2.1.7 WIND RESISTANCE (1992) (R 2022)

Though on most lines trains do not move in a constant direction with respect to winds, the possible effect of winds on train resistance should not be ignored. The additional resistance due to head-winds can be accounted for by adding the average wind velocity to the train speed in computing air resistance. Wind-Tunnel tests show that side winds at different yaw angles can increase train resistance significantly. The AAR TOES Model calculates the aerodynamic resistance "C" term as a seventh order polynomial function of crosswind yaw angle. Material on wind resistance is be found in AAR Report R-685 (Reference 29) and other references listed in References.

2.1.8 TUNNELS (R 2022)

Tunnels can increase the train resistance considerably. Factors which affect tunnel resistance are train length, tunnel length, the proportion of the cross-sectional area of the train to the cross-sectional area of the tunnel, and tunnel roughness (Reference 62)[1]. Table 16-2-4 shows Canadian National C values for typical tunnel situations.

a) In Table 16-2-4 "q" represents the ratio of the cross-sectional area of the train to the cross-sectional area of the tunnel. The freight coefficients are for average mixed consists. If the values provided in Table 16-2-4 are lower than those given in Table 16-2-3, the values for the tunnel coefficients should be adjusted upward to take into account the combined effect of high open air resistance and tunnel influence.

Table 16-2-4. Typical Values of C Coefficient in Tunnels For Use with Canadian National Train Resistance Formula Only (Reference 16)

Tunnel Length (Feet)	Train Type	q = 0.40	q = 0.65
2000	Passenger	4.0	6.0
5000	Passenger	6.3	12.0
2000	Freight	8.0	12.3
5000	Freight	12.6	24.0

2.1.9 RAIL LUBRICATION (2022)

a) Experience with wayside rail lubricators on curves has show that their use can reduce curve resistance by as much as 50 to 56% permitting reduced curve compensation.
b) Various tests have indicated large savings are available by using onboard flange lubrication. Benefits are obtained on tangent as well as curved track and are additional to benefits derived from wayside rail lubrication. Reductions averaging 0.8 lb/ton have been obtained for loaded cars on curves using this technique (Reference 64).
c) Various tests have indicated that additional savings are available through the use of Top of Rail Friction Modifiers (TOR-FM). Not to be confused with traditional flange lubrication, a TOR-FM is used principally for the adjustment of the coefficient of friction on the top of the rail to be of an intermediate value, between what it would naturally be on dry rail on the high end and at level that would be insufficient for traction and braking purposes at the low end. The primary benefits of TOR-FM are largely attributed from the design of the three-piece North American freight truck, specifically situations where the trucks may be slightly out of line with the track, thus resulting in persistent friction and energy losses through creep (microslip) in the wheel-rail interface

[1] In reviewing Table 16-2-4 for reaffirmation during the spring and summer of 2022, the committee was unable to locate a copy of the Canadian National Railways Transportation Design Standards, October 1990, to confirm the table. However, the committee confirmed that the table is unchanged from the version that was printed in the 1992 Proceedings of the American Railway Engineering Association (Vol. 93), beginning on page 129. The committee also consulted with a practitioner in the field who confirmed that this data represents current practice for North American freight railroads.

(Reference 100). With the addition of a TOR-FM, these loses are reduced, with tests indicating fuel savings in the range of 2%, from the reduced rolling resistance and reduced truck hunting (Reference 101).

R E F E R E N C E S

MAINTAINED

5. Removed

16. Canadian National Railways Transportation Design Standards, October 1990.

29. Gielow, M. A., and C. F. Furlong. 1988. Results of wind tunnel and full-scale tests conducted from 1983 to 1987 in support of the Association of American Railroad's train energy program. Report R-685. Washington, DC: Association of American Railroads, Washington Systems Center.

62. Paolo Pellis, "Resistances of the Air in the Running of Train in Tunnel" Rail International, April 1980.

64. Next Generation Corridor Equipment Committee, and Amtrak, Mechanical Department Bureau of Rolling Stock Engineering. Specification for Diesel-Electric Passenger Locomotives, PRIIA Specification No. 305-005 Revision A. Release Date July 10, 2012., p. 98. Section 6.5 Crash Energy Management (CEM).

100. VanderMarel J, Eadie DT, Oldknow KD, Iwnicki S. A predictive model of energy savings from top of rail friction control. Wear. Volume 314; Issues 1–2; June 2014: 155-61.

101. Cotter J, Eadie D, Elvidge D, Hooper N, Roberts J, Makowsky T, Liu Y. Top of Rail Friction Control: Reductions in Fuel and Greenhouse Gas Emissions. Proceedings of the International Heavy Haul Association Conference. Rio de Janeiro; Brazil; June 2005.