to implement these activities shall also be identified.

7.2 Security Technical Requirements

The Alstom Safety Management System (SMS), which is at the heart of the Alstom System Safety Program, was created using best practices based upon decades of experience in transportation. The Alstom SMS complies with many domestic and international governance standards including ASCE 21 and MIL-STD-882E.

7.3 Safety and Security Programs

The Alstom Safety and Security objective is to ensure that Alstom, and our suppliers, deliver safe products, systems, applications and services to our customers in a sustainable manner.

The goals of the SMS are:

- To ensure that safety is implemented, demonstrated, and assessed in Alstom systems and products that are delivered to the customer.
- To maintain safety and security during O&M phase with adequate safety and security management of activities performed by Alstom.
- Report and manage potential safety or security issues occurring prior to and during passenger service.

Alstom's objective is to ensure that safety and security is demonstrated, and risks assessed according to Alstom Railway Safety Policy, the customers' needs, national, regional, state, and local laws, standards and regulations. The SMS covers the following high-level tasks:

- Identify and analyze hazards, evaluate the associated risk acceptance criteria.
- Confirm and list safety and security related items with the necessary requirements for mitigating the identified risks.
- Demonstrate implementation of the safety and security requirements and ensure that the exported requirements are clearly defined and issued to customers and other entities and actors working on the Project.
- A commitment to the achieved level of safety and security with the issuing of a System Safety Certification Verification Report.

7.4 System Safety Program

Alstom promotes a positive safety program via the dedicated Alstom "Safety and Security Culture" in all aspects of our work. A positive safety culture is one that is characterized by a companywide commitment by leadership and individuals to always act in the name of safety when confronted with a competing goal. The Alstom safety culture improves safety records and encourages proactive thinking and engagement by all leaders and individuals. Our safety culture relies on five behaviors:

- A commitment to safety by top leadership.
- Support and collaboration between all employees.
- A questioning attitude to promote a "speak up" culture regarding safety.
- Continual training and learning of safety processes and procedures.
- Continued improvement of safety and safety processes.

7.5 Safety Organization

The Alstom Safety Assurance Managers and supporting Safety Engineers that belong to the project organization, support in the implementation of the related safety and security activities. The Safety Assurance Managers oversee safety analysis and of the safety verification and validation activities. The Safety Assurance Manager is also in charge of the application of safety and security during the development period of the project. The Safety Assurance Manager ensures the co-ordination at the system level the safety assurance activities performed other Safety Assurance Managers to ensure the safety and security of their respective scope of work.

7.6 System Safety Certification Program

Safety certification is the process of verifying that the APM system complies with a formal list of safety and security requirements. The safety and security requirements are defined by design criteria, contract specifications, applicable codes and standards, and industry safety and security standards.

7.6.1 System Safety Certification Plan

The process of certification is documented in an APM System Safety Certification Plan. The APM System Safety Certification Plan complies with both internal, and Contractual requirements for system safety certification. The objectives of the System Safety Certification Plan are to ensure prior to passenger service:

- Identified hazards are adequately eliminated or controlled.
- Facilities and equipment are designed, built, installed, and tested in accordance with applicable codes and standards.
- Operational and maintenance procedures, rules, and equipment are developed and procedure.
- All operations and maintenance personnel are fully trained to perform their duty.

One of the main phase of the Safety Certification Plan is Hazard Identification. The Hazard Identification and Resolution Process ensures that hazards are identified, risks assessed to each hazard, and then elimination and / or control of the hazards beginning at an early stage in the project. Alstom has extensive experience with the identification of hazards from many sources including:

- Reference APM products and projects.
- APM Project characteristics and mission profiles.
- O&M activities.

By utilizing a wide breadth of sources, potential hazards can be identified early in the design phase of the project. Once identified, the severity, frequency, and risk of the hazard is assessed using ASCE 21 based risk assessment criteria. Hazards will be mitigated to an acceptable level using the following in descending order of preference:

- Design to eliminate hazards.
- Design to control hazards.
- Use safety devices.
- Use warning devices.
- Implement special procedures.
- Accept the hazard.
- Eliminate the system, subsystem, or equipment.

To assess potential hazards Alstom will perform the following hazard analyses where appropriate:

- Preliminary Hazard Analysis (PHA);
- System Hazard Analysis (SHA);
- Subsystem Hazard Analysis (SSHA);
- Operating and Support Hazard Analysis (O&SHA).

7.6.2 System Safety Certification

The system safety certification aims at committing on the achieved safety level for deliverables to customer for the Project. The goals of system safety certification are:

- To ensure the delivered system meets all the safety requirements of the Contract.
- To ensure that the system has been subjected to and passed independent safety review.
- To ensure that the system meets or exceeds all national, regional, state, and local laws, codes, and standards.
- To ensure the same excellent safety record of existing Alstom APM Systems.

To accomplish these goals, Alstom performs incremental safety authorizations during the testing and commissioning phase of the Project. The Alstom Safety Assurance Manager ensures that all safety and security requirements are adequately fulfilled with evidence prior to beginning the test phase to ensure the safety of the system and testing personnel.

8. POWER DISTRIBUTION SYSTEM

The Power Distributions System (PDS) that Alstom proposes for the Innovia™ APM-300R will resemble the power PDS installed on the Tampa A&C Legs while incorporating the modifications required in the Technical Specification of this project for the Tampa D PDS facilities location and distribution points. Alstom will provide all power conditioning equipment, circuit protection equipment, and switchgear required to supply electric power to all APM System equipment inclusive of all necessary power panels, wiring, conduit, and other electrical equipment to power the Tampa D Leg APM propulsion power and other related system equipment demands.

8.1 Power Distribution System

The Power Distributions System (PDS) that Alstom proposes for the Innovia™ APM-300R will resemble the existing Tampa A&C Leg power PDS incorporating the modifications required in the Technical Specification of this project and for the proposed Bessie-Coleman substation location.

The new PDS will use power from two Tampa Electric Company (TECO) Medium Voltage primary power feeders (13.2 kV feeds from TECO for Tampa D) and APM transformers through medium voltage breakers switches. Prior to the transformers there is a tie contactor to allow transfer power from one source when there is loss of service. Alstom’s proposed APM system will use the TECO identified feeders to provide the primary and alternate power sources. At any single time, only one feed will power the entire Tampa D Leg system. The second feed will be available as an alternative power source.

The Technical Specification requires providing automatic switchover to alternate power source during loss of the normal feed and remote CCC control to restore to the preferred primary feed when power is restored in the normal primary source.

Alstom proposes to use a Main-Tie-Main Medium Voltage Vacuum breaker switchgear housed in the new PDS room location provided by HCAA to provide this feature. The two TECO Medium Voltage (MV) Service feeds will be terminated on the line side of the two main breakers in the MV Switchgear. The load side of the same breaker will be connected to the primary of Alstom provided 1000 kVA transformer installed in the PDS room.

The 1000 kVA transformers will step down MV utility power from the MV Switchgear, to produce 3-phase 600 Volts power to energize the traction system. The overall traction power subsystem will be comprised of the following gear as configured in the reference drawings in Figure 3, Figure 4, Figure 5, and Figure 6:

- 13.2 kV 3-ph AC to 600 3-ph AC Traction Power;
- Dual 13.2 kV feeders;
- Cross Connected 13.2kV Tie Breakers;
- 1000 kVA Traction Transformer;
- Cross 600V Tie Breakers;
- Maintenance Facility Stinger controllers, cables, plugs and related switchgear;
- Metering, instrumentation, and control equipment.

The secondary 600V terminals of the 1000kVA transformers will be connected to the line side of the feeder breakers in 600V Switchgear. The load side of these feeder breakers will be connected by feeder cables to the track power rails. Uninterruptible Power Supply will be provided with 2 hours back up battery to power all the critical APM loads individually for Tampa D Leg subsystems. Emergency Power Off Blue Light system at personnel egress points on platforms and at the substations rooms will be provided in accordance with NFPA Std 130. All shop stinger controllers, cables, plugs and maintenance bay power on lights and emergency pushbuttons will be provided in accordance with Technical Provision requirements. For maintenance work, stinger controllers in each track will receive power from the opposite direction track while de-energizing the track on which the car being maintained is located. The 300R vehicles operate at high power factor and will meet the requirement of IEEE-Standard 519 for harmonics. No power factor correction equipment or harmonic filters are required and hence are not provided as part of the power distribution system.

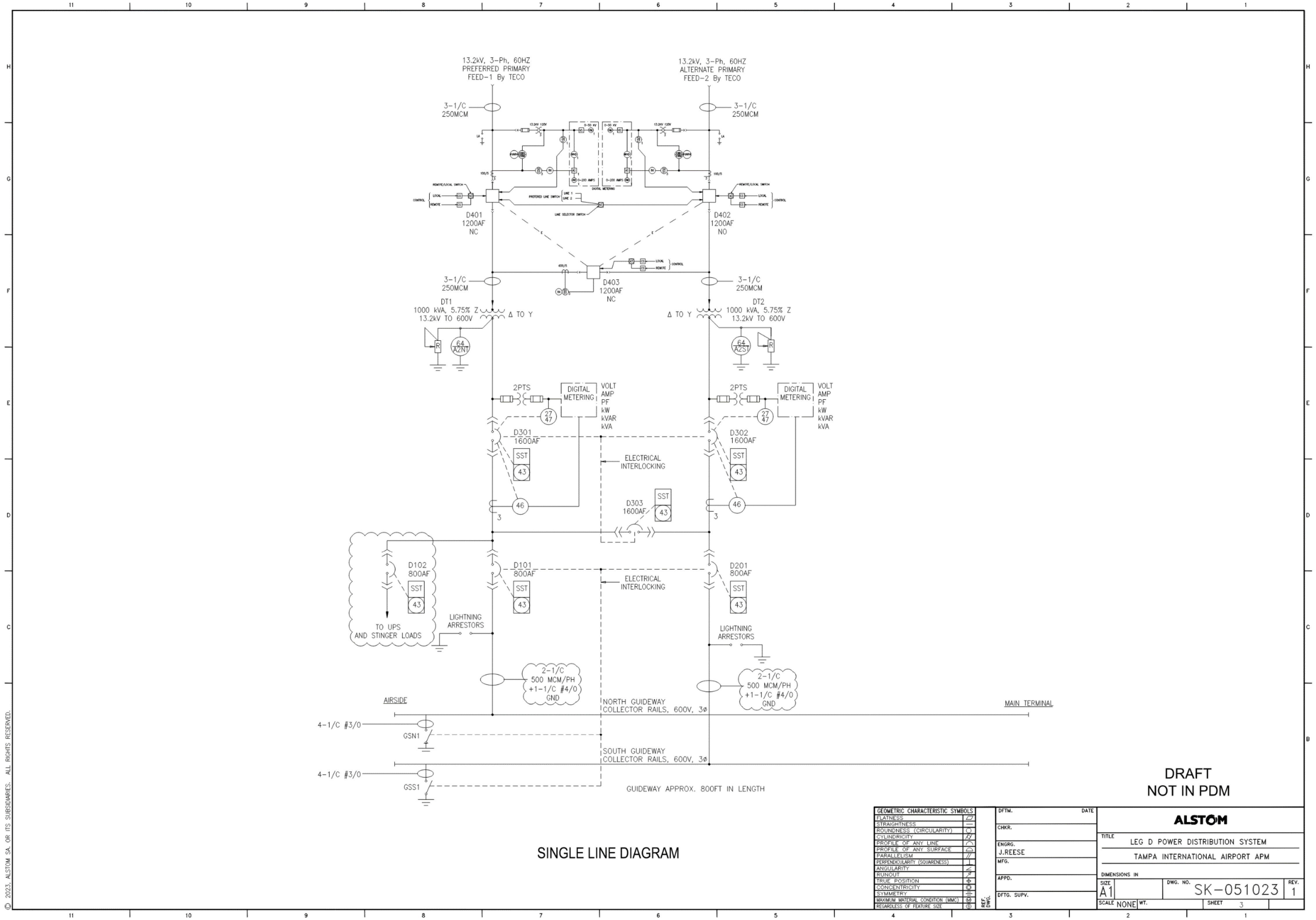


Figure 4: Preliminary Tampa D Leg Single Line Diagram

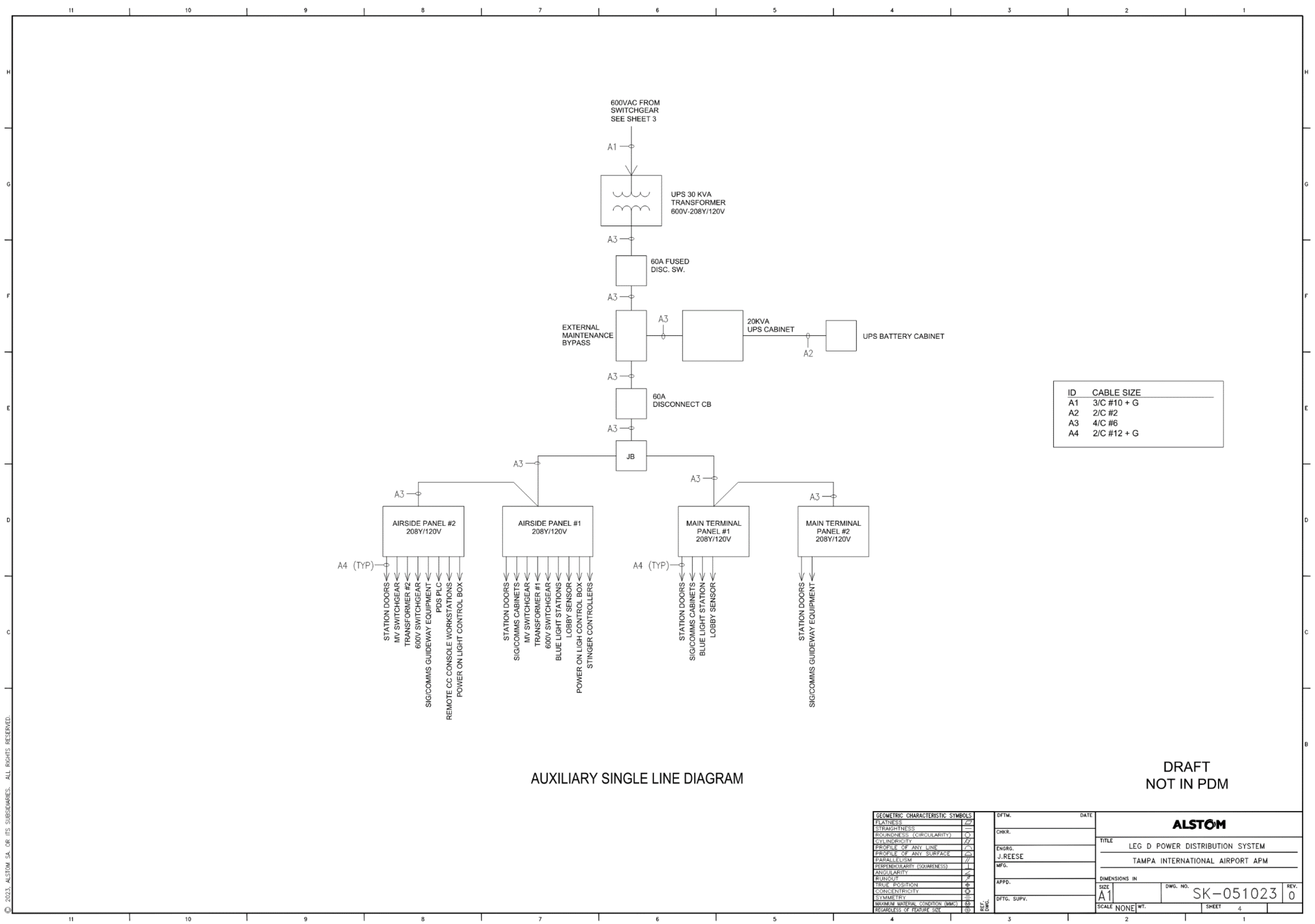


Figure 5: Preliminary Tampa D Leg Auxiliary Single Line Diagram

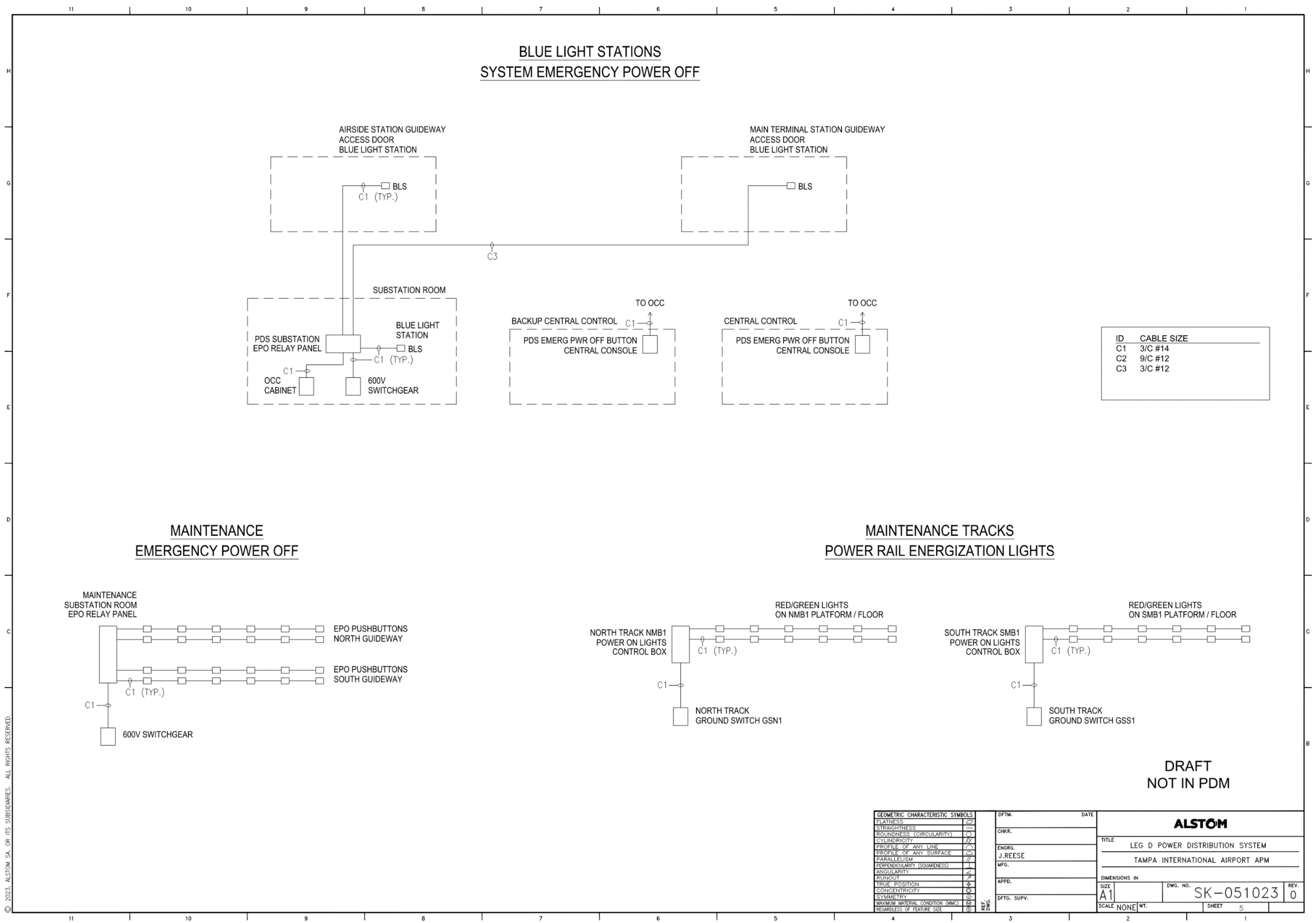


Figure 6: Preliminary Tampa D Leg Emergency Power Off Diagram

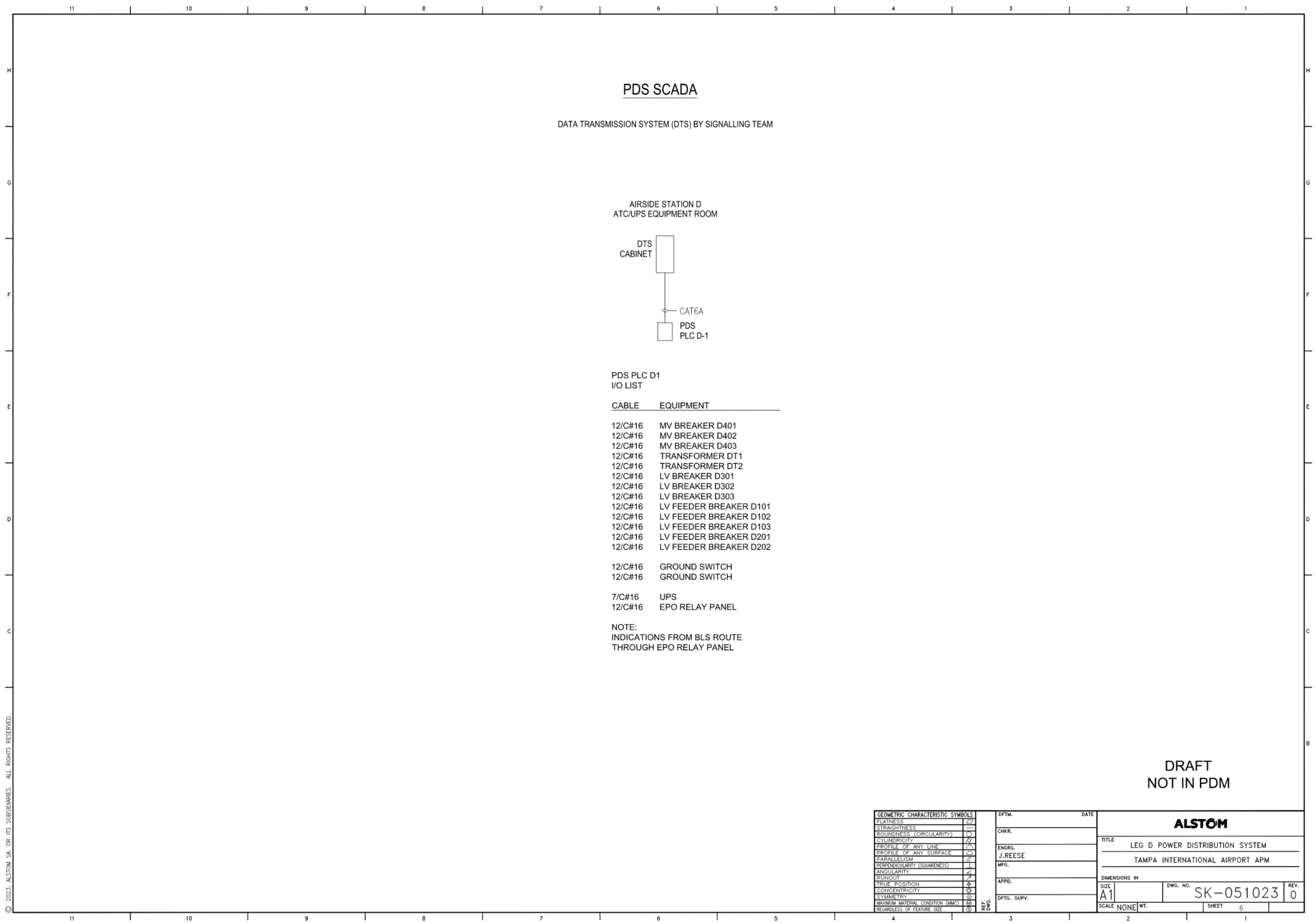


Figure 7: Preliminary Tampa D Leg PDS SCADA Diagram

8.2 System Equipment Backup Power Supply

The Alstom Team will provide an Uninterruptable Power Supply (UPS) system to ensure the continued operation off the critical loads in the Tampa D Leg APM system design as identified in the bulleted list in section 8.2.1 of the Technical Provisions. To accommodate the list of functions in section 8.2.1 the Alstom team will design supply and install the following UPS subsystem equipment:

- 20 kVA, 208/120V input and 120/208 V output, 60 Hz, UPS System;
- 2-hour battery backup;
- External maintenance bypass.

These UPS systems will comply with the ASCE 21-21 standards and requirements as will provide the 2-hour discharge capacity as well as comply with the battery re-charge requirements as agreed upon in the technical clarifications and updates to the Tampa D Technical provisions. Under that language the UPS batteries when discharged for the defined operating period, in accordance with the hazards analysis, or for a minimum of two hours (whichever time period is longer) will be capable of being recharged in 10 hours such that the normal discharge capacity (two hours or as required by hazards analysis) is again available for the system backup UPS loads.

The battery types and monitoring capabilities in central control will be provided as identified in the technical provisions.

It should be noted that in accordance with the technical provisions language, Alstom WILL NOT be designing, supplying, installing or testing any form of backup generator (diesel or other alternative fuel source) or subsystem that is designed for propulsion or backup equipment power in the Tampa D Leg system.

8.3 Housekeeping Power

In support of the non APM operating system electrical loads for the various facilities, equipment rooms, station facilities, maintenance areas, etc., power will be required that is not directly utilized by the APM operating systems. These loads are typically electrical service for APM system station equipment room housekeeping power (i.e., lights, convenience outlets, etc.) and HVAC to meet the Contractor's APM equipment related loads and will be provided by the Owner.

As described in the emergency power subsection, electrical service for the Alstom UPS subsystem, to support essential APM equipment in the Station APM equipment rooms and related station APM subsystems, will be provided from the UPS equipment via the APM auxiliary power distribution network. In accordance with the interface documentation requirements described in Section 4, the Alstom team will inform the HCAA design team of the identified housekeeping load requirements. Once the HCAA team has provided the connection point for the housekeeping loads, the Alstom design and installation teams will distribute and connect the power within the APM equipment room(s). Within the facilities, the housekeeping power (i.e., lights, convenience outlets, etc.) and HVAC to meet the Alstom Team's non-APM operating system equipment related loads will be designed supplied and installed by the owner. For other Alstom specific load requirements in the facilities, Alstom will design supply and install the panels and distribution equipment associated the APM operating system UPS Distribution, Auxiliary power, UPS and all other power and associated distribution as required for APM System equipment.

Any embedded conduits within the Tampa D Leg HCAA supplied installation will be designed supplied and installed by the owner with the appropriate interface criteria provided by Alstom to facilitate the installation of the Alstom operating system and housekeeping loads related to the APM operating system.

8.4 PDS Data Communications Delay

The Alstom PDS Programmable Logic Controller (PLC) and related SCADA information will be transmitted across the Alstom operating system digital fiber optic networks. These networks will be design supplied and installed by Alstom to comply with the data communication delay requirements as identified in Section 10.2 of the Tampa Airside D technical requirements. Refer to Section 9 of this proposal for further discussion on the digital networks and communication for the new APM system.

9. AUTOMATIC TRAIN CONTROL (ATC)

The signaling system proposed for the Tampa Leg D upgrade is Alstom's Cityflo™ 650 (CF650) moving block CBTC system which is the expansion of the CF650_CORE solution provided on Legs A&C.

The CF650_CORE solution is made up of the following components:

- EBI Screen Automatic Train Supervision (ATS) System;
- Region Automatic Train Control [RATC] System (Region Automatic Train Operations (RATO) + Region Automatic Train Protection (RATP)) for non-vital and vital wayside functionality;
- Vehicle Automatic Train Control [VATC] System (Vehicle Automatic Train Operations (VATO) + Vehicle Automatic Train Protection (VATP)_ for non-vital and vital onboard functionality;
- Data Transmission System (DTS) – Wayside Network;
- End-to-End IP Radio System (E2EIP) – Train to Wayside Wireless Communication (TWC);
- OCS950 Object Controllers for wayside device control – Distributed Vital Smart I/O System;
- Platform Door Control Unit (PDCU) – System that provides coordinated platform and vehicle door control;
- PLC Interface Cabinet – Hardware interface using PLCs for non-vital platform screen doors I/O.

9.1 CF650_CORE Solution

The CF650_CORE solution is designed to provide a fully automated and driverless train control system.

The design from Alstom signaling provides functionality from the CF650 Core solution that is typically applied on APM shuttle systems like the legs at Tampa. This means no substantial changes are expected for the proposed legs from what was delivered on Legs A&C.

One key advantage to the core solution it that it integrates moving block interlocking and movement authority calculation functionality into the Region ATP sub-system. This simplifies the system since no independent computer-based interlocking in required.

The CF650 system, by design, is very scalable. The Region equipment controlling Legs A&C will also control Leg D and future CF650 Legs. The DTS network will be expanded to accommodate additional legs. EBIScreen software will be modified to display and control the expanded system and has been planned since its installation. Strategic Wayside radios and Norming points installation provides reliable TWC and accurate vehicle position determination.

The Tampa Leg D system design plans for one region that will consist in the expansion of the region already controlling the airport Legs A&C. This decision is compliant with the definitions made during to the Legs A&C design reviews where it was indicated that within the single region design it would be possible to include future legs converted to CF650 and an additional Airside terminal if needed.

9.2 Architecture

The system will be configured as a one-region system for CBTC operation as represented in Figure 7. The system design will support two-car train operation for Leg D. The following diagram depicts the Tampa Airport high-level wayside signaling layout for Leg D with the current Leg A&C project and the Central Relocation equipment that supports the upgrade to CF650.

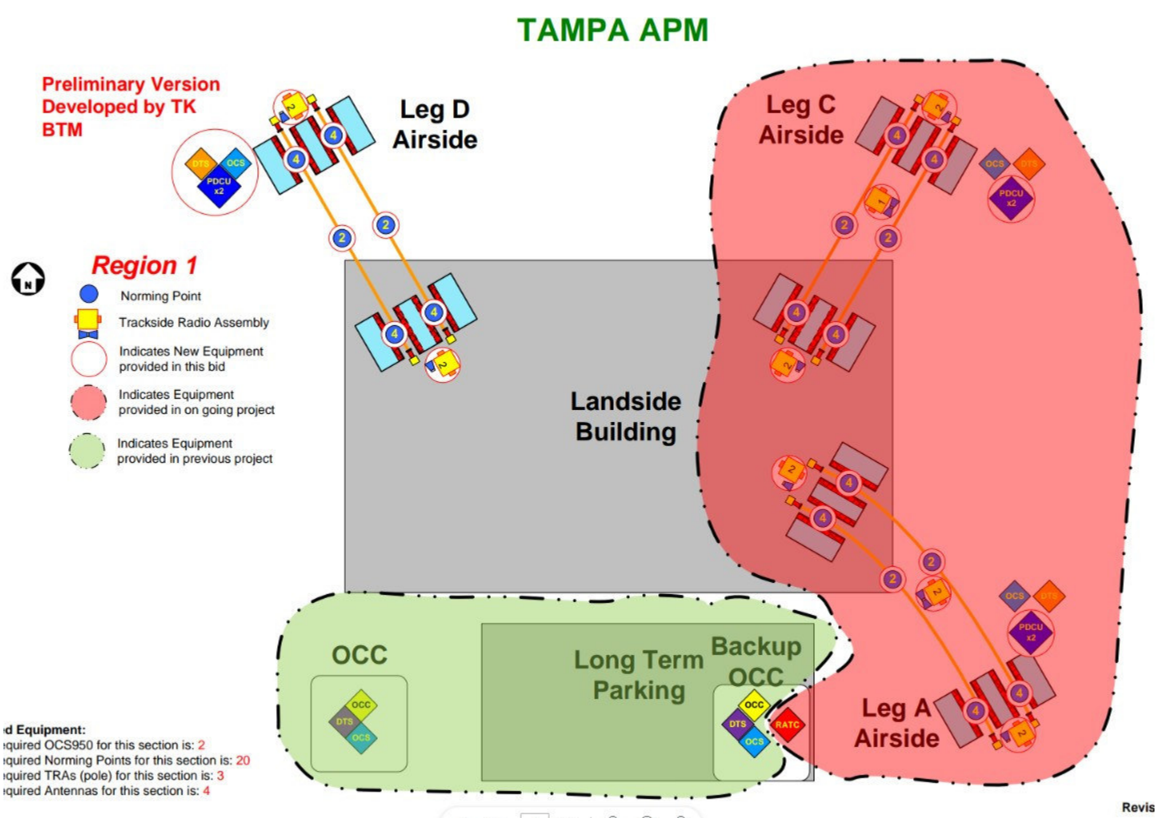


Figure 8: Tampa Airport Wayside Overview

Figure 8 visualizes the logical block diagram that shows the basic interfaces of the CF650 system. Additional diagrams will be available in the future Tampa D Leg Alstom Signaling System Architecture document.

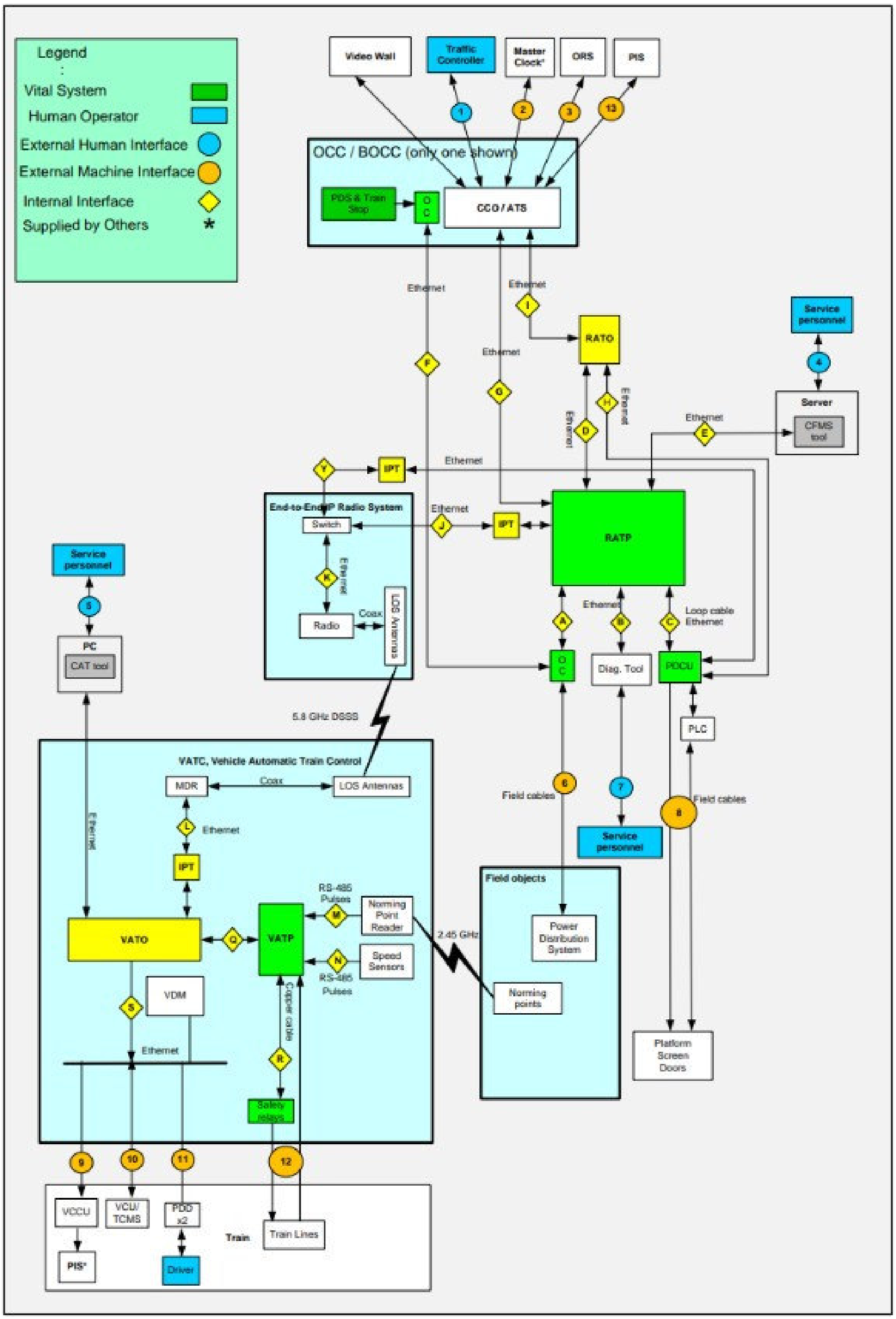


Figure 9 Logical System Architecture

9.3 Main Functionality

With CF650, moving block means the train occupancy moves along with the train in a continuous mode. This is achieved by the train calculating its physical and virtual occupancy along the alignment. A virtual occupancy is the result of applying the distance that will be travelled by the train with the current speed using the ATP breaking curve added to the front of the train.

Communication-based train control means information on the trains physical and virtual occupancy is communicated to the wayside and the movement authority and speed is sent from the wayside to the train through a wireless radio as known as Train-to-Wayside Communication (TWC) system.

The CF650 signaling system includes the following subsystems:

- Automatic Train Supervision subsystem (ATS);
- Automatic Train Protection subsystem (ATP);
- Automatic Train Operation subsystem (ATO);
- Object Controller Subsystem (OCS);
- Data Communication System (DCS);
- Platform Door Controller unit (PDCU) and PLC interface.

Many of the key subsystems use multiple redundancy fault-tolerant designs; in the case of a failure, it supports a quick restoration.

9.4 Key Equipment

9.4.1 Automatic Train Supervision (ATS)

The ATS system was delivered in the Central Relocation Project. The servers used by the *EBI* Screen are high-availability fault tolerant servers by Stratus Technologies. Through the use of the fault tolerant technology via the Stratus Servers, *EBI* Screen complies with the "no single-point of failure" requirements. The ATS will require software changes to include the Leg D into the current application supporting both CF550 for Legs E&F, and CF650 for Legs A&C.

The ATS system controls train movements through the system. The ATS also monitors the operation of the system and provides the Central Control Operator with the capability to manually override the system. The ATS logs events and alarms in the system and provides a system wide level of diagnostics. The details of the HMI are covered by the Leg A&C CDRL 3165904, this CDRL will be updated to incorporate Leg D area, but in terms of features and type of interfaces, no changes are expected for Leg D.

9.4.2 Object Controller System (OCS)

An OCS cabinet will be installed at Leg D airside signaling equipment room. The OCS cabinet provide for Leg D will be the same type of cabinet introduced to vitally implement the PSD and System stop functions for each of the four Legs (A,C,E, and F).

At the Central Control, the existing OCS will be expanded to include the emergency pushbutton related to the Leg D area which will have the same functionality provided to the other legs. Figure 9 highlights the modification to the wayside configuration.

A new object controller will be added at the Airside location. The airside OCS will manage CF650 I/O such as PDS emergency trip, the call button and lobby sensor for the On-Call function.

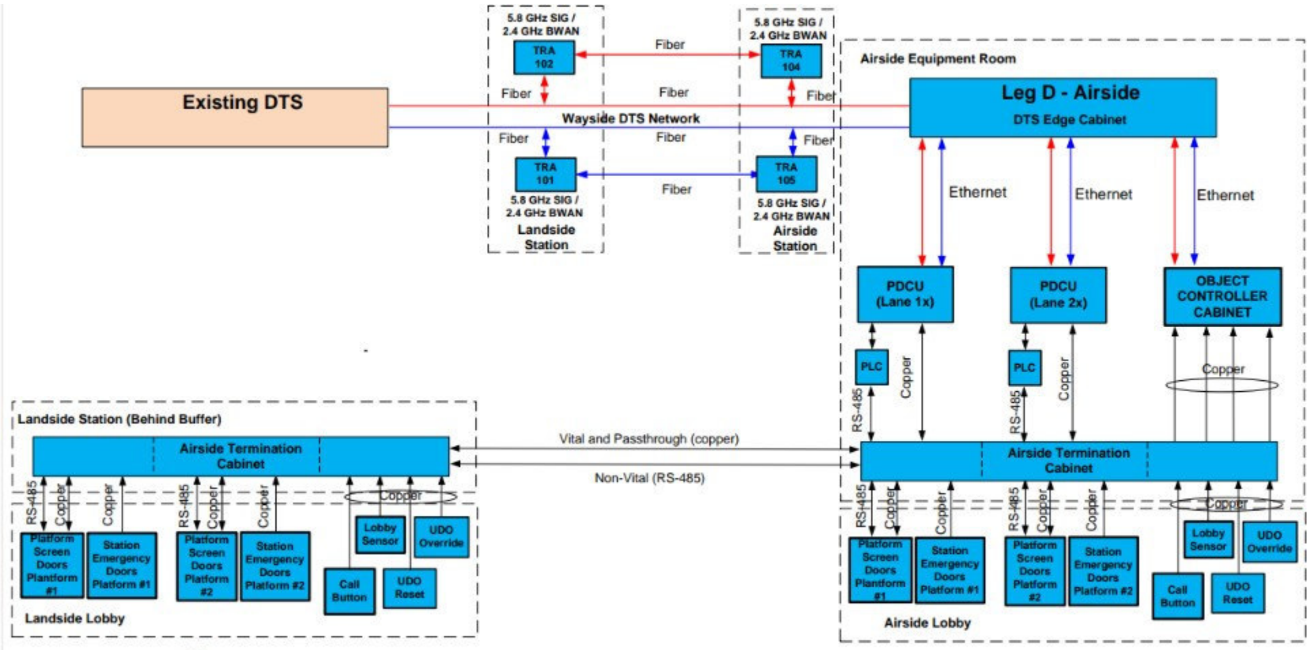


Figure 10 Wayside Configuration

9.4.3 Platform Screen Door Control Unit (PDCU)

The PDCU object controller (Figure 10) type manages the interfaces to the platform screen doors. The PDCU is comprised of redundant Vital Application Controllers, and TRIO-E controller for I/O. The VAC generates the communication messages vitally. The VAC interfaces with the TRIO-E board over the backplane of the OCS sub-rack.

The PDCU communicates directly with the vehicle (over the TWC) to provide synchronized opening and closing of the platform doors with the vehicle doors. The PDCU interfaces with the RATO (through the DTS) to send status and event messages that will be passed on to the ATS. It also interfaces with the RATP (through the DTS) to safely manage unscheduled door openings on the platform. If closed and lock is lost, the PDCU reports this to the RATP which will apply zero speed on that lane.

