



Improvement and Automation of
Work Processes at Subway Track

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Toronto Transit Commission (TTC)

Agenda

1. An overview of TTC & Subway Track
2. Work process improvement and automation:
 - a. Newly developed process: Track condition alerts
 - b. Welding process automation
 - c. Re-inspection process
 - d. Project loop
3. Accelerated life testing
4. Benefits & Achievements

1

An Overview of TTC & Subway Track

Toronto Transit Commission (TTC)

- Toronto is the heart of the Canadian economy.
- The Toronto Transit Commission (TTC), established in 1921, is a public transport agency that operates transit bus, streetcar, paratransit and subway services.

Since 1861*



Since 1921



Since 1954



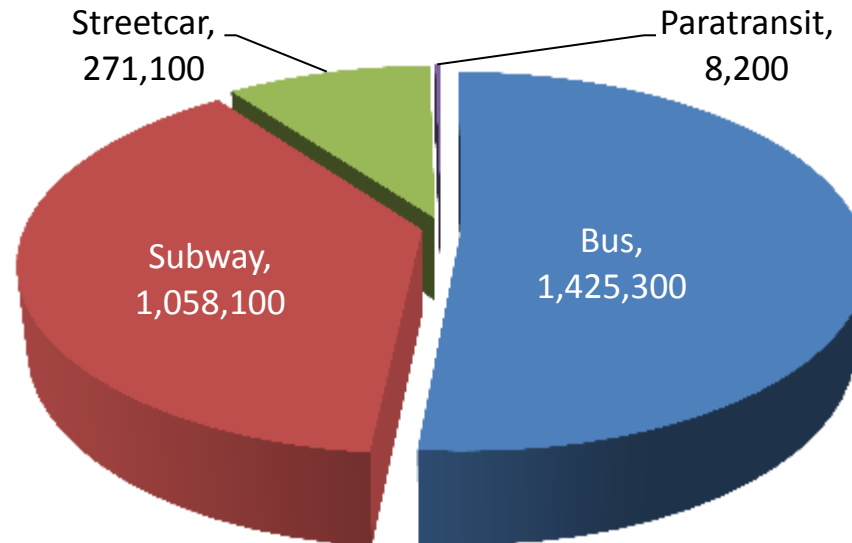
Since 1975



* The Toronto Railway Company (TRC) operated streetcars in Toronto until 1921.

Ridership

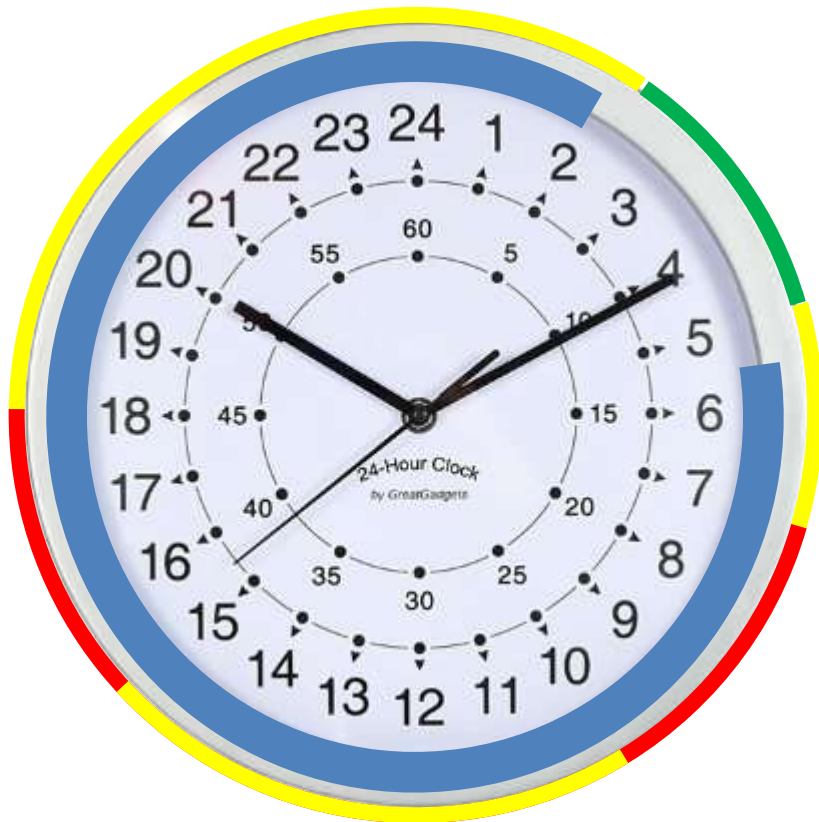
- Average daily ridership is more than 2.7 million passengers.
- The third most heavily used urban mass transit system in North America after the New York Transit Authority and Mexico City Metro.







Subway Track

- 250 employees (staff and union workers).
- 24-hour track inspection and maintenance

City of Toronto
TTC Board Members
CEO
Operations Group
Subway Infrastructure
Subway Track

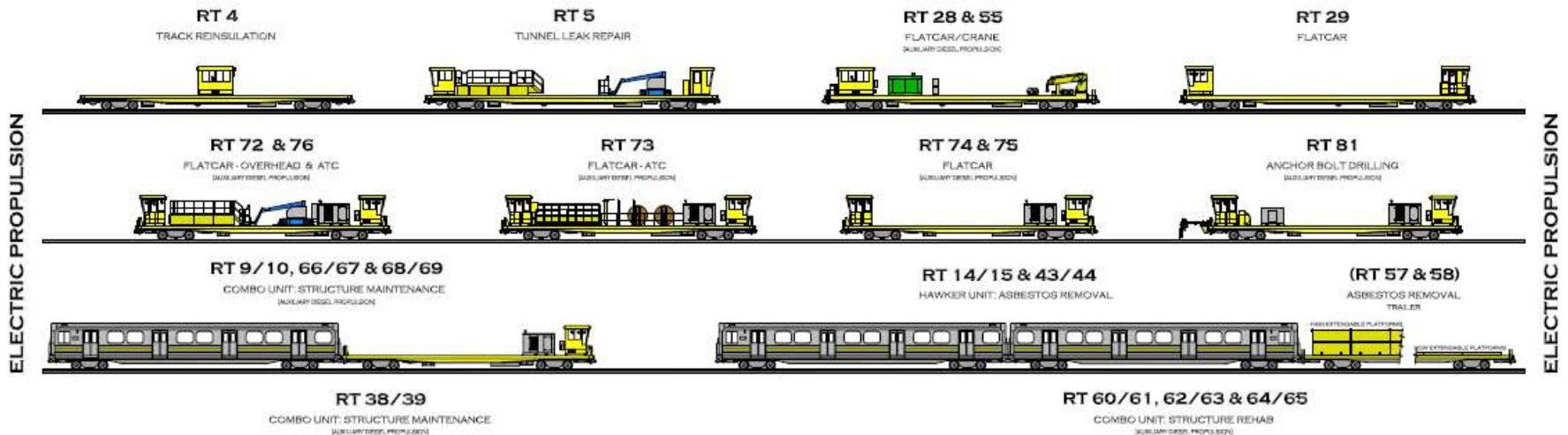


-  Service hours
-  Rush hours (emergencies only)
-  Minor work / visual inspection
-  Major work

