



161 Thorn Hill Road
Warrendale, PA 15086-7527

PROGRAM DOCUMENT

PD5000

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BRAKE LINING REVIEW INSTITUTE PROGRAM

1.0 Introduction

The Brake Lining Review Institute was established in 1994 by the SAE International (SAE) as a service to the heavy-duty commercial trucking industry. In early 2000 the operation of the Brake Lining Review Institute was transferred to the Performance Review Institute, Inc. (PRI) a wholly owned affiliate company of SAE. The purpose of this transfer was to facilitate the development of an industry recognized Qualified Products List (QPL) and to better fit the business strategies of both organizations.

The mission of the Brake Lining Review Institute (BLRI) is to provide a mechanism for reviewing and assessing data generated on brake lining materials used on typical original equipment (and equivalent) brakes and brake hardware available in the current marketplace for commercial heavy duty trucks with established standard requirements for those materials.

To fulfill its mission, the BLRI has established a Brake Lining Review Committee (BLRC) which has the responsibility of reviewing the specifications and test results of brake lining material submitted by manufacturers and assessing their conformance with the standard requirements for such materials.

The BLRC operates under Procedures approved by the Brake Lining Review Institute and the Performance Review Institute.

2.0 Review Committee Operating Procedures

2.1 BLRI Review Committees

The Brake Lining Review Institute (BLRI) Review Committees operate under the authority of the Brake Lining Review Institute of the Performance Review Institute, Inc. and its Rules and Regulations.

2.2 Purpose and Scope

The BLRI shall administer a forum for the review of test specifications and data relating to performance of heavy duty commercial brake lining material submitted for qualification to conformity with standards and specifications issued by a U.S. Federal Government Agency or to parameters identified by requesting parties.

2.3 BLRI Review Committee Membership

The BLRI Review Committee members shall be selected by the BLRI based upon the individual's qualifications to review the results of test data and experience in heavy-duty brakes and brake lining materials. The Review Committee shall consist of no less than six (6) members.

The BLRI shall obtain as broad a range of background experience as is possible within the limits of technical competence for each Review Committee.

2.4 BLRI Review Committee Chairperson

The Chairperson is appointed by the BLRI and confirmed by the Performance Review Institute (PRI). Administratively, the Chairperson will be responsible to the PRI BLRI Secretary, who will administer compensation and ensure that the Chairperson operates within the policy constraints of the Institute.

2.5 Responsibilities of the BLRI Review Committees:

1. Voting Members are to make every effort to attend meetings when scheduled. Any Voting Member who is absent without providing an alternate representative from three consecutive meetings may be dropped from Voting Membership unless the Chairperson determines that other circumstances warrant retention.
2. Review test data and test summaries for each brake lining material and recommend acceptance, non-acceptance, re-tests or correction of information supplied.
3. Provide recommendations for testing of brake lining materials as appropriate.
4. Make recommendations to BLRI and PRI for improvements and changes (as necessary) in the Procedures of the Brake Lining Review Institute and its Committees.
5. Make recommendations for changes in the specifications reported for brake lining materials and the test procedures used in the inspection of those materials.
6. Authorize the issuance of Product Review Reports and Qualified Product Lists (QPL).

2.6 Duties of Chairperson of the BLRI Review Committee(s)

1. Schedule, organize, and preside over meetings and activities of the Review Committee(s).
2. Inform interested parties of changes or clarifications in test procedures, specifications and administrative matters.
3. Provide guidance and interpretation of Committee procedures and test requirements.
4. Determine merit of requests for reconsideration of Committee recommendations and initiate appropriate action.
5. Review and confirm minutes of each Review Committee meeting.
6. Serve as spokesman for the Committee.
7. Report to the BLRI and PRI any Review Committee problems.
8. Perform such other duties as required by the BLRI or PRI.

2.7 Secretary of the BLRI Review Committees

Each Review Committee shall have a PRI Staff member assigned as Committee Secretary. The duties of the Secretary of each Review Committee shall include:

1. Issue notices of Committee meetings.
2. Arrange logistics of meetings including contracting for hotel and meeting rooms as required.
3. Record Committee recommendations.
4. Prepare draft reports of each brake lining material assessed by the Committee and transmit copies to the Committee members and other organizations specified by the BLRI.
5. Maintain records of all Committee actions and correspondence.
6. Prepare minutes of meetings for confirmation by the Chairperson. Distribute confirmed minutes to Review Committee members.
7. Arrange for appropriate legal counsel and report findings and recommendations of legal counsel to the Review Committee(s).
8. Arrange for appropriate indemnifications insurance for Review Committee members.

9. Assure compliance with all prescribed forms and procedures involving review activities.

10. Issue as appropriate Qualified Product Lists (QPL).

3.0 Introduction

These Procedures specify the mechanism for the presentation of brake block lining material for review and assessment by the Brake Lining Review Committee (BLRC) of the Brake Lining Review Institute (BLRI). All organizations or individuals who present materials to the Committee must do so in compliance with these Procedures.

Information submitted to the Review Committee and staff is submitted for the purpose of permitting the committee to carry out its function and will only be released outside the committee (a) to the extent permitted by these Procedures (b) with the authorization of the individual or organization submitting the data or (c) subpoena by a government agency. However, the members of the Review Committee may use and discuss all submitted information in the normal course of their employment except for information which has been designated proprietary prior to submission.

4.0 Definitions

The following definitions are used in these Procedures:

"Brake Lining" - any specific material used for foundation brake material for heavy-duty trucks.

"Presenter" - is any representative of the submitting organization who has been designated to appear before the Review Committee in person to discuss the material and review the test results.

"Submitting organization" - is any organization which submits a brake lining material for assessment by the Committee.

5.0 Interpretation of Procedures

Any questions concerning interpretation of these procedures must be submitted in writing and addressed to:

Brake Lining Review Committee
Performance Review Institute
161 Thorn Hill Road
Warrendale, Pennsylvania 15086

Individual members of the Brake Lining Review Committee may not provide any interpretation of these Procedures.

6.0 Meeting Schedule

The Review Committee typically holds one meeting per year, in a location and at a time agreeable to the majority of committee members. At each meeting, the dates for the next possible meeting will be discussed. Interim conference call meetings may be called at any time by the Chairman provided appropriate notice is given to the Committee members. Advance notices of meetings are distributed to interested parties by the Secretary of the Committee.