Even though the standard PDCU design is capable of door control for an entire leg, it will be applied on a per lane basis (one PDCU per lane) for Tampa Leg D following the same approach defined for Legs A&C. This configuration maintains lane isolation and prevents a failure from impacting door control on both lanes.

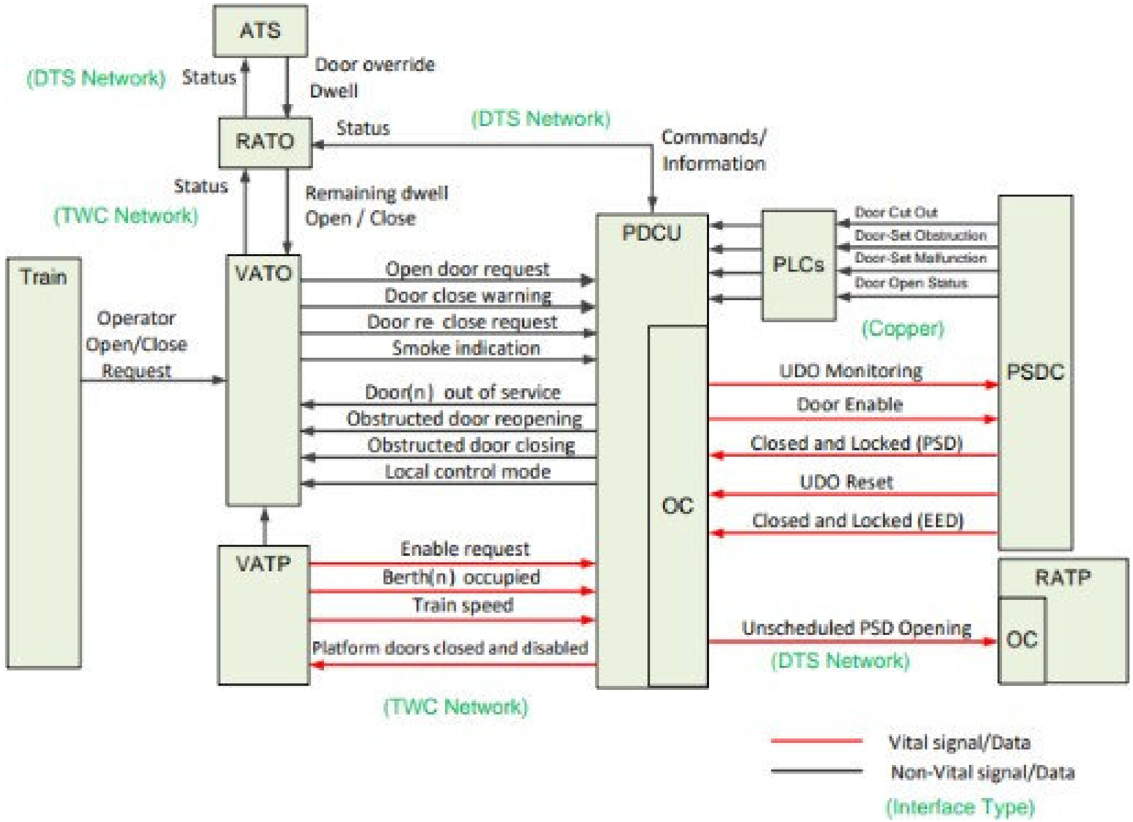


Figure 11 PDCU Signal Diagram

For instance, the failure of a PDCU (Figure 11) power supply would only affect the lane the PDCU controls. Travel to the airside terminal on the other lane continues, while repairs are made on the failed power supply. PDCU equipment will be located at Leg D Airside equipment room.

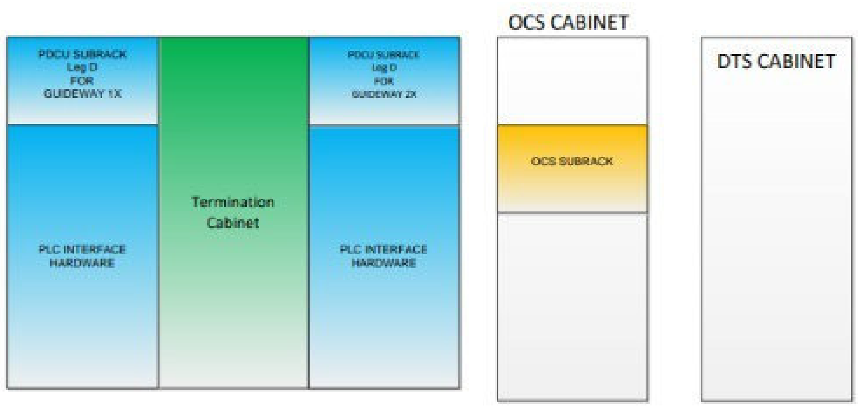


Figure 12 PDCU Cabinet Location

9.4.4 Region Automatic Train Control (RATC)

The RATC cabinet (Figure 12) houses the RATP and RATO subsystems. It is a fully redundant cabinet a will serve as the region controller for all CF650 operations. The RATC located in the in the BOCC equipment room used for Legs A&C will receive a map update to incorporate Leg D area.

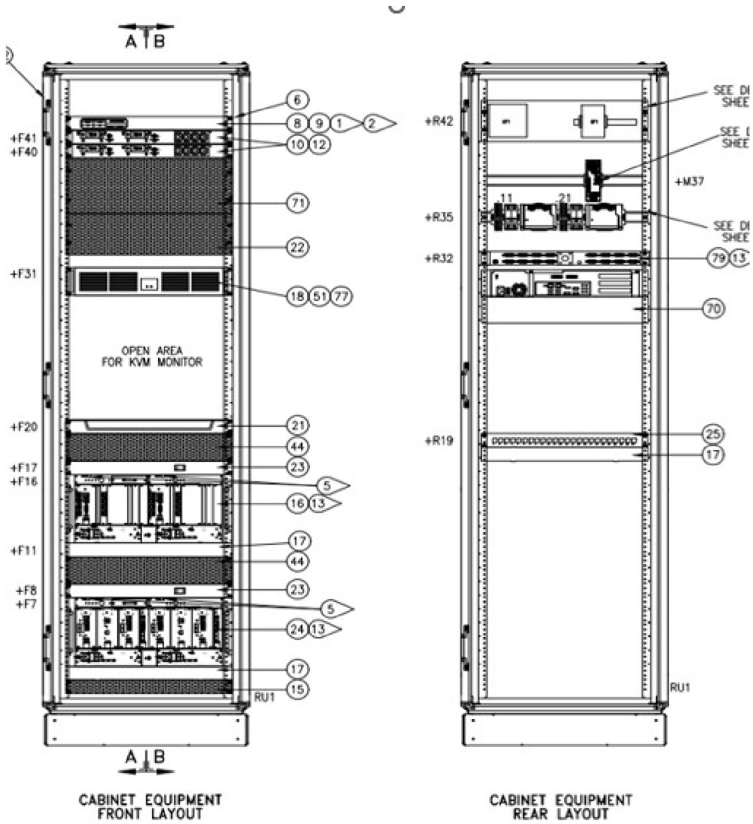


Figure 13: RATC Cabinet

9.4.5 Regional Automatic Train Operation (RATO)

RATO is a redundant wayside subsystem that manages non-safety operation for CBTC trains (Figure 13). It also has redundant network connections for dual channel communications.

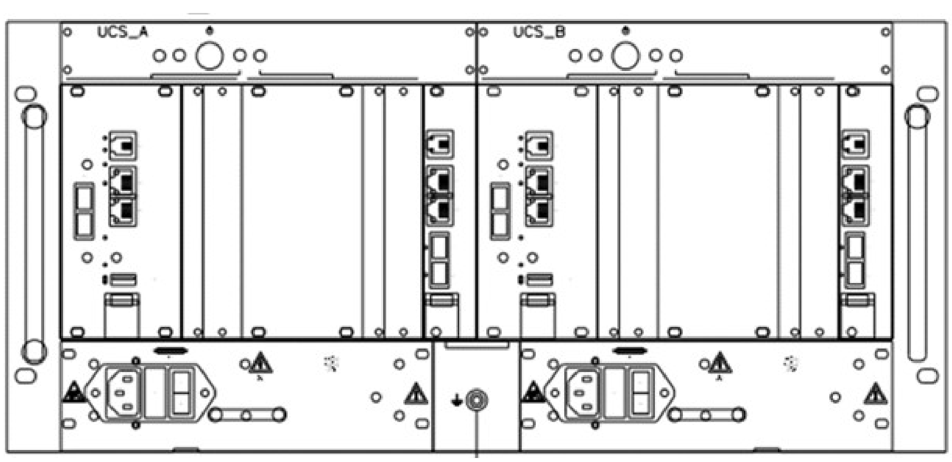


Figure 14: RATO

RATO Functions include:

- Train Routing;
- Station Dwell;
- Station Hold;
- Passes Alarms and Events to ATS;
- Door Requests;
- Regional Automatic Train Protection (RATP).

The RATP (Figure 14) is a redundant wayside subsystem responsible for the vital safety functions. It also has redundant network connections for dual channel communications.

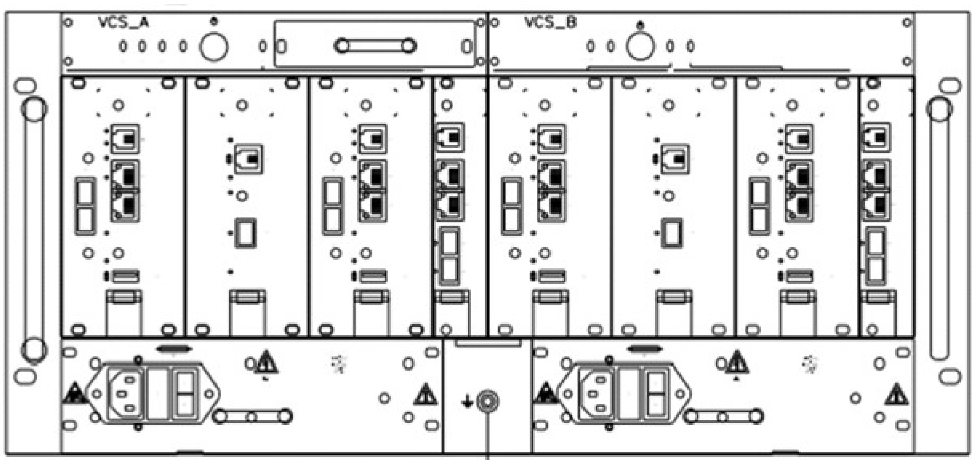


Figure 15: RATP

RATP Functions include:

- Presence Detection;
- Overspeed and Distance Protection;
- Movement Authority;
- Parted Consist Protection;
- RATP Activated Vital Train Hold;
- RATP Activated Service Brake Request;
- Unscheduled Platform Door Opening;
- Unpowered Track Detection;
- TWC System (End-to-End IP Radio);
- System Initialization;
- System Diagnostics;
- Vital Signal Transmission and Detection;
- Cityflo™ 650 Monitoring System;
- RATP Switchover and RATP Remote Reset;
- Object Controller Reset;
- Failsafe Principles and System Shutdown;
- Sweep.

9.4.6 Data Communication System (DCS)

The Data Communications System (DCS) provides the overall Internet Protocol (IP) based message delivery functionality in Cityflo™ 650.

The DCS consists of the following subsystems:

- Data Transmission System (DTS) - the wired (or fiber optical) IP-based communications subsystem between networkable office/wayside/trackside/onboard subsystems and devices;
- Train-to-Wayside Communications (TWC) System - the wireless IP-based communications network between the region ATC and vehicle ATC.

9.4.7 Wired Network (DTS)

The Data Transmission System (DTS) provides a core communications network for all Automatic Train Control (ATC) data communicated between the various ATC components within the CBTC system. Due to the high reliability and availability requirements, the DTS network architecture is designed to be highly redundant and fault tolerant. The sample DTS network in Figure 15 shows communication paths connecting Wayside ATC equipment, Central Control equipment, Train to Wayside Communications (TWC) equipment, and non-ATC equipment.

All devices on the network (e.g., computers, PLCs, etc.) plug into the DTS so that they can communicate throughout the system. The existing Tampa Airport DTS will be also expanded to include the Leg D communication devices:

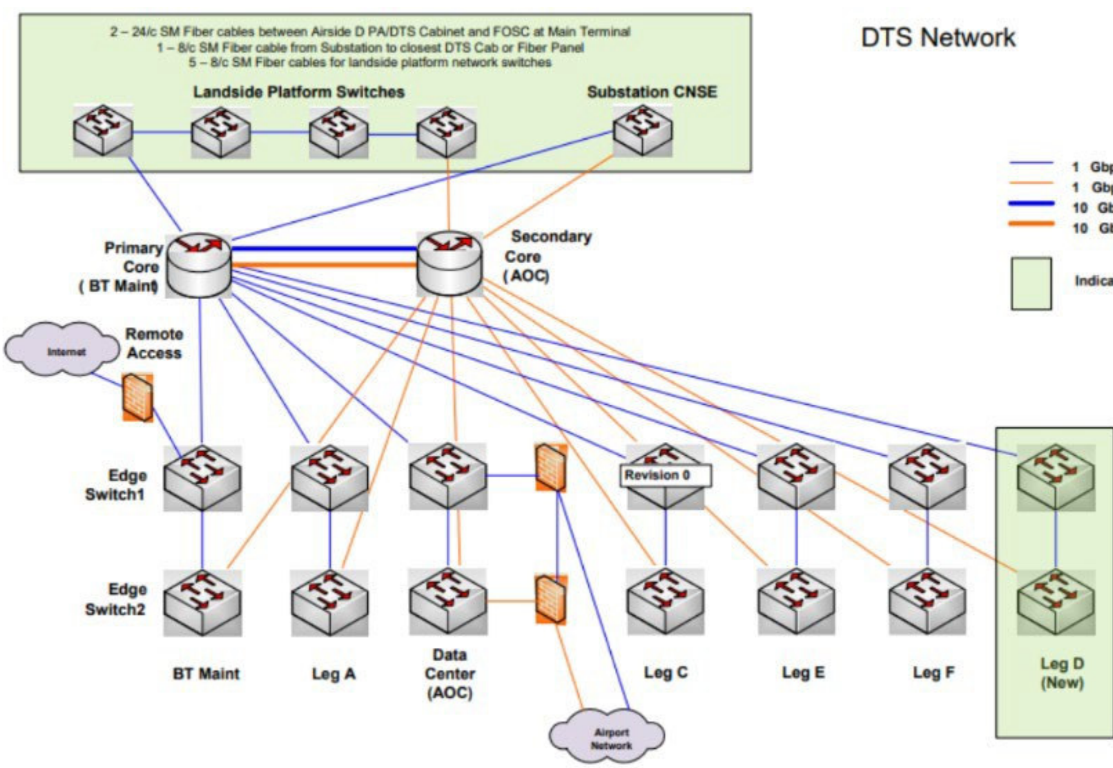


Figure 16: DTS Configuration

9.4.8 Train to Wayside Communication (TWC)

Wireless network (TWC) for onboard equipment and Wayside equipment, including dual band Trackside Radio Assembly (TRA), Line-of-sight (LoS) antenna, onboard antenna and dual band radios.

There are three core TWC equipment (Figure 16):

1. Wireless Access Controller (WAC), installed in Signaling equipment room at wayside;
2. Trackside Radio Assembly (TRA), installed along the guideways;
3. Mobile Data Radio (MDR), installed at each end car of a train.

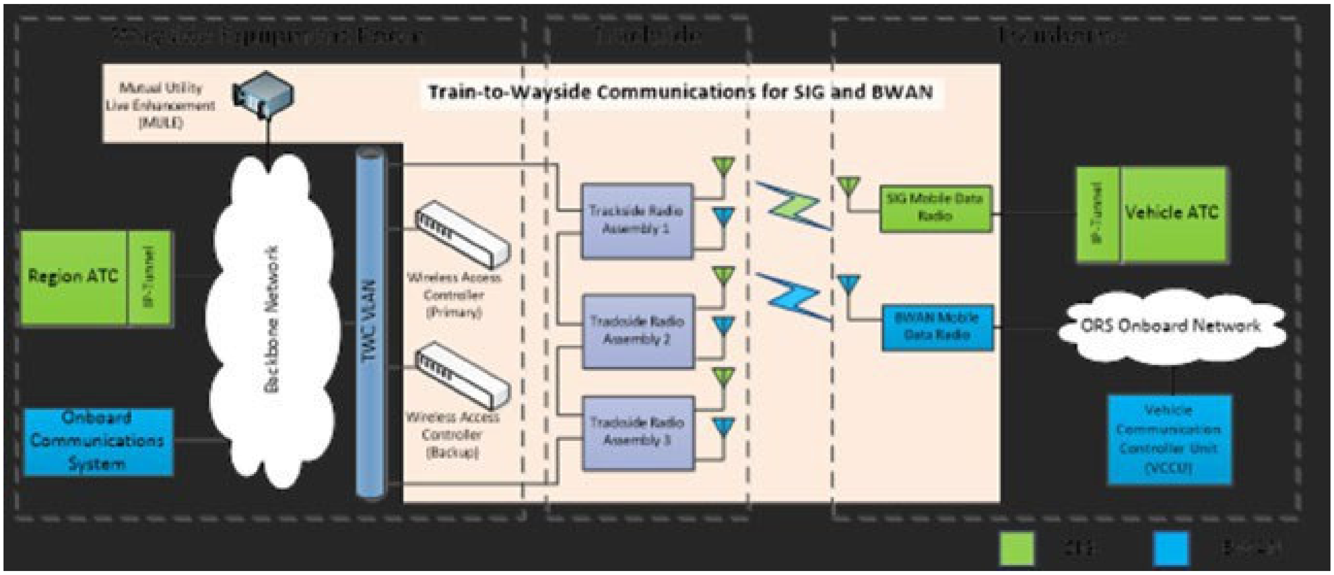


Figure 17: TWC Equipment

9.4.9 Wireless Access Controller (WAC)

Wireless Access Controller is a roaming controller responsible for train roaming management It supervises signal levels sent from the moving trains through the TRAs. It makes sure the train is utilizing the best communication path. Two WACs are installed for redundancy. If the primary fails, the second unit backs it up.

9.4.10 Trackside Radio Assembly (TRA)

TRAs are the RF radios that are placed along the guideway and in the stations providing the communications medium between the wayside and vehicle train control package refer to Figure 17 and Figure 18.

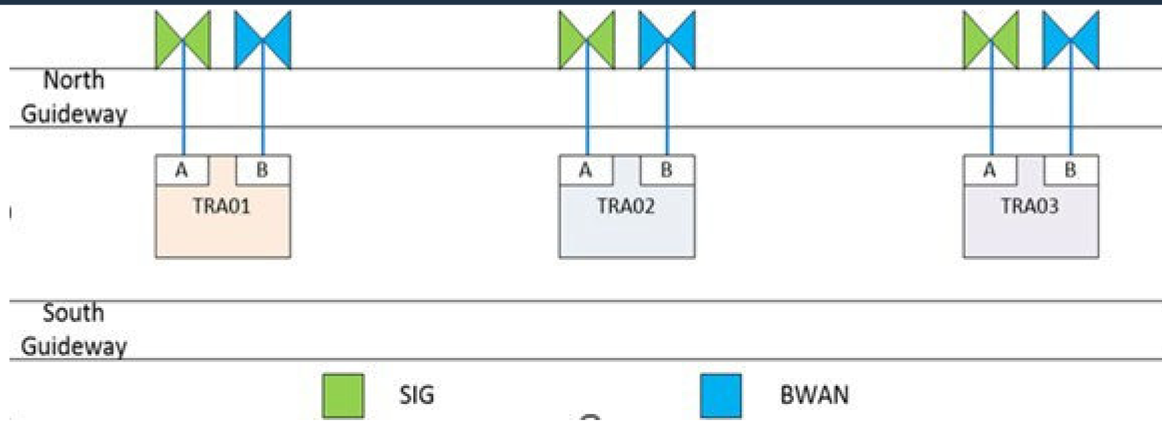


Figure 18 TRAs

The primary goal of RF design is to provide reliable communications under Line-of-Sight (LoS) propagation. RF coverage zones around each TRA are designed for adequate signal levels and Signal-to-Noise Ratios (SNR) to support the successful transfer of SIG and Broadband Wireless Access Network (BWAN) packets. The failure of any one of the three TRAs will not leave a gap in RF signal coverage due to the coverage redundancy.

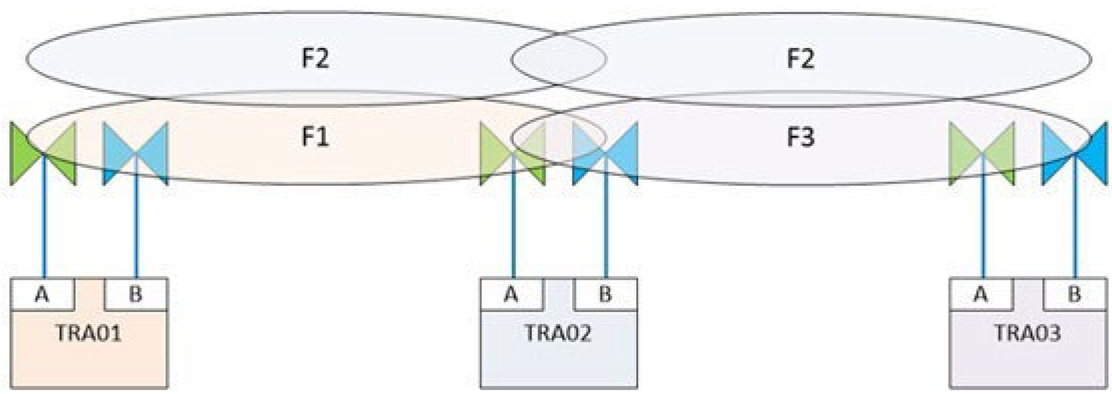


Figure 19: Redundancy Through Coverage Overlap

The design of the TWC is an WLAN based on the IEEE 802.11 standard and for this project, signaling utilizes 5.8GHz band, and BWAN utilizes 2.4GHz band. The TRAs are typically pole mounted along the Guideway. The directional panel antennas are also pole mounted, but above train height for good LOS to the roof mount vehicle antennas.

9.4.11 Mobile Data Radio (Not Scope of this contract)

The Mobile Data Radion (MDR) captures the packets sent from the wayside and passes them to the VATC (refer to Figure 19). The radio and its bi-directional antenna are responsible for sending packets from the VATC back to the wayside as well. Other non-signaling radios like the ORS and BWAN are shown in the diagram but not discussed here.

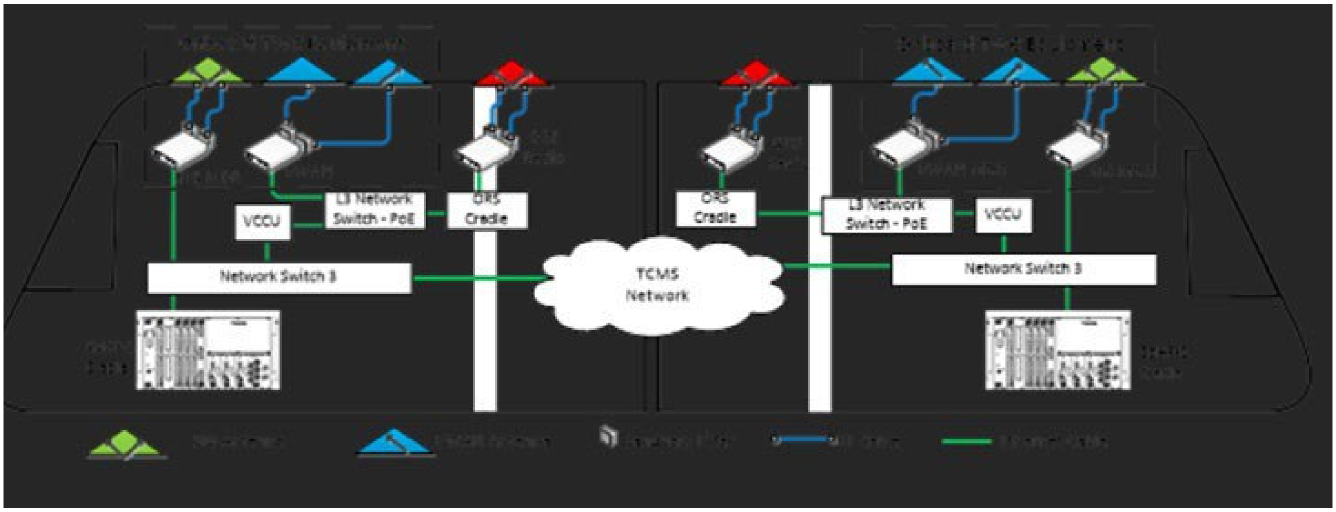


Figure 20: MDR

9.4.12 IP Tunnel SW Application

The IP Tunnel is an application that runs on the RATC and VATC to provide end-to-end Layer 2 IP-based packet transmission between wayside and onboard signaling equipment as shown in Figure 20. Packets communicated between RATP-RNET and VATC are first sent to the IP-Tunnel (IPT). The IPT will encapsulate the destination IP address on the packets, and then forward it through the network to another appropriate IPT. When a packet is received at the opposite end of the tunnel, that IPT it will de-encapsulated the packet and forwarded it to the appropriate end devices.

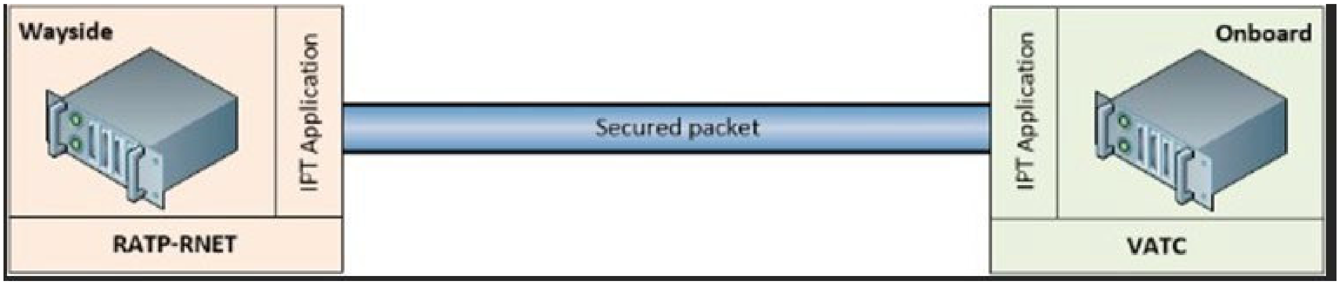


Figure 21: IP Tunnel

9.4.13 Norming Points

Wayside Signaling equipment is limited in a Communication-Based Train Control system. The train determines its location, to do so, RFID tags are mounted to the guideway (refer to Figure 21) so that when the train passes over, the RFID reader on the train interrogates the tag to get the ID of the tag. This ID is stored in the MAP database on the train along with its position in the system.

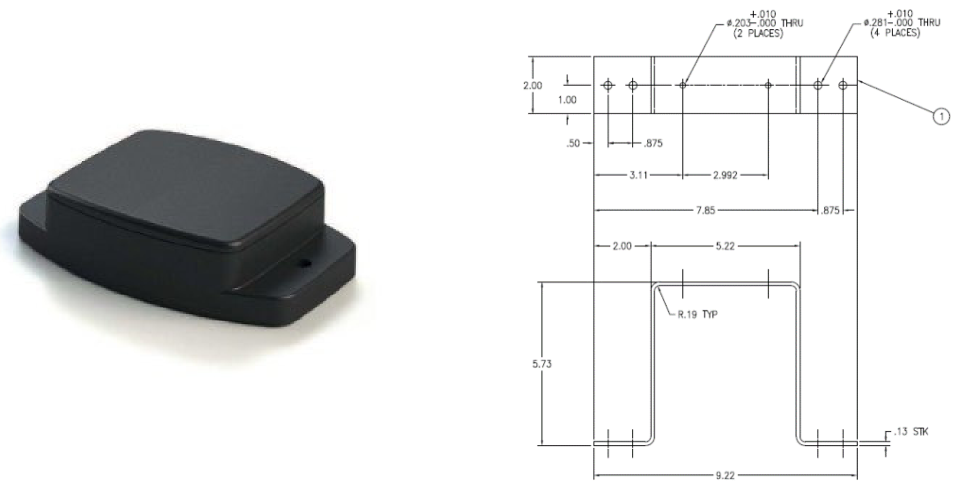


Figure 22: Norming Point and Mounting Bracket

From this the train normalizes its position error and calculates its physical and virtual occupancies.

As the train moves, the odometry system on the train provides distance traveled. The RFID tags are placed such that when read, the position of the train is corrected due to the position error of the train odometry. The location for the RFID tags is determined to cap the position error or "normalize" the position of the train.

The TagMaster norming point will be mounted to the running surface with mounting brackets to set the correct height and location within the detection area (cone) of the onboard RF tag reader.

9.5 Commissioning Strategy

Every time a new baseline is released for Tampa Leg D, regression tests over to the Leg A&C area will be done on FAT and FIELD. The field regression testing on Leg A&C will be done at night (shutdown needed) for 3 consecutive nights. The new software will be installed at the beginning of the shut down and removed before the end for Leg A&C to resume revenue service.

Once it's proven through FAT and FIELD that the new software is not impacting Leg A&C, this baseline will stay installed and testing on Leg D will start during daytime (revenue service will continue Leg A&C). It's estimated a total of 3 baselines (total of 9 nights of regression testing on the field)

9.6 ATC System Reliability

The signaling system provided into the Legs A&C project (ATS, RATO, RATP and DTS) will be expanded to support Leg D. The required new equipment provided for Leg D (OCS and PDCU) will be the same as provided to A&C.

As a result of the expansions assumptions the same level of availability described in the CDRL 3165936 (Legs A&C artifact) will be achieved by Leg D with no impacts in the values presented for legs A&C.

10. AUDIO COMMUNICATIONS

10.1 Audio Communications

Alstom will provide audio communication facilities and equipment for two-way voice communications between Central Control and passengers or maintenance personnel throughout the Airside D APM System.

The following audio communications equipment will be provided:

- Public Address (PA) equipment.
- Telephone communications equipment.
- Vehicle voice communications equipment.
- Pre-recorded audio announcement equipment.

10.2 Public Address (PA)

The Wayside Public Address (PA) subsystem, as shown in Figure 22, will be designed according to TP Section 10.1.1. Using the PA subsystem, the CCO can make direct announcements to all PA zones or any combination of zones. Available zones include the boarding area of each station (Airside D and Landside D) and three functional areas in Airside D maintenance.

The existing airside shuttle systems does not have PA coverage in the maintenance areas. However, the new PA system will include the maintenance area(s) with inside zone coverage. There are no outside areas/zones for APM maintenance.

Pre-recorded messages in stations play automatically based on current APM System operation. Live messages override pre-recorded messages. The Alstom team will work closely with the Owner to ensure the PA subsystem properly interfaces with, and allows the correct priority for, incoming audio announcements provided by the Owner’s public address system.

Ambient noise detection is achieved through sense microphones connected to the power amplifier, automatically adjusting amplifier output to volume levels of 10 dB above ambient levels up to a maximum of 95 dBA.

The PA system will meet intelligibility industry standards, providing moderate sound levels and high intelligibility speech reproduction throughout each facility.

The primary purpose of the PA subsystem is to provide messages about operations to passengers waiting for trains on platforms and for O&M staff in maintenance and administrative areas. It is not intended to be the primary fire alarm response system. The Authority's fire detection system will be used as the primary emergency evacuation system. The Airside D APM PA system will receive a mute signal to mute all audio. The mute signal will be in the form of a dry contract from the existing fire management panel(s) controlling the fire zone(s) at the station platform(s) level.

The PA equipment will meet or exceed the minimum performance characteristics as described in the TP 10.1.1. The PA subsystem hardware will include the following major components:

- Station hardware, including speaker units, microphones, and power amplifiers.
- M&SF equipment similar to that in the stations.

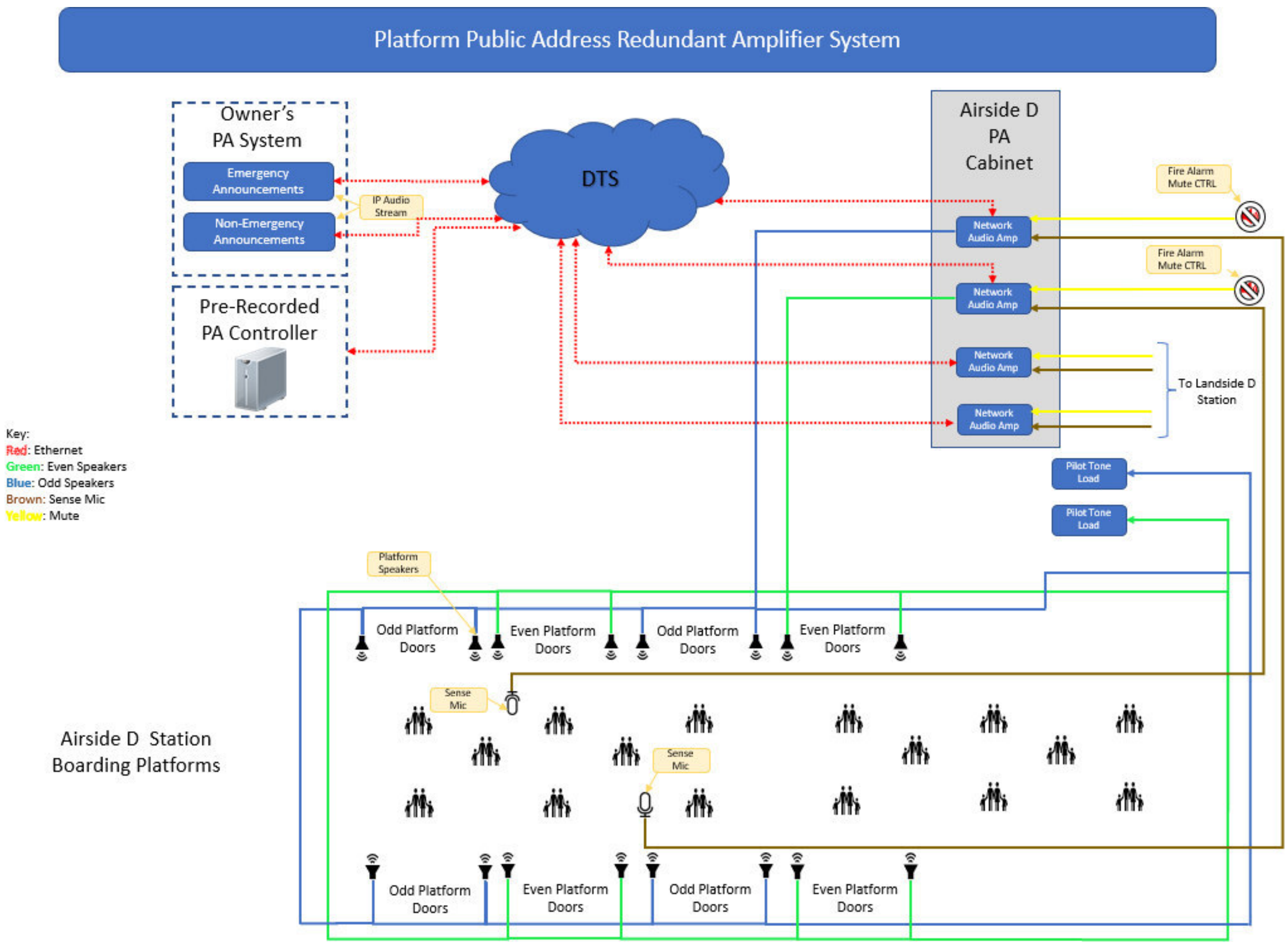


Figure 23: Example of Airside D Station PA System

10.3 Emergency Telephone (ETEL)

Alstom will extend the Owner's telephone network with the new passenger station ETELs and blue light stations. A network interface will be coordinated with the Owner to connect new telephones to the Owner's network. The ETELs will be flush-mounted as described in the Technical Provisions.

The ETELs will be programmed to call Central Control when the push-to-call button (refer to Figure 23) is activated. Each ETEL will contain a speaker and microphone for two-way communication. Users will receive an audible signal that the call is processing when the push-to-call button is activated.

Figure 24: Example ETEL

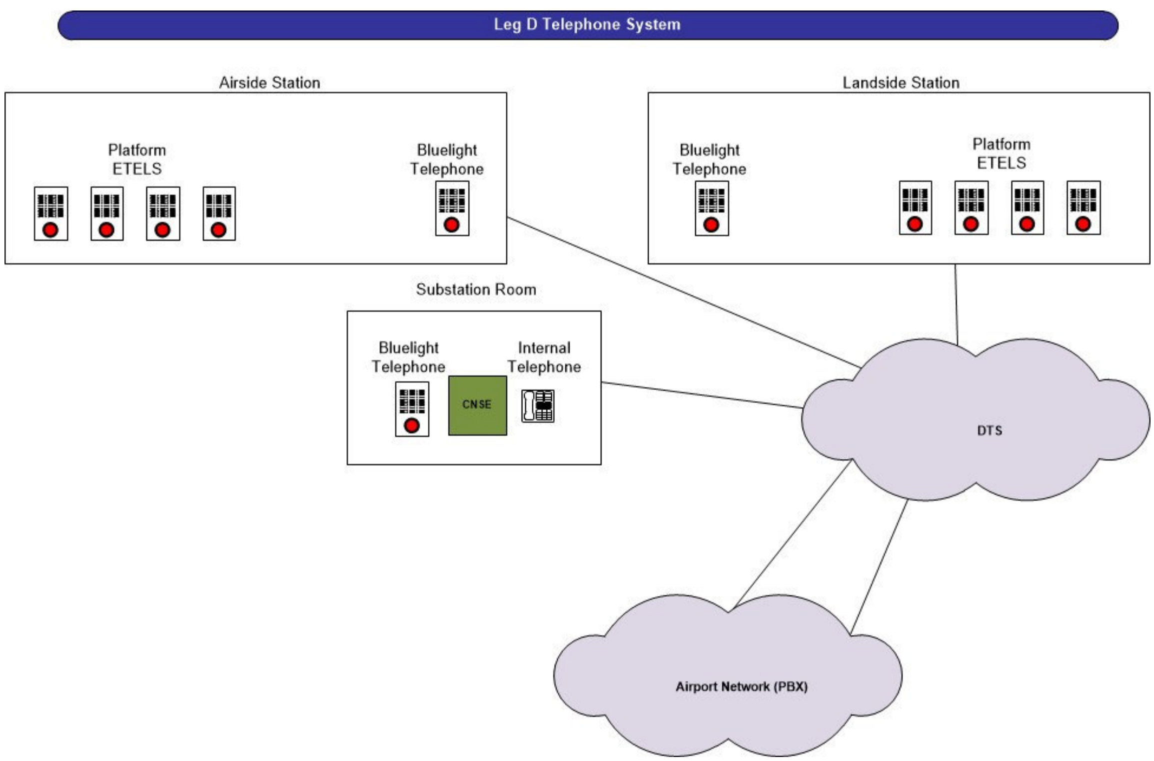


Figure 25: Leg D Telephone System

10.4 Internal Telephones

One internal telephone in the PDS substation room will be provided by Alstom. A network interface will be coordinated with the Owner to connect this telephone to the Owner's network.

10.5 Vehicle Voice Communications

A full-duplex Operational Radio System (ORS), in use by vehicles on the existing airside shuttles, provides live PA from Central Control, two-way calling between the vehicle and Central Control, and transmission of vehicle alarms to Central Control. These features will function in the same way as the existing vehicle fleet. All hardware will be compatible with the existing wayside RF infrastructure. The existing base station and control equipment will not be changing.

The ORS Graphical User Interface (GUI) will be updated to show Airside D vehicles on the train configuration screen.

10.6 Audio Announcements

An automated audio announcement subsystem for vehicles is provided. The Vehicle Communications Control Unit (VCCU) receives automated Passenger Information triggers from the VATC. This functionality is described in Submittal No. 01.11.02 – APM Communications System Final Design (3165895) – from the Airside A&C Replacement project.

Automated audio announcements for stations shall be integrated with the station PA system in a similar way to the existing system. The prerecorded announcements shall consist of the announcement of the imminent arrival of a train (doors opening) and the announcement ofthe imminent departure of a train (doors closing).

10.7 Transmission Equipment for Audio Communication Subsystems

The APM's redundant fiber optic DTS will provide the connections for protected path transmission of station audio and data between passenger stations and Central Control. The DTS will deliver low speed data, Ethernet, and live PA audio between each "node" (site).

The system will use Hot Standby Routing Protocol. Alstom has installed similar configuration of equipment at the McCarran International Airport (Las Vegas), Gatwick Inter Terminal Transit System, Beijing Capital International Airport, Madrid-Barajas International Airport, and for other Alstom delivered projects.

Under normal equipment operations, audio transmission system delay will be less than or equal to the data communications delay described in TP Sections 10.2 and 10.3.

The redundancy of the DTS ensures that, upon failure or loss of one path or link in the communications network, the transmission equipment will automatically transfer to an alternate path or link within a reasonable amount of time, based on the redundancy protocols of the industry.

10.8 Intelligibility Requirements for Audio Communications Subsystems

A good audio communications system design provides good intelligibility if the physical space permits it. The architecture of the passenger stations greatly influences the intelligibility of speech transmitted over the audio communications subsystems. Poor station acoustics do not support good intelligibility.

Alstom will assume that the station design addresses acoustics in support of good intelligibility. If we predict that the acoustical designed surfaces or treatments are impacting the intelligibility, we will inform the Owner of the need for additional acoustic finishes or modifications in the stations.

