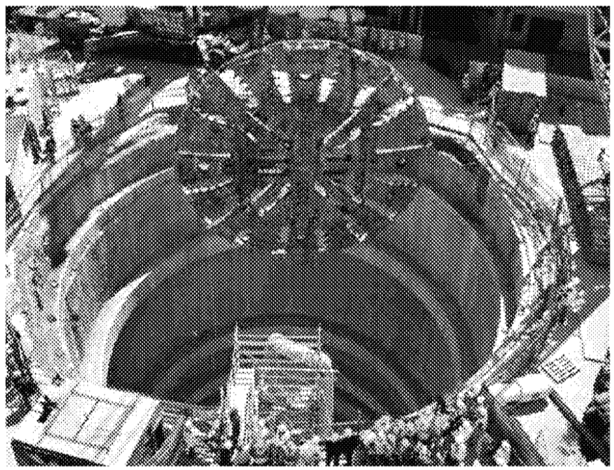
CONFIDENTIAL

February 28, 2012

RIDEAU TRANSIT GROUP



OTTAWA LIGHT RAIL TRANSIT PROJECT:

TUNNEY'S PASTURE TO BLAIR STATION
DESIGN PRESENTATION #3
Vehicles, Train Control, LRT Systems, and System-wide Safety and Certification

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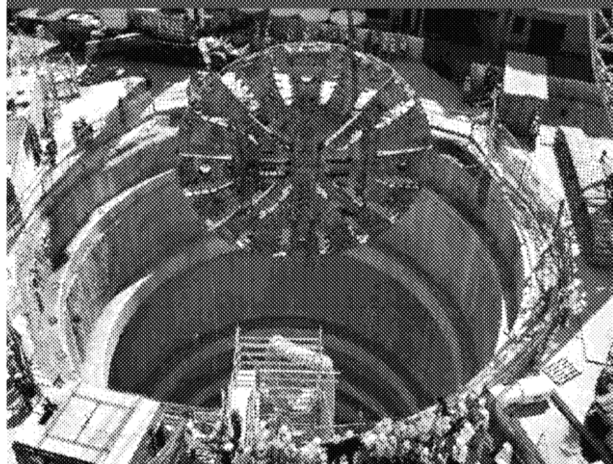

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TEAM MEMBER INTRODUCTIONS & AGENDA

RIDEAU TRANSIT GROUP

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Team Introductions & Agenda

Team Introductions: RIDEAU TRANSIT GROUP

EQUITY & DEVELOPER PRIME TEAM MEMBERS

SNC-LAVALIN Capital

ACS INFRASTRUCTURE CANADA INC.

EllisDon

FINANCIAL ADVISOR

Scotia Capital

MAINTENANCE PRIME TEAM MEMBERS

ACS INFRASTRUCTURE CANADA INC.

SNC-LAVALIN O&M

EllisDon

VEOLIA TRANSPORTATION

DESIGN-BUILD PRIME TEAM MEMBERS

SNC-LAVALIN Constructors Pacific

DRAGADOS

EllisDon

DESIGN TEAM MEMBERS

SNC-LAVALIN

MMM GROUP

Hatch Mott MacDonald

IBI GROUP

THURBER

ADAMSON

bbb architects

RIDEAU TRANSIT GROUP

Team Introduction & Agenda

Team Introductions: RIDEAU TRANSIT GROUP – BID PHASE

Concessionaire

Marc Hulin
Sammy Ayoub
Vicente Marana

DBJV

Roger Woodhead, Bid Director
Daniel Botero, Deputy Bid Director

Maintenance & Operations

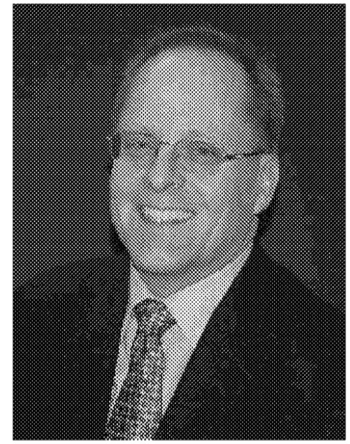
Ana Gallego, Maintenance Lead
Ramon Villaamil, Maintenance

EJV Consultants

Chris McCarthy, Design Manager
Tom Middlebrook, Deputy Design Manager
Helen Gault, Vehicles
Paul Lam, Operational Performance
John Selke, Train Control Lead
Marta Navarro, Train Control
Phil Lee, LRT Systems Lead
Keith Brown, Communications Lead

RIDEAU TRANSIT GROUP RTG

Team Introduction & Agenda



Chris McCarthy, P.Eng.

EJV Design Manager

- Over 25 years experience in design and construction
- Key management roles on two major LRT projects
  - Canada Line ($2b) – Director of Facilities Design
  - Seattle Monorail ($1.4b) – Project Manager, Lead Architect (preliminary engineering phase)
- Involved in rapid transit for past 18 years
  - From BRT systems, to LRT and Mass Transit
  - From transit planning, preliminary & detailed design, construction, commissioning, and operations interface
- Major work assignments on systems in service – 6
- Major work assignments on systems in development - 8

RIDEAU TRANSIT GROUP

Team Introduction & Agenda

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Agenda

Vehicles

1. Supply Voltage
2. Car Body Strength
3. Accessibility
4. General Arrangement
5. Consist Arrangement
6. Capacity & Passenger Density
7. Performance, Reliability & Safety in Similar Climatic Conditions
8. Compliance with Canadian Content Policy
9. Non-revenue Vehicles (Maintenance)
10. Branding Strategy

Operational Performance Requirements

11. Demonstration & Supply of Modelling & Results of Expected System Performance & Applicability to the OLRT

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Team Introduction & Agenda

Agenda

Train Control

12. Manufacturer
13. Design & Integration Methodology
14. System Engineering Process
15. Proven Design & Successful Application
16. Yard Control
17. Backup to Communication Based Train Control (CBTC) System

LRT Systems

17. Minimizing the Visual Impact of the OCS
18. Traction Power & Distribution
19. OCS
20. Corrosion Control, Stray Current & EMI
21. Medium Voltage Distribution
22. Communications

Team Introduction & Agenda

Agenda

Safety & Certification

23. Assurance Process and Methodology
24. Safety and Security Certification Plan
25. Post Construction Pre-revenue Certification
26. Safety Auditing during Operational Service
27. RAMS (Reliability, Availability, Maintainability & Safety)
28. Configuration Control
29. Integration

Issues Moving Forward

Questions

Summary & Closing Comments

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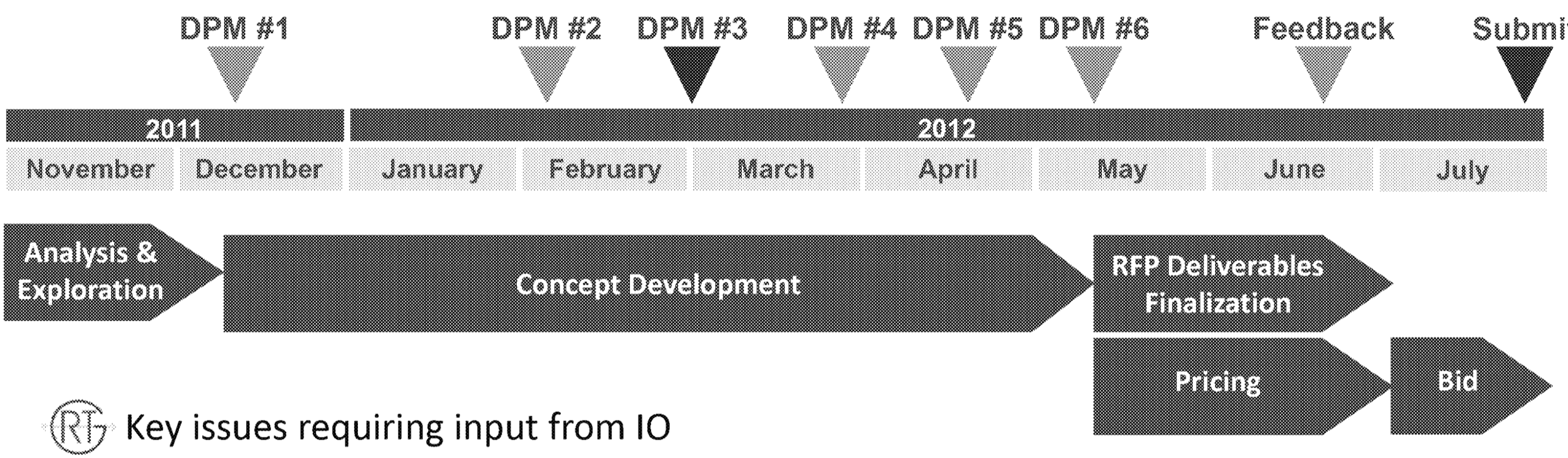
Team Introduction & Agenda

Delivering a Winning Bid

Key Objectives Today:

- Compliance of the vehicle, train control, LRT system design, and system-wide safety and certification
- Current focus – Achieving Affordability; Issues affecting compliance
- Seeking feedback / information on critical issues
- Where we are in the process



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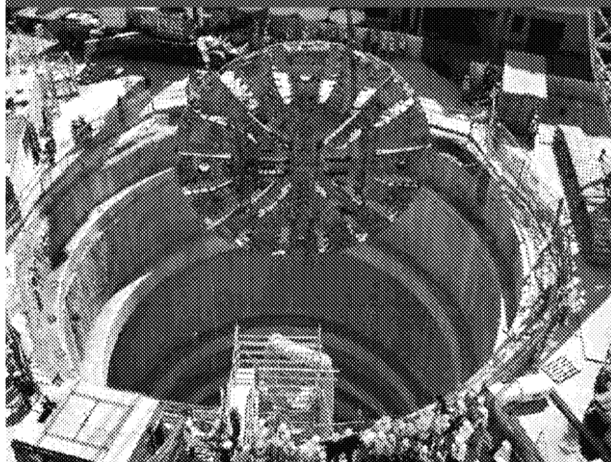

2 VEHICLES

Vehicles

Dr. Roger Woodhead, P.Eng.

DBJV Bid Director

- Over 35 years experience in design and construction
- PhD from University Calgary
- Management role on two of Canada's largest recent LRT projects
  - SkyTrain Millennium Line ($1.2b)
  - Canada Line ($2b)
- Involved in rapid transit for past 16 years
- Accolades/awards
  - CSCE National Lecture Tour -1997-8
  - Construction Award ACI 2005
  - Canada Line won Schreyer and Lieutenant Governor's Awards

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Vehicles

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Introduction

Process

- Following process recommended to Council on 14 July 2011
  - *"RFQ proponents will be directed not to commit to a vehicle. The City will focus on the qualifying the best construction consortia. The qualified bidders will be free to negotiate with interested suppliers to find value-based partners. The goal will be to include as many qualifying integrators as possible. Teams may submit as many systems/vehicle packages as they like for pre-qualification during the RFP process. Pre-qualified systems and vehicle integrators will then negotiate with short listed construction and integration teams, fostering maximum competitive tensions."*

RIDEAU TRANSIT GROUP RTG

Vehicles

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Introduction

Progress

- **January 6, 2012:** RTG submitted 36 separate and distinct Vehicle and Train Control packages

Previous Systems Integration Experience of Vehicle and Train Control Suppliers

	Vehicle Suppliers					
TC Suppliers	Alstom	Ansaldo Breda	CAF	Kinkisharyo	Siemens	Vossloh
Alstom	●	●	●	●	●	●
Ansaldo STS	●	●	●	●	●	
GE	●	●	●	●	●	
Invensys	●	●	●			●
Siemens	●	●	●		●	●
Thales	●	●	●	●	●	●

Vehicles

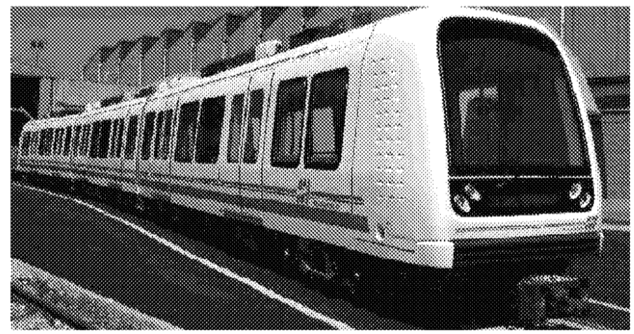
Introduction

Progress

- 21 January, 2012: Sponsor Feedback received
- 15 February, 2012: RTG submitted replies to the Feedback

List of Suppliers

	Suppliers
Vehicles	Alstom
	AnsaldoBreda
	CAF
	Siemens
	Vossloh
Train Control	Alstom
	AnsaldoSTS
	GE
	Invensys
	Siemens
	Thales



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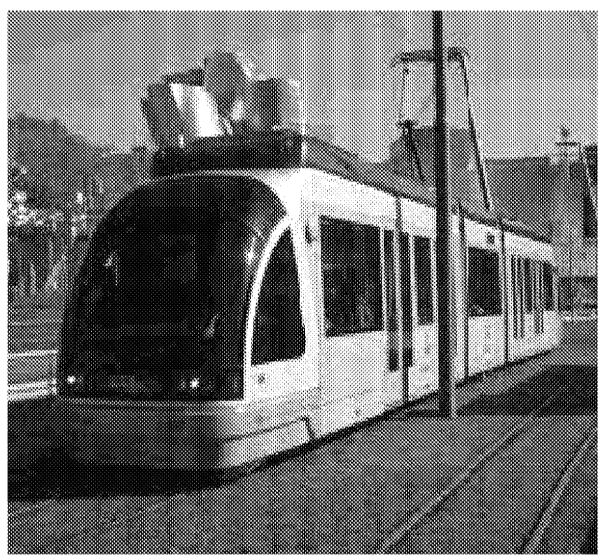
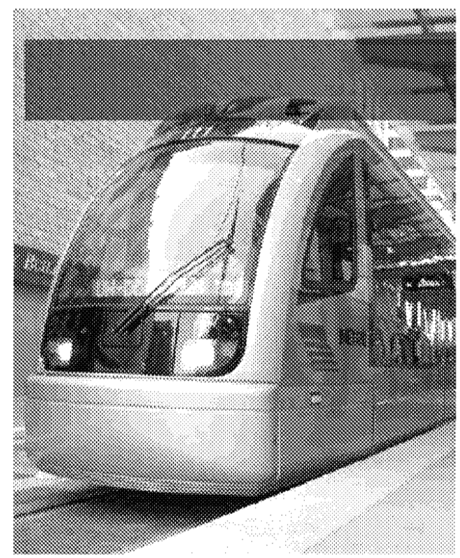
Vehicles

Introduction

Next Steps

- Sponsors to qualify Vehicle and Train Control suppliers for inclusion in the proposal
- RTG to run internal procurement process with qualified suppliers
- RTG to select the Vehicle and Train Control suppliers





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Vehicles

Supply Voltage & Car Body Strength

Supply Voltage

- All cars under consideration will operate at 1500 volts DC

Car Body Strength

- All vehicle suppliers have advised that they will fully meet the specifications or the equivalent European standards

RIDEAU TRANSIT GROUP RTG

Vehicles

Accessibility

Approach to Vehicle Accessibility

- All vehicle suppliers have advised that they can meet the AODA & ADA requirements in full
- RTG team includes accessibility specialist – Betty Dion, and we will leverage our past projects experience (e.g. Canada Line)
- Detailed Design Consultation Phase
  - Develop baseline as part of RFP
  - Engage representatives from the local disabilities / accessibility community
  - Finalize during Detailed Design Phase

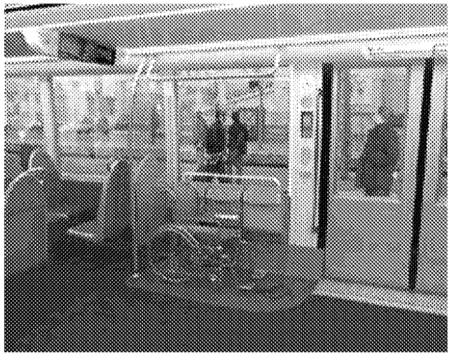
Vehicles

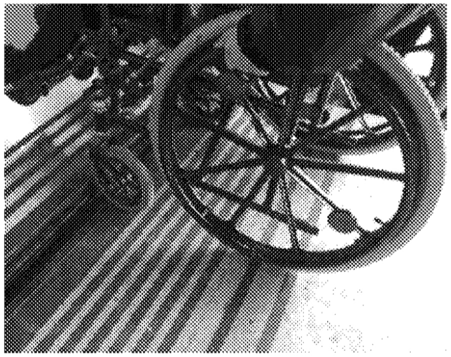
Accessibility

Accommodation of AODA and ADA Requirements

- Vehicle Elements to be Considered:
  - Different requirements of specific user groups
  - Level Boarding – minimal gap
  - Circulation between door & accommodation spaces
  - Courtesy seating
  - Audible / Visual Announcements
  - Passenger assistance call buttons
  - Visually distinctive grab rails, signage, LED lights
  - Signage and Lighting
  - Width of Aisles / Doors
  - Bellows between vehicles if an issue

- To be coordinated with Stations Approach





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Vehicles

Dr. Helen Gault, P.Eng.

Transit Planning and Development Specialist

- Over 30 years of Transit Planning experience
- Manager of Transit Services Planning and Development at OC Transpo from 1995 to 2008
  - Transit service planning, design, scheduling and operation
  - Service policy and standards development
  - Rapid transit facility design, implementation and commissioning
  - O-Train design, implementation and operation
- Canadian Urban Transit Association (CUTA) Committee Chair
  - Research and Development Committee (1993-2000))
  - Communications and Public Affairs (2000-2008)
  - Board member (2000-2008)
- National Research Council, Transportation Research Board
  - A comparison of national policies and expectations affecting transit

Vehicles

General Arrangement

Type and Manufacturers of Proposed Vehicle

- Manufacturers considered:
  - Alstom
  - Ansaldo Breda
  - CAF
  - Siemens
  - Vossloh
- Vehicle width = 2.65 m
- Various lengths available
  - 29 m to 40 m

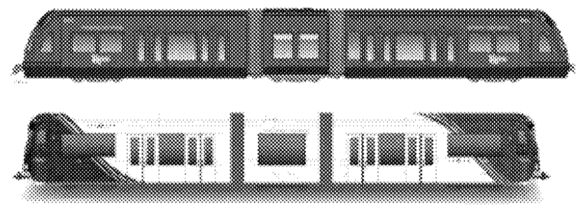
Vehicle Manufacturer	Length	Doors / Face	Top Speed
Alstom	30 m	4	100 kph
Ansaldo	31 m 39.45 m	4 5	100 kph
CAF	30 m 40 m	4 5	100 kph
Siemens	28.9 m	4	105 kph
Vossloh	31 m 37 m	4 5	100 kph

Vehicles

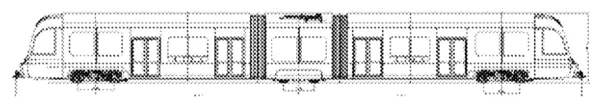
General Arrangement

General Arrangement

- Uni-directional & bi-directional
- 100% & 70% low floor
- Doors required on both sides
  - Centre & side platforms

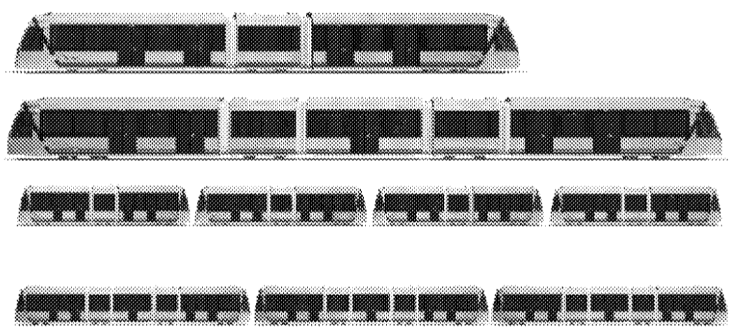


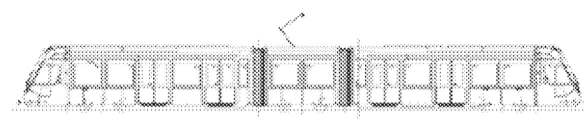
Siemens



Ansaldo

CAF





Alstom

Vossloh

Vehicles

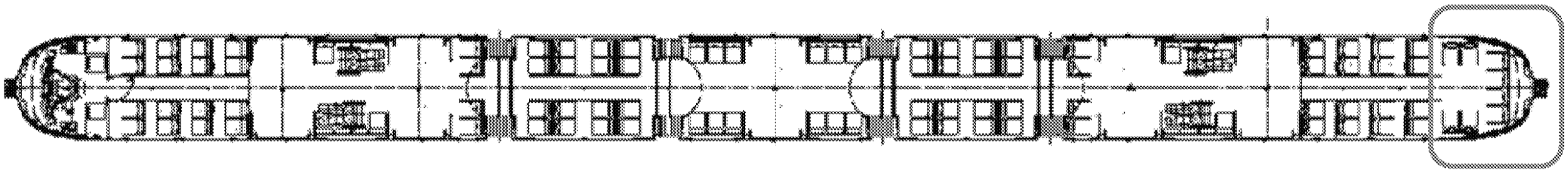
Capacity & Passenger Density

Passenger Density

- 3.33 passengers / m^2 for standees (crush load is 5 passengers/ m^2)
- 40% of capacity to be seated (including flip-up seats)

Passenger Capacity

- 181 passengers / 30 m LRV
- 248 passengers / 40 m LRV
- Additional capacity possible with:
  - uni-directional consist vs. bi-directional
  - wider LRV (e.g. 3.0 m width & 40 m length = 282 passengers)



6 – 8 Additional Seats

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Vehicles

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Consist Arrangement

Round Trip Time = (one-way trip time + headway) x 2
Fixed 5 minute headways on Saturday & Sunday

			30 m (180 passengers/veh) 2.65 m wide				40 m (248 passengers/veh) 2.65 m wide			
Capacity	Period	% of Peak	Headway	Consist	Vehicles	with 10% spares	Headway	Consist	Vehicles	with 10% spares
12,000	Weekday	100%	2.7	3	60	66	3.7	3	45	50
	Saturday	23%	5.0	2	24		5.0	1	12	
	Sunday	20%	5.0	2	24		5.0	1	12	
18,000	Weekday	100%	2.4	4	88	97	2.5	3	66	73
	Saturday	23%	5.0	2	24		5.0	2	24	
	Sunday	20%	5.0	2	24		5.0	2	24	
24,000	Weekday	100%	2.3	5	120	132	2.5	4	88	97
	Saturday	23%	5.0	3	36		5.0	2	24	
	Sunday	20%	5.0	3	36		5.0	2	24	

- 3-car consist initially, potential to operate single consist on weekends

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Consist Arrangement

Potential for Increased Capacity with 3.0 m Wide Vehicles

			40 m (248 passengers/veh) 2.65 m wide				40 m (282 passengers/veh) 3.0 m wide			
Capacity	Period	% of Peak	Headway (min)	Consist	Vehicles with 10% spares	Platform length (m)	Headway (min)	Consist	Vehicles with 10% spares	Platform length (m)
12,000	Weekday	100%	3.7	3	50	120	2.8	2	44	80
18,000	Weekday	100%	2.5	3	73	120	2.8	3	66	120
24,000	Weekday	100%	2.5	4	97	160	2.1	3	83	**120**

- Meets service requirements
- Fewer vehicles
- Shorter platforms
- No service proven vehicles

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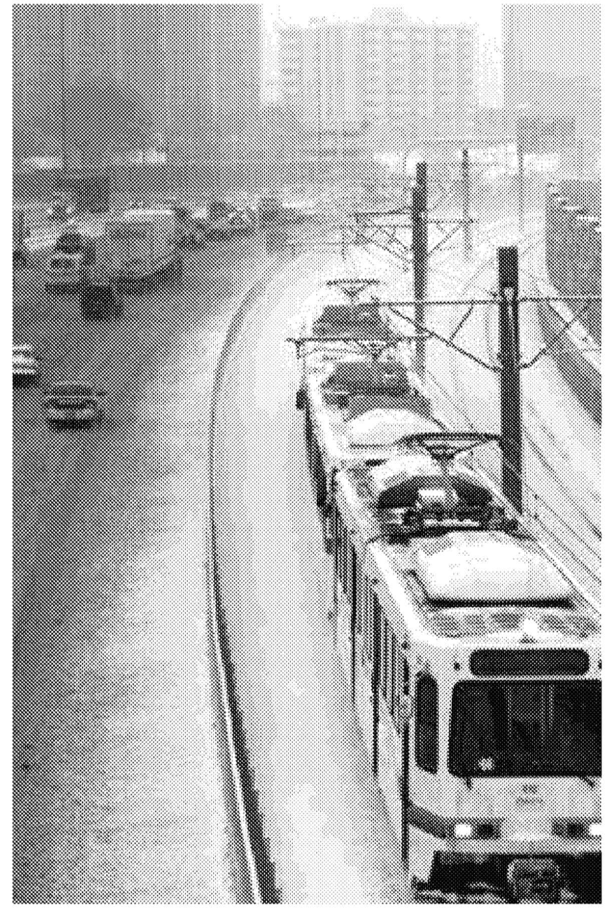
Vehicles

Performance, Reliability & Safety in Similar Climatic Conditions

Design Methodology & Strategy for Addressing Climatic Challenges

- Car body design
  - Under-frame design to avoid areas where snow and ice could accumulate;
  - Hatches outside the car body designed to avoid snow and ice build-up;
  - Floor, wall and ceiling insulation of articulation areas and areas of the underframe;
- Protection of the electronic equipment
  - Roof equipment protected from moisture and snow
  - Heating of certain articles sensitive to dew
- HVAC air inlet
  - Designed to accommodate snowfall rates and depths



