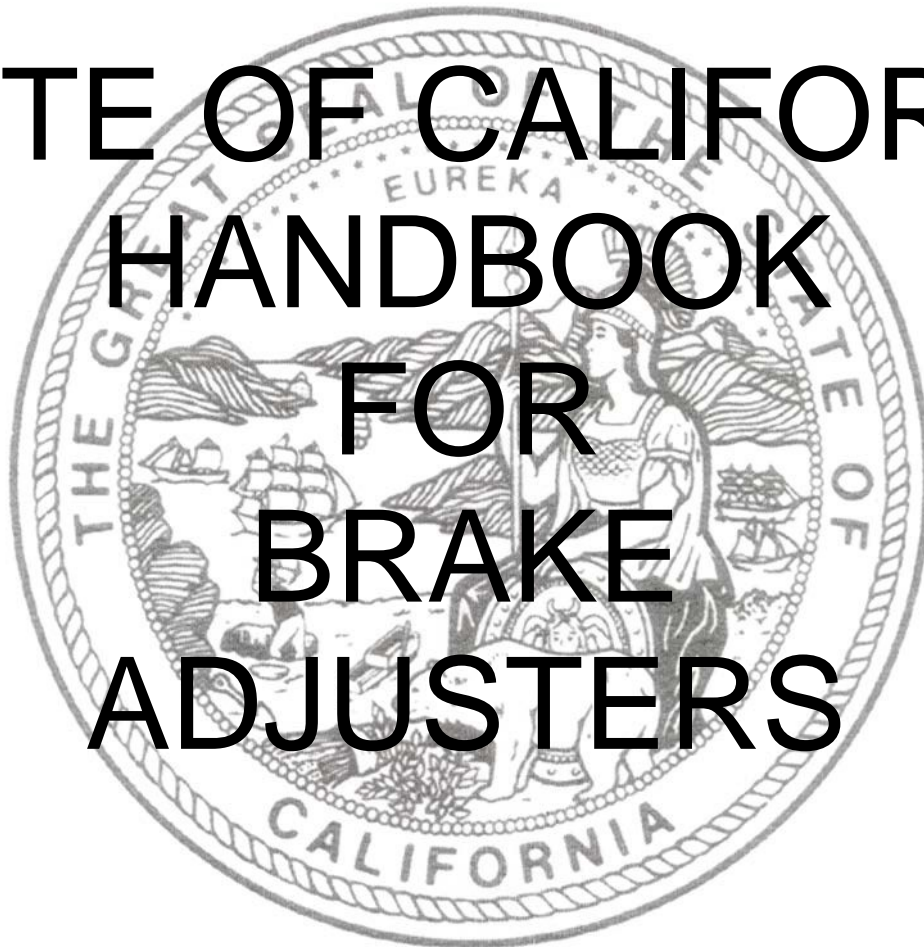


DEPARTMENT OF CONSUMER AFFAIRS



Bureau of Automotive Repair

STATE OF CALIFORNIA HANDBOOK FOR BRAKE ADJUSTERS



May 2015

STATE OF CALIFORNIA



DEPARTMENT OF CONSUMER AFFAIRS

BUREAU OF AUTOMOTIVE REPAIR BRAKE ADJUSTERS' HANDBOOK

FOREWORD

This Handbook is intended to serve as a reference for Official Brake Adjusting Stations and as study material for licensed brake adjusters and persons desiring to be licensed as adjusters. See the applicable Candidate Handbook for further information. This handbook includes a short history of the development of automotive braking equipment, and the procedures for licensing of Official Brake Adjusting Stations and Official Brake Adjusters.

In addition to the information contained in this Handbook, persons desiring to be licensed as adjusters must possess a knowledge of vehicle braking systems, adjustment techniques and repair procedures sufficient to ensure that all work is performed correctly and with due regard for the safety of the motoring public. This handbook will not supply all the information needed to pass a licensing exam.

No attempt has been made to relate the information contained herein to the specific design of a particular manufacturer. Accordingly, each official brake station must maintain as references the current service manuals and technical instructions appropriate to the types and designs of brake systems serviced, inspected and repaired by the brake station. Installation, repair and adjustment of motor vehicle brake equipment shall be performed in accordance with applicable laws, regulations and the current instructions and specifications of the manufacturer.

Periodically, supplemental bulletins may be distributed by the Bureau of Automotive Repair (BAR or Bureau) containing information regarding changes in laws, regulations or technical procedures concerning the inspection, servicing, repair and adjustment of vehicle braking equipment. Such supplemental publications should be kept with this Handbook for easy reference.

Suggestions for improvement of this handbook are welcomed. Comments should be addressed to the Bureau of Automotive Repair, 10949 North Mather Blvd., Rancho Cordova, CA 95670.

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The BAR Laws and Regulations Handbook is available from BAR, free of charge, on the Internet at www.oal.ca.gov or at www.smogcheck.ca.gov.

For California Vehicle Code Sections 26301 through 26522 (relating to brake requirements) see the California Vehicle Code (available at the Department of Motor Vehicles). The Vehicle Code and regulation sections mentioned herein are also published in the BAR Laws and Regulations Handbook. Vehicle Code and other California laws are also available on the Internet at www.leginfo.ca.gov.

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CHAPTER 1 - THE LICENSED BRAKE ADJUSTING STATION PROGRAM

OFFICIAL BRAKE ADJUSTING STATIONS. [SEE CALIFORNIA CODE OF REGULATIONS (CCR) SECTIONS 3300 THROUGH 3320]

Licenses are issued to official brake adjusting stations and to official brake adjusters that meet the requirements and qualifications for such licenses. The licenses that are issued by BAR are not transferable.

Classes of Stations.

Class A Station.

Class A stations may test, inspect, repair, adjust and certify the brakes and brake systems on all vehicles. A Class A licensed adjuster must be employed at all times the station is operating as a licensed station.

Class B Station.

Class B stations may test, inspect, repair, adjust and certify the brakes and brake systems on all buses, trucks, truck tractors, trailers and semitrailers. An adjuster holding either a Class A or B license must be employed at all times the station is operating as a licensed station.

Class C Station.

Class C stations may test, inspect, adjust, repair and certify the brakes and brake systems on all trucks and truck tractors

having a manufacturer's Gross Vehicle Weight Rating (GVWR) of less than 10,000 pounds, all trailers and semitrailers which do not use compressed air or vacuum to actuate the brakes, and all passenger vehicles including motorcycles and motor-driven cycles. A Class A or Class C adjuster must be employed at all times the station is operating as a licensed station.

Scope of Station Licenses.

A licensed station shall not certify the adjustment of brakes on any vehicle of a type not included in the scope of the station's license. The complete station license number shall always be recorded on any certificate of adjustment.

Fleet Owner Stations.

A station license of any class may be issued to an owner of a fleet of three or more vehicles provided the station meets the requirements for the class of station designated in the application. A fleet owner station need not display a sign or post prices and is required to maintain the necessary manufacturer's specifications and instructions only for those vehicles serviced by the fleet owner station. Such a station shall service and maintain only those vehicles owned and/or operated by the fleet owner and the license must be of a class appropriate to the types of vehicles being inspected.

Application for Station License.

