Proposal for Development of a Brake Balance Code of Practice

Australian Road Transport Suppliers Association
July 2008

Overview

This proposal concerns the development, of a *Brake Balance Code of Practice* by ARTSA and interested associates intended to help vehicle operators improve the brake balance of heavy vehicles within their fleets.

Poor brake balance is known to promote vehicle instability and premature brake wear. Furthermore, poor brake balance detracts from short stopping distance performance and limits the performance of antilock brake systems.

The *Brake Balance Code of Practice* will provide an assessment tool for quantifying brake balance of specific trucks, and in particular, specific combinations. Brake balance in this context is the extent to which the braking effort is distributed according to axle weight.

The rationale for this proposal is that brake balance can be quantified and thereby modifications made in a scientific way.

There is currently no recognized figure of merit for combination vehicle brake performance and no easy way to assess it. This impedes any scientific consideration of the various brake options and possible mixing of technologies.

The *Brake Balance Code of Practice* will be developed by the ARTSA Braking and Stability College in consultation with industry experts and the Industry Technical Council of the ATA. This group is already working on a number of brake related issues and holds regular meetings as well as developing specific proposals around braking issues. It has over 60 members including many of the leading brake experts in Australia and a number with international experience. As such it is a very focused and knowledgeable peer-group in the braking domain.

The Brake Balance Code of Practice is intended to build upon the Australian Air Brake Code of Practice that was developed by the Australian Trucking Association. This Code, which was developed in the late 1990s continues to be useful because it provides basic information for brake technicians and operators. It does not directly deal with brake compatibility.

The *Brake Balance Code of Practice*, is to be a major extension of the existing Code and will be available via the Internet. It will provide the information and assessment tools to allow fleet managers, technicians, workshop managers, brake engineers and enforcement officers to assess the likely stopping performance of combination vehicles.

Our vision is that in time, the *Brake Balance Code of Practice* will be an adjunct to the ADRs / AVSRs. It could be accepted as providing 'approved computations or assessments' that justify brake set-up changes on heavy vehicles. It has applications with fleet purchasing selection, individual configuration selection, set-up changes and brake modifications. Importantly it should define what can be achieved with good brake balance on combination vehicles.

Since the original Brake Code of Practice was released, there have been significant continuing developments with the application of smart electronic controls onto air brake systems. The new project must take account of the current technologies and likely new developments.

The *Brake Balance Code of Practice* will deal with the base pneumatic brake system performance. It will incorporate some simple models for electronic brake systems (ABS and ECBS). It is well understood that electronic brake control systems work best on top of a well balanced pneumatic brake system.

Purpose of the Brake Balance Code of Practice

To assist operators to determine and improve the brake balance of an individual heavy vehicle, and specifically to assess the vehicle against a performance standard.

The Brake Balance Code of Practice will have levels that are directed specifically at:

- Drivers
- Operators / vehicle specifiers
- Mechanics
- Vehicle engineers

It is recognized that different levels of presentation in the one Code are needed to cater for the range of interests and responsibilities that exist.

The *Brake Balance Code of Practice* will focus on combination vehicles but not exclusively so.

Aspects of the Code

These are:

- A *Brake Balance Code of Practice* text, available on the Internet in a format that facilitates searching , and with key-word definitions via links, etc. A paper version will also be available.
- Principles that define acceptable brake balance in the Australian context.
- Guidance to identify combinations of brake technologies that are likely to be problematical.
- A description of available brake balance technologies – both mechanical and electronic.
- A technology map that makes general predictions about the likely performance of different brake technologies when used in combination.
- A detailed overview explanation of the operating principles of the current electronic brake technologies.

- A *Figure of Merit* for heavy vehicle medium and high pressure brake performance.
- A software tool that is made generally available via the Internet. This tool facilitates the ranking of brake performance.
- Low-pressure braking compatibility tests and guidelines.
- Road test procedures to validate acceptable brake modifications.
- A statement of the procedure that should be followed to assess and modify heavy vehicle brake performance. In particular the setting of load-proportioning brakes and trailer ratio valves.
- Exemplary assessment of 'generic vehicles' so that operators might compare their vehicle with the generic combination vehicle.
- Review work by other industry groups and regulators aimed at improving brake performance (such as the IRTE Compatibility Guide and the NZ Brake Code).

The computations will account for:
- A selection of five specific vehicle types which are: rigid vehicle, semi-trailer, tipper and dog, B-double, and A-double roadtrain.
- Air control system performance. Valve crack pressures to be nominated. Selection from, say, three air system characteristics to be available.
- Temperature characteristics of the nominated brake type.
- Foundation brake torque models to be based on published trailer SARN data and vehicle manufacturer's published data.
- Electronic brake control operation.
- Vehicle dimensions.
- Weight transfers.
- Weight transfers within an axle group will not be modeled. The average axle group performance will be determined.