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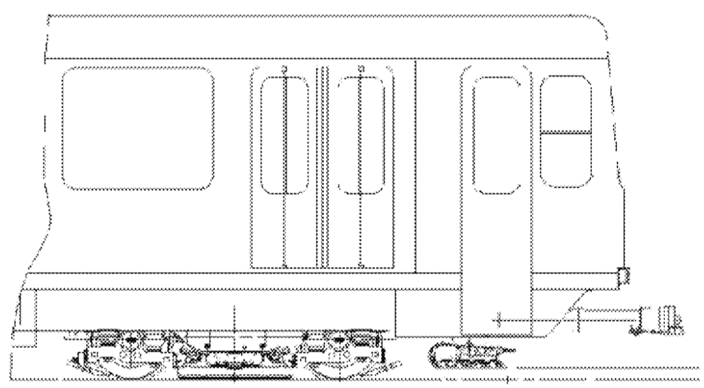
Vehicles

Performance, Reliability & Safety in Similar Climatic Conditions

Design Methodology & Strategy for Addressing Climatic Challenges

- Selection of materials suitable for low temperatures
  - All lubrication materials to have adequate viscosity work in temps to -38°C
  - All materials to resist and retain elasticity in temps to -38°C
- Vehicle Heating
  - Heated floor
  - Heated entrance thresholds
  - Heated roof equipment
- Second Pantograph as Ice Scraper
- Snow Plow



Snow Plow: CAF (Pittsburgh)

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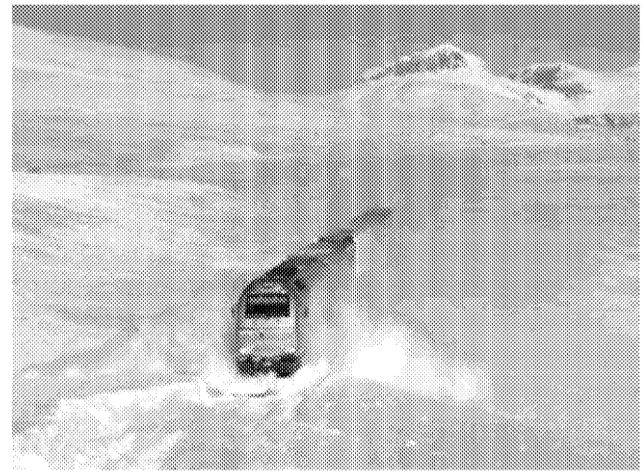
Performance, Reliability & Safety in Similar Climatic Conditions

Dealing with Weather Extremes (examples)

- Siemens: Edmonton, Calgary, Denver
- CAF: Pittsburgh, Finland, Victoria, Beograd
- Alstom: Sweden, Finland, Russia (climatic simulation chamber)
- Ansaldo Breda: Norway, Denmark, Sweden, Cleveland
- Vossloh: Norway, Switzerland (climatic simulation chamber)

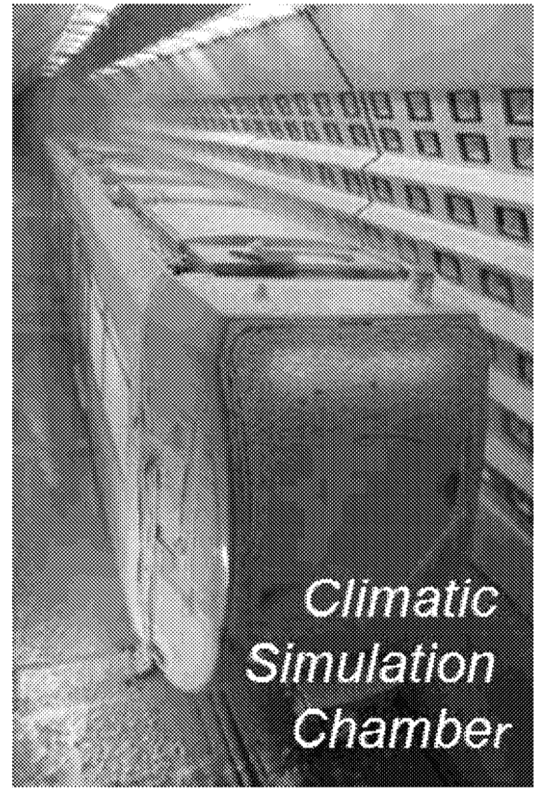


Vehicles

Performance, Reliability & Safety in Similar Climatic Conditions

Dealing with Weather during Testing

- NRC-CSST Climatic Simulation Chamber situated in Ottawa
- Test Track performance testing over winter period



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Vehicles

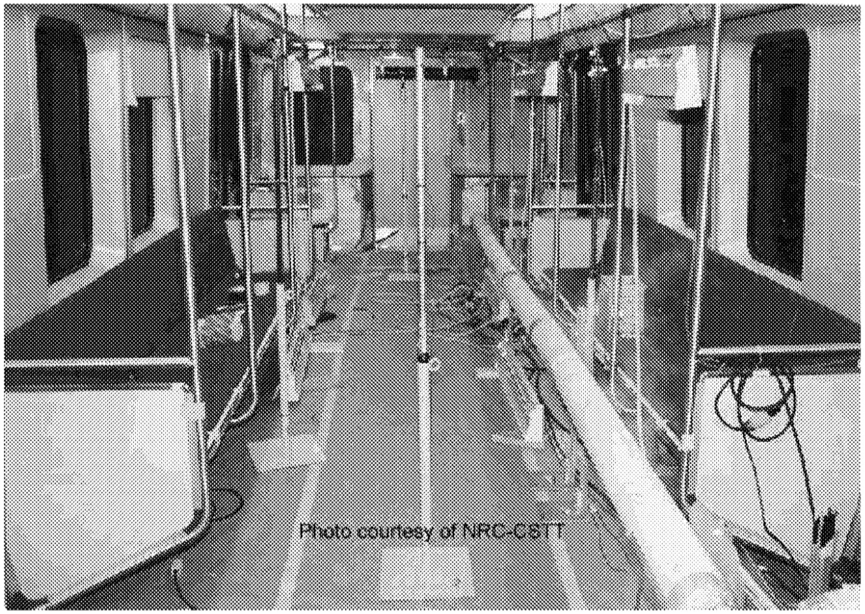
Photo courtesy of NRC-CSTT


Photo courtesy of NRC-CSTT

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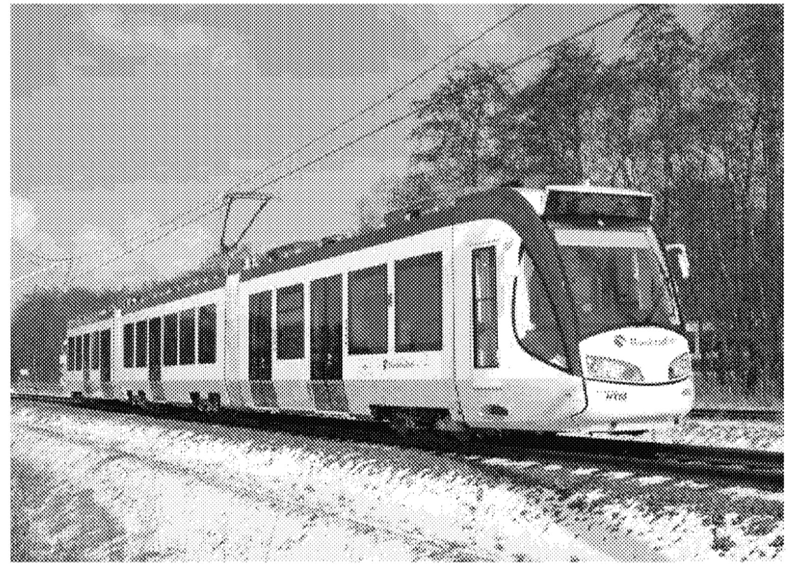
Vehicles



Compliance with Canadian Content Policy

RTG Certification of Compliance

- RTG will provide a Certificate of Compliance for the selected vehicle

Consent to Disclosure, Verification and Audit of Information

- The vehicle manufacturers being considered have all declared their consent to disclose for verification and audit information to support their achievement of at least 25% Canadian content

Vehicles

Compliance with Canadian Content Policy

25% Minimum Canadian Content in RTG Vehicles

- All manufacturers can meet the 25% Canadian Content policy
- Estimates of final percentage of Canadian content range from 25% to 33%
- The suppliers will base their approach on:
  - Using Canadian suppliers for parts and engineering
  - Local vehicle final assembly (**in Ottawa**)
  - Testing and all labour costs
  - Warranty administration, project management, administrative support
  - Freight costs

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Vehicles

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Compliance with Canadian Content Policy

25% Minimum Canadian Content in RTG Vehicles – ALSTOM (27%)

Item	% Item / Total	% Localization	Local Content
Labour	8%	85%	7%
Sub-components & Components	64%	20%	13%
Project Management	6%	25%	2%
Engineering	14%	5%	1%
Manual	0%	0%	0%
Special Tools	1%	0%	0%
Test Equipment	2%	75%	1%
Freights	1%	100%	1%
Warranty	3%	100%	3%
TOTAL	**100%**		**27%**

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Compliance with Canadian Content Policy

25% Minimum Canadian Content in RTG Vehicles – ANSALDO BREDA (28.1%)

Item	% of Total Vehicle Cost (A)	% of Canadian Content (B)	Total % Canadian Content (A*B)
Labour	24.3%	28.5%	6.9%
Sub-components & Components	60.8%	25.4%	15.4%
Project Management	1.0%	9.8%	0.1%
Engineering	5.4%	0.0%	0.0%
Manual	0.5%	78.5%	0.4%
Special Tools	0.4%	65.8%	0.3%
Test Equipment	0.7%	58.9%	0.4%
Freights	3.2%	68.3%	2.2%
Warranty	3.6%	65.4%	2.4%
TOTAL			**28.1%**

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Compliance with Canadian Content Policy

25% Minimum Canadian Content in RTG Vehicles – CAF (26% – 33%)

Eligible Cost Concepts	Canadian Content - % Range of Total Vehicle
Labour	12% - 14%
Sub-components and Components	8% - 10%
Freight / Warranty	4% - 5%
Other (1)	2% - 3%
TOTAL	26% - 33%

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Compliance with Canadian Content Policy

25% Minimum Canadian Content in RTG Vehicles – SIEMENS (25%)

- Siemens has created an initial plan and confirms compliance to the minimum 25% Canadian Content requirement
- Details of the plan are still being worked, additional information will be provided when available
- Search for the Final Assembly facility is currently focused in the Ottawa and Toronto regions
  - Final location would be determined if selected as the preferred supplier
- Currently Siemens uses the following Canadian suppliers:
  - Beclewat Manufacturing Inc., Bellville, ON (Windows)
  - Interalia Inc., Calgary Alberta (CCTV, PIS)
  - Bach Simpson, London Ontario (Event Recorders)

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Compliance with Canadian Content Policy

25% Minimum Canadian Content in RTG Vehicles – VOSSLOH (25%)

- Vossloh is confident in achieving 25% Canadian content
- Canadian content will be achieved by:
  - Final assembly at Vossloh Rail Vehicles Canada (Ontario)
  - Local test facilities
  - Local engineering consulting firms
  - Domestic components
- Vossloh will use expertise gained in the manufacture of
  - 262 electric trolley buses with New Flyer in Winnipeg, MB
  - Heavy rail locomotives for NJ Transit where final assembly plants have been set up locally for the respective projects

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Compliance with Canadian Content Policy

25% Minimum Canadian Content in RTG Vehicles – VOSSLOH (25%)

- Potential manufacturers for other equipment include:
  - Power Electronics, Inverters, Electrical Systems: Vossloh Kiepe Corp., BC
  - Motors, electrical assembly: IEC Holden, QC
  - Passenger counters: BEA Transit Solutions, ON
  - Destination signs: Axion Technologies, QC
  - Electronic subcomponents: Cantec Systems Ltd., ON
  - Windscreen wipers etc.: Densco Manufacturing Canada Inc., ON
  - Mirrors: Lucerix International Corp., ON
  - Components (gauges, molded parts, tubing, etc.): Parker Hannifin, ON
  - Signage: Provincial Sign Systems, ON
  - Lighting: divvali, QC
  - CCTV: Seon Design Inc., BC or Toronto Microelectronics Inc., ON

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Vehicles

Compliance with Canadian Content Policy

Additional Items to be Taken Into Consideration

- Vehicle providers either meet or exceed the Canadian content requirements
- There are not additional items to be taken into consideration at this time

RIDEAU TRANSIT GROUP

Vehicles

Ana Gallego, MSc.
Electromechanical Engineer, PMP

Maintenance Lead

- Over 15 years experience in design, construction and maintenance
- Involved in rapid transit for past 10 years
- Systems Project Manager: Jerez de la Frontera Tramway (Spain)
- Project Manager for the construction tender of Metro North in Dublin
- Project Manager: Training courses for staff of the Croatian Infrastructure Manager
- Project Manager: Consultancy services on the analysis of the safety regulations for Israel Railways

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Vehicles

Non-Revenue Vehicles

Non-Revenue Hi-Rail Vehicles & Equipment

- RTG proposed equipment and vehicles will:
  - Support our maintenance effort
  - Assure that the best and most cost effective equipment is provided
  - Used to inspect and maintain the track, structures and system components
  - Provide emergency response to support operations
- Lessons learned:
  - Use of hi tech equipment or vehicles with trained staff
  - Use equipment that fit the system
  - Use equipment that can do multiple tasks

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Vehicles

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Non-Revenue Vehicles

Non-Revenue Hi-Rail Vehicles & Equipment

Item Number	Type
1	Car Mover/Re-Railing/Rescue Vehicle
2	Light Duty Hi-Rail Trucks (Shared)
3	Track Crew Truck (F750 type) Hi-Rail
4	TP/OCS Crew Truck (F750 type) Hi-Rail
5	Welding Truck (F750 type) Hi-Rail
6	Crane Truck Flatbed Hi-Rail
7	Double Bucket Truck Hi-Rail
8	Wash/Vacuum Truck Hi-Rail
9	Hi-Rail Excavator/Speedswing
10	Medium Duty Switch and Production Tamper
11	Ballast Regulator/Snow Fighter Attachment
12	Ballast Car
13	Flat Car w/attachments
14	Rail Grinding Machine

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Vehicles

Non-Revenue Vehicles

- Car Mover/Re-Railing/Rescue Vehicle
  - Multi Maintenance purpose vehicle
  - Capable of being coupled to revenue train consist and move in either direction the length of the alignment
- Light Duty Hi-Rail Trucks
  - Hydraulic hi-rail gear
  - Light maintenance and inspections by track and system maintainers
- Hi-Rail Track Crew Truck
  - Track maintenance and repairs
- Hi-Rail TP/OCS Crew Truck
  - Performing traction power and catenary inspections, maintenance and repairs
- Hi-Rail Welding Truck
  - Maintain turnout components, perform rail change outs and field welding
  - Support system and wayside maintenance and repairs

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Vehicles

Non-Revenue Vehicles

- Hi-Rail Crane Truck
  - Transport equipment and materials, perform maintenance and repairs to track, structures and system components
- Hi-Rail Double Bucket Trucks
  - Perform OCS inspections, maintenance and repairs
- Hi-Rail Wash / Vacuum Truck
  - Remove trash and debris from trackway, maintain drainage systems, provide tunnel cleaning
- Hi-Rail Excavator / Speedswing
  - Speed swing to handle rail, track components and system components
  - Excavating, brush cutting and car mover if needed
- Medium Duty Switch and Production Tamper
  - Tamper for ballasted track sections and turnout spot surfacing
  - Lining and surfacing capabilities
  - Stabilizer when required

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Vehicles

Non-Revenue Vehicles

- Ballast Regulator with Snow Removal Capabilities
  - Ballast maintenance
  - Snow removal
    - Standard wings, all season plow, broom to handle ballast and snow
- Ballast Cars
  - Support track surfacing
  - Suitable for ballast distribution
- Flat Cars
  - Moving materials and equipments to support maintenance
  - Cable distribution and equipped with skid mounted reel holders
- Rail Grinding Machine
  - Preventative and corrective rail grinding
  - Restore optimal track geometry

Vehicles

Vehicle Branding Strategy

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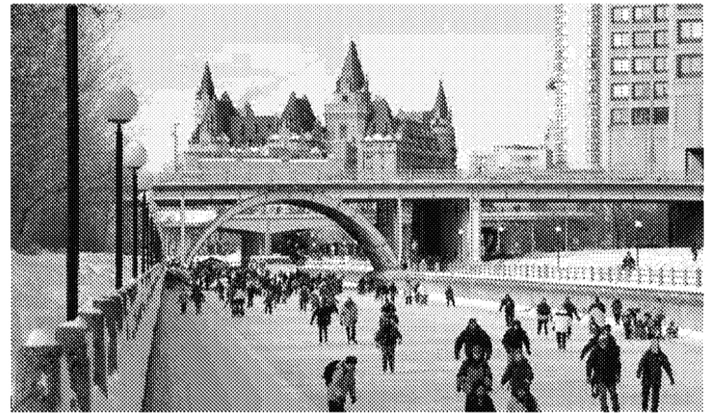
Vehicles

The Essence of Ottawa

- The vehicle and system brand must integrate with the City vision
  - A world class liveable city
  - Leadership in Public Transit
  - Leadership in sustainability
  - Technologically Progressive
- Developing the brand should be undertaken in partnership not in isolation & must be holistic
  - Communications Program
  - Stations & vehicles design
  - Operating & maintenance strategy
  - Long term operating vision



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Vehicles

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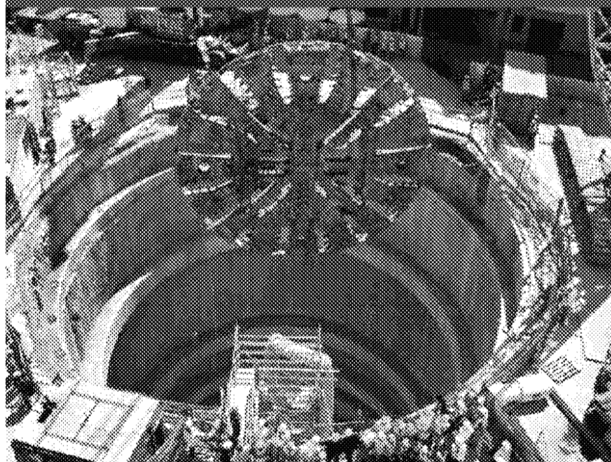
Branding Approach

- Adopt a partnership approach with the City
  - customer centric branding strategy
  - Review existing project identity
- Visioning and definition
  - Incorporate city principles
  - Integrate with designs and communications criteria
- Development and Finalization
  - Participate in key agency consultation & development of branding elements throughout detailed design
- Implementation & roll out
  - Assist with a transition strategy relative to system & vehicle branding communications prior to revenue service



3 OPERATIONAL PERFORMANCE REQUIREMENTS

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Operational Performance Requirements

Lee Cockrill

Operational Performance Requirements

- More than 20 years experience in Operations Management and Automated Train Control Systems
- Management and design role in start-up projects
- Development of transit operation plans and procedures
- Canada Line – Director of Operations
- Copenhagen Metro (DK)– Operations Manager, mobilisation, design input, procedures,
- MUNI (USA) – Commissioning and Control Room Operator training
- Jubilee Line (UK) – Design input
- Docklands Light Railway - Operations Management, Design input, Procedures

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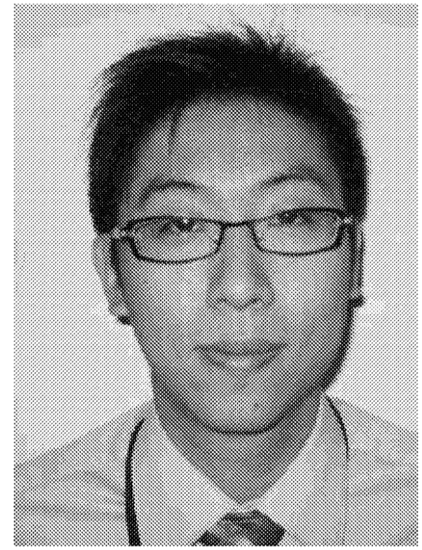
Operational Performance Requirements



Paul Lam

Operational Performance Requirements

- Manager for System Performance and Service Planning for Canada Line
- Development of service plans, single-tracking plans and train schedules
- Design role in start-up projects:
- Canada Line (CAN) – System validation and service planning
- Dubai Metro (UAE) – Design lead for Automatic Train Supervision
- Guangzhou Line 3, Wuhan Line 1 (CHN), London's Jubilee Line (UK) – ATC software design

Operational Performance Requirements

Validation of Operating Scenarios 1 and 2

- Station dwell times
- Terminal Operations
- Trip Time Simulations
- Single Line Simulations
- Fleet size and Capacity

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Operational Performance Requirements

Approach to expansion of the system to accommodate Operating Scenario 3

Stations

- Above Ground
  - Platforms to be built to accommodate Scenario 2
  - Platforms to be designed to protect for the eventual extension to accommodate Scenario 3
- Underground
  - Platforms to be built to accommodate Scenario 3

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Operational Performance Requirements

Approach to expansion of the system to accommodate Operating Scenario 3

MSF

- Built to accommodate vehicles for Scenario 2
- To be expandable for Scenario 3

Vehicle Fleet

- Vehicles provided to accommodate Scenario 1
- Vehicles to allow fleet expansion to accommodate Scenarios 2 and 3
- Extreme openings of first and last door to be no greater than 145m

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Operational Performance Requirements

Station Dwell Times

- Three sets of dwell times estimated and reviewed
  - CTP dwells set as estimated in the Operations Reference Report
  - TCRP dwell set based on APTA reference documents (TCRP Report 13 - Rail Transit Capacity)
  - EXP dwell set based on data/experience from the Canada Line
- Dwell estimates used for Trip Time simulations
  - Marginal differences between the three estimated dwell sets
  - TCRP dwells lower than the other two sets
  - Used CTP and EXP dwells for simulations
- Terminal Headway
  - Not included in the Trip Time simulations

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Operational Performance Requirements

Dwell times

- Dwell times reviewed CTP, Tom Parkinson (APTA), and from experience (Canada Line)
- Simulations performed with two sets of dwells – CTP and from experience

OLRT Dwell Calculations - Scenario 1 Year 2021 (Peak)

Direction	Station	Dwell - CTP	Dwell - TCRP	Dwell - Exper.
East	Tunney's Pasture	162.6	162.6	68
East	Bayview	19	17	18
East	LeBreton	19	17	18
East	Downtown West	34	25	26
East	Downtown East	42	30	31
East	Rideau Centre	39	23	29
East	Campus	28	22	22
East	Lees	18	16	18
East	Hurdman	28	20	22
East	Train Station	16	16	18
East	St. Laurent	22	17	18
East	Cyrville	17	16	18
West	Blair	162.6	162.6	52
West	Cyrville	17	15	18
West	St. Laurent	23	16	18
West	Train Station	16	15	18
West	Hurdman	38	17	29
West	Lees	19	16	18
West	Campus	27	21	21
West	Rideau Centre	38	24	29
West	Downtown East	46	32	34
West	Downtown West	37	26	28
West	LeBreton	18	17	18
West	Bayview	19	17	18

OLRT Dwell Calculations - Scenario 2 Year 2031 (Peak)

Direction	Station	Dwell - CTP	Dwell - TCRP	Dwell - Exper.
East	Tunney's Pasture	147	147	70
East	Bayview	37	28	33
East	LeBreton	20	18	18
East	Downtown West	35	27	31
East	Downtown East	42	32	37
East	Rideau Centre	30	25	27
East	Campus	26	22	23
East	Lees	18	17	18
East	Hurdman	29	24	26
East	Train Station	16	16	18
East	St. Laurent	22	19	19
East	Cyrville	17	16	18
West	Blair	147	147	59
West	Cyrville	16	16	18
West	St. Laurent	23	20	20
West	Train Station	15	15	18
West	Hurdman	37	29	33
West	Lees	18	17	18
West	Campus	24	21	21
West	Rideau Centre	37	29	33
West	Downtown East	40	31	36
West	Downtown West	37	29	33
West	LeBreton	18	17	18
West	Bayview	19	17	18

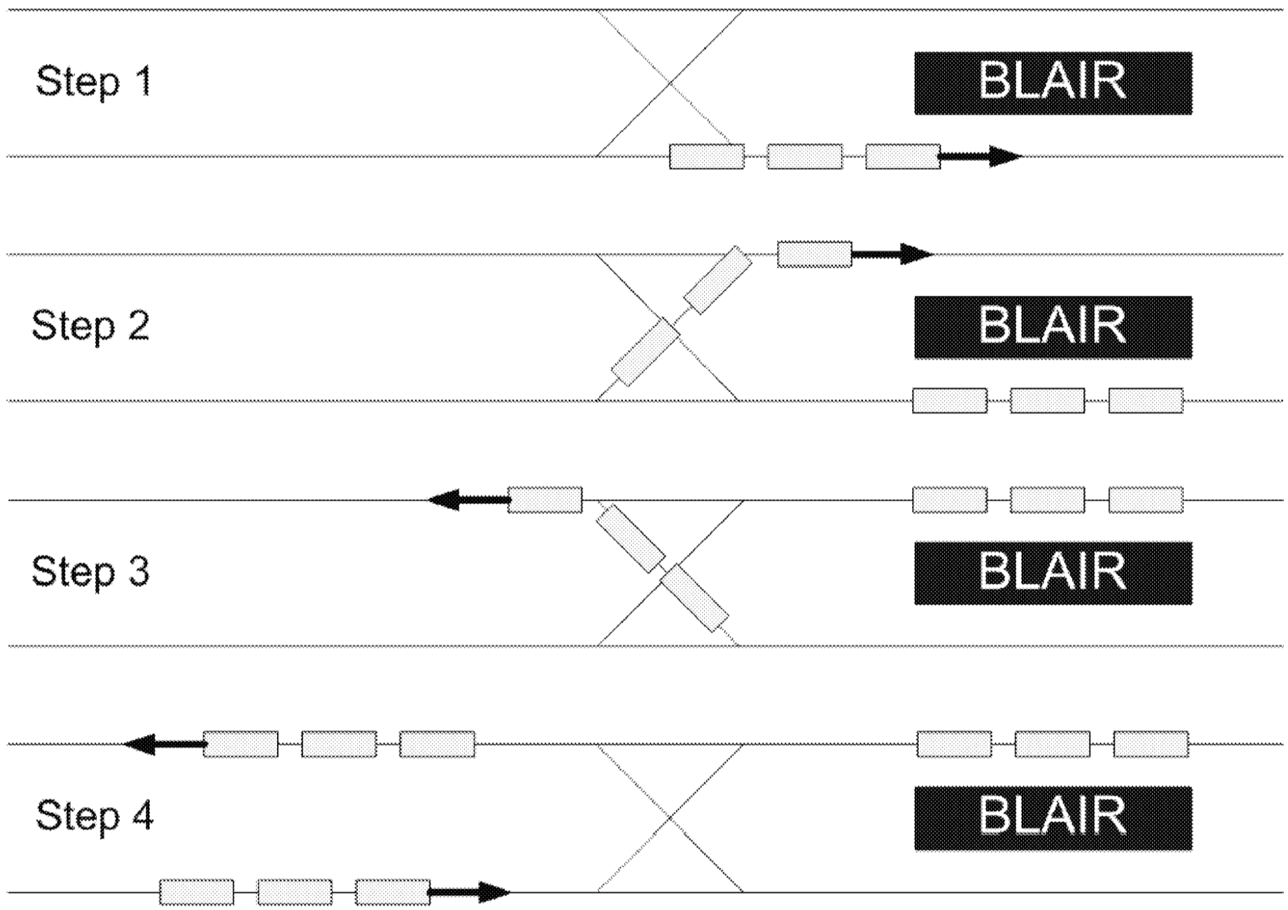
Operational Performance Requirements

Terminal Operations – General Comments

- Platform Operations
  - Our Terminal headway simulations indicate that both platforms will need to be used to operate train service
- Some operational considerations with using both platforms
  - No storage at terminal for spare trains
  - Storage of failed trains or staged equipment in one platform will impact service
  - Tunney's Pasture Station possible confusion as to next departure from station
- Would like to understand when Step Back operation will be used