The PA Subsystem, Emergency Telephones (ETELs), and Vehicle Voice Communication Subsystem, shall provide at least a 90% intelligibility rating in compliance with ANSI Standard S3.2-2020.

10.9 Data Communications Delay

The design requirements specified in Technical Provisions Section 10.2 will be used as the basis for the subsystems' designs.

10.10 Communications Systems Redundancy

The design requirements specified in Technical Provisions Section 10.3 are applied to the audio and data communications equipment being provided.

As noted in Section 9 (describing the wired DTS network), the DTS is designed to be redundant and fault tolerant. The core tier is handled by the Layer-3 core switches in Alstom Maintenance and at the Data Center. The core tier aggregates all of the physical fiber connections from the stations, and the core switches route traffic between different functional areas on the networks (VLANs). The same DTS design utilized for the Central Control upgrades will be extended to Airside D, using redundant fiber-optic cables with physically isolated routes. The edge tiers connect user devices such as PLCs or network audio amplifiers to the network. The edge 1 tier is for primary network connections, and this switch connects directly to the primary core switch. The edge 2 tier is for backup network connections, and this switch connects to the primary edge switch and to the backup core switch. In this design, there is always a path to the core even with a switch or cable failure.

10.11 Software/Hardware Calendar and Time Considerations

The APM system master clock interface from the Central Control Relocation project shall continue to be used. Software provided for the system will not be constrained or limited by calendar events or date/time representations.

11. GUIDEWAY EQUIPMENT

11.1 Running and Guidance Surfaces (Trackwork)

The Alstom Innovia APM 300R cars for the Tampa D Lega APM system will be the same vehicle as utilized on the ongoing Tampa A&C Legs, reference Figure 25 for a typical representation of the APM 300 guideway cross-section. Therefore, the vehicle to guideway interfaces, including the guideway running surface and the guidance system design, will be the same. The guideway running surface elevation and therefore the guidebeam elevation and lateral position will be dictated by the guideway alignment and the profile grade line. Via interface activities with the HCAA Team the Alstom design team will work together to define the anchorage, position, and height of the running plinths and guidebeam to meet the planned station and structural considerations of the Tampa D Leg alignment. The running surfaces of the trackwork will bear the load of the APM vehicles and be designed for the service design lives as required in the technical provisions. The standard designs of the concrete running surface and related tolerances will be reflected in the Alstom Guideway Design Criteria document as well as in the various interface documents shared with the HCAA designers and contractors.

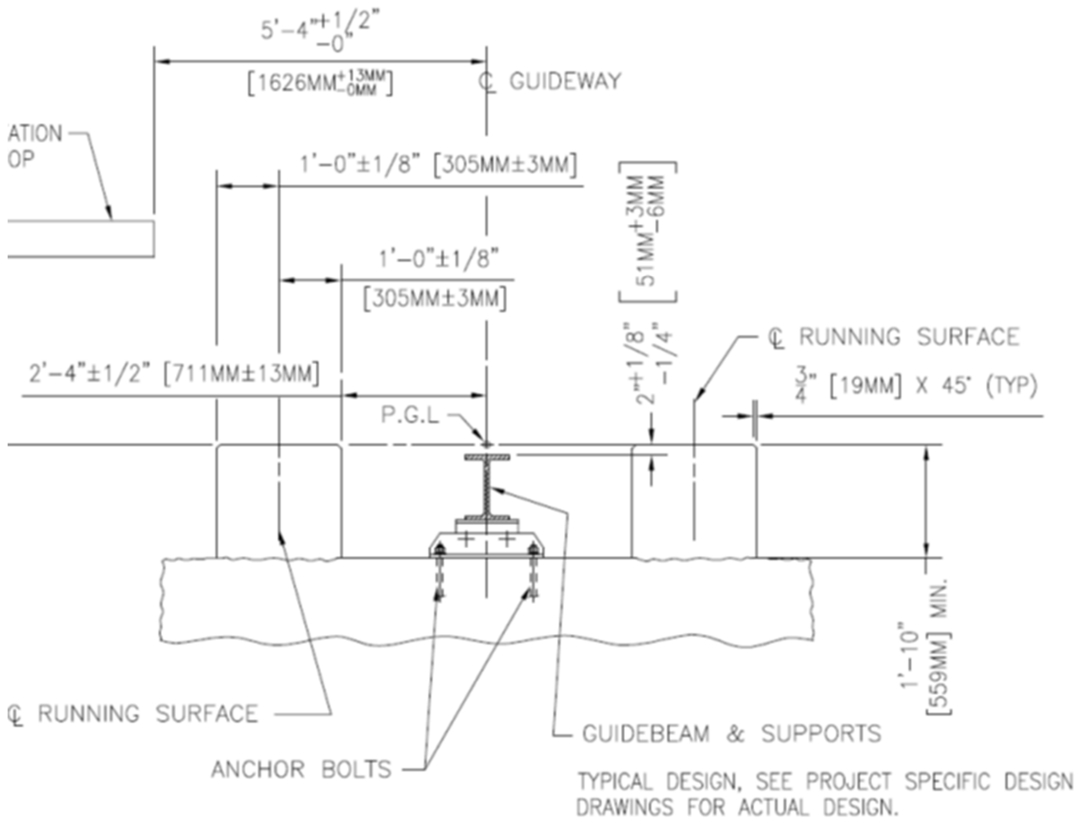


Figure 26: Cross-Section of Typical Alstom APM 300R Guidance and Running Surface

Utilizing the initial Tampa D Leg reference drawing the Alstom design team configured the preliminary alignment as discussed earlier in this proposal package. That alignment developed by the Alstom Civil Design engineering team was utilized by the system simulations team to establish the initial performance characteristics of the system. As this system is a shuttle application there will be no switch equipment on the wayside or switch mechanisms required as part of the design basis of the guideway infrastructure.

The Innovia™ 300R design operates on 2 individual running plinths approximately 2 feet in width of a nominal thickness that will be positioned equidistance from the center guidance "I" beam. The height of the running surface designed and provided by HCAA will be based upon the tangent or curved guideway and the minimum running surface thickness to address the vehicle loading criteria and platform heights. The centerline-to-centerline lane spacing will be developed in parallel with the HCAA design contractors as the final alignment vehicle operating envelope develops, refer to Figure 26 for a Typical APM 300R Vehicle Clearance Envelope. Between the two guideway lanes will be the HCAA designed and installed emergency walkway, the operating and clearance envelopes of the APM 300R vehicle will be considered in the design of the emergency walkway and will be part of the interface activities during the coordinated design efforts between HCAA and Alstom.

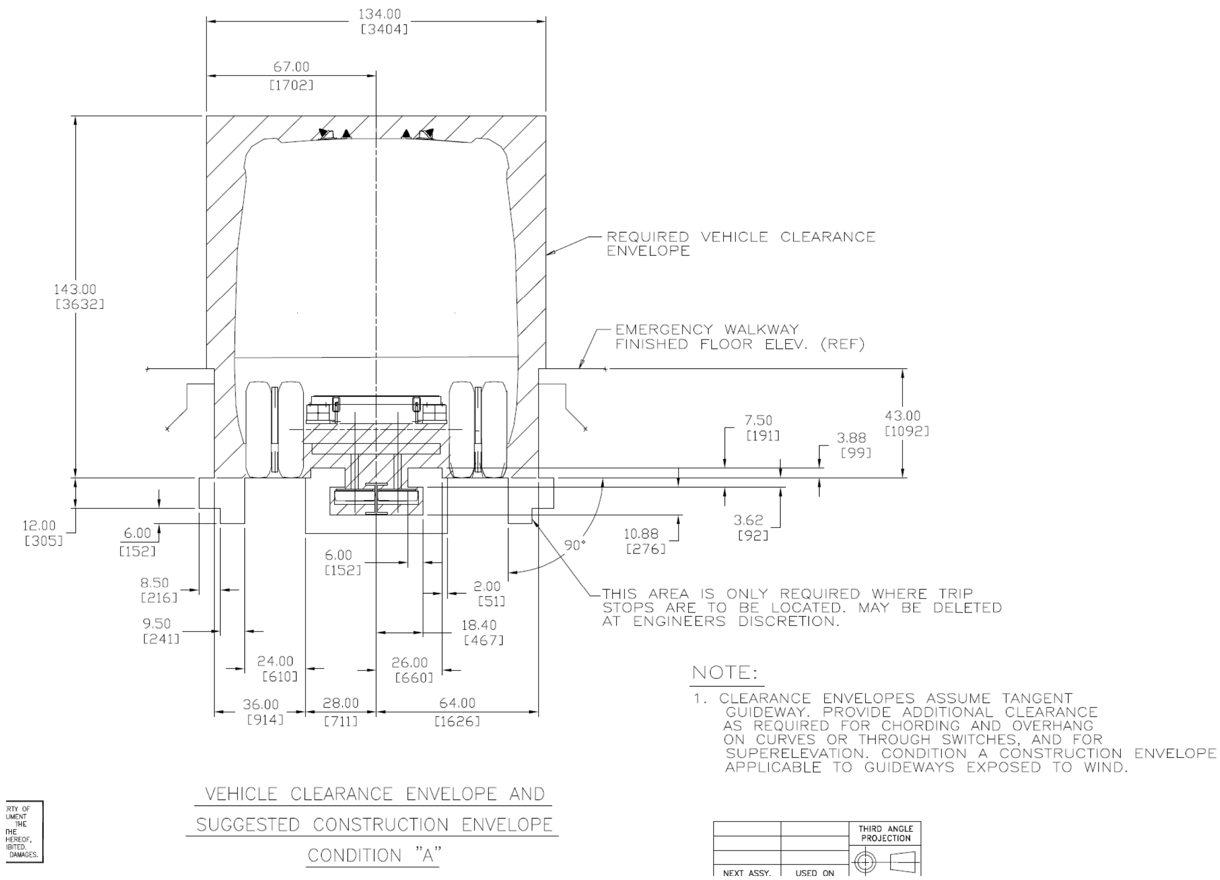


Figure 27: Cross-Section of Typical Alstom APM 300R Clearance Envelope

The guidance beam will be a structural steel beam that will be anchored to intermittent steel supports and concrete pads anchored to the HCAA guideway deck and will be painted and sealed using a detailed multi coat commercial grade painting process that will be detailed to the suppliers in the appropriate procurement specifications. As earlier discuss, the locations of the guidebeam anchorage, the type of anchorage and embedment, and the depth of the embedments will be closely coordinated as part of the interface design effort between HCAA and Alstom.

The final trackwork design and interfaces for the Tampa D Leg efforts will be closely coordinated and developed in concert with the HCAA designers and Team. The tolerances, durability, superelevation, and the interfaces with the guideway camber and other installation interfaces will be closely review and agreed upon during the design activities to ensure ride quality and performance of the system. This coordination effort is part of the interface's discussion earlier in this proposal as well as part of the early works initiated between HCAA and Alstom on the project.

11.2 Overtravel Buffer

Like the existing hydraulic overtravel buffers on Tampa A&C Legs, the new Tampa D Legs will also have hydraulic overtravel buffers. The hydraulic buffer structural mounts will be designed supplied and installed in accordance with the final Tampa HCAA design team and the Alstom design team pending the final configuration and installation design for the mounting hardware. The scope of the final design of the mounting interfaces and the installation of these mounting interfaces will depend on the final scope interface agreement being discussed during the pre-design activities between HCAA and Alstom.

This mounting hardware will interface with the frame that supports the hydraulic buffer and be the interface to the new landside and airside Tampa D Leg station or guideway structures. Many discussions and design efforts have been underway to finalize the location and methodology of the mounts and reinforcements for the buffer frame. As the process moves forward, the Alstom design team will provide the detailed design information regarding the impact and rotation forces associated with the hydraulic overtravel buffers. These buffers will be designed to withstand the forces of a 2-car married pair consist with the passenger loading as identified in the technical specification interfacing with the buffer face when the train is being driven in manual mode at the maximum manual speed.

11.3 Wayside Equipment

For the Tampa D Leg shuttle configuration, the wayside equipment, with the exception of the guidebeam, running surface, cable trays, power rail and brackets, conduits, and related subsystems cabling and penetrations will be minimal. This is primarily due to the single shuttle design, there are no wayside guideway switches that considered large amounts of wayside guideway equipment. Any required or identified wayside equipment that will require a Tampa HCAA interface will be identified and described in the guideway design criteria discussions.

11.4 Barriers and Fences

The design supply and installation of any wayside barriers and fences will be completed by the HCAA design teams. The Alstom team will support these efforts from the perspective guideway and systems interface data, however the design, supply, and installation of any barriers and fences will be part of the Tampa D Leg owner’s scope of work. Alstom will provide clearance envelop and geometric support in these area as needed.

11.5 Aesthetics, Protection, and Drainage

The Alstom design team will continue to work closely with the HCAA design and construction team to ensure that the guidebeam, conduits, cable trays, and related guideway and power distribution and signaling equipment present an aesthetic appearance. Additionally, the design will ensure appropriate protection for the equipment and cable via grouting, caulking, design measures and other concepts to provide the necessary protection from the elements of the Tampa airport environmental conditions inclusive of corrosion due to dissimilar metals and the high salt sea environment. The design of all the Alstom components such as but not limited to the guidebeam, conduits, and other wayside equipment and enclosures will be closely coordinated with the HCAA guideway and structural design teams to minimize the accumulation for water along the guideway and ensure appropriate drainage.

11.6 Emergency Evacuation

Alstom’s APM 300R vehicle will be designed to accommodate the emergency evacuation of passengers on tot eh HCAA designed and supplied emergency walkway. There will be no design configuration of the Alstom vehicles or wayside equipment that will preclude the required evacuation of passenger in the event of an emergency. Interfaces during the pre and project design efforts will ensure the appropriate design of the emergency walkway and related interfaces to ensure compliance with the applicable codes and standards. Alstom's team will complete the emergency walkway installation with the addition of the required tactile ground surface edges along the walkway.

11.7 Signage

During the final design activities of the guideway design and installation and the interfaces with the HCAA design and construction team, the Alstom team will highlight and identify and work with the HCAA Team to finalize the guideway wayside signage. These signs will be developed in cooperation with the Alstom O&M team as well as the local HCAA authorities having jurisdiction regarding the appropriate amount and configuration of the guideway signage.

12. STATION EQUIPMENT

In support of the Tampa D Leg APM shuttle system operations, the Alstom Team will provide the design, supply, installation, testing, and commissioning of the APM specific station equipment as identified in the Technical Provisions. The provided equipment will be developed, and the installation will be closely coordinated with the HCAA design team to ensure that the Alstom station equipment fits correctly and operates seamlessly with the HCAA system designs and infrastructure as described in Section 4 of this proposal. The station APM specific equipment provided by Alstom will primarily consist of the platform vehicle automatic door system associated Emergency Egress Doors (EED), platform edge safety nosing, public address speaker related to the APM operations, and the equipment related to controlling and interfacing with these elements in the station equipment room.

12.1 System Components

The APM Operating System components included in the Tampa D Leg APM project will comply with the Technical Provisions requirements of Section 12.1 and as modified by the latest HCAA responses to the requests for clarification as well as the updated versions of the Technical Provisions as a result of ongoing Alstom and HCAA pre-project design meetings.

12.2 Station Safety Components

In concert with the HCAA Team and their subcontractors, the Alstom Team will support the design supply, installation, and testing of the station safety components. These elements of station safety include but will not be limited to:

- Platform Edge Safety Protection (automatic passenger station doors).
- Emergency Egress Doors (EEDs).
- Intrusion Detection Subsystems (contacts and alarms in central).
- Station Floor Threshold.
- Platform Edge Protection.
- Platform Nosing Protection.
- Emergency power Shutoff (Blue Light Stations as described in Section 8).

To prevent the unauthorized, accidental, or malicious entry into the guideway APM automated vehicle guideway areas and vehicle envelopes and to eliminate exposure to hazardous high voltage traction power, the Alstom Team will coordinate the design of a continuous full height barrier wall the length of the APM shuttle stations. During the design activities, based on the scope split between HCAA and Alstom, the Alstom design team will coordinate the design for the automatic passenger entry doors and the associated EEDs between the automatic doors and immediately to each side for the Alstom APM 300R vehicle design. The platform automatic passenger entry doors will be configured for a 2-car married pair length train, 4 bi-parting automatic doors per platform edge and there will be 4 platform edges per station. Additional safety features regarding the recycling of doors and contact and non- contact sensors will be included in the doors designs. The recycle of the doors for passenger movement will be coordinated between the vehicle and station door systems for passenger safety. Dynamic signs over the automated door systems will be provided by HCAA.

The EEDs along the barrier wall will provide the emergency egress necessary in the event of an emergency resulting in a misaligned vehicle condition. The EEDs between the vehicle berthing positions and beyond the end cars in the train along the wall towards the buffer and station tunnel entry area will be design supplied, installed, and tested by the HCAA Team. The automated vehicle passenger entry doors will be coordinated with the signaling system and will comply with the technical provisions and automated people mover standards requirements for movement, recycle, forces, safety and emergency release and other related door operational requirements. The automatic doors will be controlled and monitored by the APM automatic train control system to provide coordinated passenger movements on and off the trains to achieve the require passenger flow rates in the system, refer to section 5 for the calculation related to the passenger flow rates. During the project execution a System Performance and Failure Management Analysis (SPFMA) will be developed to describe the operation and system performance functions of the APM system. The location of the passenger automatic and EEDs barrier wall elements will be coordinated with HCAA and will resemble the HCAA provided diagram on sheet 5 of the Contract Reference Drawings.

During train entry into the Station Guideway areas, the vehicles will encounter platform edge protection including a threshold vehicle ramp. This element provides protection for a vehicle entering the station under a failed condition, that could result in the operating envelope for the vehicle shell being in conflict with the barrier wall, by ensuring the vehicle is partially up-righted to avoid this interference. Additionally, the rub strip and the door threshold provide the reduction of the gap between the passenger boarding platform and the vehicle interior floor area.

12.3 Station Passenger Information

As noted in Section 10, automated announcements for stations shall be integrated with the station PA system in a similar way to the existing system. The prerecorded announcements shall consist of the announcement of the imminent arrival of a train (doors opening) and the announcement of the imminent departure of a train (doors closing). Station dynamic signs and associated control equipment shall be furnished by the Owner, in a similar way to the existing system. The interface between the Station dynamic sign system and the ATC for automated messaging triggers will be determined during preliminary design. The Alstom design team will coordinate the presentation of the station arrival and departure queues to the HCAA Team for the integration of the station dynamic signage as required for the project. Alstom will provide output "triggers" for the initiation of the dynamic sign messages. Coordination of all sign triggers and announcements will be completed with the HCAA Team during final design and via the appropriate CDRL.

Static Signage will be developed by the Tampa D Leg project team including the HCAA design Team, Alstom design Team, and the Alstom Operations and management team and the local Authority Having Jurisdiction (AHJ). Signage related to the APM operating system designs will be designed, supplied, and installed by the Alstom Team. All other non-APM signage will be designed, supplied, and installed by the HCAA Team.

12.4 Public Address System

The Alstom Team will design supply and install a PA system similar in design to the other Tampa operating legs A&C. The provided PA system will be specific to the APM Operating System components and will be triggered as appropriate via the Alstom Automatic Train Operation packages. Refer to section 10 for additional information on the Alstom PA system scope and design plans. All PA subsystems not related to the APM Operating System and part for the station or airport infrastructure will be designed and supplied by the appropriate HCAA design entity.

12.5 Emergency Telephone System

Reference Section 10 of this proposal for additional information regarding the passenger station emergency telephone subsystem design.

12.6 Station UPS Equipment

Reference Section 8 of this proposal for additional information regarding the station UPS subsystem design.

12.7 APM Equipment Room

The APM Operating System components will be in a number of Tampa D Leg facilities. However, the key operating system equipment such as the server cabinet, train control equipment, UPS equipment, door control equipment, network communications equipment and related control and signaling systems equipment will be installed in the APM equipment rooms within the stations. As part of the D/CID and interface coordination activities, the Alstom design team will identify and highlight the equipment floor areas, heat loads, weights, and other infrastructure requirements described in the interface requirements and Section 4.3.6 of the Technical Provisions. This will be completed as part of the development of the HCAA subcontractors design and configuration of the station and maintenance area facilities in concert with the Alstom Team and related interface criteria. It will be the responsibility of the Alstom Team to provide the level of details as required to implement the architectural and mechanical, electrical plumbing requirements for the APM Operating System Equipment Rooms in the stations.

13. MAINTENANCE FACILITIES AND EQUIPMENT

13.1 Functional Requirements

Via the D/CID and related HCAA and Alstom interfaces as discussed in section 4 of this proposal package, the Alstom team will provide the information required for the HCAA development of the Tampa D Leg Maintenance facility located in the Airside station are of the D Leg facilities. Similar in design to the other online maintenance facilities at Tampa A&C Leg the D Leg facilities will meet the functional requirements as described in Section 13 of the technical provisions and in accordance with the Alstom Operations and Maintenance Teams input.

Since the APM maintenance facility will reside in the airside station facilities area, the ability to automatically store the vehicles into the storage and maintenance areas is inherent. Once in the station areas, the interior cleaning, maintenance, and other undercar maintenance activities can be accomplished, in the same manner as current completed on similar Alstom shuttle systems. The movements of the vehicles to the washing are provided by the HCAA design team just outside the Airside station and MSF area will be accomplished in manual mode of operation.

Maintenance activities including regular preventative regularly schedule maintenance actions, as well as vehicle and equipment repairs will be completed in the online maintenance area. Additionally, vehicle static testing following repairs will also be completed in this are as well as the Departure testing procedures. The Departure test procedure will utilize not only the station berthing area/maintenance bay for departure testing, but it will also utilize the guideway just outside the online maintenance area to complete the remaining departure test actions.

The maintenance activities as listed, but not limited to, those identified in Section 13.1.5 of the Technical Provisions will be performed and managed in the online maintenance area in the Airside D Station berthing position.

13.2 Location, Design, and Finishing

The facilities in the online Maintenance and Storage Facility bays as well as those rooms and storage areas surround the online bay will be designed to accommodate the necessary equipment, spare parts, tools, cleaning, batteries, supplies, and other related APM hardware and equipment not only for the maintenance of the APM vehicles but also for the maintenance and support of the other APM operating system equipment and controls. The size, configuration, and location of rooms in the MSF as well as the MEP requirements will be design and coordinated with the HCAA Design and Construction Team as part of the interface effort as discussed in Section 4 of this proposal and the scope split definition in the Technical Provisions. Signage and graphics for the facilities and the areas surrounding it will be coordinated with the Alstom Team, the Tampa Airport Team as well as the AHJ's.

13.3 M&SF Guideway and Related Equipment

The M&SF Guideway will be in the form of an online facility and will be configured the same as the Tampa A&C MSF areas. The requirements as identified in Section 13.3 of the Technical Provisions will be followed as and where applicable. It is practical to have both powered and unpowered sections for these maintenance activities as power rail segmentation along the guideway and in the maintenance area does not exist on the current Airsides and is not advised on shuttle systems. For maintenance activities the power on the passenger service guideway will have the capability to be powered off and locked out for the performance of maintenance in and around the de-activated power rail as needed. However, segregations of the MSF as would be designed for an offline maintenance facility is not available for this online shuttle APM facilities design. The Alstom and HCAA design teams shall coordinate all aspects of the maintenance activities and the location where unpowered services will be performed. Additionally, to remove guideway power rail power to perform guideway maintenance activities, the APM wayside system design will have alternate “stinger” power available to the vehicles. The connection of this alternate vehicle power or 600VAC stinger cable will be designed to remove connection to the collector shoes on the cars that will preclude the energization of the vehicle’s collector shoes and hence the guideway power rail.

The Alstom APM 300R technologies have no equipment roof mounted that would require any permanently installed cranes or hoists. The Alstom team will provide the necessary portable jacks, bottle jacks, fork truck, lift tables and similar equipment to remove equipment on the vehicles for maintenance. Additionally, the Alstom Operations and Maintenance Team assumes that HCAA will install the guideway running surface “H” bent structure in the maintenance facility (similar to the existing design) to have a designed-in location where the running surface can be “removed” to allow a forklift or lift to facilitate the lowering of the vehicle bogie for maintenance activities as needed. The appropriate audible and visual indications will be provided as part of the safety system design to alert all personnel to the status of the hazardous voltage in the guideway station operating areas.

13.4 Maintenance Tools and Equipment

Alstom will prepare a list of the required maintenance tools and equipment and provide the require maintenance tools and equipment necessary for the maintenance of the APM vehicle, passenger station doors, as well as the train control equipment computers and other APM Operating System components. Table 2 is a Sample/Example list of the typical maintenance facility tools and equipment provided to and stored in the maintenance facility tools and maintenance rooms for servicing the vehicles. During the further development of the Tampa D Leg program the Alstom team will evaluate the tools and equipment requirements and refine a sample list such as Table 2 based on the specific site requirements for the new Tampa D Leg operations and maintenance team. The final list of tools and equipment will be mutually accepted by Alstom and HCAA. Alstom shall provide all tools and equipment required for pre-operations checkout, servicing, inspections, troubleshooting, maintenance, and repair of APM System equipment. If the supply of tools and equipment is found to be insufficient to perform the aforementioned functions during the identified 12-month APM System operations and maintenance period, Alstom shall provide the necessary tools and equipment at no cost to the Owner.

Table 2: Example MSF Tools and Equipment List

Maintenance Tools and Equipment
CFMS Diagnostics tool
CAT vital I/O review tool
VAST Vehicle Automatic System Tester
Wire Shark network review tool
Drive tire lift dolly
60,000 lb. vehicle jacks (set of 4)
Jack stands w/adaptors - short
Jack stands w/adaptors - tall
Coupler main control gauge (154187)
Coupler slot gauge (156462)
Coupler link gauge (154136)
Wrench, Seal holder (157383)
Wrench, Buffer (168820)
Contact Wrench (158192)
Assembly tool for centering (1006409)
Mounting tool for connections (156475)
Disassembly tool for connections (156475)
HVAC Test Unit
HVAC Support for lift table
Refrigerant recovery and recycle unit
Vehicle lifting bar (set includes 4 each)
Lifting beam retaining pin (set of 4 each)
Guidewheel spanner socket (BASM-07)
Guidewheel snap ring pliers (12650-K)
Guidewheel bearing removal driver
Guidewheel bearing installer driver
Guidewheel dust shield installer
Guidewheel assembly fixture
Axle snap ring pliers
14mm Hex socket 1/2" drive - oil fill/drain
Hub nut socket wrench (claw-type)
Wheel hub bearing puller
Wheel hub bearing thrust piece
Wheel hub bearing clamping ring
Inner race extractor
Whell hub seal driver

Maintenance Tools and Equipment
Steering knuckle countering support
Steering knuckle bushing extractor
Bottom steering knuckle extractor
Steering knuckle axle stub heater (9 Ton axle)
Socket for pinion flange nut
Pinion seal driver
Pinion flange puller
Steering knuckle driver
Top ball joint press-off
Steering arm press-off
Brake spring hook
Axle housing seal extractor
Steering alignment fixture (Set of 4)
Plumb bob adaptor for steering fixture
Steering ball and socket axial play tool (27351)
Extractor for 40-50mm ball/socket (27284)
Steel spacer
Vehicle air compressor portable test equipment + training
Power supply 42V 10A
Whell stud protector
Gage, Roller Position (RG-11727-01)
Wrench, Open End 3/4" Modified (RP-11728-01)
Trunnion Alignment (RP-11729-01)
Torque Wrench Head, Box End 3/4" Modified (RP-11730-01)
Hex Bit Socket, 1/4" Hex, 3/8" Drive (RP-11731-01)
Torque Wrench 3/8" Drive, Preset 50 ft/lbs (RP-11733-01)
Torque Wrench, Interchangeable Head, Preset 18ft/lbs (RP-11732-01)
Bead Lifter Assembly (RP-10727-01)
Roller Retaining Clip (RP-11743-01)
Master gauge (0 to 300 psi)
1/2" Drive speed wrench 13 5/8" length (for gear drive) (5523A11)
7/8" - 8 point (double square) socket for speed wrench (gear drive) (5545A84)
17mm socket (3/8" drive modified to 1/4" swivel drive for lock pin)
3 1/2" crows foot (style G)
3 1/2" crows foot (style U)

Maintenance Tools and Equipment
J-handle 3/4" socket
7/8" combination wrench
1-1/2" socket extension
Chain tensioner assembly
Spanner socket for pivot shaft
90 needlepoint coupler
Modified screwdriver with socket for intermediate support arm. (active intermediate stop)
Switch roller adjustment tool
Bent 7/16" gear wrench (ground rail fix point)
Bent 1/2" gear wrench (ground rail)
Power rail tree mounting tool (3/4" sockets)
Ground rail tree mounting tool (dog bone 2 each of 3/4" sockets)
MEGAPRO Multi-bit screwdriver (5PA34)
Compact force gauge (CFG+)
PSD & EED Access Key (L1315)
PDLCP Key (card key)
PTU (Palm device w/ software)
Wayside / Vehicle PTU laptop
Portable vast
Bench vast
NP Tag programmer
Handheld NP Reader
Power rail grounding device
Multi tire rack
Safe-T-Cable kit
Safety wire twisting pliers
Megger
Earth ground tester (milli-ohm meter)
Data logger required for troubleshooting
Other external power supply- AC and DC
Coupler Head Wear Gauge (154133)
Coupler Main Pin Bore Gauge (169707)
Coupler Link Pin Bore Gauge (154135)
Coupler Slot Gauge
Assembly Tool for Centering
Mounting Tool for Connections - Alt 1
Portable Filler Unit (0-101600)

Maintenance Tools and Equipment
Seal Installation Tools (0-101791)
Crimp Tool Panduit (CT-1550)
Drive Axle Support Beams
Hub Assembly Cradle Fixture
Axle Housing Seal Driver
Axle Seal Driver
Brake Shoe Bushing Driver
Tire Monitor System, Sensor Reader
Tire Replacement Tools (Set)
Tire Replacement Special Tool (Atlas® TTC305 Automatic Heavy Duty Truck Tire Changer)
RF Tone Generator 1 Watt Adj. Trans. (0016-1.0-0)
Lizard Accessories (LIZ-ACC)
Spectrum Analyzer w / Option 29 (S332D)
Audio/Tone Generator Drive For Oil Fill/Drn (3001)
Tone Tracer (77HP)
Network / LAN Wire Tester (TS565A)
Sound Pressure Level Meter (33-2055)
Portable CCTV LCD (V8000T)
Fiber Optic Power Meter (9081-0000)
Fiber Optic Test Light (DXL-10)
Crimper (1.6 / 2.5mm Contacts) CTX CM-9018490000
Insert / Extract Tool HDC-DW-M10 (1688200000)
Tag Programmer (For HDFP Tags) (183000)
8 Channel Thermal Arraycoder
2 Channel Chart Recorder
N-Female / N-Female Adapter
Attenuator: 20DB N-Connector
N-Male / N-Male Adapter
SMA-Female / N-Female Adapter
RG213 Cable, N-Male / Male 5.0 ft
50 Ohm Termination, N-Male, 18 GHz, 2W
Bird 43 Watt Meter
Low Power Element (5 Watt)
High Power Element (25 Watt)
Test Jumper / Patch Cable
N-Female to UHF-Female Adapter
RJ45 Cable
Region Automatic Train Protection Software

Maintenance Tools and Equipment
Cityflo™ Monitoring System Software
Serial Cable
Vehicle Automatic Train Control Software
PC/MCIA Card to Connect to Station Door PLCs
Station Door PLC Tester Software
Ethernet Patch Cable
PDS PLC Software Editor
TCC MVB PC Access
Faiveley PTU (HVAC, Vehicle Doors) Connector and Software
Fiber Optic Tester
Wall Mount PDS Circuit Breaker Tester
PDS Operating Handles
Grounding Straps
Vital Relay Test Fixture

13.5 Spare Parts, Expendables, and Consumables

In preparation for the development of the Spare Parts, Expendables, and Consumables fleet support stores, the Alstom team will review the targeted daily, monthly, and yearly service miles for the Tampa D Leg vehicles and related APM operating systems. The resultant fleet operations and the MTBF for the identified components will result in the development of the spare parts lists anticipated and based on the service periods would further define the expendables and consumables. Based on these analyses the Alstom team will create the appropriate levels of inventories to stock for the spare parts and equipment based on the targeted need as well as the replenishment and ordering times required for replacement. In addition to the targeted spares discussed above, based on the analyses discussed, in accordance with the Technical Provisions the Alstom O&M development team will also identify the inventories and requirements for the overhauls and the equipment required for the identified 12-month operating periods. Table 3 provides a reference sample listing of a typical APM 300R spare Parts Consumable and Expendables List. This table is a sample representation only and will be reviewed and updated based on the final vehicle service performance expected as well as the anticipated overhauls and services required. The final list of spare parts, expendables, and consumables will be mutually accepted by Alstom and HCAA. Alstom shall provide all spare parts, expendables, and consumables necessary to carry out all maintenance in accordance with the Maintenance Plan and Manuals for the identified 12-month operating period. If the supply of spare parts, expendables, and consumables is found to be insufficient to perform the aforementioned functions during the identified 12-month APM System operations and maintenance period, Alstom shall provide the necessary spare parts, expendables, and consumables at no cost to the Owner.

Table 3: Sample APM 300R spare Parts Consumable and Expendables List

Product or part name	Quantity	Category	Subsystem	Components
AIR SUPPLY UNIT	1	Spare Parts	APM 300R	Air Supply Unit - AIR SUPPLY UNIT
BOGIE ASSEMBLY	1	Spare Parts	APM 300R	Bogie - BOGIE ASSEMBLY
GUIDE WHEEL ASSEMBLY	2	Spare Parts	APM 300R	Bogie - GUIDE WHEEL ASSEMBLY
GUIDE TIRE ASSEMBLY	4	Spare Parts	APM 300R	Bogie - GUIDE TIRE ASSEMBLY
DRIVE WHEEL ASSY	1	Spare Parts	APM 300R	Bogie - DRIVE WHEEL ASSY
TIRE 10R-22.5	1	Spare Parts	APM 300R	Bogie - TIRE 10R-22.5
Operator	1	Spare Parts	APM 300R	Doors - Operator
Left Door Leaf	1	Spare Parts	APM 300R	Doors - Left Door Leaf
Right Door Leaf	1	Spare Parts	APM 300R	Doors - Right Door Leaf
HVAC unit	1	Spare Parts	APM 300R	HVAC - HVAC unit
TM 1104SP Traction Motor	1	Spare Parts	APM 300R	Propulsion - TM 1104SP Traction Motor
LCM Assembly Primepack	1	Spare Parts	APM 300R	Propulsion - LCM Assembly Primepack
MCM Assembly Primepack	1	Spare Parts	APM 300R	Propulsion - MCM Assembly Primepack
MOTOR YOKE	1	Spare Parts	APM 300R	Propulsion - MOTOR YOKE
BRAKE RESISTOR ASSEMBLY	1	Spare Parts	APM 300R	Propulsion - BRAKE RESISTOR ASSEMBLY
PROPULSION DC LINE REACTOR	1	Spare Parts	APM 300R	Propulsion - PROPULSION DC LINE REACTOR
TRANSFORMER CURRENT 1600:5 5-3/4 ID	2	Spare Parts	Power Distribution	600V Switchgear Spare Parts
ELECTROSWITCH 3 POS SW W/	2	Spare Parts	Power Distribution	600V Switchgear Spare Parts
FUSE	20	Spare Parts	Power Distribution	600V Switchgear Spare Parts
CARTRIDGE FUSE 5 AMP	20	Spare Parts	Power Distribution	600V Switchgear Spare Parts
FNQ-R-1.30REJECT FUSE	20	Spare Parts	Power Distribution	600V Switchgear Spare Parts
FNQ-R 3	20	Spare Parts	Power Distribution	600V Switchgear Spare Parts
BUSSMAN FUSE 5AFNQ-R5	20	Spare Parts	Power Distribution	600V Switchgear Spare Parts
3A POWER FUSE,UL CLASS CC	20	Spare Parts	Power Distribution	600V Switchgear Spare Parts
2A 24VDC POWER SUPPLY	2	Spare Parts	Power Distribution	600V Switchgear Spare Parts

Product or part name	Quantity	Category	Subsystem	Components
460R-600	2	Spare Parts	Power Distribution	600V Switchgear Spare Parts
RLY REPEAT CYC. 1 SEC	2	Spare Parts	Power Distribution	600V Switchgear Spare Parts
RELAY 600V 10AMP TESYS + OPTIONS	2	Spare Parts	Power Distribution	600V Switchgear Spare Parts
SELECTOR SWITCH 230VAC 2AMP XB5 +OPTIONS	2	Spare Parts	Power Distribution	600V Switchgear Spare Parts
3POS NON-ILLUM SPRING RET SELECTOR	2	Spare Parts	Power Distribution	600V Switchgear Spare Parts
PILOT LIGHT	4	Spare Parts	Power Distribution	600V Switchgear Spare Parts
PILOT LIGHT HEAD	4	Spare Parts	Power Distribution	600V Switchgear Spare Parts
PILOT LIGHT	4	Spare Parts	Power Distribution	600V Switchgear Spare Parts
24-120V PROT GRN LED W/MTG BASE	4	Spare Parts	Power Distribution	600V Switchgear Spare Parts
24-120V PROT RED LED W/MTG BASE	4	Spare Parts	Power Distribution	600V Switchgear Spare Parts
24-120V PROT YLW LED W/MTG BASE	4	Spare Parts	Power Distribution	600V Switchgear Spare Parts
PILOT LIGHT	4	Spare Parts	Power Distribution	600V Switchgear Spare Parts
PILOT LIGHT	4	Spare Parts	Power Distribution	600V Switchgear Spare Parts
PILOT LIGHT	4	Spare Parts	Power Distribution	600V Switchgear Spare Parts
Switch, Control	2	Spare Parts	Power Distribution	600V Switchgear Spare Parts
Switch, Control	2	Spare Parts	Power Distribution	600V Switchgear Spare Parts
Relay, Lockout	2	Spare Parts	Power Distribution	600V Switchgear Spare Parts
Relay, Sepam	2	Spare Parts	Power Distribution	600V Switchgear Spare Parts
Current Transformer	2	Spare Parts	Power Distribution	600V Switchgear Spare Parts
Auxiliary Relay	2	Spare Parts	Power Distribution	600V Switchgear Spare Parts
5A Fuse	20	Spare Parts	Power Distribution	600V Switchgear Spare Parts
15A Fuse	20	Spare Parts	Power Distribution	600V Switchgear Spare Parts
RELAY, LOCKOUT, 125VDC/120VAC, TYPE LOR, 3 DECK, 6 TRIP, 6 RESET	4	Spare Parts	Power Distribution	600V Switchgear Spare Parts
RELAY, LOCKOUT, 125VDC/120VAC, TYPE LOR, 3 DECK, 6 TRIP, 6 RESET	4	Spare Parts	Power Distribution	600V Switchgear Spare Parts
RELAY, LOCKOUT, 125VDC/120VAC, TYPE LOR, 3 DECK, 6 TRIP, 6 RESET	4	Spare Parts	Power Distribution	600V Switchgear Spare Parts

Product or part name	Quantity	Category	Subsystem	Components
RELAY, LOCKOUT, 125VDC/120VAC, TYPE LOR, 3 DECK, 6 TRIP, 6 RESET	4	Spare Parts	Power Distribution	600V Switchgear Spare Parts
RELAY, LOCKOUT, 125VDC/120VAC, TYPE LOR, 3 DECK, 6 TRIP, 6 RESET	4	Spare Parts	Power Distribution	600V Switchgear Spare Parts
BUSS_FUSE_10_AMP_TIME_DLAY REJECTION_TYPE_200KA_CC_	8	Spare Parts	Power Distribution	600V Switchgear Spare Parts
BUSS_FUSE_15_AMP_TIME_DLAY REJECTION_TYPE_200KA_CC_	8	Spare Parts	Power Distribution	600V Switchgear Spare Parts
BUSS_FUSE_20_AMP_TIME_DLAY REJECTION_TYPE_200KA_CC_	8	Spare Parts	Power Distribution	600V Switchgear Spare Parts
BUSS_FUSE_5_AMP_TIME_DLAY REJECTION_TYPE_200KA_CC_	16	Spare Parts	Power Distribution	600V Switchgear Spare Parts
Hart Latimer K20-1-507-096-1 - K Type Thermocouple	4	Spare Parts	Power Distribution	1000 kVA Power Transformers
Qualitrol 118ITM-P-4 - Electronic temp monitor	4	Spare Parts	Power Distribution	1000 kVA Power Transformers
Littelfuse 314 020 - 20A 250V fuse	4	Spare Parts	Power Distribution	1000 kVA Power Transformers
Fasco Industries Model D218 - Fan motor, 115v, 1ph, 1/20hp	4	Spare Parts	Power Distribution	1000 kVA Power Transformers
Thorgren 9C312DWXRH235STN-1 - 9" fan blade - nylon	4	Spare Parts	Power Distribution	1000 kVA Power Transformers
Bussmann BMM603-2SQ - fuse block, 2 pole	4	Spare Parts	Power Distribution	1000 kVA Power Transformers
Bussmann KTK-10 - 10a, 600V fuse	4	Spare Parts	Power Distribution	1000 kVA Power Transformers
Acme T-2-53110-S - CPT, 1PH 1KVA 600-120/240	4	Spare Parts	Power Distribution	1000 kVA Power Transformers
LAMP, 120 VAC/VDC, REPLACEMENT FOR 9001KM25 AND 9001KM38 MODULES, RESISTOR	4	Spare Parts	Power Distribution	12.47 kV Switchgear
LAMP, 48VAC/DC, REPACEMENT FULL VOLTAGE LAMP.	4	Spare Parts	Power Distribution	12.47 kV Switchgear

