High-Frequency Squeal Noise in Large Radius Curves

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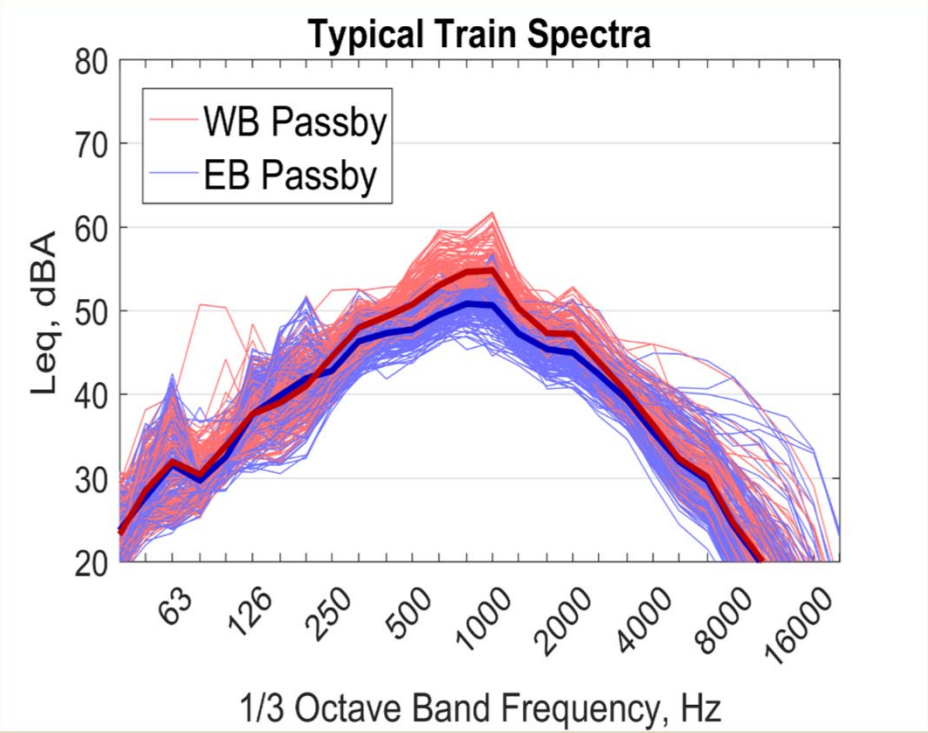
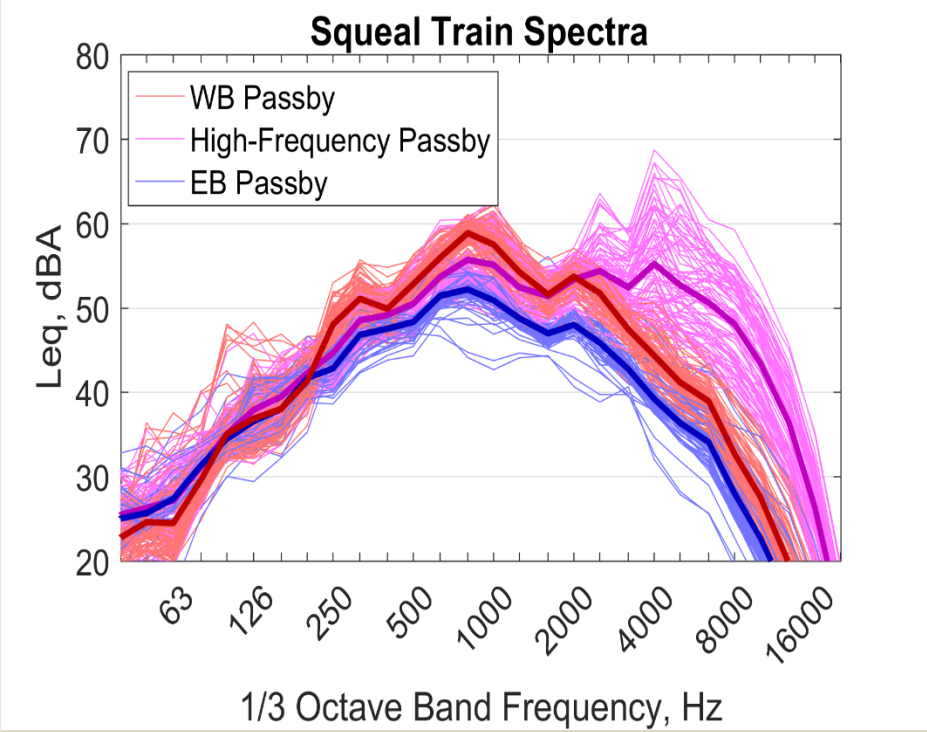
What is the Problem?