An Automotive Repair Dealer may obtain an application for a brake station license from a BAR office or from the BAR

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Licensing Unit. Applications are also available on the BAR Internet Web Page at www.autorepair.ca.gov or by calling BAR's toll free number: 800-952-5210.

Once an application is received by the Licensing Unit, a BAR representative will inspect the station and approve the application if the station meets BAR requirements, including the employment of an adjuster having a license of the appropriate class, required tools, signs, etc.

Station License Fees / Renewal.

Brake station licenses issued by BAR are subject to the following fees:

a. For an initial license, including a change of ownership or class of station: \$10.

b. For a renewal license that is renewed prior to expiration of the old license: \$5. The application must be postmarked on or before the license expiration date.

c. For a renewal license renewed within 30 days after expiration of the old license: \$7.50. A license will not be renewed if the application is received by BAR more than 30 days after the date of expiration. The dealer will have to apply for a new license and send \$10, the fee for a new license, to BAR.

d. For a duplicate of a lost, destroyed, or mutilated license: \$2.

e. For a replacement of a license due to a change of address, or a change of name

not involving a change of ownership: No Fee.

(1) Change of Address Defined: "Change of address" means any relocation of a licensed business not involving a change in ownership, or any change in the mailing address including a change resulting from street renumbering.

(2) Change of Ownership Defined: "Change of ownership" means any change in legal ownership of the licensed business, including the addition or deletion of partner, transfer of ownership between members of a family, or disposal of one business in favor of a similar business at a different location.

Lost, Destroyed, or Mutilated Station Licenses.

If an official station license is lost, destroyed, or mutilated, an application with the appropriate fee must be submitted for a duplicate license. If a lost license is found following issuance of a duplicate, the original license shall then be returned to BAR.

Replacement License.

In the event of a change of name not involving a change of ownership, or a change of address of the licensed station, the license shall be returned to BAR with an application for a replacement license. Applications for replacement licenses are available at your local BAR field office, by calling BAR's toll free number (800) 952-5210, or on the Internet at www.autorepair.ca.gov. The original

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license will be canceled and a corrected license for the balance of the unexpired term will be issued.

License Term. Official Brake Adjusting Station licenses are valid for one year and may be renewed upon expiration. Stations whose license has expired and has not been renewed shall immediately cease any activity requiring a license.

License Renewal. A renewal application is normally mailed to the dealer prior to the expiration of the license. (If the dealer does not receive a renewal application before the station license expires, the dealer should call the Licensing Unit for further instructions.) The dealer should send the renewal application plus a fee of \$5 to the Licensing Unit during the 30-day period prior to the date of expiration. If the license is allowed to expire, the station may no longer operate as a licensed station, but the dealer may still apply for renewal of the license by sending an application plus a late renewal fee of \$7.50 during the 30-day period following the expiration date. A license will not be renewed if the application is received by the Licensing Unit more than 30 days after the date of expiration. The dealer will have to apply for a new license and send \$10, the fee for a new license, to the Licensing Unit.

General Requirements.

The specific and detailed requirements applicable to official brake adjusting stations are contained in Article 2 starting with Section 3304 and Article 4 starting with Section 3320 of Title 16 of the California Code of Regulations (CCR). These

regulations are also contained in the Laws and Regulations Handbook published by BAR. Certain requirements are as follows:

a. **Display of Station Sign.** Each official brake adjusting station must obtain and display an official station sign meeting the specifications contained in Section 3309 of Title 16, CCR prior to being inspected by a BAR representative. The sign must be displayed in a location where it is clearly visible from outside the station, either on the exterior of the premises or in a window. Information regarding vendors of official station signs may be obtained from the BAR Representative who inspects the station, the Consumer Information Center, (800-952-5210), or the BAR Internet site www.autorepair.ca.gov.

b. **Presence of an Official Adjuster.** A licensed brake station must provide the services of an appropriately licensed adjuster during normal daytime business hours for not less than 40 hours per week, or if open less than 80 hours per week, for not less than one-half of the total hours each week the station is open for business. An official station which no longer employs a licensed adjuster shall immediately remove or cover the official station sign and cease to operate as a licensed station. If the station does not employ an official adjuster within 60 days, the official station license and all unused certificates of adjustment shall be returned to BAR.

c. **Posting of Price Sign.** Each official station except a fleet owner station may make reasonable charge for the work performed and shall post conspicuously a list of price ranges for the specific activities

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for which it is licensed. Prices may be stated either as a fixed fee or an hourly rate on a time-and-material basis. No added charge shall be imposed for the issuance of an Official Brake Adjustment Certificate or certifications on enforcement documents of the correction of brake violations. No charge relating to repair, replacement of parts, or adjustment of brakes shall be imposed in addition to the posted price for such adjustment or inspection unless such additional work and added charges are authorized in advance by the vehicle owner or operator.

d. Brake Adjustment Certificates and Certification of Enforcement Documents. Official brake stations may obtain brake adjustment certificates at the nearest BAR office or by mail. Mail requests may be made by sending a request for certificates with a check to: Department of Consumer Affairs - BAR P.O. Box 989001, West Sacramento, CA 95798-9001. Certificates are sold only to an authorized representative of a licensed brake station and identification of such persons is required.

(1) A copy of each brake certificate issued shall be filed and retained by the station for three years from the date of issue. It is a good idea to write the certificate number on the repair order for future reference. The class of both the station's and installer's licenses shall be included on the certificate of adjustment.

(2) Brake certificates and repair orders/invoices shall be available for inspection by a representative of the Bureau of Automotive Repair. All records must be maintained for a period of 3 years.

e. Adjustment and Repair. All adjusting and repairing of brakes and related systems necessary to correct and clear violations noted on an enforcement document and to issue an official Certificate of Compliance - Brake Adjustment shall be performed in an official station in accordance with accepted industry practices, standards, and recommendations, the specifications and instructions of the vehicle or brake component manufacturer, and the instructions and regulations of BAR. Official stations are advised to maintain reputable business and performance standards in all transactions, including work not requiring official certification.

The adjuster shall inform the customer of any other defective conditions present or likely to occur in the future which have come to the adjuster's attention in conjunction with inspection of the vehicle and correction of specified defects. The adjuster shall inform the customer of the amount of braking material remaining on the pads/shoes, as appropriate.

If the customer does not authorize additional repairs to correct other defects found during the inspection, the adjuster shall certify that only the specific defects listed on the enforcement form have been corrected. BAR suggests that needed repairs also be documented on the repair order.

Certification by a licensed adjuster on an enforcement form that a violation has been corrected shall include date of correction, station and adjuster license numbers, and the adjuster's signature.

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f. Required Tools and Equipment. Official Brake Adjusting Stations are required to post and maintain the appropriate signs and licenses as specified in Title 16, CCR, Section 3307 (c).

Stations must also have, on the station premises, all tools, manuals, certificates, and other materials as specified in CCR Section 3321.

g. Inspection of Stations. Each official brake adjusting station will be inspected periodically by a BAR representative. The BAR representative will inspect to ensure the station has all of the required tools and reference materials as specified in CCR Section 3321. The licensee or an authorized employee will be required to sign the completed Official Station Inspection Form. A copy of the inspection form will be provided to the licensee. Violation of BAR regulations noted during the inspection will be brought to the attention of the licensee for immediate corrective action. Failure to correct violations may result in action to suspend or revoke the station license or in the filing of a criminal complaint against the station owner and/or adjuster.

