Benefits of a New Rail Wheel Profile

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Presentation Agenda

- BART System Overview – Facts, Fleets, Rails
- Why Choose a Cylindrical Wheel Profile?
- What’s Wrong with a Cylindrical Wheel Profile?
- Opportunity for Change
- Evaluation of the Change Opportunity
- Benefits of the New BT-3 Modified Tapered Profile
- Operation began in 1972, 450 Rohr cars
- 110 miles (168 km) mainline
- 46 stations
- Commuter and urban operation
- 430,000 weekday riders
- 3 – 10 car consists
- Full ATC operation
- 80 mph (129 km/h) top speed
- 1000 VDC 3rd rail
- 5.5 ft (1676 mm) wide gauge track
- Full dedicated right-of-way
- 3 miles (4.8 km) dedicated test track
BART Overview – Existing Fleet

- 669 heavy rail cars
  - **Lead Cars – 289**
    - 59 A2 Rohr cars
    - 150 C1 Alsthom cars
    - 80 C2 Morrison Knudsen cars
  - **Mid consist cars – 380**
    - 380 B2 Rohr cars
- 2 door openings per side
- 60 & 56 seats per car
- 615 ft² (57 m²) & 655 ft² (61 m²) interior area
- 70 ft (21.3 m) x 10 ft (3.2 m)
- 63k lb (28.6 t) empty car – super light weight
- 110k lb (49.9 t) max car weight – civil limited
Unique Vehicle Characteristics

- Full lightweight Aluminum carbody structure
- **Wide gauge for improved ride and roll stiffness**
- Low roof line for compact frontal area
- **Lightweight Aluminum wheels for low rotational inertia**
- 1k Vdc operation for lower operating currents
- Full regeneration capability for maximum efficiency
- Stringent fire, smoke, toxicity requirements
- Advanced crash energy management design

775 cars, includes 310 “D” cab cars and 465 “E” mid consist cars

10 pilot cars currently in non-revenue testing, production cars in 2017

Transition phase with both fleets in operation – approximately 10 years

Each car will have 3 doors per side, advanced passenger information system, AC propulsion, robust HVAC, TCMS with advanced diagnostics, etc.

Performance specification – optimize car without constraint to existing fleet
Existing Rail System Statistics

- 110 route miles of main track
  - 235 mainline track miles
  - 28% aerial direct fixation (36" fastener spacing)
  - 27% subway direct fixation (36" fastener spacing)
  - 45% at-grade ballasted concrete ties (30" Tie spacing)
- 29 interlockings / 289 mainline turnouts
- 119RE continuous welded rail
- Custom trackwork for cylindrical profile
Why Choose a Cylindrical Wheel Profile?

- Not entirely uncommon when District began operation – SF Muni, CTA, PATH
- District has mostly tangent track
- District operates at high speed – 80 mph
- No hunting at high speed on tangent track
- Ride quality with new wheels and rails is generally good
- Typical 1,000,000 mile wheel life when originally condemned at #8 flange and use of wheel lathes to minimally reprofile worn wheels
What’s Wrong with a Cylindrical Profile?

- No inherent wheelset steering through curves
- 2-point contact prevalent as wheel and rail profiles become worn
- Systemic issues with corrugation growth in tunnels and elevated track, accentuated in curves
- Areas with corrugation are unbearably noisy – mostly direct fixation
  - Reverberation in tunnels results in a resonating howling noise inside the cars
  - Noise from elevated tracks floods surrounding neighborhoods with noise
- Severe wheel flange wear and rail head wear in sharp curves – difficult to grind
- Expense to maintain wheels and rails has become excessive
Opportunity for Change – Bombardier

- Collected data:
  - Laser measurements of the BART mainline – rail profiles new and worn
  - Measured wheel profiles new and worn
  - Ran two instrumented wheelsets and truck over entire system to understand ride quality requirements and dynamic characteristics of rail network

- Analyzed the data and confirmed poor wheel/rail interaction with pervasive 2-point contact resulting in excessive noise and severe wear

- Bombardier experts walked various track sections to confirm severity of rail conditions

- Optimized simulations to develop custom tapered wheel profile
Opportunity for Change – Bombardier

Several iterations to settle on custom BT-3 modified tapered wheel profile

Special trackwork difficult to simulate; requested BART to verify compatibility
BART tasked ENSCO through LTK to evaluate BT-3 profile compatibility with special trackwork and to confirm acceptability system wide

- *Dynamic mainline tests using the 2 IWS modified with BT-3 profile*
- *Track geometry and rail profile map of BART rail network*
- *Special trackwork compatibility analysis*
- *Computer simulation analysis to corroborate Bombardier analysis*
Evaluation of the Change Opportunity

BT-3 profile, tangent track

Cylindrical profile, tangent track
Evaluation of the Change Opportunity

Wheel L/V Events

- BT-3
- Cylindrical
ENSCO and LTK confirmed definite operational improvements:
- Safe
- Compatible with special track work
- Good stability and ride quality

Confirmed long term expectations:
- Slower corrugation growth
- Reduced wheel/rail wear
- Lower noise

Bombardier, ENSCO and LTK helped BART refine transition strategy:
- 6 years to reach steady state wear – need to monitor wheels / rails
- OK to convert fleet within 1 year
- 2-step grinding program: sharp gauge points first, then rest of rails

Conclusion: LOWER NOISE and LOWER MAINTENANCE COSTS!
THANK YOU!

Q&A?