7.0 Material Presentation Fees

A fee structure for the presentation of materials to the Brake Lining Review Committee has been established by the BLRI Board. Material presentation fees are used to cover the costs of the BLRI program.

8.0 Fee Areas

Fees will be charged for:

1. Presentation of data on one formulation with only one marketed name.
2. Presentation of data on one formulation with more than one marketed name.
3. Candidate lining materials submitted that require independent lab testing and then presentation of data.
4. Review of Laboratory qualification data.
5. Presentation of additional information requested by the Review Committee
6. Representation of any data required for acceptance by the Review Committee

9.0 Evaluation of Brake Lining Materials

9.1 In order to have a candidate material used for heavy duty trucks evaluated by the BLRC, the submitting organization shall complete the tests specified in FMVSS 121 using SAE J2115 Section 1-6 and TMC RP 628 and submit the results of those tests to the Secretary of the Committee for distribution to the Committee members.

9.2 The Review Committee will review the test results and the requirements set forth in the FMVSS 121 retardation, brake power, and recovery dynamometer requirements in accordance with TMC RP 628 and assess whether or not the tests indicate the material satisfies these requirements. PRI will also develop and publish a Qualified Products List based on the outcome of this review. This review does not constitute an approval by SAE. The PRI Qualified Products List only verifies that the brake lining material, as represented by the data presented, has demonstrated its ability to meet the test criteria set forth above.

9.3 The Review Committee may request additional testing of the material, retesting or any other information which the Committee, in its sole determination, feels is needed in order to assess the material. In order to verify that the material being marketed has performance characteristics consistent with the original material submitted for review and to maintain the integrity of the Brake Lining Review Program, each submittal must comply with the “off-the-shelf” brake lining selection, testing, and reporting procedure. A copy of this procedure is included in Appendix C.

9.4 If a Submitting Organization fails or refuses to submit the additional test results or other information requested by the Committee in a timely manner, the Committee will not forward the appropriate information to ATA's TMC.

9.5 It is suggested that if a presenter intends to deviate from these procedures, or those outlined in Appendix B, that they consult with the Review Committee to seek guidance on how best to present the information.

10 Test Procedures

Brake Lining Materials shall be tested in accordance with FMVSS 121 and TMC RP 628.

11 Submissions to Review Committee

11.1 Advance Submittal of Information and Test Parts

In order to have brake lining materials considered for review, each Presenter shall be responsible for the following:

- A. A written notification requesting evaluation of Submitting Organization materials. The request for evaluation must include:
 - The material or materials to be assessed.
 - Name and address of all laboratories which the Submitting Organization proposes to use for material testing.
 - The name of the brake material, the corporate name, address and communications numbers of the Submitting Organization.
- B. All test reports, and test summaries for materials shall arrive at PRI Headquarters, Warrendale, Pennsylvania at least two (2) weeks prior to the scheduled Committee meeting.
- C. The Committee will consider for review only those materials for which test results have been received by the deadline.

- D. PRI Staff will code all test data so that identification of the brake lining material being reviewed by the committee will remain anonymous.
- E. All test reports and test summaries will be accompanied by a signed and notarized affidavit indicating the tests were conducted in accordance with the prescribed procedures and that the results are a true representation of the brake lining materials expected performance. An example of this affidavit can be found in Appendix A.
- F. All necessary requirements and data report forms are shown in Appendix B. These forms are to be used when submitting data to the Review Committee.
- G. Tests submitted for review and qualification must have been conducted within 12 months of submission.

11.2 Attendance of Committee Meetings

During the review of a candidate material by the Committee, no person(s) shall be permitted to attend or appear before the Committee. PRI Staff personnel, as needed, will be available to assist in handling of paperwork during the presentations. Where question(s) arise about specific test results, a request will be made by the committee through the PRI Staff to contact the manufacturer to resolve the questions.

11.3 Restrictions on Disclosure of Information Designated as "Proprietary" Submitted to the Committee

Each Committee member by accepting his appointment to the Committee or such other person having access to such information by virtue of a Submitting Organization's submission to the Committee agrees to refrain from disclosing to anyone outside the Committee any information designated by the Submitting Organization as "Proprietary."

This obligation of non-disclosure is binding on each Committee member and such other person having access except in the event that such information:

- A. Was available to the public at the time of presentation to the Committee.
- B. Becomes available to the public except as the result of unauthorized disclosure by the Committee member.
- C. Was known to the Committee member prior to its disclosure to the Committee.
- D. Is required to be disclosed by enforceable legal process.

- E. Is obtained from other sources without knowingly violating the rights of the Submitting Organization.

This obligation of non-disclosure of such information shall cease five years after its initial presentation to the Committee except that it may be extended by written request to the Committee Secretary from the Submitting Organization for successive one-year periods up to a maximum of three such one-year periods.

In the case of conference call meetings, all data must be destroyed immediately following the conference call.

11.4 Procedure for Submitting and Handling of "Proprietary Information"

- A. In the event a Submitting Organization deems any such compositional or test result information to be supplied to a Review Committee as proprietary, then all such material shall be marked "Proprietary" to come within the provisions of paragraph 11.3 and bear such marking at the time of submission to the Committee. In the event that it is thought by the Chairman that the information marked "Proprietary" does not warrant the special obligation of paragraph 11.3 or is not proprietary, then the Secretary shall within 10 days, so notify the Submitting Organization by registered or certified mail and the Submitting Organization shall have three (3) weeks to submit comments substantiating the designation as Proprietary. Failure to respond to such notice shall be deemed to constitute a withdrawal of the material submission to which such information pertains. All information to which a substantive response is received shall be submitted to the respective Review Committee in accordance with paragraph 11.3.
- B. As to any information which continues to be proprietary at the end of the three-year term provided in paragraph 11.3, a Submitting Organization may request an additional one-year renewal term. No more than three such renewals shall be granted and no renewal shall be effective if the material is not proprietary as provided in paragraph 11.3. Each request shall be sent to the Secretary of the Review Committee identifying the information. The Secretary shall notify all members of the Committee having received such proprietary information that the term of confidentiality has been extended an additional year.

