



Audit of the Toronto Transit Commission's Streetcar Overhead Assets: Strengthening the Maintenance and Repair Program to Minimize Asset Failures and Service Delays

TTC Board Meeting

November 22, 2023

Presenter: Fortunato Monaco, Chief Operations & Infrastructure

Agenda

- Streetcar Overheads Ongoing Initiatives -
 - ✓ Evolution to Pantographs
 - ✓ Continuous Improvements
 - ✓ Industry Participation



Evolution to Pantographs

Pole

Legacy State



Pole Technology

- ✗ 100 year old technology
- ✗ Not pantograph friendly
- ✗ Lower current draw (limits speed, air conditioning, etc.)
- ✓ Simple straight trolley wire
- ✗ Heavy overhead hardware
- ✗ Carbon life (1 – 3 days)
- ✓ Wire life 10 years (pole)
- ✗ Risk of pole de-wirements

Hybrid

Transition (Hybrid) State



Hybrid Technology

- ✗ Transitional non optimal system
- ✓ Accommodates dual modes (pole/panto)
- ✓ Permits limited trolley wire stagger
- ✗ Extra heavy overhead hardware
- ✓ Carbon life (1 day – 3 months)
- ✗ Accelerated wire wear (pole/panto)
- ✗ Risk of pole de-wirements
- ✗ Risk of pantograph drop downs