Workcars (worktrains)

There are 20+ workcars available for track work:

- Cranes
- Tampers
- Flatcars
- Tunnel washer



Main Concerns

1. **Safety**: passengers and employees
2. **Service Reliability**: Track down, restricted speed zone, fire at track, work area during service
3. **Cost**

Responsibility

Subway Track is responsible to safely inspect and maintain the following components at track level:

1. Running Rail
2. Power Rail and coverboards
3. Trackbed
4. Fasteners
5. Rail Joints & welds
6. Switches
7. X-over and turnout
8. Yards

Subway Track Crew

Track inspection crew:

1. Track patrollers
2. Non-destructive test (NDT) crew
3. Roadmasters
4. Reliability & Quality assurance (QA)

Track maintenance crew:

1. Rail jobs (night crew)
2. X-over maintenance
3. Cleaning crew
4. Yards
5. Capital projects

Challenges

- **Old infrastructure:** structure, signaling system
- **Limited Resources:** employees, equipment
- **Harsh Weather:** high and low temperature, raining, snow, humidity
- **Track level access**

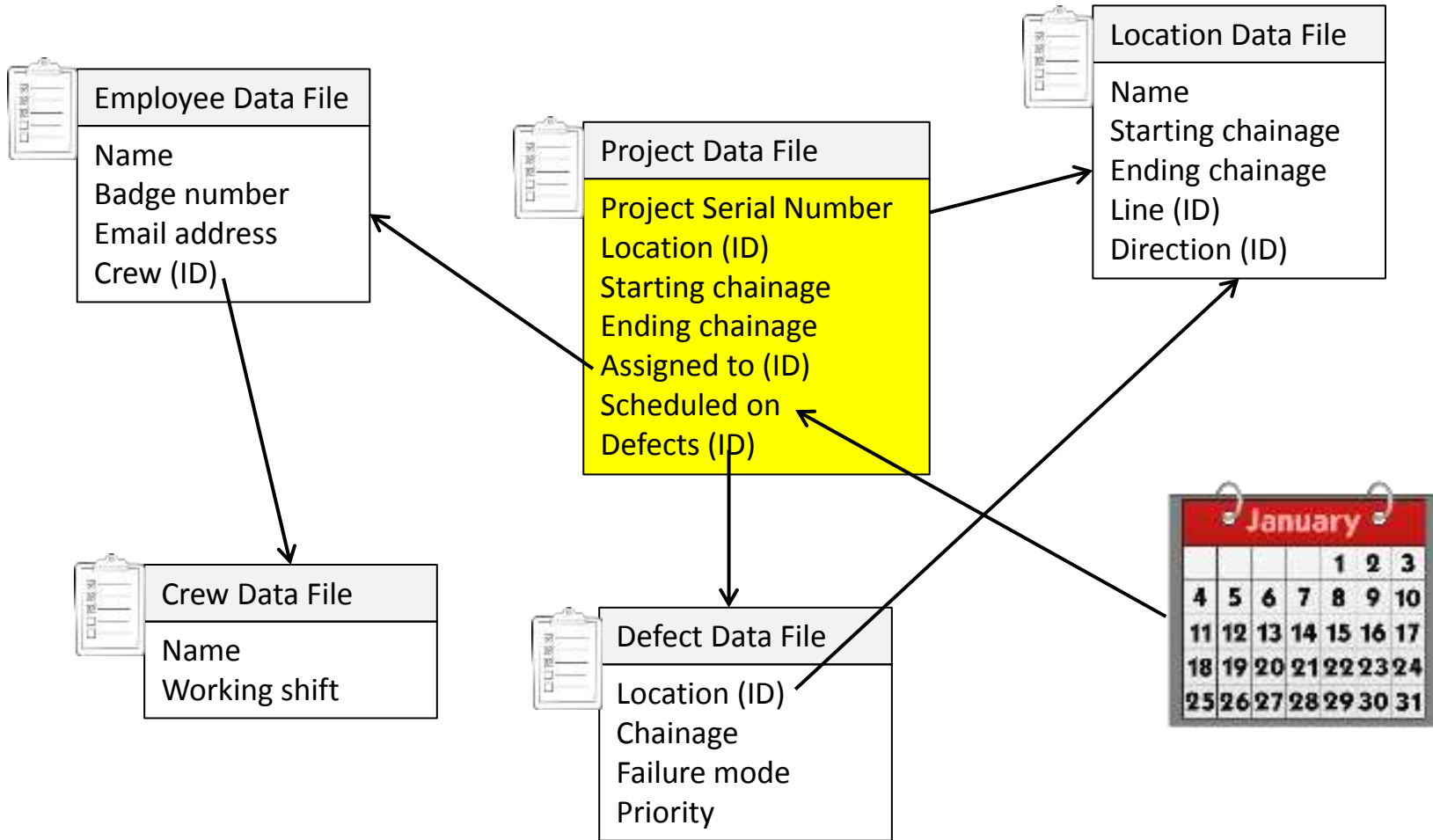
2

Work Process Improvement & Automation

Work Process (Improvement & Automation)


- Work Process: Who does what, how, where and when, assigning works
- Design of Database: Data file format and connection, search engines, etc.
- Computer Codes: Installation, Access, Security, User friendly, Embedding history
- Effective Email Communication
- Calendar
- Update Reports
- Training

Design of Database
























Effective Email Communication

- Consent
- Recipient(s)
- Body
- Attachment(s)
- Required action(s)
- Updated List
- More Info

 Burzese, Dean

Sent: Fri 12/08/2016 1:33 PM

To:  Armenis, Peter;  Badenoch, Lyndon;  Browne, Neil;  Brownlee, Don;  Budaci, Steve;  Clark, Geoff;  Dominelli, Vito;  Elliott, Carlous;  Fitzgerald, John;  Ghaus, Mo;  Giro;  Johnstone, Glen;  Jorge, Arthur;  Konstantinidis, Tom;  Mohammadian Masooly, Seyed;  Rezaie, Ali;  Rinaldi, Frank;  Rose, Davian;  Simpson, Ryan;  Smith, Kirk;  Snow, R

A new track condition alert has been entered.

