General Information Bulletin No. 6

Measurement Requirements for Remote Ride Quality Monitoring

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MEASUREMENT REQUIREMENTS FOR REMOTE RIDE QUALITY MONITORING

Recommended Practice RP-804-96
Adopted 1996

1.0 INTRODUCTION

1.1 The purpose of this specification is to provide guidelines to vendors of systems which monitor rail ride quality. The specification provides the vendor, manufacturer, designer, etc. the details to comply with to measure ride quality aspects of rail transport of freight.

1.2 Typically the most critical aspect of rail ride quality is lengthwise shock. This specification addresses the measurements and methodology necessary to identify and define longitudinal shocks. The same measurement parameters have been shown to accurately measure lateral and vertical accelerations of rail vehicles.

2.0 GLOSSARY OF TERMS AND DEFINITIONS

(Reference from "Random Data, Analysis and Measurement Procedures" Bendat And Piersol)

2.1 Vibration

2.1.1 Vibration is a term that describes oscillation in a mechanical system. It is defined by frequency and amplitude. Any observed phenomenon can be classified as deterministic or nondeterministic. Deterministic data are those that can be described by a specific mathematical relationship. These can be categorized as periodic or non-periodic. Periodic data can be sinusoidal or complex periodic (combination of two or more discrete frequencies but waveform exactly repeats itself). Non-periodic data include transient data.

2.1.2 However there are many data that are not deterministic, also called random, because each observation of the phenomenon is unique. In other words, any observation will represent only one of many possible results that might have occurred.

2.1.3 Random data is again categorized into stationary and non-stationary. (Please refer to above reference for more details.)

2.1.4 A single time history representing any phenomenon is called a sample record when observed over a finite length of time.

2.2 Shock

Shock is a somewhat loosely defined aspect of vibrations wherein the excitation and response may be periodic or non-periodic, e.g. in the form of square wave (periodic) or a random pulse or other transient vibration, e.g. a yard impact (non-periodic). A shock is also characterized by a large amplitude change in a short period of time.

3.0 DATA ACQUISITION AND INSTRUMENTATION

Measurements will be taken of accelerations in the longitudinal direction, and may additionally be taken in the lateral and vertical directions. Measurements are to be made inboard of the trucks (except where this is not possible), preferably at or near the center of the rail car, with transducers rigidly mounted to the car structure, preferably its center or side sills.

3.1 Data Acquisition

3.1.1 Resolution of the data acquisition system is preferred to be 12-bit, but if an 8-bit system is used the setup shall provide a minimum resolution of +/- 0.04 g.

3.1.2 Acceleration data should be acquired so that peak acceleration and change of velocity computations are based on a signal low pass filtered at 10 Hz. The preferred filter characteristics are fourth order (analogous to four pole in analog terms) with a cut off rate of 24 db/octave. Details of the filter characteristic are to be documented.

3.1.3 The choice of 10 hertz is predicated on several facts. The harmonic modes (like roll, bounce, pitch and yaw) excited by the rail environment are in the range of 1 to 5 hertz. The kinematic lateral instability mode, better known as hunting in rail terminology, is also in the range of 2 to 4 hertz (as a function of existing wheel/rail profiles, adhesion and suspension wear). Frequencies above 10 hertz are a result of mechanical friction and/or elastic structural resonance and/or vibrations. These result in high accelerations but are associated with very low displacement or damage potential from a ride quality perspective.

3.1.4 Yard and in-train longitudinal accelerations are better quantified when low pass filtered at 10 hertz. Higher frequencies associated with longitudinal accelerations are often either due to local structural resonances or friction in the components of a car to car coupling device or elastic bending.

3.1.5 The sample rate shall be no less than 100 samples per second.

3.2 Instrumentation

3.2.1 The type of transducers used shall be accelerometers. Transducer range (accelerometer) shall be no greater than +/- 10.0 g and no less than +/- 5.0 g. The frequency response of the transducers shall be a minimum of 100 hertz.

3.2.2 Transducers shall be rigidly mounted to the car structure, preferably its center or side sills, and preferably at or near the lengthwise and crosswise center of the rail car.

4.0 <u>MEASUREMENT/REPORTING CRITERIA</u>

4.1 Longitudinal accelerations shall be continuously monitored. The monitoring systems shall have the capability of processing the first order integration of the time domain acceleration, or change of velocity. Sufficient data buffer shall be provided to assure that all events exceeding specified peak acceleration and change of velocity thresholds are captured.

4.2 An alarm message shall be transmitted any time the calculated change of velocity (positive or negative) exceeds the specified threshold. Change of velocity is to be calculated any time the rail car longitudinal acceleration exceeds the specified threshold.

4.3 The message shall contain (as a minimum): car identification; car location; date and time of threshold exceedance; time/date of message transmission; peak acceleration amplitudes; and the calculated positive and/or negative change of velocity.

4.4 Optionally, the message may contain: system service status; error prompts; or a portion of the acceleration time history surrounding the peak acceleration. The time window should be a minimum of 0.6 seconds in length and centered about the peak acceleration amplitude.

4.5 The alarm message shall be of a format consistent with the requirements of the messaging service provider.

Closed Car/Trailer Loading Pamphlets:

1 Freight Forwarder (2/80)
3 Bags, Commodities In (10/93)
4 Barrels, Drums or Kegs (11/65), Includes Special Supplement (6/74)
6 Building Brick in Closed Cars (8/83)
8 Plywood in Closed Cars (11/85)
14 Minimum Loading Standards for Freight (12/84)
15 Furniture (7/79)
17 Packaged Food Products (10/88)
20 Lumber in Closed Cars (10/87)
21 Machinery (5/95)
23 Steel Products in Closed Cars (4/95)
25 Flat Paper Stock in Closed Cars & Trailers & Containers for TOFC/COFC Service (5/93)
29 Household Appliance (10/79)
37 High Density Metallic Commodities (11/84)
39 Supplemental Loading Standards for Roll Paper/Pulpboard in Closed Cars (11/96)
Also see **Best Practices for Loading of Roll Paper in Rail Cars** for additional information.
41 Dictionary of Standard Terms (7/82)
42 Glass, Flat (6/94)

Intermodal Loading Guide (ILG) for Products in Closed Trailers and Containers (7/95)
Best Practices for Loading of Roll Paper in Rail Cars (8/96)
Also see Pamphlet No. 39, **Supplemental Loading Standards for Roll Paper/Pulpboard in Closed Cars**, for additional information.

Operations and Maintenance Department Circulars

42-I General Rules Covering Loading of Carload Shipments of Commodities in Closed Cars (2/94)
43-C Rules Governing the Loading, Blocking and Bracing of Freight in Closed Trailers and Containers for TOFC/COFC Service (7/95)

General Information Bulletins (G.I.B.)

1 Handling and Shipping Fresh Fruits and Vegetables by Rail (5/76)
2 Rules and Procedures for Testing of New Loading and Bracing Methods of Materials (8/90)
3 Instructions for Applying Polyethylene Sheets as Weather Protection in Boxcars (11/91)
4 weather Protection for Open Top Wallboard Shipments (4/93)
5 Overloaded of Unbalanced Hopper Cars are Unsafe (8/93)
6 Measurement Requirements for Remote Ride Quality Monitoring (9/96)