Public Relations.

Vehicle owners are referred to official brake adjusting stations by the California Highway Patrol and the Department of Motor Vehicles. Stations should make it as easy as possible for motorists to have brake deficiencies corrected.

a. Official brake adjusting stations are difficult to identify in some areas.

Accordingly, station licensees are urged to advertise or provide other public notice regarding their official status, locations, and services.

b. An official brake adjusting station is required to register as an Automotive Repair Dealer and the law requires such station to maintain a registration that is valid. This station, as an Automotive Repair Dealer, is required to give each customer a written estimated price for labor and parts necessary for a specific job, and no work shall be done and no charges shall accrue before authorization to proceed is obtained from the customer (CCR Section 3353). No charge shall be made for work done or parts supplied in excess of the estimated price without the oral or written consent of the customer. The customer shall also be given an itemized invoice as specified in CCR Section 3356(a).

Official station operators should also review the regulations pertaining to the proper posting of prices for brake adjustment and repair. (See CCR Section 3307.)

c. Official brake adjusting stations are designated by BAR to certify that corrective action has been performed on vehicles cited for certain deficiencies and/or to inspect and certify a specially constructed or reconstructed vehicle. Therefore, the owner of such a vehicle looks upon an official station as an authorized agent of the State. This places added responsibility upon the official station to treat customers fairly and courteously.

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OFFICIAL BRAKE ADJUSTERS.

Classes of Adjuster Licenses.

There are three classes of official brake adjuster licenses. Licensed adjusters shall not certify the brake system on any vehicle of a type for which he/she does not have an adjuster's license. The three classes of adjusters licenses are:

a. Class A. Class A Official Brake Adjuster licenses may be issued to persons who have shown by examination that they are qualified to test, inspect, adjust, and repair the brakes and brake system on all vehicles including motorcycles and motor-driven-cycles.

b. Class B. Class B Official Brake Adjuster licenses may be issued to persons who have shown by examination that they are qualified to test, inspect, adjust, and repair all brakes and brake systems on all buses, trucks, and truck tractors, trailers, and semitrailers.

c. Class C. Class C Official Brake Adjuster licenses may be issued to persons who have shown by examination that they are qualified to test, inspect, adjust, and repair all brakes and brake systems on all trucks and truck tractors having a manufacturer's gross vehicle weight rating (GVWR) of less than 10,000 pounds and all trailers and semitrailers which do not use compressed air or vacuum to actuate the brakes, and all passenger vehicles including motorcycles and motor-driven-cycles.

Scope of Adjuster's License.

A licensed brake adjuster shall not certify the adjustment or operation of brakes on any vehicle that is not in compliance with the California Vehicle Code sections relating to brake adjustment and/or requirements.

Adjuster Licensing Procedures.

a. A person desiring an Official Brake Adjuster license may obtain an application at any BAR office, or from the BAR Internet web site www.autorepair.ca.gov. The completed application must be mailed to the BAR Licensing Unit in Rancho Cordova. Care should be taken that information on the application is accurate and legible. Each application for a new or renewal license shall be accompanied by a fee of ten dollars (\$10) for a new license or five dollars (\$5) for a renewal license. If the renewal application is received by the bureau within 30 days after the date of expiration, the late renewal fee shall be \$7.50. The application shall be made upon a form furnished by the director. It shall contain such information concerning the applicant's background and experience as the director may prescribe, in addition to other information required by law.

b. If the application is acceptable, the applicant can schedule a written examination on applicable laws, regulations, brake repair and adjustment procedures. A passing score on the examination is required for the issuance of an adjuster license.

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License Term and Renewal.

Official brake adjuster licenses issued by the BAR are valid for four years and shall expire on the last day of the adjuster's birth month; therefore, an initial license may be valid for 42 to 54 months. Subsequent licenses are valid for up to four years, expiring on the last day of the adjuster's birth month.

Display of License in Official Station.

The license of each official adjuster employed in an official brake adjusting station must be prominently displayed in the station under glass or other transparent covering. The home address of the adjuster may be covered while the license is posted at an official brake station. When any licensed brake adjuster ceases to be employed at an official station, the adjuster's right to act as an official brake adjuster shall immediately cease, and he/she shall not engage in the activity of an official brake adjuster until he/she is again employed at an appropriate official brake adjusting station. While unemployed he/she shall not certify the adjustment of brakes on any vehicle or sign enforcement documents.

Lost, Destroyed, or Mutilated Adjuster Licenses or Additional Copy Needed.

An application for a duplicate license (available at your local BAR office, BAR Headquarters in Rancho Cordova or on the Internet at www.smogcheck.ca.gov) shall be submitted to the Licensing Unit whenever an adjuster's license is lost, illegible, destroyed, or if an additional copy

is needed to post in a second station. If a duplicate is desired for an illegible or mutilated license, the original license shall accompany the application. If the license has been lost or destroyed or an additional copy is needed, it shall be so noted on the application. A written examination is not required when the application is for a duplicate license. The fee for a duplicate license is \$2 each.

DISCIPLINARY ACTIONS.

Suspension or Revocation of Licenses.

The director may suspend, revoke, or take other disciplinary action against a license as provided in this article if the licensee or any partner, officer, or director thereof:

(a) Violates any section of the Business and Professions Code which relates to his or her licensed activities.

(b) Is convicted of any crime substantially related to the qualifications, functions and duties of the license holder in question.

(c) Violates any of the regulations promulgated by the director pursuant to this chapter.

(d) Commits any act involving dishonesty, fraud, or deceit whereby another is injured.

(e) Has misrepresented a material fact in obtaining a license.

(f) Aids or abets an unlicensed person to evade the provisions of this chapter.

(g) Fails to make and keep records

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showing his or her transactions as a licensee, or fails to have the records available for inspection by the director or his or her duly authorized representative for a period of not less than three years after completion of any transaction to which the records refer, or refuses to comply with a written request of the director to make the records available for inspection.

(h) Violates or attempts to violate the provisions of this chapter relating to the particular activity for which he or she is licensed.

(i) Is convicted of a violation of Section 551 of the Penal Code.

Voluntary Surrender of Licenses.

The voluntary surrender of an official station or adjuster's license is subject to the provisions of Section 3308 of Title 16 of the California Code of Regulations.

CHAPTER 2 - SERVICE TO THE CUSTOMER.

Complaint Prevention.

In order to prevent complaints, brake adjusting station owners are encouraged to:

a. Advertise Station Location. Public notice as to station location and services available should be provided.

b. Post Prices. Official stations are required to post prices for adjustment and repairs (see 3307(d) CCR). Where repairs are necessary to obtain a proper

adjustment, the motorist must be advised of the reasons and additional cost for such repairs and authorize the work.

c. Maintain Station Image. Official Brake Adjusting Stations are designated by the Bureau of Automotive Repair to certify that corrective action has been performed on vehicles cited for certain deficiencies. Therefore, the owner of such a vehicle looks upon an Official Brake Adjusting Station as an authorized agent of the State and, as such, he/she expects to be treated accordingly.

Quality Service.