Pantograph

Modern State

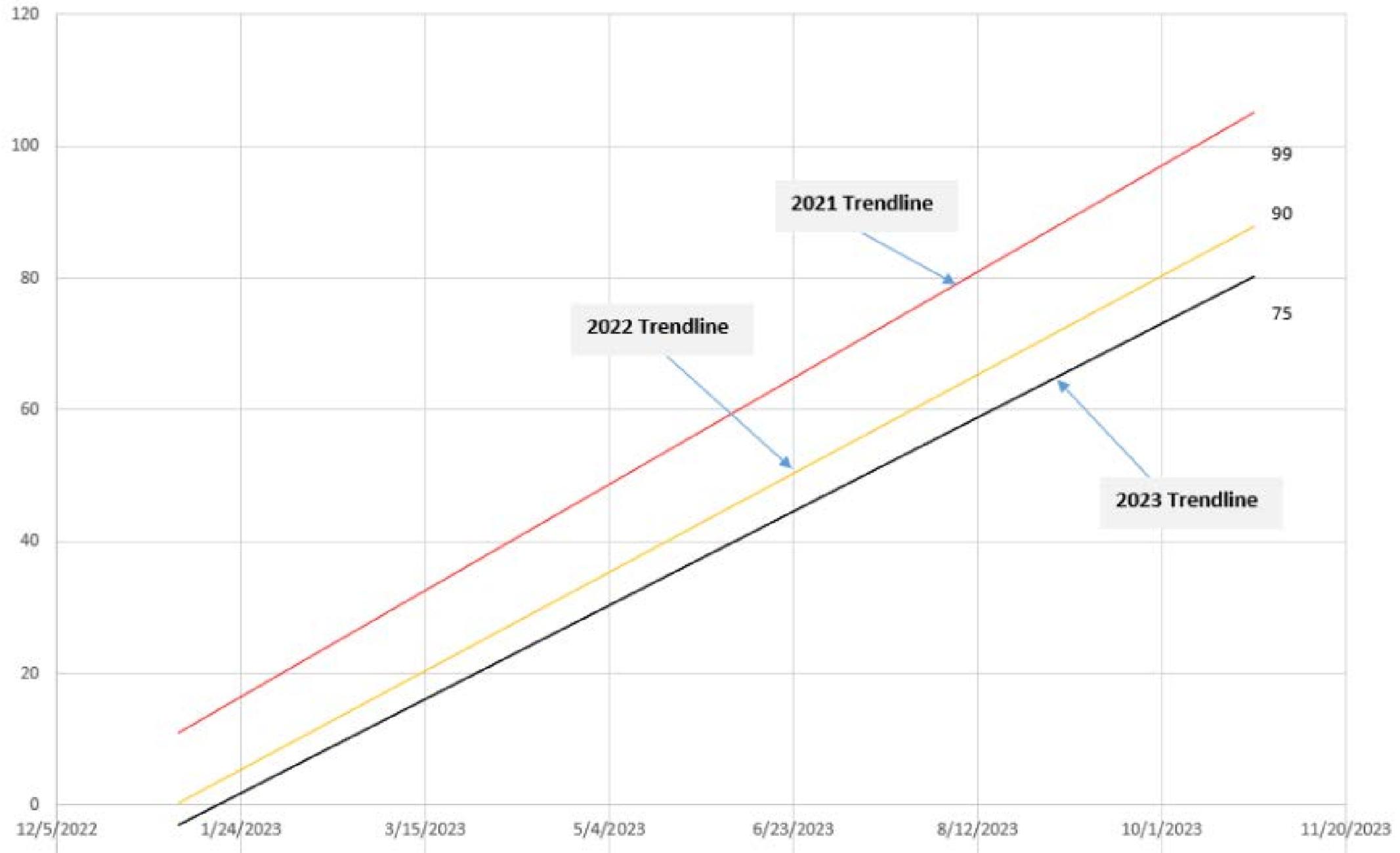


Pantograph Technology

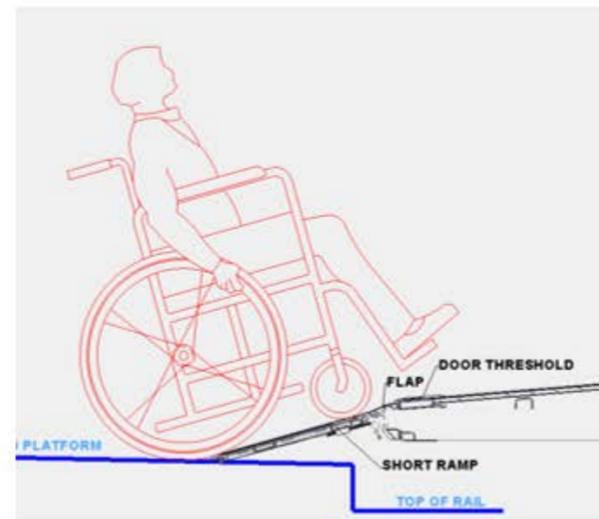
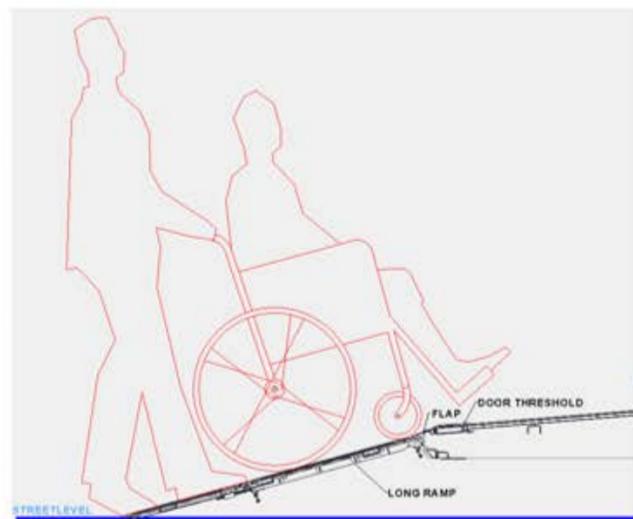
- ✓ Modern industry standard
- ✗ Not pole compatible
- ✓ Draws higher current
- ✓ Permits maximum trolley wire stagger
- ✓ Carbon life (6 – 12 months)
- ✓ Wire life: 10 years (Panto)
- ✓ Minimal overhead hardware
- ✓ Eliminates de-wirements
- ✓ Low risk of pantograph drop downs

