Implementing a Top-of-Rail Friction Control Strategy

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Why Top-of-Rail (TOR) Friction Control?

Gauge spreading (lateral) forces are created when a vehicle negotiates a curve.
These forces cause ....

- tie plate cant
- fastener issues
- rail wear
If the forces are high enough, they can roll the rail over.
To address this problem, one can either INCREASE the STRENGTH of track or REDUCE the FORCE applied to it.
Track Degradation

Reduce applied lateral force
- Use better trucks
- Reduce curvature
- Reduce car weight
- Lubricate center bowl
- Run at balance speed
- Control top-of-rail friction
- Optimize rail/wheel profile

Increase track strength
- Stronger ties
- Stronger spikes
- Larger tie plates
- Different fastener systems
TOR Friction Control addresses the problem by REDUCING the applied FORCE.
Force $\sim \mu_k \cdot W \cdot C$
To control top of rail friction, “friction modifiers”, not lubricants, are required.

<table>
<thead>
<tr>
<th>LOWER SPEC LIMIT</th>
<th>UPPER SPEC LIMIT</th>
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<tbody>
<tr>
<td>Lateral force reduced but friction too low, affecting locomotive adhesion and ability of car to properly steer</td>
<td>Lateral force controlled</td>
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<tr>
<td>Lateral force not controlled - friction too high</td>
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Lubricants

Friction Modifiers

TOP OF RAIL FRICTION VALUE
Top-of-Rail Friction Control Solutions

Locomotive

Hi-rail

Wayside
Locomotive TOR Systems

Requires no additional operator, but can require train crew to enter train trailing tonnage.

Is applied at all times unless the automatic air brake is applied.

Requires out-of-service locomotive time to install (3-4 days).

Requires fleet wide implementation unless equipped-locomotives can be kept as the trailing unit in the consist.

Requires time for the material to build-up on the rail/wheels and transfer throughout the train.

Requires proper alignment and begins to miss the rail head at curvatures greater than 10 degrees.

Requires infrastructure to keep on-board reservoirs filled.

Below certain temperatures, material freezes and will not apply to the rail.

Is washed off the rail during rain.

Can selectively utilize on heavy-axle load trains.
Hi-rail TOR Systems

Requires an additional operator and requires vehicle to be driven at a constant speed.
Requires track time in order to apply.
Does not last long (~ 800 axles) and requires constant re-application.
Dries to rail, requires no transfer mechanism and is effective immediately.
Once dry, is not washed off by rain.
Can apply material in any degree of curvature.
Operational in all temperatures.
Wayside TOR Systems

Requires no additional operator.
Is applied whenever a train passes.
Configurable for bi-directional or unidirectional traffic.
Requires out of service track time to install (1/2 day).
Requires Solar-based power.
Effective immediately once installed.
Requires spacing of 1-2 miles, depending on the curvature.
Requires a large number of systems to employ system wide.
Below certain temperatures, material freezes and will not apply to the rail.
Is washed off by the rain.
Not possible to selectively utilize on heavy-axle load trains.
TOR Implementation Experiences

Captina Secondary, Ohio
Locomotive-based TOR Implementation

Time period – 2 months

- No TOR: 19%
- TOR Activated: 14%

Frequency (All Axles)

Lateral Force (kips)
Conclusions reached

An all-season formulation is needed.
Conclusions reached (con’t)

Entering the trailing tonnage by the crew is a problem.
Conclusions reached (con’t)

Rail condition and rail force must be monitored to control and improve the process.
Gauge-face lubricant interaction
Trackside Experiences
Captina Secondary, Ohio
Wayside-based TOR Implementation

![Graph showing the effect of TOR activation on lateral force frequency.](image)

- **Frequency (All Axles)**
- **Lateral Force (kips)**
- **Time period – 1 week**

- **No TOR**
- **TOR Activated**

- USL

- 17%
- 5%
Conclusions reached

Sanding at the application bar
Locomotive Experiences (con’t)

Winston-Salem Mainline, Virginia
Winston Salem Line Coal Train Operation

Automatic Air Brake Applied
Future Implementation Issues

How do you reduce lateral forces in areas where trains require the use of automatic air brakes which disable their application?

Can the locomotive TOR system apply material under automatic air brake usage without compromising train handling characteristics and still reduce lateral force?

If not, can wayside or hi-rail TOR systems be used in these areas to supplement the locomotive TOR systems?

What effect do all of these systems have on existing gauge-face lubrication practices?
Future Initiatives

Determine if locomotive, hi-rail and wayside TOR systems can reduce lateral forces under automatic air brake usage.

Determine the correct spacing for wayside TOR systems.

Determine revenue train energy savings for all TOR systems utilizing LEADER technology.

Determine where TOR hi-rail systems are best utilized.

Determine a territory approach to reducing lateral forces.