- Elevated levels of high-frequency (4kHz – 16kHz) noise
- Perceived as annoying and intrusive





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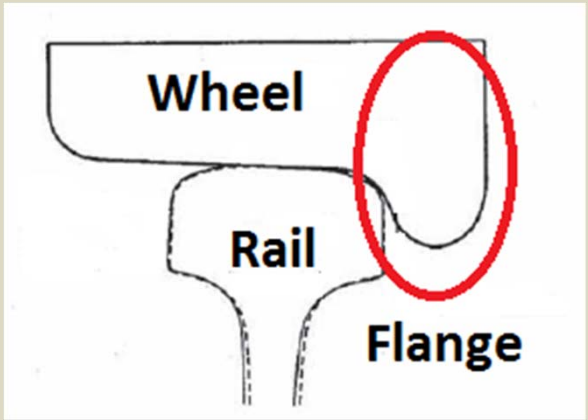
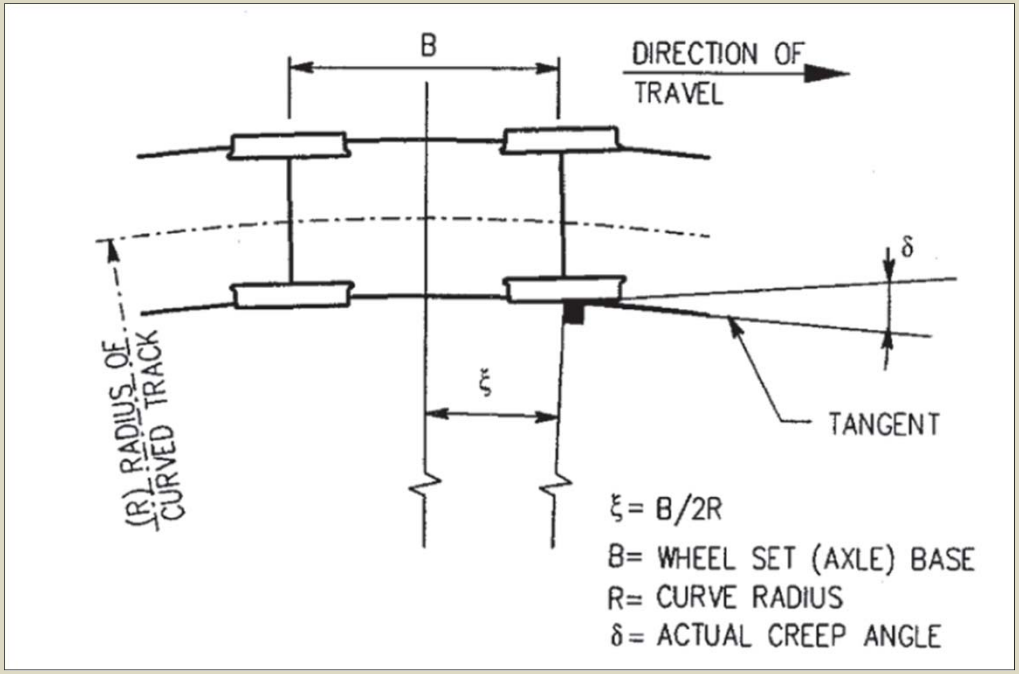
Causes of Wheel Squeal

- Caused by stick-slip interaction of the rail with a wheel navigating a turn on a fixed axle.