Quality brake service requires the technician to perform an inspection of the brake system and inform the customer of the work necessary to bring the vehicle's brake system to within manufacturer's specifications. The customer has the option of choosing the amount of work to be performed. The technician must follow proper estimate and invoice procedures.

Complete Brake Service.

Complete brake service means repairing the vehicle to the vehicle manufacturer's specifications. This is the final result which every car owner wants when he or she has brake work done. Therefore, it is the final result which every technician should achieve when performing brake service work.

Mechanical Know-How.

The know-how which you as a technician acquire must include a sound working

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knowledge of complete brake systems - from pedal to wheel - with an understanding that all parts of the system must work together when the brakes are applied. A thorough understanding of modern brake systems, including manual systems, power assisted systems, disc/drum systems, disc/disc systems and anti-lock systems, is essential.

CHAPTER 3 - HISTORY OF BRAKES AND PRINCIPLES OF OPERATION

HISTORY OF BRAKES.

Definition of Braking Action.

When force is applied to retard or stop a moving object, braking action is being applied. To stop a revolving wheel, an opposing force is placed against it, thus causing a braking action.

External Mechanical Brake.

The first automotive brake was an external type, so called because the brake lining was attached to a steel band which was fitted around the outer surface of the drum. Through mechanical means the brake band was clamped around the drum, thus causing braking action.

Internal Mechanical Brakes.

Higher vehicle speeds require faster stops. The fact that external brakes were subject to weather and road conditions, and that normal drum expansion often caused brakes to lock, brought about the adoption

of internal brakes for both service and parking purposes.

Early internal type brakes were called "mechanical brakes." The brake shoes were pedal-operated through a system of rods or cables and cams. These mechanical wheel brake assemblies each consisted of three principal parts: (1) a brake drum; (2) brake linings; and (3) brake shoes.

Internal Emergency Brakes.

The internal expanding brake was first used only as an emergency hand brake and was operated by a simple hand brake lever.

Hydraulic Brakes.

Hydraulic brakes are operated by applying pressure to a foot operated master cylinder which forces a special-type hydraulic fluid, through tubing, to each of the wheel cylinders. The hydraulic brake was first used about 1921. Since that time, hydraulic, air, vacuum, and electrically operated systems have replaced mechanical systems, with few exceptions, i.e., some older motorcycles, etc.

PRINCIPLES OF OPERATION.

Application of the Braking Principle.

Brakes reduce motion of the wheels of a moving vehicle by developing friction to convert the kinetic energy of the vehicle into heat. This heat is dissipated into the surrounding air as rapidly as possible.

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Cooling also occurs during non-braking intervals.

Friction in Braking.

Several applications of friction occur in the braking process:

a. Rolling Friction. The only contact between the vehicle tires and the road is a rolling friction and it is this friction which must actually stop the vehicle. Should the brakes overcome rolling friction to the extent that any wheel is locked, all of the heat produced is confined to the small skid area of the tire. More time and distance is required to stop the vehicle, control is lost, and tire wear is increased. Therefore, many manufacturers now equip their vehicles with an anti-lock type brake system.

b. Coefficient of Friction. The stopping distance is influenced by the road's coefficient of friction, which is approximately 60 percent on dry concrete, less on asphalt, still less on gravel, and quite low on wet or icy surfaces. This maximum brake retarding effect of the road is one of the forces which determines the amount of deceleration, often called the "K" percent of the weight being stopped. A 0.60 "K" stop (60 pounds retarding force per 100 pounds of weight) is the approximate limit of present highways.

c. Tire Diameter. Tire diameter is also a factor, since leverage between the brake and wheel is reduced by increases in the rolling radius. Therefore, the amount of brake torque capacity (stopping power) needed depends primarily upon gross

vehicle weight, tire size, and the desired "K" factor. Excess brake torque capacity would not improve performance and could make braking unduly sensitive, reducing control during normal easy stops or on slippery surfaces.

The Foundation Brake.

The brake shoe arrangement, commonly known as the "foundation brake," must be controlled with some form of "brake actuating system." With drum brakes, the shoes are forced against the drum by pistons under fluid pressure. To assist or supplement manual operation, the system may include a power unit operated by vacuum or compressed air. Cam-operated brake shoes are actuated mechanically and, in modern usage, are found on heavy trucks and trailers equipped with air or vacuum-powered brake actuating systems.

Stopping Torque.

The amount of stopping torque developed by a foundation brake of given type and size depends upon the amount of controlling actuating force being used. It also depends upon built-in factors such as the amount of shoe energization, amount of shoe leverage, and characteristics of the brake lining.

Shoe Energization Factor.

When shoes contact the drum, the friction drag tends to rotate each shoe about the hinge point (anchor). When this shoe friction presses the shoe lining into tighter contact with the drum, it acts as a "self-energizing" force which is added to the

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actuating force to assist the braking operation. Conversely, if the drag tends to force the shoe away from the drum, it resists the actuating force and is described as a "de-energizing" force. Self-energized shoes are frequently referred to as "forward," "leading" or "primary" shoes and the de-energized shoes as "reverse" or secondary "trailing" shoes. All drum type brakes make use of these energization principles in varying degrees.

Shoe Leverage Factor.

Actuating force is applied to one end (toe) of the shoe and the shoe anchor, at the opposite (heel) end, becomes a fulcrum about which the shoe rotates. This makes the shoe a lever and this leverage assists the actuating and self-energizing forces to press the shoe against the drum. Obviously, a larger drum diameter permits more shoe leverage; thus, the modern trend toward smaller wheels and drums requires brake designs which make most effective use of leverage and energization.

Since leverage assists the shoe throughout the lining-contact area, the leverage effect is less near the anchor than at the opposite end or "toe." If the leverage effect occurs too near the toe end of the lining arc, the movement of the shoe becomes wild and uncontrollable. If the lining surface is in good, even contact with the drum, and the average leverage occurs near the center of the lining arc, braking will be effective and controlled. If, however, the maximum force is concentrated too near the fulcrum (anchor) end of the shoe, the average leverage will be relatively small and the braking effect lessened. This last condition

can result in a "pull" which swings the vehicle to the opposite side when brakes are applied if the brake on the opposite wheel is operating normally. Likewise, when concentrated too near the shoe toe, the brake will "grab" and pull the vehicle toward the side on which the grabbing brake is located.

Drum Deflection and Thermal Expansion.

It is normal for the pressure of lining contact to produce some brake drum "deflection." This term means the distortion of the brake drum as it rotates about the shoes. The amount of deflection varies with each stop since no two stops are alike. Deflection does not expand the drum; instead, the shape of the drum is distorted as it rotates so that maximum deflection (distortion) occurs at the area of greatest contact pressure. The brake shoe will also flex in a balancing action. A "turned" drum will have more deflection since removal of metal weakens the drum structure. If the brake drum is out-of-round, out-of-square, scored, turned too thin, or if improper lining contact or poor shoe centering exists, deflection becomes abnormal and contributes to "grab," "pull," and noise problems. Overheating, whether the result of unusually severe service, improper lining contact, or too thin a drum, produces an abnormal thermal expansion of the drum which may cause a noticeable loss of pedal reserve (pedal fade) as the shoes move outward to maintain lining contact in the expanded drum. This often occurs in conjunction with lining fade.