Product or part name	Quantity	Category	Subsystem	Components
LAMP, 125VAC/DC, REPACEMENT RESISTOR TYPE LAMP.	4	Spare Parts	Power Distribution	12.47 kV Switchgear
LAMP, 18VAC/DC, REPACEMENT LAMP FOR RESISTOR TYPE, K, SK, AND KX	4	Spare Parts	Power Distribution	12.47 kV Switchgear
ANTI-PUMP REPLACEMENT KIT, 120VAC.	2	Spare Parts	Power Distribution	12.47 kV Switchgear
CLOSING COIL REPLACEMENT KIT, 120VAC	2	Spare Parts	Power Distribution	12.47 kV Switchgear
TRIP COIL REPLACEMENT KIT, 125 VDC	2	Spare Parts	Power Distribution	12.47 kV Switchgear
MOT CHRG 125VDC/120VAC	2	Spare Parts	Power Distribution	12.47 kV Switchgear
LAMP, 120 VAC/VDC, REPLACEMENT FOR 9001KM25 AND 9001KM38 MODULES, RESISTOR	4	Spare Parts	Power Distribution	34.5 kV Switchgear
LAMP, 48VAC/DC, REPACEMENT FULL VOLTAGE LAMP.	4	Spare Parts	Power Distribution	34.5 kV Switchgear
LAMP, 125VAC/DC, REPACEMENT RESISTOR TYPE LAMP.	4	Spare Parts	Power Distribution	34.5 kV Switchgear
LAMP, 18VAC/DC, REPACEMENT LAMP FOR RESISTOR TYPE, K, SK, AND KX	4	Spare Parts	Power Distribution	34.5 kV Switchgear
ANTI-PUMP REPLACEMENT KIT, 120VAC.	2	Spare Parts	Power Distribution	34.5 kV Switchgear
CLOSING COIL REPLACEMENT KIT, 120VAC	2	Spare Parts	Power Distribution	34.5 kV Switchgear
TRIP COIL REPLACEMENT KIT, 125 VDC	2	Spare Parts	Power Distribution	34.5 kV Switchgear
MOT CHRG 125VDC/120VAC	2	Spare Parts	Power Distribution	34.5 kV Switchgear
FAN ASSY SBS150KVA	2	Spare Parts	UPS System	UPS Spare Parts
ASSY FAN BOX PM	2	Spare Parts	UPS System	UPS Spare Parts
Galaxy VS Air Filter Kit	4	Spare Parts	UPS System	UPS Spare Parts
PCB ASSY SYS PSU	2	Spare Parts	UPS System	UPS Spare Parts

Product or part name	Quantity	Category	Subsystem	Components
PCB ASSY SYSTEM CONNECTION BOARD	2	Spare Parts	UPS System	UPS Spare Parts
PCB ASSY UNIVERSAL EMI BOARD	6	Spare Parts	UPS System	UPS Spare Parts
PCB ASSY RFI IN	2	Spare Parts	UPS System	UPS Spare Parts
PCB ASSY RFI OUT	2	Spare Parts	UPS System	UPS Spare Parts
PCB ASSY OUTPUT CURR XFMR 3 PHASE	2	Spare Parts	UPS System	UPS Spare Parts
PCB ASSY I/O INTERFACE 1, IOB1 - kingyo	2	Spare Parts	UPS System	UPS Spare Parts
PCB ASSY I/O INTERFACE 2, IOB2-Kimyo	2	Spare Parts	UPS System	UPS Spare Parts
FUSE 315A AR SCW DIN80,000	2	Spare Parts	UPS System	UPS Spare Parts
FUS 400A AR SCW DIN80,000	2	Spare Parts	UPS System	UPS Spare Parts
ASSY CABLE HOLDER LEFT 50KW	2	Spare Parts	UPS System	UPS Spare Parts
ASSY CABLE HOLDER RIGHT 50KW	2	Spare Parts	UPS System	UPS Spare Parts
LED 24V GRN 16MM PANEL TAB 2.8 ROHS	2	Spare Parts	UPS System	UPS Spare Parts
SWITCH-DISCONNECTOR COMPACT NSX250NA -3P	2	Spare Parts	UPS System	UPS Spare Parts
ROTARY HANDLE MODIFIED FOR PC	2	Spare Parts	UPS System	UPS Spare Parts
FAN ASSY SBS150KVA	2	Spare Parts	UPS System	UPS Spare Parts
ASSY FAN BOX PM	2	Spare Parts	UPS System	UPS Spare Parts
Galaxy VS Air Filter Kit for 521mm wide UPS	4	Spare Parts	UPS System	UPS Spare Parts
Assy Generic Power Module 50KW	2	Spare Parts	UPS System	UPS Spare Parts
SBS100KVA MODULE	2	Spare Parts	UPS System	UPS Spare Parts
ASSY UC-SLC BOX	2	Spare Parts	UPS System	UPS Spare Parts
PCB ASSY SYS PSU	2	Spare Parts	UPS System	UPS Spare Parts
PCB ASSY SYSTEM CONNECTION BOARD	2	Spare Parts	UPS System	UPS Spare Parts
PCB ASSY UNIVERSAL EMI BOARD	12	Spare Parts	UPS System	UPS Spare Parts
HANDLE FRONT DOOR	2	Spare Parts	UPS System	UPS Spare Parts
CoHP-2 Cradle 24 VDC	3	Spare Parts	Sig. & Tel-Com.	ATC Onboard
CoHP-2 USB CONFIG PLUG WITH LANYARD KIT	2	Spare Parts	Sig. & Tel-Com.	ATC Onboard

Product or part name	Quantity	Category	Subsystem	Components
QN10 Relay 24 VDC Coil 12F4B (Q Relay)	2	Spare Parts	Sig. & Tel-Com.	ATC Onboard
Norming Point Reader Tag Master 2.4 GHz	7	Spare Parts	Sig. & Tel-Com.	ATC Onboard
Speed sensor GEL248G0053-X-004 assembly for VATC (Cable and Plug included)	3	Spare Parts	Sig. & Tel-Com.	ATC Onboard
Onboard Ethernet Switch Viper 212A 12 Port Managed	2	Spare Parts	Sig. & Tel-Com.	ATC Onboard
Norming Point Reader Tag Master 2.4 GHz	7	Spare Parts	Sig. & Tel-Com.	ATC Onboard
Trackside Radio Assembly (TRA) Pole mount (Replace radio 404P127169 with 100345686)	2	Spare Parts	Sig. & Tel-Com.	Radio Equip.
Trackside Radio Assembly (TRA) Wall mount (Replace radio 404P127169 with 100345686)	2	Spare Parts	Sig. & Tel-Com.	Radio Equip.
Directional Antenna SISO 5.8GHz with N Type-Female	2	Spare Parts	Sig. & Tel-Com.	Radio Equip.
Directional Antenna SISO 5.8GHz bracket	2	Spare Parts	Sig. & Tel-Com.	Radio Equip.
5,8 GHz Bandpass Filter	2	Spare Parts	Sig. & Tel-Com.	Radio Equip.
Gate Lights (Green/Yellow/Red)	2	Spare Parts	Sig. & Tel-Com.	Signals
MRR Lights (Yellow)	2	Spare Parts	Sig. & Tel-Com.	Signals
Norming Points	2	Spare Parts	Sig. & Tel-Com.	Norming points
Innovia Switch Control Box	2	Spare Parts	Sig. & Tel-Com.	Switch Control Box
Mobile data radio (MDR)	2	Spare Parts	Sig. & Tel-Com.	TWC Onboard
SIG onboard antenna	2	Spare Parts	Sig. & Tel-Com.	TWC Onboard
Onboard SIG bandpass filter	3	Spare Parts	Sig. & Tel-Com.	TWC Onboard
Mobile data radio (MDR)	2	Spare Parts	Sig. & Tel-Com.	TWC Onboard
Trackside radio assembly (TRA)	2	Spare Parts	Sig. & Tel-Com.	TWC Wayside
Wireless access controller (WAC)	2	Spare Parts	Sig. & Tel-Com.	TWC Wayside
DataTrans Vehicle L3 Switch	2	Spare Parts	Sig. & Tel-Com.	Vehicle COMS
DataTrans Vehicle SD Card	2	Spare Parts	Sig. & Tel-Com.	Vehicle COMS
DataTrans Vehicle Switch Power Supply	2	Spare Parts	Sig. & Tel-Com.	Vehicle COMS
DataTrans Vehicle L2 Switch	2	Spare Parts	Sig. & Tel-Com.	Vehicle COMS
DataTrans Vehicle SD Card	2	Spare Parts	Sig. & Tel-Com.	Vehicle COMS

Product or part name	Quantity	Category	Subsystem	Components
DataTrans Vehicle Switch Power Supply	2	Spare Parts	Sig. & Tel-Com.	Vehicle COMS
Power Distribution Block	2	Spare Parts	Sig. & Tel-Com.	Vehicle COMS
VORS-M Enclosure Assembly	2	Spare Parts	Sig. & Tel-Com.	Vehicle COMS
Driver's Handheld Speaker Mic	2	Spare Parts	Sig. & Tel-Com.	Vehicle COMS
Manual Control Panel Audio Assembly	2	Spare Parts	Sig. & Tel-Com.	Vehicle COMS
AIM Panel	2	Spare Parts	Sig. & Tel-Com.	Vehicle COMS
PA Amplifier	2	Spare Parts	Sig. & Tel-Com.	Vehicle COMS
PA Speakers	2	Spare Parts	Sig. & Tel-Com.	Vehicle COMS
Ceiling Microphone Assembly	2	Spare Parts	Sig. & Tel-Com.	Vehicle COMS
Passenger Intercom Assembly	2	Spare Parts	Sig. & Tel-Com.	Vehicle COMS
VORS-S Enclosure Assembly	2	Spare Parts	Sig. & Tel-Com.	Vehicle COMS
VCCU-C for CCTV & OPICS (RAID1 w/ 4TB)	2	Spare Parts	Sig. & Tel-Com.	Vehicle COMS
Comms Soft Shutdown Assembly	2	Spare Parts	Sig. & Tel-Com.	Vehicle COMS
M3057-PLVE Panoramic Dome	2	Spare Parts	Sig. & Tel-Com.	Vehicle COMS
CCTV Cabinet Assembly w/ Directory Server	2	Spare Parts	Sig. & Tel-Com.	Wayside COMS
CCTV Video Archiver Server	2	Spare Parts	Sig. & Tel-Com.	Wayside COMS
CCTV Workstation Assembly	2	Spare Parts	Sig. & Tel-Com.	Wayside COMS
CCTV Workstation	2	Spare Parts	Sig. & Tel-Com.	Wayside COMS
CCTV Workstation Assembly	2	Spare Parts	Sig. & Tel-Com.	Wayside COMS
CCTV Workstation Assembly	2	Spare Parts	Sig. & Tel-Com.	Wayside COMS
O&M Radio Workstation	2	Spare Parts	Sig. & Tel-Com.	Wayside COMS
OPICS Workstation Computer	2	Spare Parts	Sig. & Tel-Com.	Wayside COMS
Cabinet Assy	2	Spare Parts	Sig. & Tel-Com.	Wayside COMS
Core Processor	2	Spare Parts	Sig. & Tel-Com.	Wayside COMS
Speakers	2	Spare Parts	Sig. & Tel-Com.	Wayside COMS
Speaker Baffle	2	Spare Parts	Sig. & Tel-Com.	Wayside COMS

Product or part name	Quantity	Category	Subsystem	Components
Speaker Enclosure	2	Spare Parts	Sig. & Tel-Com.	Wayside COMS
Horn Speakers	2	Spare Parts	Sig. & Tel-Com.	Wayside COMS
Pendulum Speakers	2	Spare Parts	Sig. & Tel-Com.	Wayside COMS
End of Line Module	2	Spare Parts	Sig. & Tel-Com.	Wayside COMS
Noise Sensing Microphones	2	Spare Parts	Sig. & Tel-Com.	Wayside COMS
24-Port 1U Rack-Mount STP Shielded Cat6a Feedthrough Patch Panel, RJ45 Ethernet, TAA	2	Spare Parts	Sig. & Tel-Com.	DTS
Dell PowerEdge R350 Rack Server	2	Spare Parts	Sig. & Tel-Com.	DTS
Cisco ASR920 Series - 24GE Fiber and 4-10GE : Modular PSU	2	Spare Parts	Sig. & Tel-Com.	DTS
ASR 920 AC Power Supply	2	Spare Parts	Sig. & Tel-Com.	DTS
SNTC-8X5XNBD Cisco ASR920 Series - 24GE Fiber and 4-10GE - (Hardware)	2	Spare Parts	Sig. & Tel-Com.	DTS
Cisco ASR920 Series - 24GE Fiber and 4-10GE : Modular PSU	2	Spare Parts	Sig. & Tel-Com.	DTS
ASR 920 AC Power Supply	2	Spare Parts	Sig. & Tel-Com.	DTS
ASR 920 Fan for Fixed Chassis	2	Spare Parts	Sig. & Tel-Com.	DTS
SNTC-8X5XNBD Cisco ASR920 Series - 24GE Fiber and 4-10GE - (Hardware)	2	Spare Parts	Sig. & Tel-Com.	DTS
SFP, 1.25Gb/s, 1310nm, 20km, SMF, LC, -40-85C	2	Spare Parts	Sig. & Tel-Com.	DTS
SFP 10/100/1000BASE-T, 100m, RJ-45	2	Spare Parts	Sig. & Tel-Com.	DTS
Catalyst 9300L 48p data, Network Essentials ,4x1G Uplink, Network Essentials	2	Spare Parts	Sig. & Tel-Com.	DTS
Catalyst 9300L 24p data, Network Essentials ,4x1G Uplink, Network Essentials	2	Spare Parts	Sig. & Tel-Com.	DTS
Cisco Firepower 1120 ASA Appliance, 1U	2	Spare Parts	Sig. & Tel-Com.	DTS
Cisco Firepower 1K Series 200GB for FPR-1120/1140	2	Spare Parts	Sig. & Tel-Com.	DTS

Product or part name	Quantity	Category	Subsystem	Components
SNTC-8X5XNBD Cisco Firepower 1120 ASA Appliance, 1U	2	Spare Parts	Sig. & Tel-Com.	DTS
Firepower 4000 Series Fan - Single	2	Spare Parts	Sig. & Tel-Com.	DTS
1000BASE-T SFP transceiver module for Category 5 copper wire	2	Spare Parts	Sig. & Tel-Com.	DTS
Firepower 4000 Series 800GB SSD for FPR-4145/4155	2	Spare Parts	Sig. & Tel-Com.	DTS
PRETIUM PCH-04U FIBER OPTIC CLOSURE	2	Spare Parts	Sig. & Tel-Com.	DTS
AC PWR PANEL,20A,RACK MT 100-240VAC, 16-C13	2	Spare Parts	Sig. & Tel-Com.	DTS
24-Port 1U Rack-Mount STP Shielded Cat6a Feedthrough Patch Panel, RJ45 Ethernet, TAA	2	Spare Parts	Sig. & Tel-Com.	DTS
Cisco ASR920 Series - 24GE Fiber and 4-10GE : Modular PSU	2	Spare Parts	Sig. & Tel-Com.	DTS
ASR 920 AC Power Supply	2	Spare Parts	Sig. & Tel-Com.	DTS
ASR 920 Fan for Fixed Chassis	2	Spare Parts	Sig. & Tel-Com.	DTS
SNTC-8X5XNBD Cisco ASR920 Series - 24GE Fiber and 4-10GE - (Hardware)	2	Spare Parts	Sig. & Tel-Com.	DTS
Catalyst 9300L 48p PoE, Network Essentials ,4x1G Uplink	2	Spare Parts	Sig. & Tel-Com.	DTS
715W AC 80+ platinum Config 1 Power Supply	2	Spare Parts	Sig. & Tel-Com.	DTS
715W AC 80+ platinum Config 1 SecondaryPower Supply	2	Spare Parts	Sig. & Tel-Com.	DTS
SFP, 1.25Gb/s, 1310nm, 20km, SMF, LC, -40-85C	2	Spare Parts	Sig. & Tel-Com.	DTS
10G SFP+ Direct Passive Attached Cable 1m	2	Spare Parts	Sig. & Tel-Com.	DTS
PRETIUM PCH-04U FIBER OPTIC CLOSURE	2	Spare Parts	Sig. & Tel-Com.	DTS

Product or part name	Quantity	Category	Subsystem	Components
STATION DOORS	1	Spare Parts	Station Platform Doors	Misc
PLC's for Station Doors	14	Spare Parts	Station Platform Doors	PLC
PLC's for Station Doors	14	Spare Parts	Station Platform Doors	PLC
PLC's for Station Doors	14	Spare Parts	Station Platform Doors	PLC
Station Platform Call Button Panel	10	Spare Parts	Station Platform Doors	Panel
VDH EXTENDER BOARDS	8	Spare Parts	Station Platform Doors	Board
DOOR CONTROL CABINET MASTER ASSEMBLY	1	Spare Parts	Station Platform Doors	Cabinet Assembly
DOOR CONTROL CABINET ASSEMBLY	1	Spare Parts	Station Platform Doors	Cabinet Assembly
CENTRAL CONTROL - PWR SUPPLY ASSY	7	Spare Parts	Station Platform Doors	Power Supply
RF DATA MODEM SHELF ASSEMBLY	1	Spare Parts	Station Platform Doors	Modem Assembly
WIRELESS RADIO MODEM, RF	9	Spare Parts	Station Platform Doors	Modem
PLC ASSEMBLY	1	Spare Parts	Station Platform Doors	PLC Assembly
MODULE I/O BASE	14	Spare Parts	Station Platform Doors	Base
REDUNDANT MODBUS PLUS OPTION ADAPTER	14	Spare Parts	Station Platform Doors	Adapter
CONTROLLER, MOMENTUM PROCESSOR	14	Spare Parts	Station Platform Doors	Controller
RELAY TERMINAL BLOCK ASSEMBLY	1	Spare Parts	Station Platform Doors	Terminal Block
#FUSE PLUG 15-30V AC/DC W/LIGHT	32	Consumable	Station Platform Doors	Fuse

Product or part name	Quantity	Category	Subsystem	Components
MINIATURE RELAY 24VDC RAIL MOUNT	36	Spare Parts	Station Platform Doors	Relay
115 VAC TERMN BOX & BLOCK ASSEMBLY	1	Spare Parts	Station Platform Doors	Terminal Block
AC LIGHT SWITCH 15A, 120VAC, SGL POLE	32	Spare Parts	Station Platform Doors	Switch
RS485 ETHERNET CONVERTER ASSEMBLY	1	Spare Parts	Station Platform Doors	Converter Assembly
CONVERTER RS485 ETHERNET 24 VDC	14	Spare Parts	Station Platform Doors	Converter
RESISTOR 1.5K OHM 2W +/-5% TOL	20	Consumable	Station Platform Doors	Resistor
FUSE 4 AMP 250V 5X20 MM	32	Consumable	Station Platform Doors	Fuse
Station Door Modbus (2 per door)	32	Spare Parts	Station Platform Doors	Modbus
STATION DOOR Terminating Connectors (2 per platform)	16	Spare Parts	Station Platform Doors	Connector
RS485 Modbus plus Comm (1 per door)	20	Spare Parts	Station Platform Doors	Modbus
Termination Blocks for doors (1 per door)	20	Spare Parts	Station Platform Doors	Terminal Block
I/O Modular Base for doors (1 per door)	14	Spare Parts	Station Platform Doors	Base
Momentum PLC (for local digital I/O)	14	Spare Parts	Station Platform Doors	PLC

13.6 Safety

Alstom has vast experience in the O&M industry with many operating system technologies both in the rail, light rail, and the automated people mover industries. With Alstom's extensive experience in the APM technology we are well versed to know and understand the hazards and Environmental Health and Safety (EHS) requirements in the operations and maintenance facility areas. The experience of the Alstom EHS supervisors provides them the knowledge and abilities to ensure compliance to all corporate, local, regional and national safety standards. The existing site O&M Team is well versed and knowledgeable in the local AHJ's requirements and compliance to their demands at Tampa International Airport based on our continued O&M site presence since 1971.

The design of the APM vehicles will not require an overhead hoist or crane system as there is no roof mounted equipment requiring maintenance or replacement. The team will typically utilize lift jack and equipment lift tables to remove and move large equipment around the site. However, even with the absence of cranes and hoists the Alstom EHS Teams will review the local site hazards and local regulations and ensure that the appropriate signage related to electrical, hydraulic, pneumatic, vehicle movements, confined spaces, pinch points, or other hazards will be properly identified with appropriate hazards and cautions.

The Alstom O&M team and EHS organization will prepare MSDS data sheets and maintain these data sheets for all materials hazards in the maintenance facility.

Safety is of utmost importance to the Alstom Team and as with all companies the goal is for a zero-incident policy at the O&M and Alstom Team levels.

14. CODES AND STANDARDS

For the design, fabricate and installation activities on the Tampa A Leg new APM program, the Alstom design engineering procurement and testing teams are familiar with the applicable codes and standards. Realizing the list of Codes and Standards in the specification is not exhaustive and there may be other applicable codes and standards or that some areas of the identified codes and standards may not be specifically applicable is part of the overall Alstom Team and subcontractors design experience. Based on the knowledge of the Alstom design team, the appropriate codes and standards applicable to the project will be applied.

Alstom acknowledges the defined language regarding the conflict in code requirements and that the more restrictive codes will apply. However, any conflicts between the Owner's codes and Standards and the industry requirements will be thoroughly reviewed and vetted with the HCAA Team, the Alstom design and subcontract teams, as well as the Alstom O&M team and finally the AHJ's as needed. Any deviations from the Owners specification, if required and agreed upon, will be brought to the overall Tampa A Leg Project team, inclusive of HCAA, Lea+Elliott, and Alstom for agreement from the entire team as to the best way forward for the best project and safety objectives.

During the design, survey, procurement, installation, and testing commissioning phases, any permitting required that is directly related to the Alstom Design Build Scope of work and installation will be acquired by the Alstom Design Build group. These building and related permits will be obtained by the Alstom teams and its subcontractors including all fees and associated approval required for the execution of the work. However, any Building and Related Permits for the HCAA infrastructure and non APM related works as Identified in the Appendix A division of responsibilities to be the responsibility is the Owner is understood to be the responsibility and cost of the Owner to obtain and pay related fees.

Appendix B

Airside E Technical Proposal

Tampa International Airport Airside E Technical Proposal

VEHICLES

DESIGN, SUPPLY, INSTALLATION, TESTING & COMMISSIONING FOR AUTOMATED PEOPLE MOVER (APM) AND ASSOCIATED WORKS AT HILLSBOROUGH COUNTY AVIATION AUTHORITY (HCAA)

ALSTOM
• mobility by nature •

TABLE OF CONTENTS

TABLES

FIGURES

LIST OF APPENDICES

1 ABBREVIATIONS

Abbreviation	Definition
ADA	Americans with Disabilities Act
ANSI	American National Standards Institute
APM	Automated People Mover
ASCE 21	American Society of Civil Engineers – Automated People Mover Standards
BWAN	Bombardier Wireless Access Network
CDRL	Contract Data Requirements List
NFPA	National Fire Protection Association
OCC	Operation Control Centre
ORS	Operational Radio System
TCMS	Train Control and Management System
TPE	Tampa Airport Airside E
VLT	Visible Light Transmission

Table 1: Abbreviation List

2 INTRODUCTION

The vehicles covered by this specification will be Alstom INNOVIA APM 300R. The APM 300R is an Alstom Product designed to meet the operational and infrastructure interfaces of existing Systems using APM 100 generation vehicles. The Vehicle weight and construction outline are different than the Existing APM 100 currently used in Tampa. Detailed information about the clearance gauge and weight limits of the Tampa infrastructure will be validated in the first weeks of the project by HCAA.

The proposed vehicles will utilize the same wheelbase, door size and spacing, as the vehicles currently in service. Guidance and power collection will be the same as the existing fleet. The vehicles will offer improvements in interior appearance, energy consumption, diagnostics, and other areas.

The vehicles will utilize an AC-AC propulsion system similar to the Alstom INNOVIA APM 300 vehicle technology and will be able to operate with the newly installed Alstom CITYFLO 650 signaling control system.

This combination of subsystems is intended to combine the advantage of maintenance reduced energy saving AC-AC propulsion technology with the modern properties of the Alstom INNOVIA APM 300 series and make them available for the TPE APM system.

The product reviews will be performed as ”for Information Only” as the APM 300R vehicles for Airside E have already been procured and will follow the approved design from Airsides A&C.

3 VEHICLES

Alstom INNOVIA APM 300R Vehicles will be automatically controlled and operate normally without a driver. The TPE APM, two-car married-pair vehicles will be deployed. All newly supplied cars will be identical.

Alstom, INNOVIA, CITYFLO and MITRAC are trademarks of Alstom or its subsidiaries.

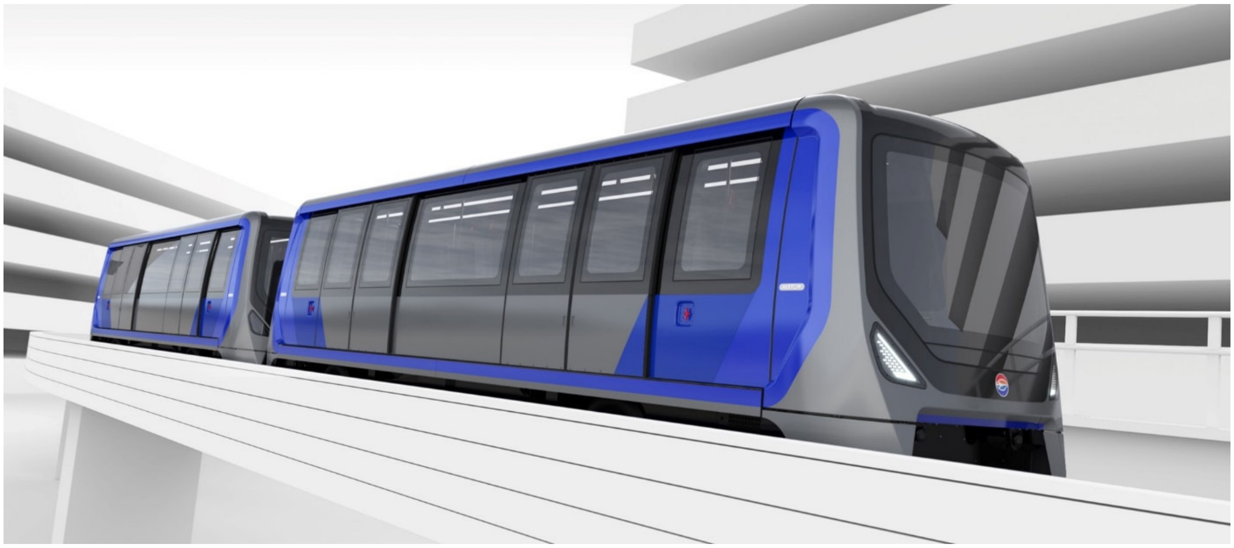


Figure 1: Vehicle Isometric View (Colors and Livery to be coordinated with HCAA)

3.1 Clearance Envelope and Platform Length

Alstom INNOVIA APM 300R vehicles and the existing Alstom APM 100 vehicles were both developed in line with ASCE 21. The replacement APM 300R vehicles will have the same static and dynamic clearance envelope as the existing in service vehicles.

3.2 Vehicle Space and Weight Allocations

Vehicle space and weight allocations in accordance with the Particular Specification will be:

Mass		Floor Area per Passenger		
		Seating Capacity	**Normal Capacity**	**Design Capacity**
Standing	70 kg (154 lbs)	n/a	0.33 m^2 (3.55 ft^2)	0.25 m (2.69 ft^2)
Seated	70 kg (154 lbs)	0.14 m^2 (1.51 ft^2)	0.14 m^2 (1.51 ft^2)	0.14 m^2 (1.51 ft^2)
Wheelchair	272 kg (600 lbs)	0.465 m^2 (5 ft^2)	0.465 m^2 (5 ft^2)	0.465 m^2 (5 ft^2)

Table 2: Space and Weight Allocations

- Vehicle weight definitions are:AW0 – The weight of an empty car.
- AW1 – The weight of the car computed by adding AW0 and the passenger weight, assuming all seats are occupied with passengers, no wheelchair passengers, and one standing passenger for each 0.25 m2 for all the remaining floor space in the vehicle, including the space for wheelchairs that is available to standees.
- AW2 – The maximum weight of the car. This weight will be computed by adding AW0, 520 kg for each square meter of floor area available to standees, 70 kg for each fixed seat, and 170 kg per square meter of wheel

well, sill, or other interior surface area on which passengers or passenger cargo can be loaded. This definition shall apply for references to AW2 in the ASCE APM Standards.

- AW3 – As defined in ASCE 21-13, Section 7.1, Car Capacity and Load, shall be AW2 as defined above. All references to AW3 in the ASCE APM Standards

The following table is based on the current estimated weight for the proposed TPE car.

Condition	Mass
AW0	16,435 kg (36 233 lbs)
AW1	23,838 kg (52 554 lbs)
AW2	29,712 kg (65 504 lbs)
AW3	29,712 kg (65 504 lbs)

Table 3: Vehicle Weight

For vehicle dimensions, see the **Attachment -** Drawing 1.

Fatigue analysis were conducted and there is no need for a weight limiting function to protect the vehicle. As such, Alstom proposal does not include a weight management function to close the vehicle doors in automatic operation when a certain car weight is reached.

The current proposal does not account for any civil infrastructure work or vehicle weight reduction initiatives related to the APM 300R weight increased compared to the APM 100 current weight.

3.3 Car Capacity

The vehicle passenger capacity, calculated in accordance with the Particular Specification, is as shown below:

	Number of Passengers		
	Seating Capacity	**Normal Capacity**	**Design Capacity**
Standing	0	71	94
Seated	8	8	8
Wheelchair	2	2*	2*
TOTAL	10	79	102

Table 4: Vehicle Passenger Capacity

3.4 Structural Design

This Section defines the structural requirements for the System vehicle. A complete structural analysis of the car major suspension elements and frame load paths has been performed and documented by Alstom.

The car body will be made from aluminum with friction-stir welded extrusions, where applicable, and fiberglass end caps.

The following figure shows an example of a car body model.

Figure 2: Car body FEA model example

3.4.1 Design Criteria

The vehicle is designed to sustain all of the loading conditions defined in the above section without detrimental permanent deformation or any interference with safe operation.

The design criteria for a car structure will include the following:

- Design loads for the frame, coupler and draft gear, trucks, and major steering/suspension members. They will be defined as either working loads (normal loads expected in service) or limit loads (worst-case loads expected in service).
- The safety factor applied to these loads. The safety factor will be identified as being with respect to yield strength, ultimate strength, or endurance limits.
- Additional safety factor applied to castings and welds.
- Additional safety factor applied to any part, the failure of which could result in an unsafe condition.
- The torsional and flexural deflection of the car frame under load and how these criteria are to be verified.

Any structural material used in the car structure will not have a yield strength that exceeds 80 percent of its tensile strength, unless the design can be substantiated to have a proven record of successful use in a similar transit application.

All structural body and panels will have resonant frequencies that are sufficiently removed from primary excitation frequencies to preclude resonant vibrations at all speeds and power conditions below 110 percent of maximum cruise speed.

Car structural design will comply with ASCE 21-13 Section 7.4.

3.4.1.1 Fail-safe structured design

Tipping analysis will be performed as a hand calculation (sum of moments) to verify that the drive tires remain loaded under all required scenarios. The following figure shows a typical example of a tipping stability free body diagram (FBD).

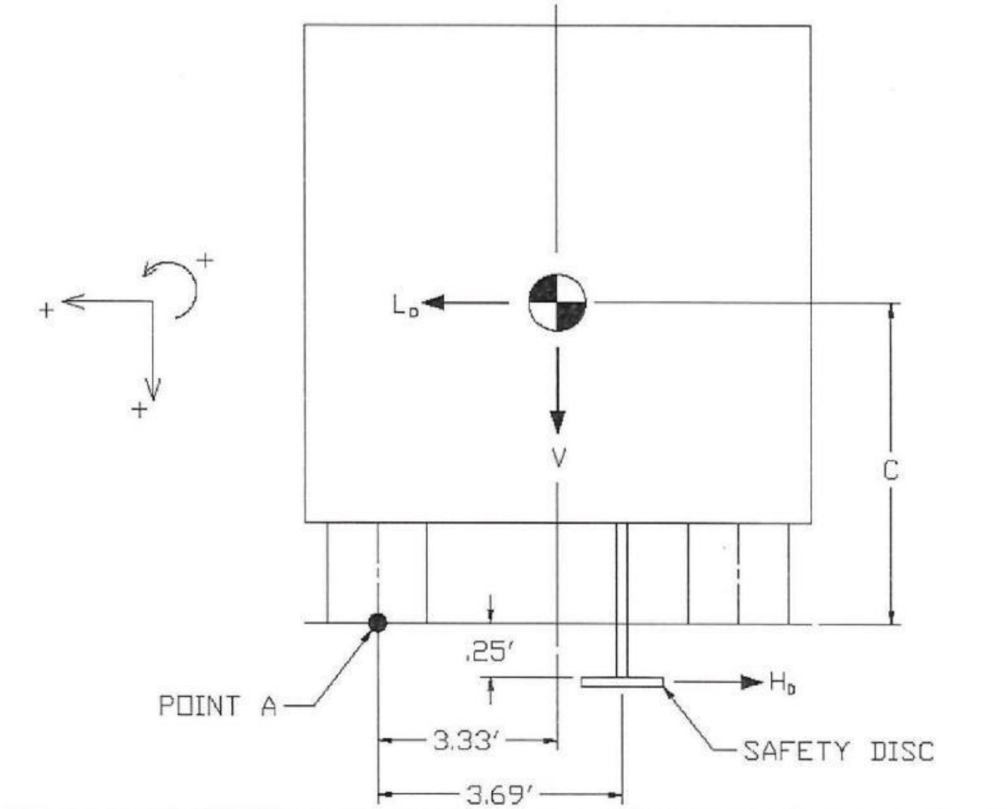


Figure 3: Typical tipping stability FBD

3.4.2 Deformation

Notwithstanding any of the foregoing, the car structure will be shown to be capable of meeting the following additional design criteria:

- Deformation will comply with ASCE 21-13 Section 7.4.4.6.
- All exposed parts of the drawbar which a person can stand on will withstand a downward vertical load of 350 pounds without damage or permanent deformation. Drawbar and draft gear will be designed so that no combination of car deflections including failures to suspension components, loss of tire pressure, and guideway lateral and vertical curvature, will cause the drawbar to bind or produce stresses which will damage the drawbar or the cars.
- The Seats, doors, floor, roof, and stanchions will withstand loading as specified in ASCE 21-13 Section 7.4.4.1.2.

3.4.3 Tipping Stability

Alstom will determine the location of the center of gravity (C.G.) for the car at AW0 and AW2 loads. Alstom will analyze the tipping stability of the car and document its compliance with the requirements defined below. If the height above the running surface and longitudinal and lateral location of the proposed car's C.G. is within 5 percent of the C.G. location of essentially identical cars that have been successfully proven in previous deliveries, the approval of the customer will not be required. However, the results of analyses and/or testing of tipping stability for car C.G. location changes greater than 5 percent will be submitted to the customer for record.

The car will be verified as stable under the conditions specified in ASCE 21-13 Section 7.4.4.8.

3.4.4 Jacking Pads and Hoists

Adequate attachment points for hoisting the car with a crane, including any special slings or fixtures, will be provided by Alstom. Jacking pads will be provided to facilitate jacking the chassis at all suspension tie-down points. If the cabin is not integral with the chassis, jacking pads or hoisting points will be provided to permit its removal. It will be possible to jack the car where required to remove a disabled car or train, with sufficient space to place jacking equipment at all locations along the guideway.

Jacking and lifting will comply with ASCE 21-13 Section 7.4.4.2.

3.4.5 Crashworthy Design

The car and/or train will be capable of withstanding collisions with overtravel buffers, deceleration rates and damage limitation just as with the existing System. Cars will be designed with an anti-climbing capability to maintain alignment and engagement of the collision structure and to prevent excessive damage and telescoping. The passenger compartment will be completely enclosed with no openings through which passengers' heads or limbs may protrude.

The cars will be provided with a shell design compliant with crashworthiness requirements specified in ASCE 21-13 Section 7.4.4.9.

3.4.6 Bolts, Nuts, Fasteners, and Welding Standards

All bolts will be equal in strength to, at least, an SAE grade 5.

Unless otherwise specified, all structural connections will be designed and implemented so that the ultimate strength of a fastener or the local area of the fastened structure will not be the limit of the load-carrying capacity of that structure.

Each removable bolt, screw, nut, pin, or other fastener will incorporate a locking device, if it is:

- Part of a major structural load path, including all suspension members and propulsion and braking force paths; or
- Part of a sensor, detector, or antenna mounting essential to control system operation; or
- Part of an actuator or control linkage essential to car control; or
- Performing any other safety-related function.

Self-locking nuts may be used to satisfy this requirement only if Alstom provides data specifically demonstrating that such fasteners are suitable for the above applications.

3.5 Car Design Life

Alstom is offering a car that will operate up to or exceeding 67,000 miles per year for 25 years in passenger service in an operating duty cycle. The car will provide safe and reliable service during its entire design life. Normal deterioration due to causes such as corrosion and fatigue will not degrade safety or performance of the body, chassis, and running gear.

Axles and suspension, propulsion motors and controls, door equipment, HVAC and draft gear will operate 10 years without major overhaul. Consumables, such as tires, and brake linings, are excluded from this requirement.

All car-borne wiring, conduit, and piping will not require replacement during the design life of the car.

3.6 Safety and Reliability

Alstom's Reliability, Availability, Maintainability & Safety (RAMS) group carries the right authority and resources to influence the evolution of the vehicle design. Through a dedicated Reliability and Safety program, Alstom RAMS group ensures that all the reliability and safety requirements are well captured, allocated, designed in, optimized, and verified, and managed through all the design phases. In the past, using this approach, Alstom has developed and delivered many successful products globally that have achieved and sustained high levels of reliability and safety.

For the TPE APM 300R cars, Alstom will ensure that safety and reliability is built in the design by implementing its proven Design for Reliability and Safety processes.

3.7 Passenger Comfort

This Section defines the requirements for passenger comfort on the car. The following sub-sections provide descriptions of acceptable environmental performance, and testing conditions with regards to HVAC, interior noise, and ride quality.

3.7.1 Heating, Ventilation, and Air Conditioning

Car heating, ventilation, and air conditioning (HVAC) will meet the following performance requirements. HVAC load calculations will be submitted for information.

The Alstom INNOVIA APM 300R Heating, Ventilation, and Air Conditioning (HVAC) system will consist of two independent, identical package units (no split units) per car, mounted to the undercar at each end. The HVAC units will use R-407C; an environmentally friendly, non-ozone-depleting refrigerant. Each unit uses highly reliable scroll compressors. The condenser coils are cooled by air drawn through the coils by an axial fan.

The evaporator blower unit draws air through the evaporator coils and forces it through the sidewall ducts to the air distribution diffusers in the ceiling of the car. The air diffusers distribute the supply air throughout the length of the passenger compartment to maintain temperature uniformity.

The controls of each fully automatic unit are accessible only to authorized personnel. A temperature sensor is in the return air stream of the unit and provides an input signal to the temperature controller, which compares the return air temperature to an adjustable set point temperature. In automatic operation, the HVAC units will automatically select the necessary mode of operation: recirculation, cooling or heating. An HVAC maintenance page will be available on the Pedestal Driver's Desk (PDD) to control and monitor the two HVAC units of the car. It will provide the control of the target temperature and the units' operating mode. It will also provide real-time visualization of units' operational parameters and fault information.

The HVAC blower assemblies provide the required airflow at design conditions. Fresh air enters the unit in the evaporator section and mixes with the return air before it enters the evaporator coil. Normal operation supplies fresh outside air. Return air filters in each unit filter the air before it enters the evaporator coil.

3.7.1.1 Air Conditioning

Each car will have two equal and independent air conditioning units having an aggregate cooling capacity equal to the maximum calculated cooling requirement for the car. The failure of one unit will not cause extreme temperature differences along the length of the car.

The systems will maintain car interior conditions of 75.5°F (24°C) Design Dry-Bulb and 60% relative humidity under the specified ambient design conditions. Ambient design conditions will be the 0.4% Design Dry-Bulb and the mean coincident 0.4% Design Summer Wet-Bulb temperatures reported in the ASHRAE, 2017 Fundamentals Volume, for the Official Weather Observation Station closest to the Airport.

3.7.1.2 Ventilation

Each HVAC unit will condition 153 CFM of fresh air for a total of 306 cfm per car which provides 3 CFM per passenger at design conditions. The proposed fresh airflow is in line with the existing Tampa APM 100 cars. While the proposal ensures equivalent comfort as the existing Tampa vehicles, it is noted that it offers a lower fresh airflow than the recommended 9 CFM per passenger from ASCE 21-13. All of the ventilated air will be introduced through the air conditioning equipment and will not include air which might be introduced when the doors are open. Incoming as well as recycled air within will be sufficiently filtered. This air flow rate considers 100% solar load in the performance analysis; higher air flow rates can be achieved only if a higher shading coefficient is used (note that the current APM100 vehicle's HVAC performance was analyzed with reduced solar load).

3.7.1.3 Heating

Each air conditioning system will contain direct resistance electric heaters located in the air stream and arranged to provide heating for the vehicle interior when the control system so dictates. Heaters will maintain the vehicle interior at 75°F when the ambient conditions are at the 99.6% Design Dry-Bulb Winter temperature as listed in the previously-cited ASHRAE reference. Heating capacity calculations will include only the transmission and ventilation losses. Heating may be provided elsewhere in the vehicle if the above performance requirements, including ambient air, are met. The maximum air supply outlet temperature will not be greater than 100°F.

3.7.1.4 Controls/Temperature Uniformity

A control system will be provided to control the interior temperature at 75°F during cooling condition. The control set point will be adjustable between 65°F to 85°F. The inside temperature in the occupied portion of the car will not vary more than +/-4°F from the design temperature one (1) foot from any inside surface.