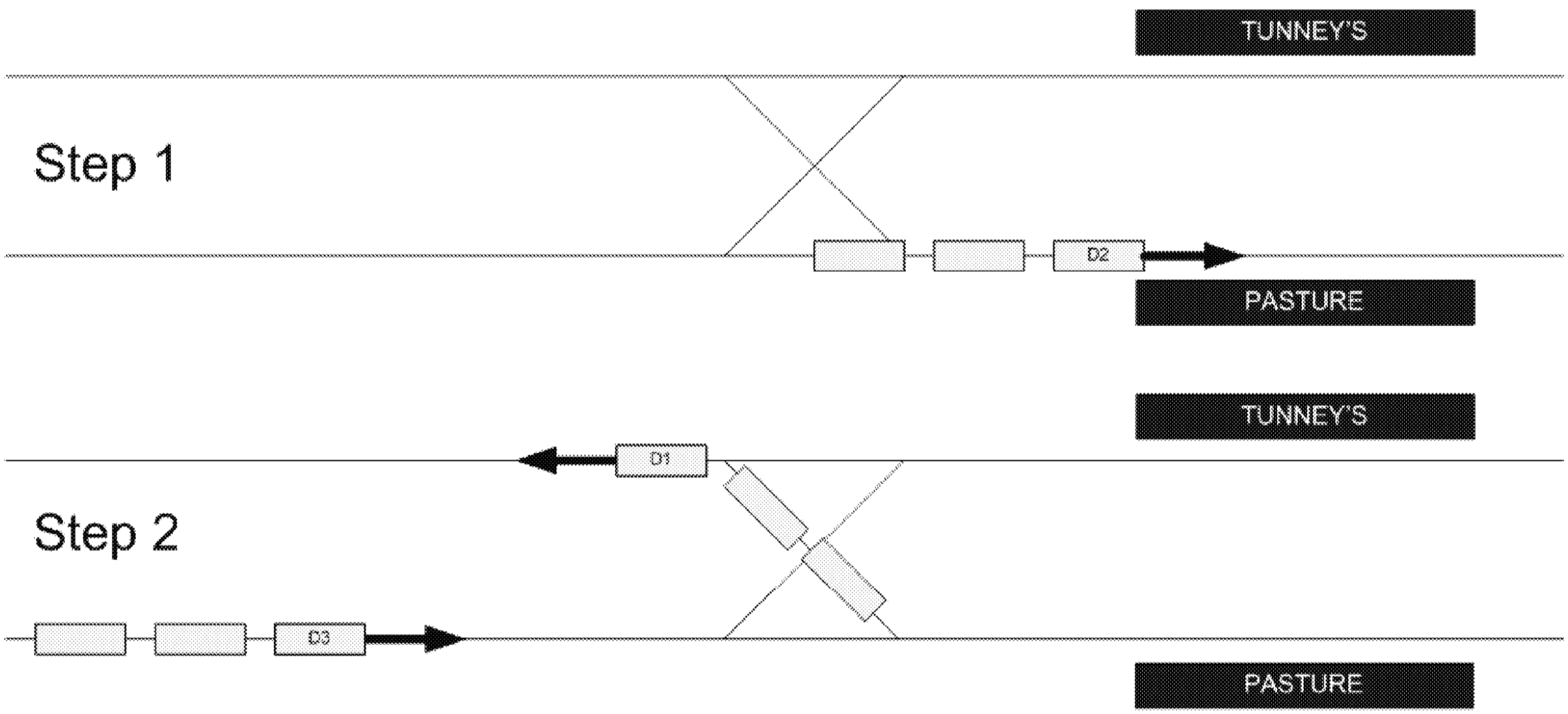
Operational Performance Requirements

Terminal Operations – Single platform used



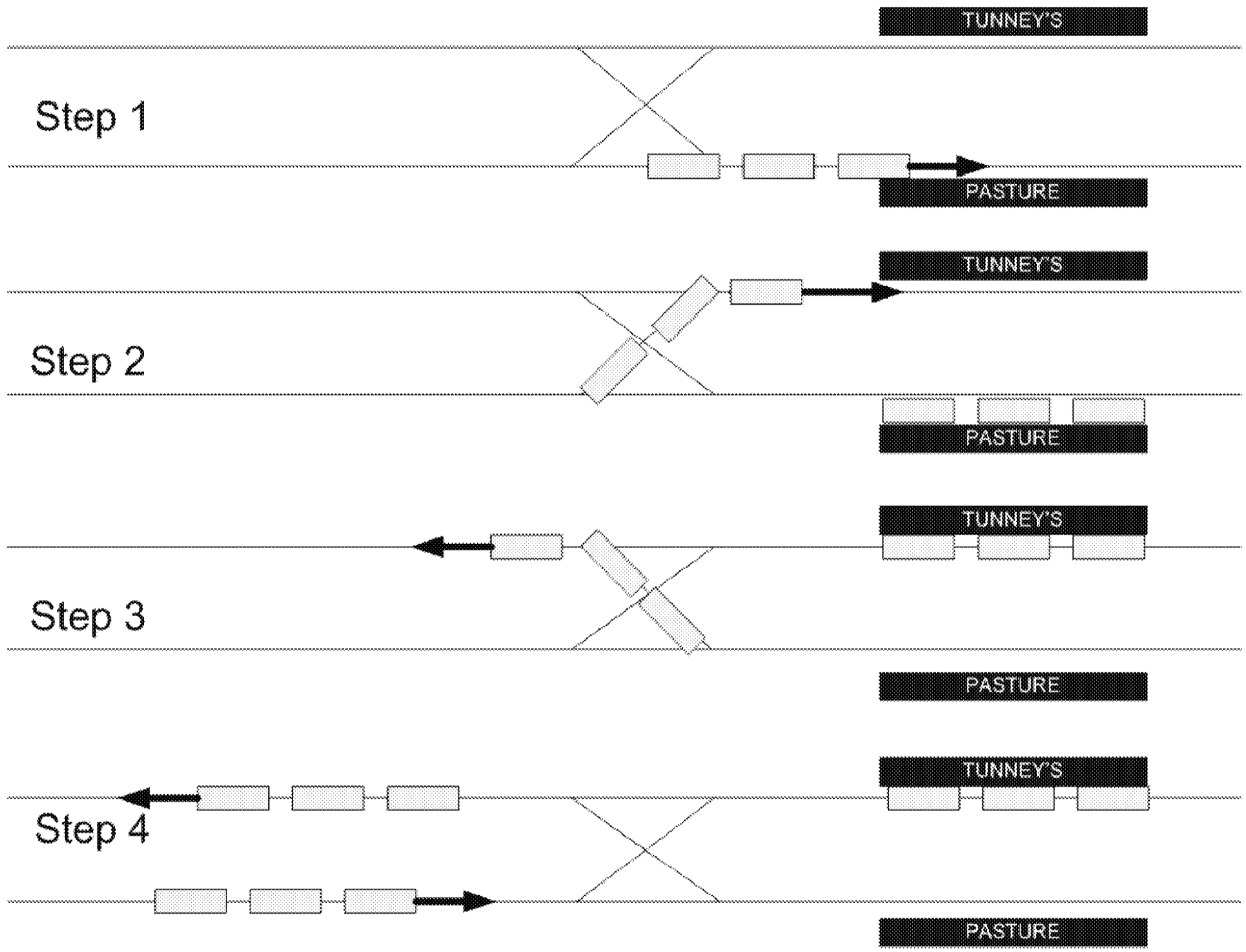
Operational Performance Requirements

Terminal Operations – Single platform used



Operational Performance Requirements

Terminal Operations - Both platforms used



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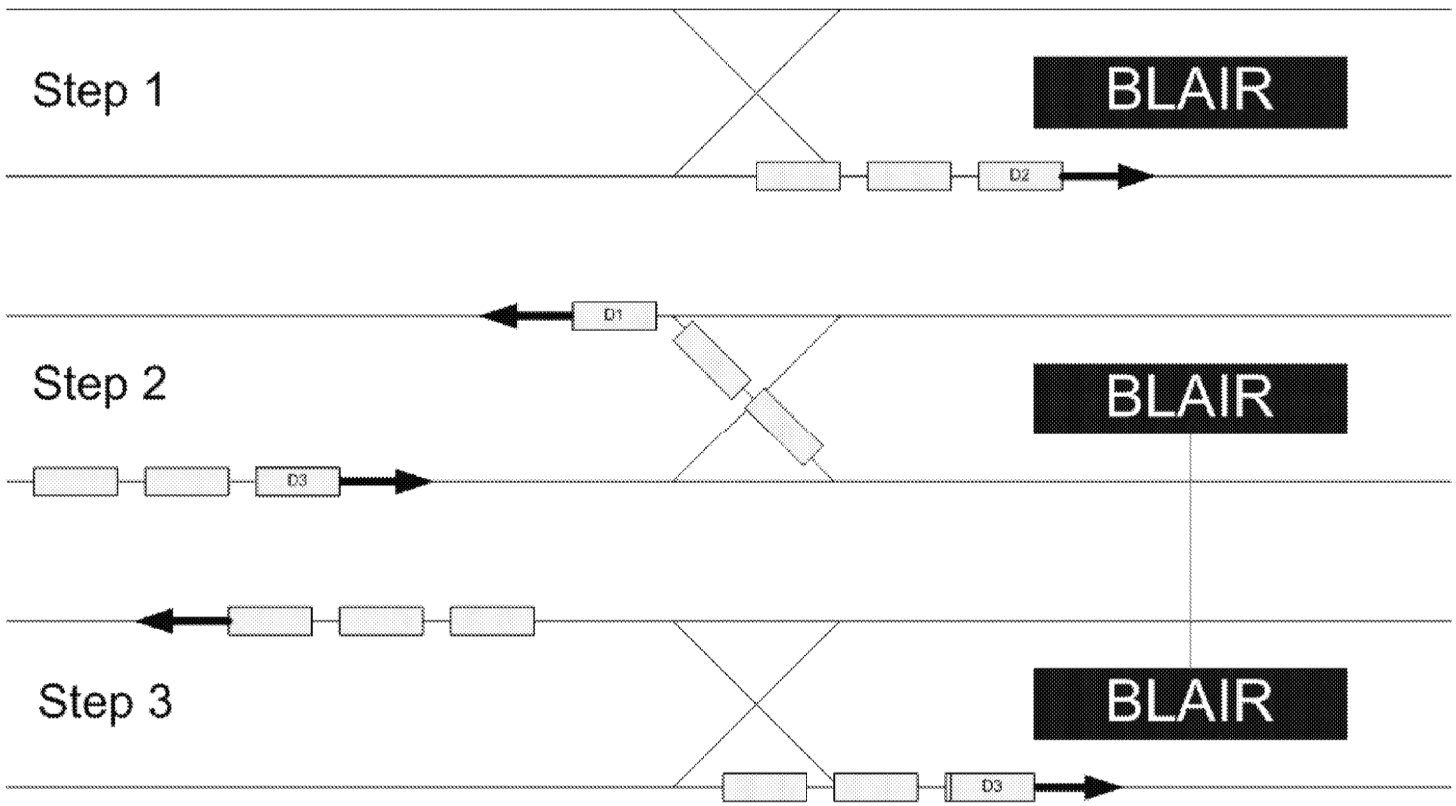
Operational Performance Requirements

Terminal Operations – Both Platforms used



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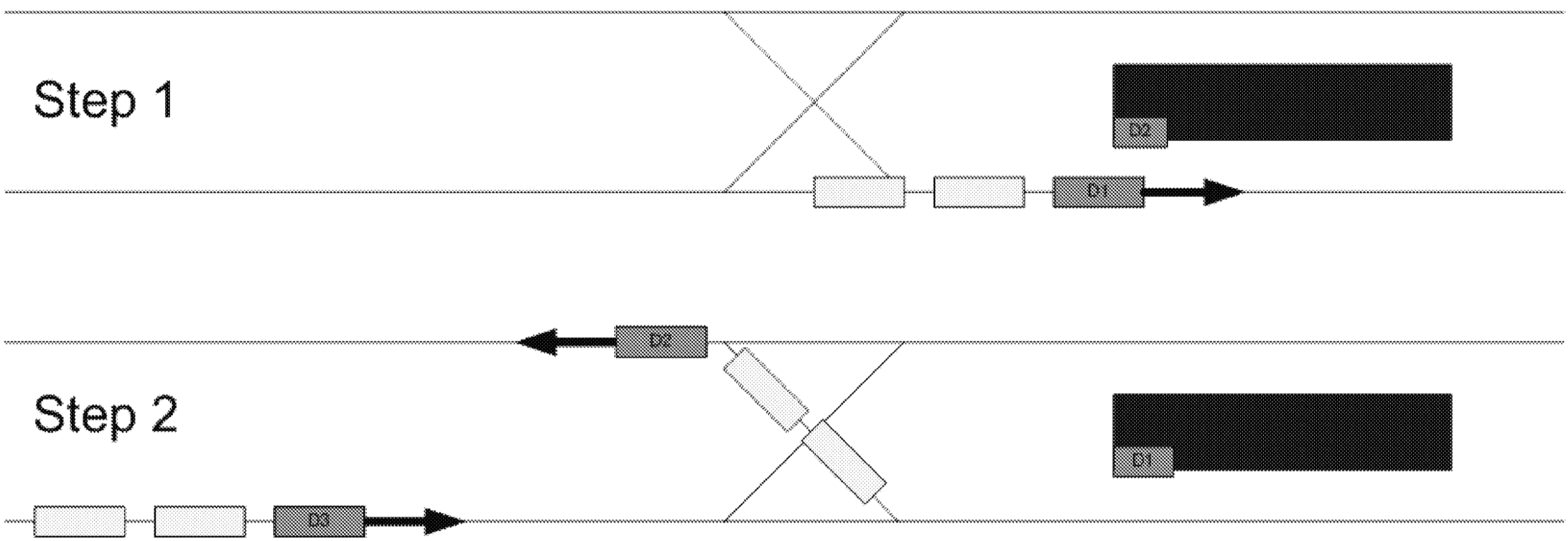
Operational Performance Requirements

Terminal Operations – Step Back Operations



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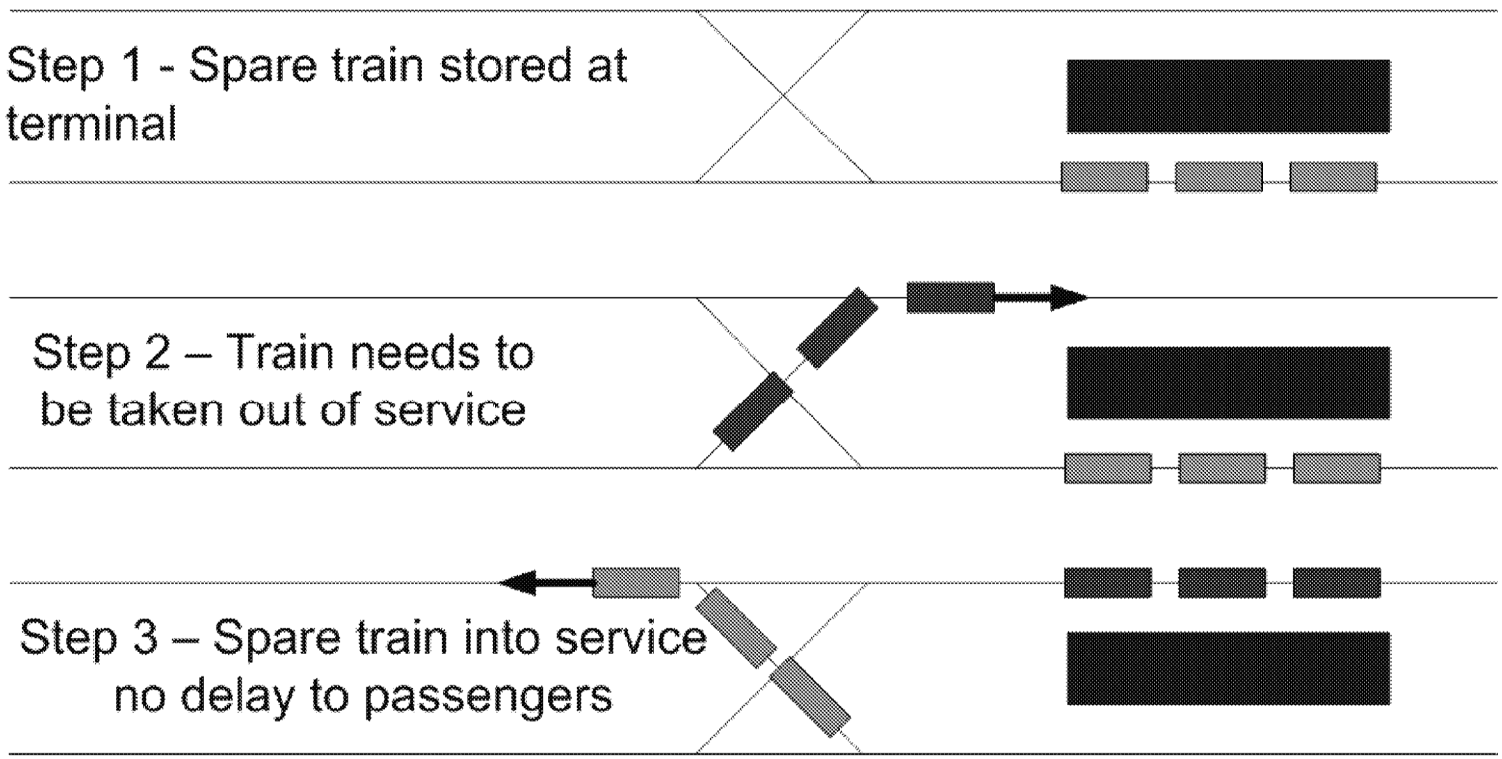
Operational Performance Requirements

Terminal Operations – Storage and use spare train



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Train Control

Terminal Operations – Headways

Operations Scenario 1

- Short Dwell

	Terminus Station	Dwell Times at Terminus Stations	Travel Time (35km/h Crossover)	Travel Time (40km/h Crossover)	Travel Time (45km/h Crossover)	Interlocking Assumptions	Minimum Headway (35km/h Crossover)		Minimum Headway (40km/h Crossover)		Minimum Headway (45km/h Crossover)	
							Dual Platform	Single Platform	Dual Platform	Single Platform	Dual Platform	Single Platform
EB-to-WB Turnaround	Blair Station	66	78.4	77.1	76.3	45	123.4	189.4	122.1	188.1	121.3	187.3
WB-to-EB Turnaround	Tunney's Pasture Station	87	53.6	52.3	51.5	45	98.6	185.6	97.3	184.3	96.5	183.5

Train Control

Terminal Operations – Headways

Operations Scenario 2

- Short Dwell

	Terminus Station	Dwell Times at Terminus Stations	Travel Time (35km/h Crossover)	Travel Time (40km/h Crossover)	Travel Time (45km/h Crossover)	Interlocking Assumptions	Minimum Headway (35km/h Crossover)		Minimum Headway (40km/h Crossover)		Minimum Headway (45km/h Crossover)	
							Dual Platform	Single Platform	Dual Platform	Single Platform	Dual Platform	Single Platform
EB-to-WB Turnaround	Blair Station	60	78.4	77.1	76.3	45	123.4	183.4	122.1	182.1	121.3	181.3
WB-to-EB Turnaround	Tunney's Pasture Station	80	53.6	52.3	51.5	45	98.6	178.6	97.3	177.3	96.5	176.5

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Operational Performance Requirements

Trip Time Simulations

- Simulation software – SYSTRA RAILSIM
- Data assumptions
  - Latest Alignment data
  - Vehicle Specification
    - 30m train, 2.6m wide,
    - Performance spec as per the requirements
- Terminal time
  - For Trip Time simulations terminal time is not applied

Component	Data
Length	90m
Max. Acceleration Jerk	1.34m/s^2
Max. Deceleration Jerk	1.34m/s^2
No. of Cars	3.00
Total Axles	18.00
Max Acceleration	1.78 m/s^2
Max Deceleration	2.41 m/s^2
Train Weight	190244 Kg

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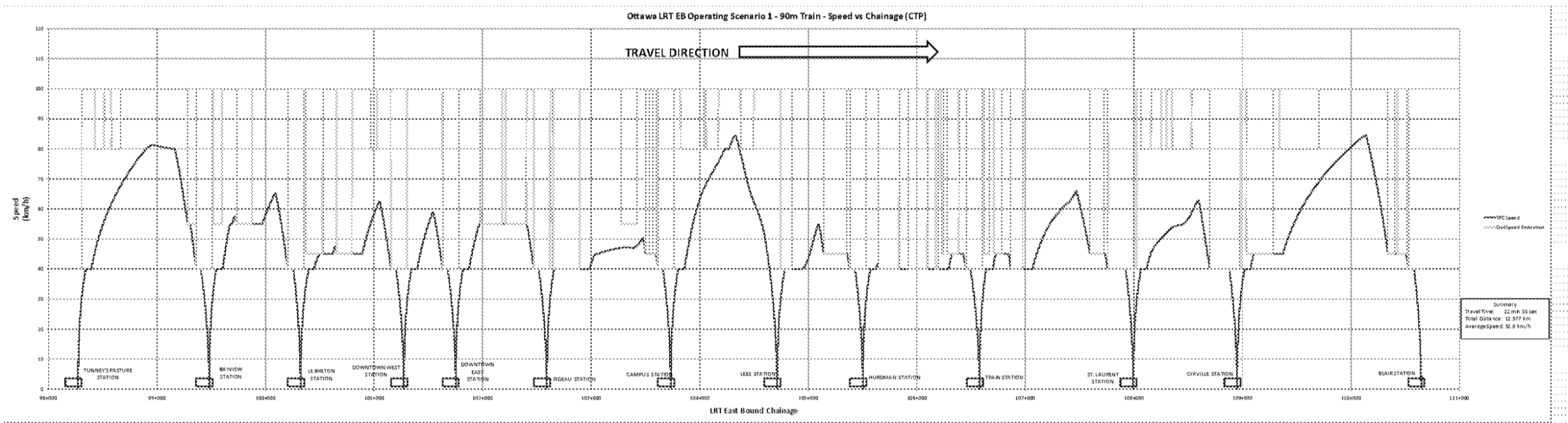
Operational Performance Requirements

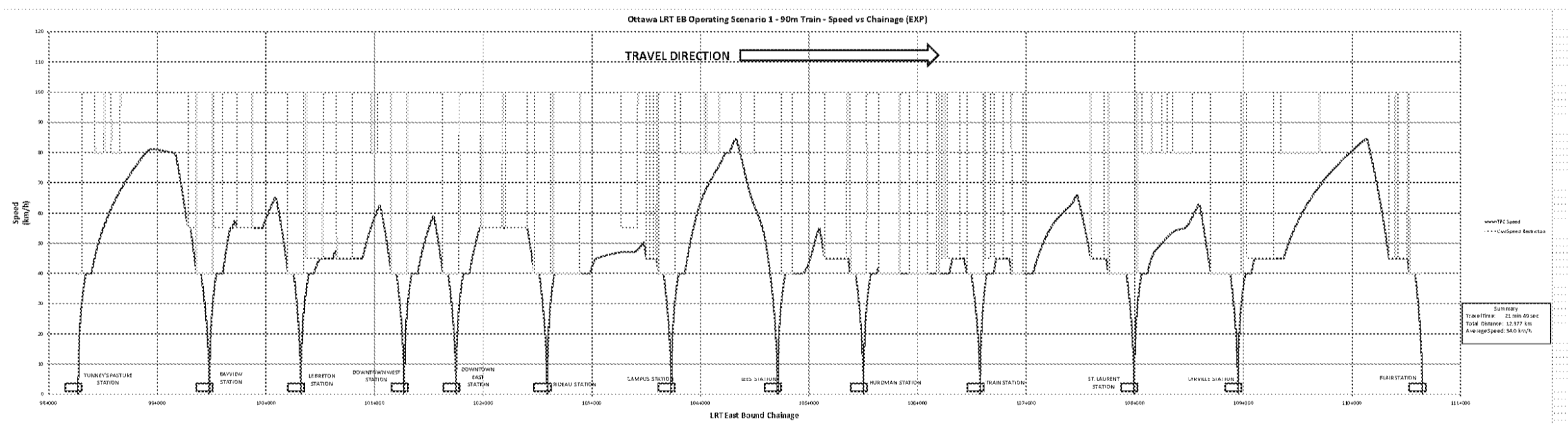
Trip Time Simulations

Scenario	Operations Scenario	Mode	Dwell Set
A	1	AUTO	CTP
B	1	AUTO	Exp
C	2	AUTO	CTP
D	2	AUTO	Exp
E	1	Manual	CTP
F	1	Manual	Exp
G	2	Manual	CTP
H	2	Manual	Exp