11.5 Committee Recommendations

PRI will post an updated QPL within two weeks following the BLRC Meeting.

The PRI QPL listing is valid through the expiration date indicated in the formal approval letter. If the approval is suspended, revoked for cause, or is not renewed, the supplier is responsible to immediately cease using the Mark of Conformity, distributing literature or other materials which carry the Mark of Conformity. The rules and regulations of usage are documented in PRI s-fm-48 which is provided with the approval letter.



11.6 Reconsideration of a Committee Recommendation

Any Submitting Organization which is dissatisfied with the recommendation of the Review Committee may request reconsideration. This request and the reasons for it must be submitted in writing to the Secretary within thirty (30) days of the receipt of the BLRC Assessment Report. If the Chairman determines that the request has sufficient merit, the request will be reconsidered by the Review Committee at its next meeting. However, the Committee's assessment will be based on the test information originally submitted and any additional material which clarifies the original test results.

11.7 Errors in Submission

Submitting Organizations are responsible for the completeness and accuracy of the test reports and other material submitted to support the Committee's assessment and, therefore, should review them prior to presentation to the Committee to assure they are free from typographical errors, errors in data, discrepancies, and/or omissions.

12 Transmittal of Data to the TMC

The brake lining material manufacturer will also be notified of the outcome of the BLRC's review of their test results. In the event of the BLRC finds the test results unacceptable, only the brake lining material manufacturers will be notified.

All BLRC results will bear the following notice:

NOTICE

The information contained in this report was provided by the material manufacturers. The SAE International and the Performance Review Institute, Inc. has not tested this material. The review of this information does not constitute an approval by SAE. Listing on the PRI Qualified Products List only verifies that the brake lining material, as represented by the data presented, has demonstrated its ability to meet the established test criteria. It is the sole responsibility of the user to determine whether the material is or is not suitable for a particular application.

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APPENDIX A

Company Name

Date

Company Address

Product Name

Test Identification, Dynamometer Identification and Test Facility Address:

I/We do hereby certify that the information presented for the candidate brake lining material is accurate, that the tests were conducted in compliance with the prescribed test procedures, and that the test results represent the expected performance of this formulation in the specified tests. I/We also understand that the review of this information does not constitute an approval or certification by SAE/PRI and/or TMC and that statements to such effect will not be used in the marketing of this product.

Submitters Name

Title

Submitters Signature: _____

Corporate Officials Name:

Title:

Corporate Officials Signature: _____

Date:

Notary Seal

Do Not Write Below This Line

Date Received _____ Program Number _____

Date Reviewed _____

Acceptable _____ Not Acceptable _____ Additional Information Required _____

Staff Signature _____

Appendix B

SUBMISSION OF INFORMATION TO THE BRAKE LINING REVIEW COMMITTEE
PROCEDURE.

1.0 SCOPE

This Appendix outlines the necessary details for submission of information to the Brake Lining Review Committee. This Appendix is intended to act as a guide for those presenting information to the Review Committee so that it can be accomplished in an orderly fashion. The accuracy of any information submitted to the Review Committee is the sole responsibility of the Organization submitting the data. All new data presented will be good for a five-year period. When submitting data to the Review Committee, all forms should be filled out in their entirety. It is suggested that any deviations from the procedures set forth be discussed with the Review Committee prior to submission of the data.

2.0 LABORATORY QUALIFICATION

Any organization that submits data for review by the Review Committee must have the testing done by a facility that is capable of performing the tests described in TMC RP 628. Evidence that the facility has the ability to perform this testing, as confirmed by an independent organization, must be presented with the initial submission to the Review Committee and then every five years thereafter. Shown in Attachment B.1 are the appropriate site and dynamometer qualification report sheets to be presented to the Review Committee. Procedures for calibrating brake dynamometer inertia are offered in Attachment B.2. Reference Figure B.1 for the workflow on how to calculate brake inertia. Reference Figure B.2 regarding the format to report test results. No data will be reviewed from a laboratory that does not have current site qualification. Any time a dynamometer is moved, it must be re-qualified following the move.