3.7.1.5 Temperature Variations

If temperatures encountered throughout the year exceed the defined design values, the car interior temperature will be permitted to rise or drop degree for degree with the temperature in excess of or below the design values at full load.

3.7.1.6 Air Flow and Diffusion

The air distribution system will provide sufficient diffusion at the outlet or diffuser so that air mixing will prevent direct impingement of coil discharge temperature air onto occupants. In addition, air velocities one foot from the diffuser or outlet face will not exceed 400 fpm and velocities throughout the occupied portion of the car will not exceed 150 fpm. Moisture carryover from cooling coils will not be permitted. The air will be longitudinally distributed throughout the car.

3.7.1.7 Failure Operations

In the event of failure of both cooling systems, indicated by an inability to maintain interior temperatures, the systems will continue the highest speed blower operation.

If the car's primary electrical power is lost, ventilation of at least 5.3 cfm (per ASCE 21-13) of outside air per passenger at AW1 loading will be provided for at least 60 minutes, using power from the car batteries (see Section 3.9.2).

3.7.2 Interior Noise Level

Interior noise, measured at five feet above, and at the geometric center of the floor, will not exceed the levels indicated below under normal operating conditions with all equipment functioning, in accordance with ASCE 21-13:

- Vehicle stationary, doors shut 74 dBA
- Vehicle moving up to 48km/h (30 mi/h) 76 dBA
- Vehicle moving above 48km/h (30 mi/h) 79 dBA

All noise measurements will be taken with no more than three (3) test/observation personnel and necessary equipment in an otherwise empty car. All auxiliary systems, including maximum air conditioning and all air compressors and pumps will be operating. Noise measurements will be made using a Type II instrument, as defined in ANSI Standard S1.4, "Sound Level Meters," with a fast response setting.

Pure tones, as defined in ASCE 21-13, will be eliminated if found to exist.

3.7.3 Ride Comfort

The Alstom INNOVIA* APM 300R bogie and suspension incorporate the latest design changes and improvements which should improve ride quality compared to the current cars.

Car ride characteristics for maximum sustained acceleration and deceleration, maximum rate of change of acceleration, and ride quality will satisfy the following:

- Maximum Sustained Acceleration/Deceleration
  - Lateral 0.10g
  - Vertical 0.05g with respect to 1g datum
  - Longitudinal – normal 0.16g
  - Longitudinal emergency 0.32g including effects of grade
- Maximum Jerk
  - Lateral 0.06g/sec.
  - Vertical 0.04g/sec.
  - Longitudinal 0.04 to 0.09g/sec., selectable
- Ride Quality
  - Weighted RMS values of acceleration averaged over any single station to station trip will fall below the ISO 2631 one-hour whole body reduced comfort limits, in accordance with ASCE 21-13 §7.7.3.

"Sustained" refers to the nominal values used for design of curves, crests, sags, and speed profiles and excluding random vibration effects. Sustained will include durations equal to or greater than 0.10 seconds.

"Longitudinal" is fore and aft motion, the x direction in ISO 2631; "vertical" is up and down motion, the z direction in the ISO 2631; and "lateral" is side to side motion, the y direction in ISO 2631.

Lateral and vertical acceleration and deceleration include grade effects and are the values obtained with an inertial accelerometer.

Longitudinal acceleration and deceleration ignoring grade are the rates of change of speed as determined from the maximum slope of tachometer-generated data. Longitudinal acceleration and deceleration including grade are the values obtained with a standard piezoelectric accelerometer with a frequency range of at least 0.1 – 80 Hz.

“Jerk” is the rate of change of sustained acceleration/deceleration with lateral and vertical acceleration/deceleration and with longitudinal acceleration/deceleration ignoring the effect of grade. In switch turnouts, lateral acceleration need not be jerk limited, providing the total change of lateral acceleration and braking. Longitudinal jerk during removal of emergency brakes need not be controlled.

Ride quality will be measured on an empty car, with no more than three (3) test/observation personnel and necessary equipment, using a Bruel & Kjaer Type 2512 Human Response Vibration Meter or equivalent with a 4322 triaxial accelerometer located on the floor of the car at the geometric center of the floor. The “equivalent continuous vibration level” or “1 eg.,” weighted according to ISO 2631, will not exceed the value for one hour of exposure using the “whole body reduced comfort” criteria. This value is 0.038g RMS or 111.43 dB re 1 micrometer per second squared. Weighted peak acceleration as measured by the peak detector will not exceed 0.14g (122.76 dB re 1 micrometer per second squared) for lateral vertical acceleration and 0.08g (117.90 dB re 1 micrometer per second squared) for longitudinal acceleration.

3.7.4 Elderly and Handicapped Considerations

Special consideration will be given to the car interior so as not to impede elderly and handicapped passengers from having full accessibility to the System. Each car will provide a clear space to accommodate one wheelchair. This wheelchair parking area will be free of vertical stanchions or other obstructions. There is currently no wheelchair restraint device in the standard vehicle design. Passengers will be able to walk on and off the car without being impeded by the wheelchair. Maneuvering room inside the car will provide easy travel for a passenger in a wheelchair between the door and the designated wheelchair parking area. No width dimension will be less than 34 inches. Areas requiring 90° turns of wheelchairs will have a clearance arc dimension no less than 45 inches. In the wheelchair parking area, where 180° turns are expected, space will be clear in a full 60-inch diameter circle. A vertical clearance of 12 inches above the floor surface will be provided on the outside of turning areas for wheelchair footrest clearance. Wheelchair locks are not consistent with automatically controlled, short-duration airport APM station stops; wheelchair passengers do not have sufficient time to park and engage the lock prior to departure nor disengage the lock and exit the vehicle upon arrival. Alstom will incorporate its standard solution, a wheelchair space defined by stanchions and handrails that will restrain wheelchair motion in three directions, with handholds to supplement the wheelchair's own parking brakes.

Cars will have automatic on-board audible announcements that identify each station as it is approached to inform passengers, particularly the visually impaired, of the impending stop. Automatic announcements will also announce the next station the car is destined for after the car departs. This subsystem may have other appropriate messages related to passenger information and safety. The graphic station door displays will visually indicate the impending door movements before the closing operations commence. On-board dynamic signs located for good visibility will provide station information concurrently with the station identification announcements (see Section 3.14.9).

3.8 Propulsion and Braking Systems

The TPE vehicle composed of 2-car unit will be capable of continuous operation at the maximum speeds proposed for the System for an AW1 vehicle operating on tangent System guideway. All vehicles will be fully bi-directional, with equal propulsion and braking performance in either direction.

Each car will have two separate propulsion traction circuits, using proven ALSTOM INNOVIA APM 300 technology, 3 phase AC-AC propulsion equipment. The cars will have two brushless 3 phase AC motors, that will also be used for regenerative braking. Each traction circuit will have two ALSTOM MITRAC converters, one to rectify the 600V (Line Converter Module), 3-phase AC line current to a DC link, and then a second to variable-voltage, variable-frequency AC to power AC traction motors (Motor Converter Module). This system enhances energy efficiency through full regenerative braking and power factor correction, in addition to the inherent efficiency increase of an AC control system.

The vehicle will be capable of continuous operation at sustained cruise speed in either direction for the maximum speeds proposed for the system for vehicles loaded at AW1 and operating on level, tangent system guideway.

Simulation analysis of the cars will be performed for all configurations under AW1 load conditions to verify that the operating system technology can:

- Cruise at least at maximum normal cruise speed under all conditions along the guideway where grade, geometry, and station constraints permit.

- Maintain normal cruise speeds on the steepest grade in the Operating System guideway.
- When stopped on the steepest uphill grade, start and accelerate without violating the ride quality requirements.

The propulsion and braking systems are rated to provide traction and all train movement along the guideway, under the expected loads and environmental conditions. The vehicle ATC, in automatic mode, and TCMS (Train Control and Management System), in manual mode, will ensure motion control up to the maximum specified speed, such that acceleration, deceleration and jerk rates are within the acceptable range of passenger comfort.

Each car has two independent traction circuits each powering one bogie. Each traction circuit is equipped with a dedicated CM-DUO propulsion converter assembly which is made up of a four-quadrant line converter and traction converter built into a single unit. Each traction converter assembly receives power from 600VAC three phase distribution, converts this power to a dedicated DC link voltage via the line converter and, based on communication between the car control system and propulsion control system, converts the DC link voltage to variable frequency variable voltage which is fed to an AC traction motor mounted on the car bogie.

The design of the line converter at the input of each traction circuit allows energy recovered from motor braking to be fed back to the 600VAC distribution system. A resistor element is included also in each traction circuit to facilitate control of the link voltage and quickly discharge the DC link capacitor for maintenance activity. These independent traction circuits maximize the use of available adhesion and minimize performance loss in a failure condition.

Both traction converter circuits are equipped with the drive control units (DCUs) which receive commands and information from a single propulsion subsystem controller. This propulsion subsystem controller interfaces directly with the TCMS system where Input/output functional control signals such as direction request, tractive effort request, wheel diameter, line voltage, tractive effort delivered, etc., as well as various protection features are computed, converted, and passed.

The energy savings per car are expected to be over 30% with a fully-receptive wire compared to a regular TPE APM100 vehicles. The regenerated brake energy will be fed into the system for other cars to be used or, whenever this is not possible, will be fed into the feeding power system. Alstom will coordinate the electrical energy feedback with the local power supply company.

The unity power factor of the Alstom INNOVIA APM 300R will be 0.99 in all modes. The live harmonic will be controlled per IEEE-519.

3.8.1 Propulsion and Braking Control

The propulsion control system will respond to signals from the TCMS and adjust tractive effort, blend friction with electrical braking, and produce the tractive effort and braking necessary for smooth vehicle acceleration, deceleration, and cruising. The propulsion control system will accelerate the cars and any length train up to and including the Ultimate-length for the System from rest to a maximum cruise speed at rates not to exceed the maximum longitudinal acceleration and jerk rates given in Section 3.7.3.

The propulsion control system will be stable over time. Periodic adjustments required to compensate for drift or other problems will be capable of being incorporated efficiently in the car check-out routine. Under no circumstances will the propulsion control require adjustments more than once every 10,000 car miles to maintain performance within specifications.

The propulsion control equipment will have thermal overload protection.

Upon the occurrence of an overtemperature condition in either the propulsion controller or the propulsion motor, an alarm will be sent to Central Control indicating that condition with the affected car identified. Upon cooldown, the overtemperature sensing device will automatically reset and the alarm at Central Control will automatically discontinue. A change of state (e.g., “return to normal”) message will be sent to Central Control and be displayed.

The TCMS system passes the required information to the propulsion subsystem controller based on a network of data collection as well as interaction directly with the ATC system. This allows the TCMS system to adjust tractive effort, blend friction with electrical braking, and produce the tractive effort and braking necessary for smooth car acceleration, deceleration, and cruising.

Communication with the propulsion system is done over a car network connection between the TCMS and the propulsion subsystem controller. The propulsion subsystem controller has multifunction vehicle bus (MVB) Network connections to control the drive control units (DCU) located at each traction converter. The DCUs are designed to work in a structure where the propulsion subsystem controller performs the vehicle level control interface and supports the communication between DCUs. Inter-vehicle communication on a multi-car train is performed by TCMS and ATC (levels above the propulsion subsystem controller) so the functions of the propulsion control system on a particular car pertain strictly to the commands communicated through the TCMS interface on that car.

3.8.2 Duty Cycle

The thermal capacity of the propulsion and service brake systems will be based on the greater of the following two requirements:

- Continuous operation of an Ultimate-length train over the System guideway. Dwell time as currently used on the existing system. Headways will be set for the maximum line capacity. All cars in the train will be loaded to AW2. The maximum ambient temperature will be assumed and does not include local temperature changes due to car or wayside equipment. Air conditioning and other accessories will be operating.
- One AW0-loaded car will be able to push or pull another AW2-loaded inoperative car into the most convenient station, regardless of where it is located, and then push or pull the same car with both cars empty (AW0) to the Online Maintenance Facility. The environmental and operating conditions of the above paragraph will apply except when degradation in speed, acceleration, and deceleration rates will be permitted. Assuming only one car is operable, the brakes on one car will be able to stop both cars. Emergency braking will be available from both cars; that is, an emergency brake condition will cause emergency brake application on both cars, except under special conditions when the emergency brakes of the failed train will be disabled for it to be moved.

3.8.3 Service Brakes

A service braking system will be provided. It will be designed to stop the car within its normal deceleration profile and deceleration and jerk constraints for all car speeds, loadings, grades, turn radii, and environmental conditions within the System's operating range. Brake capacity will be sufficient to stop any length AW2-loaded train under the conditions specified in Section 3.8.2 and will be designed to ASCE 21-13 Section 8. Service brake system failure will result in application of emergency brakes in accordance with this proposal Section 3.8.4 and 3.8.5.

Service brakes will use either electric motor braking and friction braking or only friction braking. If both are used a smooth transition from one braking mode to the other will be provided in accordance with the acceleration and jerk requirements of Section 3.7.3. If regenerative braking is used, the power generated will be accepted by the System or will be fed back into the supply system. Friction braking wear material will have a minimum service life of 50,000 miles, except that no more than 3 percent of all such wear components may have a service life of less than that amount.

The friction brake is an electro-pneumatic controlled, air or spring actuated drum brake. The friction brake system provides 1) supplemental service braking to blend with dynamic brakes when it is fading; 2) substitute service braking to dynamic brake when it is unavailable; 3) emergency braking for safe operation; and 4) holding/parking braking.

The friction brakes are used for supplementing service braking or emergency braking as a fail-safe back-up. Normal service braking is accomplished by dynamic braking. When dynamic braking is insufficient, the friction brakes automatically blend in to supplement the dynamic brake. If dynamic braking is not available, the friction brakes take over the entire braking duty.

The pressure-applied service brakes are also used to hold the car docked in a station during a passenger exchange. The service braking pressure is monitored to ensure that this braking effort is sufficient to hold the car at a standstill, under the worst conditions. The emergency brakes also function as a parking brake for holding the car at a standstill when the car needs long term parking.

Service braking is normally accomplished by the dynamic brake. When dynamic braking is insufficient, the friction brakes automatically blend to provide seamless braking effort. If the dynamic braking is not available, the friction brakes take over the entire braking duty.

3.8.4 Emergency Brakes

The emergency brakes will stop the train whenever a potentially dangerous condition occurs. Such conditions include failure to maintain proper safe speed, failure of the normal braking system, or other ATP conditions as required. Emergency braking rates will meet the requirements of Section 3.7.3.

During automatic operation, the emergency brakes will be irrevocable, that is, once the command is issued for them to be applied, they will remain applied until the train comes to a complete stop, even if the initiating command is removed. After the train has stopped, the emergency brakes may be reset for normal operation by a manual reset on the train by authorized personnel; additionally, the emergency brake may be reset by a control signal to that train from the Central Control Operator, unless otherwise prohibited for specific situations by these Technical Provisions. If conditions are not safe for the train to move, the emergency brakes will remain applied regardless of any reset signals or actions. If, when safe conditions exist, and the train is allowed to move, a subsequent malfunction occurs, the emergency brakes will be applied as before.

The emergency brake controls will be interlocked with the propulsion controls, to include removal of propulsion power during emergency braking, in a fail-safe or checked-redundant manner such that braking commands dominate. The emergency brake may use components of the service braking system but will operate properly without any guideway or propulsion system power and in the event of failure of electrical, or pneumatic power sources. In addition, the emergency brake will incorporate sufficient redundancy and capacity such that the safe train separation assurance requirements can be met with a single worst-case element failure of the emergency brakes considering the design stopping analysis and in compliance with Section 3.8.5.

3.8.4.1 Heat Fade

The emergency braking system will function without degradation for three (3) successive applications from the maximum speed with an AW2 load and without overheating at the maximum ambient temperature. If the emergency braking system has any components in common with the service braking system, then the emergency braking system will function without degradation after meeting all requirements for the service brake duty cycle as specified in Section 3.8.2.

3.8.4.2 Wet Fade

Verified by calculations, ingress of water to the braking system will not cause any departure of the braking capability from the deceleration and stopping distance requirements necessary for the safe train separation assurance requirements.

3.8.4.3 Contaminants

Contamination of the emergency braking system by any fluids or foreign substances in proximity to braking components that might reasonably enter through a leak or other system malfunction will not adversely affect the deceleration levels required for the safe train separation assurance requirements.

3.8.5 Design Stopping Conditions

Design stopping distances for the System will be developed analytically according to ASCE 21-B 5.1.2 and the results provided for review in the appropriate design review. Such computations will include all worst-case time delays, train and motor over speeds, and acceleration conditions. The effects of any grade will be properly accounted for. The Ultimate-length, AW2 loaded train will be used. Guideway, tire, and other relevant conditions will be the cumulative worst-case conditions. The deceleration rate will be appropriately reduced to reflect the emergency brake performance and holding capability resulting from a single worst-case element failure or loss within the brake system. This consideration is to be applied irrespective of emergency brake fail-safe design criteria.

The stopping distances, as computed above, will be greater than the actual worst-case stopping distance exhibited by the completed System.

3.8.6 Parking Brake

The parking brake function will be provided by a mechanical or friction parking brake. It will be activated wherever the car is stopped including normal service stops in station. The parking brake function may be provided by elements of the service and/or emergency brake equipment, provided that the requirements of Sections 3.8.3 and 3.8.4 that are applicable to that equipment are met.

The parking brake will sustain an AW2-loaded, Ultimate-length train in a stopped position for an indefinite period on the maximum grade without application of guideway or car-borne power and with 50% of the parking brakes inoperative. Alternatively, it will hold for at least 24 hours, provided that subsequently a method capable of holding, such as chocking the wheels, is provided to immobilize the train indefinitely. If a separate parking brake is provided, it does not have to be applied during normal service such as regular stops in stations. Parking brake system failure will result in the application of emergency brakes in accordance with Sections 3.8.4 and 3.8.5.

3.8.7 Additional Overrun Protection

The standard vehicle length (2 cars) is required to operate near end of line devices. Therefore, the system will provide end of line overrun protection.

3.9 Electrical Subsystem

The car electrical subsystem will comply with the following requirements.

3.9.1 Primary Power Subsystem

Primary power for the car will be obtained from 3-phase, 60Hz, 600V AC power rails on the guideway and conditioned on the car to 120V AC single phase via as well as 24V DC control power.

3.9.2 Emergency Power Subsystem

In the event of loss of primary power, on-board battery emergency power will assure uninterrupted continuation of the following functions for a period of at least one hour, unless otherwise specified:

- Public address and continuous two-way communications with Central Control.
- Fresh air ventilation.
- Car emergency illumination levels of Section 3.9.8 or better and all car exterior lights.
- Any car function required for disabled car recovery.
- TCMS System; and
- Alarm and malfunction reporting.

Each car will have a means of keeping the emergency battery(ies) in a constant state of readiness and an indicator showing the level of charge in the battery(ies). All batteries on the car will be suitable for a transit application, will be properly encased, ventilated, if necessary, and mounted in a corrosion-resistant mounted box isolated from the passenger compartment. Also contained in this box is a temperature sensing device. A low battery charge condition will be alarmed at Central Control. The emergency batteries will be Lithium Iron Magnesium Phosphate, or similar, specifically designed for motive applications with single cell monitoring through the TCMS.

Implementation of lithium-ion chemistry requires use of a Battery Management System (BMS) to provide additional autonomous protection and ensure that the battery is maintained within safe operating limits. The BMS is designed to communicate directly with the battery modules via an RS-485 communication link which is directly connected to a processor within the battery module case. The BMS will act to remove the batteries from the distribution system if threshold limits are exceeded to ensure safe operation is maintained.

3.9.3 Power Collection

Car power will be obtained via the power collectors. Each car will be provided with power collectors compatible with the characteristics of the existing contact rail. The power collector will function under the maximum expected excursions of the car from wind loads, passenger load, centrifugal load, dynamic load, and normal variations in tire pressure.

Power collector redundancy will be provided to ensure continued contact throughout the guideway. Each collector assembly will be sized to carry the entire car electrical load for an indefinite period.

The brushes used in the power collectors will have a minimum service life of 7,500 miles, except that no more than 3 percent of all brushes may have a service life of less than that amount.

The connector(s) of the power collectors and the car electrical system will ensure that power to the collectors is disconnected whenever maintenance shop power is provided to the car. This connector and the location(s) for application of shop power will be protected from the environment by a manually operated cover which cannot be left open for revenue service. They will include a locking device to ensure that connections are not broken while the car is in service. They will not expose maintenance personnel to hazardous conditions.

3.9.4 Circuit Breakers and Interrupters

All onboard circuits and devices of the auxiliary subsystems will be protected from overload and faults by circuit breakers, fuses, or other interrupt devices. All such devices will be manufactured in accordance with NEMA standards or have demonstrated proven operation in the same or similar service. All faults will be isolated to the smallest isolatable segment of circuit.

Each breaker will have a name plate clearly and permanently marked with the name of the circuit it protects.

The electrical system distributes the 600V AC through the appropriate circuit breakers for power and protection of HVAC system, the air supply unit, low voltage power supply, convenience outlets, battery charger, and the propulsion subsystem. The low voltage DC system is distributed to user loads through a circuit breaker distribution panel accessible in the above floor compartment. User loads are distributed among circuit breaker distribution by function, redundancy, and criticality (for load shed purposes).

3.9.5 Wiring

All wiring will be unalloyed copper and at least equal to that specified in NFPA 130, 2020 Section 8.6.7. Wiring will be clearly marked in accordance with the car electrical schematic for ease of identification in maintenance and troubleshooting. Wiring will meet the requirements for flammability and smoke emission described in this proposal Section 3.15.

All car wiring will be properly secured and protected in enclosures or secured in wiring trays that are properly drained and that physically separate high and low voltage wiring. All plastic materials will meet the flammability and smoke emission requirements of Section 3.15.

All conduits will be of a material capable of withstanding the duty and environment into which it is applied. Wire in conduit, ducts, and raceways will be free of kinks, insulation abrasions, and insulation skinning.

Wire will not be bundled if in a conduit, duct, or raceway. Each wire will be removable for replacement without disturbing other wiring in the enclosure. Where wire is in open areas, bundling will be permitted if this wire removal criterion is met. Any exposed wire will be cleated, tied, or secured by other suitable means.

3.9.6 Connections, Connectors, and Splices

Connections will be through environmentally protected locking-type plugs, or bolt-on terminal strips. Wires between terminals will not be spliced or soldered. Bolted terminal connections with overall insulating sleeves may be used to connect car wiring to the propulsion motor leads and the maintenance power connection. If unavoidable, solderless connectors installed under a controlled process may be used.

3.9.7 Grounding

Each car will be grounded at all times by means of a non-fused grounding circuit. A minimum of two grounding brushes, each with sufficient current-carrying capacity to handle fault currents of the entire car electrical subsystem, will be in contact with the ground rail at all times. The worst-case fault current will not permit a voltage greater than 25 volts to appear between the car with the car operating at any location on the guideway and with only one ground brush contacting the ground rail.

The car body, frame, or structure will not be used to carry current for any vehicle electrical circuit. All electrical and electronic metal enclosures and all equipment that uses electrical power will provide a low-impedance path from the enclosure/equipment to the car structure. Where feasible, bonding will be direct metal-to-metal contact between the enclosure/equipment and car structure; otherwise, conductors of sufficient cross-sectional area to carry fault current of the equipment will be used.

3.9.8 Lighting

3.9.8.1 Interior Lighting

Car interiors will be designed with lighting fixtures that are secure, rattle free, and vandal resistant. Powered fixtures will be inaccessible to passengers. Diffusers of a material that is shatterproof will be provided.

Interior lighting is provided by 2 rows of energy efficient LED lighting fixtures that run the full length of the car and are integral to the ceiling. These fixtures provide a consistent level of light throughout the car interior with no “hot spots” unpleasant to the eye. These LED light fixtures also house air diffusers that run the entire length on both sides of the car for even air distribution ensuring passenger comfort.

The LED light fixtures also provide emergency lighting in the event of track power loss. End interior lighting can be manually dimmed via the manual controller located on the car by an operator to reduce glare while operating in manual mode.

Interior LED-type lights will provide illumination levels that will be at least 210 lux (20-foot candles) when measured 76 cm (30 in) above the floor level and at least 54 lux (5-foot candles) at all floor level locations. When power is provided by the car emergency battery, the lighting system will provide minimum illumination level per NPFA 130:2017. Emergency LED spotlights will illuminate the path from each car exit to walkway. The values are to be measured with all light diffusing panels in place. LED units are guaranteed for the design life of 50,000h.

3.9.8.2 Exterior Lighting

LED-type headlights and directional lights will be provided on each end of each car. The exterior lights are designed to function as follows:

- During normal (automatic) operation of the vehicle, all the headlights are off.
- During manual mode driving (including manual supervision of ATP), only headlights of forward end will be illuminated such that they provide a good view of the guideway ahead such as to permit safe manual operation of the vehicle.
- Under any operation conditions, the directional lights are always illuminated in WHITE in direction of travel and RED at the tail end.
- Directional lights between cars are off.

The headlights are compliant to FMVSS 108 and will provide sufficient illumination for forward visibility of at least 5 lux at 10 m (0.5 foot-candle at 33 ft).

3.9.9 120-Vac Power Supply

An on-board power supply will provide 120V AC, 60 Hz sine wave power through two (2) American standard, three-prong grounded outlets. Each outlet will be protected against unauthorized use or vandalism by a tamper-resistant cover.

3.9.10 Maintenance Power Connection

The car will include a device to accommodate the connection of electrical power to the car from a source other than the power collectors described in Section 3.9.3. This device will be protected from weather when not in use. Such a connection will be for the purposes of conducting car maintenance and will be through an umbilical cable and connector assembly. It will be possible to operate all car electrical loads, including propulsion at AW0 loading, through this connection. Connection of this umbilical connector to the car electrical subsystem will ensure that it is not possible for the car collectors to be powered from the maintenance power source. When the shop power is connected, the car is not operationally limited in speed. While connected to the maintenance power source, the car will be grounded through a non-fused grounding circuit.

3.10 Suspension and Guidance Subsystems

The car suspension and guidance subsystems will provide positive mechanical methods for retaining the car in the lateral direction. The car will be stable against tipping for all operating and environment conditions (see Section 3.4.2).

3.10.1 Suspension and Guidance System Overview:

Each bogie incorporates a single rigid truck axle equipped with two sets of dual pneumatic tires. Each car bogie has a fully functional drive train that consists of the following major items:

- Traction motor;
- Drive shaft;
- Drive axle.

These major underframe subassemblies are standard designs that have millions of miles of proven field service at all APM 100 sites where Alstom systems are in operation. Bogie structural elements which support the wheels and suspension are designed and analyzed in accordance with load cases defined in ASCE 21.2-08; in particular, a horizontal static load of 0.3g.

Two AC traction motors provide propulsion to each car to obtain the required speeds and accelerations. Connecting the motor and the axle is a short tubular drive shaft, utilizing single Cardan U-joints and a slip-yoke at the motor end.

Central to each bogie is a rigid (non-steering) truck axle suspended from the bogie by conventional leaf springs. The drive axle assembly on a bogie is composed of an off-highway rigid axle with planetary hubs commonly used as a rear axle of a tandem arrangement. Primary speed reduction is through a full-floating differential with hypoid-type gears mounted in a machined housing. Planetary geared hubs provide a secondary speed reduction.

The vertical suspension consists of two semi-elliptic taper leaf springs and two air springs per bogie. The leaf springs support the empty car weight while the air springs support the passenger load. Height control valves are provided with the air springs to level the suspension.

In the event of an air spring failure, the air springs are equipped with an internal rubber spring. The car envelope is studied under various failure conditions to guarantee clearance between the car and civil structures. Failure conditions include all possible combinations of failures at the drive tires, guide tires and air springs.

Steering is affected by allowing the rigid axle and the entire suspension system to pivot on a large diameter bearing that attaches the bogie to the underframe of the car.

A combination of split lock washers, cotter pins and safety wire are utilized on the bogie and underframe equipment to ensure fastener integrity. Fastener configuration has evolved to the current level through years of operating experience.

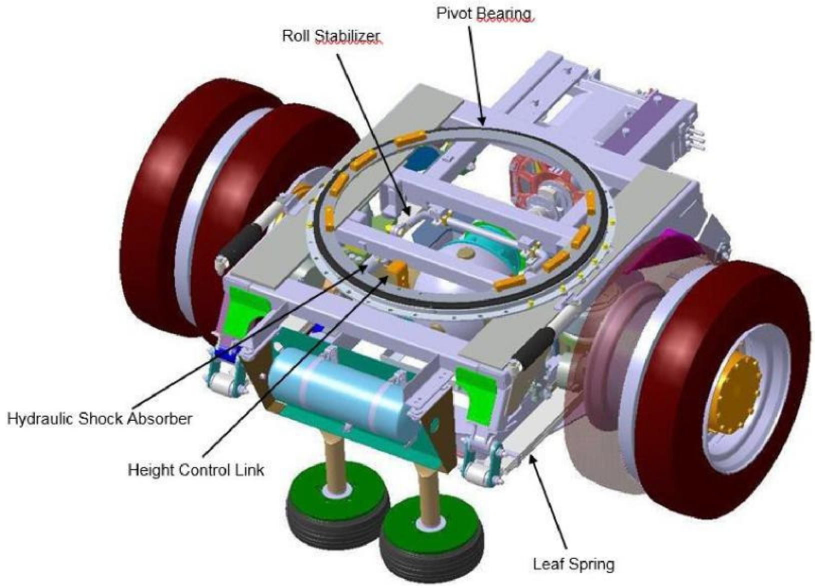


Figure 4: Suspension System Outline

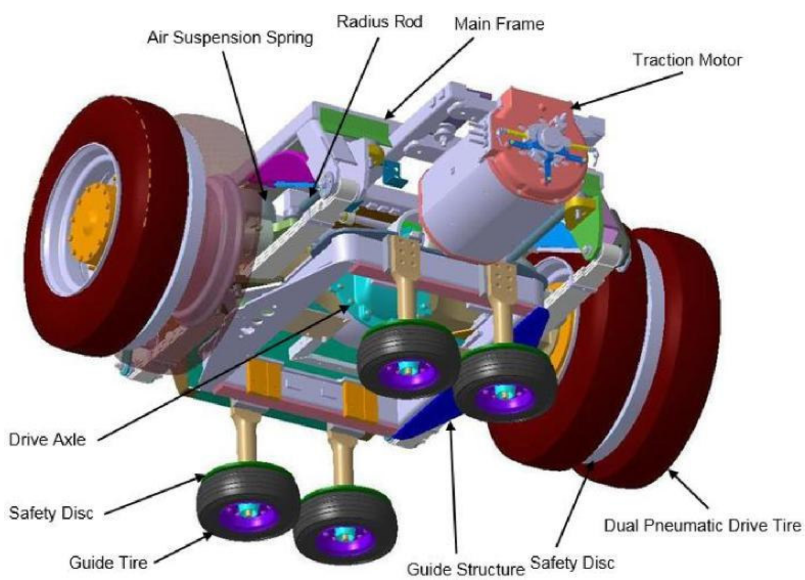


Figure 5: Suspension System Outline

3.10.2 Suspension and Guidance System Component Description

3.10.2.1 Drive Tires

The drive tires are 10R22.5 tires in a dual set configuration. They are equipped with a safety disc located between each dual set to limit the drop of the car in the unlikely event of dual flat tires. The drive tires will achieve a minimum life of 50,000 miles. The tires are equipped with a tire pressure monitoring system. In the event of pressure falling below the designated threshold, an alarm will be sent to central control and the car will hold at its next station.

3.10.2.2 Air Springs

Four air springs (two on each suspension assembly) support all loads added to an empty car. They are controlled by height control valves to keep the car floor the same height as the station platform.

Two height control valves (one at each side) on the #2 end axle, and one in the center of the #1 end axle, provide a stable tripod arrangement of height-sensing that adjusts the air pressure in all four of the air springs to keep the car body height constant at all times.

As the car is loaded, the leaf springs deflect, lowering the main body frame. The height control valves sense this lowering and open to provide air to the air springs, raising the car floor back to platform height.

When the load lightens as passengers leave the car, the frame rises. The height control valves sense this rise and open to exhaust air from the springs, lowering the car body until the floor is even with the station platform.

The air springs receive air from the car's compressed air system that also supplies the brakes. Air enters the springs via a hollow box-beam reservoir that is part of the drive and suspension assembly frame.

3.10.2.3 Leaf Springs

The weight of the car and its passenger load is shared by a combination of leaf springs and air springs. The leaf springs support the car weight when it is empty, while the air springs support the passenger load. The weight of the car is supported by four of these leaf springs, one on each side of each drive and suspension assembly.

3.10.2.4 Pivot Bearing

The pivot bearings are ball-bearing ring assemblies that attach the drive and suspension assemblies to the underframe. The drive and suspension assemblies pivot on these bearings to address any curves on the guideway.

3.10.2.5 Radius Rod

Two radius rods stabilize each drive and suspension assembly by overcoming the tendency of the springs to wrap-up due to the torque produced when accelerating or braking. One end of the rod is attached to a bracket on the drive and suspension assembly, the other end attaches to the axle. There are ball joints on each end of the radius rods.

3.10.2.6 Shock Absorbers

Two heavy-duty shock absorbers are attached diagonally between the axles and the suspension frame. These shock absorbers stabilize the car against sway and wheel bounce due to irregularities in the roadway. Each drive and suspension assembly are equipped with twin-opposed horizontally mounted shock absorbers that dampen rotational motion of the drive and suspension assembly with respect to the car body.

3.10.2.7 Guide Structure

The guide structure is a welded steel frame attached to the underside of each drive and suspension assembly. It supports the four guide wheel assemblies and the current collectors.

The guide structure steers the drive and suspension assembly along the roadway, following the central guide beam with the guide wheels. When following a curved section of the guide beam, the guide structures pivot the drive and suspension assemblies on the pivot bearings beneath the car.

The four guide wheel assemblies are bolted to the guide structure so that each wheel is in contact with either side of the web of the guide beam. The guide tires are designed to operate for a minimum life of 50,000 miles.

3.10.2.8 Main Frame

The main frame connects the suspension components to the ring bearing. The main frame sits above the axle and is rigidly connected to the guide structure. Structural hollow tubes of the main frame act as the air reservoir for the air suspension system.

3.10.2.9 Guide Wheel Safety Disc

The outside diameter of the safety disc is 14.50", slightly smaller than the outside diameter of the rubber guide tire (16.00") it attaches to. It is provided just above the wheel to engage the upper flange of the guide beam. This lock-on feature precludes the need for debris deflectors, as debris cannot cause vehicle derailment.

3.10.2.10 Roll Stabilizer

A roll stabilizer is provided to minimize car roll motion. This function is provided by a simple mechanical torsion type anti-sway bar mounted between the drive axle and the bogie main frame.

3.10.3 Loss of Load Levelling

Load levelling is used to provide vertical alignment. Unsafe car tilting in the event of a failure will be prohibited. In addition, the sides of the cars that might contact the platform edge will be sufficiently strong to withstand such contact without being damaged.

3.10.4 Odometers

Each wheeled car will have its mileage recorded. The propulsion application will compute the car travelled mileage regardless of the direction of vehicle travel on a car basis. The car mileage will be displayed on the Manual Controller Driver's screen.

3.11 Doors

Automatic, power-operated, bi-parting, horizontally sliding doors will be provided on both sides of the car for passenger entrance and exit. These car doors will operate in coordination with the station platform barrier doors. There will be a minimum of two sets of doors per side of each car. The number of doors will be the same as the existing APM100 vehicles.

3.11.1 Features and Dimensions

Both door panels of a car door will be controlled and operated by one overhead door operator. The dimensions of the car doors will be identical to the existing APM100 car fleet, apart from the door height.

The car door system configuration is a bi-parting outside sliding arrangement with overhead door operators. There are left-hand and right-hand door panels. Door panels are honeycomb design with safety glass. Both panel leading edges have a rubber seal to prevent pinching when the door is closed. The door panels also have a trailing edge seal which forms a watertight seal at the end of the door. The door operator is mounted under a cover for easy access from the outside.

Each door operator is controlled by a Door Control Unit (DCU). The DCU controls the function of the door opening according to the signals from train network or the ATC alternate door opening trainline in case of train control failure.

The door operator is powered by a 24 Volt motor. The motor drives a screw which then opens or closes the doors depending on the rotation direction.

The doors nominal opening time is 3 seconds and the closing time is 4 seconds.

3.11.2 Door Operation

Enabling of the car and corresponding station doors will be authorized by the ATP sub-system and will occur only if the following conditions are satisfied.

- The train speed is zero;
- The train is properly aligned with the station doors, and;
- The brakes have been properly applied and power has been removed from the propulsion motors.

Automatic operation of the car and corresponding station doors will be controlled by the ATO sub-system, subject to the safety checks of the ATP sub-system.

The TCMS interfaces to the door control units and the TCMS controls the doors based on train-wide commands received from the controlling vehicle ATC.

The door system normally operates fully automatically. Under certain conditions it may be necessary for the passengers to open the doors, however this can only occur when the car is stopped and only at the positions and side that are permitted to be opened.

3.11.3 Door Safety

Door or door control subsystem failures will not result in a car door unlocking or opening when not commanded to do so and will meet the following requirements.

The ATP subsystem will ensure that no automatic mode failure will result in the unlocking or opening of a car or station door.

If any car door or emergency exit unlocks for any reason while a train is in motion, the train will be irrevocably service braked to a stop. For all instances in this paragraph, only manual reset on board the train will be permitted.

If any station platform or emergency door is unlocked for any reason, cars will be prohibited from entering or leaving that station platform. If any station platform or emergency door is unlocked for any reason after a car has entered the station platform area, the car will be emergency braked or irrevocably service braked to a stop. Brake reset will be only by local manual reset onboard the car. For any unscheduled car or station door unlocking or opening, regardless of the cause, an alarm will be automatically annunciated at the Central Control indicating that this emergency condition has occurred.

It will not be possible to entrap fingers, hands or clothing between door panels and adjacent fixed sections while doors are opening or closing. All car door panels will have a door reopening feature which, when door motor senses a resistance, will cause both panels to recycle stop, reverse direction, return to the fully opened position, and then begin the closing cycle again. The cars will conform to EN 14752 wherever applicable. Entrapment of any object down to 10mm in width will cause reopening with both door panels operating. Door test will be performed with test object the size of 10x50mm at three locations (high, middle, low). The force to extract will not be greater than 33lbs (150 N). The door reopening period in this cycle will be adjustable from one to ten seconds and in not greater than one second increments. Activation of the door reopening feature on any car or station door panel will operate all car and station door panels at the affected doorway. Door panels at unaffected doorways on the train will not be recycled. Activation of the door reopening feature causing the doors to recycle three times will result in an alarm at Central Control.

The ATP subsystem will ensure that a train stopped in a station will not be allowed to move unless all train and station platform doors are properly closed and locked and the train brakes have been released. Once these conditions are satisfied, the service brakes will be applied, and an alarm will be sent to Central Control if the train does not move within ten (10) seconds of being commanded to do so. Manual and remote brake reset will be provided.

With car power applied to the door operating mechanism, the door panels will automatically unlock and open, and close and lock. The doors will not be locked until the space between door edges is 0.25in (6.5mm) or less. This will be tested with a test object in the size of 5x30mm at three locations (high, middle, low). In the event of loss of power to any car door mechanism, it will be possible to open the failed door manually (after unlocking) with a force not exceeding 156 N. All car doors will have a mechanism on the exterior of the car to unlock and open the door panels manually without car power and without the use of a key or similar device.

No door will exert a closing force more than 35lb (133 N) for the full range of door motion, even when the reopening feature has been deactivated. The kinetic energy of each car door panel, including all parts rigidly connected to the door and completed for an average closing speed will not exceed 7 foot- pounds (9.5 J). The average closing speed will be calculated by measuring the time required for the leading edge of the door to travel from a point 1 inch (25.4mm) away from the open jamb to a point 1 inch (25.4mm) away from the point of closure. When the door reopening feature is no longer active, just before door closure, the kinetic energy, as computed above, will not exceed 2.5 foot-pounds (3.4 J).

The door panels will not separate due to forces from acceleration or deceleration in combination with guideway grades.

Each door panel will be of sufficient strength to meet the requirements of Section 3.4.2. Door performance will not be adversely affected after such loads are removed.

3.11.4 Door Alignment

Under all load conditions, the car door threshold will be level with the platform floor so that the difference in elevation between the car and station floors will not exceed 7/8-inch in either direction (see also Section 3.10.3). The horizontal gap between the platform edge and the car floor edge, with the door open, will not exceed 2.0 inches.

3.11.5 Emergency Exits

Each car will be equipped with one or more emergency exit(s) which will lead to a safe emergency egress route at any point in the System, regardless of train length. If emergency exits separate from the regular passenger doors are required to meet evacuation requirements, they will meet the retention and release requirements of Federal Motor Vehicle Safety Standard 217. Emergency doors will not impede passenger exiting. Opening any emergency door and/or regular passenger door used as an emergency door will be possible from inside and outside the car by means of a mechanical latch that operates independently of any on-board power and complies with Section 3.11.3 and the following requirements. The emergency door-operating mechanisms on the inside of the car will be conspicuously marked including simple operating instructions and will be permitted only on the emergency walkway side. The mechanism on the unsafe side of the car will be electrically disabled to prevent the possibility of unsafe opening. These mechanisms

and instructions will be clearly visible under normal and emergency lighting conditions. The emergency door and any such operable passenger door will open onto the emergency walkway. The emergency door operating mechanism will fail in a manner which permits the emergency doors to open when operated. Such failure will result in an alarm message to Central Control. (See Section 3.11.3)

3.11.6 Door Reliability

Car doors have been tested for operation for at least one million cycles without failures exceeding predicted reliability values with normal scheduled maintenance. After one million cycles, doors will continue to meet all performance requirements of this specification.