Evolution to Pantographs

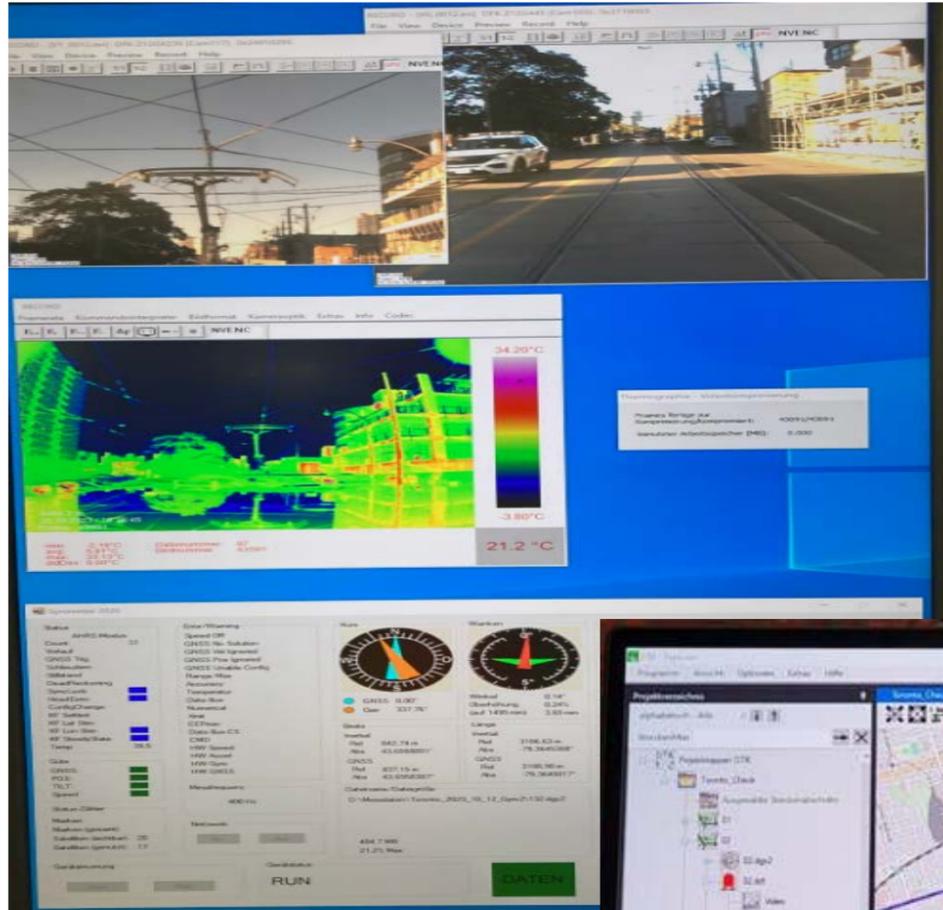
ADDs 2021 vs 2022 vs 2023



Continuous Improvements



Continuous Improvements



Trolley Wire Hotspots



Revenue Vehicle Outfitted for Inspections



Trolley Wire Wear Inspection



Industry Participation



Calgary, Repurposed Automated Inspection Vehicle



Calgary, Monitoring OCS

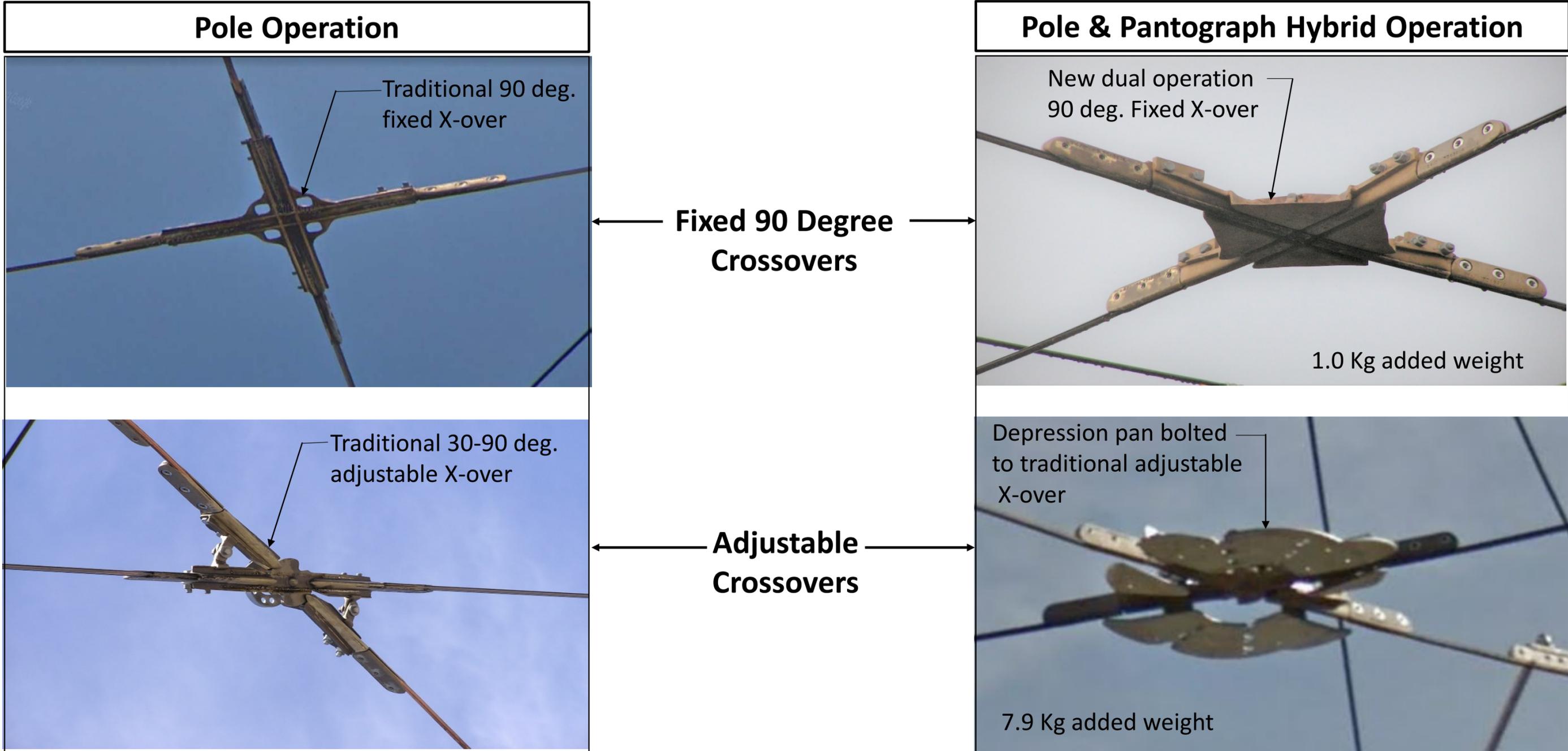