3.0 TEST HARDWARE REQUIREMENTS

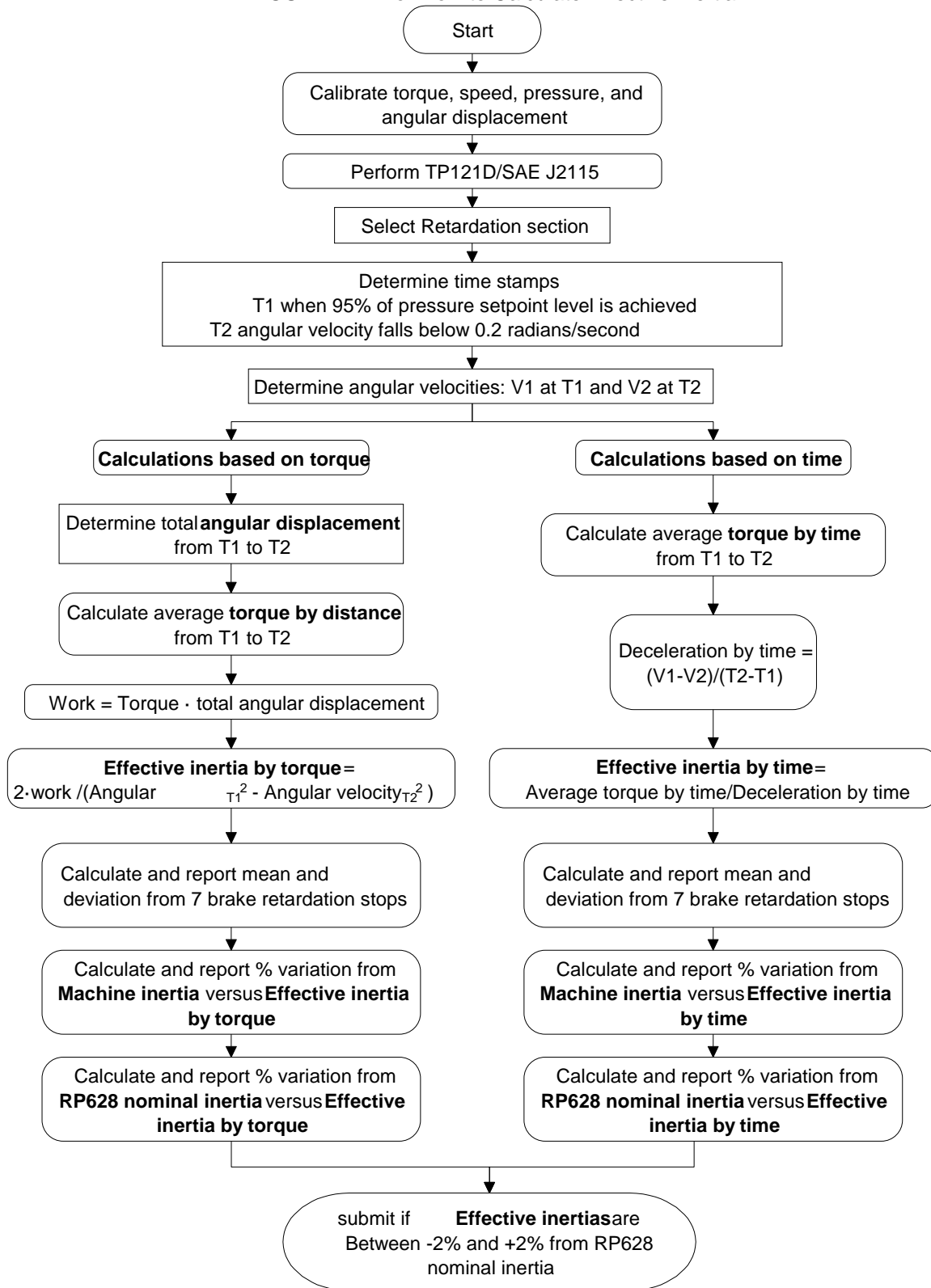
LINING TEST CONDITIONS AND THE VEHICLE CONFIGURATIONS THEY REPRESENT									
Rim Size		Drive/Trailer				Steer			
22.5 In.	Brake Size (Drum - Dia./Width, in., Disc - Rim Size, in.)	16.5x7 Drum	16.5x7 Drum	16.5x7 Drum	22.5 Disc	22.5 Disc	15x4 Drum	16.5x5 Drum	22.5 Disc
	GAWR (lbs.)	20,000	20,000	23,000	20,000	23,000	12,000	14,600	14,600
	Air Chamber Size (type)	30	24	30	Various	Various	20	24	Various
	Cam Brake Slack Adjuster Size (in.) -	5.5	5.5	5.5	Not Req'd.	Not Req'd.	5.5	5.5	Not Req'd.
	Tire Size for Test, Rolling Radius (in.)	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6
	Range of Tire Sizes on Vehicle	18.5 - 21.0	18.5 - 21.0	18.5 - 21.0	18.5 - 21.0	18.5 - 21.0	18.5 - 21.0	18.5 - 21.0	18.5 - 21.0
19.5 In.	Brake Size (Drum - Dia./Width, in., Disc - Rim Size, in.)	15x8.625 Drum	15x8.625 Drum	19.5 Disc	Additional brake sizes, linings, axle ratings, etc. can be supplied as special configurations for any wheel size.				
	GAWR (lbs.)	14,500	14,500	14,500					
	Air Chamber Size (type)	30	24	Various					
	Cam Brake Slack Adjuster Size (in.) -	5.5	5.5	Not Req'd.					
	Tire Size, Rolling Radius (in.)	15.3	15.3	15.3					
	Range of Tire Sizes on Vehicle	15.1 - 16.3	15.1 - 16.3	15.1 - 16.3					
17.5 In.	Brake Size (Drum - Dia./Width, in., Disc - Rim Size, in.)	12.25x7.5 Drum	12.25x7.5 Drum	17.5 Disc	Additional brake sizes, linings, axle ratings, etc. can be supplied as special configurations for any wheel size.				
	GAWR (lbs.)	19,200	19,200	19,200					
	Air Chamber Size (type)	30	24	Various					
	Cam Brake Slack Adjuster Size (in.) -	5.5	5.5	Not Req'd.					
	Tire Size, Rolling Radius (in.)	14.6	14.6	14.6					
	Range of Tire Sizes on Vehicle	14.1 - 17.0	14.1 - 17.0	14.1 - 17.0					

The above sets of FMVSS 121 test conditions - which depend on gross axle weight rating (GAWR) and air chamber size - can be used to test and evaluate brake lining friction materials. The test conditions simulate vehicle configurations which are commonly used in on-highway tractor-trailer operations.

4.0 DATA SUBMISSION

The Data Submission Sheet shown in Attachment B.3 is to be used for submission of data on all candidate brake lining materials. The data should be reported and presented as recorded. Zero's are needed to be used as place holders when completing the forms. The passing limits for an acceptable brake lining material are those specified in TMC RP 628 and F.M.V.S.S. 121. A series of three tests must be presented for review with each of the three tests meeting the passing requirements at their original testing parameters (averaging is not allowed). The average deceleration should reflect a calculation based on speed and time per F.M.V.S.S. 121 paragraph 5.5.4.

FIGURE B.1 Workflow to Calculate Effective Inertia



Includes technical notes from Richard G. Bayer – Abex Friction Products and Rick Sandberg – Link Engineering Co. from 14Feb95.