Location: **Dundas West to Keele WB** (from 302+94 to 302+94)
Alert ID: **285**
Report: Aug 12, 2016 by D . Burzese

List of concerns:

1. Chipped Frog (Frog # 99): Exists

Photos added to the alert: 1.[Photo](#) 2.[Photo](#) 3.[Photo](#)

Alert Comments: Point of F #99 chipped needs attn asap..

List of 1 open defects (out of 1)

1. MOWIS #167484: Dundas West to Keele WB 302+94 - 302+94 SR
Failure mode: STW / Frog Point / Cracked/Broken
Comments: needs attention as soon as possible

Number of active track condition alerts: **22**

1. **Dundas West to Keele WB** (ID: 285) from 302+94 to 302+94
Report: August 12, 2016 by D . Burzese
Concern(s): 1.Chipped Frog (Frog # 99): Exists
Comments: Point of F #99 chipped needs attn asap..

Calendars

Calendars are great tools for scheduling and alerting.

The screenshot shows the 'Way Project Calendar' application window. The title bar reads 'Way Project Calendar'. The main interface includes a header with the title 'Way Project Calendar', navigation buttons for 'Oct' and '2016', and filter options for 'Way Project', 'Location', and 'Work'. The calendar grid displays days from Sunday to Saturday, with dates 01 through 31. Tasks are represented by colored boxes with radio buttons, indicating their status: Completed (dark green), Ongoing (light green), Cancelled (orange), Scheduled (yellow), and N/A (grey). A legend at the bottom right explains these colors. An 'Edit Job' button is located at the bottom of the calendar grid.

Sun	Mon	Tue	Wed	Thu	Fri	Sat
						01
02 <input type="radio"/> Kennedy Station (SRT) SB	03	04	05 <input type="radio"/> St. George to Museum SB	06	07	08 <input type="radio"/> Museum to St. George
09 <input type="radio"/> St. George to Museum SB <input type="radio"/> Lawrence to Eglinton SB <input type="radio"/> St. George to Spadina NB	10 <input type="radio"/> St. George to Museum SB	11 <input type="radio"/> St. George to Museum SB <input type="radio"/> Kennedy to Warden WB	12 <input type="radio"/> York Mills Station SB <input type="radio"/> Kennedy to Warden WB	13 <input type="radio"/> York Mills Station SB <input type="radio"/> Kennedy to Warden WB	14 <input type="radio"/> Kennedy to Warden WB	15
16 <input type="radio"/> Union to King NB <input type="radio"/> King to Union SB	17 <input type="radio"/> Union to King NB	18 <input type="radio"/> Rosedale to Bloor SB	19 <input type="radio"/> Rosedale to Bloor SB	20	21	22 <input type="radio"/> Finch Station SB
23	24	25	26	27	28	29
30	31	Edit Job				

Legend: Completed Ongoing Cancelled Scheduled N/A

Reports

Reports must:

- 1) be easy to understand
- 2) be easy to get more details
- 3) have a fast search engine
- 4) show necessary information

Search Way Projects

Drawing: Open Completed

Direction: YUS BD

Keyword:

Progress: Search Way Projects

Way Project Details

[Schedule Jobs](#) | [Drawing](#) | [Prepared](#) | [Completed](#) | [Photos](#)

Complete 2016-YUS-127

Scope	Addressed?
Defective Fasteners	Yes
Plates	Yes
Power Rail Repairs	Yes
Replace Guard Rail	Yes


Required cleaning? Yes [Edit](#) No

Much damage to PH plates, repair / replace plates / replace rubbers / insulators as

Way Project Calendar

Enter Welds

Developed Processes & Applications

1. High Priority Defects (Apr 2013)
2. Way Projects (Jan 2014)
3. Restricted Speed Zone or RSZ (Mar 2014)
4. **Track Condition Alerts** (Oct 2014) 
5. Out of Service Switches (Jan 2015)
6. Maintenance Planning and Scheduling or MAPS (Aug 2015)
7. Plan B (Jan 2016)
8. Weld Automation System (Jun 2016)
9. Trouble Calls (under development)
10. Switch Inspection (under development)

Restricted Speed Zone (RSZ)

Non-Standard Track:

Broken/Missing Fasteners

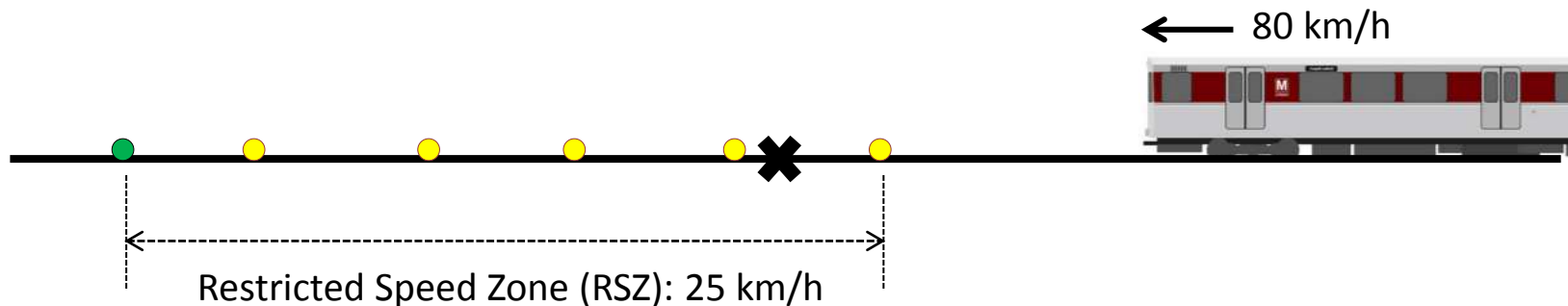
Defected rail (visual and internal cracks)

Joint issues (welds, joint bars)