Appendix 1



POLE TO PANTOGRAPH CONVERSION

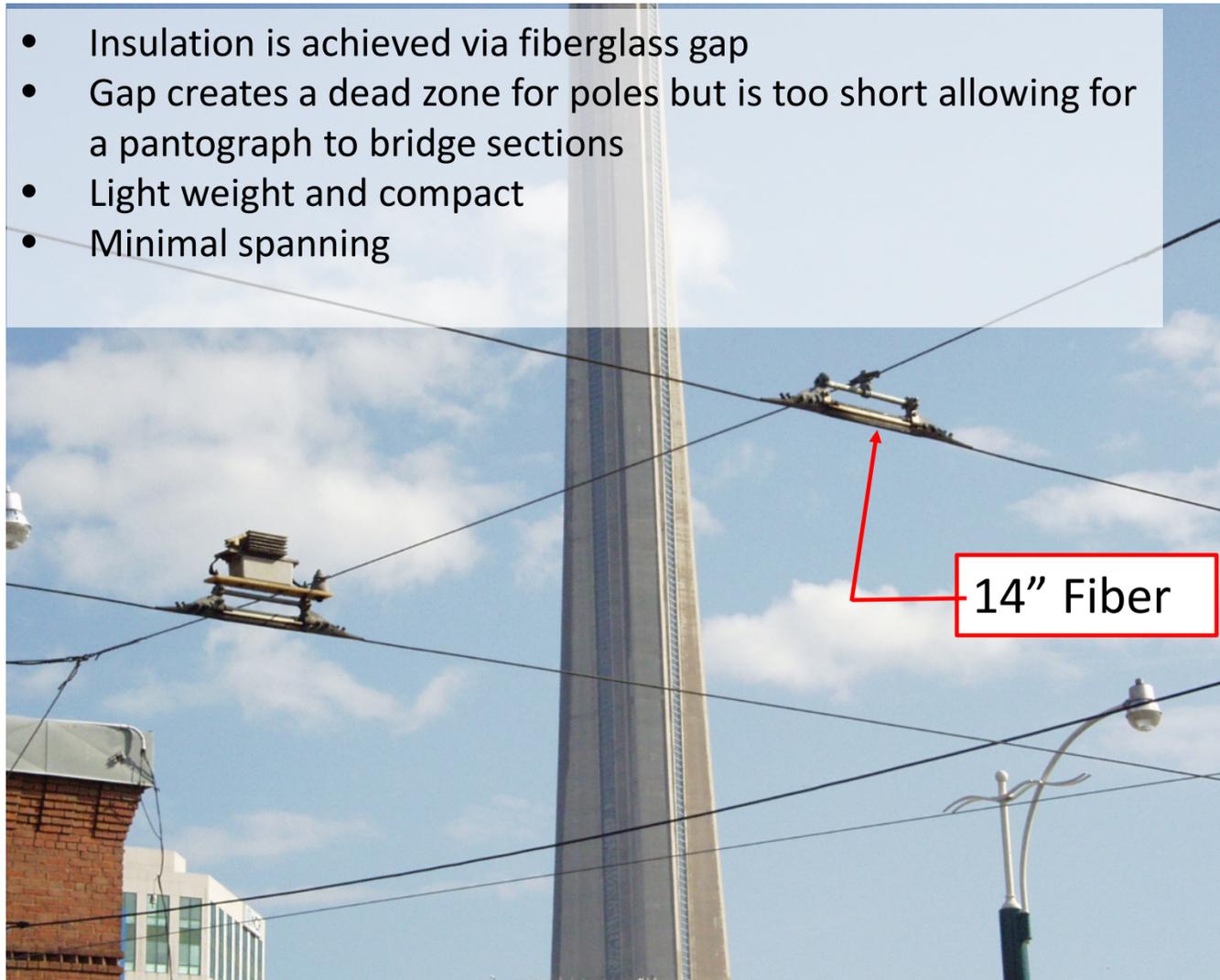
CROSSOVERS



POLE TO PANTOGRAPH CONVERSION

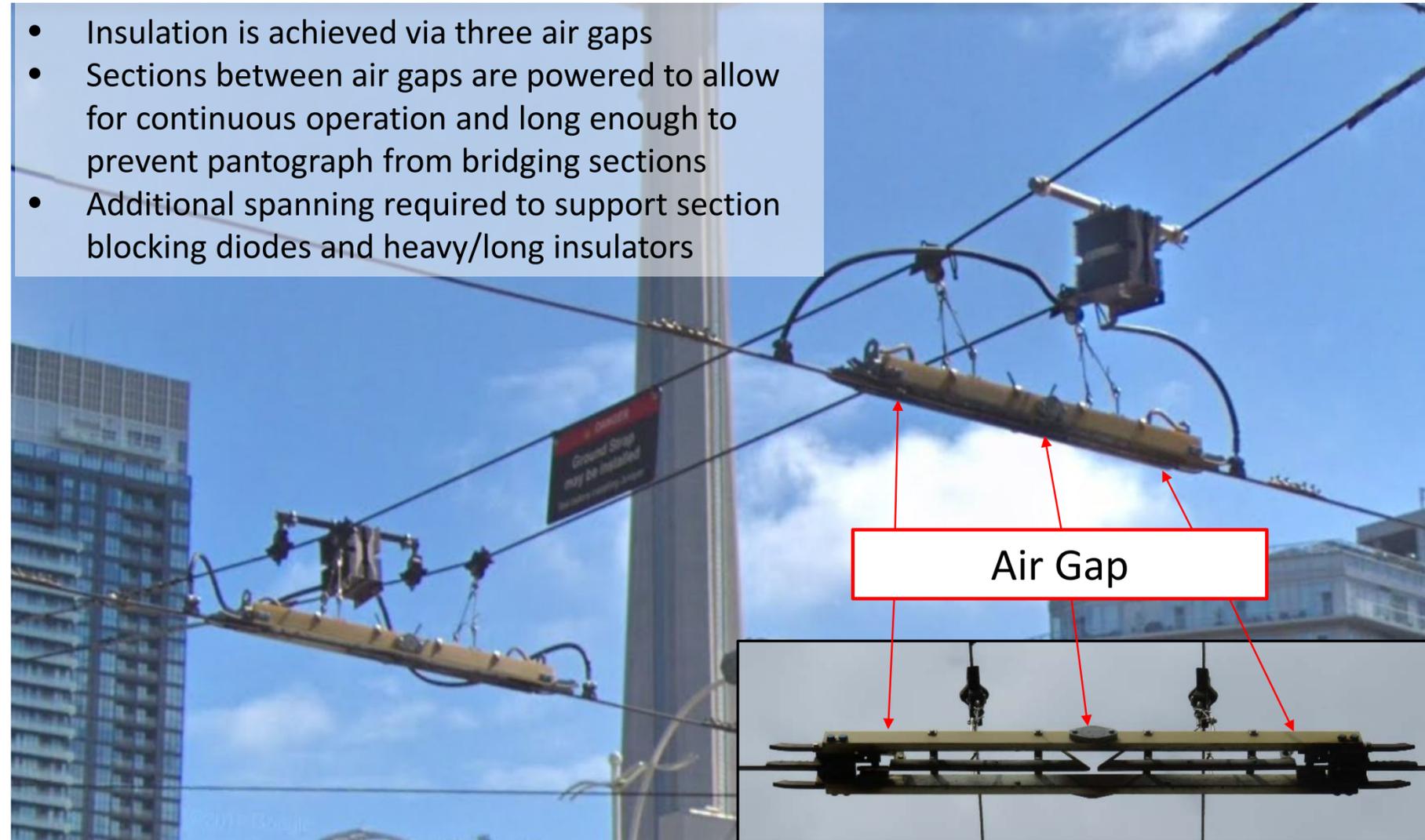
Section Insulators

- Insulation is achieved via fiberglass gap
- Gap creates a dead zone for poles but is too short allowing for a pantograph to bridge sections
- Light weight and compact
- Minimal spanning