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B.2 REPORT LAYOUT FOR EFFECTIVE INERTIA CALCULATIONS WITH ACCEPTANCE CRITERIA

Testing Facility:												
Test Lab Name Here						RP628 specified Inertia: 952.78 slug-ft²						
Dynamometer: <i>Dyno Number Here</i>						Asle Load: 23000 lbs						
Test: <i>Original Test Number Here</i>						Static Loaded Radius: 19.6 inches						
RP628 Report Date: <i>Report Date Here</i>						Inertia Upper Limit (+2%): 971.8 slug-ft²						
RP628 Brake Retardation Stops <input type="text"/>						Inertia Lower Limit (-2%): 933.7 slug-ft²						
Version 3.00												
Calculations Based on Torque						Calculations Based on Time						
Angular Displ.	Average Torque (by dist.)	Angular Velocity	Work	Eff Inertia by Torque		Initial Time	Final Time	Angular Velocity	Angular Velocity	Average Torque (by time)	Decel by Time	Eff Inertia by Time
radians	lb-ft	at press	lb-ft	slug-ft²		sec	sec	rad/sec	rad/sec	lb-ft	rad/s²	slug-ft²
T1 · T2	T1 · T2	T1	T1 · T2	T1 · T2		T1	T2	V1	V2	T1 · T2	T1 · T2	T1 · T2
20 psi	417.29	2287	44.86	954535	948.8	0.14	18.06	44.86	0.69	2294	2.47	930.6
30 psi	264.09	3635	44.95	959984	950.4	0.18	11.74	44.95	0.25	3601	3.87	931.4
40 psi	187.43	5098	44.77	955523	953.4	0.22	8.64	44.77	0.16	4972	5.30	938.4
50 psi	144.57	6486	44.34	937690	953.9	0.28	7.00	44.34	0.24	6168	6.56	939.9
60 psi	120.61	7667	43.92	924783	958.9	0.32	6.00	43.92	0.27	7252	7.68	943.7
70 psi	104.13	8765	43.67	912754	957.3	0.36	5.40	43.67	0.22	8095	8.62	939.0
80 psi	88.81	10111	43.27	897928	959.0	0.40	4.84	43.27	0.05	9069	9.74	931.5
Stds:					4.05	Stds:					5.15	
Avg:					954.5	Avg:					936.4	
Stds/Avg:					0.42%	Stds/Avg:					0.55%	
% Deviation from RP628 Nominal:					0.18%	% Deviation from RP628 Nominal:					-1.72%	
Within Inertia Limits:					Yes	Within Inertia Limits:					Yes	
Prepared By: _____						Reviewed By: _____						
						Date: _____						

“OFF THE SHELF” BRAKE LINING SELECTION, TESTING, AND REPORTING PROCEDURE

1.0 BACKGROUND

In 1995 SAE implemented a Truck Brake Lining Review Program in response to a request from the American Trucking Association (ATA) Truck Maintenance Council (TMC) for such an activity. In 2000 responsibility for operation of the program was transferred to the SAE's wholly owned affiliate company the Performance Review Institute, Inc. (PRI). This program reviews SAE J2115 dynamometer test data in accordance with TMC's RP 628 and makes recommendations on the acceptability of this test data to TMC. This information is then to be transmitted to TMC for whatever action they deem appropriate. A Qualified Products list is also generated and published by PRI.

2.0 PURPOSE

In order to maintain the integrity of such a Review Program, it was recognized that off the shelf testing was desirable. Samples of materials will be randomly selected from the TMC and/or PRI QPL list and tested. The purpose of this testing will be to verify that the material being marketed has performance characteristics consistent with the original material submitted for review.

3.0 PROCEDURE

The following criteria will be used in the selection, testing, and reporting of test results on all brake lining materials.

- 3.1 **SELECTION:** All materials that appear on the TMC and/or PRI list will be included in the “pool” for possible selection. This “pool” will change as the TMC and/or PRI list changes. Once a material has been selected, it will be removed from the “pool” until all eligible materials have been tested. Two axle sets of blocks will be purchased for each material selected. In purchasing the axle sets, the same FMSI number will be purchased as that listed on “Data Submission Sheet 1”.
- 3.2 **TESTING:** All materials will be tested by an independent laboratory. It is intended that this testing will be evenly distributed among the independent laboratories. However, if initial testing was done by an independent laboratory, every effort will be made to use an alternative independent laboratory for this testing. Testing performed will be SAE J2115 as specified in TMC's Recommended Practice RP 628. Once material has been purchased and distributed to a testing laboratory, the manufacturer of the brake lining material will be contacted and informed of this action. The lining manufacturer may then contact the independent test laboratory to review test set up and operation is consistent with the testing originally performed on the lining material. Once testing has commenced, the lining material supplier is to have no further interaction with the testing laboratory until testing is completed with the exception that the lining manufacturer may be present to witness the running of the test. All test results will be sent directly to PRI Staff only for coding prior to review by the Review Committee.

PRI Staff will then forward a copy of the test results to the manufacturer. This will allow the manufacturer to prepare any response it may deem necessary for the Review Committees discussion.

- 3.3 **REPORTING OF RESULTS:** All results sent to PRI will be coded to protect the manufacturer's identity prior to presentation to the Review Committee. These test results will then be compared with the test results originally submitted with the lining material. This will allow for a comparison of the test results by the review committee. The Review Committee will compare test results and make a determination if the results of the "off-the-shelf" testing indicates the same performance level as that originally submitted. The comparison criteria will be as follows: the results of the retardation of the "off the shelf" test must be within limits specified for the brake size in accordance with Appendix C and must also generally pass FMVSS 121. The results of this review will be transmitted to the lining manufacturer. If the results of this comparison are not favorable, the lining manufacturer will be requested to provide a written response to the Review Committee for their consideration. This could include the submission of additional test data, analysis of tested materials for comparison to formula specification, or, if the material manufacturer so chooses, a face to face meeting with the Review Committee. If the Review Committee concurs with the response from the lining manufacturer, then appropriate further action will be taken. If the Review Committee does not concur with the response from the lining manufacturer, then a notice will be sent to the Truck Maintenance Council indicating that a lining material was tested from "off the shelf" and that the results did not agree with those originally submitted for review and that TMC should take what ever action they deem necessary. Additionally, the material will be removed from the PRI Qualified Products List.

APPENDIX C
Acceptance Limits for Dynamometer Testing per PD5000

RATIONALE

The proper assessment of test results during the initial testing and subsequent audit tests involves a statistical component for test variability. Test results variation are a function of the brake hardware used for the test(s), the performance of the friction material under testing, and the contribution from the laboratory conducting the test, its testing practices and methods (setup, test fixture, brake adjustment, control programs, etc.). This document outlines a simplified statistical method which allows the comparison of tests conducted on the same dynamometer (test-to-test variability or repeatability), or tests conducted on different dynamometers (dyno-to-dyno, lab-to-lab variability, or reproducibility). The method uses the ISO statistical approach, tests results from the initial qualification tests, and the off-the-shelf audit test to establish acceptable limits and, ultimately, allow the Review Committee to make a more comprehensive decision at the time of reviewing test results. This assessment will enhance the data review by the Review Committee and does not replace their subjective review. The statistical evaluation for critical differences is conducted at the brake application level to allow the detection of specific issues instead of conducting the assessment using average values for the section or the entire test.