Operational Performance Requirements

Trip Time Simulations – RAILSIM Results Example





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Operational Performance Requirements

Trip Time Simulations – Auto Mode Results summary

- Travel time requirements were met in all cases
- Slightly shorter Trip Times than DTP simulations

Scenario	Operations Scenario	Mode	Dwell Set
A	1	AUTO	CTP
B	1	AUTO	Exp
C	2	AUTO	CTP
D	2	AUTO	Exp

Simulation	Travel Time (min:sec)	Travel Time (sec)	Travel Distance (km)	Average Speed (km/hr)
A - EB	22:32.6	1352.6	12.37686	32.9
A - WB	22:40.1	1360.1	12.37572	32.8
B - EB	21:48.6	1308.6	12.37686	34
B - WB	21:51.1	1311.1	12.37572	34
C - EB	23:01.1	1381.1	12.37686	32.3
C - WB	22:37.0	1357	12.37572	32.8
D - EB	22:37.1	1357.1	12.37686	32.8
D - WB	22:19.0	1339	12.37572	33.3

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Operational Performance Requirements

Trip Time Simulations – Manual Mode

- Based on research Manual Mode on an automated system is generally 2-4% slower than Auto Mode
- Manual Mode in Automatic system can be very vulnerable to variations in drivers performance
- Manual Mode simulations indicate that the required travel times could be met

Scenario	Operations Scenario	Mode	Dwell Set
E	1	Manual	CTP
F	1	Manual	Exp
G	2	Manual	CTP
H	2	Manual	Exp

Simulation	Travel Time (min:sec)	Travel Time (sec)	Travel Distance (km)	Average Speed (km/hr)
E - EB	23:26.7	1406.7	12.37686	31.67
E - WB	22:40.9	1360.9	12.37686	32.74
F - EB	23:34.5	1414.5	12.37572	31.50
F - WB	22:43.5	1363.5	12.37572	32.67
G - EB	23:56.3	1436.3	12.37686	31.02
G - WB	23:31.4	1411.4	12.37686	31.57
H - EB	23:31.3	1411.3	12.37572	31.57
H - WB	23:12.6	1392.6	12.37572	31.99

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Operational Performance Requirements

Cycle Time Operations Scenario 1 (2021)

Direction	Station	Travel Time	Dwell - CTP	Dwell - Exper.
East	Tunney's Pasture	87.1	162.6	86
East	Bayview	72.2	19	18
East	LeBreton	87.5	19	18
East	Downtown West	50.7	34	30
East	Downtown East	74.3	42	37
East	Rideau Centre	107.2	39	35
East	Campus	72.9	28	25
East	Lees	78	18	18
East	Hurdman	108	28	25
East	Train Station	122.9	16	18
East	St. Laurent	85.6	22	19
East	Cyrville	122.9	17	18
West	Blair	124.2	162.6	65
West	Cyrville	73.9	17	18
West	St. Laurent	122.5	23	20
West	Train Station	106.8	16	18
West	Hurdman	74.6	38	34
West	Lees	83.1	19	18
West	Campus	98.5	27	23

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Operational Performance Requirements

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Cycle Time Operations Scenario 1 (2021)

Direction	Station	Travel Time	Dwell - CTP	Dwell - Exper.
West	Rideau Centre	84.5	38	34
West	Downtown East	50.1	46	41
West	Downtown West	80.3	37	33
West	LeBreton	80.2	18	18
West	Bayview	84.7	19	18

Total

Eastbound Trip	1069.3	282	261
Westbound Trip	1063.4	298	275
Terminus Dwell - Tunney's	0	162.6	86
Terminus Dwell - Blair	0	162.6	65
Cycle Time		**3037.9**	**2819.7**

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Operational Performance Requirements

Cycle Time Operations Scenario 2 (2031)

Direction	Station	Travel Time	Dwell - CTP	Dwell - Exper.
East	Tunney's Pasture	87.1	147	70
East	Bayview	72.2	37	33
East	LeBreton	87.5	20	18
East	Downtown West	50.7	35	31
East	Downtown East	74.3	42	37
East	Rideau Centre	107.2	30	27
East	Campus	72.9	26	23
East	Lees	78	18	18
East	Hurdman	108	29	26
East	Train Station	122.9	16	18
East	St. Laurent	85.6	22	19
East	Cyrville	122.9	17	18
West	Blair	124.2	147	59
West	Cyrville	73.9	16	18
West	St. Laurent	122.5	23	20
West	Train Station	106.8	15	18
West	Hurdman	74.6	37	33
West	Lees	83.1	18	18
West	Campus	98.5	24	21

Operational Performance Requirements

Cycle Time Operations Scenario 2 (2031)

Direction	Station	Travel Time	Dwell - CTP	Dwell - Exper.
West	Rideau Centre	84.5	37	33
West	Downtown East	50.1	40	36
West	Downtown West	80.3	37	33
West	LeBreton	80.2	18	18
West	Bayview	84.7	19	18

Total

Eastbound Trip	1069.3	292	268
Westbound Trip	1063.4	284	266
Terminus Dwell - Tunney's	0	147	70
Terminus Dwell - Blair	0	147	59
Cycle Time		**3002.7**	**2795.7**

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Operational Performance Requirements

Single Line Sections – Headway Simulations

- Headway in 14 single line segments simulated
- Assumed 60 seconds to release interlocking (to be refined with the signalling design for exact clearance limits)
- Travel time though section doubled to give headway assuming that 1 train run through in both directions
- Two segments over 15 minute requirement
- Platoon mode in ATO or Manual modes offer an opportunity to increase capacity through the single line sections.

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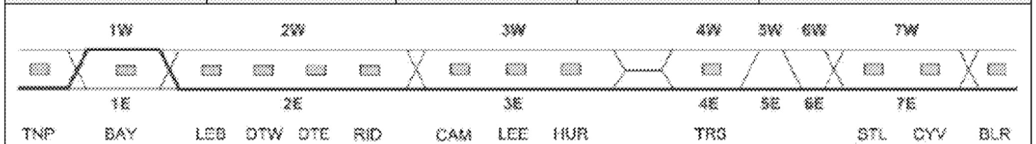
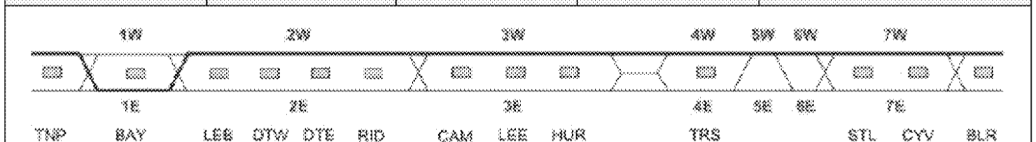
Operational Performance Requirements

Single Line Simulations – Results

Segment with Outage	Bypass Route	Segment Travel Time	Minimum Headway	Distance between Crossovers
1E	1W	2:43 minutes	6:26 minutes	1.870 km

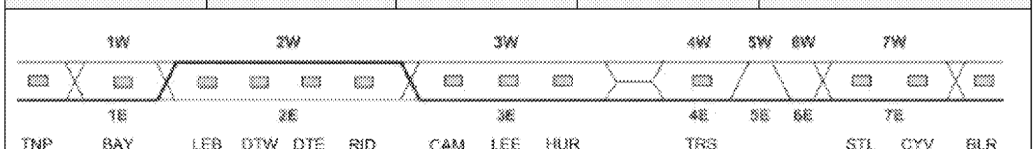


Segment with Outage	Bypass Route	Segment Travel Time	Minimum Headway	Distance between Crossovers
1W	1E	2:45.8 minutes	6:31.6 minutes	1.870 km



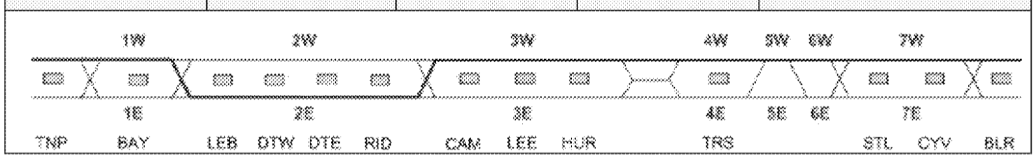
Over 15 minutes

Segment with Outage	Bypass Route	Segment Travel Time	Minimum Headway	Distance between Crossovers
2E	2W	7:35.5 minutes	16:11 minutes	3.378 km



Over 15 minutes

Segment with Outage	Bypass Route	Segment Travel Time	Minimum Headway	Distance between Crossovers
2W	2E	7:43.8 minutes	16:27.6 minutes	3.374 km



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Operational Performance Requirements

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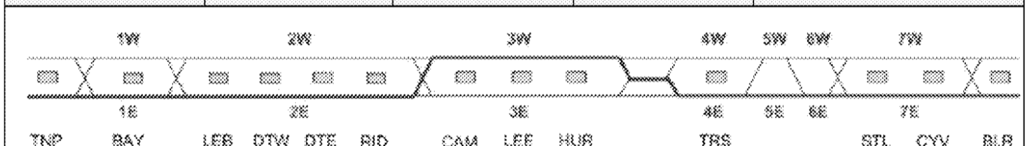
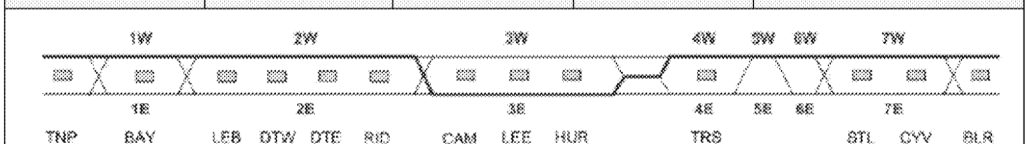
Single Line Simulations – Results

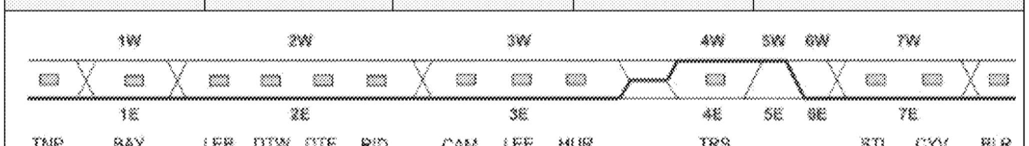
Segment with Outage	Bypass Route	Segment Travel Time	Maximum Headway	Distance between Crossovers
3E	3W-POCKET	5:32 minutes	12:04 minutes	2.727 km



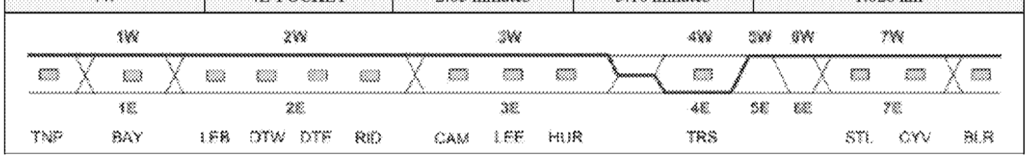
Segment with Outage	Bypass Route	Segment Travel Time	Maximum Headway	Distance between Crossovers
3W	POCKET-3E	5:48 minutes	12:36 minutes	2.739 km



Segment with Outage	Bypass Route	Segment Travel Time	Maximum Headway	Distance between Crossovers
4E	POCKET-4W-5W	2:21 minutes	5:42 minutes	1.211 km



Segment with Outage	Bypass Route	Segment Travel Time	Maximum Headway	Distance between Crossovers
4W	4E-POCKET	2:05 minutes	5:10 minutes	1.028 km



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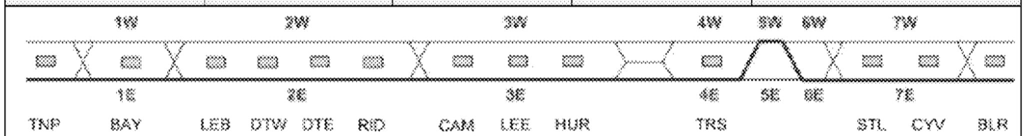
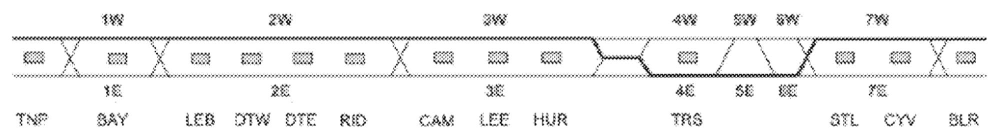
Operational Performance Requirements

Single Line Simulations – Results

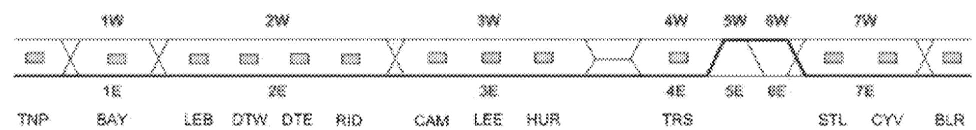
Segment with Outage	Bypass Route	Segment Travel Time	Minimum Headway	Distance between Crossovers
5E	5W	0:26.3 minutes	1:52.6 minutes	0.256 km



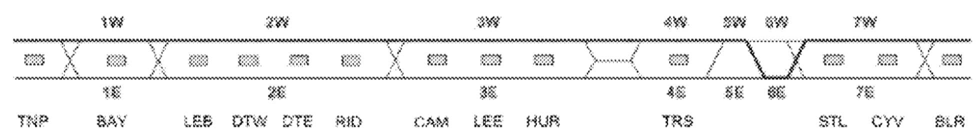
Segment with Outage	Bypass Route	Segment Travel Time	Minimum Headway	Distance between Crossovers
5W	6E-5E-4E-POCKET	2:57.2 minutes	6:54.4 minutes	1.755 km



Segment with Outage	Bypass Route	Segment Travel Time	Minimum Headway	Distance between Crossovers
6E	5W-6W	1:06 minutes	3:12 minutes	0.801 km



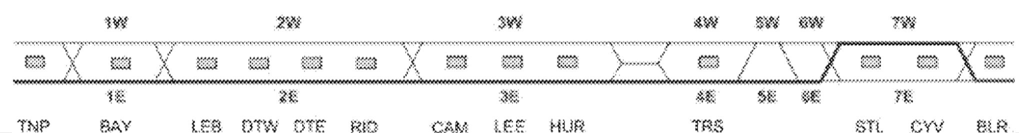
Segment with Outage	Bypass Route	Segment Travel Time	Minimum Headway	Distance between Crossovers
6W	6E	0:50.1 minutes	2:40.2 minutes	0.617 km



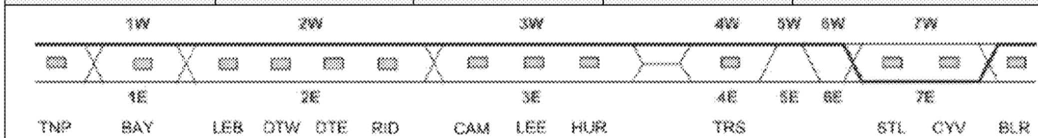
Operational Performance Requirements

Single Line Simulations – Results

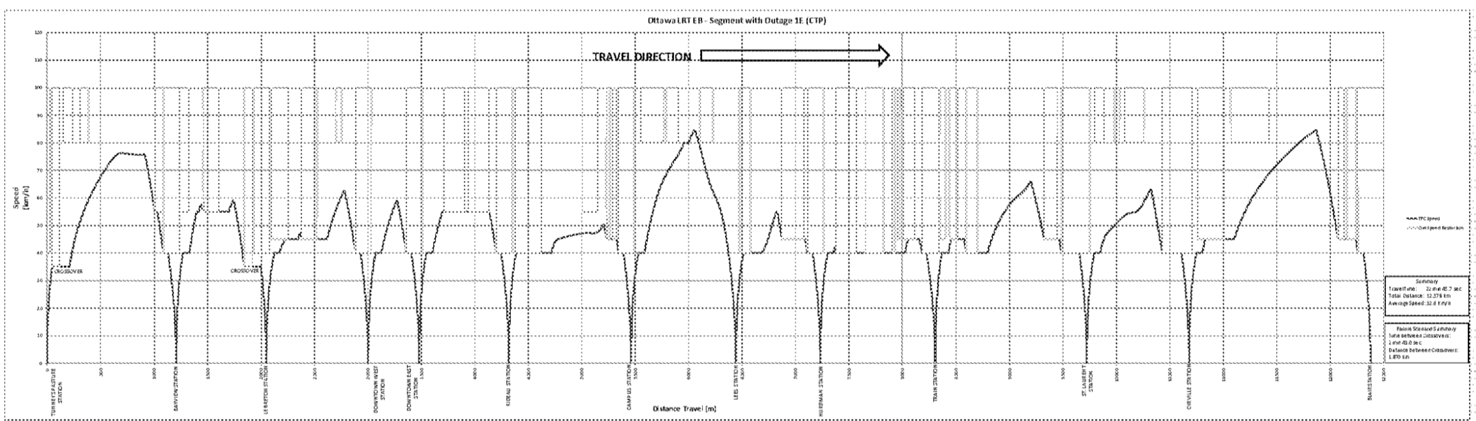
Segment with Outage	Bypass Route	Segment Travel Time	Minimum Headway	Distance between Crossovers
7E	7W	4:34 minutes	10:08 minutes	2.812 km



Segment with Outage	Bypass Route	Segment Travel Time	Minimum Headway	Distance between Crossovers
7W	7E	4:27.6 minutes	9:55.2 minutes	2.817 km



Single Line Simulations – RAILSIM Results Example



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Operational Performance Requirements

Fleet Size and Capacity

Vehicle Capacity (30m x 2.65m)

Number of Vehicles	3	4	5
Capacity per Vehicle	181	181	181
Capacity per Train	543	724	905

Fleet Size – Peak Service plus spares

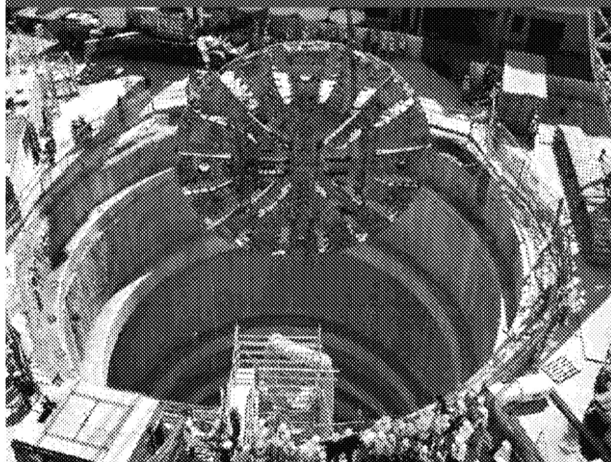
Capacity	Period	Headway	Consist	Vehicles	with 10% spares
12000	Weekday	2.7	3	60	66
	Saturday	5	2	24	
	Sunday	5	2	24	
18000	Weekday	2.4	4	88	97
	Saturday	5	2	24	
	Sunday	5	2	24	
24000	Weekday	2.26	5	120	132
	Saturday	5	3	36	
	Sunday	5	3	36	

Operational Performance Requirements

Fleet Size and Capacity

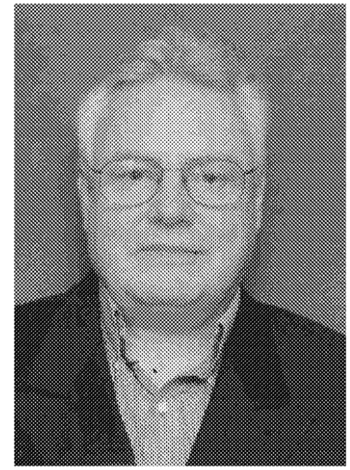
Capacity – Weekday Service

	SCENARIO 1		SCENARIO 2	
Peak Headway (min)	Headway	PPHPD	Headway	PPHPD
05:00 - 06:30	8	4073	8	5430
06:30 - 09:00	2.7	12022	2.4	18025
09:00 - 15:00	5	6516	5	8688
15:00 - 18:00	2.7	12022	2.4	18025
18:00 - 21:30	5	6516	5	8688
21:30 - 23:00	8	4073	8	5430
23:00 - 01:30	15	2172	15	2896
Capacity per Vehicle	181	181	181	181
Number of Vehicles	3	3	4	4
Capacity per Train	543	543	724	724



4 TRAIN CONTROL

Train Control



John Selke, P.Eng.

Train Control Lead

- 30 years experience in System Engineering of CBTC Transit Systems including T&C Manager on Canada Line
- During commissioning of Train Control system for the initial phases of Vancouver SkyTrain:
  - Pioneered the development of the system engineering processes for CBTC systems
  - Worked closely with the operator to develop operational strategies (operational requirements analysis)
  - Achieved every major milestone opening date
- Lead the team which leveraged the SkyTrain success to other projects including the San Francisco Municipal Railway (MUNI) and the Docklands Light Railway in London, UK

RIDEAU TRANSIT GROUP RTG

Train Control

Marta Navarro, B.Sc., Telecommunications Engineer

DBJV Systems Specialist

- 15 years experience in Railway Systems
- Project Manager CBTC, OCC and Platform Screen Doors – L9 Metro Barcelona
- Systems Manager – Abu-Dhabi's LRT design
- Vehicle and Systems Manager – Metro Bogota design
- Project Manager – CBTC Project Specifications L1 Metro Santiago, Chile

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Train Control

Manufacturer

Potential Suppliers

- RTG has proposed the following potential suppliers:
  - Alstom Transport
  - Ansaldo STS
  - GE Transportation
  - Invensys Rail
  - Siemens
  - Thales Rail Signalling Solutions

COW0148076

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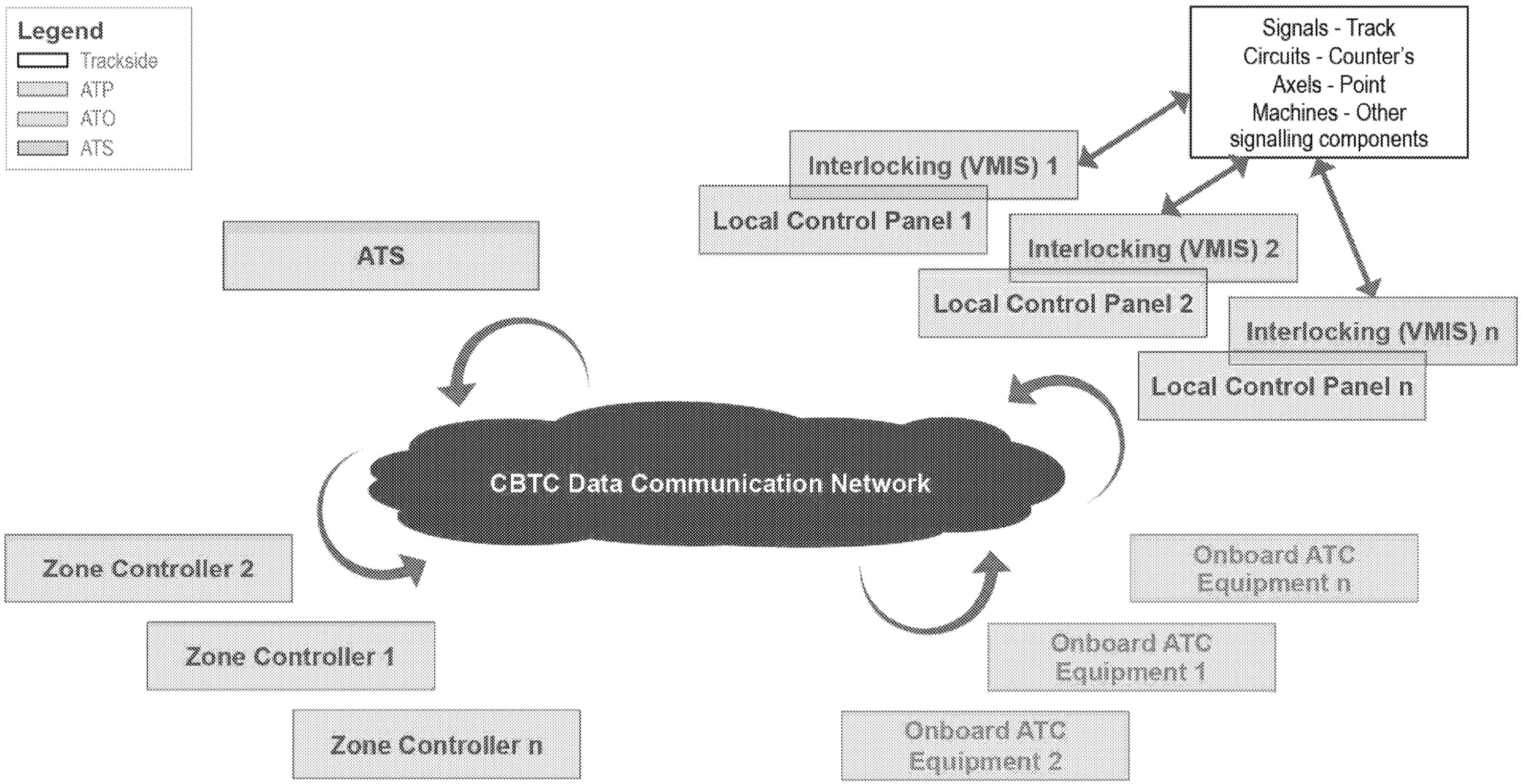
Train Control

CBTC General – Architecture



Train Control

Automatic Train Supervision – Major Functions

- Train Regulation:
  - Schedule
  - Headway
  - Energy Conservation
- Automatic Train Routing
- Trip Assignment
- Turnback Handling and Deadlock prevention
- TSCC Operator Interface
- Firewalled Interface to other systems (SCADA, City Systems)
- Local control of Interlocking for failure management

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Train Control

Automatic Train Protection – Major Functions:

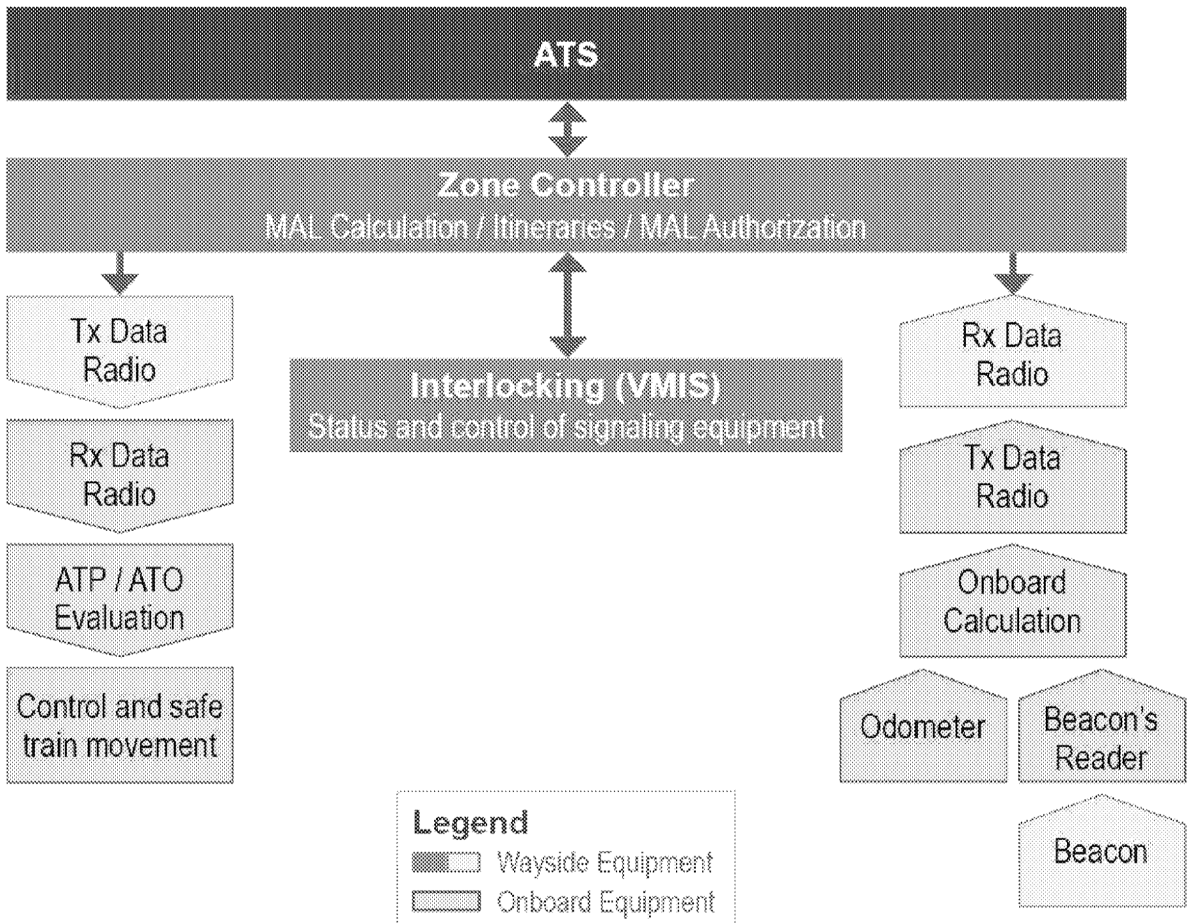
- Train tracking
- Safe train separation, including rollback management
- Interlocking Management (route locking, approach locking, etc.)
- Enforcement of safe train speed, including zero speed
- Train door supervision
- Train mode supervision
- Deadman switch supervision
- Train integrity supervision

Automatic Train Operation – Major Functions:

- Control train speed in accordance with scheduled profile
- Operate train within passenger ride quality limits
- Automatic door opening and closing with override

Train Control

ATP-ATO Functions Wayside – Onboard



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Train Control

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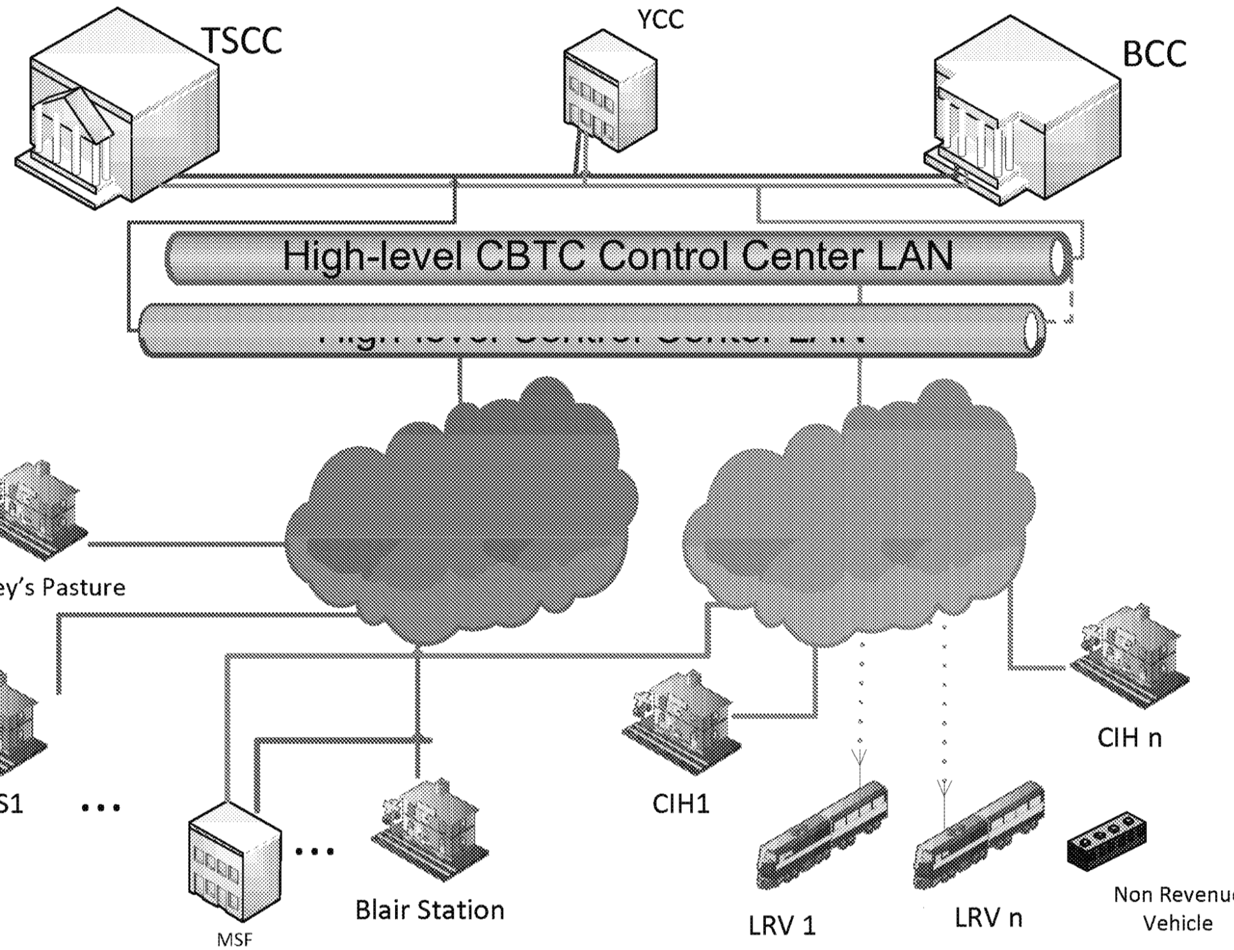
Basic Architecture

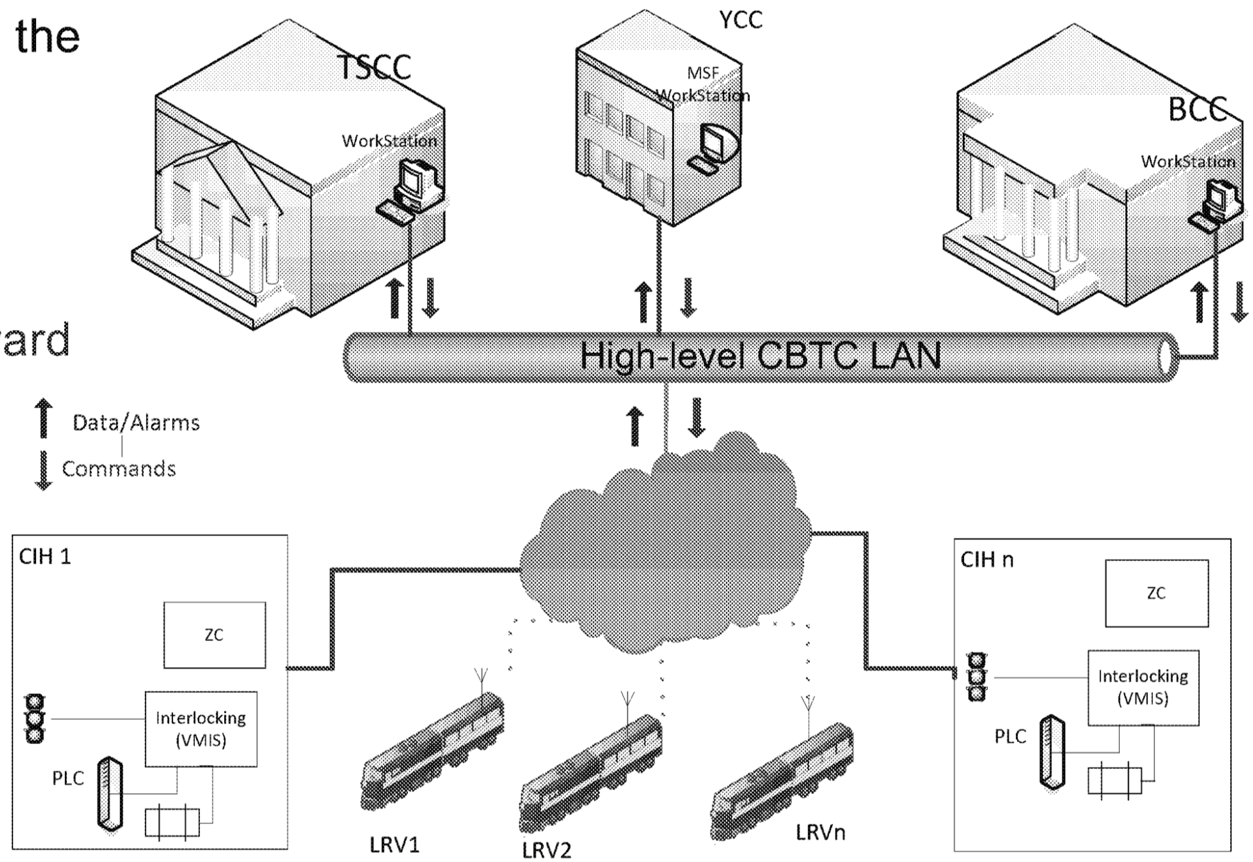
- Distributed configuration
- High availability
- Separated CBTC network



Train Control

Operation

- Data available at both TSCC and BCC all the time
- Mainline can be controlled by the TSCC or the BCC
- YCC controls the yard only



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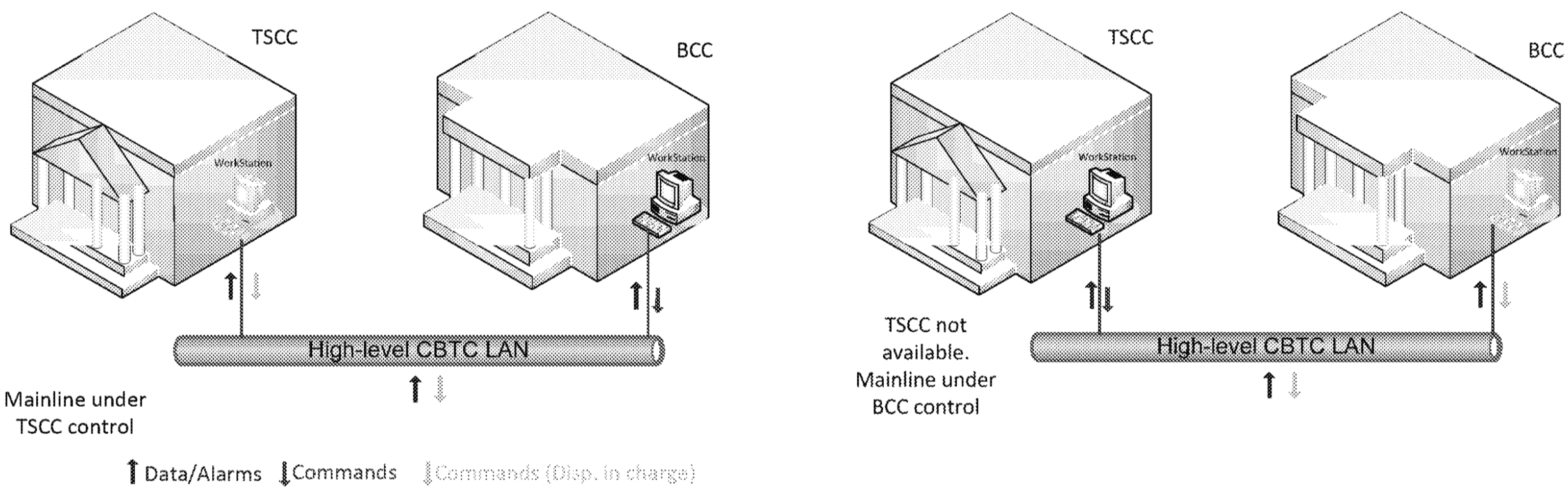
Train Control

Dynamic Control Management

- Only one location can be in control at any given time
- Transfer of control restricted to supervisory personnel



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Train Control

Back Up System in case of Communication Failure

- CBTC System Availability > 99.99 %
- Dedicated Fibre Optic Network
  - Fully redundant
  - Cables physically separated to minimize common mode failures
- Dedicated wireless train - wayside network
  - Redundant APs
  - Robust secure bi-directional communication system
  - Radio coverage guaranteed along the trackside in case of AP failure
- Alarms and status of all CBTC and signalling components (wayside and onboard) will be reported and logged by the ATS.
  - Failures will be corrected promptly while the redundant unit maintains operation
- **Total failures of CBTC System or CBTC Subsystems will be very rare**
- Ongoing operator training will be required to maintain failure management skills

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Train Control

Back Up System in case of Communication Failure

- Total Failure of central ATS or DCS:
  - Fixed Block Train Detection System supports operation
  - Interlocking will work independently during failure
  - Onboard Manual Release Mode will limit train speed
  - Train drivers will operate according to line of sight
  - Signals at interlockings assist safe operation
- Total failure of onboard CBTC
  - CBTC Bypass mode will support removal of train from service in the unlikely event of a total failure of onboard CBTC
- All failure modes will be analyzed and appropriate operational procedures developed in cooperation with the operator

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Train Control

Methodology for Broken Rail Detection

- Broken Rail Detection System. Different options:
  - Track Circuits
  - Ultra-Sound System
- Alarms of unexpected Track Circuit Occupancy or Broken Rail Detection reported to ATS and driver
- Restricted speed forced by the System
- Operational procedures required to instruct drivers to watch for a broken rail. If the driver confirms there's no broken rail the speed restriction may be lifted from TSCC

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Train Control

Yard Control

- Limited space results in challenging yard operating procedures
- Specified vehicle may require frequent coupling and uncoupling for unscheduled maintenance
- Optimal solution is driverless yard operation
  - ATP system will enforce that driver is on the train before it can exit the yard
  - ATP System will Emergency Brake a train which is switched to Yard Mode when not in the Yard
- Each Controller (Yard/Mainline) controls entry into their respective control area

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Train Control

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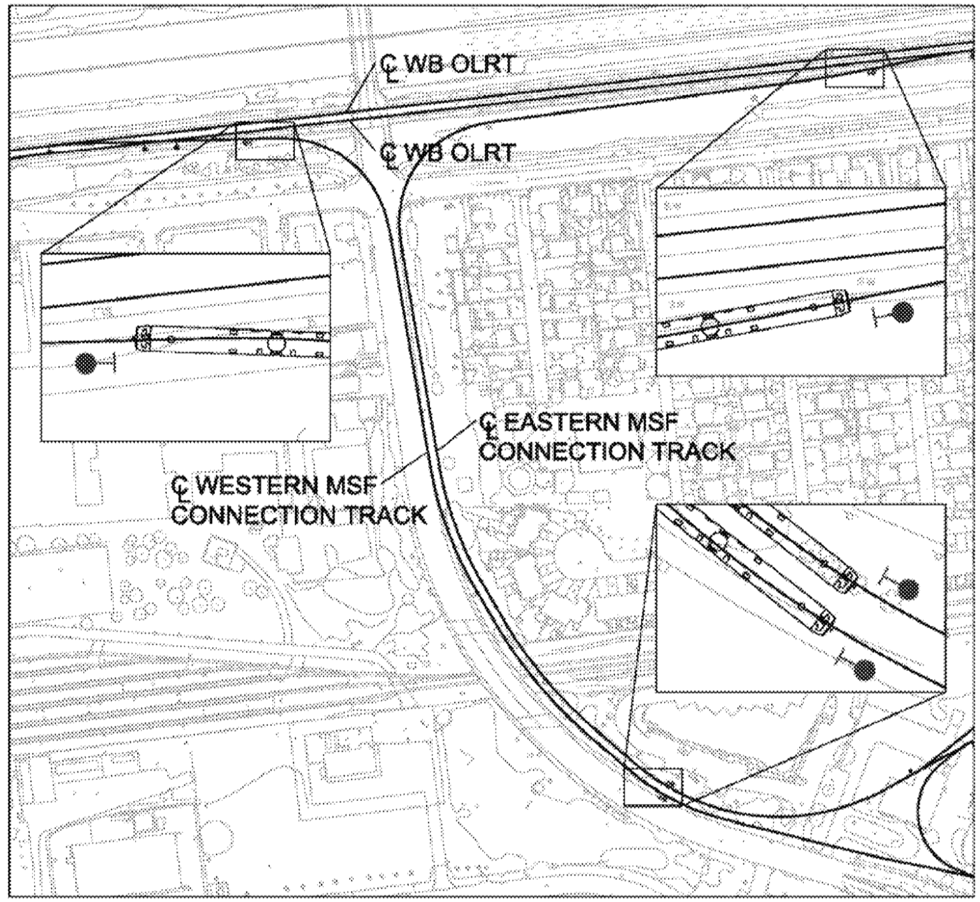
Transfer - Yard to Mainline

- Normally scheduled by the Train Control System
- Yard Controller will route the train to a platform in the Yard
- Dispatcher informed and Driver dispatched
- Driver performs inspection and changes mode to ATO/ATP
- Yard Controller calls route to Mainline entry signal
- Mainline Controller calls route to allow train entry onto mainline



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Train Control

Transfer – Mainline to Yard

- Normally scheduled by the Train Control System
- CBTC System or Mainline Controller calls route to Yard entry signal
- Yard Controller will route the train to a platform in the Yard
- Driver changes mode to driverless yard operation and exits the train
- Yard Controller will route the train to storage or maintenance as appropriate

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Train Control

Proven Design & Demonstration of Successful Application in an Operating System

CBTC System

- A CBTC System operating low-floor LRVs in a climate similar to Ottawa's has not been proven in revenue service
- Major components of the CBTC System will be service proven
- Major components of the Revenue Service vehicle will be service proven
- RTG will perform a due diligence review to satisfy ourselves that the system integration risks are manageable

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Train Control

Design & Integration Methodology

- Thorough requirements analysis
- Able to choose proven suppliers and subsystems
- Comprehensive test & verification planning
- Emphasize off-site acceptance testing
- Maximize simulator and test tracks
- Propose to involve the operator in commissioning as early as possible
- We will mobilize our maintenance staff early

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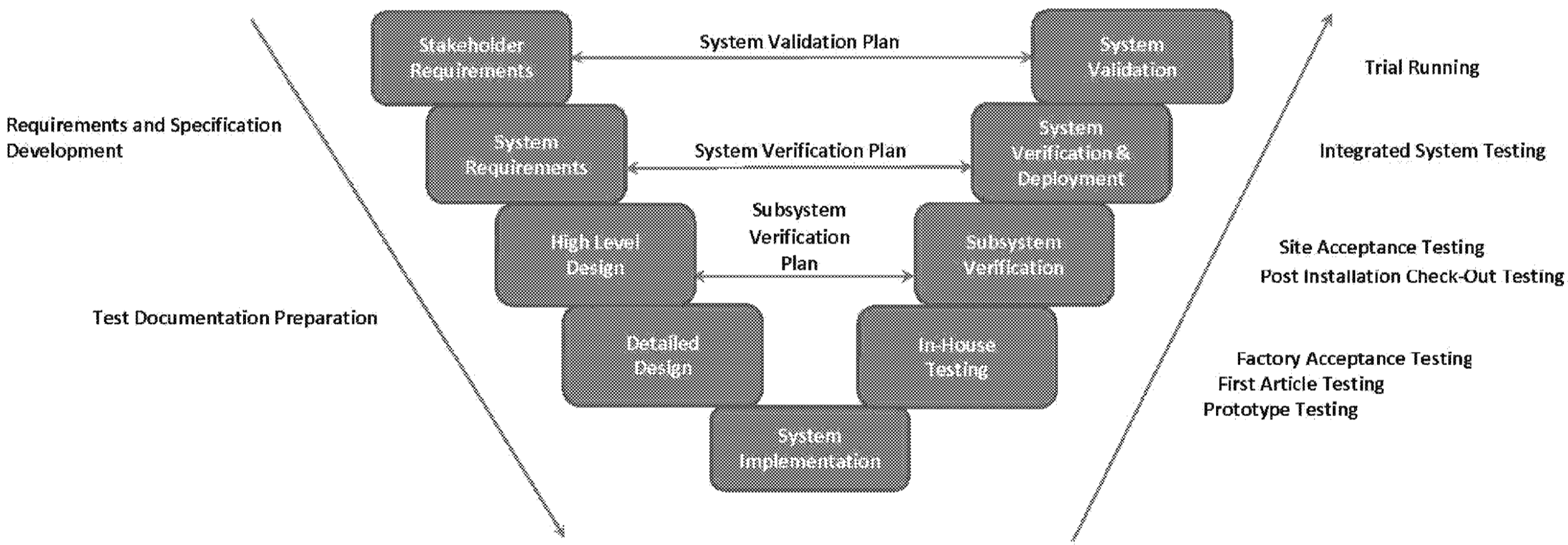
Train Control

Design & Integration Methodology

- Stakeholders Requirements Validation
- Design Reviews
  - Conceptual Design Review
  - Preliminary Design Review
  - Final Design Review
- System Interface Management Plan
  - Identify all interfaces
  - Define interface management organization, responsibilities and processes
- System Interface Specifications
  - Assign responsibility for managing and engineering the interface
  - Identify any other entities involved
  - Specify the agreed interface arrangement
  - Specify the interface functional, performance, reliability, maintainability and safety requirements
  - Specify the method and schedule for verifying the interface integrity

Verification and Validation



Typical Validation and Verification Engineering Model

System-Wide Safety & Certification

Configuration Control – Project Phase

Management of Software and Hardware Configuration Status

- Cannot test systems which are not under configuration control
- Configuration Management Plan:
  - Methodology and procedures to control and document the System configuration
  - Major subcontractor configuration management processes and procedures
  - The organizational structure with respect to configuration management
- Change Control Management Plan:
  - Methods and procedures to be employed to handle changes during the project period
  - A detailed description of the change life cycle and statuses
  - Major subcontractor change control processes and procedures
  - The change control organization

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System-Wide Safety & Certification

Configuration Control – Project Phase

Management of Software and Hardware Configuration Status

- Configuration Data Management Plan:
  - Process and methods to handle configuration data
  - Configuration data to be supplied to third-parties
  - Configuration data to be supplied by third-parties
  - Configuration data formats to be employed
  - Configuration management procedures to be employed for the configuration data
  - Configuration data schedule

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System-Wide Safety & Certification

Configuration Control – O&M Phase

Management of Proposed Equipment to Ensure Operational Safety

- Asset management system tracks all configurable items, systems plans, maintenance reports, remedial actions, instructions and procedures
- Change Management Board - key personnel of the organization to authorize, review and approve changes to those baselines including deviations
- Evaluation of Change Request: benefit/risk criteria are examined:
  - Benefit analysis
  - Impact on safety
  - Impact on quality
  - Impact on human resource planning
  - Impact on interfaces to the entire system or to related systems
  - Impact on reliability, availability and performance

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System-Wide Safety & Certification