Pole Only Operation

- Insulation is achieved via three air gaps
- Sections between air gaps are powered to allow for continuous operation and long enough to prevent pantograph from bridging sections
- Additional spanning required to support section blocking diodes and heavy/long insulators



Pole & Pantograph Operation

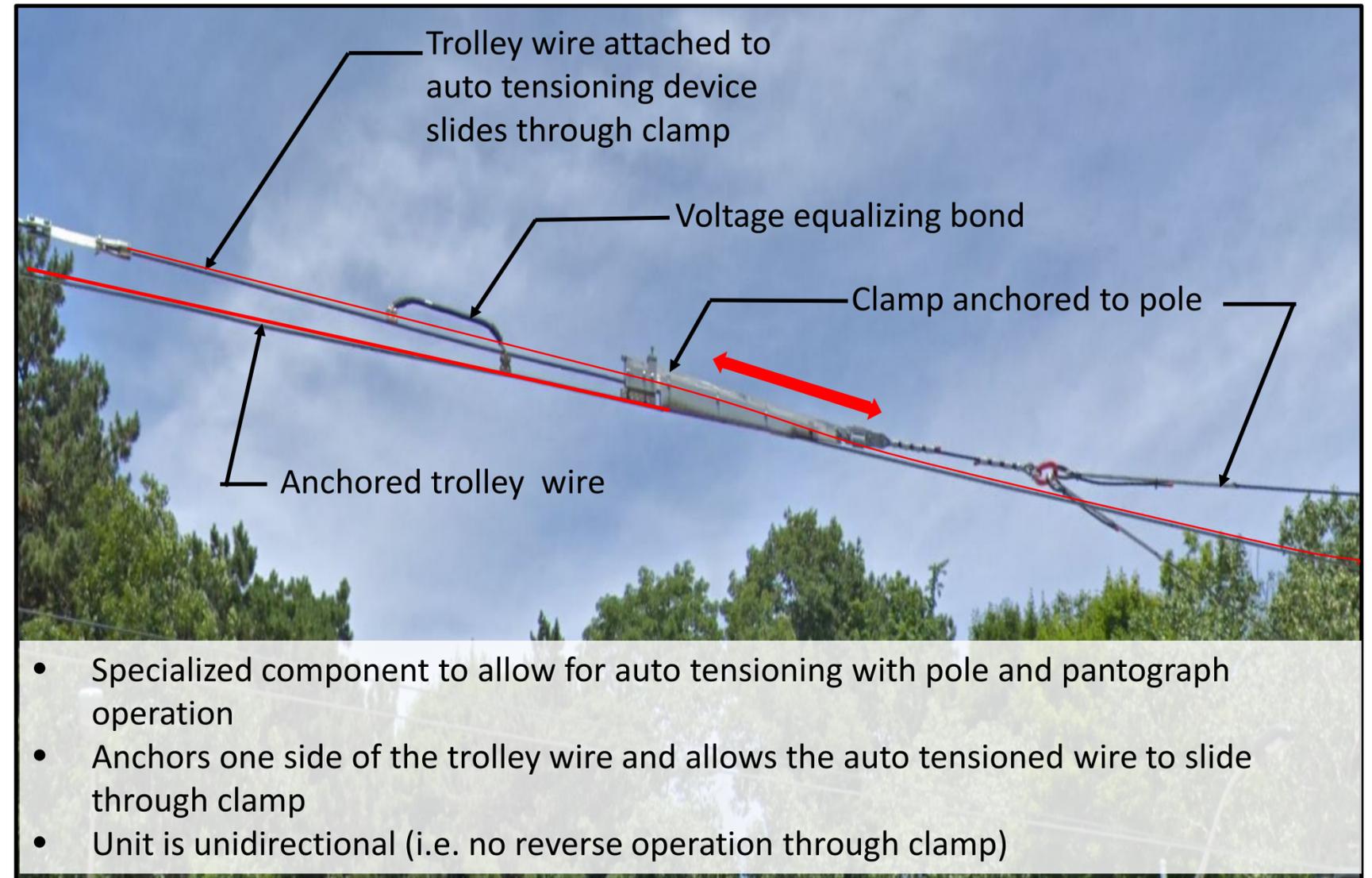
POLE TO PANTOGRAPH CONVERSION

Hybrid Auto Tensioning



- Compact design allows for installation on shared poles
- Tensioning device location is out of reach of the public
- 500m tension length with 2000 lbs. of constant tension from -40°C to +40°C