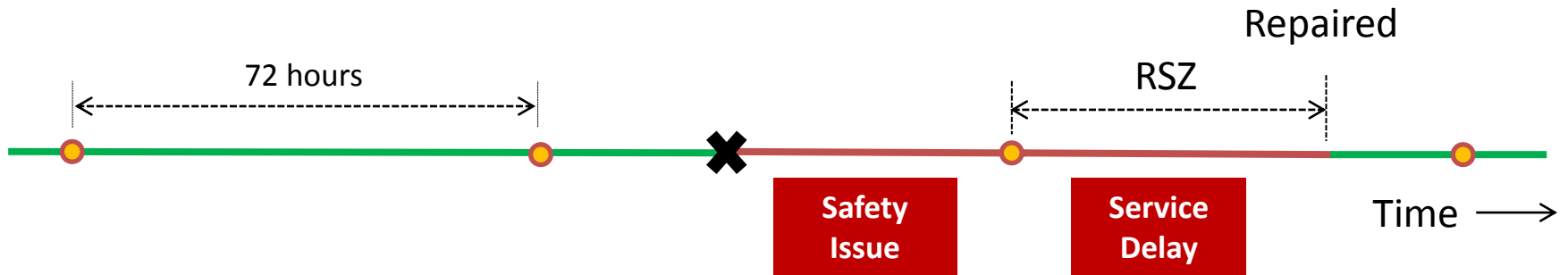
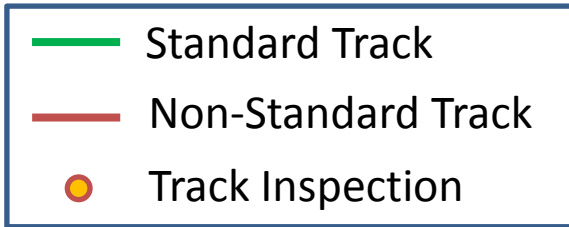
Geometry & Track Deflections

Track Rehabilitation *



More ...