FOREWORD

The methods presented apply key concepts from the statistical process utilized during accuracy studies (under repeatability and reproducibility conditions), but since they are limited to the tests results available at the time of the development of this simplified process, certain statistical assumptions are required in order to complete a working instruction and metrics. If test results from accuracy studies become available to the Review Committee, it would be preferable to update the method presented with a complete set of statistical evaluations and with actual quantification of variability under repeatability and reproducibility conditions for heterogeneous materials. This program document currently applies to s-cam drum brakes on a 16.5"x7" size. This document shall be revised, (a) when the Review Committee accumulates at least three complete qualification and audit tests for air-disc brakes or other brake configurations, or (b) whenever two s-cam drum brake complete qualification and audit tests for 16.5"x7" brakes are added to the database.

1. REFERENCES

The latest revision of the following documents are part of this document and shall be used in case of questions or additional evaluations or assessment are required as part of the review process by the Review Committee.

SAE J2115 (R) Air Brake Performance and Wear Test Code Commercial Vehicle Inertia Dynamometer

ISO 5725-2 Accuracy (trueness and precision) of measurement methods and results -- Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method

ISO 5725-6 Accuracy (trueness and precision) of measurement methods and results -- Part 6:
Use in practice of accuracy values

SAE-PRI PD5000 Appendix C spreadsheet

2. DEFINITIONS

To facilitate the application of this PRI Program Document, the following definitions are provided.

2.1 Critical difference for repeatability — CD_r

Maximum allowable difference between two tests conducted on the same dynamometer under repeatability conditions with a probability level of 95%. See Eq. 1

$$CD_r = 2.8\sigma_r \text{ (Eq. 1)}$$

where:

σ_r = standard deviation for repeatability and calculated as 1/6 of the range from the three submission tests for a given brake application; expressed as a percentage of the average of the three brake applications. [%]

2.2 Critical difference for submission-to-audit tests — CD

Maximum allowable difference between the average of the three submission tests to the value of the audit test with a probability level of 95%. See Eq. 2

$$CD = \sqrt{(2.8\sigma_R)^2 - (2.8\sigma_r)^2(1 - \frac{1}{2n_1} - \frac{1}{2n_2})} \text{ (Eq. 2)}$$

where:

σ_R = standard deviation for reproducibility and calculated as two times the standard deviation for repeatability. [%]

n_1 = number of tests from the submission tests = 3

n_2 = number of tests from the audit test = 1

3. DETERMINATION OF LIMITS FOR STANDARD DEVIATION FOR REPEATABILITY ON OUTPUT PARAMETERS

Follow the steps below to establish the initial values for test output limits as a function of the standard deviation for repeatability for a given brake configuration and size.

3.1 For each brake application use all tests from each material (three submissions and one audit), calculate the standard deviation for each output parameter as a percent of the average of the four tests. Conduct the calculation for the following parameters. See Table 1:

Avg torque during retardation section - output			
STD DEV/AVG BL-216	STD DEV/AVG BL-217	STD DEV/AVG BL-222	STD DEV/AVG BL-223
4.31%	1.90%	2.54%	0.31%
3.97%	1.52%	2.50%	0.35%
3.49%	0.93%	2.96%	0.45%
3.30%	1.05%	2.34%	0.71%
2.97%	1.15%	2.21%	0.58%
3.06%	1.01%	1.93%	0.97%
3.24%	0.87%	1.38%	0.69%

TABLE 1. STANDARD DEVIATIONS AS PERCENT OF AVERAGE (RETARDATION TORQUE EXAMPLE)

- 3.1.1 Retardation Torque
- 3.1.2 Maximum pressure during the brake power section
- 3.1.3 Maximum pressure during the brake recovery section
- 3.1.4 Initial brake temperature during the brake recovery section

3.2 For each parameter, calculate the 95th percentile value of the probability distribution (95% confidence interval and P-value ≥ 0.05). See Fig 1. In case there is no probability distribution with a P-value ≥ 0.05 , use an empirical cumulative distribution function (see Fig. 1.d).

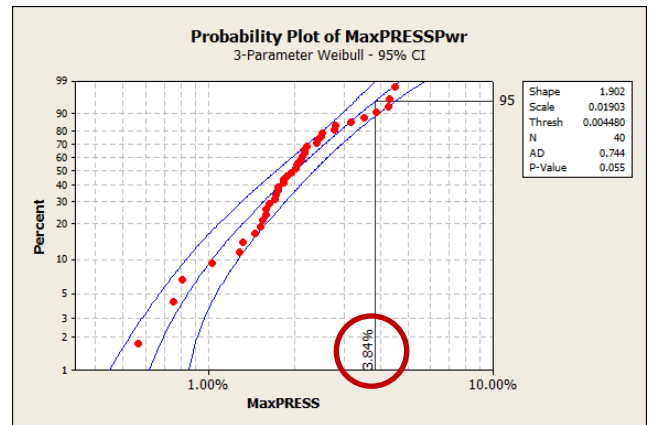
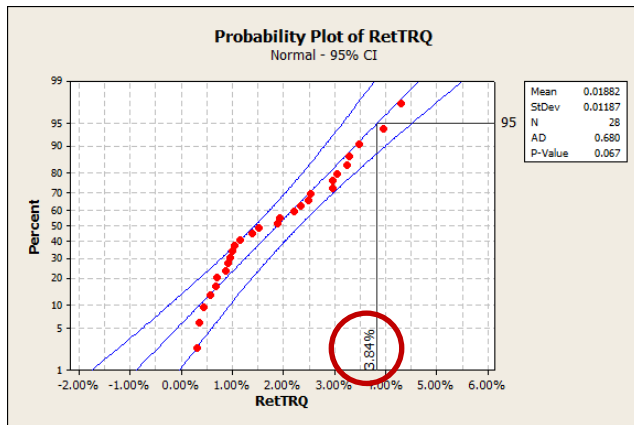