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Lining Characteristics.

Suitable linings for hydraulic brakes normally provide medium-high frictions while the lower-medium frictions are generally used with full-powered cam brakes equipped with the thicker block linings. Modern linings serve a rather wide low-to-high friction coefficient range from approximately 0.30 to 0.43. The use of too high a lining friction can result in a severe, grabby braking action with a sensitive pedal; too low a friction could render stopping more difficult because of an extremely "hard" pedal. Other characteristics may be just as important as suitable friction value. These are: little tendency to compress, to swell, or to expand when heated; little sensitivity to humid or wet conditions; freedom from drum scoring; quiet and odor-free operation; and life-long operating stability with suitable wear life in the anticipated range of brake heat.

a. Overheating. Overheating a lining accelerates its wear. For this reason, heavier vehicles and passenger cars equipped with smaller wheels (and drums) have comparatively wide linings to provide the necessary contact area. Overloaded vehicles, extremely severe operating conditions, or, most important to every technician, improperly fitted linings with spotty contact, cause increases in the local contact pressure and heat rise and can result in overheating. Overheating is also the cause of potentially dangerous "lining fade;" a friction-reducing condition which "hardens" the pedal and lengthens the stop. In a "panic" stop from extremely high speeds, almost any lining shows some

fade, but if it has quick recovery characteristics, will usually return to normal in time for the next stop. Continual overheating, however, will eventually push lining past the point of recovery into a permanent "fade" condition. Overheating is indicated when the lining is charred, has a glass-hard glazed surface, or severe and random cracking of the surface. In addition to fade, overheating may cause "squeal."

b. Grooved Linings. Grooved linings are used on some passenger cars, usually with the wider shoes, to relieve a concentrated stress above the shoe web and thus achieve a more uniform contact pressure. Ungrooved linings should not be "field grooved" since the reduction in contact area would lead to higher braking temperatures.

c. Classes of Linings. All lining characteristics are relative, so it is not always possible to select the ideal replacement lining for every diversified modern braking condition. Most linings are considered general purpose and are suitable for "every day driving." Adjusters should inform their customers that use of a lining other than a general purpose type may affect the vehicle's ability to stop in some situations.

(1) General Purpose, Universal Type Lining. This type should provide the characteristics required for safe stopping in the braking range of most drivers.

(2) High Speed Heavy-Duty Service Lining. This type should have more heat-resistant, fade-resistant, quick-recovery characteristics for

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automotive uses demanding a durable, superior performance. Brake linings with these characteristics require the most accurate shoe alignment and initial adjustment and break-in.

d. Shoe-Lining Attachments. The three methods currently used to attach lining to brake shoes are:

(1) Bonding. This method utilizes special sheet or liquid adhesives to bond the lining directly to the shoes. This method requires heat and special pressure equipment to properly bond shoe and lining.

(2) Riveting. Rivets of the semi-tubular type anchor the lining to the brake shoe. Soft rivets are used for their easy crimping qualities and the selection of correct size, type and method of riveting is very important to ensure that the lining is firmly and evenly anchored to the shoe.

(3) Bolting. This method is generally limited to block-type lining used on extra heavy duty trucks and other heavy-duty vehicles. Brass bolts are commonly used to reduce the possibility of scoring brake drums and to facilitate the removal of worn linings.

e. Seating of New Lining. New brake lining should be broken in using the brake and/or vehicle manufacturer's recommendations.

Conclusion. The material presented in this chapter briefly reviews the history and fundamentals of the modern motor vehicle drum brake. A complete review of the

history would fill several large volumes, therefore, a great deal of material has been omitted.

CHAPTER 4 - PASSENGER VEHICLE BRAKE SYSTEMS

HYDRAULIC SYSTEM

General.

Passenger cars and light trucks are universally equipped with a hydraulic system for operation of the service brakes. The major components of the hydraulic system include application pedal, master cylinder assembly, brake fluid, fluid distribution lines (tubing or hoses), and individual wheel cylinder or caliper assemblies. The system may also include a power-assist feature to supplement pressure applied manually to the system and an anti-lock feature that prevents wheel lock-up during hard braking.

Application of Force.

In the hydraulic system, pressure applied to the brake pedal forces fluid from the master cylinder reservoir through distribution lines to the individual wheel cylinders or calipers. Pistons in the wheel cylinders or calipers apply mechanical force to move the brake lining against the brake drum or rotor to provide braking action.

Self-Equalizing.

The force applied by the hydraulic system is self-equalizing upon brake pedal application. Since the pressure is normally

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equal in all parts of the hydraulic system, braking pressure cannot be applied to any one brake drum or rotor until each shoe or pad is in contact with its respective drum or rotor and each wheel cylinder or caliper piston has moved to the limit of its travel.

Maintenance.

Maintenance problems associated with the hydraulic system include exterior leaks of fluid, interior leaks in wheel or master cylinders, air in system, restrictions in the fluid distribution system and problems with the anti-lock system components. All servicing, maintenance, and repair of the hydraulic system should be in accordance with the manufacturer's specifications and recommendations.

HYDRAULIC BRAKE FLUID.

General.

Brake fluid is a specially blended liquid which provides a means of transmitting hydraulic pressure between the master cylinder and the brake wheel cylinders or calipers. Brake fluid is one of the most important parts of the hydraulic brake system since it ties all of the hydraulic system components of the modern brake system together into an integral operating unit. Federal laws require that brake fluid must meet SAE (Society of Automotive Engineers) specifications. Do not use brake fluid that does not meet SAE specifications. Add only the D.O.T. brake fluid number listed on the master cylinder reservoir, or specified in the vehicle owner's manual. Never mix D.O.T. 5 (Synthetic) brake fluid with D.O.T. 3 or D.O.T. 4 fluid.

Characteristics.

Brake fluid must have the following characteristics:

- a. Viscosity (free flowing at all temperatures)
- b. High boiling point (remain liquid at highest operating temperatures).
- c. Non-corrosive (must not attack metal or rubber parts).
- d. Lubricating ability (must lubricate piston and cups to reduce wear and internal friction).

Contaminated Brake Fluid.

As a result of use, brake fluid becomes contaminated and loses some of its original qualities. Therefore, many vehicle manufacturers recommend replacing the brake fluid as part of a vehicle's routine maintenance.

If brake fluid is old, rusty, contaminated, or if major brake work is being performed, it is good practice to bleed the brake system until all old fluid is removed following the manufacturer's recommendations. When installing new brake fluid, again, follow the manufacturer's recommendations regarding the correct fluid to use and the procedure to bleed the system.

Also, if any of the rubber parts of the hydraulic system are soft or swollen, old fluid should be removed, and the hydraulic system should be flushed with clean brake fluid or cleaned per the vehicle

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manufacturer's recommendations. (All cups and seals also should be replaced.) Do NOT use "used" brake fluid.

Handling and Storing.