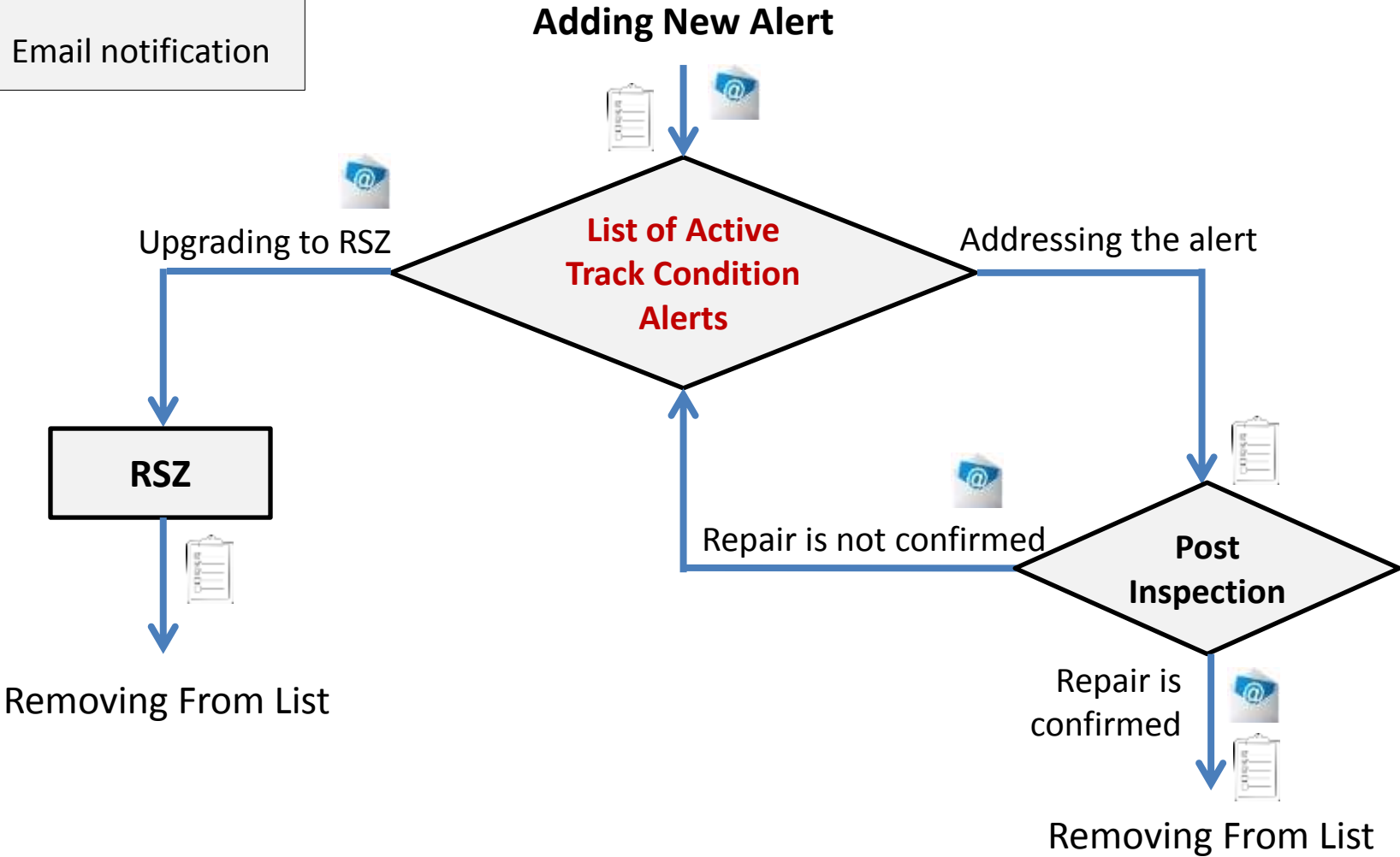


RSZ vs. Track Condition Alert



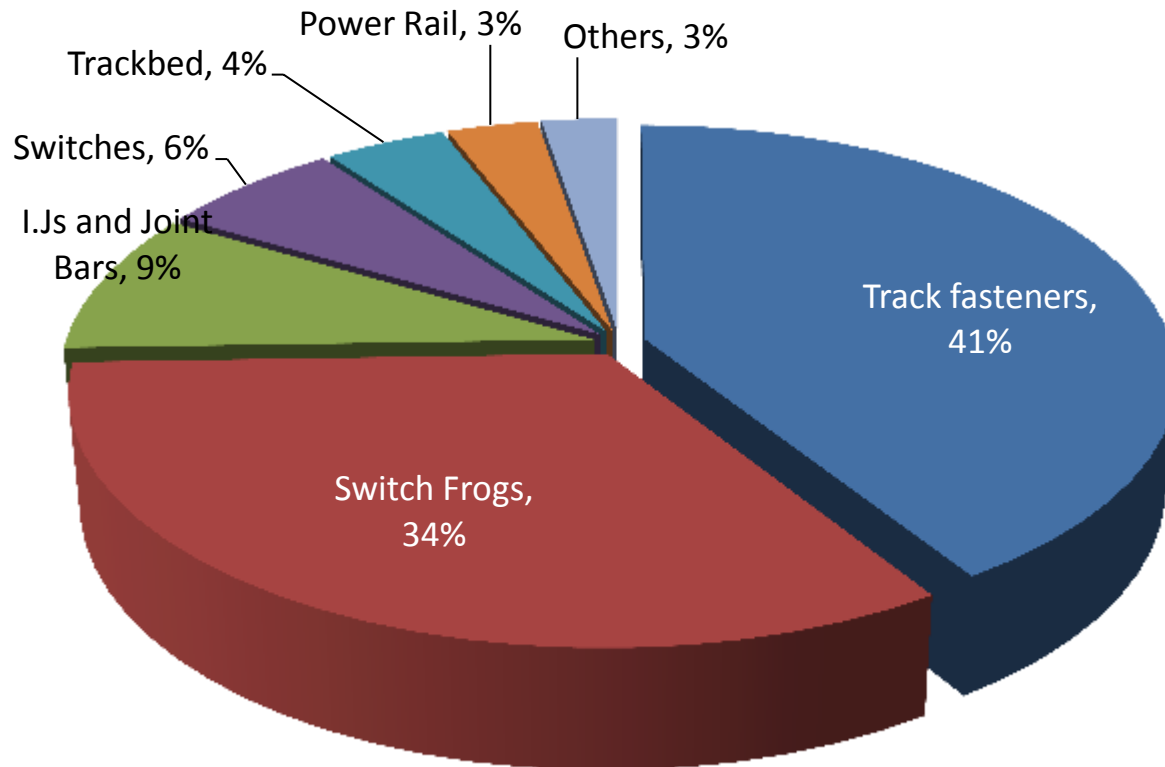
Track Condition Alerts (Process)

 Data file
 Email notification



Track Condition Alerts (Statistics)

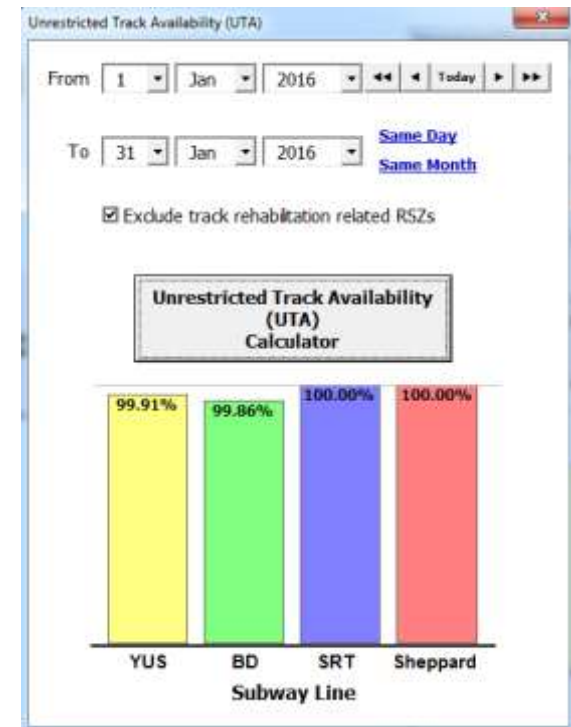
According to statistics, more than 90% of track condition alerts are fixed before upgrading to RSZ.



Unrestricted Track Availability (Definition)

Unrestricted Track Availability (**UTA**) of a subway line is the ratio of unrestricted foot.hour to total foot.hour.

$$\text{UTA} = \frac{\text{Unrestricted foot.hour}}{\text{Total foot.hour}} \times 100\%$$



Unrestricted Track Availability (Calculations)

Example: UTA of BD line in January 2016:

- Length of BD line (both directions)=175,974 feet
- Total number of hours in January=(31 days).(24 hours)=744 hours

Total feet.hours = (175,974).(744)=**130,924,656** feet.hours

There were 2 RSZs in BD line in January 2016:

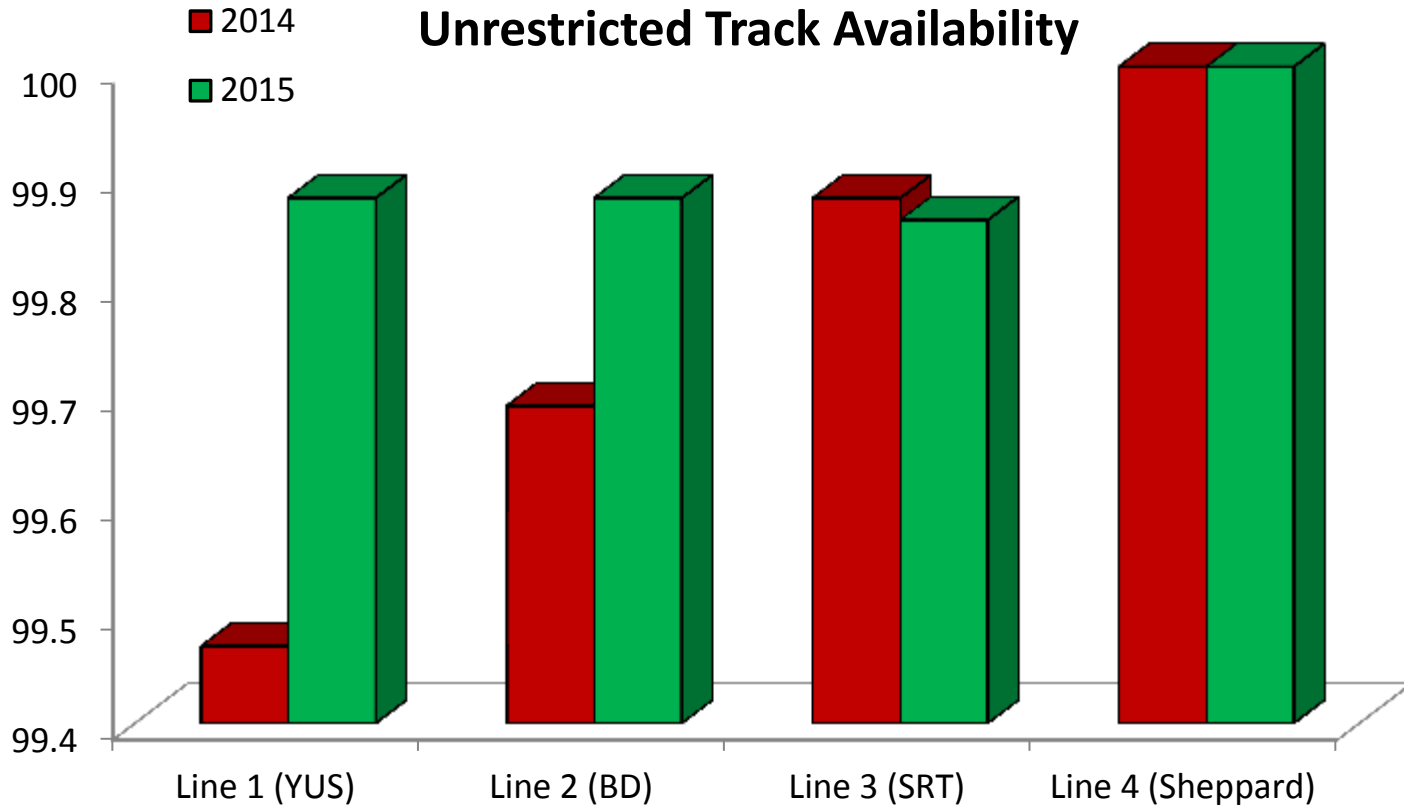
1. Coxwell to Woodbine EB: 500 feet for 12 hours
2. Donlands to Greenwood EB: 600 feet for 299 hours