- "Flanging" – wheel flange makes contact with the gauge face of the rail





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Source: FTA Track Design Handbook for Light Rail Transit, Second Edition

Causes of Wheel Squeal

- Painting the rail reveals points of contact between the wheel and rail
- Consistent, clean contact band on the top of rail is ideal
- FTA states that turns with radii greater than 1,000 ft "avoids squeal"
  - This curve is 1,400 ft

Outside (high) rail – evidence of flanging

Inside (low) rail – consistent contact band

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Noise at Northvale Curve

- Moderate impact threshold: L_{dn} = 56 dBA
- Measured, train-only level: L_{dn} = 50 dBA
- Residents complain about the high-frequency noise from the trains
- Measurements conducted between May 2016 and April 2017

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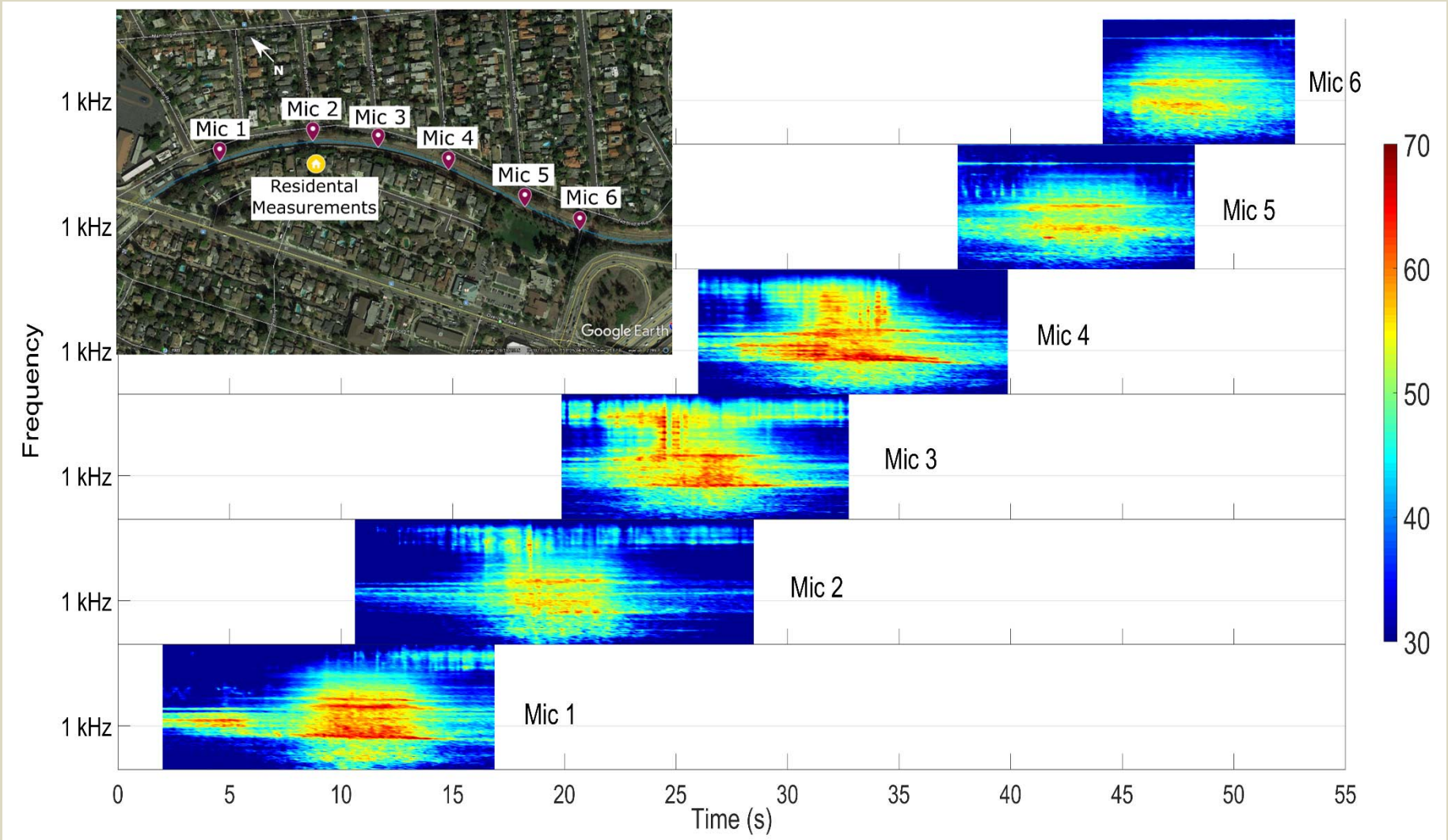
Squeal Doubling Pass-by Length