3.12 Exterior Design

The car will have a clean, smooth, simple design. The exterior and body features will allow complete and easy cleaning, including in an automatic car wash. Body and windows will be sealed to prevent leaking of air, dust, or water under normal operating conditions and during cleaning by personnel or the automatic car wash.

The color scheme and design of the cars will match the approved designs as submitted for Airsides A&C. Below are the two approved exterior color scheme renderings which will be delivered for Airside E.

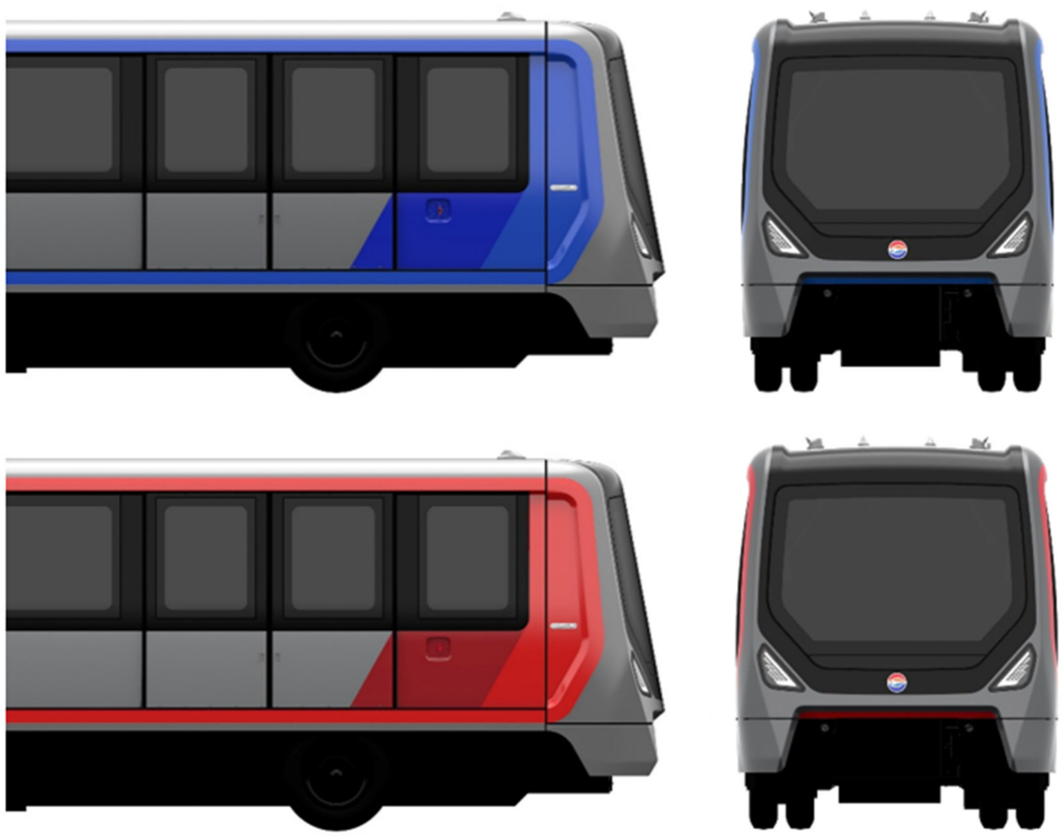


Figure 6: Vehicle Side and Front Views

3.12.1 Passenger Module

The passenger module will be fabricated of stainless steel, aluminum, high-strength low-alloy (HSLA) steel, gel-coated fiberglass reinforced plastic, high-strength composite material, or a combination of these materials. Aluminum will be "A" in resistance to corrosion as defined in the Aluminum Association Structural Handbook. All exterior metallic car body materials (as shown in Figure 7 Passenger Module) will be designed for corrosion-resistance sufficient to withstand salt spray test in accordance with ASTM Procedure B117, "Method of Salt Spray (Fog) Testing". Weathering steel, such as ASTM A588, will not be used. All dissimilar metal components including fasteners will be electrically insulated from each other to prevent galvanic corrosion.

The passenger module is primarily made up of aluminum extrusions welded and or bolted into large sub-assemblies as shown in Figure 7 Passenger Module. These panels are joined together using structural fasteners. The undercar has some steel substructures associated with various interfaces. The passenger module uses modern materials and assembly techniques, minimizing the use of special processes at assembly and maximizing the value of the assembly.

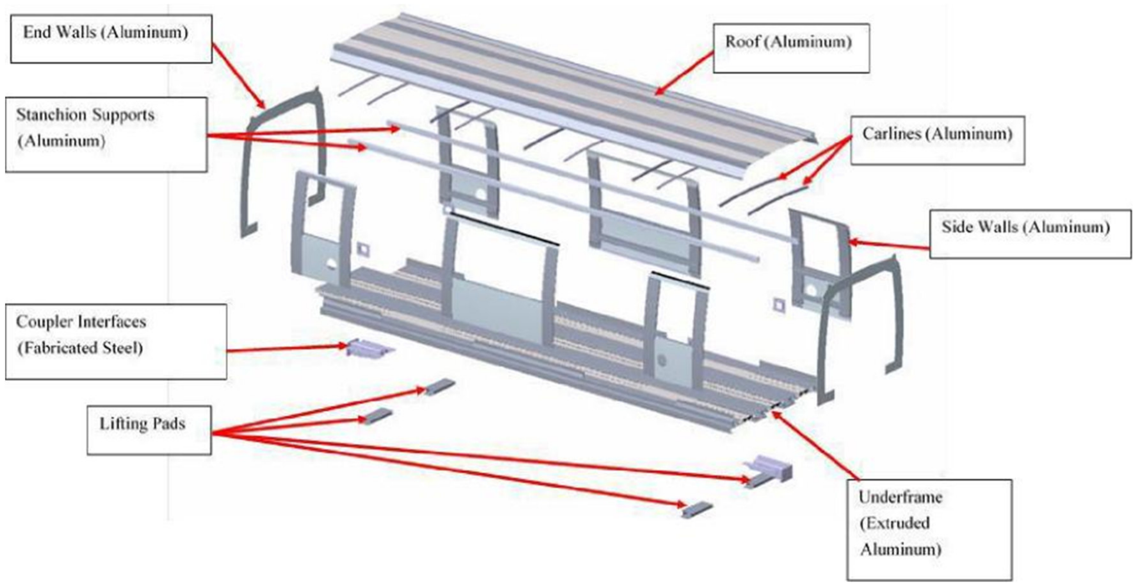


Figure 7:Passenger Module

3.12.2 Finishing

The car exterior will be painted completely to conform with the approved color scheme and design. Fiberglass need not be painted if the desired finish colors are an integral part of the gel-coat. Steel will be completely primed and painted. Stainless steel will be painted only as needed to meet aesthetic and thematic design requirements. Aluminum will be anodized or completely coated with zinc-chromate primer or similar and painted.

Numbers, signage, and logos are applied to the exterior using decals. The exterior paint system is suitable for the purpose of transit applications and is expected to provide protection and aesthetics throughout the design life of the car.

3.13 Watertight Construction

Each Car/Vehicle, at AW0 and AW2 loading with doors and window seals installed, shall be watertight when exposed to water spray from a 40 psi, 5 gpm nozzle located five feet from the exterior surface and directing the water perpendicular to the surface during factory tests required. The entire Vehicle, sides, ends, and roof shall be tested after a minimum soak time of ten (10) minutes.

At least one watertightness test shall be performed on one Car/Vehicle.

At least one watertightness test shall be performed with the passenger compartment loaded to simulate the normal passenger floor loading condition, to reflect actual floor loading on the vehicle, and another shall be performed at AW0 and AW2 after all materials and equipment have been installed. Insulation that is integral with walls of a sandwich construction shall be permitted in both tests as long as tests include detection of any leaks and seepage at any holes in, and at the edges of, such wall material. A small amount of seepage will be permitted at the door seals; however, no water shall spray into the Vehicles at the door seals. During the watertightness testing, water will not enter, or in any way impair the operation of, any subsystem or equipment.

Each car will be watertightness tested as a finished car over its range of AW0 loads, including doors and window seals.

3.14 Interior Design

Car interior dimensions will accommodate the range of the 5th percentile of female population to the 95th percentile of male population in accordance with ISO 3411. Corridors and aisles will have a height of at least 80 inches. The main aisle width will be at least 34 inches to permit access by a wheelchair (see Section 3.7.4). All standing passengers will have access to vertical stanchions or handholds (see Section 3.14.8).

The interior will have no sharp depressions or inaccessible areas and will be easy to clean and maintain. Handholds, lights, air vents, armrests, and other interior fittings will appear to be integral with the car interior. There will be no sharp, abrasive edges, corners, or surfaces and no unnecessary or hazardous protuberances.

Interior panels and partitions will be permanently mounted by tamper-resistant and vandal-resistant fasteners or welded in place. Interior panels will be attached so that there are no exposed edges or rough surfaces. Panels and fasteners will not be removable by passengers. Use of moldings and small pieces of trim will be minimized. Individual trim panels and parts will be interchangeable to maximum extent practicable.

As part of the car design review and in conjunction with the similar requirement of Section 3.12, Alstom will submit a color rendering and other drawings showing general layout and design of the proposed interior design and color scheme for review with customer. The interior design and rendering will match the approved designs as submitted for Airsides A&C.

Figure 8: Interior Layout

3.14.1 Interior Materials

Materials will be selected based on ease of maintenance, durability, appearance, safety, and tactile qualities. Materials will comply with the requirements of Section 3.15. Trim and attachment details will be simple and unobtrusive. Interior trim will be secured to avoid resonant vibration.

All composite panels, floor covering, and interior materials are easy to maintain, resistant to vandalism, and impervious to normal cleaners and ink from most felt tip pens. The materials meet the minimum requirements for flammability and smoke emission characteristics as defined by NFPA 130 with revision current at time of Notice to Proceed. Gelcoat color for the FRP liners is a customer choice item.

Interior panel material will permit easy removal of paint, greasy fingerprints, and ink from felt tip pens, etc. Materials will be strong enough to resist everyday abuse and vandalism and will be resistant to scratches and markings. Door frames will be manufactured in stainless steel.

Flooring is described in Section 3.14.4. Seat materials are described in Section 3.14.5.

3.14.2 Access Panels

Access for maintenance and replacement of equipment will be provided by panels and doors that appear to be an integral part of the interior. All equipment compartments will be sealed to prevent unauthorized entry. Opening of all interior access panels will require a special tool or key. The manual controller cover and equipment cover use the same key, which is different from other access panel keys. Panel fasteners will be standardized so that only one tool is required for special fasteners within the car. Access doors for the door actuator compartments will prevent entry of mechanism lubricants into the car interior. Removal of fixtures or equipment unrelated to the repair task to gain access will be minimized. Access doors will be hinged with props to hold the doors out of the technician's way. Overhead access panels will have safety catches to prevent the panel from dropping.

3.14.3 Fire Barriers

The passenger compartment will be separated from any of the compartments containing the propulsion units, the propulsion control units as well as any high-voltage powered auxiliary equipment by the car structural floor which incorporates fire-resistant materials in its construction. These fire barriers will resist the propagation of any fire from propulsion or propulsion control unit compartment into the passenger compartment. These fire barriers will meet the requirements of NFPA 130 (2020), which includes compliance to ASTM E119 (2015) and ASTM E648.

All panels that provide separation between the car interior and any electrical or mechanical equipment other than communication panels, light switches, destination switches, etc., will meet the requirements of NFPA 130 (2020).

Any penetration through the fire barrier into the passenger compartment will be designed to meet the requirements of NFPA 130 (2020) and ASTM E119 (2015).

3.14.4 Floor

The floor deck will be made of floating floor panels resting on the structure securely to prevent chafing or horizontal movement and increase passenger comfort. Floor fasteners will be secured and protected from corrosion and rot for the service life of the car. Floor covering will withstand a pressure of 5 MPa with a maximum residual indentation of 0.15 mm as per ISO 24343. Floors will meet the structural requirements of Section 3.4.1.

The floor covering material is a 2mm thick rubber ultra-resistant to wear.

The floor of the passenger cabin will be a continuous flat plane. The entire floor will be covered with material that remains skid-resistant in all weather conditions. Flooring material will be installed to prevent edges from coming loose. Floor covering joints are transverse to reduce the waste of material and ease the installation. The floor covering and transitions of floor material to thresholds will be smooth and create no tripping hazards. Door threshold plates are raised above the top of the finished floor approximately 6.4 mm to cap the floor covering edge; this is within the ADA definition of "flat" with respect to tripping hazard. Where the flooring meets the walls of the car, the surface edges will be blended to prevent debris accumulation. Samples of floor covering material will be submitted to customer for review and approval as part of the car design review with a choice of standard colors.

The floor, as assembled, including the sealer, attachments, and covering, will be waterproof, non-hygroscopic, resistant to wet and dry rot, resistant to mold growth, and impervious to insects. Any access openings in the floor will prevent entry of fumes, flames, and water into the car interior.

Side kick panels will be mounted to a minimum 1ft high and will be made from stainless steel.

3.14.5 Seats

Per the current Alstom INNOVIA APM100 vehicles of Tampa system, the cars will offer bench seating at both ends of the passenger compartments sufficient for eight (8) persons (four per bench); there are no seat backs on these seats. There are no free-standing or wall-mounted seats within the floor area of the passenger compartments.

Interior equipment is housed under each hinged bench seat and is easily accessible with removable covers and panels.

3.14.6 Windows

All windows will be fixed in position. The windows should be structurally designed to withstand the impact of a falling person during emergency braking. All windows will be replaceable without disturbing adjacent windows. Flexing during operation will not be apparent. The window glazing will be free of visual distortions.

Visible light transmittance (VLT) of all windows (side and end windows) will be 23%. The tint color will be dark grey.

All car glazing will be certified to meet the requirements of ANSI Z26.1. Front and rear windows will be certified to item 1 tests (AS1) (except for VLT test which is less than 70%). All other windows will be certified to item 3 tests (AS3). All windows will be of laminated glass with a minimum thickness of 0.25 inches.

The window in front of the operator's position at both ends of trains equipped with on-board manual controllers will provide a field of view which will permit the operation of the car manually on the guideway. During manual driving of the car, reflection from inside the car on the end windows will be reduced by diming interior light fixtures. The current standard design does not include interior condensation removal system.

3.14.7 Insulation

Any insulation material used between the inner and outer panels will be fire-resistant as identified in Section 3.14 and sealed to minimize entry of moisture and to prevent moisture retention in sufficient quantities to impair insulation properties. Insulation properties will be unimpaired by vibration compacting or settling during the service life of the car. The insulation system will be non-hygroscopic, resistant to fungus and breeding of insects, and will not absorb or retain oils.

Alstom will incorporate modern design philosophies by creating a vapor barrier to prevent the formation of condensation behind insulation against cold surfaces.

The insulation will have a foil sheet material (FSK) applied to the inner surface. This FSK material will be a barrier against water and air (vapor) and prevent passage from the inner face. To complete the system, the edges of the insulation will be sealed with a similar foil tape to the adjacent insulation pieces or the vehicle structure.

Air will not pass through the insulation barrier to make contact with cold surfaces, and any potential moisture from the front face will be blocked by tape and foil.

In addition, the foil will be a deterrent to vermin and the insulation possesses no nutrient properties to support growth.

The combination of inner and outer panels on the sides, roof, and ends of the car and any material used between these panels will provide a thermal insulation sufficient to meet the interior temperature requirements identified in Section 3.7.1. The car body will be thoroughly sealed so that drafts cannot be felt by the passengers during normal operations with the passenger doors closed.

3.14.8 Stanchions and Handrails

Any standing passengers at any location in the car will be able to easily reach either a vertical stanchion, a horizontal handhold between vertical stanchions, or a handhold.

Handrails and stanchions will be convenient in location, shape, and size for both the 95th percentile male and the 5th percentile female standee in accordance with ISO 3411. Vertical stanchions will be located throughout the car interior but not in areas where they obstruct aisles, doors, or wheelchair access or cause congestion near doors. While any person within the 5^{th} to 95^{th} percentile will have access to at least one handhold, not all types of handholds will be accessible to all passengers in this range (i.e., ceiling handgrips will not be accessible to 5^{th} percentile females but limited to 11^{th} percentile females).

Stanchions and handholds will be of colored powder coating finish or stainless-steel tubing with brush satin finish. They will be able to support the forces in accordance with ASCE21-13 section 7.4.4.1.2 analysis and design requirements. Any joints in the handrails or stanchions will prevent vibration or passengers from moving or twisting them.

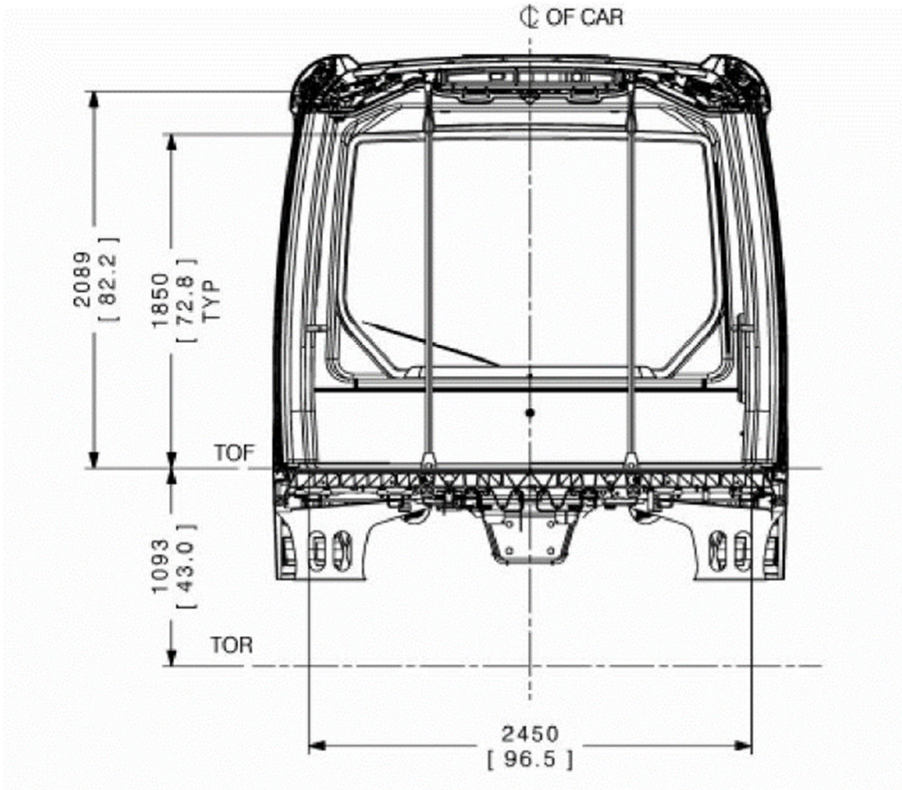


Figure 9: Griping Layout – Vertical Position

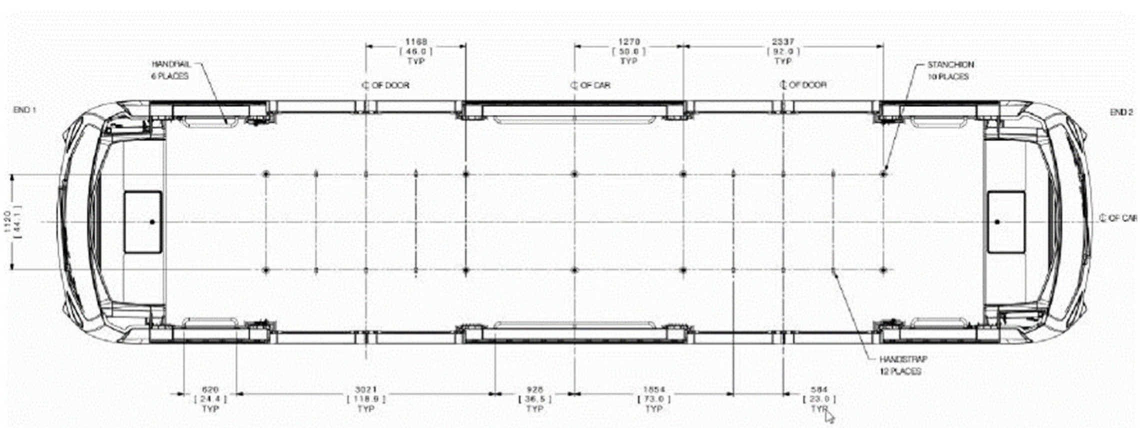


Figure 10: Griping Layout – Horizontal Position

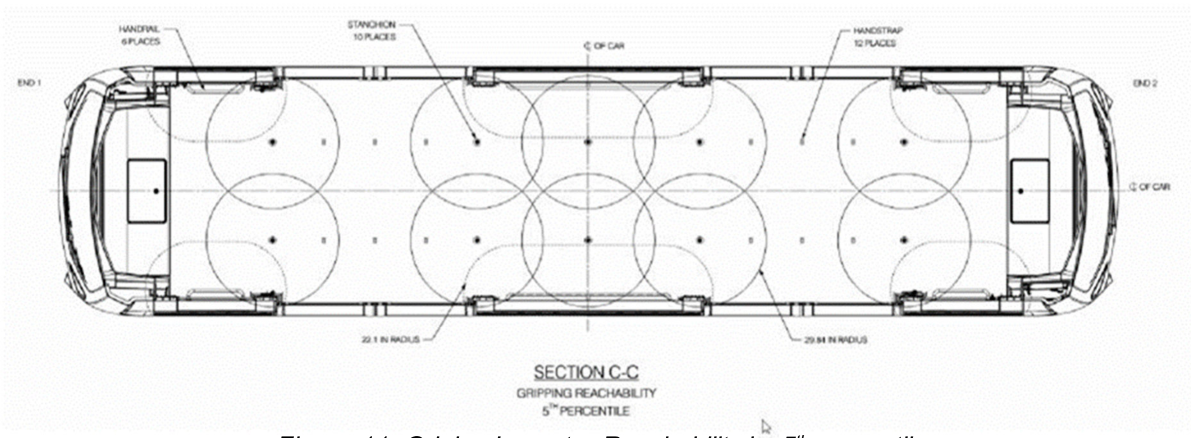


Figure 11: Griping Layout – Reachability by 5th percentile

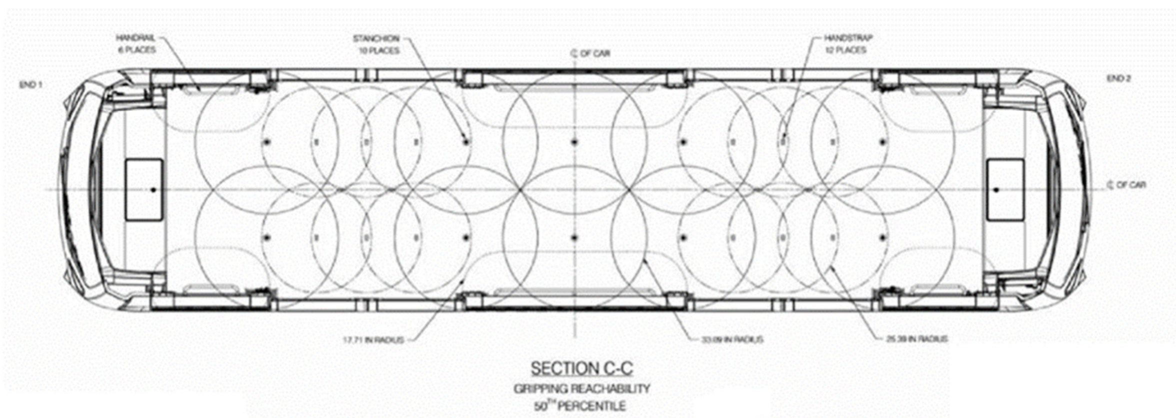


Figure 12: Griping Layout – Reachability by 50th percentile

3.14.9 Passenger Information

3.14.9.1 Audio Announcements

All passenger compartments for all cars will have automatic on-board announcements, provided in English that accomplish the following:

- Pre-Departure message from either station;
- Arriving Airside message;
- Arriving Landside message;
- Door obstruction message;
- Improper stop message.

3.14.9.2 Graphics

Static graphical information for passengers will be self-evident representations that require minimal written instructions. Alstom will provide graphics to indicate the normal exit doors, priority seating for mobility challenged passengers. Emergency instructions to passengers concerning use of fire extinguisher, the two-way communication system, emergency braking, emergency egress, and manual door opening controls will be prominently displayed using pictorial representations as much as possible. Where words are necessary, graphics will meet the requirements of the latest edition of ANSI Z35.1. Each passenger compartment will have standard provisions for "advertising graphics" where feasible, along the tops of the side and end walls. Other information, including prominent "no smoking" and similar prohibition signs will be provided in accordance with Section 3.7.4. All interior graphics will be subject to the review and approval of customer as part of the Graphics Plan.

Dynamic LCD signs will be provided for each passenger compartment of such trains that indicate the name of the station at which the train is approaching or has stopped. These dynamic signs will be located above each door set.

These devices will conform to the following requirements:

- Be observable and readable from all standing locations within the car;
- Display the same messages in each display of a car;
- Display messages in characters at least the same height as the existing cars;
- Automatically display passenger informational messages as initiated by the car position; these messages will be substantially the same as the audio messages described in Section 3.14.9.1;
- Can display any message type such as text, images and video or any such combination.

3.14.10 Resistance to Vandalism

Blind fasteners are preferred for fastening trim, and panels. Where blind fasteners cannot be used, tamper-resistant screws are to be used. Walls and ceilings will meet, at a minimum, the graffiti-resistance rating of two (2) as specified in the "Transit Security Guidelines Manual", Section 21, published by the American Public Transit Association.

A CCTV system will also be installed on each car to further discourage vandalism, as confirmed in the approved design for Airsides A&C and included in the vehicle procurement for Airside E.

3.15 Flammability and Smoke Emission

The car, including its materials, will comply with the requirements contained in Chapter 8 of NFPA 130-2020 or later revision as applicable at time of contract execution. These requirements apply to all combustible materials used in the cars.

No polyvinyl chloride, polyurethane foam, or polystyrene foam will be used. No flammable oils or hydraulic fluids will be used except as required for normal lubrication.

Calculations of the combustible fire load of a car will be submitted by Alstom. These calculations will include a listing of all non-metallic materials used in the construction of the vehicle. Each element within a section and each element's fire load will be identified.

3.15.1 Electrical Wire Insulation

All wires and cable will be resistant to the spread of fire and will have reduced smoke emissions by complying to NFPA 130-2020 Section 8.6.7 as described in Section 3.9.5 of this proposal.

3.16 Fire Protection

Each passenger compartment will have three (3) smoke detectors which, when activated, will annunciate a discrete alarm in Central Control. The detectors will be appropriate for transit car application. One smoke and heat detector will be mounted on the ceiling side cove at the center of the passenger compartment and not directly in the air flow from the HVAC system. One smoke detector will also be located in the return air duct of each air conditioner. There will be a means to test the smoke detectors.

Each car will be equipped with two five-pound Class C fire extinguisher clearly visible in a compartment enclosed with a breakable glass cover and with clear instruction for its use. Removal of an extinguisher from its mounting location will activate an audible alarm on the car and send an alarm to Central Control.

Thermal protection for each electric motor will be provided. This protection will be in accordance with NFPA 70 Article 430.32(A) revision current at time of contract execution.

3.17 Car Coupling

A car-to-car connection with drawbar will be used to form a married-pair vehicle. All mechanical couplings will be slack-free and will have bearing and/or wear surfaces which have a means to compensate for wear. All couplings, regardless of type, will meet the requirements of Sections 3.4.1 and 3.4.4.

Failure of the critical mechanical, electrical, or pneumatic connections in any coupler in a train or car will result in the application of car brakes. Reset of this brake application will be accomplished only on each car and only by authorized personnel.

3.17.1 Trainlines

Trainline couplings will be used to provide pneumatic and electrical connection between cars. It will not be possible to move a mechanically coupled train automatically unless all trainlines necessary for safe operation are complete.

Intercar electrical couplings will provide proper trainline connections and will be weather- and moisture-resistant. High-voltage circuits will not be trainlined. To prevent ground loop currents, electrical grounds will not be connected between cars. Shielded cables will have shields grounded only at one end.

Pneumatic trainline will share the pneumatic power between the two cars of the married-pair vehicle.

3.17.2 Drawbar & End plates

The two cars will be semi-permanently connected using a drawbar. In place of automatic or mechanical couplers, end plates to accommodate wayside buffer will be provided at both ends of married-pair vehicle. Drawbars will allow to form closed and fixed consists that would not be resized during system operation.

As per the current APM100 vehicles, coupling and uncoupling of the two cars per married-pair will be possible as part of maintenance activities.

3.18 Train Interaction

Trains operating on adjacent guideways will not interact with one another to adversely affect acceleration and braking rate limits, jerk limits, stability, stopping precision, or in any way degrade the operating efficiency or safety of each other.

Controls and coupling slack within individual cars will ensure that when two cars are coupled together, they will not interact with one another in any way to cause hunting, instability, overheating, degradation of operating efficiency or safety, or acceleration and jerk limits more than those specified in Section 3.7.3. This requirement will be met in all operating modes and for any combination of allowable passenger loading within the individual cars.

3.19 Communications and Passenger Information

On-board public-address speakers will be located along the sides of the car to provide undistorted messages at a sound level of at least 5 dBA above the ambient noise levels of Section 3.7.2 in each car. It will be possible for maintenance personnel, but not passengers, to adjust the volume of each on-board speakers in each car individually. Other aspects of car communications and passenger information are contained in Sections 3.7.4 and 3.14.9.

Two passenger intercoms will be located near diagonally opposite side doors of the car. The intercoms will provide full-duplex voice communications between the car and Central Control.

The intercoms will:

- Be clearly identifiable;
- Be vandal-resistant;
- Have a push-to-call button, a speaker and microphone and no handset; and
- Have clear instructions.

3.19.1 CCTV

There will be CCTV installed in the cars as confirmed in the approved design for Airsides A&C and included in the vehicle procurement for Airside E.

Alstom will provide two fixed-mount forward facing network cameras, and one ruggedized Network Video Recorder (NVR) per car. The cameras, NVR and car network switch are designed for a vibration prone environment. The cameras are powered by the network switch through Power over Ethernet (PoE).

The car cameras will be tamper and vandal resistant with IP66 rated protection against dust and water, and able to withstand tough conditions such as vibrations, shocks and temperature fluctuations. The cameras can respond quickly to changes in light level, ensuring high image quality is maintained for viewing the car interiors. The placement of the cameras will be in the ceiling at the end of the cars. The cameras will provide a high definition 1920 x 1080 resolution. A typical car camera is shown in following figure.

Figure 13: CCTV Camera

The ruggedized Network Video Recorder (NVR) will be used to continuously record video from the cameras on the car. The NVR will use hard drives designed for 24x7 operation in a harsh industrial environment, and have enough storage to record at least 30 days of 1080p video at 25/30 fps (50Hz/60Hz).

As confirmed in the approved design for Airsides A&C, Alstom will provide the CCTV system described above with the addition of the Live stream communication for datalink from vehicle to wayside via BWAN. The on-board CCTV video will be transmitted over the BWAN at 4 Common Intermediate Format (CIF) (704x480) resolution and 7 fps. The live video streams will be available at a CCTV workstation provided at the Data Center and Maintenance Central Control.

3.20 Vehicle Control

3.20.1 Automated Mode

The Alstom INNOVIA APM 300R vehicles will be fitted with the Alstom CITYFLO 650 ATC solution. The Alstom CITYFLO 650 on-board unit will be upgraded to the latest product components by utilizing the Common On-Board Hardware Platform (CoHP-2) VATC and the latest generation of train to wayside transmitter and receivers.

The VATC is the on-board ATC sub-system that ensures safe automatic train operation (ATO) within all system constraints by interfacing train lines with the propulsion system, brake system, door system and manual controllers.

The ATC system includes the VATP, VATO, and TWC sub-systems. The VATP handles the vital safety-related functions onboard the train (e.g., determining the location of the train, speed limit enforcement, maintaining the train within its movement authority, and vital door enabling).

The VATO handles the non-safety-related functions onboard (e.g., speed regulation, accurate station position stopping, door opening and closing, controlling passenger information devices and fault and data logging). The TWC communicates between the train and the wayside ATC systems.

CoHP-2 is a computer-based hardware and software platform dedicated to safely executing VATP and VATO applications and providing vital input and output. The onboard VATC is a dual-channel, checked-redundant architecture that uses the fail-safe principle.

To ensure system safety, two Central Processing Units (CPUs) independently read the same inputs and determine the proper state of the outputs. The inputs and outputs are then cross-checked by each CPU board to ensure that no undetected single-point failure has occurred.

All safety-related outputs are either fail-safe in design or implemented with dual output architecture so that a single failure in the output hardware cannot cause an unsafe condition.

The VATC performs the following functions:

3.20.1.1 VATP Functions

The vehicle ATP functions establish the criteria for safe vehicle operation and guarantee that the safety criteria are met regardless of any requests made by the ATO functions.

3.20.1.1.1 Train Position Determination

All communicating passenger trains will be continually detected on the system. Train detection, or train position in the ATC is determined by the VATC which continually reports its position to the RATC. The VATP system uses two types of sensors to determine the position of the train in the system: (tachometers and norming points).

Tachometers: There are four located on each VATC equipped car. The tachometer outputs a pulse that equates to the displacement the wheel has travelled. These tachometers are also used to determine the speed and direction of the train for other VATP and VATO functions that require this information. Direction is determined by the phase relationship of the tachometers on an axle. Train distance travelled is the average displacement of the known good tachometers. Train speed is the highest velocity reading from the tachometers.

Norming points: A norming point is a self-contained device located along the track. These devices normalize the train’s actual position by transmitting unique identities that correspond to a physical location in the VATC’s physical map. A norming point antenna (one for each ATC) for reading the wayside norming points. As a train travels through the transit system, its reader determines the unique identity of all norming points encountered, giving the ATC an exact geographical point of reference. When a norming point is encountered, the location of the norming point is compared with the VATC-assumed location of the train using the on-board system map. The norming point is used to eliminate the accrued errors in positioning that may occur in the on-board position system.

3.20.1.1.2 Safe Train Separation Assurance

The controlling VATP will vitally determine the safe distance that the train must maintain from the preceding train or other obstacles. An obstacle will be defined as a conflict point. The RATP sends the nearest Conflict Point to the VATP. The VATP is constantly calculating a worst-case stopping distance. This is the safe distance the train must use. If the safe distance is encroached upon, then the emergency brakes will be applied, and the propulsion will be disabled. The emergency brakes are permitted to be reset either locally at the train or remotely via a central control operator command.

3.20.1.1.3 Unauthorized Motion Prevention

In the situation where a standstill condition is required but is not fulfilled, irrevocable emergency brakes will be applied. If the conditions for standstill are met, the emergency brakes will not be applied. The conditions of standstill are:

- The train must be at zero speed;
- The propulsion must be disabled;
- The service brakes must be applied.

Brake reset can be accomplished through remote CCO command from ATS, or locally on-board the train.

3.20.1.1.4 Overspeed Protection

If an overspeed condition occurs, the emergency brakes will be applied and bring the train to a full and complete stop. Brake reset will be by remote CCO command from ATS, or locally on-board the affected train.

Given the train's route through the system, the VATP enforces safe movement by calculating a velocity versus distance braking profile (overspeed ramp). This is the maximum safe speed allowed leading up to a conflict point. By monitoring the actual speed of the train as it approaches the conflict point (such as a buffer), the VATP enforces the overspeed ramp. The VATP permits movement if the actual speed of the train is less than the overspeed ramp. If the actual speed exceeds the overspeed ramp, the VATP applies the emergency brakes to bring the train to a full stop.

The VATP generates a similar overspeed ramp when the train is approaching a section of track with a reduced civil speed, such as a curve. The overspeed ramp causes the train to decelerate so that it is at the lower speed limit prior to reaching the new speed zone.

RATP generates an authorized path for the train to travel, as well as the speed limits along that path. The speed limits are determined based upon a maximum civil speed as provided through the system map, vital zero speeds generated from emergency stops and unscheduled door operations, as well as non-vital speed restriction from ATS and RATO. In the case of multiple speed restrictions on a particular section of track, the RATP will always send the most restrictive speed limit to the train. The path and speed limits are sent to the train via the NRS. As the train is traveling along its path, the VATP will use the speed limits to compare it against the actual speed of the train. If the train exceeds its speed limit, the VATP will command the emergency brakes to be applied and bring the train to a full stop.

Train speed is the highest velocity reading from the tachometers. If the maximum error on the actual velocity measurement, due to all tachometer reading errors, exceeds a limit, or, if tachometer power is lost, the VATP applies emergency brakes. If the VATC loses indication from all tachometers, the VATC hardware will report that it is inoperable and the active VATC halts. The train will emergency brake to a stop once the active VATC halts. Each VATC uses independent tachometers. Remote reset of emergency brakes is possible after the train is at zero speed. Also, as usual, a manual reset is possible on board the train. The VATP can distinguish between a simultaneous loss of all tachometers and actual zero speed.

3.20.1.1.5 Unscheduled Door Open Protection

Except where train doors are being operated in stations as part of passenger operations, the ATP will irrevocably service brake the train to a stop, if any train door is opened. If a station door or station platform emergency door is opened, all trains occupying the ATC-defined protection area shall be irrevocably braked to a stop. Once all trains are stopped, the ATC prohibits any additional trains from entering the area using a zero-speed restriction. The occupying trains will only be permitted to move after the unlocked door condition has been removed, the zero-speed restriction has been removed from the station area and a local reset of the train’s brakes has been applied. The speed restriction placed on the ATC-defined protection area can only be cleared once the offending door(s) are no longer open.

The VATP will electrically enable train door operation only when the footprint of the train is within the designated passenger exchange area (station platforms) and the train is at zero speed. If any of the system doors are unlocked or opened for any unscheduled reason, an alarm will be generated and displayed at the CCF along with an alarm at the station platform.

Alarming at a station platform for an unscheduled door opening is not an ATC specific alarm.

The VATP will ensure that no automatic mode failure will result in the unlocking or opening of a train door.

3.20.1.1.6 Departure Interlocks

The VATP will not allow the train to start-up from zero speed until all the train and station doors are closed and locked and a movement authority has been granted by the RATP.

Once the above requirements are satisfied, the VATC system will initiate departure of the train from the station. The VATC will release the brakes and attempt to start the train. If the train fails to start-up, the emergency brakes will be irrevocably applied, and an alarm will be generated and displayed at the CCF. Independently, the ATS will also report a Late Departure alarm when the time the train remains in the station exceeds a period during an expected departure.

3.20.1.2 VATO Functions

The ATO governs planned vehicular movements within the pre-established safety principles. It manages speed regulation, precision stopping, dwell times, graphics and announcements.

During automatic operation, the train travels along the guideway under the control of the ATO within speed limits set by the RATP and monitored by the VATP. The VATC processes wayside signals into commands to the propulsion and braking systems, the train door system and other equipment. The controlling VATC controls door operation for the whole train.

3.20.1.2.1 Station Stop

The ATC is a position-based system where the VATC always calculates the location of the train. The VATC is programmed with an infrastructure database referred to as the physical map. The physical map contains all the information required for the ATP to calculate the train’s location. Elements within the physical map include the location of all station platforms, the number of berths within each platform, and the stopping location for each berth. The stopping location for each berth is set to the location where the centerline of the car doors will align exactly with the centerline of the station doors.

If the train is scheduled to stop in a station, the RATP issues a route into the station to the VATP. The RATO informs the VATO that it is to stop at the station. Based on a default berth location or the berth location sent from the RATO, the VATO determines the distance from the train's current location to the berthing location in the station. The VATO then determines the proper approach speed for the train based on the predefined deceleration and jerk rates. The approach speed is used to guide the train into the station and to stop it at the desired berth locations. Once the train is stopped and zero speed is detected, the VATO applies the parking or friction brakes and holds them applied until the train is ready to depart the station. The stopping positions will be specified so that all train and station doors align for a maximum length train.

3.20.1.2.2 Train Movement Control

Fully automatic, bi-directional control will be provided throughout the system within limits prescribed by the ATP system.

The VATO regulates train speed under the safe speed and distance limits established by the RATP. If, at any time, the speed of the train exceeds the safe speed limit established by the VATP, the VATP disables the propulsion and applies the emergency brakes. The VATO will generate a "tractive effort request" to the propulsion/braking systems to regulate the speed of the train in a comfortable, jerk-limited fashion. The VATO also configures the propulsion system for the proper direction of travel.

For train start-up, the VATP will determine if all safety conditions are met. If the safety conditions are met, the train will be permitted to begin movement. During the initial movement period, the VATP speed and direction integrity checks are relaxed to allow the VATO to propel the train to a speed sufficient for sensing of dynamic speed sensors.

The VATO generates an acceleration and jerk-limited speed control ramp that is the commanded velocity of the train. If the train is at zero speed, the VATO must wait for the VATP to permit start-up before generating the command velocity. The command velocity increases, at the pre-programmed rate, until it reaches 2 MPH below the safe speed limit set by the VATP.

When approaching a section of track with a lower speed limit, the VATO decreases the command velocity, at the pre-programmed rate, until it reaches two mph below the speed limit of the approaching track section. The command velocity will reach the new speed just before the train enters the next track section.

When approaching a section of track with a higher speed limit, the VATO waits until the entire train (train footprint) clears the section of track with the lower speed limit. Then the VATO increases the command velocity at the pre-programmed rate until it reaches 2 MPH below the speed limit of the occupied track section.

When approaching a station where the train is scheduled to stop, the speed control ramp follows the station stopping profile into the station stopping location.

The starting, stopping, and regulation of speed and operation of the trains traveling over the guideway is controlled by the VATO such that acceleration, deceleration, and jerk are within the required ride comfort limits.