Restricted feet.hours = (500).(12)+(600).(299)=**185,400** feet.hours

Unrestricted feet.hours = 130,924,656 - 185,400 =**130,739,256** feet.hours

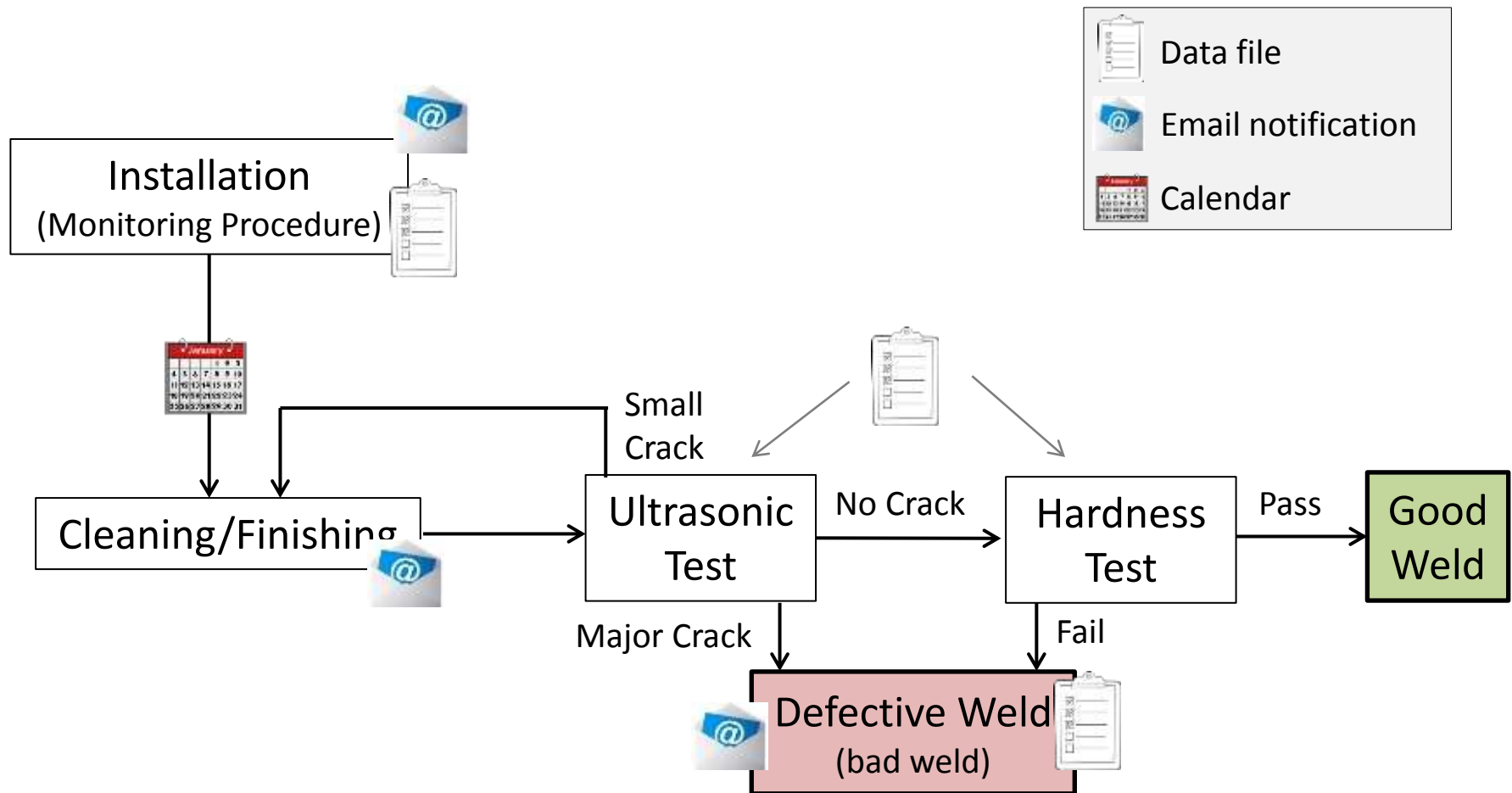
UTA = 130,739,256 / 130,924,656 * 100% = **99.86%**

Improving Track Availability

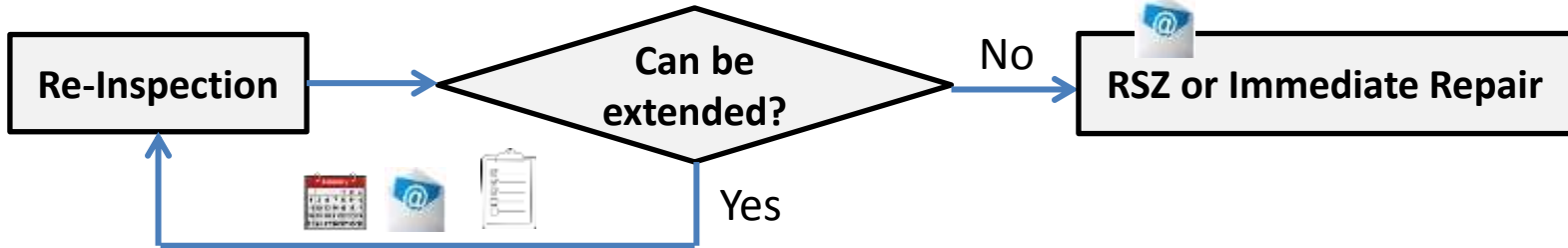


Thermite welds Process

Thermite welds are used to join the end of rails together.