Cam/Spiral – Constant Tensioning Device



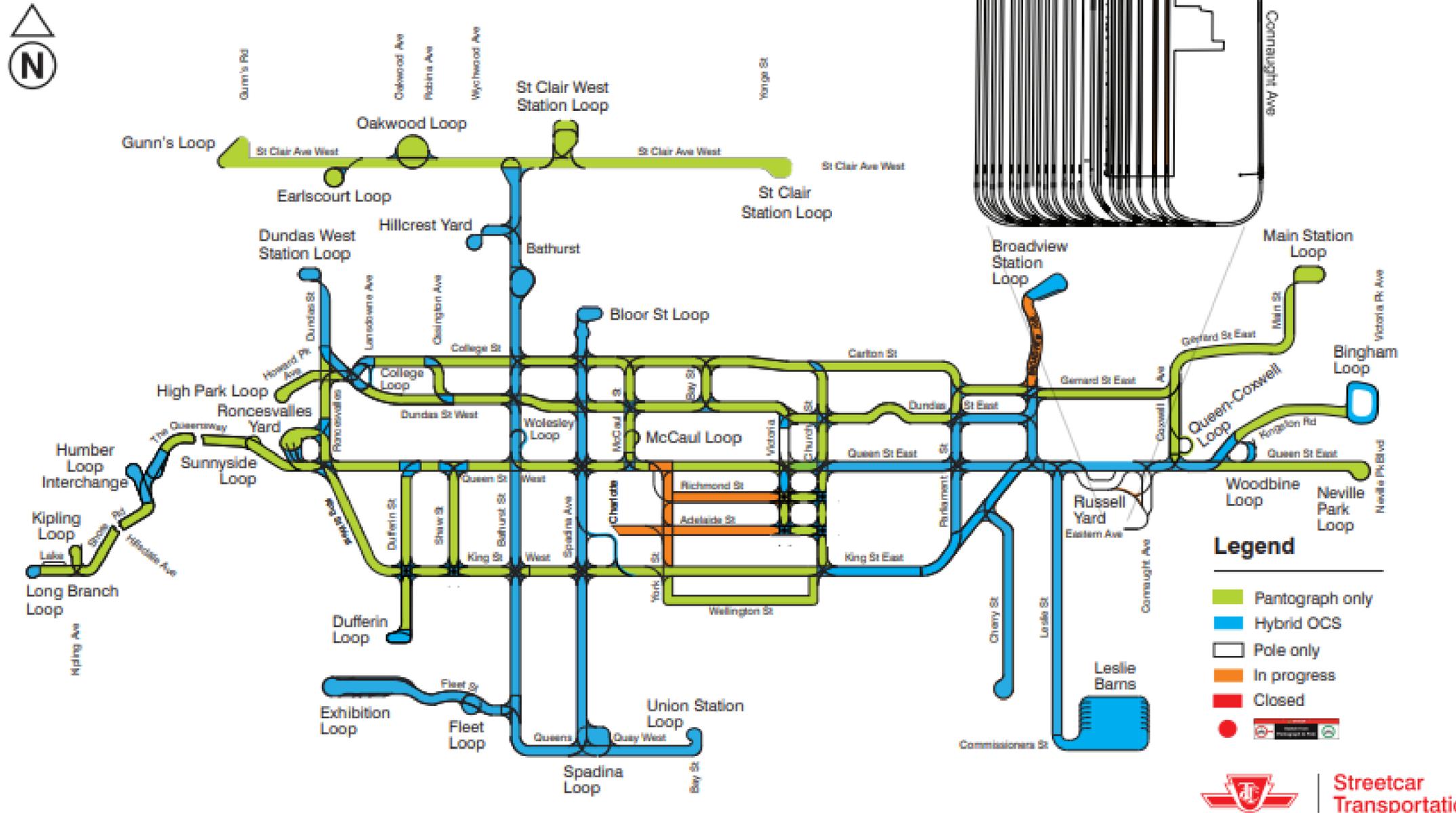
- Specialized component to allow for auto tensioning with pole and pantograph operation
- Anchors one side of the trolley wire and allows the auto tensioned wire to slide through clamp
- Unit is unidirectional (i.e. no reverse operation through clamp)

Pole & Pantograph Compatible
Overlap Transition Clamp



Panto Conversion Schedule

Streetcar network – Pantograph operation and Russell Yard map
 Updated October 28, 2023



Assessment Findings: Response and Action Plan

1

To support continuous improvement and increase streetcar service reliability by:

- a. Reassessing and strengthening existing policies and procedures in Streetcar Overhead Operations to provide more criteria and clarity on the nature and extent of the root cause analysis and investigation required for service delays;
- b. Determining the root causes for those delays that require investigation according to the policy, in order to prevent the same issues from recurring; and
- c. Developing and implementing a process in Streetcar Overhead Operations to ensure compliance with the policies and procedures regarding root cause analyses and investigations of service delays.

Work Completed/Ongoing

- Conducting investigations to determine the root cause to prevent the same issues from reoccurring on safety-critical incidents and incidents resulting in significant delays, such as Automatic Drop Down incidents

Next Steps

- Establish specific criteria and clarity for root cause analysis and investigations for service delays
- Reassess and strengthen existing policies and procedures



Assessment Findings: Response and Action Plan

1

To improve communication and information sharing across relevant streetcar and other departments, in order to support continuous improvements and reduce the number of fail-to-operate switch emergency calls. Information collection and sharing across these departments should include:

2

a. Collecting and tracking appropriate and relevant data regarding fail-to-operate switch emergency calls, including but not limited to switch IDs, number of calls, and their results; and

b. Using the data collected to perform root cause analyses and investigations with the goal of reducing the number of fail-to-operate switch emergency calls.

Work Completed/Ongoing

- Engineering Technologist is auditing delay logs to ensure data captured can be mined to determine current frequency and trends at various switch locations across the network

Next Steps

- Collection and tracking appropriate and relevant data regarding FTO switch emergency calls
- Assessing methods to collect and track data related to fail-to-operate switch emergency calls in an enterprise database
- Analyzing and sharing the current data with all relevant stakeholders



Assessment Findings: Response and Action Plan

1

To develop and use a centralized database of assets across departments (Streetcar Infrastructure, Transit Control, Streetcar Transportation) to ensure Streetcar Overhead Operations is using an accurate and complete asset database, including a centralized switch inventory, to inform their operational decision-making and optimize their resource allocation.