3.20.1.2.3 Loss of Propulsion Power

If propulsion power is lost, the VATC will continue to coast under VATO control and RATP protection. If the train has enough kinetic energy, it can coast into the next station and perform a normal station stop. Normal train operation will resume once power has been restored to the train. When the train reaches zero speed, the service brakes will be irrevocably applied to hold the train at rest. Brake reset will be accomplished through remote CCO command, or locally on-board the train, under the constraints of the ATO and ATP.

Then a section of track is detected to be un-powered, the RATO will initiate zero speed restrictions on the segments associated with the un-powered section. These speed restrictions are applied to prevent stopping a train in the un-powered sections and avoid stopping trains that are approaching these sections between stations. As part of the automatic routing of trains the RATO, prior to initiating the process for a train to depart a station, will make a check to determine if the train can make it to the next station.

An alarm will be generated and displayed at the CCF anytime a train stoppage occurs due to a loss of propulsion.

3.20.2 Manual Mode

A manual mode of operation will be incorporated. Each self-propelled car will be capable of manual operation. This will be implemented by means of a permanently installed manual control panel at each end of each car. Remote manual train operation will not be possible, regardless of the means of propulsion or control. In manual operation, the on-board operator will have direct control over all necessary train functions, and the Central Control Operator will have no control of any train functions. It will be possible to operate a train manually in either direction. Manual train operations will be limited to a maximum speed of 5 mph in all locations and conditions throughout the system; there is no separate speed limit for operation within the maintenance facility or when connected to maintenance power rather than track power. Each self-propelled car/train will enable on-board personnel to operate a train manually to push/pull a train. A train will be switchable between the automatic and manual modes of operation only by a manual action performed on the train by authorized personnel. A status change update will be sent to the Central Control Facility and require Central Control Operator acknowledgement. It will not be possible to affect a change-over between manual and automatic modes solely from Central Control. The manual control equipment will be interlocked with the car propulsion control system so that only the manual control equipment at the forward (direction of travel) end of the train can be used to move a train manually. It will not be possible to move, drive under power, or coast unpowered, a train in the reverse direction from the manual control panel in the forward end of the train.

Controls for manual operation of self-propelled cars will be in special, locked control panels convenient to each end of the car. The manual control panel key ("Auto/Manual key") is unique from equipment locker cover keys to ensure that only technicians authorized to operate trains (as compared to those authorized to maintain equipment within the manual control locker) can do so. An operator at this position will have a field of view which will permit an operator to perform all manual operations anywhere in the System (see also Section 3.14.6). The manual operations controls will be designed and configured in a manner that provides an acceptable level of operator comfort should extended manual operations be required. All manual control designs will be submitted for review as part of the car interior design CDRL process. Each panel will control all cars in a train and have at least braking and propulsion thrust level controls, a stop button to operate the emergency brakes, and a key switch to activate the panel. The propulsion control will have a "dead man" control to prevent train movement without positive manual actuation by the operator. If that control is released, emergency braking only will be immediately applied.

All panels will also have door, propulsion, and braking controls.

Manual operations are not subject to any ATP safety restrictions; however, cars being manually operated will be detected by the ATP subsystem and all other cars which are under automatic control will remain subject to all ATP safety restrictions.

3.21 On-Board Diagnostics

3.21.1 Malfunction Annunciation

An annunciator device will be provided on each car to indicate Priority I and Priority II car malfunctions. Each malfunction will be uniquely indicated on an onboard status panel readily accessible to maintenance personnel. Each indicator will continue to annunciate the specific malfunction until the indicator is reset. For malfunctions which are remotely reset, the indications will also be remotely reset at the same time. Those malfunctions which are “manually reset only” will have their indications also reset when the emergency brakes are reset. All Priority II malfunction indications will be resettable by a separate means on-board the car.

All Priority I and II car alarms are transmitted to the wayside by the ATC. There are dual-path car alarms that are routed through the car ORS to the wayside.

3.21.2 Malfunction Classifications

Malfunctions will be indicated in one of at least two classifications. The level of classification and reporting of faults will be developed by Alstom and will be sufficiently detailed to allow operating and maintenance personnel to make rational decisions in reacting to the reports.

Priority I malfunctions are those which pose an immediate threat to passenger safety and/or system operation.

Priority II malfunctions are those which do not pose an immediate threat to either passenger safety or system operations, but which cause a potential threat to system operation or safety if not corrected.

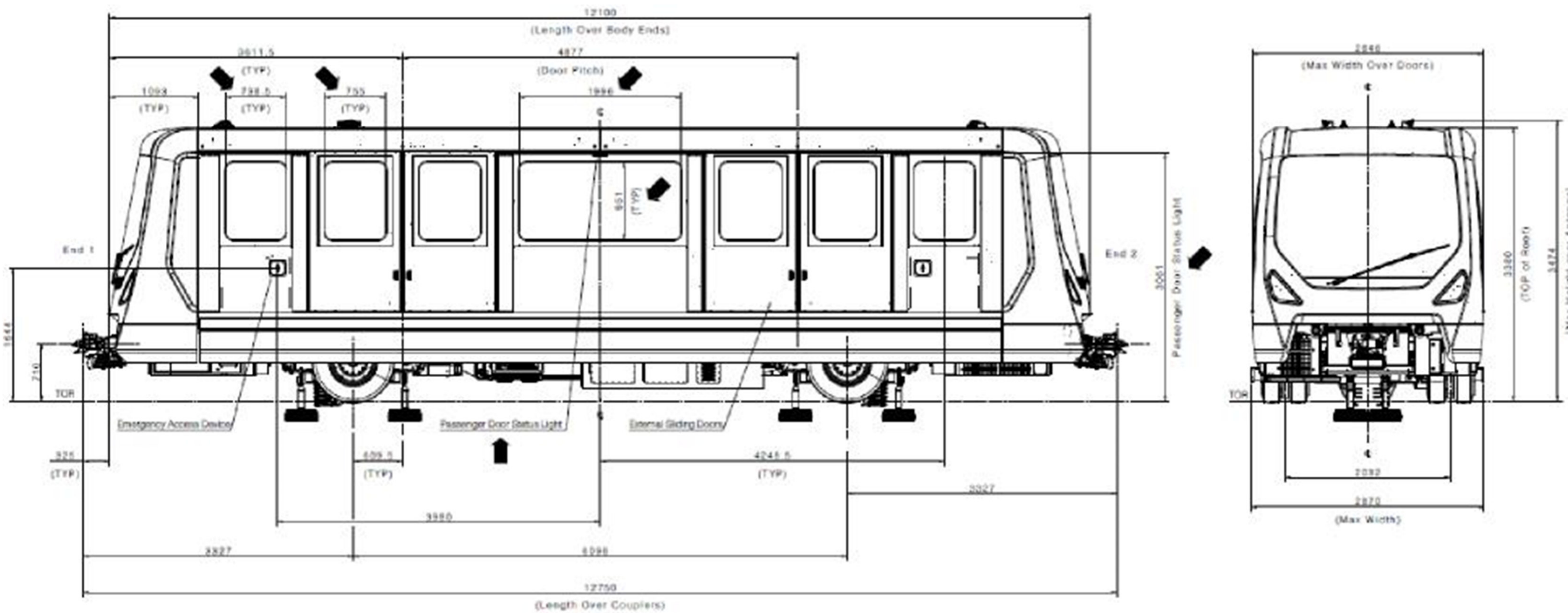
Alstom will develop a complete list of Priority I and Priority II malfunctions for annunciation on-board the cars. The list will reflect both the unique characteristics of Alstom’s system, and the proposed operational procedures, and will be match the approved design for Airsides A&C.

Appendix A. Attachments

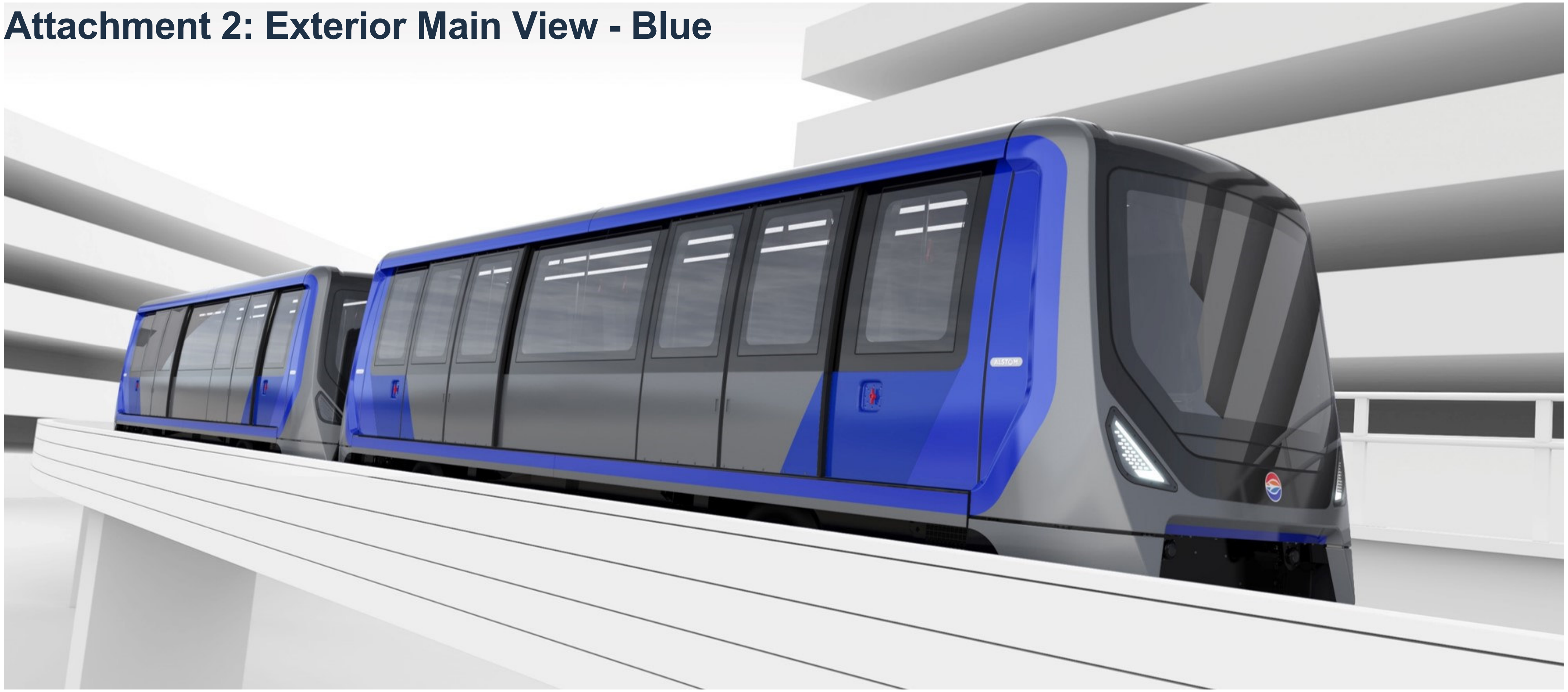
NOTICES:

1. Illustrations contained in this document and attachments are for information purposes only, final design will be coordinated with the Client Team(s) for the Airside E Leg at Tampa International Airport.
2.

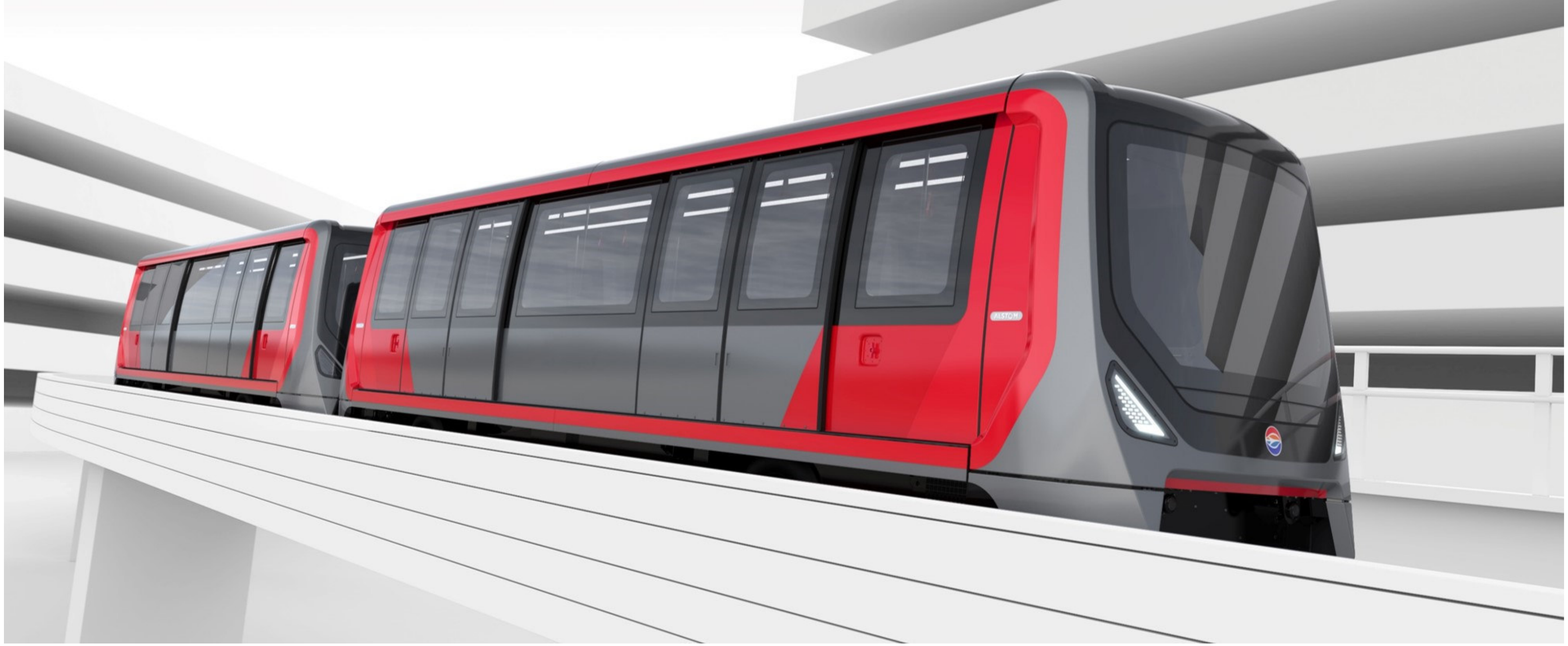
Attachment 1: APM 300R Vehicle Outline Plan and Elevation



Attachment 2: Exterior Main View - Blue

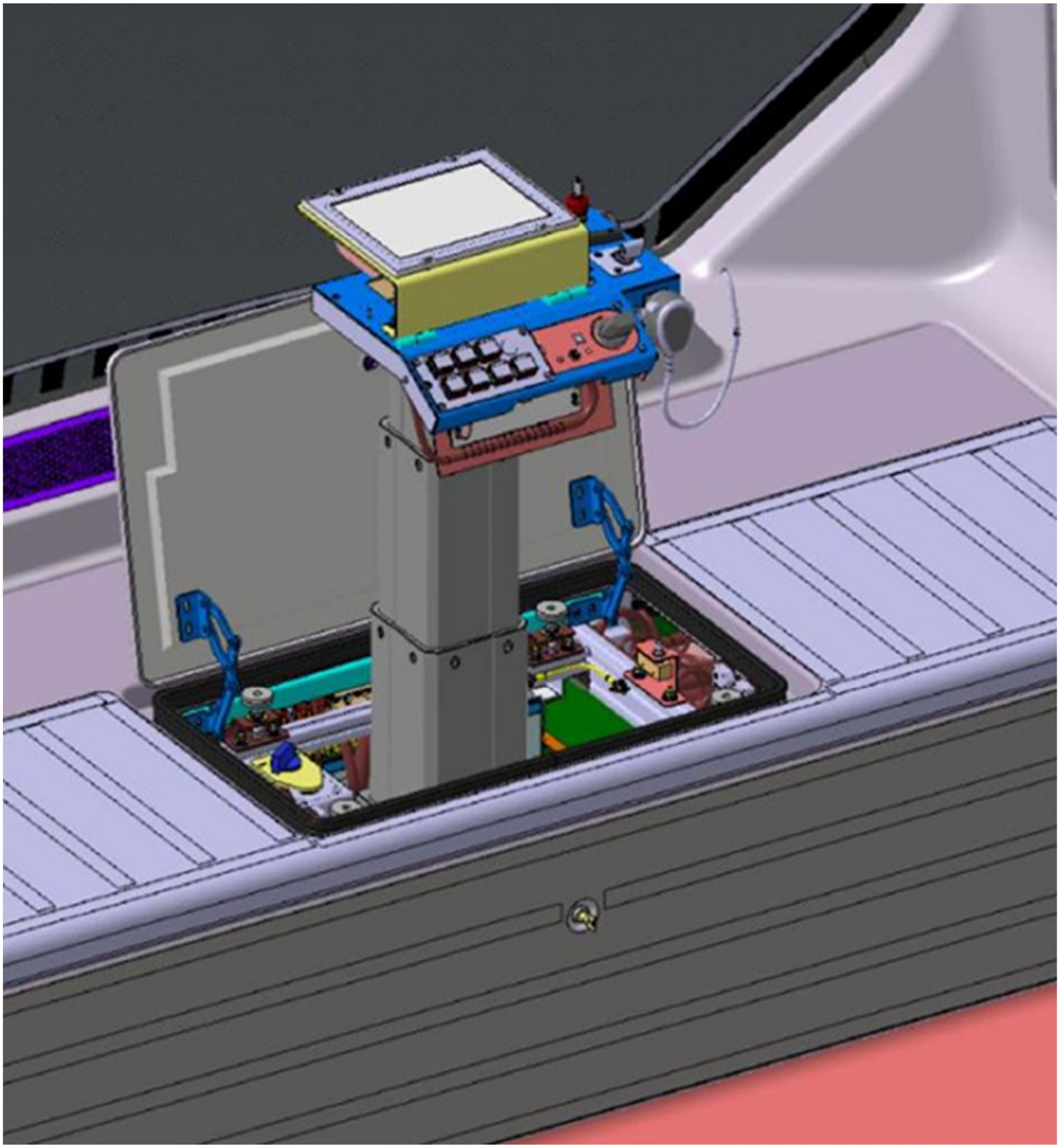


Attachment 3: Exterior Main View - Red



Attachment 4: Interior Main View

Attachment 5: Interior End View, Manual Controller Extended



Appendix B

Technical Proposal – CityFlo 650 and Power Rail

ALSTOM
• mobility by nature •

Technical Proposal CITYFLO 650 and Power Rail Upgrade

ALSTOM

• mobility by nature •

1 PROJECT WIDE

- The Hillsborough County Aviation Authority has been evaluating programs to upgrade the existing APM to a modern level of technology and sustainability.
- In 2020, Bombardier was awarded a contract to upgrade and relocate the central control to the new Airport Operations Center. Additionally, a backup central control was installed in the new Operations and Maintenance offices located in the long-term parking garage.
- As a part of the central control relocation, network infrastructure and object controllers were installed to manage the existing hardwired I/O for power cutout and signaling train stop.
- The signaling system currently in use is at its end of life and a signaling upgrade is necessary to provide the availability required for the system.
- The existing vehicles are at the end of their life and new vehicles have been proposed and separately procured.

1.1 Acronyms

ADA	Americans with Disabilities
ATS	Automatic Train Supervision
CBTC	Communication Based Train Control
DB	Design, Build
DCS	Data Communication System
DTN	Data Transmission Network
ECS	Environmental Control System
EMC	Electrical Magnetic Compatibility
ICS	Integrated Control System
NMS	Network Management System
OCS	Object Controller Subsystem
OTB	Overtravel Buffer
PDS	Power Distribution System
RAMS	Reliability, Availability, Maintainability, Safety
RATC	Region Automatic Train Control
RATO	Region Automatic Train Operation
RATP	Region Automatic Train Protection
RTU	Remote Terminal Unit
SER	Signaling Equipment Room
TBD	To Be Determined
TRA	Trackside Radio Assembly
TWC	Train to Wayside Communication
UPS	Uninterruptable Power Supply
VATC	Vehicle Automatic Train Control
VATO	Vehicle Automatic Train Operation
VMSF	Vehicle Maintenance Storage Facility

1.2 Project Description

- Design Build project
- Upgrade existing CITYFLO 550 to CITYFLO 650 for Leg E
- Maintain interfaces to existing CITYFLO 550 on Leg F
- Provide new INNOVIA 300R APM vehicles equipped with CITYFLO 650 on-board (procured separately)
- Replace worn-out areas of power and signal rail
- Analyze existing switchgears and provide recommendation to the Tampa customer for any required upgrades

1.3 Design Life

- New wayside Automatic Train Control (ATC) and communications equipment ~15 years, with the expectation that they will be replaced with new equipment that will have at least a 15-year design life
- New traction power rails ~15 years, with the expectation that they will be replaced with new equipment that will have at least a 15-year design life
- All new wayside wiring and cabling ~30 years

1.4 Standards

The following industry standards are referenced in the project contract:

- NFPA 130
- ADA Americans with Disabilities Act
- ACSE 21-13 Automated People Mover Standard
- To be developed further as part of Basis of Design
- EN 50126, 50128 and 50129
- All local codes and standards as applicable.

1.5 Other Considerations

- Outdoor equipment to consider marine environment
- Equipment to be compatible with salt/corrosive environment
- Florida Professional Engineer Stamp required on all structural and electrical installation, including ATC antenna poles.

1.6 Climate Data

The system will operate normally under the full range of normal climatic conditions that occur in Tampa. The following ambient conditions are assumed.

Tampa Climatic Data

Observations for Tampa*	
Maximum Recorded Temperature(1)	99° F
Minimum Recorded Temperature(1)	18° F
Average High Temperature(2)	81.7° F
Average Low Temperature(2)	65.1° F
Average Number of Days below 40F/4C(2)	1.3
Average Number of Days below 32F/4C(2)	0.1
Average Annual Rainfall	46.3 in
Most Rain in a Month (Aug)	7.8 in
Relative Humidity (morning, evening)	88%, 58%

(1) over 66 years of data

(2) over 30 years of data

http://www.weatherbase.com

1.7 EMC Requirements

All vehicle / rolling stock equipment and wayside / trackside equipment within Alstom's scope of supply will be electromagnetically compatible within themselves and with the power supply system, signaling system, communication system, electrical, and other electronic equipment carried by passengers or exist in the environment. To achieve this, Alstom will apply EMC management and a control plan for the system design with IEC 62236 or equivalent EN 50121 series of EMC standards for railway applications.

For overall system and vehicle, the following standards will be applied:

- IEC 62236-2 and EN 50121-2 - Railway Applications – Electromagnetic Compatibility Part 2: Emission of the whole railway system to the outside world
- IEC 62236-3-1 and EN50121-3-1 - Railway Applications – Electromagnetic Compatibility Part 3-1: Rolling Stock Train and Complete Vehicle

For the vehicle onboard signaling and communications system, the following standard will be applied:

- IEC 62236-3-2 and EN50121-3-2 - Railway Applications – Electromagnetic Compatibility Part 3-2: Rolling Stock Apparatus

For the wayside signaling and communications system, the following standard will be applied:

- IEC 62236-4 and EN50121-4 - Railway Applications – Electromagnetic Compatibility Part 4: Emissions and Immunity of Railway Signaling and Telecommunications Apparatus

In addition, all system transmitting and receiving equipment, such as for ATC and audio and visual communications, will meet the FCC regulation requirements when applicable.

1.8 Earthing, Bonding and Lightning Protection

All new wayside metallic equipment/hardware enclosures will be connected to the existing grounding system in accordance with the National Electric Code (NEC). Low voltage power will be sourced from existing distribution panels and grounded in accordance with the NEC. Any new equipment installed on the walkway will be provided with lightning protection in accordance with local codes.

The existing PDS substations and traction power delivery system to the cars operate using a high-resistance grounding system. The new cars will operate using this same system. No new traction power grounding system or related equipment is expected to be required for new train operations. The existing grounding system will be inspected to verify integrity and reviewed to determine if further action is required.

2 OPERATIONS

Key Customer Requirements:

- Maintain existing operation of the system with current functionality.

2.1 System Performance

As with all automated people mover systems, there are specific criteria and passenger service requirements for frequency of passenger service and total passenger movements. Additionally, the APM systems must have provisions for operations during maintenance periods, off peak periods and failure management periods of service. This system operating criteria section provides a brief overview of the proposed operating criteria at a high level.

2.1.1 Passenger Service Characteristics

The Tampa E Leg APM system is a dual lane shuttle configuration and will have two 2- car married pair consists operating on the dual lane guideway. Since the application is a shuttle design like the Tampa A&C Legs, the trains will "normally" operate in a synchronized double shuttle mode. This operational configuration will result in the following system performance characteristics.

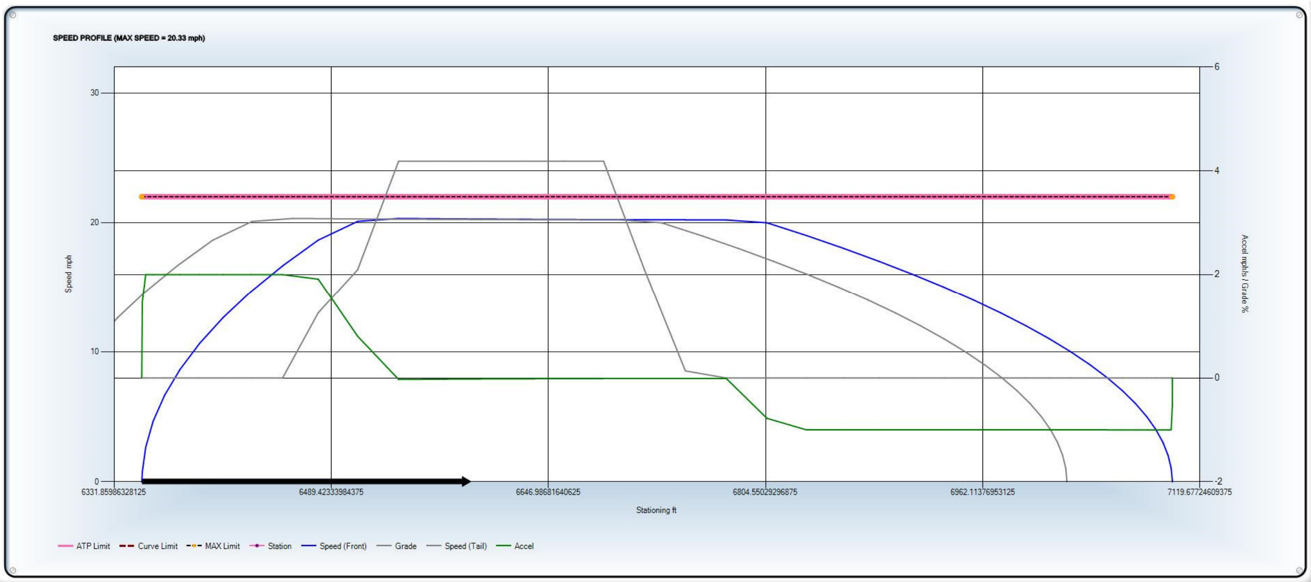
The following table summarizes the System Performance parameters:

Leg E system Performance Characteristics

Round Trip Travel Distance Leg E	1,500 ft
Travel Time Leg E one direction	43 seconds
Station Dwell Time Leg E	37 seconds
Scheduled Round Trip Time Leg E (43+43+37+37)	160 seconds
Peak Period Capacity (2 lanes, 2 car train)	7110 pphpd
Off-Peak Period Capacity (1 lanes, 2 car train)	3555 pphpd

Assumptions:

A. Based on alignment from drawing 2008E37 earlier;
B. Vehicle 300R capacity = 79 pax normal load (as per Leg A and Leg C, same performance and loading used);
C. Dwell time = 37 seconds based on what was used for Leg A and C (100 % on and 100% off using 1 side of the car 6 exit lanes per side at 1 sec per lane movement time, 10 second technical time, no passenger movement during door opening);
D. Maximum ATP speed set at 22 mph (20 mph operating, see attached speed profile plot as reference to operations);
E. Brake rate = 1 mphps (due to close buffer location like Leg C);
F. Buffer Impact Speed = 5 mph impact speed on the buffer with the End of Line (EOL) set behind the buffer;
G. "Special" Station Map Segment = May be required, TBD with SIG Team but not applied to Date;
H. Modified VATO/VATO operations similar to other legs may be required.
I. Overrun distance extends approximately 7ft past the face of the buffer under worst-case stopping conditions and allows hitting the buffer at 5 mph in failures.



Sample Tampa E APM System Performance Curve (Airside to Landside)

3 SIGNALLING / TRAIN CONTROL

The signaling system proposed for the Tampa Leg E upgrade will follow the approved final design for Airsides A&C and is Alstom's state of the art moving block CBTC system which is an application of the CITYFLO650_CORE solution.

The 650_CORE solution is made up of the following components:

- EBI Screen 1500 Automatic Train Supervision (ATS) System
- Region Automatic Train Control [RATC] System (RATO+RATP) for non-vital and vital wayside functionality
- Vehicle Automatic Train Control [VATC] System (VATO+VATP) (CoHP-2) for non-vital and vital onboard functionality
- Data Transmission System – Wayside Network
- End-to-End IP Radio System (E2EIP) – Train to Wayside Wireless Communication
- OCS950 Object Controllers for wayside device control – Distributed Vital Smart I/O System
- Platform Door Control system (PDCU) – System that provides coordinated platform and vehicle door control

3.1 650 CORE Solution

The 650_CORE solution is designed to provide a fully automated and driverless train control system. The proposal from RCS is to provide the basic functionality implemented on the current APM and Monorail projects (for example Phoenix Airport Phase II). Most APM and Monorail projects apply the CITYFLO650 Core solution.

CITYFLO650 core solution incorporates moving block interlocking and movement authority calculation functionality into an integrated sub-system called the Region ATP. There is no independent computer-based interlocking, it is integrated into the RATP itself.

A CITYFLO650 system is modular and a system is defined in regions. Each region will have one RATP and one RATO. Regions are defined based on a number of factors. These include number of trains to control, physical size of the region, phases of the project or specific definition of a zone of control.

3.2 Architecture

The system has been configured as a 1-region system for CBTC operation. Airside E will be integrated into the 1-region system implemented with Airsides A&C. The system design will support 2-car train operation.

3.3 Main Function

For CITYFLO650 specifications which is the communication-based moving block train control systems (CBTC), moving block means the train occupancy moves along with the train in a continuous mode. This is achieved by the train calculating its physical and virtual occupancy. A virtual occupancy is the result of applying the distance that will be travelled by the train with the current speed using the ATP braking curve added to the front of the train.

Communications-based train control means the information of the train's physical and virtual occupancy is communicated to the wayside and the movement authority. Speed is sent from the wayside to the train through a wireless radio as known as Train-to-Wayside Communication (TWC) system.

The signaling system, CITYFLO650, will be provided including Automatic Train Supervision subsystem (ATS), Automatic Train Protection subsystem (ATP), Automatic Train Operation subsystem (ATO), Object Controller Subsystem (OCS) and Data Communication System (DCS), which are installed based on one area control principle.

Please note, all key subsystems use multiple redundancy fault-tolerant designs. In case of a fault, it supports a quick restoration.

3.4 Key Equipment

3.4.1 ATS Automatic Train Supervision

The ATS system will be installed and operate in conjunction with CITYFLO550 in the Central Relocation Project. The ATS will require software upgrades to interact with both CITYFLO550 and CITYFLO650 legs of the system.

3.4.2 OCS Object Controller System

The function of OCS is controlling the wayside objects. Its cabinets are distributed along the line, in each Signaling Equipment Room (SER) to close to Wayside objects. Object information and commands from the RATP are transmitted to the OCS via the DTS (Data Transmission System). The OCS will be configured to receive status and issue commands to all switch machines, signals if present and any other object configured for this project.

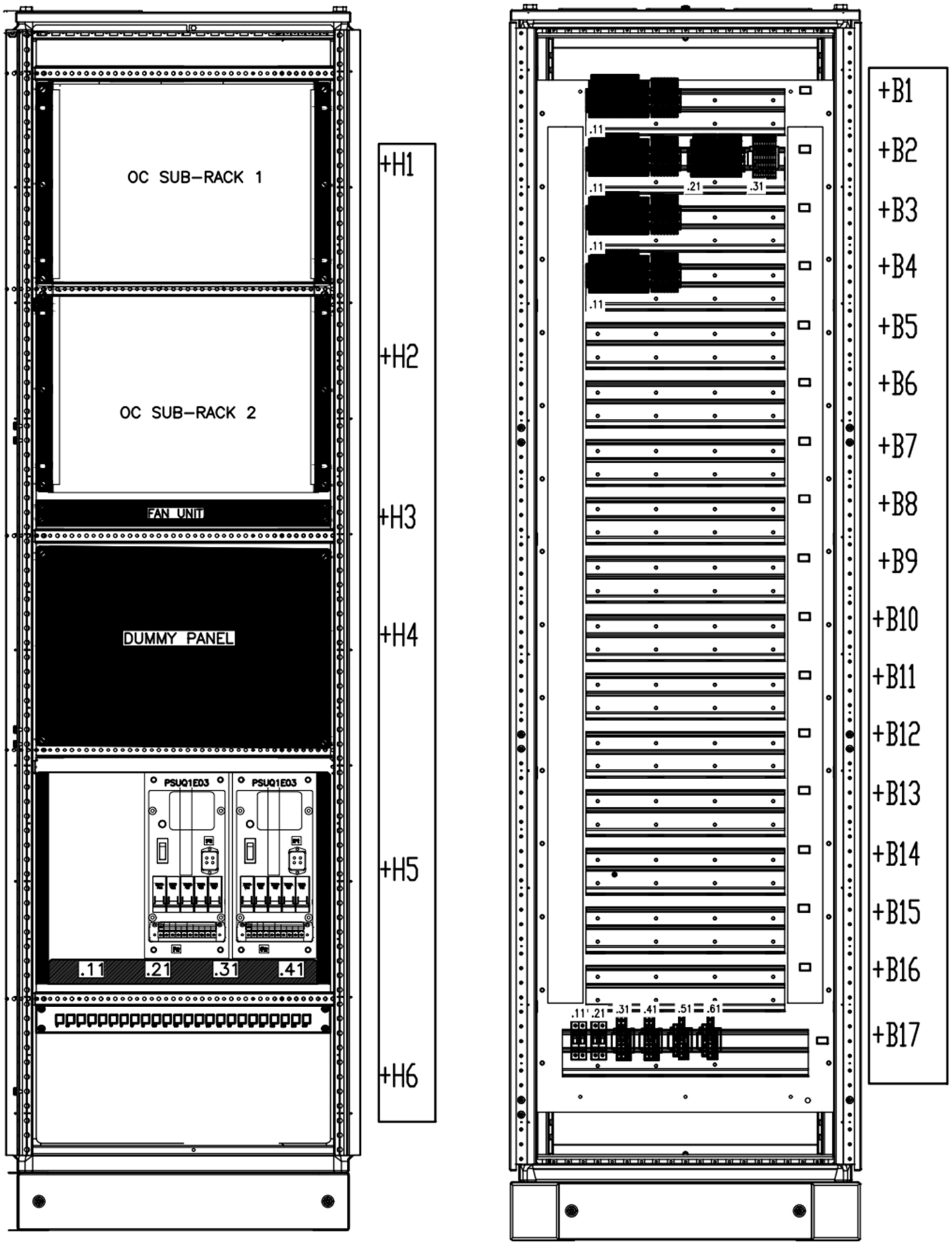
The Object Controller System will be deployed under the Central Relocation Project. In Central Control the Vital Application Controller (VAC) will be installed with the EBILOCK software and a Generic Adaptation and Application will be developed to manage the vital I/O for PDS power removal and ATC stopping of trains.

A special OCS is configured to operate as a Platform Door Control Unit called a PDCU. This OCS type manages the interfaces with the platform screen doors and communicates to the trains in the station to coordinate the operation of platform and vehicle doors.

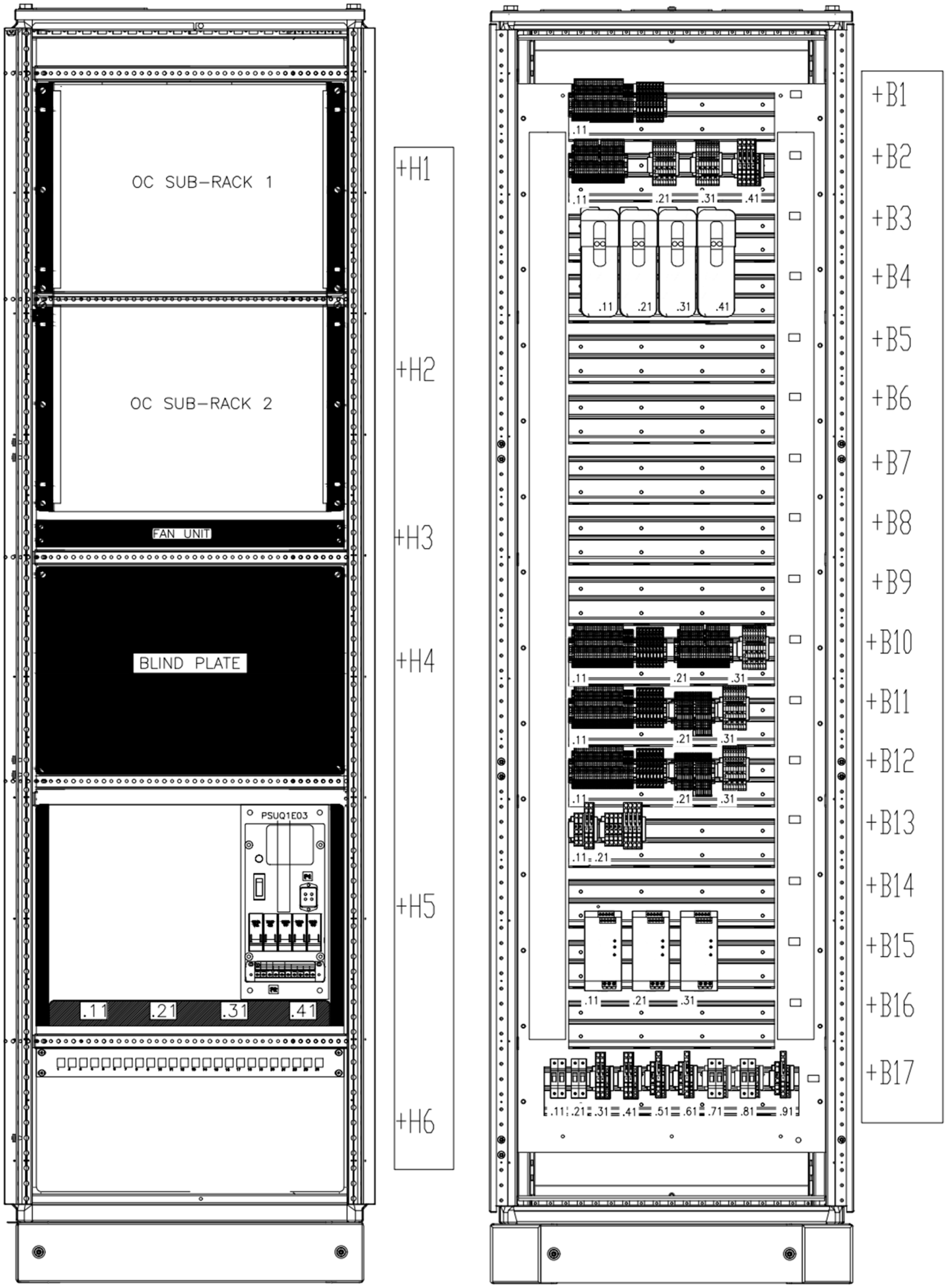
The PDCU communicates to the RATO for non-vital control of the doors and communicates directly with the vehicle to coordinate the opening and closing of the platform doors. There are two components that make up the PDCU, the OCS and the PLCs. The OCS manage all control and synchronization between the vehicle and the wayside. The OCS also handles all vital connections. The PLC manages the non-vital interface between the OCS and the door system.

The OCS was installed as part of the Central Relocation Project, however the PDCU will be installed as part of this bid. Please refer to the diagram on the next page as to the planned additions of OCS at each airside leg.

The schematics below of the OCS cabinets reflect the design from the A & C project Central and Airside locations and will be modified if necessary for Leg E application.



OCS Cabinet Located at Tampa APM Systems Central Control



OCS Cabinet Located at Tampa APM Systems Airside E

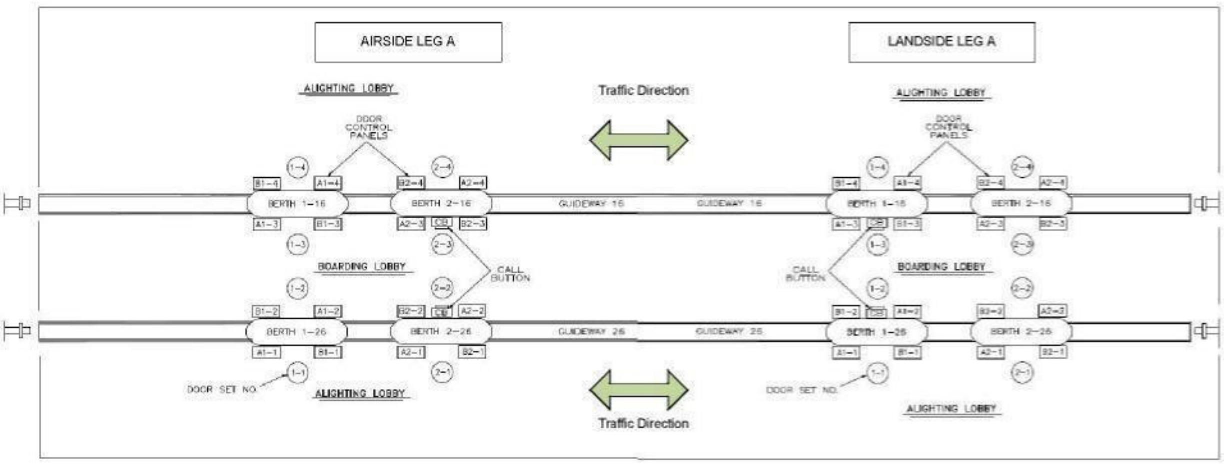
3.4.3 RATO Regional Automatic Train Operation

Manages non-safety operation for CBTC train including determining the choice of the train's performance level and station dwell in relation to Train Control and Status Information, Train Routing and Degraded Operation, Door Operations and Station Hold.

