SURFACE VEHICLE RECOMMENDED PRACTICE

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Subjective Rating Scale for Vehicle Ride and Handling

RATIONALE

Guidance on normalization of subjective rating results to improve correlation between subjective and objective measures of ride and handling is added.

PURPOSE

This SAE Recommended Practice establishes a numerical rating scale for passenger vehicle ride and handling. The scale is a concise way to rank performance and enable juried ratings.

INTRODUCTION

Vehicle ride and handling performance objectives are primarily subjective. Objective measures enable analysis and understanding of vehicle dynamics performance, but subjective impression is usually the ultimate objective.

The scale described in this SAE Recommended Practice is based on customary practice that evolved over many decades and is used by engineers in developing vehicle ride and handling performance.

The references provide related information, including: SAE J1060 establishes a rating scale for tire-related noise and ride comfort that is very similar to the rating scale of this SAE Recommended Practice. SAE J2834 is an SAE Recommended Practice for establishing objective measurements that relate to subjective ratings for ride. SAE 780010, SAE 730492, and DOT-HS-801-4070 describe experimental studies that relate objective measurements to subjective assessments of vehicle handling and controllability. SAE 880583 exemplifies the use of fractional rating values and of statistical analysis to determine least significant differences for rating values. Evidence in SAE 880583 shows that the variability of highly trained and skilled raters is quite small. AFFDL-TR-68-76 describes the evolution of rating scales for aircraft handling and explains issues including uniformity of the scale and ambiguity of the descriptive adjectives associated with the rating numbers.

1. SCOPE

This SAE Recommended Practice establishes a rating scale for subjective evaluation of vehicle ride and handling. The scale is applicable for the evaluation of specific vehicle ride and handling properties for specified maneuvers, road characteristics and driving conditions, and on proving ground and public roads. The validity of the evaluation is restricted to the individual ride and handling disciplines defined by these maneuvers and to the particular combination of conditions of the vehicle (e.g., equipment, degree of maintenance) and of the environment (e.g., road, weather).

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This rating scale may not be suitable for some applications, such as specific types of ride or handling qualities, driver populations and market segments, or for correlating with objective measures. Appendix A discusses rating scales that better suit such applications.

This document is intended as a guide toward standard practice and is subject to change to keep pace with experience and technical advances.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J1060 Subjective Rating Scale for Evaluation of Noise and Ride Comfort Characteristics Related to Motor Vehicle Tires

SAE J2834 Ride Index Structure and Development Methodology

Bergman, W., "Measurement and Subjective Evaluation of Vehicle Handling," SAE Technical Paper 730492, 1973, https://doi.org/10.4271/730492.

Fairlie, A. and Pottinger, M., "Statistics of Double Lane Change Handling Tests Conducted on Tires Differing in Tread Compound Physical Properties," SAE Technical Paper 880583, 1988, https://doi.org/10.4271/880583.

Weir, D. and DiMarco, R., "Correlation and Evaluation of Driver/Vehicle Directional Handling Data," SAE Technical Paper 780010, 1978, https://doi.org/10.4271/780010.

2.1.2 U.S. Government Publications

Available from National Technical Information Services, https://ntrl.ntis.gov/NTRL/, report access number PB240208.

McRuer, D.T., and Klein, R.H. (1975). *Automobile Controllability - Driver/Vehicle Response for Steering Control, Volume I* (Summary Report DOT-HS-801-4070). National Highway Traffic Safety Administration, Washington, D.C.

Available from the Defense Technical Information Center, https://apps.dtic.mil/sti/pdfs/AD0681845.pdf.

McDonnell, J.D. (1968). *Pilot Rating Techniques for the Estimation and Evaluation of Handling Qualities* (Technical Report AFFDL-TR-68-76). Air Force Flight Dynamics Laboratory, Air Force Systems Command, Wright-Patterson Air Force Base.

3. SUBJECTIVE RATING SCALE

The subjective rating scale shown in Figure 1 provides a means by which evaluators can assign numerical values to their subjective judgments about vehicle ride and handling performance. The adjectives in the "Disturbance" column relate to vehicle responses to disturbances, which are, by definition, best when minimal ("minimum best"). The adjectives in the "Control" column relate to vehicle responses to driver control inputs and may be "minimum best," "nominal best," or "maximum best." Most ride issues are disturbance events, while most handling issues are control events.

The scale is continuous from 1 to 10. Fractional rating numbers may be used for finer resolution. The highest rating, a "10," corresponds to ideal vehicle performance, free of any possible deficiencies, and is included as a high level anchor point. The lowest rating, a "1," corresponds to totally deficient performance and is also included for use as an anchor point. Ride and handling performance of a vehicle with a rating between 5 and 10 is considered desirable, and performance of a vehicle with a rating between 1 and 5 is considered undesirable. A rating of 5 corresponds to borderline performance.