Fig 1.A. RETARDATION TORQUE

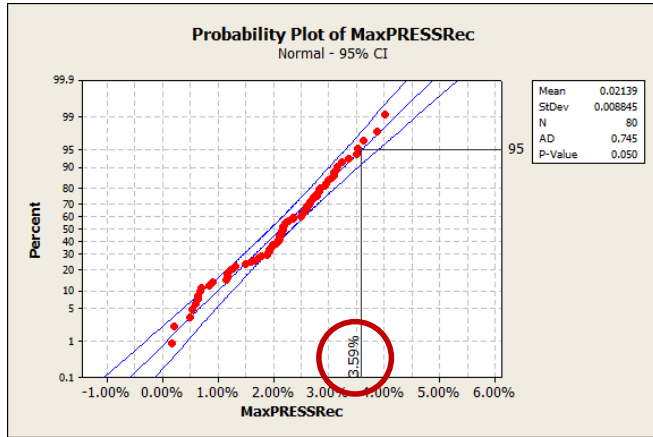


Fig 1.B. MAXIMUM BRAKE POWER PRESSURE

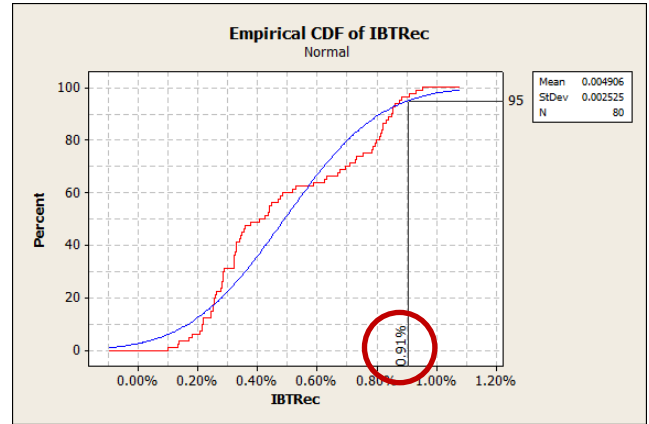


Fig 1.C. MAXIMUM BRAKE RECOVERY PRESSURE

Fig 1.D INITIAL TEMPERATURE BRAKE RECOVERY

For each parameter calculate the critical difference for repeatability and reproducibility per items 2.1 and 2.2. see Table 2.

expressing std dev as % of average submission tests

parameter	equation	RetTRQ	Max PRESS Pwr	Max PRESS Rec	IBT Rec
σ_r		3.8%	3.7%	3.6%	0.9%
CD_r	$2.8\sigma_r$	10.6%	10.4%	10.1%	2.5%
σ_R	$2 \times \sigma_r$	7.6%	7.4%	7.2%	1.8%
CD	see eq.	22.1%	21.6%	21.0%	5.3%

TABLE 2. CALCULATION OF NOMINAL VALUES FOR CRITICAL DIFFERENCES

3.4 For s-cam brake 16.5"x7" configuration, use the following critical differences for test-to-test repeatability:

- 3.4.1 Retardation torque; CD = 10%
- 3.4.2 Maximum pressure during the brake power section; CD = 10%
- 3.4.3 Maximum pressure during the brake recovery section; CD = 10%
- 3.4.4 Initial brake temperature during the brake recovery section; CD = 2.5%

3.5 For s-cam brake 16.5"x7" configuration, use the following critical differences for submission-to-audit tests:

- 3.5.1 Retardation torque; CD = 22%

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- 3.5.2 Maximum pressure during the brake power section; CD = 22%
- 3.5.3 Maximum pressure during the brake recovery section; CD = 22%
- 3.5.4 Initial brake temperature during the brake recovery section; CD = 5.5%

4. CALCULATION STEPS FOR TEST OUTPUTS

4.1 Copy each individual submission tests and the audit test into the corresponding tabs on the PD5000 spreadsheet. See Table 3.

RTDN RETARDATION FORCE FACTOR TEST (50 MPH STOPS)			POWR BRAKE POWER TEST (50-15 MPH SNUBS, 9 FT/S ² DECEL)							RECY RECOVERY (30 MPH STOPS, 12 FT/S ² DECEL)						
STOP NO.	AVERAGE PRESSURE PSI	AVERAGE TORQUE LBF-IN XXXX AVG PRESS	STOP NO.	AVG FT/S ²	BRAKE PRESSURE MIN PSI XXX	MAX PSI XXX	0 STROKE MAX INCH XXX	INITIAL SHOE IB PAD/SHOE (F)	INITIAL DRUM ROTOR/DRUM (F)	STOP NO.	AVG FT/S ²	BRAKE PRESSURE MIN PSI XXX	MAX PSI XXX	0 STROKE MAX INCH XXX	INITIAL SHOE IB PAD/SHOE (F)	INITIAL DRUM ROTOR/DRUM (F)
RTDN NO.	RTDN BL-216 4 AVG PRESS	RTDN BL-216 4 AVG TORQ	POWR NO.	POWR BL-216 4 AVG DEC	POWR BL-216 4 MIN PRESS	POWR BL-216 4 MAX PRESS	POWR BL-216 4 STK MAX	POWR BL-216 4 IBT SHOE	POWR BL-216 4 IBT DRUM	RECY NO.	RECY BL-216 4 AVG DEC	RECY BL-216 4 MIN PRESS	RECY BL-216 4 MAX PRESS	RECY BL-216 4 STK MAX	RECY BL-216 4 IBT SHOE	RECY BL-216 4 IBT DRUM
1	19.8	25284	1	9.19	38.2	50.5	1.3	151	153	1	11.83	56.3	75.3	1.86	447	553
2	29.9	41784	2	9.02	39.6	49.6	1.41	203	255	2	12.09	55.8	73.8	1.84	451	550
3	40	56616	3	8.97	39.2	51.9	1.54	247	330	3	12.02	54.5	72.8	1.84	454	546
4	49.9	71220	4	8.91	40.9	52.3	1.63	285	387	4	12.13	53.4	72.2	1.82	456	541
5	60	83808	5	9.01	42.9	54.2	1.69	318	436	5	11.94	54.8	71.5	1.81	456	536
6	70	96096	6	8.94	43.4	54.4	1.73	350	480	6	12.2	55.3	73.4	1.82	456	534
7	79.9	105972	7	9	43.1	53.4	1.76	379	520	7	12.29	52.9	71	1.78	456	532
			8	9.01	43.4	53.1	1.79	405	554	8	12.03	51.8	72	1.78	459	530
			9	9	43.1	53.7	1.83	428	586	9	11.96	51.4	69.1	1.76	458	525
			10	8.91	43.1	54.9	1.85	454	613	10	11.9	50.7	69.3	1.76	459	525
										11	12	50.9	67.3	1.73	458	522
										12	12.03	52.1	71.2	1.75	459	520
										13	11.98	50.4	68.6	1.73	458	518
										14	11.93	51.3	68	1.72	461	518
										15	11.96	51.6	70.7	1.74	461	518
										16	11.9	51.6	70.5	1.74	461	516
										17	12.08	50.9	69	1.73	461	514
										18	12.02	50.9	70	1.73	461	513
										19	12.04	49.6	67.2	1.69	461	513
										20	11.98	50.6	68.9	1.73	461	513