Verification

Testing of vehicles in each of the five types is necessary to validate the computation tool. It is envisaged that straight-line brake testing of both laden and unladen vehicles will be conducted to determine the minimum stopping distance without wheel lock-up occurring. That is, measurement of the Figure of Merit.

The control air pressure (pedal pressure) and the temperature of each brake after test will also be measured.

ARTSA members and associates will provide the test vehicles to the project either free or at cost. Some variations in the configuration of each vehicle are anticipated. The opportunity may exist to test some other innovative vehicles of interest such as a B-triple.

Validation testing must occur in a safe environment off public roads. Instrumentation, track-hire and logistics costs are anticipated. A budget allocation is made specifically for this testing.

Contents Sketch

Each sub-section of the *Brake Balance Code of Practice* to have a three-level approach.

First Level – concept suitable for layman

Second Level – detailed understandings suitable for mechanics.

Third Level – Engineering detail, including necessary maths / equations and graphs, suitable for advanced technicians and brake engineers.

Section 1 Good Braking Performance Definition.

- Factors defining acceptable/good brake performance.
- Theoretical, practical and typical emergency brake performance.
- Theoretical, practical and typical low pressure brake performance.
- Weight transfers.
- Vehicle dynamic basics: Instabilities modes due to wheel lock-ups. Trailer over-run forces, trade-offs between forward retardation and lateral stability.

Section 2 Characteristics of Modern Brake Technologies

- Disk and drum brake characteristics: torque and temperature.
- Air valve characteristics.
- Load proportioning brakes, trailer ratio and predominance valves.
- Electronic brake technologies: ABS, EBS, VSS.

Section 3 Differences between US, European and Japanese Brake Set-Ups and Approaches

- Typical North Heavy American Motor Vehicle
- Typical European Heavy Motor Vehicle
- Typical Japanese Heavy Motor Vehicle
- Typical Australian Trailer.
- Typical European Trailer

Section 4 Figure of Merit for Emergency Brake Performance

- Brake balance as defined by friction utilization
- Straight line stopping distance limits.
- Braking in a curve stopping distance limits.
- Figure of Merit definition.
- Connection between Figure of Merit and ADR Compatibility Limit Curves.
- Relationship between Figure of Merit and AVSR brake performance limits.

Section 5 Figure of Merit for Low Pressure Brake Performance

- Threshold pressure definitions and measurements
- Valve characteristic adjustments.
- Thermal tests.
- Figure of Merit for low pressure braking definition.

Section 6 Technology Matrix

- Three matrices that give qualitative assessments of likely brake performance for various combinations of braking technologies.
- One matrix for American, one for European and one for Japanese vehicles.
- Matrix to deal with rigid, semi-trailer and tipper & dog combinations
- Variables: Disk, Drum, Predominance valve brakes, EBS, …

Section 7 Computation of a *Figure of Merit* for Combination Braking

- Assumptions and simplifications.
- Basis of models.
- Selection of set-up parameters.
- Guide to using the computational tool.

Section 8 Practical Testing

- On road tests. Practical problems.
- Driver feel of acceptable brake performance.
- Temperature testing.
- Threshold pressure tests.
- On-road stopping distance tests.

Section 9 Examples

Apply the Brake Balance Code of Practice to say five 'typical' vehicle set-ups (semi, B-double, truck and dog, rigid truck, road train) to evaluate the figure of merit calculation. Each truck to be studies with various brake technologies in place.

Timeframe

Nominal 9 month project.
Delivery by mid 2009.

Start September 2008

Stage 1 Detailed Project and Code plan. Finalize contents and exemplar vehicle selection. **September 2008**

Stage 2 Drafts of written Code sections produced sequentially. **September – November 2008**

Stage 3 Demonstration of computational tool. **December 2008**

Stage 4 Review and Revision. **January - February 2008**

Stage 6 Web implementation of Code and Computational tool. February - **March 2009**

Stage 7 Hard copy production. **May 2009**.

Editorial and overall project control

This will be undertaken by:

- ARTSA group with ITC input and invited industry experts to provide editorial and directional guidance.
- Brake Consultant to develop the draft Code (including software).
- Editorial panel of three to oversee the project and review the draft output. Additional reviews from industry experts via the ARTSA Brake College to be sought.

- A separate project control panel consisting of two representatives from the ARTSA Brake College, one from the National Transport Commission and one from VicRoads will have overall budgetary control with respect to controlling project funds and their expenditure.

Validation

Selected operators will be involved. Specific combination vehicles will be studied and modified according to the Brake Balance Code of Practice principles. Validation of the Code recommendations will be sought as part of the Code of Practice process.

Deliverables

These will consist of:

- A Code document in publishable form.
- A software tool written in Visual Basic on a CD.
- A library of vehicle computations that can potentially be made available on the ARTSA website.
- The Code text to be available in a searchable form on the web.

A hard copy of the Code to be available in commercial quantity, subject to funding agreement.

Consideration will need to be given to future updates and maintenance of the proposed Brake Balance Code of Practice. The proposal only includes the preparation of the Code. It does not consider future updates.