The following basic rules should be applied when handling and storing brake fluid.

a. Keep the brake fluid clean. Do not get any foreign material in the fluid.

b. Be careful to keep any petroleum product (gasoline, kerosene, oil, grease, etc.) or moisture from getting into the brake fluid.

c. Use only clean containers for dispensing brake fluid. Do not use containers contaminated with dirt, oil, grease, water, rust, etc.

d. Always cover or cap brake fluid containers when not actually dispensing the fluid.

e. Brake fluid is a hazardous material and therefore, it must be discarded in a manner consistent with environmental laws and regulations.

f. Store brake fluid containers in a clean, dry place.

g. Clean, dry compressed air is essential in air operated pressure bleeding equipment. Residue from air lines, misted oil and water can be picked up from the compressor tank. If the equipment for pressure bleeding does not provide positive separation of the compressed air from the brake fluid, means must be provided to

have a source of clean, dry compressed air to prevent contamination of the fluid.

MASTER CYLINDER.

Description.

The master cylinder is a form of hydraulic pump operated by the brake pedal through a link or push rod. A typical master cylinder consists of a cylinder, a piston with a primary and secondary cup, a residual pressure check valve, a return spring and a fluid reservoir.

Operation.

When force is applied to the brake pedal, the force is multiplied by the pedal lever and transmitted through the push rod or link to the master cylinder piston. The piston converts the force into hydraulic fluid pressure. Hydraulic fluid under pressure is forced through the check valve and hydraulic lines into the wheel cylinders to expand the shoes against the drums. When the brake pedal is released, the brake shoe return springs force the fluid through the hydraulic lines and residual check valve back into the master cylinder. The compensating port is reopened when the master cylinder piston reaches the full release position. When the brake pedal is released quickly, the master cylinder piston may return faster than the fluid from the wheel cylinders. If this happens, fluid from the reservoir enters the cylinder through the inlet port to keep the chamber ahead of the piston full of fluid. As the wheel cylinder pistons return to the fully released position, the excess fluid in the system is returned to

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the fluid reservoir through the compensating port.

Pressure Reducing Valve.

A specially designed hydraulic pressure reducing valve is connected between the master cylinder and the rear wheel cylinders to properly balance the output of the rear brakes with the front brakes when high pressure stopping is required. This reduction of hydraulic pressure to the rear brakes prevents premature rear wheel lockup. All vehicles equipped with disc brakes on the front axle and duo-servo brakes on the rear axle use the pressure reducing valve as described above. It is sometimes called the proportioning valve. The valve design and its performance varies, depending upon the vehicle on which it is installed. Do not adjust or disassemble the pressure reducing valve. BAR recommends replacing it with a new unit when a malfunction of the valve is present.

SPLIT SYSTEMS (DUAL SYSTEMS).

Description.

Most passenger cars and light trucks, starting with the 1967 model year, are equipped with split hydraulic systems (also called dual systems).

The split system is designed to protect against a complete loss of braking action in the event of a failure of the hydraulic system. One part of the system actuates two wheels and the other two wheels are

actuated by the other part of the master cylinder (usually divided as front wheels and rear wheels); two independent hydraulic systems separated by means of a split master cylinder. Hydraulic leakage or complete failure in one portion of the system cannot affect the other portion. Brake pedal travel increases when only one half of the system is operating and should alert the driver to a malfunction in the hydraulic system. A warning light on the instrument panel of most 1967 and later model cars will also alert the driver. Stopping distance may increase as braking action is being applied to only two wheels.

Checking the System.

There are two checks to be performed on split systems. The master cylinder has separate reservoirs and both should be checked for fluid level. Secondly, the warning light should be checked in accordance with manufacturer's recommendations.

Master Cylinder Brake Fluid Level.

a. Drum Brakes. Fluid level drop in the master cylinder is not directly related to brake wear. Periodic level checks are necessary since slight reservoir loss may be expected.

b. Disc Brakes. Since disc brake pads or shoes have no retracting springs, master cylinder fluid level will drop as pads wear. Fluid level drop in the master cylinder is related to brake pad wear.

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POWER-ASSISTED SYSTEMS.

General Description.

Many passenger cars and light trucks have power-assisted brake systems. A unit powered by vacuum from the intake manifold provides force supplementing manual pressure on the hydraulic system. Two of the three types of power units supplement manual pressure applied to the master cylinder and one type of unit boosts hydraulic pressure applied by the master cylinder to the wheel cylinders.

Types of Systems.

The three basic types of vacuum power brake units are as follows:

a. Integral Type. The integral type supplements manual pressure to the master cylinder and is any type power brake unit having the master cylinder assembly mounted directly on the vacuum chamber.

b. Pedal Assist Type. The pedal-assist type power brake unit applies force to the brake pedal linkage to supplement pressure applied manually to the master cylinder. The hydraulic master cylinder is independent of this type of power brake unit.

c. Pressure Multiplier Type. The pressure multiplier type of power brake unit has a self contained hydraulic cylinder known as a "slave" that works in conjunction with, and is actuated by, the master cylinder on the vehicle to boost hydraulic pressure to the wheel cylinders.

DRUM TYPE BRAKES.

Types.

There are numerous types of drum brakes, each given a name descriptive of its design. Drum-type brakes are generally classified as "Servo" or "Non-Servo" types. The servo-type is also known as the "compound shoe" type.

Operation.

The brake shoes are anchored to a backing plate rigidly attached to the axle housing or wheel suspension unit and the drum rotates with the wheel. Fluid pressure forces the wheel cylinder pistons to move the brake shoes toward the rotating drum. As the brake shoe linings contact the drum, braking action is applied. Upon release of the hydraulic pressure, coiled springs return the brake shoes to the unapplied position.

Braking Force.

All the brakes on a vehicle are designed to be applied equally since they normally receive the same hydraulic pressure. (As previously noted, disc/drum and disc/disc systems use a proportioning valve that distributes pressure proportionately front and rear.) However, the amount of braking force upon a wheel is determined by the diameter of the wheel and master cylinders, and/or the size of the brake drum and shoes.

Self Energizing Brakes.

Some drum-type brakes are designed to use the rotating force of the drum to assist

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in applying the service brakes. The brake shoes, anchor, and connecting linkage are so arranged that, when the shoes contact the drum, the rotating forces cause the front shoe to rotate slightly with the drum until it contacts the rear shoe and forces it against the anchor pin. Use of frictional force to increase the pressure of the shoes against the drum is called self-energizing and use of the force in one shoe to apply the other shoe is called servo action.

Self Adjusting Brakes.

Most drum-type brakes are designed with a self-adjusting mechanism. When sufficient lining has been worn from the shoes, a self-adjusting lever picks up a tooth on the star wheel of the adjusting screw. If the brakes are operated while the vehicle is moving in reverse, the adjusting lever turns the star wheel slightly to reduce the shoe-to-drum clearance. The mechanism is designed to prevent over-adjustment. When replacing worn linings, always perform any necessary cleaning, lubrication, and readjustment of the self adjusting mechanism.

DISC TYPE BRAKES.

Used With Power Assisted Systems.

Most late model passenger cars and light trucks are equipped with power assisted disc/drum or disc/disc brake systems. In addition, many manufacturers equip their vehicles with an anti-lock system on either the rear brakes or on all brakes.

The Caliper.

The caliper, as its name implies, provides a gripping action on the rotor of a disc brake. The caliper may be compared to a vise, the pads representing the jaws of the vise while the caliper housing represents the base. As the jaws close on a rotating plate, the clamping action retards and finally stops the rotation as pressure is exerted by the jaws. This is a very basic description of an automotive disc brake.