Figure 3. SPREADSHEET FOR TEST RESULTS FROM EACH TEST

- 4.2 For each individual brake event, calculate the range and compare to the critical difference for repeatability per item 3.1.
- 4.3 For each individual brake event, calculate the range, standard deviation for repeatability, standard deviation for reproducibility, actual difference between the average of the three submission tests and the audit test for each brake event per items 2.1 and 2.2. Compare to the critical difference as defined by the Review Committee per item 3.2. Use the PD5000 spreadsheet. Use equation 3. See Fig. 3.

$$\left| \frac{s_1 + s_2 + s_3}{3} - a_1 \right| \leq L\% \left(\frac{s_1 + s_2 + s_3}{3} \right) \text{ (Eq. 3)}$$

where:

s_1, s_2, s_3 = value for test output parameter from each submission test (1 thru 3)

a_1 = value for test output parameter from audit test

$L\%$ = limit for critical differences (22% for retardation torque and pressure outputs; 5.5% for initial brake temperature)

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Avg torque during retardation section - output										22%				
RTDN BL-216 1	RTDN BL-216 2	RTDN BL-216 3	RTDN BL-216 4				STD							
AVG TORQ	AVG TORQ	AVG TORQ	AVG TORQ	RANGE 1-3	STD DEV 1-3	AVG	DEV/AVG	CD _f	CD _R	CD	CD/AVG	[AVG1-3]-4	ACCEPTANCE	
22611	20336	26313	25284	5977	996	23087	4.31%	2789	5579	5341	23%	-2197	ABOVE CD	
35751	33487	42343	41784	8856	1476	37194	3.97%	4133	8266	7914	21%	-4590	OK	
49955	48198	59196	56616	10998	1833	52450	3.49%	5132	10265	9828	19%	-4166	OK	
66337	62899	76467	71220	13568	2261	68568	3.30%	6332	12663	12124	18%	-2652	OK	
80532	75687	90354	83808	14667	2445	82191	2.97%	6845	13689	13106	16%	-1617	OK	
93573	87212	104692	96096	17480	2913	95159	3.06%	8157	16315	15620	16%	-937	OK	
105197	98858	119864	105972	21006	3501	107973	3.24%	9803	19606	18771	17%	2001	OK	

Max pressure during brake power section - output													
POWR BL-216 1	POWR BL-216 2	POWR BL-216 3	POWR BL-216 4				STD						
MAX PRESS	MAX PRESS	MAX PRESS	MAX PRESS	RANGE 1-3	STD DEV 1-3	AVG	DEV/AVG	CD _f	CD _R	CD	CD/AVG	[AVG1-3]-4	ACCEPTANCE
47.5	52.7	40.5	50.5	12.2	2.0	47	4.34%	5.7	11.4	10.9	23%	-3.60	ABOVE CD
48	54.7	43.4	49.6	11.3	1.9	49	3.87%	5.3	10.5	10.1	21%	-0.90	OK
47.5	54.4	46.2	51.9	8.2	1.4	49	2.77%	3.8	7.7	7.3	15%	-2.53	OK
48.8	54	49.1	52.3	5.2	0.9	51	1.71%	2.4	4.9	4.6	9%	-1.67	OK
49.3	54.1	52.1	54.2	4.8	0.8	52	1.54%	2.2	4.5	4.3	8%	-2.37	OK
50.2	57.3	52.4	54.4	7.1	1.2	53	2.22%	3.3	6.6	6.3	12%	-1.10	OK
52.5	60.5	54.4	53.4	8	1.3	56	2.39%	3.7	7.5	7.1	13%	2.40	OK
53.2	65.5	56.4	53.1	12.3	2.1	58	3.51%	5.7	11.5	11.0	19%	5.27	OK
54.8	70.6	59.3	53.7	15.8	2.6	62	4.28%	7.4	14.7	14.1	23%	7.87	ABOVE CD
59.1	77	62.3	54.9	17.9	3.0	66	4.51%	8.4	16.7	16.0	24%	11.23	ABOVE CD

Figure 3. CALCULATIONS FOR STANDARD DEVIATIONS AND CRITICAL DIFFERENCES (EXAMPLE FOR RETARDATION TORQUE AND MAXIMUM PRESSURE DURING BRAKE POWER)

5. ACCEPTANCE LIMITS FOR DECELERATION AND PRESSURE CONTROL

Verify deceleration control within ± 0.33 ft/s² from set-point, and pressure control within ± 1 psi from set-point.

6. PANEL ASSESSMENT

Present results to the Review Committee for a panel discussion, assessment, and decision on the product/laboratory results.

7. OFF-THE-SHELF TESTING ESTIMATED FEE STRUCTURE

Off-the-Shelf Brake Lining Selection, Testing and Reporting – Estimated costs:

Parts (1 Brake Drum, 1 Brake Set) - \$200 to \$300

Testing - \$1,250 to \$1,500

Empower test labs to purchase parts

Pricing may be determined on an individual basis to account for the cost of the disc brake rotor.

PREPARED BY REVIEW COMMITTEE FROM SAE-PRI QPL COMMERCIAL VEHICLE
PROGRAM PER RP628