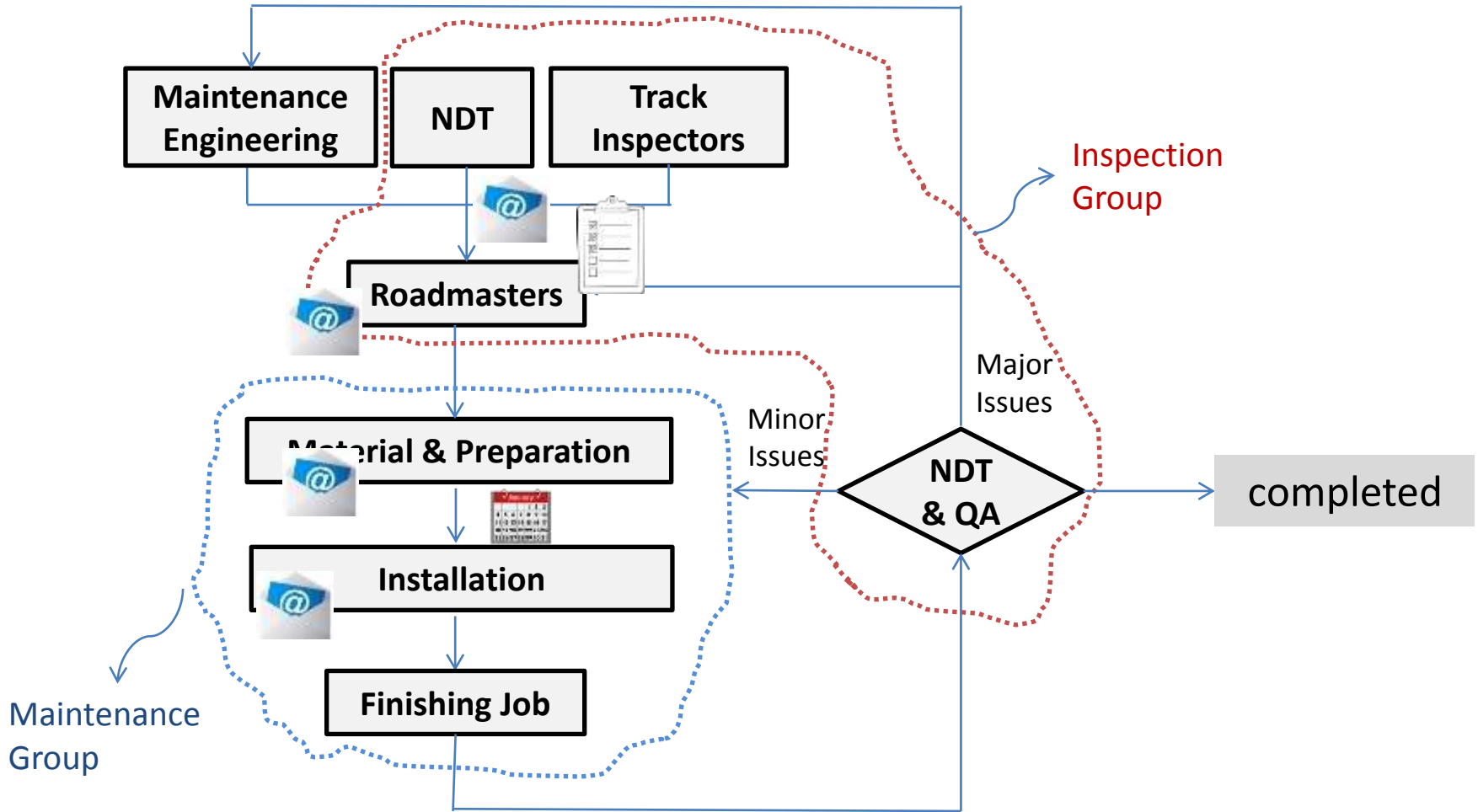


Re-Inspection Process



NDT Calendar						
NDT Calendar		◀	Oct	2016	▶	
Sun	Mon	Tue	Wed	Thu	Fri	Sat
						01
02	03	04	05	06	07	08
				<input type="radio"/> NDT-2016-157 <input type="radio"/> NDT-2016-156 <input type="radio"/> 9 more HPDs		
09	10	11	12	13	14	15
<input type="radio"/> NDT-2016-180	<input type="radio"/> NDT-2016-90 <input type="radio"/> NDT-2016-89 <input type="radio"/> 9 more HPDs	<input type="radio"/> NDT-2016-166 <input type="radio"/> NDT-2016-165		<input type="radio"/> NDT-2016-209 <input type="radio"/> NDT-2016-231 <input type="radio"/> 9 more HPDs	<input type="radio"/> NDT-2016-133 <input type="radio"/> NDT-2016-80 <input type="radio"/> 12 more HPDs	
16	17	18	19	20	21	22
<input type="radio"/> NDT-2016-168 <input type="radio"/> NDT-2016-183 <input type="radio"/> 5 more HPDs	<input type="radio"/> NDT-2016-142 <input type="radio"/> NDT-2016-141 <input type="radio"/> 9 more HPDs	<input type="radio"/> NDT-2016-244 <input type="radio"/> NDT-2016-176	<input type="radio"/> NDT-2016-246 <input type="radio"/> NDT-2016-245	<input type="radio"/> NDT-2016-117 <input type="radio"/> NDT-2016-116 <input type="radio"/> 21 more HPDs		
23	24	25	26	27	28	29
	<input type="radio"/> NDT-2016-225 <input type="radio"/> NDT-2016-248 <input type="radio"/> 9 more HPDs	<input type="radio"/> NDT-2016-205 <input type="radio"/> NDT-2016-204 <input type="radio"/> 9 more HPDs	<input type="radio"/> NDT-2016-208 <input type="radio"/> NDT-2016-207 <input type="radio"/> 2 more HPDs	<input type="radio"/> NDT-2016-50 <input type="radio"/> NDT-2016-184 <input type="radio"/> 5 more HPDs	<input type="radio"/> NDT-2016-227	<input type="radio"/> NDT-2016-103 <input type="radio"/> NDT-2016-124
30	31	See Details				
	<input type="radio"/> NDT-2016-137					

Project Process



3

Accelerated Life Testing (ALT)

Accelerated Life Testing (ALT)