Caliper Housing.

For strength, the caliper housing is a rather heavy casting. Its size and location enables the caliper to absorb some of the heat generated by the friction material and rotor.

The Rotor.

The rotor may be ventilated to increase surface area and to act as an air pump. Most of the heat is carried away through the rotor which creates its own air flow. These factors aid in rapidly dissipating heat to the air stream.

Brake Pad Assemblies.

Brake pad assemblies fit into the caliper housing and rest on the metal tabs that are located at each end of the steel portion of the brake pad. Hydraulic force applied against the cylinder pistons moves the pads in the caliper housing toward the rotor surfaces. A brake pad assembly consists of friction material, a steel plate, guide pins, and mounting clips.

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Splash Shield.

To protect against foreign matter, a metal splash shield may be fastened to the top of the caliper housing. These splash shields must be installed properly to assure proper brake pad movement.

Splash Plate.

The disc brake assembly may be further protected from water and contamination by a splash plate located at the inboard side. This may be compared to the backing plate of the shoe and drum brake. The wheel assembly protects the outboard side. Any liquid or foreign matter hitting the rotor surfaces would tend to be discarded by centrifugal force as the rotors revolve.

Operation.

During a brake application, the caliper bores receive hydraulic pressure from the master cylinder through hydraulic lines, cross-over tubes, and internal passages. This hydraulic pressure in the bore then forces the pistons against the brake pads and applies force to the rotor surfaces. Braking action then takes place. As the hydraulic system is pressurized, the square section of the rubber sealing ring in each cylinder bore tends to distort in the applied direction as the pistons move the brake shoes toward the rotor. When hydraulic pressure is released, the distorted seals return to their normal position causing the pistons to retract in the cylinder bores. The pads stay in near contact with the rotors.

Automatic Adjustment.

Automatic adjustment of the brake pads is obtained by the piston movement past the seals as brake lining wear takes place. Clearance is continually controlled between the friction material and rotor assembly as the piston changes its position with respect to the seal. Parallelism and lateral run-out of the rotor must be within manufacturer's specifications to maintain the proper pedal reserve and prevent brake pedal pulsation. Pads may have wear indicators that will contact the rotor surface when the brake linings are worn sufficiently thin, warning the driver that the brake pads require replacing.

ANTI-LOCK BRAKES

Anti-Lock Systems.

Anti-Lock systems are also known as ABS. Some ABS systems are also part of the vehicle traction control system (TCS). Inspection, diagnosis, system bleeding, depressurizing, testing, and service procedures will vary. Refer to the specific vehicle manufacturer's service manuals for the correct inspection, test, and repair procedures.

Warning: Failure to properly depressurize ABS before working on the system may cause physical injury and/or component damage. Refer to the specific vehicle manufacturer's instructions.

Anti-lock brake systems apply force many times per second to maintain tire speed at

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a controlled rate of slip. Most systems operate in basically the same way. Sensors provide signals to an electronic control module which continuously monitors wheel speed. If wheel speed drops rapidly, indicating that a wheel is about to lock up, the electronic control commands a modulating device to reduce hydraulic pressure to that wheel. Once the wheel is rotating normally, the control module again allows increased pressure to the brake. This release and apply cycle occurs many times per second, much faster than a human could pump the brake pedal.

Note the vehicle tire size.

Installing a tire size other than the one recommended by the vehicle manufacturer may adversely affect the sensitivity of the anti-lock system.

ABS systems are not designed to function until enough force is applied to either lock or nearly lock the wheels. During normal braking, the ABS system remains ready, but does not operate. If the ABS system fails, usually the vehicle's brakes continue to function as though the vehicle was not equipped with ABS. However, a warning light should illuminate on the instrument panel alerting the driver of a malfunction.

In addition to the components listed for disc/drum systems, most anti-lock brake systems also have the following components:

Electronic Control Module.

The electronic control module provides application management information for the

brake modulator assembly.

Wheel Speed Sensors.

Speed sensors are usually located at the wheel/hub assembly. However, some applications use the drive shaft or internal axle components to determine wheel movement and speed. These sensors provide information to the electronic control module and braking decisions are made based upon wheel speed.

Modulator Assembly.

The modulator assembly executes the commands provided by the electronic control module to control hydraulic pressure to each wheel or axle.

Anti-Lock Brake System Indicator Light.

Vehicle manufacturers use various anti-lock system indicator lights. Some vehicles have more than one light. The purpose of these lights are to alert the driver if the system is not functioning properly.

PARKING BRAKES

Description.

The parking brake is a hand or foot operated mechanical brake for holding the vehicle stationary while parked. There are two basic types of parking brakes - the integral type, which is a part of the regular service brakes; and the transmission or drive shaft type, which is independent of the wheel brakes. Systems that apply hydraulic pressure to the service brake

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system do not suffice as a legal parking brake.

Integral Type.

Most integral type parking brake systems consists of a parking brake lever or pedal mechanism in the driver's compartment and a cable and conduit system which connects to the parking brake levers in the rear wheel brakes. When the parking brake lever is applied, the parking brake cables apply a balanced and equalized pull on both wheel parking brake levers. The levers then move linkage to force the brake shoes or pads against the brake drums or rotors.

Transmission Mounted or Drive Shaft Type.

The transmission or drive shaft type consists of the parking brake lever mechanism in the driver's compartment, a cable or rod control system which connects to the lever mechanism of the brake and a brake drum attached to the drive shaft near the transmission. This type of parking brake may be the external band (contracting) type or the internal shoe (expanding) type. When the parking brake is applied, force is transmitted through the cable or rod control to either contract the external band or expand the internal shoes against the drum. Internal "park" mechanisms in the transmission do not suffice as a legal parking brake.

Servicing.

The parking brake should be serviced when it fails to hold the vehicle on an incline with the parking brake lever at or near the limit

of its travel or when the parking brake fails to release. These conditions may be caused by wear, grease on the linings, linkage out of adjustment, damaged parts or lack of lubrication. Worn linings, damaged parts or a scored drum should be replaced. When binding occurs, linkage should be lubricated and adjusted or repaired if necessary.

CHAPTER 5 - TYPICAL BRAKE ADJUSTMENT - INSPECTION PROCEDURES FOR PASSENGER CARS AND LIGHT TRUCKS

CHECK OUT PROCEDURES

Note: A Certificate of Compliance - Brake Adjustment may not be issued to a vehicle unless it complies with Vehicle Code Sections 26451, (parking brake requirements), 26453 (brakes in good condition and in good working order), and 26454 (requirements for controlling and stopping the vehicle). The vehicle brake lights must function when the brake pedal is depressed and released. In addition, if the vehicle is equipped with a brake "warning lamp" in the dash which indicates a malfunction in the brake system, check and follow the vehicle manufacturer's recommendations before proceeding.

Condition of Brakes.

The California Vehicle Code, Section 26453 states that "all brakes and component parts thereof shall be maintained in good condition and in good working order. The brakes shall be so adjusted as to operate as equally as

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practicable with respect to the wheels on opposite sides of the vehicle.”