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Mic 2, Mic 3, & Mic 4 have elevated levels of high frequency noise that extend beyond the train pass-by, making the pass-by seem longer

System Investigation

- Features that impact squeal generation
  - Travel direction
  - Speed of trains
  - Distance from friction modifier applicator

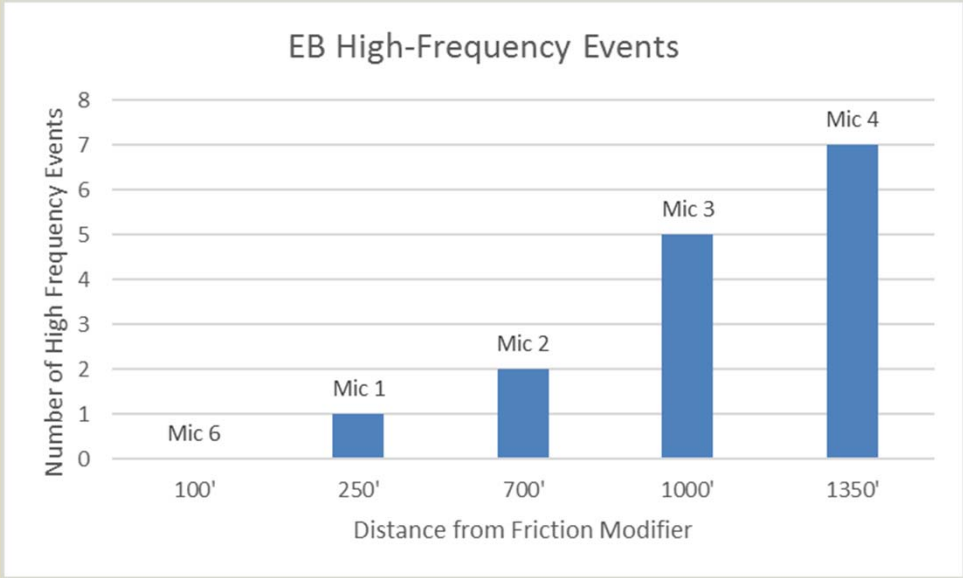
- Features unlikely to impact squeal generation
  - Old vs new vehicles
  - Train consist length (2 or 3 car trains)
  - Weather

Mitigation Techniques – Considered

- Profile adjustment/Gauge face grinding
- Gauge width adjustments
  - Gauge width cannot be adjusted on this section of track
- Gauge face lubrication
  - Safety concerns at Metro
- Vibration dampers

Mitigation Techniques – Implemented

- Top-of-rail grinding
  - Completed January 2017: wheel squeal unchanged
- Friction modifiers
  - Installed mid 2016: eliminated high frequency noise when operating properly
  - Applicator is prone to clogs
  - Wheels might not carry material very far down tracks



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Conclusions

- Identifying the root cause of the high-frequency noise is challenging
  - Multiple factors combine to generate the irritating noise
- Friction modifier applicators reduce the noise when operating properly
  - Additional applicators will be added every 500ft along curve
- New noise measurements are planned after new applicators are installed to quantify their effectiveness

Questions?

Appendix – Friction Modifier Applicators

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