Integration

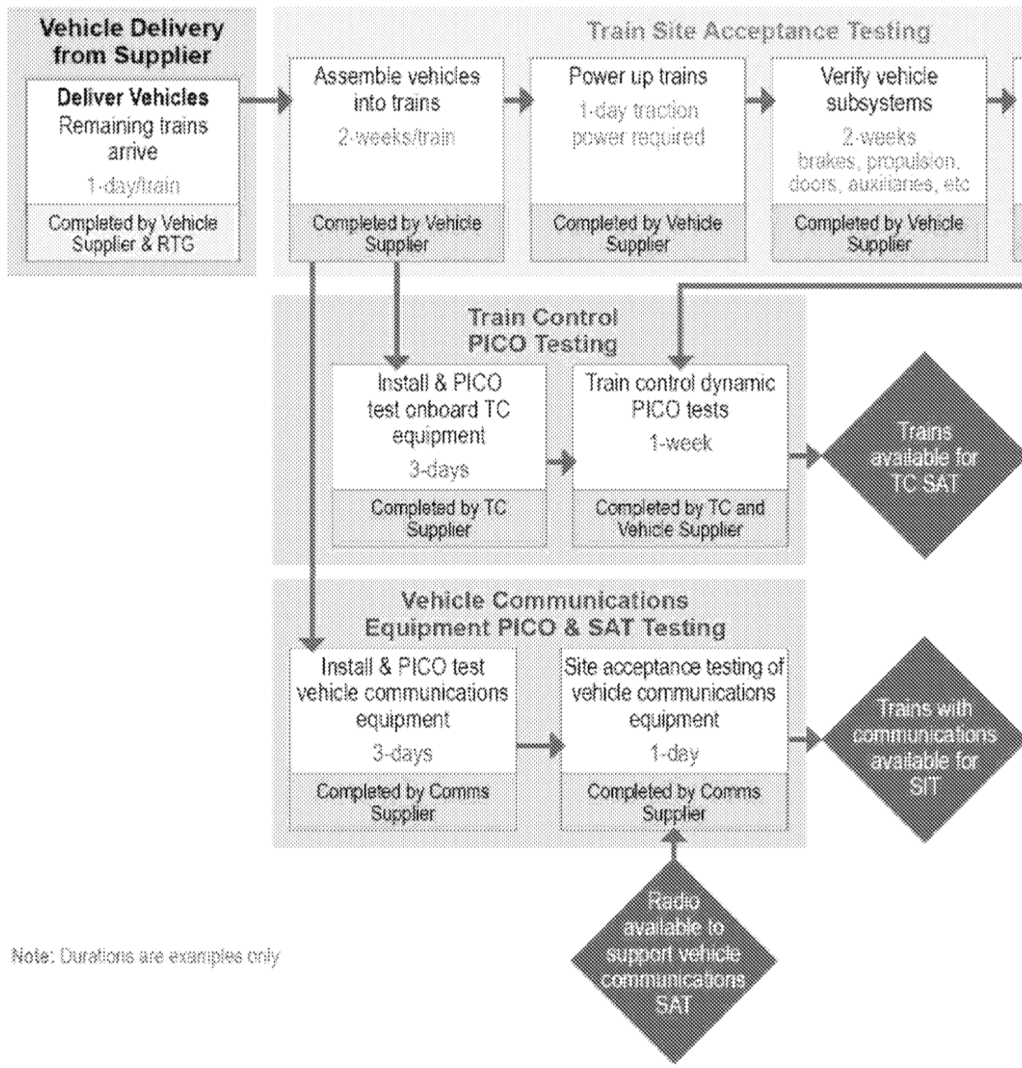
Systems Integration

- Formal system engineering processes
- Use proven systems and components
- Identify risks and mitigate with expertise etc.
- Test systems offsite as far as possible
- Prioritize key interfaces
- Systematically add functions and subsystems
- Use Yard as an initial test bed

System-Wide Safety & Certification

Integration: Process Flow Charts

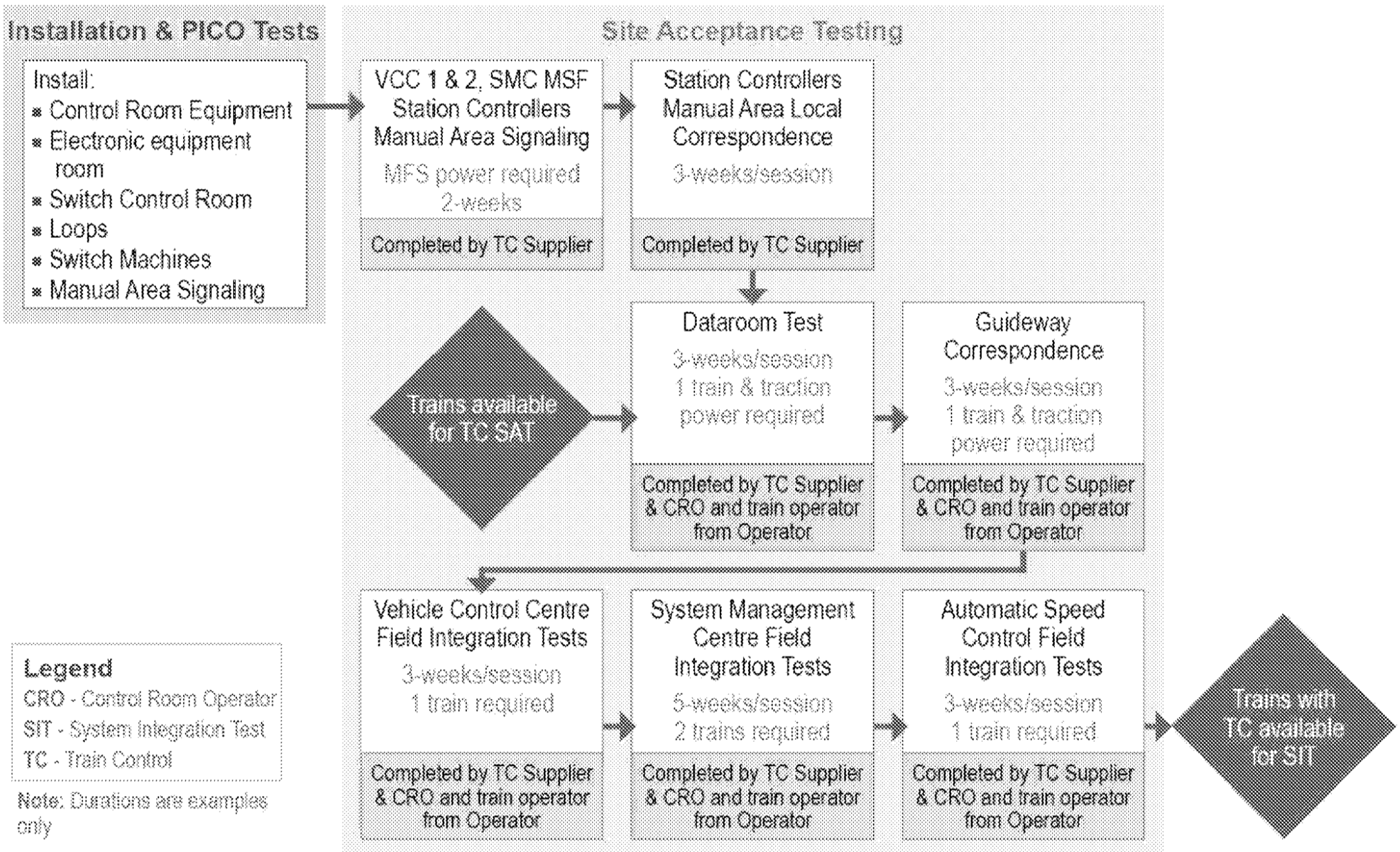
Vehicle Commissioning for Typical Project



Note: Durations are examples only

Integration: Process Flow Charts

Train Control Commissioning for Typical Project



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System-Wide Safety & Certification

Integration

Systems Integration – Environmental Factors

- Systems designed for Ottawa's extreme climate
- Major subsystems service proven
- Environmental qualification testing
- O&M Procedures to deal with "extremes of weather" prepared
- T&C personnel trained in these procedures
- Use inclement weather as a test tool as far as possible
- Simulate extreme conditions when necessary (soaping rails for adhesion testing)

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System-Wide Safety & Certification

Integration

Lessons Learned from Other Project Integrations

- Safety training and management during T&C
- Use proven suppliers and subsystems
- Use Yard as a test bed
- Involve operations early
- Test subsystems and key interfaces off-site as much as possible
- Use expert resources to mitigate project challenges

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System-Wide Safety & Certification

Post Construction Pre-revenue Certification

Test & Commissioning and System Demonstration

- T&C Plan, Schedule and test procedures prepared
- Key O&M Rules and Procedures prepared (e.g.):
  - Clearances, including Track Access and Authorizing Train Movements
  - Activating and deactivating Traction Power
  - Hand signals
  - Train Entry/Exit from maintenance shop
  - Train re-railing
- Sufficient O&M staff trained and ongoing training schedule prepared
- T&C Site Safety and Security procedures and training complete
- Emergency Services personnel orientation and training in progress
- Agree on Test Readiness authorization criteria (e.g.):
  - First train in ATO
  - Trial Running
  - Revenue Service

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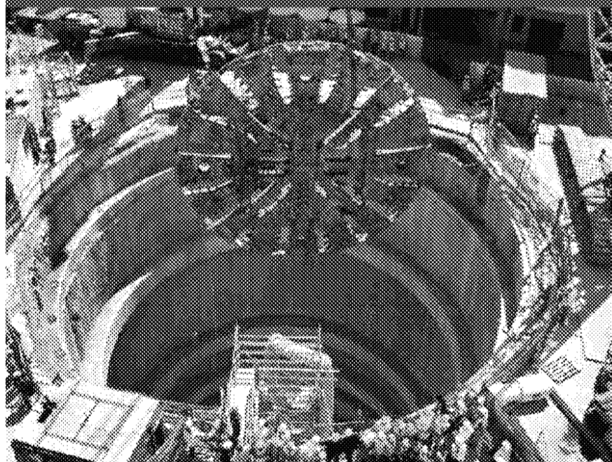

5 LRT SYSTEMS

LRT Systems

Minimizing the Visual Impact of the OCS

- Optimal Solution - No OCS
  - More expensive
  - Less reliable in cold weather

- Single Messenger Wire Solutions
  - Slender structures
  - Attach to underside of structures to optimise pole spacing
  - Consider colour to blend with context

RIDEAU TRANSIT GROUP RTG

LRT Systems

Philip Lee, P.Eng.

LRT Systems Lead

- Over 20 Years Experience in Power Distribution
- Major Projects include
  - Canada Line
  - Calgary West LRT Extension
  - Edmonton North LRT Extension (CM Role)
  - Vancouver Skytrain Expo Line Traction Power System Upgrade
  - Kuala Lumpur Monorail
  - Kuala Lumpur LRT2

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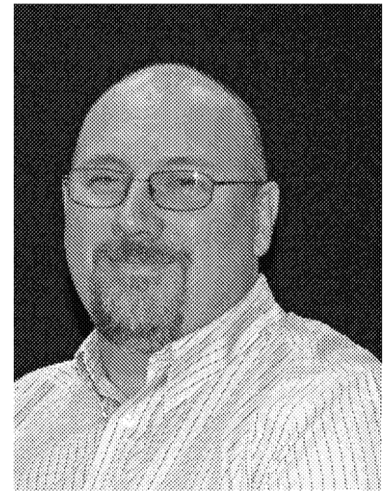
LRT Systems



Keith Brown

Communications Lead

- Over 25 Years in Communications & Control
  - Radio
  - SCADA
  - CCTV
  - PA
  - Networks/Fibre Optics
  - Telephony
  - Expert and complex control systems
- Major Transit Projects include
  - Canada Line
  - Calgary West LRT Extension
  - Edmonton North LRT Extension (CM Role)

RIDEAU TRANSIT GROUP

LRT Systems

Traction Power & Distribution

Traction Power Supply and Design Methodology

- Preliminary Design – Traction Load Flow Modelling
  - Train Operation Model (TOM) Simulation Program
  - Simulation performed in two parts
    - Train Performance Simulation
    - Electric Network Simulation
  - Train Performance Simulation provides
    - Train power profile output
    - Summaries of train trip times and energy consumption

LRT Systems

Traction Power & Distribution

Traction Power Supply and Design Methodology

- Preliminary Design – Traction Load Flow Modelling (continued)
  - Electric Network Simulation provides
    - Current and Power flow through transformer rectifier units and feeders at each traction substation
    - Train voltages at locations on the Guideway
  - Results of Simulation verifies proposed Electric Network is suitable for the train Operation
  - Simulation is performed for cases:
    - Normal – All traction power substations functioning properly
    - Contingency - Any one substation out of service

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LRT Systems

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Traction Power & Distribution

Traction Load Flow Modelling Results & the Implications for System Design

- Project Requirement Traction Power System designed to support
  - Scenario 2 (18,000 pphpd)
  - upgradeable to support Scenario 3 (24,000 pphpd)
- System Characteristics used in Simulation:
  - 1500Vdc traction Voltage
  - 8 Traction Power Substation
    - Locations as shown in Project Agreement
    - 3MW extra heavy duty transformer rectifier unit
  - OCS – one 500kcmil messenger wire and one 350kcmil contact wire (20% wear)
  - Running Rail – 115lb with 10% wear

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LRT Systems

Traction Power & Distribution

Traction Load Flow Modelling Results & the Implications for System Design

- Scenario 2 Simulation Findings
  - TPSS 2 slightly overloaded
    - Locations of the Substations not optimal spacing
    - TPSS 2, TPSS 3, TPSS 4 and TPSS 5 should be more to the West
- Scenario 3 Simulation Findings
  - Many transformer rectifier units overloaded
    - Require increase in rectifier size (4MW)
  - Train voltage low and will affect train performance
    - Require additional messenger wire
  - Recommend to review and upgrade at the time Scenario 3 is required

LRT Systems

Traction Power & Distribution

Traction Power Supply Design, Failure Modes & Mitigation Measures

- General Network Layout
  - Each OCS section is fed from two neighbouring substation at both ends
  - DC switchgear in each Substation is common and ties all the OCS Sections together
- For a Failure of a Substation
  - Bypass switches are provided to ensure the OCS section is tied through and not single end fed
  - For a failure of the terminal Substation a tie switch will be provided to tie Westbound and Eastbound OCS Section

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LRT Systems

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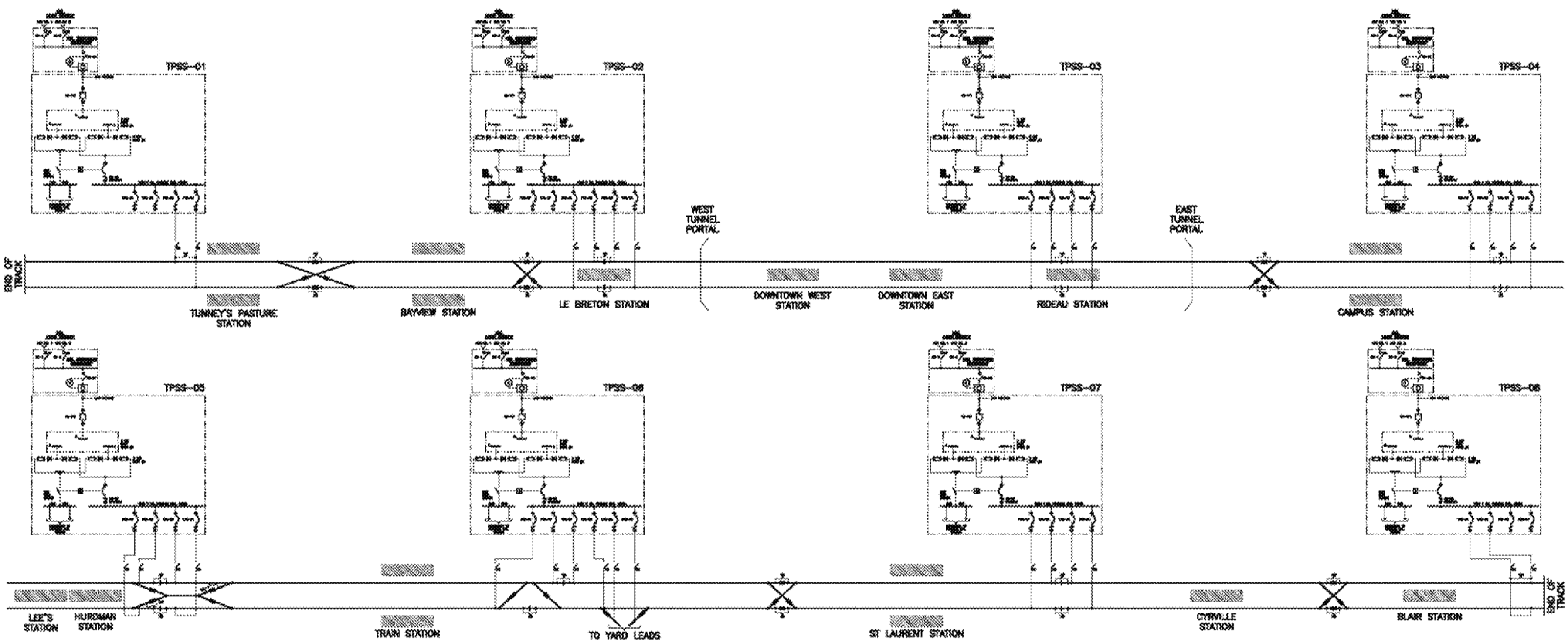
Traction Power & Distribution

Preliminary Traction Power System – Single Line Diagram

- Single Line Diagram of Mainline

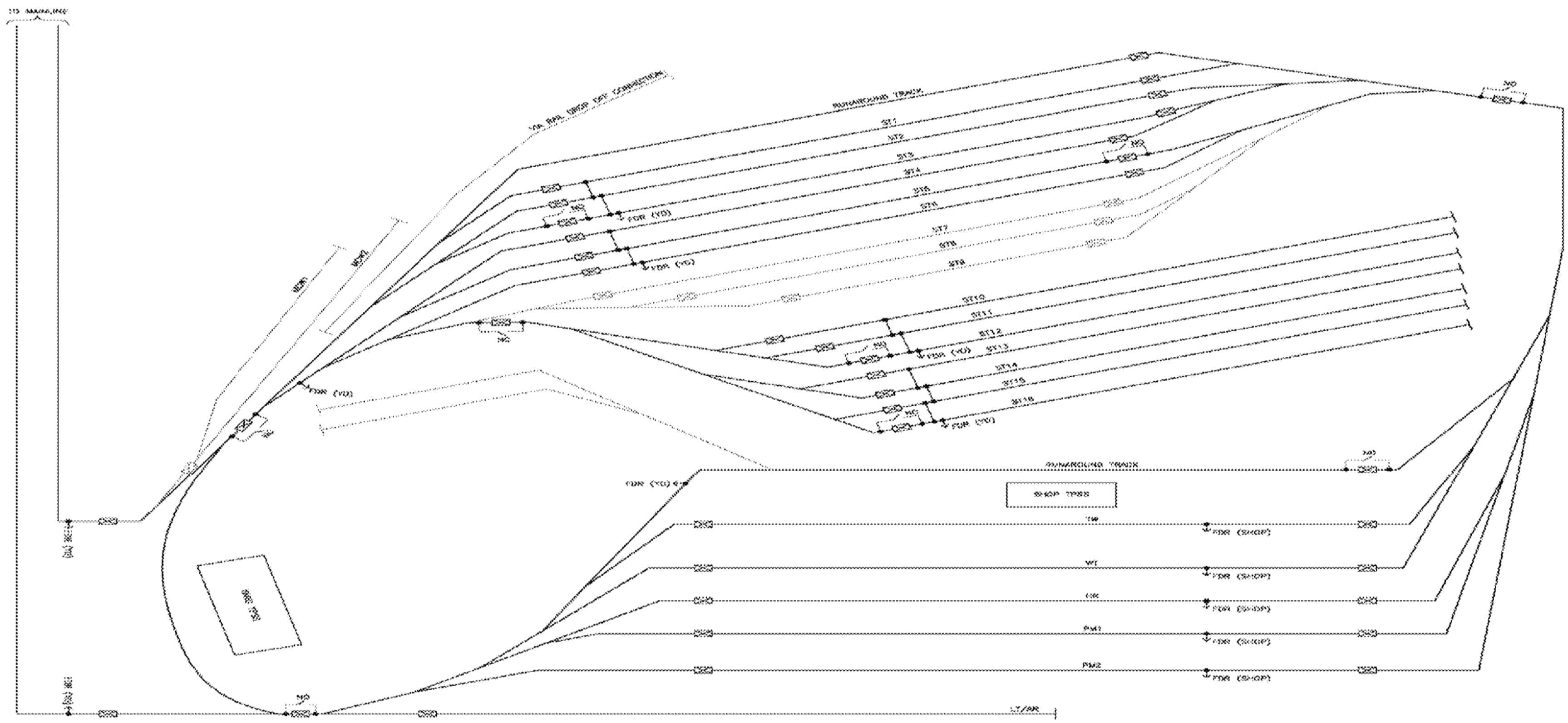


LRT Systems

Traction Power & Distribution

Preliminary Traction Power System – Single Line Diagram

- Single Line Diagram of MSF



LRT Systems

Traction Power

Medium Voltage Distribution: Mainline & MSF TPSS

- Mainline Traction Power Substations:
  - Each Traction Power Substation will be loop fed at 13.2kV from Hydro Ottawa
- MSF Traction Power Substations:
  - Two Traction Power Substations
    - Yard
    - Maintenance Shop
  - Yard Traction Power Substation fed at 13.2kV from Hydro Ottawa
  - Maintenance Shop Traction Power Substation may share 13.2kV feed with building feed
- Three underground passenger station will have redundant 13.2kV feeds
  - Hydro Ottawa feeds at Downtown West Station and Rideau Station and looped to the stations

LRT Systems

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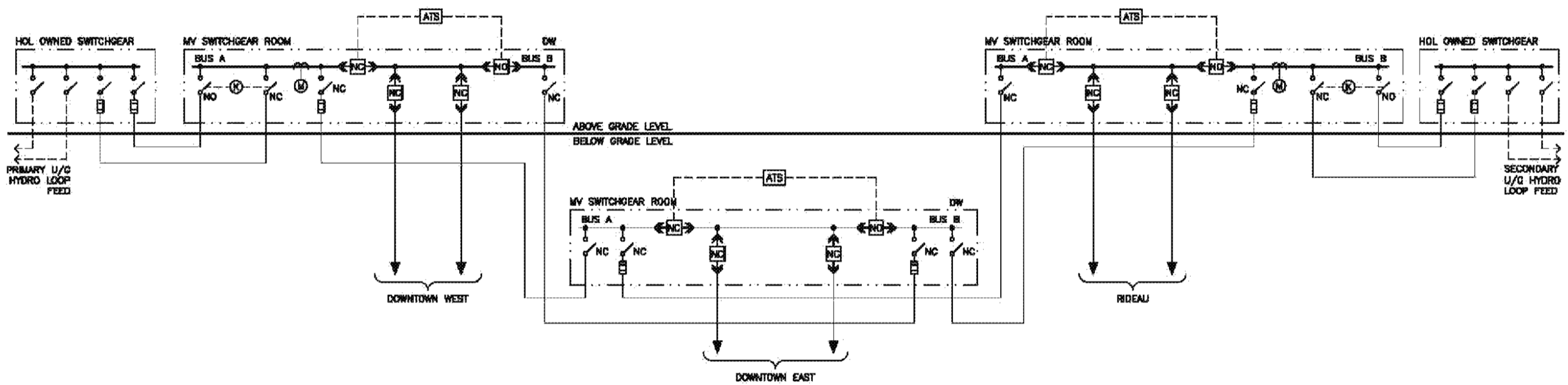
Traction Power & Distribution

Preliminary Traction Power System – Single Line Diagram

- Underground Stations – Medium Voltage – Single Line Diagrams



LRT Systems

OCS

Description of OCS

- Designed for the Ottawa Environment
- Mainline
  - Simple catenary with 350 kcmil contact wire (hard drawn copper) and 500 kcmil stranded messenger wire
  - Stagger typically 300mm
- Mainline: At grade and elevated sections
  - Simple catenary auto tensioned
  - Existing overpasses with low clearance use of elastic supports
  - Pole spacing no more than 60 m

RIDEAU TRANSIT GROUP

LRT Systems

OCS

Description of OCS

- Mainline: Tunnel and Underground Areas
  - Simple catenary fixed termination
  - Alternative use of rigid conductor rail. Benefits include:
    - Ease of installation
    - Minimal Maintenance
    - Higher conductivity than simple catenary to the voltage drop to trains
    - Reduce height of tunnel
    - No tension, therefore wire breakage is not an issue.

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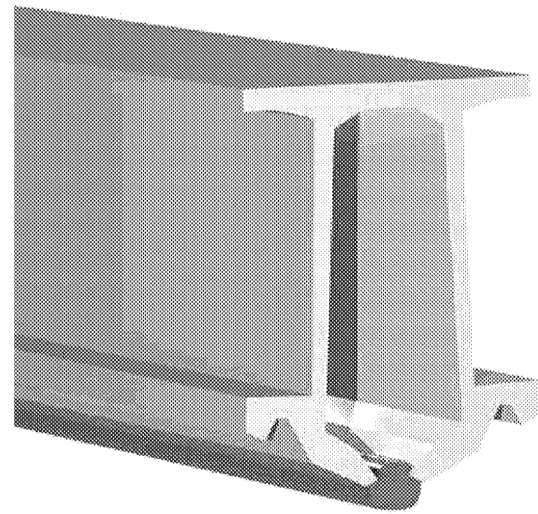
LRT Systems

OCS

Protecting passengers and public from OCS Failures

- Adhere to EN 50122-1
  - Where clearances can not be met protective guards will be installed
    - Catenary shrouds on bridges and other locations where pedestrian traffic is close to messenger/contact wire
  - Metal structures and metal protective guards properly grounded



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LRT Systems

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Corrosion Control, Stray Current & EMI

Corrosion Control Strategy

- General Strategy
  - Minimize the levels of stray current through track design
  - Review of underground metallic utilities under or near the guideway and provide necessary protection
  - Grounding and bonding of guideway structures
  - Provide surveys of levels of stray current during stage of construction and operation

LRT Systems

Corrosion Control, Stray Current & EMI

Methodology of Stakeholder Engagement for Stray Current & EMI

- Stray Current
  - Metallic utilities near or under the guideway will be documented
  - Discussion with Utility Companies
    - Existing protection applied
    - Agree on any further protection if required.
- EMI
  - Identify Potential Stakeholders
    - CBC
    - NRC
    - University of Ottawa
  - Identify Other Potential Stakeholders (VIA Rail, O-Train)
  - Standard Levels of EMI from LRT Equipment

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LRT Systems

Corrosion Control, Stray Current & EMI

Stray Current Monitoring and Metering during Construction & Operations

- Stray Current Measurements in 3 Phases:
  - After construction of guideway and relocation of utilities are completed
  - After completion of all construction
  - After commencement of revenue service
- Provides baselines
  - Verifies the level of stray current from the LRT does not impact any structures or utilities

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LRT Systems

Corrosion Control, Stray Current & EMI

Stray Current Best Practices & their Applicability to the OLRT Project

- Use of 1500Vdc instead of 750Vdc to reduce traction current and therefore reduce the rail to ground voltage
- A floating negative traction system for the mainline
  - No diode grounding
- Electrically isolate the Mainline, Yard and Maintenance Shop rails
- Track Design with rail to ground electrical isolation of at least 250 Ohm/300m
  - Rigorous testing program during installation to ensure this criteria is met.