3.4.4 RATP Regional Automatic Train Protection

The RATP system is a major subsystem which is responsible for the vital safety functions with train information and information from the wayside equipment such as Train Initialization, Train Tracking, Train Movement Authority, Safe Train Separation, Speed Restriction, Traffic Direction Control, Backup RATP Switchover, Remote Reset, and Diagnostic Tool Interface.

In a shuttle system, the RATP will mainly control traffic direction and movement authority as a result of train tracking.



Traffic Zone (Typical Sample)

3.4.5 DCS Data Communication System

To support a transparent transmission channel for each equipment and ensure accurate and real-time data transmissions by:

- Wired network (DTS) for central control ATS, wayside to wayside subsystems, and connects internal and external systems. The wired network is being implemented during the Central Relocation Project.
- Wireless network (TWC) for onboard and wayside equipment, including Trackside Radio Assembly (TRA), LoS antenna, onboard antenna and a 5.8GHz radio.

3.4.6 VATC Vehicle Automatic Train Control

The VATC takes control of the train lines with two main subsystems:

- Vehicle Automatic Train Protection (VATP) subsystem for the vital functions - determining the location of the train, speed limit enforcement, maintaining the train within its movement authority, and vital door enabling.
- Vehicle Automatic Train Operation (VATO) subsystem for the non-vital functions - speed regulation, accurate station position stopping, door opening and closing, controlling passenger information devices, and fault and data logging.
- The VATC also provides the train operating modes. The following modes of operation will be available for this monorail system:

1) ATO – Automatic Operation in driverless mode.
2) Manual plus ATP – Manually driving the train with ATP protection.
3) Manual – VATC is in bypass and the driver is in control of train movement with a speed limit.

The VATC for Tampa will be based on the Singapore NCX2 design and it is expected that no changes to the design will occur for this project. All interfaces will remain the same including the PA/PI triggers and vehicle alarms.

Physical interfaces will also remain the same as the NCX2 design for Singapore.

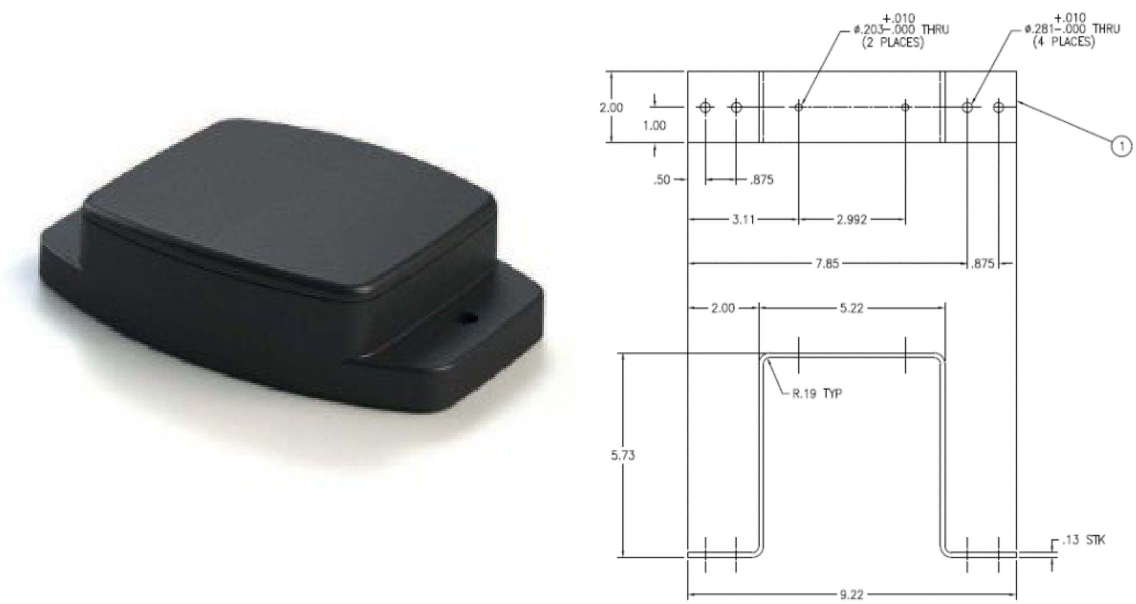
3.5 Wayside Signaling Equipment

3.5.1 Norming Points

Wayside Signaling equipment is limited in a Communication Based Train Control system. The train determines its location using RFID tags that are embedded into the guideway so when the train passes over, the RFID reader on the train interrogates the tag to get the ID of the tag. This ID is stored in a table on the train that is related to the position in the system. From this the train identifies its position in the system and calculates its physical and virtual occupancies. As the train moves, the odometry system on the train provides the distance travelled.

The RFID tags are placed such that when read, the position of the train is corrected due to the position error of the train odometry. The location for the RFID tags is determined to cap the position error or “normalize” the position of the train. Alstom coined the term for the RFID tags called “Norming Points.

Norming points (as shown below) will be installed on the guidebeam in between the power rails.



Norming Point and Norming Point Wayside Bracket

4 COMMUNICATIONS

Alstom intends to provide the following communication subsystems onboard the vehicles as part of the upgrades for the new INNOVIA 300R APM vehicles proposed for Legs A and C.

The equipment to be installed in the vehicles includes:

- Operational Radio System (ORS) Radio Assembly
- ORS Antenna (roof)
- ORS Communication Controller Cradle
- ORS Power Converter Assembly
- LED Dynamic Displays
- Network Switch
- Vehicle Communications Controller Unit - Audio (VCCU-A)
- Passenger Call Panels
- Driver's Communication Panel
- PA Amplifier
- PA Speakers

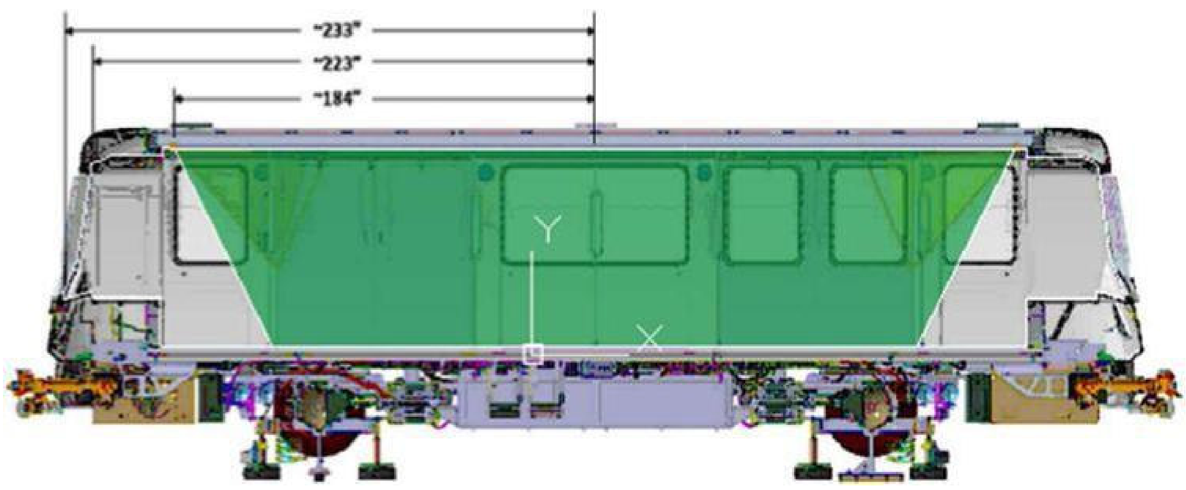
The ORS (Operational Radio System) provides live PA from Central Control, two-way calling between the vehicle and Central Control, and transmission of vehicle alarms to Central Control. These features will function in the same way as the existing vehicle fleet. All hardware will be compatible with the existing wayside RF infrastructure. The existing RF distribution system, base station, and control equipment will not be changed.

Four (4) LED dynamic signs will be similar in design to existing dynamic signs used on the Tampa cars. In case of hardware or software failure, pre-recorded audio announcements will fail-over in a similar way to existing vehicles. An on-board audio level controller will monitor two audio inputs and switch to the secondary input if the primary fails.

An on-board ethernet network switch will be installed to support IP connections between on-board devices. The devices attached to the network switch include dynamic signs and the Vehicle Communications Controller Unit - Audio (VCCU-A).

4.1 On Board CCTV

An on-board video surveillance system (VSS) will be installed on each vehicle. Two cameras will face inside the vehicle compartment as shown below.



Vehicle Interior CCTV Typical Coverage

The on-board Vehicle Communications Controller Unit will be modified with additional hard drives for video storage. The VSS will record on-board each vehicle utilizing the VCCU. The VCCU will record the IP video streams from all on-board cameras. The VCCU will have enough storage capacity to store the recorded video for 31 days at a resolution of 720p, 30 frames per second. The VCCU will permit a method to export the video to a mass storage device via a local connection.

In addition, the wayside network (DataTrans) will be modified to accept a high throughput wireless network along Leg E. A Central Control workstation will be provided at AOC and Maintenance Central for viewing CCTV.

4.2 BWAN Wireless Access Network

The Alstom Wireless Access Network known as the BWAN is a wireless data network based on switched mesh wireless networking. The BWAN serves to augment the DataTrans, providing real-time train-to-wayside communications integrated with the DataTrans which is designed to support high-capacity, low-latency, and vehicular mobility. The design of the BWAN is based on IEEE 802.11 standard utilizing 2.4 GHz band..

The major components of the BWAN are:

- Wayside (Fixed) Access Points
- Vehicle (Mobile) Access points
- Wayside Antenna System
- Vehicle Antenna System
- Wireless Access Controllers

. The in-vehicle data network is connected to a rugged, high-performance mobile node which then wirelessly connects to similar nodes installed along the guideway. These wayside radios then connect to DataTrans through ethernet switches along the guideway. Antennas are used to transmit and receive the data. Thus, the combination of onboard and wayside infrastructure provides continuous network connectivity throughout the APM system.

The on-board vehicle network is connected to a rugged, high-performance mobile node which wirelessly connects to similar fixed nodes installed along the guideway. The radio system supports rapid handoff to provide continuous network connectivity throughout the track area.

Each vehicle will contain mobile BWAN radios, connected to the on-board network switches. Roof-mounted mobile antennas will be required for each vehicle.

Wayside (fixed) access points will be placed strategically along the guideway and station areas. The wayside access points will be connected to strategically placed network switch enclosures. The network switches will be connected to each other in a ring configuration to a core switch at Central Control.

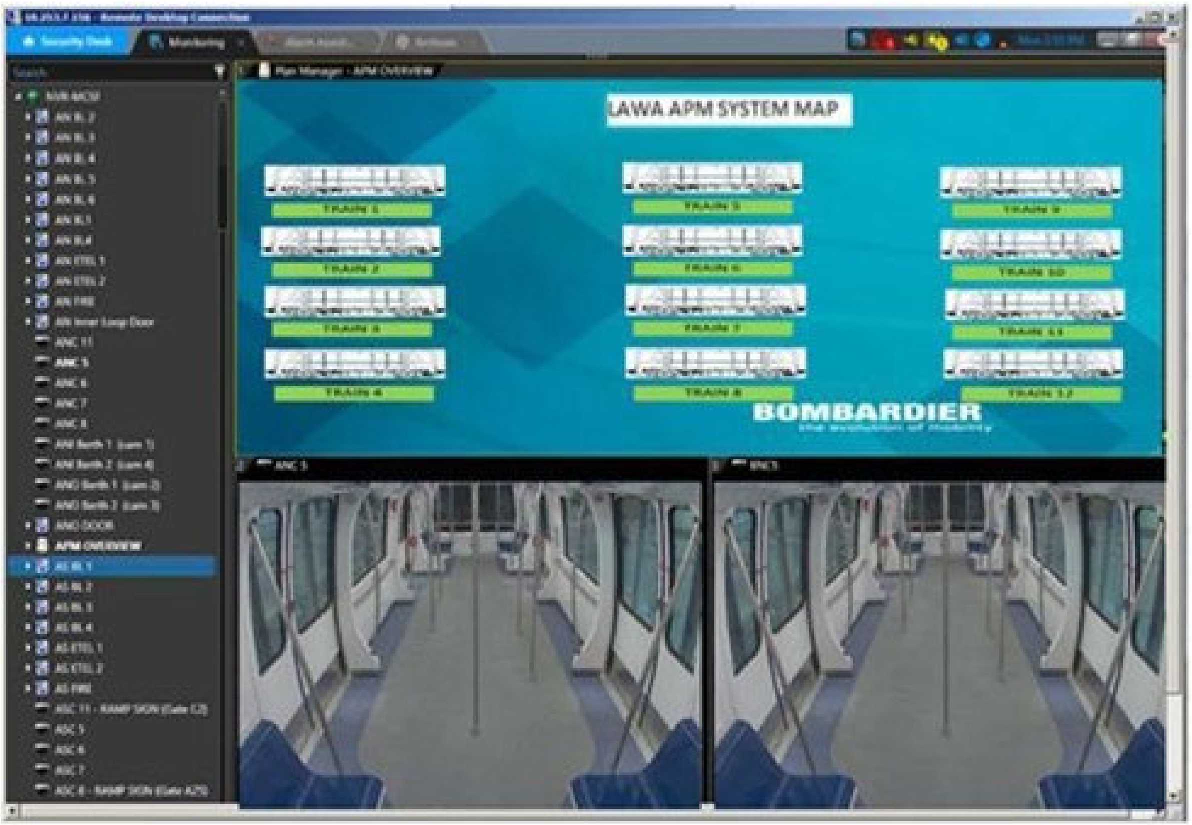
New single-mode fiber optic cabling will be installed along each guideway. This fiber is required to support the number of splice enclosures required to implement the BWAN system.

4.3 Video Surveillance System

A Video Surveillance System (VMS) will be provided for monitoring the passenger space of the APM vehicles as shown below.

The VMS provides a Graphical User Interface (GUI) allowing complete control of the camera using the workstation mouse. The CCO can select the camera to be viewed on any available video tiles either by selecting it from the area view by drag-and-drop, or by double clicking on the camera. The GUI also provides an integrated overview map with camera icons. The cameras can be selected from the map by either single clicking on the camera for a thumbnail live view, or by double clicking the camera to be populated in an available video file.

The overview map shall display all cameras onboard the vehicles. The GUI provides full access to all live and recorded video.



VSS User Interface Example

The VMS will use the BWAN system to transport live video from the vehicle cameras to the wayside VMS workstation. Recorded video onboard the cars can also be retrieved on-demand when needed.

The video will be streamed at 704x480 resolution and 7 frames per second

5 TRACTION POWER DISTRIBUTION SYSTEM ANALYSIS

The traction Power Distribution System (PDS) of Leg E will be analyzed using computer simulation to determine the effects of the 300R vehicles on the existing substation. The electrical model used in the simulations replicates the substation design, ratings, cables, power rails, and protections of the existing system. Normal and failure mode loss of one of the two available utility/transformers will be analyzed using AW1 vehicle weight. The analysis will determine if the existing substations can support the new vehicles and if any changes are required to the existing PDS. No changes to the existing PDS infrastructure are anticipated at this time and is not included.

All new wayside control equipment requiring 120Vac UPS power will be sourced from existing sub-distribution panelboards which accounted for these additional circuits during the Phase 1 Central Relocation project.

6 CIVIL UPGRADES

As part of the upgrades to Leg E, Alstom is proposing the following:

6.1 Power Rail

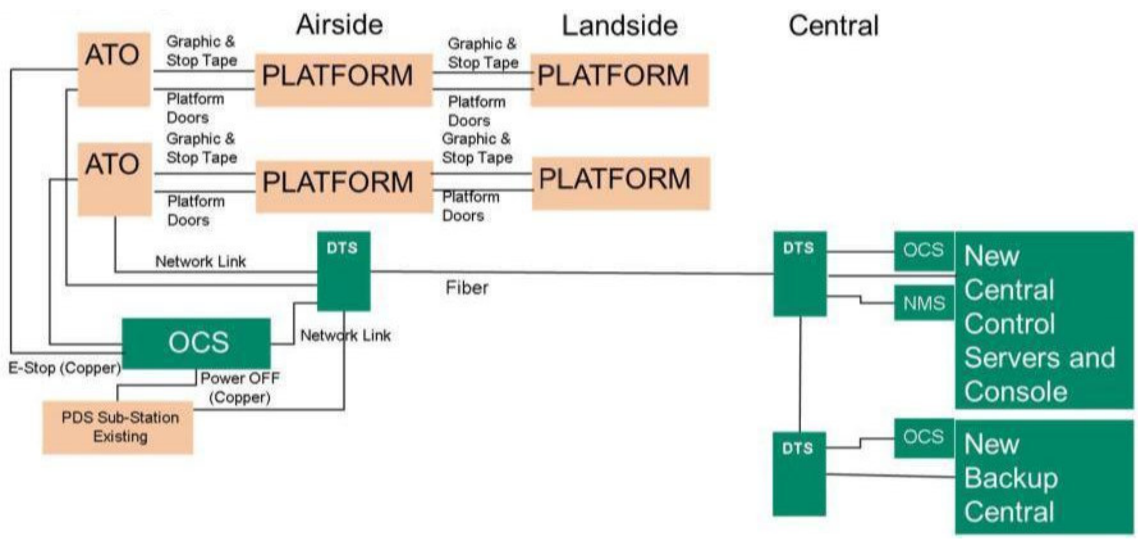
The INNOVIA APM 300R uses the same power rail and ground rail as the CX-100 APM. The existing power rails and ground rail will be replaced. The APM 300R does not use a signal rail with the new CBTC and will be removed but not replaced.

6.2 CUTOVER

The upgrade of the Tampa APM signaling is tied with the installation of new vehicles in each lane of the system. This upgrade will only include Leg E but will integrate with the same upgrades on Legs A&C and will apply to Leg F when new vehicles are procured for that Leg.

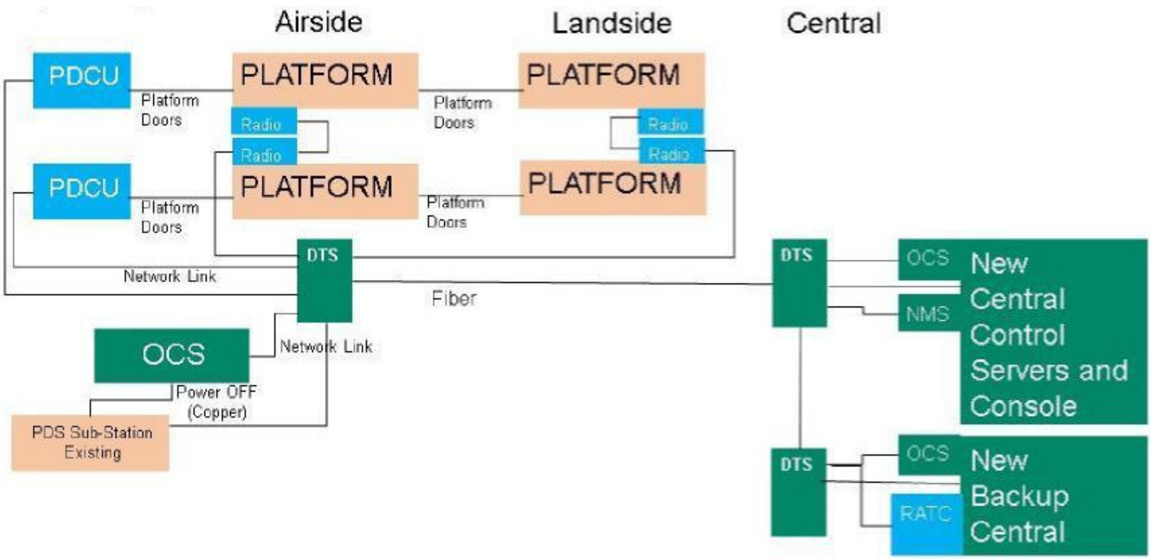
The upgrade will be designed so that each lane can be taken down for vehicle installation and when complete will be started up with the new vehicle in CITYFLO 650. Therefore, the cutover must take into consideration running one lane in CITYFLO 550 and the other in CITYFLO 650.

With the completion of the Central Control Relocation Project the upgraded configuration developed during the A&C leg upgrades will be in place for the E Leg Upgrades:



All new equipment in the Central Control Upgrade Project is highlighted in Green and the existing CITYFLO 550 equipment remaining is highlighted in a Peach color.

None of the wayside signaling will be modified. Station ATO and Door control will remain as a CITYFLO 550 shuttle system. The only Signaling equipment that will be replaced is the ATS. A new *EBISCREEN* 1500 ATS system was deployed in the Central Control Relocation Project.



Example High Level Shuttle Leg Cutover (Similar to Leg C)

High Level Cutover Leg E

- Install Line of Site CITYFLO650 hardware at wayside including all required cabling back to Leg E ATC equipment room during nighttime shutdown.
- Shutdown Lane 5 during shutdown period.
- Tweak software in Lane 5 ATO cabinet for CITYFLO650 operation and upgrade Vital I/O controller to R4.
- Replace existing Power/Ground rail during shutdown period. Requires removal of all ATO and PDS cable terminations and subsequent re-termination of PDS cables only.
- Remove existing 2 cars from Lane 5 and install 2 new INNOVIA APM 300R's during shutdown period.
- Test and commission new CITYFLO 650 with new vehicles on Lane 5 during shutdown period.
- Remove existing 550 hardware from guideway (lane 5) during shutdown period.
- Repeat previous procedures for Lane 6.
- Test and commission for dual lane operation.

7 KEY CUSTOMER ASSUMPTIONS

1. Customer moves forward with *CITFLO* 650 upgrade as part of this contract.
2. UL compliance expected.
3. Buy America not part of terms.
4. No Building Information Modeling (BIM) required.
5. Internal Safety Assessment acceptable by the Customer.
6. One (1) Preliminary Design Review and one (1) Final Design Review only. No Intermediate Design Review required.
7. Reasonable involvement of an HCAA third-party consultant or Independent Safety Assessor.
8. Authorization for operation to be done separately for each Leg.
9. No availability or reliability analysis required.
10. All guideway superstructure analysis and repair by the Customer.
11. Similar to the scope split on Airsides A&C, Alstom has assumed no Cybersecurity scope requirements.
12. Onboard Operational Radio System (ORS) will function same as existing Legs.
13. No ORS software changes required for existing fleet or Central.
14. No vehicle sign control from Central.
15. 5.8 Ghz frequency for CITYFLO650 operation is acceptable to Customer.
16. Alstom will strive to meet the existing operational characteristics (Dwells Times, Round Trip Times, Passenger Flow Rates, etc.) as current system on Leg E based on the new equipment configurations, revised safety standards and related requirements for the updated configuration.
17. No changes to the mechanical portion of the existing platform doors or platform dynamic signs as part of this upgrade.
18. Upgrades to Leg F are not part of this contract.
19. No existing traction power distribution system or utility interface modifications.

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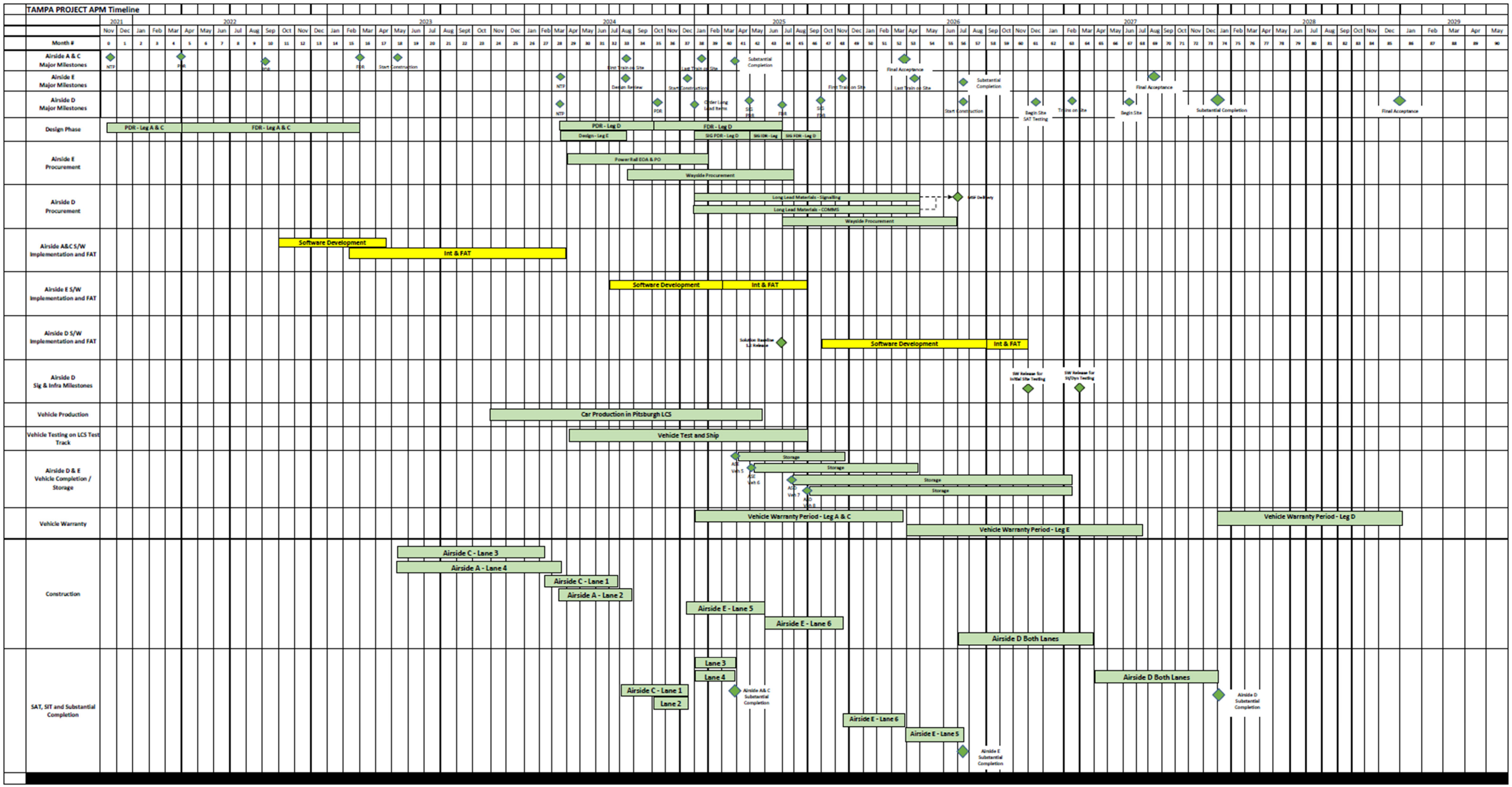
Appendix C
Project Schedule



TAMPA PROJECT APM Timeline
2021
2022
2023
2024
2025
2026
2027
2028
2029
Month #
Airside A & C Major Milestones
Airside E Major Milestones
Airside D Major Milestones
Design Phase
Airside E Procurement
Airside D Procurement
Airside A&C S/W Implementation and FAT
Airside E S/W Implementation and FAT
Airside D S/W Implementation and FAT
Airside D Sig & Infra Milestones
Vehicle Production
Vehicle Testing on LCS Test Track
Airside D & E Vehicle Completion / Storage
Vehicle Warranty
Construction
SAT, SIT and Substantial Completion
NTP
PDR
FDR
Start Construction
First Train on Site
Last Train on Site
Substantial Completion
Final Acceptance
Design Review
Order Long Lead Items
Begin Site SAT Testing
Train on Site
Begin Site
PDR - Leg A & C
FDR - Leg A & C
PDR - Leg D
FDR - Leg D
Design - Leg E
SIG PDR - Leg D
Power Rail EOA & PO
Wayside Procurement
Long Lead Materials - Signalling
Long Lead Materials - COMMS
Software Development
Int & FAT
Solution Baseline 1.1 Release
Car Production in Pitsburgh LCS
Vehicle Test and Ship
Storage
Vehicle Warranty Period - Leg A & C
Vehicle Warranty Period - Leg E
Vehicle Warranty Period - Leg D
Airside C - Lane 3
Airside A - Lane 4
Airside C - Lane 1
Airside A - Lane 2
Airside E - Lane 5
Airside E - Lane 6
Airside D Both Lanes
Lane 3
Lane 4
Lane 2
Airside A&C Substantial Completion
Airside D Substantial Completion
Airside E Substantial Completion

Appendix D

Payment Schedule

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Tampa Airside D Payment Schedule

Month	Percentage	Cumulative Percentage	Amount	Cumulative Amount	Events	Evidence
Mar-24	25.00%	25.0000%	$ 12,842,500.00	$ 12,842,500.00	Down Payment/Mobilization	Signed Contract / NTP
Aug-24	2.50%	27.5000%	$ 1,284,250.00	$ 14,126,750.00	Project Work Schedule and D/CID	Document submission
Nov-24	2.50%	30.0000%	$ 1,284,250.00	$ 15,411,000.00	Hold Preliminary Design Review (non-signaling)	Issue Design Review minutes
Mar-25	10.00%	40.0000%	$ 5,137,000.00	$ 20,548,000.00	Place PO for Wayside Equipment	Provide POs
May-25	4.00%	44.0000%	$ 2,054,800.00	$ 22,602,800.00	Place PO for Power Rail	Provide PO
May-25	2.50%	46.5000%	$ 1,284,250.00	$ 23,887,050.00	Hold Preliminary Design Review (signaling)	Issue Design Review minutes
Jul-25	7.50%	54.0000%	$ 3,852,750.00	$ 27,739,800.00	Hold Final Design Review (non-signaling)	Issue Design Review minutes
Nov-25	7.50%	61.5000%	$ 3,852,750.00	$ 31,592,550.00	Hold Final Design Review (signaling)	Issue Design Review minutes
Jan-26	7.50%	69.0000%	$ 3,852,750.00	$ 35,445,300.00	Start Fabrication/Build of Wayside Equipment	Provide pictures of occurrence or site visit
Aug-26	2.50%	71.5000%	$ 1,284,250.00	$ 36,729,550.00	Start Installation of Running Surface	Site Tour/Audit
Aug-26	2.50%	74.0000%	$ 1,284,250.00	$ 38,013,800.00	Start Installation of Traction Power Equipment	Site Tour/Audit
Sep-26	4.00%	78.0000%	$ 2,054,800.00	$ 40,068,600.00	Hold Software Factory Test Review	Verification through Site Visit
Oct-26	2.00%	80.0000%	$ 1,027,400.00	$ 41,096,000.00	Start Installation of Wayside Signalling Equipment on Site	Site Tour/Audit
Nov-26	2.00%	82.0000%	$ 1,027,400.00	$ 42,123,400.00	Start Installation of Guidebeam	Site Tour/Audit
Dec-26	2.00%	84.0000%	$ 1,027,400.00	$ 43,150,800.00	Start Installation of Platform Screen Doors	Site Tour/Audit
Dec-26	3.00%	87.0000%	$ 1,541,100.00	$ 44,691,900.00	Start Wayside Field Testing Activities	Site Tour/Audit
Mar-27	2.00%	89.0000%	$ 1,027,400.00	$ 45,719,300.00	Cars 13 & 14 Delivered and Lifted onto the Guideway	Site Tour/Audit
Mar-27	2.00%	91.0000%	$ 1,027,400.00	$ 46,746,700.00	Cars 15 & 16 Delivered and Lifted onto the Guideway	Site Tour/Audit
Jul-27	2.00%	93.0000%	$ 1,027,400.00	$ 47,774,100.00	Start System Integration Testing	Site Tour/Audit
Dec-27	2.00%	95.0000%	$ 1,027,400.00	$ 48,801,500.00	Start System Demonstration	Site Tour/Audit
Jan-28	3.00%	98.0000%	$ 1,541,100.00	$ 50,342,600.00	Substantial Completion	Substantial Completion Documents
Jan-29	2.00%	100.0000%	$ 1,027,400.00	$ 51,370,000.00	Final Acceptance	Final Acceptance Documents

100.0000%	Airside D Total	$ 51,370,000.00	

Tampa Airside E Payment Schedule

Month	Percentage	Cumulative Percentage	Amount	Cumulative Amount	Events	Evidence
Mar-24	25.00%	25.00%	$ 3,056,387.50	$ 3,056,387.50	Down Payment/Mobilization	Signed Contract / NTP
Jun-24	10.00%	35.00%	$ 1,222,555.00	$ 4,278,942.50	Place PO for Power Rail	Provide PO
Oct-24	20.00%	55.00%	$ 2,445,110.00	$ 6,724,052.50	Place PO for Wayside Equipment	Provide POs
Dec-24	12.50%	67.50%	$ 1,528,193.75	$ 8,252,246.25	Start Fabrication/Build of Wayside Equipment	Provide pictures of occurrence or site visit
Jan-25	10.00%	77.50%	$ 1,222,555.00	$ 9,474,801.25	Hold Software Factory Test Review	Verification through Site Visit
Sep-25	10.00%	87.50%	$ 1,222,555.00	$ 10,697,356.25	Start Installation of Wayside Equipment on Site	Site Tour/Audit
Dec-25	6.50%	94.00%	$ 794,660.75	$ 11,492,017.00	Start Wayside Field Testing Activities	Site Audit
Aug-26	4.00%	98.00%	$ 489,022.00	$ 11,981,039.00	Substantial Completion	Substantial Completion Documents
Aug-27	2.00%	100.00%	$ 244,511.00	$ 12,225,550.00	Final Acceptance	Final Acceptance Documents

100.0000%	Airside E Total	$ 12,225,550.00
	Owner's Allowances	$ 500,000.00
	Total Supplemental Contract B	$ 64,095,550.00

Appendix E

CPA Formula

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Escalation Mechanism

Escalation effective: At notice to proceed.
Inflation base date: February 2024

Index used for escalation:

- Labor: *Average Hourly Earnings of All Employees: Total Private in Florida (SMU12000000500000003)*
- Material and Others: *Producer Price Index by Commodity: Special Indexes: Machinery and Motive Products (WPUSI093011)*
- *Fixed firmed portion: part of the price not subject to escalation, here 17%.*

Weight of Index:

- $W_{Labor} = 50\%$
- $W_{PPI} = 33\%$
- $W_{FF} = 17\%$

Terms of Payment:
Base milestones amounts will be billed following the billing plan provided in Appendix D.

The Escalation amount will be billed on each progress payment invoice, with the indexes in force at the time of invoicing.

It is understood that the indices whose publication is the most recent will be used at the time of billing for the months N and that any necessary adjustments will be made annually using the final or most recent indices for the months N. These annual adjustments will be invoiced on March 1 of each year, detailing the indices used at the time of billing and the final indices for the invoices that were issued during the 12-month period ending 6-months prior to March 1 of each year. The initial 25% down payment will be exempt from any adjustments.

The Escalation amount (E_N) will be calculated with the formula below:

$$E_N = (P_B * EPA_N) - P_B$$

Where:

- P_B is the Base milestone amount, as provided in billing plan Appendix D.
- EPA_N means the Economic Price Adjustment factor to be applied, based on following formula:

$$EPA_N = \left(\frac{Labor_N}{Labor_B}\right) * W_{Labor} + \left(\frac{PPI_N}{PPI_B}\right) * W_{PPI} + W_{FF}$$

Where:

- $\boldsymbol{Labor_N}$ means the value of following Cost Index : *"Average Hourly Earnings of All Employees: Total Private in Florida (SMU12000000500000003)"* on the billing date.
- $\boldsymbol{Labor_B}$ means the value of following Cost Index: *"Average Hourly Earnings of All Employees: Total Private in Florida (SMU12000000500000003)"* on the Inflation Base Date (being February 1, 2024).
- $\boldsymbol{W_{Labor} = 50\%}$ as per index weight.

- $\boldsymbol{PPI_N}$ means the value of following Cost Index : "*Producer Price Index by Commodity: Special Indexes: Machinery and Motive Products (WPUSI093011)"* on the billing date.

- $\boldsymbol{PPI_B}$ means the value of of following Cost Index : "*Producer Price Index by Commodity: Special Indexes: Machinery and Motive Products (WPUSI093011)"* on the Inflation Base Date (being February 1, 2024).
- $\boldsymbol{W_{PPI} = 33\%}$ as per index weight.

ATTACHMENT 2

SECTION 01020 - OWNER'S ALLOWANCES – REVISED WITH SUPPLEMENTAL CONTRACT B

PART 1 - GENERAL

1.01 DESCRIPTION OF REQUIREMENTS

A. Owner's allowances in the amounts indicated and as described below have been established for certain types of work. The Contractor will perform such Work only upon receipt of written work orders from the Owner. For this purpose, a Work Order will have the same meaning for requirements pertaining to submittals, approvals, etc. as in the Contract, as modified, except the Work Order is only signed by the Owner.

B. If the Work Order directs that the allowance work be performed, the provisions of the Contract, as modified, will govern the conduct and payment for this Work.

C. Definitions and Explanations: All Work, including any allowance work if authorized, shall be performed in full compliance with the requirements of the Contract. All allowance work, if and when authorized, shall be performed by the Contractor in accordance with the Work Order.

1. Contractor shall coordinate allowance Work with related Work to ensure that each selection is completely integrated and interfaced with related Work, and shall include all aspects of Work to fully integrate the Work with all other Work and Related Work.

D. "Purchase and Installation" means the allowance covers both the purchase and installation of the indicated Work. The Contractor will bear the cost of coordinating the Work, providing the installer with access to the Work, temporary heat, ventilation, light, workspace, storage space, parking and toilet facilities, the cost of which will be included in the Contract Sum and not in the allowance.

E. Work Order Data: Where applicable when a lump sum price has not been agreed, Contractor shall include in each Work Order proposal both the quantities of products being purchased and units requested, and furnish survey-of-requirements data to substantiate quantities. Indicate applicable taxes, delivery charges, and amounts of applicable trade discounts.

F. Upon issuance of a Work Order, the Work Order funds will be tracked separately on the Contractor's Schedule of Values by Work Order number and the amount of the Cost of Work. If multiple subcontractors are employed for the Work Order, each Subcontractor's Pay Requisition will include a separate line with the description Work Order number that will flow to the Contractor's Schedule of Values. Once work is complete on the Work Order, the Contractor has 30 days in which to reconcile the Work Order, as follows:

1. Provide Owner Project Management with a package containing cost support documents totaling the Cost of Work.

ATTACHMENT 2

2. Calculate mark-ups and fee using the same formula/calculations used to create the original Work Order budget.

3. Any unused Work Order funds will be returned to the Owner's Allowance budget via a negative Work Order.

The Contractor will forfeit their fee on the Work Order for any Work Orders that have not been reconciled within 60 days of the completion of the work, following the process above.

G. Work Order Mark-Up: The amount of each Work Order resulting from final selection and installation of products and systems covered by an allowance will be the difference between the amount of installed Work and the allowance. This is a procedural clarification of the Contract, as modified.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.01 SCHEDULE OF OWNER'S ALLOWANCES

A. These allowances will cover the total cost of all Work authorized under a Work Order, including but not limited to design, cost of materials and equipment delivered and unloaded at the Project site, and all applicable taxes, permits, fees, labor, installation costs and integration as applicable. The Contractor's percentage, overhead and profit for the allowance will be included in the Work Order amount.

B. Should the aggregate of charges for all approved Work Orders issued by the Owner under the allowances be less than the amount of the allowance, the final Contract Sum will be decreased by the amount of the difference. No Work will be performed that would cause total charges under the allowances to exceed the authorized allowance amount. The authorized allowance amount may be increased by Change Order. Should the aggregate charge for an approved Work Order issued by the Owner under the Allowance be less than the amount of the Work Order, the Owner may issue another Work Order in a negative amount to reconcile the Work Order. Such reconciliation Work Orders do not require executive management approval.

C. The following allowance amounts will be included in the Contract Sum amount in the Contractor's proposal:

OWNER'S ALLOWANCE: Allow an amount of <u>$1,000,000.00</u> of the Contract Sum for:

ATTACHMENT 2

1. Owner's Allowance may be used for repair, removal, relocation and/or replacement of utilities (sanitary system, storm system, potable water system, fire protection system, mechanical system, electrical system, communications, security system, etc.).

2. Owner's Allowance may be used for the resolution of unforeseen conditions with the existing airport property. This includes all elements associated with or discovered during the current contract scope including structural, sub surface, paving, lighting, signage, navigational aid, civil, irrigation, building envelope, or other elements associated with the contract scope.

3. Owner's Allowance may be used for relocation and adjustments of Work associated with the airport's tenants (airlines, rental car companies, concessions, TSA, CBP, FAA, Fed Ex, FBO, etc.) and other contracts. This Work shall include all disciplines: architectural, structural, mechanical, plumbing, electrical, communications, fire protection, civil, signage, etc.

4. Owner's Allowance may be used for temporary signage as directed by the Owner.

5. Owner's Allowance may be used for Contractor's project office space or office trailer and furnishings as directed by the Owner.

6. Owner's Allowance may be used for changes required to Contractor's Scope of Work due to the final design of the guideway which are not included in Contractor's proposal.

7. Owner's Allowance may be used for any Work not shown in the Contract Documents, but which is necessary to complete the Project, with approval of executive management.

D. Contract Time will not be extended as a result of the issuance of any Work Order under this Section 01020 – OWNER'S ALLOWANCES.

E. The Contract Sum will not be adjusted for any costs of acceleration resulting from the issuance of Work Orders under this Section 01020 – OWNER'S ALLOWANCES. In addition, the Contract Sum will not be adjusted for any costs of acceleration of the whole work resulting from the issuance of Work Orders under this Section 01020 – OWNER'S ALLOWANCES.

END OF SECTION