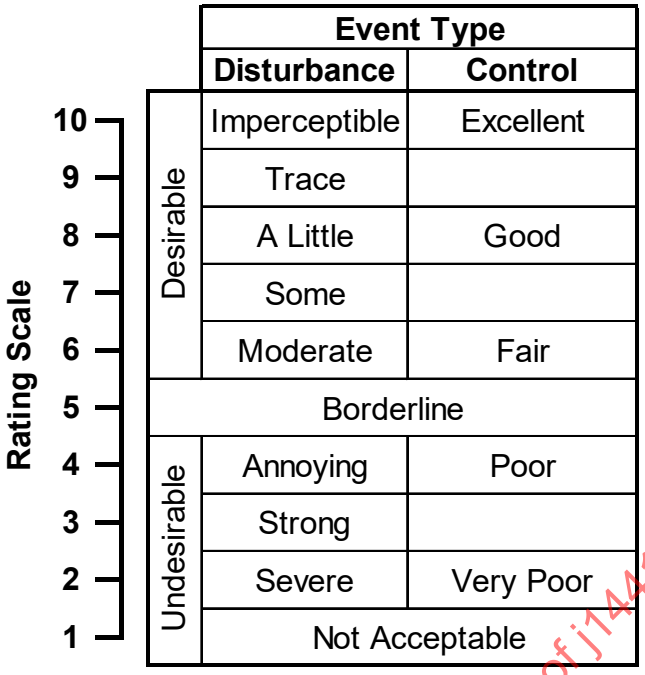

Figure 1 - Subjective rating scale

4. USE OF THE SUBJECTIVE RATING SCALE

This scale can be used for the subjective evaluation of any type of vehicle by employing evaluation criteria corresponding to the vehicle class. Since ride and handling criteria vary with vehicle type and mission (sports cars versus commercial vehicles, for example), an appropriate evaluation reference frame should be considered and established prior to the evaluation. An unchanged reference vehicle(s) enables long-term rating consistency. Reference vehicle(s) representing target performance are especially useful. A reference vehicle representing the starting point or baseline is also helpful for rating consistency.

Vehicle ratings obtained through use of this scale are best made by a jury consisting of a small group of expert evaluators who are familiar with the needs and expectations of the target customer. The rating scale can also be used by non-expert evaluators, but a much larger jury size will be necessary for meaningful results due to increased scatter in the ratings. Jury evaluation provides a more dependable measure of average vehicle rating than is possible using a single evaluator and, at the same time, provides a useful estimate of evaluator variability. Ratings may be influenced by the conditions of the evaluation as well as by the composition of the jury. The ratings will be compatible only for vehicles of the same class evaluated under the same conditions by the same jury. The ratings of a single skilled expert are commonly used to sort through large numbers of tuning alternatives as quickly as possible, but jury ratings are best for final overall results.

Evaluation conditions include the following factors: maneuvers or tasks (lane change, straight-ahead driving, entry to or exit from a curve, acceleration in a curve, etc.); road geometry (curves, camber, change in elevation, etc.); road surface (coefficient of friction, bumps, potholes, grooves, etc.); vehicle operating conditions (speed, load, etc.); and environmental conditions (temperature, wind, fog, snow, ice, etc.).

Correlation of subjective ratings with objective test measures may lead to vehicle development and test method advances that streamline development time. When a jury consisting of a small group of evaluators is used, normalization of individual ratings may improve correlation of subjective ratings and objective measures. Appendix B provides an example normalization approach when multiple raters are used.

5. NOTES

5.1 Revision Indicator

A change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

PREPARED BY SAE VEHICLE DYNAMICS STANDARDS COMMITTEE

APPENDIX A - OTHER SCALES

Modified or alternative rating scales may be better suited for some applications, such as specific types of ride or handling qualities, driver populations and market segments, or for correlating subjective ratings with objective measures. For example:

a. This rating scale may not be well suited for correlating with objective measures that have optimum or preferred values, such as the steering angle required or steering torque required. For such issues, ratings per this scale can be supplemented with comments explaining whether the response is too much or too little in order to indicate the direction of desirable change.

b. The adjectives in Figure 1 may not be commonly understood by evaluators from different populations or market segments (e.g., Australia, Germany, or China). For such applications, modifying Figure 1 with different adjectives may work better.

c. Special purpose psychometric-based rating scales may be better suited for specific applications (e.g., for developing ride indices according to SAE J2834). Such psychometric scales typically have adjectives and rating scale positions and spacing that are determined by psychometric tests in order to obtain more uniform sensitivity and suitability for the specific type of rating and user population. As a result, the adjectives on a psychometric scale do not typically correspond to integer values and do not typically have equal spacing. Therefore, in practice, with such psychometric scales the rater would enter a location on a continuous rating scale with only adjectives appearing along its length, rather than recording rating numbers. This tends to increase rating resolution, reduces uncertainty in the precise meaning of the adjectives, and results in a more uniform rating sensitivity.