2

3

Work Completed/Ongoing

- Asset Management recruited to support Overhead Operations and the ITS department to conduct data collection and cleansing of the existing databases and asset inventories

Next Steps

- On-boarding vendor that will review the current database and provide recommendations to improve efficiency
- Utilize the EAM consulting support to establish asset management policies that will ultimately improve operational decision-making and optimization of resource allocation



Assessment Findings: Response and Action Plan

4

To implement policies and procedures in Streetcar Overhead Operations, including oversight and monitoring policies and procedures, to ensure the assets in the Maintenance Schedule are always accurate and complete, and that any required asset changes, additions, and/or removals are made to the Maintenance Schedule on a timely basis.

Work Completed/Ongoing

- Utilizing Asset Management Planner to audit Maintenance Schedule for accuracy and completion
- EAM consultants brought on to assist in establishing industry best practices for asset management policies that will ultimately improve operational decision-making and optimization of resource allocation

Next Steps

- Begin establishing and implementing policies and procedures within Streetcar Overhead Operations to ensure the Maintenance Schedule accurately and comprehensively represents our assets
- On-boarding vendor to review the current database and provide recommendations to improve efficiency



Assessment Findings: Response and Action Plan

4

To implement policies and procedures in Streetcar Overhead Operations to ensure all completed work orders are recorded on the Maintenance Schedule, in order to plan, manage, and schedule preventative inspections in an efficient manner that optimizes the use of time and resources.

5

Work Completed/Ongoing

- Utilizing EAM consulting support to establish asset management policies that will ultimately improve operational decision-making and optimization of resource allocation

Next Steps

- Begin establishing and implementing policies and procedures within Streetcar Overhead Operations to ensure the Maintenance Schedule accurately and comprehensively represents our assets
- On-boarding vendor that will review the current database and provide recommendations to improve efficiency



Assessment Findings: Response and Action Plan

4

To review, update, and approve all maintenance and inspection policies, procedures, and manuals in Streetcar Overhead Operations to ensure they are accurate, complete, and relevant, and provide training to staff on them.

5

6

Work Completed/Ongoing

- In 2022, consulting support from Gannet Fleming was utilized to produce a manual that will assist maintenance personnel with the maintenance and inspection of Overhead Contact System (OCS)
- Manual currently under review by the workforce for acceptance

Next Steps

- Work with Overhead Engineering to conduct a review of the existing maintenance, inspection manuals, policies, and procedures to ensure that they are aligned with industry best practices
- Overhead Operations will update the relevant training accordingly



Assessment Findings: Response and Action Plan

7

To:

- a. Review and update the annual preventative inspection targets in Streetcar Overhead Operations on both an annual and as-needed basis; and
- b. Establish policies and procedures to provide clear guidance in Streetcar Overhead Operations on which source data and information is needed for the reassessment.

Work Completed/Ongoing

- Regular reviews of annual preventative inspection goals are being facilitated

Next Steps

- Update of targets to be conducted by the Engineering Technologist and sections
- Create policies and procedures that offer precise direction on the required source data and information for the re-evaluation with the advisement of the enterprise asset management consultants



Assessment Findings: Response and Action Plan

7

To establish and implement standard time expectations for common preventative inspections in Streetcar Overhead Operations and incorporate them into the employee performance evaluation.

8

Work Completed/Ongoing

- Assessing existing activities within the section that can serve as benchmarks to establish and enforce standardized time expectations for routine preventative inspections

Next Steps

- Update of targets will be conducted by the Engineering Technologist and sections
- Create policies and procedures that offer precise direction on the required source data and information for the re-evaluation with the advisement of the EAM consultants
- Revision of employee performance appraisal template incorporating new benchmarks



Assessment Findings: Response and Action Plan

7

To install and enable GPS on Streetcar Overhead Operations' non-revenue vehicles to effectively monitor and assess performance.

8

9

Work Completed/Ongoing

- In collaboration with Vehicles Group, an agreement to purchase and install GPS equipment for non-revenue vehicles has been finalized which will allow improved monitoring and better evaluation of employee performance

Next Steps

- Issue agreement for Geotabs installation to enable GPS tracking on non-revenue vehicles



Assessment Findings: Response and Action Plan

10

To:

- a. Ensure policies, procedures and manuals in Streetcar Overhead Operations provide clear directions as to how preventative inspections' activity tasks, results, and observations should be performed and documented; and
- b. Develop and implement an oversight process in Streetcar Overhead Operations (e.g., quality assurance audit program, spot checks, increased supervision) to ensure the accuracy, completeness, and reliability of the documented work orders and consistency of the work performed.

Work Completed/Ongoing

- Auditing existing documentation to both documented policies, procedures, manuals as well as the crew's documented work orders, by taking a risk based approach to prioritizing those in most need of improvement

Next Steps

- Audit of the existing documentation to both documented policies, procedures, manuals as well as the crew's documented work orders, focusing on improving those in the worst condition
- Utilize the EAM consulting support to establish asset management policies that will ultimately improve operational decision-making and optimization of resource allocation



Assessment Findings: Response and Action Plan

1

To develop and implement formalized processes in Streetcar Overhead Operations to:

- a. Ensure preventative inspections comply with annual inspection targets; and
- b. Ensure preventative inspections are scheduled and completed in accordance with Overhead Operations' specified time intervals.

11

1

Work Completed/Ongoing

- Created controls for ensure preventive inspections comply with annual inspection targets

Next Steps

- Upload all preventative inspection procedures into Maximo with support of ITS
- On-boarding support of a vendor that will review the current database and provide recommendations to improve efficiency
- Utilize the EAM consulting support to establish asset management policies that will ultimately improve operational decision-making and optimization of resource allocation



Assessment Findings: Response and Action Plan

1

To develop and implement policies and procedures in Streetcar Overhead Operations to:

- a. Provide clear expectations as to how crews should communicate and document preventative inspections that are only partially completed; and
- b. Track and ensure partially completed inspections are appropriately rescheduled to be fully completed.