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LRT Systems

Corrosion Control, Stray Current & EMI

EMI / EMC Strategy, Applicable Design Techniques & Mitigation Measures

- Strategy is to eliminate, reduce or mitigate EMI
  - Source equipment complying with relevant sections of EN 50121
  - Lightning Protection and Grounding
- Follow recognised design standards, guidelines and techniques
  - AREMA, APTA and IEEE
  - EN and IEC
- Review Traction Power delivery
  - OCS
  - TPS locations
- Mitigation
  - Measurement and field surveys
  - Mounting location
  - Shielding and blocking

LRT Systems

Corrosion Control, Stray Current & EMI

EMI / EMC Best Practices & their Applicability to the OLRT Project

- Recognition of Sources and Receptors:
  - Early identification of Sources of EMI
    - Within railway, likely to affect external bodies
    - External, like to affect the railway
  - Early identification of affected Receptors
    - External bodies likely to be affected by EMI
- Development of EMI/EMC Control Plan
  - Engagement with all potentially affected parties
  - Discussion of all potential risks arising together with mitigation
- Design Practices
  - Design and installation in accordance with recognised standards
- EMC Demonstration at the end of the Project

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LRT Systems

Corrosion Control, Stray Current & EMI

EMI / EMC Best Practices & their Applicability to the OLRT Project

- Development of supporting documentation
  - EMC Control Plan
    - RTG will prepare an EMC Control plan that outlines the responsibilities of the various participants and defines all EMC deliverables schedule and standards.
  - EMC Control Report
    - RTG will prepare the EMC Control Report, which summarizes the complete OLRT system and integrates the EMC Control Analysis and Reports from various subcontractors.
  - EMC Risk Assessment
    - Each subcontractor shall support the RTG's EMC Risk Assessment activities including providing support personnel for any Review Team, as required.
  - EMC Control Analysis
    - Where appropriate, as determined by the RTG as part of it's EMI/EMC work, any Subcontractor will be required to prepare, maintain, update and submit to us, an Electromagnetic Compatibility Control Report

LRT Systems

Corrosion Control, Stray Current & EMI

EMI / EMC Best Practices & their Applicability to the OLRT Project

- Development of supporting documentation (2)
  - EMC Demonstration Plan
    - RTG will prepare an EMC Demonstration Plan that will be conducted during the Trial Running period and will demonstrate that, in the reasonable judgment of RTG, the System has met the specified performance criteria and that the System is capable of safely operating.
  - EMC Demonstration Report
    - RTG will prepare the EMC Demonstration report outlining and summarizing the results of the demonstration including presenting the pass fail conclusion together with any applicable recommendations.

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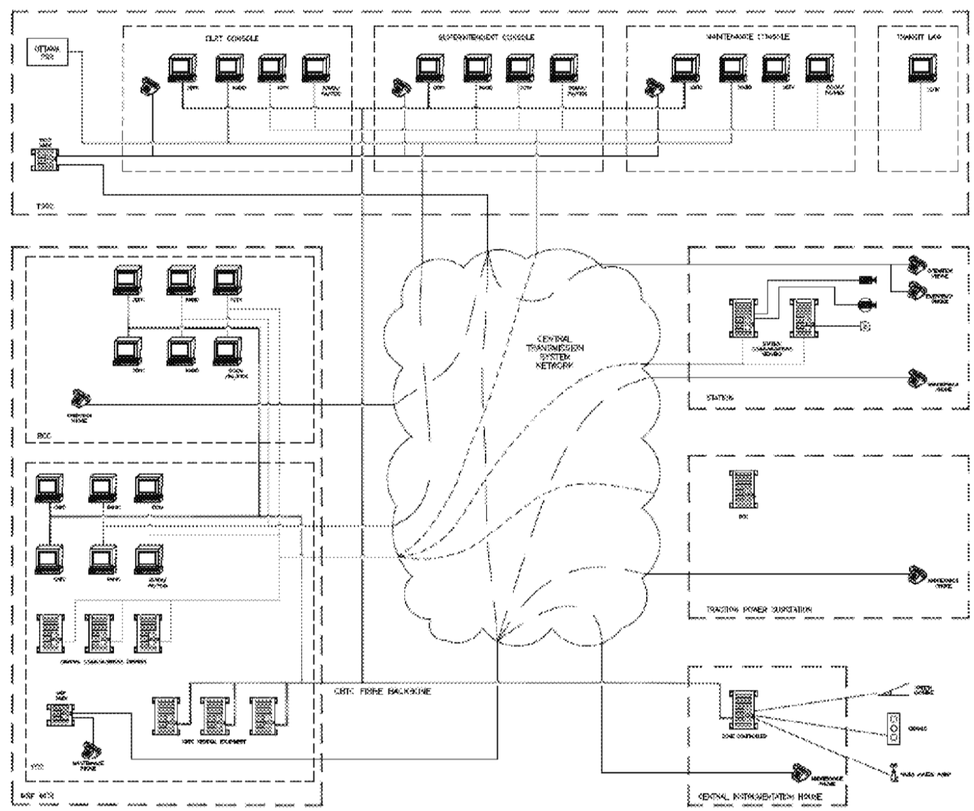
LRT Systems

Communications

Overall Systems Topology / Systems Connection Diagram

- SONET based CTS
  - Links all operating facilities
    - CCTV
    - Telephony
    - SCADA (E&M, TPS, TVS)
    - PA/PIDS
    - IAC
    - BMS
    - Corporate LANs
- Two major Control Centres:
  - TSCC
  - MSF



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LRT Systems

Communications

Integration of Proposed Communication Systems with Existing City Communication Systems

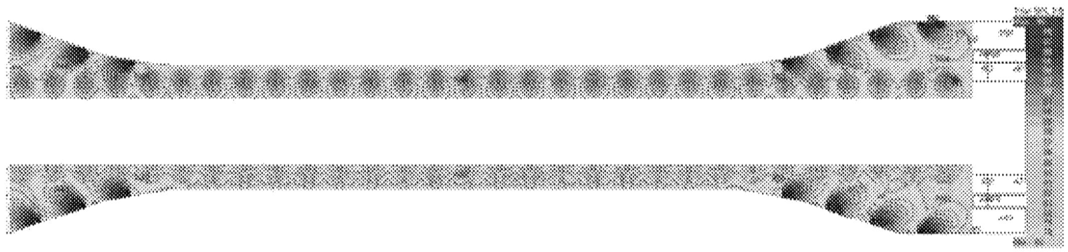
- Key existing systems to be integrated:
  - Ottawa Public Service Radio (PSR)
    - Voice and low speed radio to vehicle and voice to operating staff
  - OC Transpo PABX
    - Passenger telephony and intercoms
    - Operational staff telephony
  - PA/PIDS System
    - Common interface for delivering Public Address and station variable electronic signage
  - Intrusion and Access Control
    - Common access control across all OC Transpo sites
    - Able to control RTG Maintenance staff access

LRT Systems

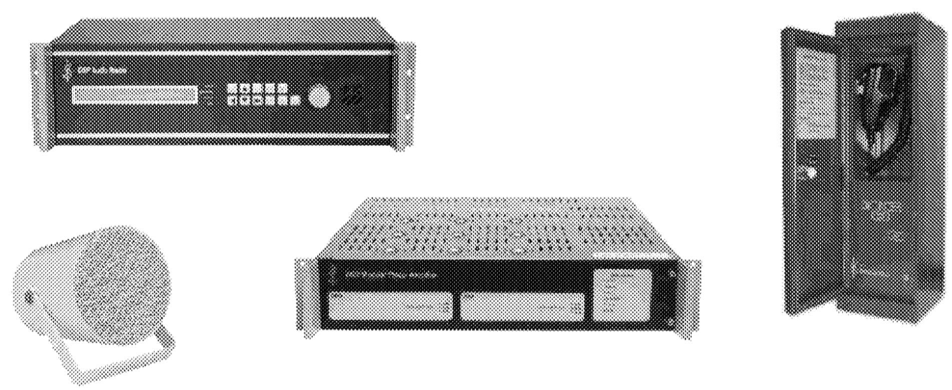
Communications

Public Address

- Design:
  - Built around the requirements of PSOS, NFPA 130, etc.
  - Stations modelled using EASE



- Equipment:
  - Digital signal processor
  - Amplifiers
  - Speakers
  - Microphones

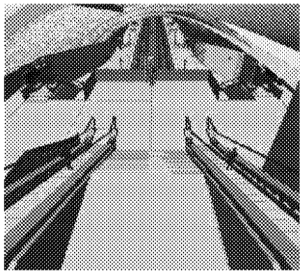


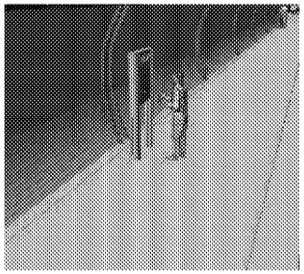
LRT Systems

Communications

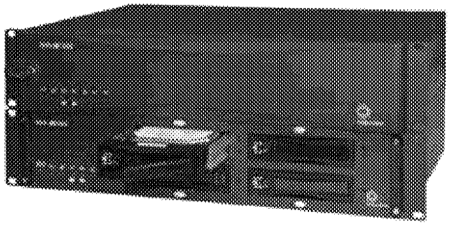
CCTV

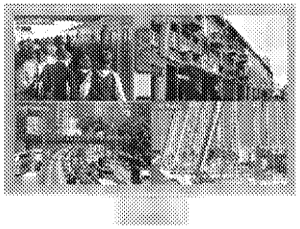
- Design:
  - Built on the requirements of Transport Canada, APTA IT-CCTV-RP-001-11
  - Camera views modelled as part of station layout





- Equipment:
  - Fixed and PTZ cameras
  - Switches
  - Storage
  - Workstations



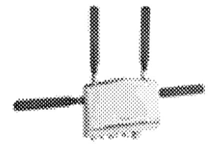


LRT Systems

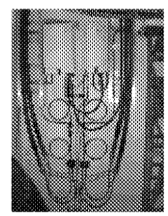
Communications

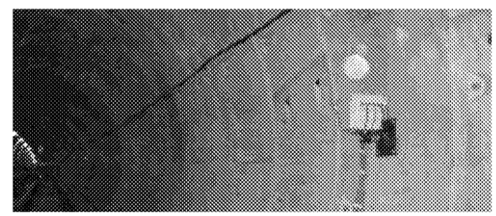
Radio Systems

- Design:
  - Built on the requirements of IEEE 802.11, and the existing Ottawa PSR
  - Coverage models run for tunnel, guideway and station coverage
- Equipment:
  - Access Points and antennae for High Speed Radio

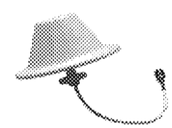


  - Distributed Antenna System for tunnel coverage for Ottawa PSR





  - Station antennae for underground stations for Ottawa PSR

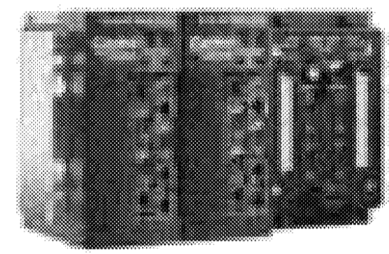


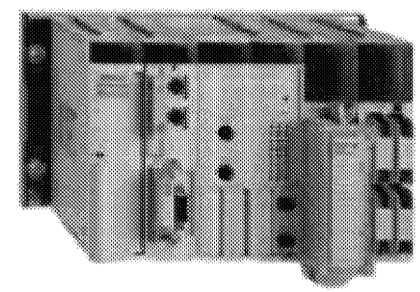
LRT Systems

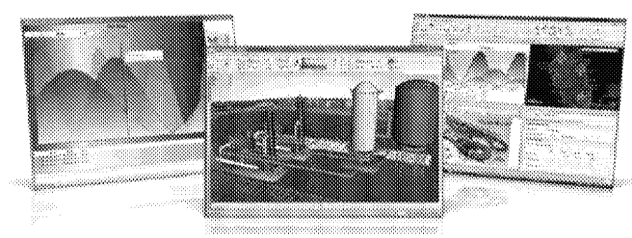
Communications

SCADA

- Design:
  - Built to monitor and manage Station E&M and Traction Power systems
  - Built to control Tunnel Ventilation for normal and abnormal situations
- Equipment:
  - RTUs for Station E&M and TPS
  - PLCs for TVS Control
  - Central system for TSCC/BCC and YCC interfaces







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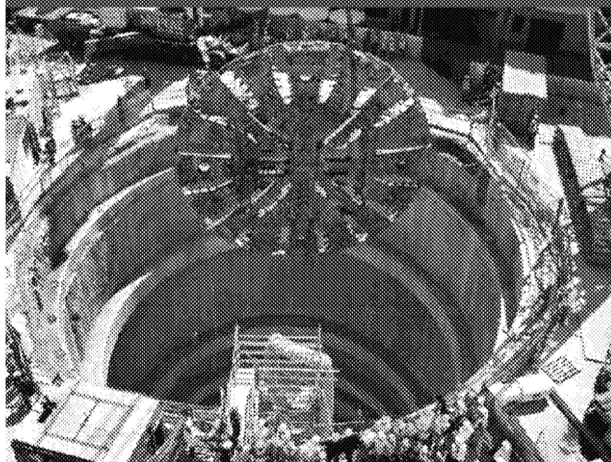

6 SYSTEM-WIDE SAFETY & CERTIFICATION

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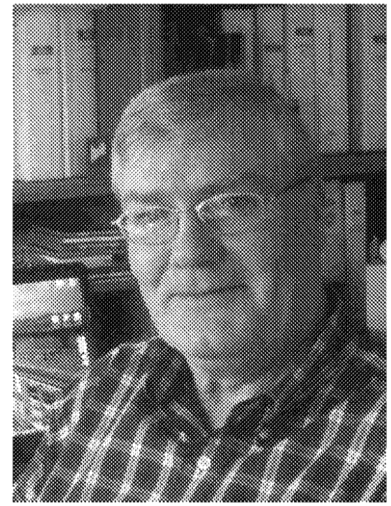
System-Wide Safety & Certification



Brian McDonnell, P.Eng.

McDonnell Consulting Inc.

- Specialist in Systems Assurance for the Transit Industry
  - System Safety
  - Reliability, Availability, Maintainability
  - Plans
  - Analysis
  - Certification
- Clients Include
  - Toronto Transit Commission
  - GO Transit
  - SNC-Lavalin (Canada Line)

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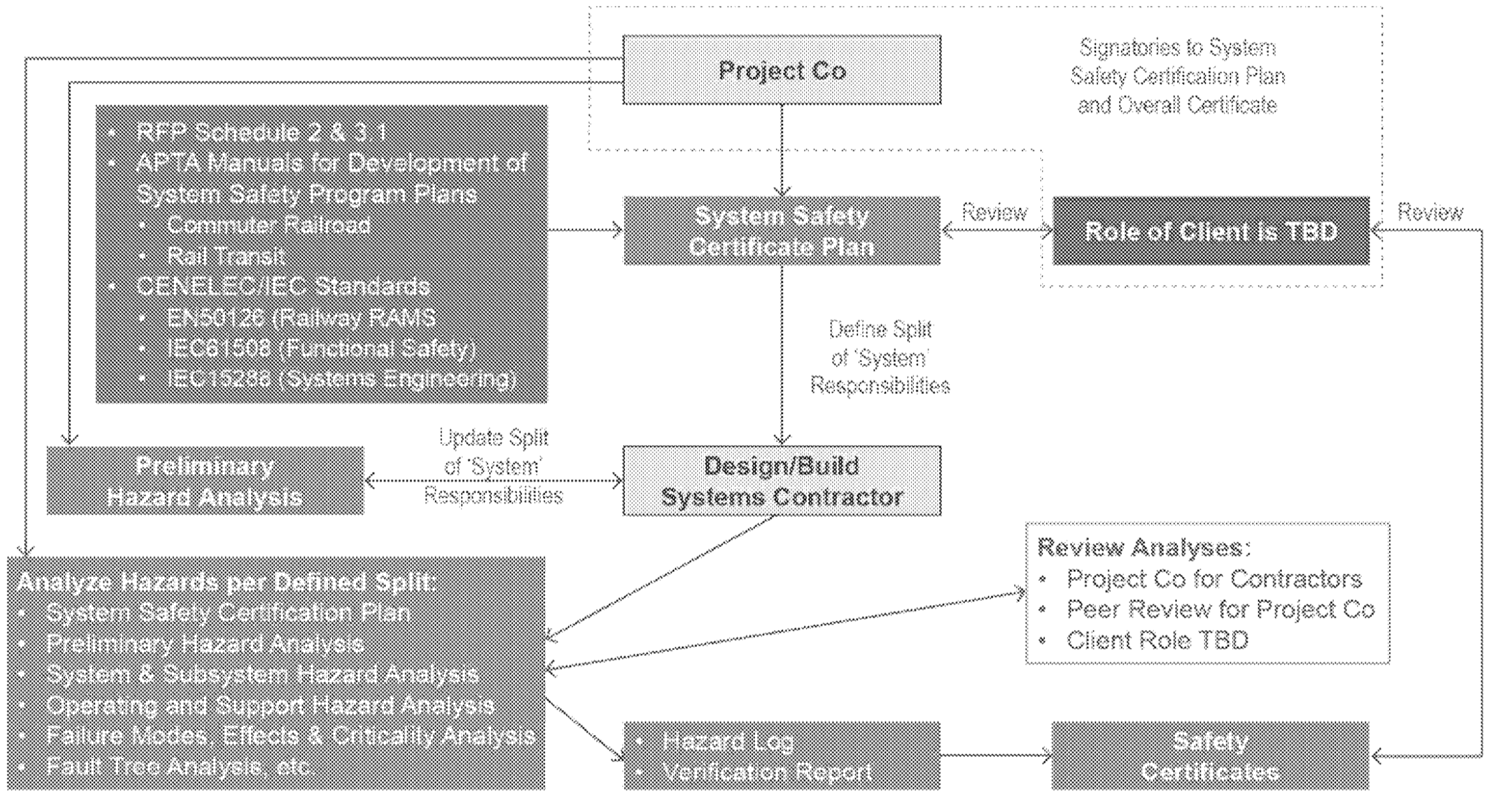
System-Wide Safety & Certification

Assurance Process & Methodology – Safety Case

Management of Safety and Systems Assurance throughout Design, Construction & Maintenance



Note: Boxes with green shading are documents produced specifically for the Ottawa LRV Project.

RIDEAU TRANSIT GROUP RTG

System-Wide Safety & Certification

Assurance Process & Methodology – Safety Management System

Development Process for the System Safety Case and Safety Management System

- Safety and Security of the OLRT during revenue service operation:
  - Responsibilities
  - Policies
  - Operating Rules & Procedures (jointly with system operator)
  - Data gathering
  - Audits
  - Corrective Actions
- Templates Available:
  - Non-proprietary sections of the Canada Line SMS
  - Transport Canada's Railway Safety Management System Guide

System-Wide Safety & Certification

Safety & Security Certification Plan

System Safety Program Plan

- Use of North American & International Standards
- Roles and Responsibilities of:
  - Major Contractors in supplying documents & signing certificates
  - Project Co in supplying documents & signing certificates
  - Client in reviewing and accepting documents and certificates
- Types of analysis to be provided by Major Contractors and Project Co
- Preliminary List of Safety Certificates with draft samples
- Relationship with other professionals
  - Civil Works
  - Architecture
  - Fire/Life Safety
  - Code Compliance
- System Safety Certification Plan for Canada Line available to RTG as template

RIDEAU TRANSIT GROUP RTG

System-Wide Safety & Certification

Safety & Security Certification Plan

Reliability, Availability & Maintainability Plan

- Suggest Combining with System Safety Program Plan
- Will provide the following requirements:
  - Listing of project RAM numerical requirements
  - Listing of project RAM testing or demonstration requirements
  - Allocation of numerical requirements to major subsystems
  - Outline of RAM documentation from major subcontractors
  - Outline of RAM numerical roll-up by RTG to overall project

System Security Program Plan

- Separate document suggested with tighter distribution
- Threat Identification
- Threat Mitigation
- Risk Register
- Security Certification

RIDEAU TRANSIT GROUP RTG

System-Wide Safety & Certification

Safety Auditing during Operational Service

RTG Responsibilities

- RTG & Major subcontractors will provide Operating & Support Hazard Analyses as part of Safety Case
- RTG will be Responsible for Maintenance
- RTG will conduct annual audit of maintenance procedures for
  - Evidence of adherence to Maintenance Procedures
  - Evidence of mitigation as per Operating & Support Hazard Analyses
  - Evidence of mitigation as per all Hazard Log items
  - Appropriate training for all safety critical roles
  - Reconcile variances
- Agree with Operator that similar steps will be taken for operating procedures

Sample Safety Certificates for the Canada Line

Canada Line System Safety Certificate No. 0001 & 0103 (p. 1)

SNC·LAVALIN

CANADA LINE
SYSTEM SAFETY CERTIFICATE
No. 0001

Canada Line PROJECT OFFICE

Completion of this certificate indicates that the Canada Line complies with all applicable safety criteria in accordance with the System Safety Certification Plan for the Canada Line, and is therefore safe to be placed in service for public use in accordance with the Safety Management System.

This certificate and referenced documentation were also prepared as evidence of compliance with the requirements of Clause 4.13, *Engineering Work* of the draft document received from BCSA on June 10, 2008 *Certification, Design, Construction, Operation and Maintenance Guidelines for British Columbia Commuter Railways.*

Date of Certificate: This certificate is effective as of July 29, 2009 in advance of service commencement which is scheduled for August 1, 2009.

RESTRICTIONS STATUS & CLOSURE REQUIREMENTS: During times when a single stay cable is being replaced on the North Arm Bridge, operation shall be restricted to one train (three cars maximum) on the bridge at a time. Restriction to be lifted when cable replacement is complete. Special Instructions, Operating Notes and Operating Restrictions are documented in Operations Bulletin 110. Inspections are to be performed per Operations Bulletin 108 until magnetic valves are installed on all vehicles.

The attached System Safety Certificates spreadsheet identifies each of the safety certificates for the Canada Line, and the status of signatures. The signatures on each indicate acceptance by one or more Professional Engineers registered in BC for that element of the Canada Line.

Also attached is the Hazard Log as required by the System Safety Certification Plan. The signatures on the Hazard Log indicate that all hazards have been administered in accordance with the System Safety Certification Plan.

There are four other Hazard Logs for the Canada Line project. Rotem provided a Hazard Log for the Vehicles. Thales provided a Hazard Log for the ATC system. WRSL (Westinghouse) provided a Hazard Log for the Communications Systems. SNC-Lavalin prepared an Interface Hazard Log covering the interfaces between the Vehicles, ATC and Communications Systems. All hazards in all Hazard Logs have been administered in accordance with the System Safety Certification Plan.

The original signed certificates and supporting system safety documentation are located in a 3-ring binder with the title 'System Safety Certificates'. These are located in the Canada Line Project Records file. A preliminary copy of this binder was provided to BCSA on June 1, 2009, that date being 60 days prior to the scheduled service commencement, but with some of the certificates in draft and unsigned. The complete binder is being issued to BCSA as of the date of this certificate, including all signed certificates, the System Safety Certification Plan, the Preliminary Hazard Analysis, the System Safety Analysis for the Tunnel Ventilation System, and the Hazard Log.

Recommended: B. McDonnell P. Eng.	Approved: R. Woodhead P.Eng.
(Systems Assurance Manager – Canada Line)	(Technical Director – Canada Line)

SNC·LAVALIN

CANADA LINE
SYSTEM SAFETY CERTIFICATE
No. 0103

Canada Line PROJECT OFFICE

Completion of this certificate indicates that appropriate evidence has been provided that the Certifiable Element described below complies with all applicable safety criteria, and is hereby certified in accordance with the System Safety Certification Plan.

CERTIFIABLE ELEMENT NUMBER & NAME:	DATE OF CERTIFICATE:
0103 Vehicles Inspection & Testing	Date: July 24, 2009

RESTRICTIONS STATUS & CLOSURE REQUIREMENTS: Inspections to be performed per Certificate 0921 until magnetic valves are installed.

BACKGROUND

1. In accordance with the EPC Contract Part 1 Section 1.1 "EPC Work" and "EPC Obligations", SNC-Lavalin is responsible for Vehicle design and fabrication per Concession Agreement, Schedule 2, Section 6.2 q and for testing and commissioning per Schedule 2, Section 6.2 kk and Schedule 3, Section 18.
2. Under Contract 016876-PC4000, the Hyundai-Rotem Company (Rotem) is responsible for the supply of the Vehicles, including design, manufacture, assembly, testing, and performance, and for the integration of the vehicles with the Communications and Automatic Train Control systems, both of which are supplied by others.
3. Responsibilities were shared between Rotem and SNC-Lavalin (the EPC) as follows:

Test Type	Rotem Responsibilities	EPC Responsibilities
Factory Acceptance Tests (FAT)	Prepare Procedure, perform test, prepare report	Accept Procedure, witness test, accept report
First Article Inspection (FAI)		
Post Installation Check Out (PICO)		
Site Acceptance Tests (SAT)		
System Integration Tests (SIT)	Support as required	Prepare Procedure, perform test, prepare report
Trial Running		

RELATED CERTIFICATES

1. Certificate 0101 Design Requirements for Vehicles identifies safety critical and safety related elements of Vehicle subsystems, Vehicles and integrated trains.

EVIDENCE

1. Rotem provided a Vehicle History Book for each Vehicle and for each Train. These are kept in Document Control at SNC-Lavalin.