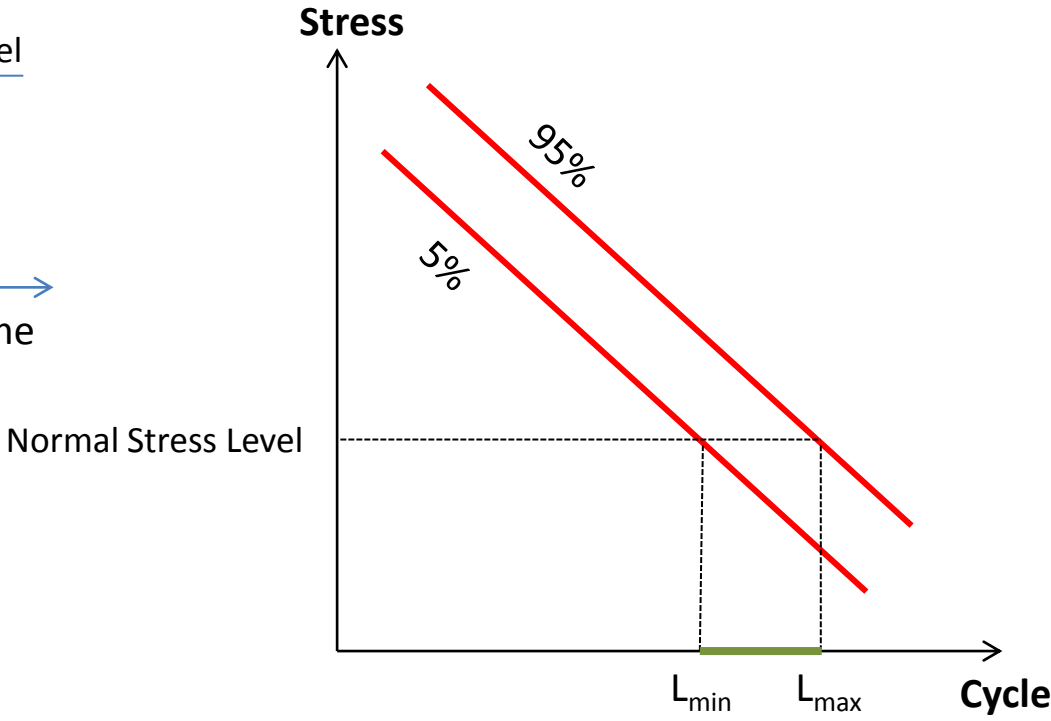
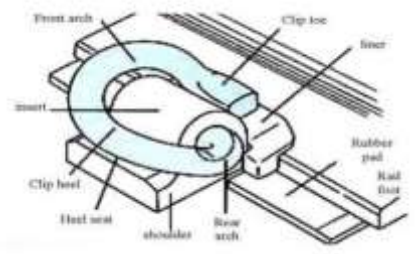
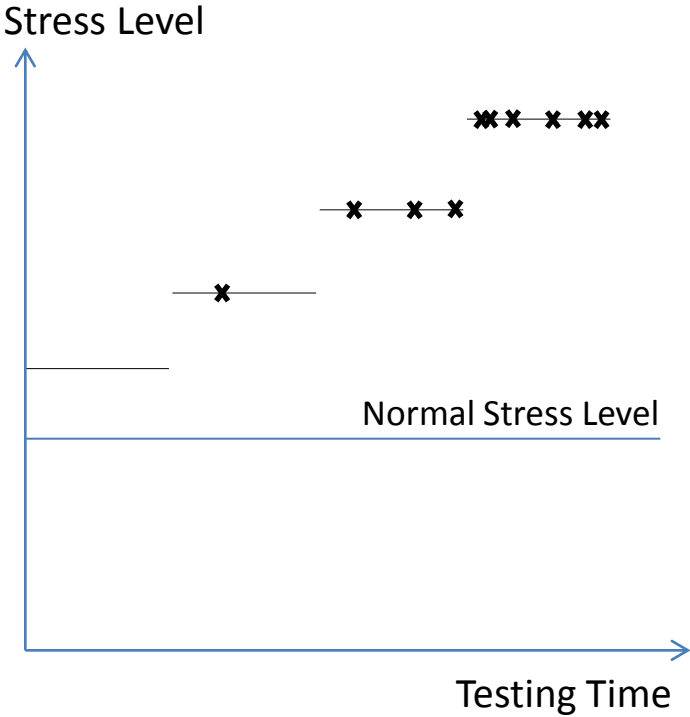
- Objectives of ALT:
 - To estimate the life, reliability, availability and warranty cost of newly developed products
 - To compare different versions of a product
 - To detect latent failure modes
 - To study the effects of parameters affecting the life
- How to relate test and service results?
- How many samples should be tested?
- What if no sample fails?



Accelerated Life Testing (ALT)

- What to accelerated: Service & Environmental stresses (temperature and humidity), frequency
- Stress level(s): Step stress test
- Accelerated catastrophic testing (ACT) or accelerated degradation testing (ADT)
- Life-cycle diagram
- Sample size

Accelerated Life Testing (ALT)



4

Benefits & Achievements

Benefits

1. Nobody is assigned specifically for this office job, BUT everybody is responsible for updating their own job.
2. Since the system is transparent and real time, employees feel a sense of responsibility to do their best and reflect their job as soon as the job is done.
3. No paperwork, no fax machine, no binder
4. Fast, easy and real time access for managers
5. Getting reports and sending emails are as easy as clicking a button.
6. A faster and more reliable access to the database
7. Reputation through the organization
8. Saving time and cost

TTC 5-Year Corporate Plan

SAFETY

- Adopt an Enterprise Risk Model
- Decentralize and replace System Safety Plan with new model
- Streamline operational safety
- Ensure environmental safety compliance

ASSETS

- Increase capacity on all routes
- Improve reliability
- Improve cleanliness
- Reduce short-turns

REPUTATION

- Communications strategy to support the Corporate Plan
- Increase use of social media to communicate directly with customers
- Undertake positive political engagement
- Launch Stakeholder Satisfaction Survey

GROWTH

- Complete Toronto-York Spadina Subway Extension
- Complete Union Station second platform & concourse improvements
- Continue Easier Access program
- Integrate and operate new LRT Lines (with Metrolinx)
- Improve station signing
- Complete Station Modernization Program

PEOPLE

- Establish a new performance management model
- Develop a new labour and employee relations strategy
- Overhaul management development and succession planning
- Improve communications with all employees with innovative tools

CUSTOMER

- Deliver customer focused business model
- Engage with customers in new ways
- Measure customer satisfaction
- Deliver an annual Customer Charter
- Introduction of new proof-of-payment fare system on all streetcar routes
- Overhaul fare policies with introduction of PRESTO

FINANCIAL SUSTAINABILITY

- Maximize efficiency and focus on core programs
- Reduce overtime expenditures
- Leverage economies of scale / buying power
- Modernize and streamline TTC systems (SAP)
- Improve claims management
- Consolidate office space

Achievements

- Improving track safety and availability
- Three consecutive years of safety excellence records
- Transparency
- Nominating for 2015 TTC Team Working Award.
- Nominating for 2015 TTC Excellence in Leadership award.
- Receiving 2016 TTC Excellence in Leadership award.

Questions?