1

Work Completed/Ongoing

- Continuous updating of the inspection form to provide greater clarity on the specific inspection areas that were not fully completed and still require attention
- Ongoing audits for proper completion of forms

Next Steps

- Provide refresher trainings
- Enable Maximo to trigger partially completed work orders with support of ITS

12



Assessment Findings: Response and Action Plan

13

To develop and implement policies and procedures for Streetcar Overhead Operations' preventative and corrective maintenance program, which includes but is not limited to providing:

- a. A set of criteria for each asset type to determine if corrective maintenance and repair work orders need to be generated, based on risks and implications;
- b. Clear timing expectations for reviewing completed preventative inspections and generating any necessary corrective maintenance work orders; and
- c. Clear criteria and timing expectations for the prioritization and completion of corrective maintenance work orders, based on risks and implications.

Work Completed/Ongoing

- Active participation in Institute of Electrical and Electronics Engineers Standards Committee meetings with industry peers
- Active participation in meetings with Network Rail Consulting, American Public Transportation Association and International Association of Public Transport to measure against industry standards and practices

Next Steps

- Set Specific criteria for each asset type
- Define clear timeframes for reviewing preventative and corrective work orders
- Set distinct criteria and timing expectations for prioritizing corrective maintenance



Assessment Findings: Response and Action Plan

1

To develop and implement in Streetcar Overhead Operations:

a. Standard Operating Procedures that outline the steps to be taken to ensure the measuring tools used by crews during inspections (e.g., calipers) are in good working order; and

b. An oversight process to monitor and ensure compliance with the Standard Operating Procedures

14

1

Work Completed/Ongoing

- Conducting review of all existing SOPs, noting any that are not available or outdated

Next Steps

- Establish a periodic review process to maintain the quality of data and both crew documentation and documented work orders



Assessment Findings: Response and Action Plan

13

To develop a comprehensive Maximo implementation plan to ensure Maximo is implemented as both an enterprise asset management system and workflow process management system for Streetcar Overhead Operations. This implementation plan should include, but not be limited to:

14

- a. Detailed implementation target dates and timelines; and
- b. Implementation of Maximo Anywhere to all crews, not just emergency crews.

15

Work Completed/Ongoing

- Workshops completed to identify functional requirements of Maximo and data gaps
- Request for proposal drafted and to be issued
- Asset Management Planner recruited to conduct data collection and cleansing of the existing databases and asset inventories

Next Steps

- On-boarding vendor that will review the current database and provide recommendations to improve efficiency
- Utilize the EAM consulting support to establish asset management policies that will ultimately improve operational decision-making and optimization of resource allocation



Assessment Findings: Response and Action Plan

16

To provide appropriate Maximo training to responsible frontline crews/technicians/staff and management in order to fully leverage existing Maximo technology for Streetcar Overhead Operations.

Work Completed/Ongoing

- End-to-end life cycle management processes for Streetcar Overhead under review
- Request for proposal of Maximo overhaul to be issued

Next Steps

- Overhead Operations will facilitate Maximo refresher training courses of current platform
- Overhead Operations will update the relevant training accordingly with updated platform



Assessment Findings: Response and Action Plan

1

To review and update Streetcar Overhead Operations' asset inventory and job plans/activity tasks in Maximo to ensure they are complete, accurate, and up-to-date, in order to support the planning and completion of repair and maintenance work.

17

1

Work Completed/Ongoing

- Asset Management Planner recruited to support Overhead Operations asset inventory register

Next Steps

- On-boarding vendor that will review the current database and provide recommendations to improve efficiency
- Utilize the EAM consulting support to establish asset management policies that will ultimately improve operational decision-making and optimization of resource allocation



Assessment Findings: Response and Action Plan

16

To develop and implement a process in Streetcar Overhead Operations using Maximo to track the real-time status of work orders to support ongoing work order management and supervision.

17

18

Work Completed/Ongoing

- Asset Management Planner recruited to support Overhead Operations asset inventory register

Next Steps

- On-boarding vendor that will review the current database and provide recommendations to improve efficiency
- Utilize the EAM consulting support to establish asset management policies that will ultimately improve operational decision-making and optimization of resource allocation



Assessment Findings: Response and Action Plan

19

To leverage Maximo to collect and track observations from Streetcar Overhead Operations' assets inspections, and information about maintenance and repairs activities, that can be used for data mining and trend analysis to support KPI reporting and inform decision-making.

Work Completed/Ongoing

- Asset Management Planner recruited to support Overhead Operations asset inventory register

Next Steps

- On-boarding vendor that will review the current database and provide recommendations to improve efficiency
- Utilize the EAM consulting support to establish asset management policies that will ultimately improve operational decision-making and optimization of resource allocation



Assessment Findings: Response and Action Plan

1

To improve the Key Performance Indicator reporting for Streetcar Overhead Operations by:

- a. Establishing clearly defined, appropriate, outcome-focused Key Performance Indicators and targets;
- b. Developing short- and long-term strategies to meet these targets;
- c. Regularly reassessing to determine whether Key Performance Indicators and targets need to be revised; and
- d. Retaining supporting data and verifying the accuracy of data used for Key Performance Indicator reporting, ongoing oversight, and management decision-making.

20

Work Completed/Ongoing

- On-going area of improvement as documentation and database become more robust

Next Steps

- Utilize the EAM consulting support to improve KPIs metrics and presentation to better align with industry meetings