1.1 The Vehicle History Book for each Train includes:

1.1.1 A Certificate of Conformance, signed by Rotem, certifying that the two Vehicles have been manufactured and inspected per specification, and tested with acceptable results.

continued on Page 2

System-Wide Safety & Certification

Sample Safety Certificates for the Canada Line

Canada Line System Safety Certificate No. 0103 (p. 2 & 3)

Page 2

System Safety Certificate No. 0103, Vehicles Inspection & Testing

1.1.2 Train Composition, showing the Train Number, Vehicle Numbers, Carbody Numbers and Bogie Numbers.

1.1.3 Software Version Numbers for each of the relevant subsystems.

1.1.4 Train Test Reports for the FATs and PICOs. The SAT reports are kept in the same location, but are in separate binders for each train.

1.2 The Vehicle History Book for each Vehicle include:

1.2.1 A Certificate of Conformance, signed by Rotem, certifying that the Vehicle has been manufactured and inspected per specification, and tested with acceptable results. The component routine results are included in the Vehicle History Books; the component Type Test reports were provided as official documentation – hard copies are kept in Document Control at SNC-Lavalin.

1.2.2 Vehicle Composition, showing the Vehicle Numbers, Carbody Numbers and Bogie Numbers.

1.2.3 List of outstanding Items (Punch List), which was generated at the time of the Pre-Shipment inspection, was maintained in the History Book for each vehicle. These items did not interfere with the FATs and have been corrected with the following one exception, which is not safety-related; a hostler panel cover modification to prevent rattling when closed and locked - this has been transferred to ProTrans' Work Order system). After each item was corrected, it was inspected and signed off as complete by the EPC Contractor or a designate representative. In May 2009, all remaining items were waiting for material delivery and were transferred to ProTrans' Work Order system. The list of outstanding items is a dynamic list and all current items are tracked either in the T&C SharePoint Defects or by the Work Order system.

1.2.4 Non-conformance Records, which are a record of all NCRs generated by Rotem against each vehicle. These were corrected and did not interfere with testing.

1.2.5 Engineering Change Notices, which are a record of all ECNs generated by Rotem against each vehicle. Although these are unrelated to this testing certificate, these are identified here, since all other items in the books are listed. These modifications have been applied to all trains, with the two following exceptions which are not safety-related; the application of interior decals, and the hostler panel modification identified in 1.2.3 above.

1.2.6 Equipment Serial Numbers of subsystems and components.

1.2.7 Bogie and Carbody Inspection Records include the assembly records and dimensionality checks carried out by Rotem's quality inspectors. Copies of the FAI reports are kept in Document Control at SNC-Lavalin. Certificates and Test Reports for the installed equipment confirm that they function as designed.

.... continued on Page 3

Page 3

System Safety Certificate No. 0103, Vehicles Inspection & Testing

2. A letter was provided (RTPM-RAV-09-0590), which certifies that the Software and Hardware components of the delivered rolling stock under contract ref. 016876-PC4000 are safe and suitable for revenue service (subject to regular maintenance and successful completion of the SITs).

3. All SATs and SITs have been carried out with satisfactory results, with the exception of the vehicle wash test, which is not safety related. Copies of the procedures and reports for these tests have been signed and are kept in Document Control at SNC-Lavalin.

4. All safety critical and safety related items that are listed in Certificate 0101 have been addressed by vehicle design and/or testing. All test specifications and reports were reviewed by the EPC Contractor and signed copies are kept in Document Control at SNC-Lavalin. Hyundai-Rotem confirmed that the trains comply with all safety critical and safety related items (RTPM-RAV-09-0590).

5. In accordance with Contract 016876-PC4000 Section 11.1, SNC-Lavalin issued Taking-Over Certificates to Rotem: Taking Over Certificate for Trial Running (document 016876-5000-46PA-SW-0013, issued 12th June 2009 for all trains) and Taking Over Certificates for Revenue Service Trainsets 101 ~ 120 (documents 016876-5000-46PA-SW-0014 ~ 016876-46PA-SW-0033, issued 24th July 2009 for all trains). Each Certificate stated that the trains were substantially complete according to the Contract and included a Punch Items List of items that would not interfere with the upcoming operations. The Final Acceptance of the trains will take place 2 years after the start of Revenue Service.

Confirmed: S. Oakley 23 July 2009 (Rolling Stock Manager)	Confirmed: R. Ibowski (Vice President, Mass Transit Transportation)
Approved: B. McDonnell (Systems Assurance Manager)	Approved: A. Cunningham 2009-07-23 (Quality Assurance Manager)
Approved: J. Seike 2009-07 (Testing & Commissioning Manager)	

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System-Wide Safety & Certification

Sample Safety Certificates for the Canada Line

Canada Line System Safety Certificate No. 0204

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CANADA LINE
SYSTEM SAFETY CERTIFICATE
No. 0204

Canada Line PROJECT OFFICE

Completion of this certificate indicates that appropriate evidence has been provided that the Certifiable Element described below complies with all applicable safety criteria, and is hereby certified in accordance with the System Safety Certification Plan.

CERTIFIABLE ELEMENT NUMBER & NAME:	DATE OF CERTIFICATE
0204 ATC Systems Assurance	Date: July 29, 2009

RESTRICTIONS STATUS & CLOSURE REQUIREMENTS: None

BACKGROUND

1. The Automatic Train Control (ATC) system for the Canada Line was designed and assembled by Thales Rail Signalling Solutions Inc. (formerly Alcatel Canada Inc.) Company under subcontract 016876-P4300.
2. In accordance with the Canada Line System Safety Certification Plan, System Safety documentation guidelines for the ATC (as well as Vehicles and Communications Systems) were provided in a Design Brief, System Safety Guidelines for Canada Line Contractors.

EVIDENCE

The following system safety documents were provided by Thales, and reviewed and accepted by SNC-Lavalin. These meet the requirements of Background item 2 above.

1. Canada Line ATC System ATC System Safety Program Plan, rev 03, 3CU 00351 0003 DUZZA,
2. Canada Line ATC System ATC Preliminary Hazard List and Analysis, rev 02, 3CU 00351 0051 DUZZA,
3. Canada Line ATC System VOBC Interface Relay Unit Safety Analysis, rev 02, 3CU 00351 0086 DUZZA,
4. Canada Line ATC System Safe Braking Model, rev 03, 3CU 00351 0072 DUZZA,
5. Canada Line ATC System ATC System O&SHA, rev 02, 3CU 00351 0116 DUZZA,
6. Canada Line ATC System ATC System Hazard Analysis, rev 02, 3CU 00351 0087 DUZZA,
7. Canada Line ATC System ATC System Fault Tree, rev 02, 3CU 00351 0099 DUZZA,
8. Canada Line ATC System ATC System FMECA, rev 02, 3CU 00351 0092 DUZZA,
9. Canada Line ATC System ATC EMC Control Plan, rev 02, 3CU 00351 0004 UEZZA,
10. Canada Line ATC System ATC System Preliminary EMC Control Report, rev 03, 3CU 00351 0071 QZZZA,

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Page 2

System Safety Certificate No. 0204, ATC Systems Assurance

11. Canada Line ATC System VOBC Subsystem Safety Analysis, Rev 02, 3CU 00351 0076 DUZZA,
12. Canada Line ATC System STC Relay Rack Safety Analysis, Rev 01, 3CU 00351 0134 DUZZA,
13. Canada Line ATC System ATC VCC Subsystem Safety Analysis, Rev 02, 3CU 00351 0102 DUZZA,
14. Canada Line ATC System ATC System Data Communications Safety Analysis, Rev 01, 3CU 00351 0151 DUZZA,
15. Canada Line ATC System ATC System Station Controller Subsystem Safety Analysis, Rev 02, 3CU 00351 0089 DUZZA,
16. Canada Line ATC System Hazard Log, rev 01, 3CU 00351 0088 DUZZA, and
17. Safety Certification Letter # 0686.

The following documents were produced by Thales, and reviewed and accepted by SNC-Lavalin and Rotem:

18. Canada Line ATC System Vehicle Interface Control Document, rev 04, 3CU 00351 0014 PBZZA, and
19. ATC System On-Board/Vehicle PHA/IHA rev. 03, 3CU 00351 0028 DUZZA.

The following documents were produced and accepted by SNC-Lavalin:

20. ATC-Vehicle Hazard Logs; i.e. Design Briefs 016876-3030-48EB-SW-001 and 016876-3030-48EB-SW-002

Confirmed: B. McDonnell (Systems Assurance Manager)	Approved: M. Palmer (ATC Project Manager)
Approved: K. Tagg (Systems Manager)	Approved: R. Woodhead (Technical Director)

Sample Safety Certificates for the Canada Line

Canada Line System Safety Certificate No. 0703

SNC·LAVALIN

CANADA LINE
SYSTEM SAFETY CERTIFICATE
No. 0703

Canada Line PROJECT OFFICE

Completion of this certificate indicates that appropriate evidence has been provided that the Certifiable Element described below complies with all applicable safety criteria, and is hereby certified in accordance with the System Safety Certification Plan.

CERTIFIABLE ELEMENT NUMBER & NAME:	DATE OF CERTIFICATE:
0703 PS&D Installation, Inspection & Testing	Date: July 16, 2009

RESTRICTIONS STATUS & CLOSURE REQUIREMENTS: None.

BACKGROUND

1. In accordance with the EPC Contract Part 1 Section 1.1 "EPC Work" and "EPC Obligations", SNC-Lavalin is responsible for the design and construction design of the Power Supply and Distribution system (PS&D) per Concession Agreement, Schedule 2, Section 6.2 (z) and for testing and commissioning per Schedule 2, Section 6.2 kk and Schedule 3, Section 18.
2. SNC-Lavalin subcontracted the supply and installation of elements of the PS&D system to a number of subcontractors. Responsibilities for Factory Acceptance Tests (FAT), First Article Inspection (FAI), Post Installation Check Out (PICO), Site Acceptance Tests (SAT), System Integration Tests, (SIT), and Trial Running were split between the subcontractors and the EPC as follows:

Equipment	Subcontractor Responsibilities	EPC Responsibilities
All PS&D Equipment	Prepare FAT and FAI procedures, perform tests, prepare reports	Accept procedures, witness tests, accept reports
	Perform inspections, prepare reports	Prepare PICO procedures, accept reports
	Support as required	Prepare procedures for SITs and Trial Running, perform tests, prepare reports
Substation	Prepare SAT procedures, perform tests, prepare reports	Accept procedures, witness tests, accept reports
Wayside Disconnect Switches	Support as required	Prepare SAT procedures, perform tests, prepare reports
Stinger system		
Blue light system		
UPS	Prepare SAT procedures, perform tests, prepare reports	Accept procedures, witness tests, accept reports
FNAGS	Prepare SAT procedures	Accept procedures, perform tests, prepare reports
Generators and Power Distribution Centres	Site commissioning, prepare report	Accept report

.... continued on Page 2

Page 2

System Safety Certificate No. 0703, PS&D Installation, Inspection & Testing

EVIDENCE

1. All tests (FATs, FAIs, PICOs, SATs, SITs and Trial Running) have been performed with satisfactory results. Copies of the procedures and reports for these tests have been signed and are kept in Document Control at SNC-Lavalin.

Confirmed: P. Lee (PS & D Manager) July 22, 2009	Approved: J. Selke (Testing & Commissioning Manager)
Approved: A. Cunningham (Quality Assurance Manager)	Approved: B. McDonnell (Systems Assurance Manager) July 21 2009
Approved: R. Woodhead (Technical Director)	

RIDEAU TRANSIT GROUP RTG

System-Wide Safety & Certification

Sample Safety Certificates for the Canada Line

Canada Line System Safety Certificate No. 0903

SNC·LAVALIN

CANADA LINE
SYSTEM SAFETY CERTIFICATE
No. 0903

Canada Line PROJECT OFFICE

Completion of this certificate indicates that appropriate evidence has been provided that the Certifiable Element described below complies with all applicable safety criteria, and is hereby certified in accordance with the System Safety Certification Plan.

CERTIFIABLE ELEMENT NUMBER & NAME:	DATE OF PERMIT:
0903 Electromagnetic Compatibility	Date: May 28, 2009

RESTRICTIONS STATUS & CLOSURE REQUIREMENTS: None

BACKGROUND

1. As the Engineering, Construction and Procurement Contractor, SNC-Lavalin is responsible for ensuring the mutual Electromagnetic Compatibility of each of the Canada Line systems, as well as the Electromagnetic Compatibility (EMC) of the Canada Line with its neighbours, and specifically YVR.
2. Supporting responsibilities were contracted to Rotem, Thales, and WRSL via the E&M Systems General Specification, section 2.11.

EVIDENCE

1. Thales described how EMC would be achieved between the ATC and other systems in document 3CU 00351 0004 UEZZA, Canada Line ATC System EMC Plan, Rev 02.
2. Thales provided evidence of successful verification of the EMC requirements in document 3CU 00351 0071 QZZZA, Canada Line ATC System EMC Control Report, Rev 03.
3. Rotem provided the following EMC reports, which indicate that the specified EMC limits are not exceeded.
   3.1 RAV-1000-6O-001(A1)_EMC Factory Test Report presents the test results of the electromagnetic compatibility of the vehicle (carried out 19-20 September 2007 in the Changwon factory).
   3.2 RAV-1000-6O-003(A1)_EMC Main Line Test Report presents the test results of the electromagnetic compatibility of the vehicle (carried out in the OMC depot on 12-13 February 2008 and on the main line on 20-21 May 2008).
4. SNC-Lavalin described how overall EMC would be achieved in document 0168766-1010-40PA-SW-005, Rev 00, Canada Line System EMC Control Plan.
5. Testing was performed in accordance with the Canada Line System EMC Control Plan, and specifically to assess the potential interference which the Canada Line could cause to the navigation systems at YVR. The test was performed by CNSS Engineering on behalf of YVRAA and NAV CANADA using a two-car Canada Line train at the OMC on January 24, 2008 at a time when there was ice and frost buildup on the energized power rail. These conditions were sought, since electromagnetic emissions increase when there is a poor contact between the collector shoe and the power rail. The Conclusions section of the test report states: "On the basis of those tests, the operation of the light rail system at Vancouver International Airport should have negligible effect on communication systems located at the Air Traffic Control Tower."

…………… continued on Page 2

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System Safety Certificate No. 0903, Electromagnetic Compatibility

6. All other EMC related commissioning tests have been completed, including ATC testing, vehicles testing and multitrain testing. No EMC issues have been identified.
7. WRSL document FH26-16.02-PL00007, Rev 1.3, EMC Control Plan described how EMC would be achieved between the Communications System and other Canada Line systems, and the surrounding environment, including YVR.
8. WRSL will provide a report which describes the results of activities performed in accordance with the Communications System EMC Control Plan. In consideration of item # 6 above, this is not necessary before this certificate is signed.

Confirmed: K. Tagg (Systems Manager)	Confirmed: M. Palmer (ATC Project Manager)
Confirmed: I. Davidev 29 May 2009 (Communications Project Manager)	Confirmed: S. Oakley 28 May 2009 (Rolling Stock Manager)
Approved: B. McDonnell May 28 2009 (Systems Assurance Manager)	Approved: R. Woodhead (Technical Director)

RIDEAU TRANSIT GROUP RTG

System-Wide Safety & Certification

Construction Site Safety & Security

RTG Member Firms

- Based on Corporate policies of RTG Partners
  - No compromise on providing safety
  - ISO Certified; Corporate safety manuals
  - Senior Executives Accountable; staff accountability
- Develop and implement controls
  - Hazard analysis; prioritize and classify
  - Training; prevention planning; tool box meetings
  - Lockout and control procedures
- Verification Activities
  - Audits, inspections and reporting
- Track Record
  - EllisDon – recipient of John Beck Award, two of past three years

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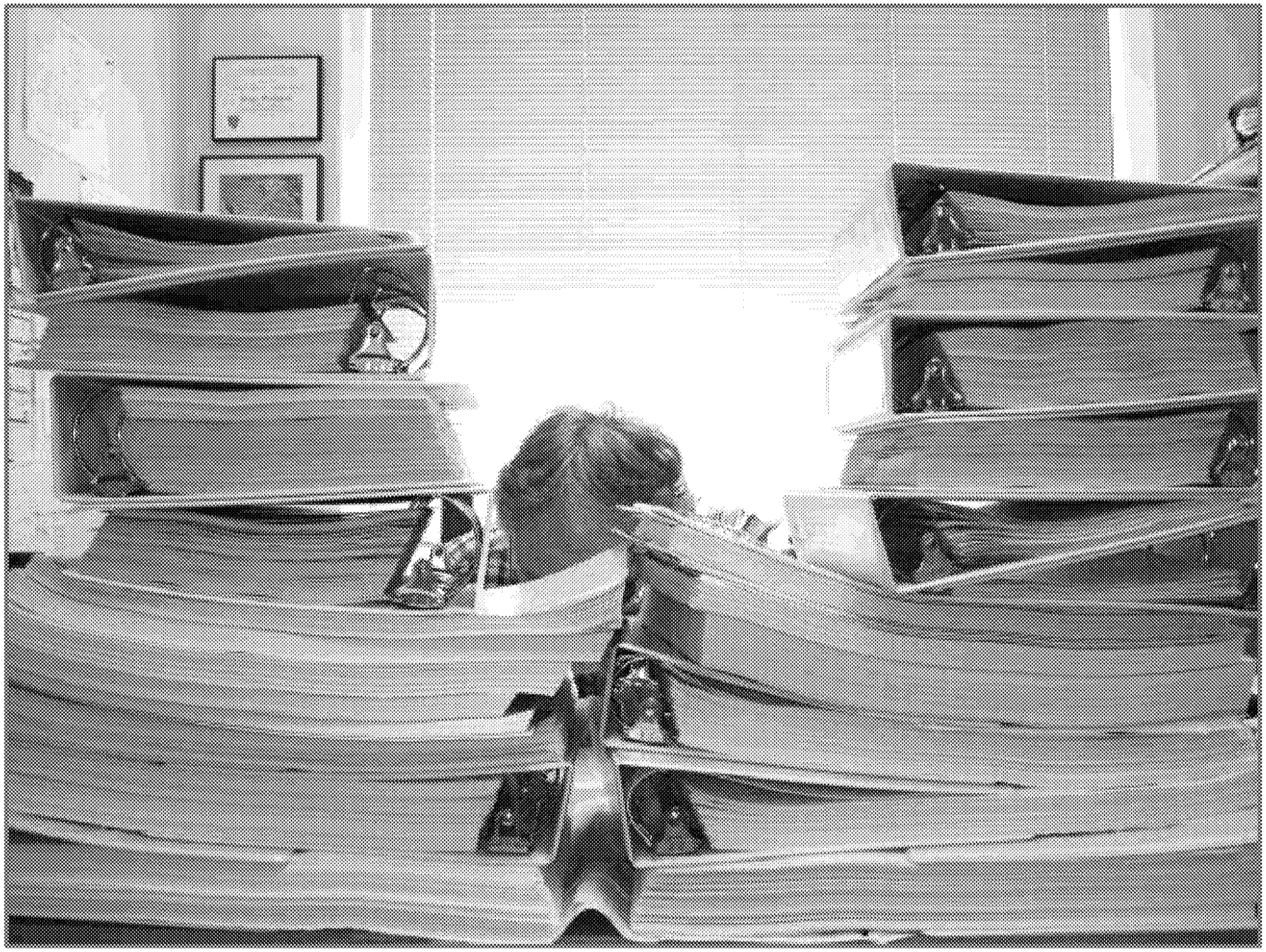
Key Issues Moving Forward

The job isn't finished until…



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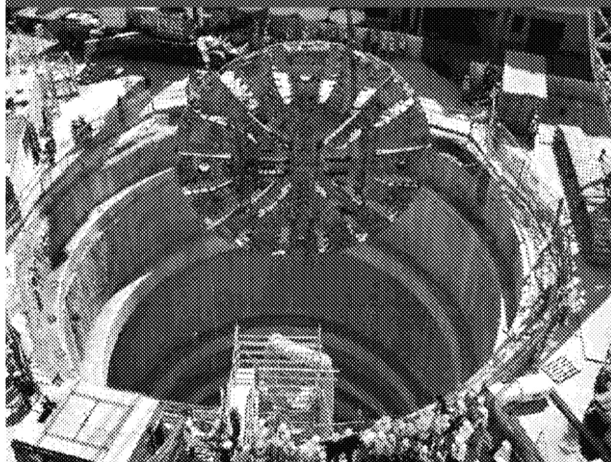

7 KEY ISSUES MOVING FORWARD

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Key Issues Moving Forward

Key Issues Moving Forward

Issue #1: Affordability Cap

Issue #2: PSR Upgrade

- The Project Agreement, in Article 6.2 (j) of Part 5 of Schedule 15-2 states that the Ottawa PSR will be upgraded to a P25 system in 2015. This has unknown implications to:
  - System design
  - Radio interface to the vehicle
  - Tunnel/underground station radio distributed antennae system

  We need some more information on the anticipated system design, frequencies, deployment, etc.

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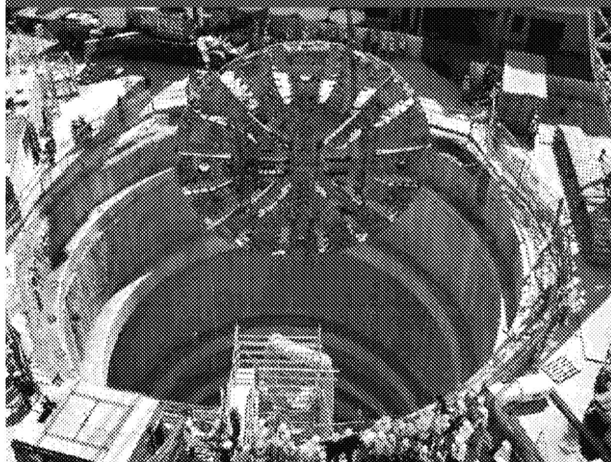

8 QUESTIONS

RIDEAU TRANSIT GROUP

Questions

Five Key Questions

Question #1: OLRT Project Ridership Forecast

- Article 2.5 (a) of Schedule 15-2 Part 1 of the PA reads as follows: *"Based upon the City's Ridership Forecast (revised January 24, 2011), the City has established the following service scenarios: ……"*

  Based on the response provided to RFI OLRT-0075 it is our understanding that the "OLRT Project Ridership Forecast" dated January 27, 2011 and attached to that RFI are the ridership numbers that will be used to measure compliance with the Operating Scenario's, Station Sizing and Capacity, etc… The Ridership Forecast includes Scenario's for "Without Gatineau" and "With Gatineau". Please clarify which of these Scenario's will govern compliance.

Questions

Five Key Questions

Question #2: Operations Permit

- Please identify the organization(s) who will be responsible for signing acceptance of the Project Co recommendation that the OLRT is ready for
  1. Traction Power Energization,
  2. First Train Movement,
  3. Multiple Train Movements,
  4. Trial Running, and
  5. Revenue Service.

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Questions

Five Key Questions

Question #3: Software Only Algorithm

- In the response to a certain Vehicle and Train Control Prequalification submission the Sponsor's stated: *"… uses Doppler Radar to assist localization during spins and slides. Schedule 15-2 had requested this be done with software only for reliability."*

  We agree that Schedule 15-2 requires that the Train Control System employs an algorithm to maintain train position during spins and slides but we can find no clause that requires a `software only` algorithm.

  Can the sponsors please identify this clause?

  Also RTG cannot find a CBTC System that uses a "software only" algorithm to maintain train position during spins and slides.

  Can the Sponsor's please provide further information on where this solution has been successfully implemented?

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Questions

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Five Key Questions

Question #4: ATO Mode Rationale

- In DPM #1 RTG asked about the rationale behind the requirement in Schedule 15-2 Part 4 (d) ATO Mode (Vehicle) (iii) *"A Driver may be required to take control of Train operation even during ATO operation. The interface with the Train Control system shall be such that a Driver may assert control of the Train with the same Master Controller handle movement as would be used if the CBTC system were in ATP Only Mode. For example, it may be necessary for the ATO function to monitor the Master Controller output as well as its own propulsion and braking requests and output to the trainlines the more restrictive of the two."*

  We were told that the rationale was that the "driver must be able to take control of the train without causing an Emergency Brake." If the latter is indeed the requirement would the Sponsors consider updating the specification to match the requirement?

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Questions

Five Key Questions

Question #5: OCS

- Clause 8.2 (c) (i) B (i) states: *"In tunnel and underground areas, a low profile two-wire fixed termination simple catenary system shall be used."*

As an alternative, would the use of rigid conductor rail be acceptable?

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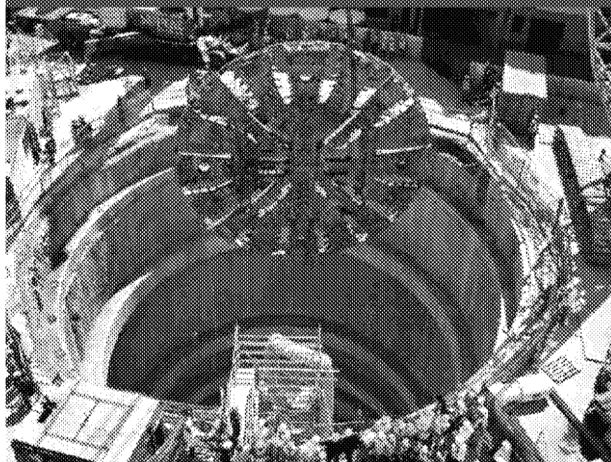

9 SUMMARY & CLOSING COMMENTS

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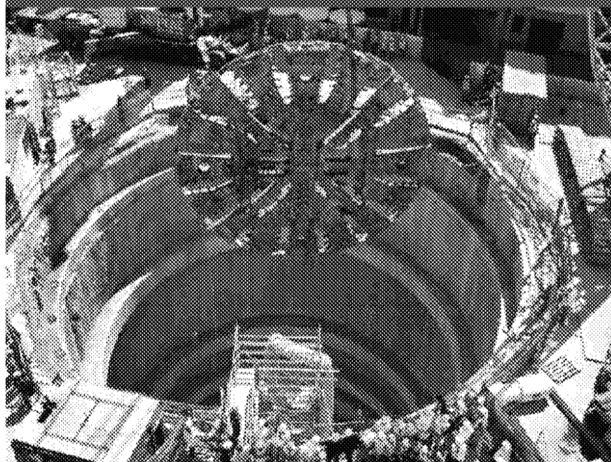
RTG



THANK YOU