The adjuster should not certify a vehicle if (1) any drum or rotor exceeds the vehicle or parts manufacturer's service limits, (2) the thickness of the brake lining (friction material) is found to be less than that specified by the manufacturer's service limits, (3) the vehicle fails to stop within the required distance, (4) the parking brake system is found to be inadequate or inoperative, or (5) any other condition is found that would make the service braking system unsafe.

Preliminary Examinations.

Before starting to check out the brake system itself, the following related components on the vehicle should be inspected. If a non-brake related item is found defective, but does not affect the vehicle's ability to stop in a straight line or within the specified distance, a certificate may be issued without repairing the defect. However, the customer should be informed of the defect and a notation of such defect(s) written on the work order.

a. Tires. Check tire pressures to ensure they are properly inflated. Tires on the same axle should have the same tire pressure, tread pattern, and size. Also, radial and bias or bias belt tires should not be intermixed.

b. Wheel bearings. Loose wheel bearings may allow a brake drum or rotor to lean to one side, causing uneven brake shoe contact and erratic braking.

c. Shock absorbers or Struts. Worn or broken shocks or struts may cause a vehicle to react erratically during severe braking.

d. Wheel alignment. Misalignment of the front and/or rear end of a vehicle may cause the appearance of unequal braking action from side to side. Check for uneven tire wear for signs of this problem.

e. Suspension system. Broken, worn, or misadjusted suspension systems may cause a vehicle to react erratically when braking. Suspension components should be inspected as part of the brake performance diagnosis.

f. Dash Warning Lights. Most vehicles equipped with anti-lock brakes are also equipped with a lamp in the dash to warn the driver of an anti-lock system malfunction. Therefore, when servicing a vehicle with an anti-lock brake system, check to see if any brake related dash warning lamps are illuminated, indicating that an anti-lock trouble code may be stored in the computer.

Most vehicles manufactured after the mid 1960s are also equipped with a red warning light in the dash. The purpose of this light is to warn the driver of a fault with the vehicle brake system.

If the dash brake warning lamp or ABS lamp is lit, check the vehicle manufacturer's recommendations before proceeding. If the manufacturer indicates that a lit warning lamp represents a condition that will/could cause the vehicle's service brake system

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to malfunction, a certificate cannot be issued.

System Check Out.

The following brake system check out procedures apply to both drum brakes and disc brakes except when a procedure is marked specifically for drum brakes or disc brakes. The check out procedures should be performed in the sequence listed to avoid overlooking any component of the brake system. The adjuster should follow the manufacturer's check out procedure if one is available.

a. Master Cylinder Check.

(1) Fluid Level. Unless marked otherwise, the fluid level should be within $\frac{1}{4}$ to $\frac{1}{2}$ inch from top of the reservoir (both reservoirs of a dual system master cylinder).

(2) Vent Hole in Filler Cap or Reservoir Cover (If Used). Vent hole must be clear and unrestricted.

(3) Reservoir Diaphragm (If Used). Diaphragm must not be torn or damaged.

(4) External Leak. Check for leaks at hydraulic line connections and at push rod end.

(5) Boot. Inspect for stains on boot and general condition visually. Squeeze the boot or pull it back to determine if it is wet and to see if fluid can be expelled from it. Such stains or expulsion of fluid indicates

leakage at the secondary cup.

(6) Pedal Linkage. Check pedal linkage for excessive wear or looseness and signs of interference at frame members or with other parts. Also check for loose locknuts and condition of pedal return spring (if used).

(7) Power Brake Unit. If the vehicle is equipped with a power brake unit, inspect the unit visually, including tubing and hose connections. Clean the air intake filter on the vacuum unit. Separate vacuum line from unit and inspect for signs of hydraulic fluid which would indicate seal leakage within the unit. This kind of leak could, in addition to braking trouble, cause harm to the engine.

(8) Electrical Pumps and Motors (if equipped). Check hydraulic lines for proper connection and leaks. Check electrical connectors and wiring.

(9) Hydraulic Modulators (if equipped). Check hydraulic lines for leaks, proper routing and connection. Check electrical connectors and wiring.

(10) Brake Lights. Check the operation of the brake lights. Vehicle brake lights must function correctly when the brake pedal is depressed and released.

(11) Primary Cup Clearance of Compensating Port. Check cup clearance by watching for surge of fluid in master cylinder reservoir when pedal is depressed (may be visible only in front reservoir of dual system master cylinder).

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b. Brake Pedal Check.

(1) Depress the Brake Pedal. If the pedal locks or binds, make needed repairs before proceeding with the inspection. Check for loose master cylinder mounting and binding linkage (including power booster linkage, when used).

(2) Check Hydraulic Brake Pedal Free Play. A minimum amount of free play should exist, enough to make sure the piston is fully returned and does not block the master-cylinder compensating port (except on certain vehicles without a separate pedal return spring). Refer to manufacturer's specifications.

(3) Depress the Brake Pedal. The brake pedal should be depressed slowly until it can be depressed no further. If pedal pressure builds up, drops off sharply, then builds up again as the pedal moves downward, it is an indication that a piston is sticking in one or more wheel cylinders or that one of the hydraulic lines is partially blocked. Such blocking would be more likely to occur in a flexible hose due to flaking or separation of inner layers.

(4) Check Pedal Reserve. If the pedal moves downward past the point of reserve (1/2 to 2/3 of the possible stroke), check the brake adjustment and thickness of the vehicle's brake lining. If, in a hydraulic system, the brake can be depressed to the floor, pump the system by rapidly pumping the pedal several times to determine if a reserve can be built up. If there is still no reserve after pumping, check fluid level in the master

cylinder. If the level is low, fill the master cylinder and repeat the test. If the reserve is still not built up, it is an indication that the master cylinder cup has failed or that the brake system has a severe leak. If the pedal feel is "spongy," it is an indication of air in the hydraulic system.

(5) Check for External Leakage. If a pedal reserve is present, hold the pedal down hard for a period of one minute. If, instead of remaining stable, the pedal moves down, lessening the reserve, it is an indication that the hydraulic system is leaking fluid.

(6) Check Internal Leakage. After holding the brake pedal down hard, lessen foot pressure without completely releasing the pedal. Then depress the pedal again gradually with light foot pressure. If the reserve gradually fades under light foot pressure, hydraulic fluid may be leaking past the master cylinder primary cup lip causing pressure to be dissipated within the cylinder. If this should be the case, no external leak would be noticed, since the fluid would remain in the master cylinder. Power assisted and anti-lock system test procedures may vary. Refer to the vehicle manufacturer's test procedures.

(7) Check for Dragging Brakes. If after repeated brake applications (not pumped) the pedal reserve increases and brakes at all wheels begin to drag, it indicates a blocked master cylinder compensating port, due to a swollen primary cup, lack of necessary pedal lash, or dirt.

(8) Check Vacuum Braking. If the

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vehicle is equipped with a vacuum assist brake, stop the engine and depress the brake pedal several times to eliminate the vacuum reserve. Depress pedal hard, and while holding it start the engine. If the power unit is working, the pedal should drop appreciably under foot pressure.

(9) Check Parking Brake. Apply parking brake to check amount of travel and feel of the lever. The brake should apply firmly, well before the hand or foot lever reaches its limit of travel. The adjustment should permit the brake applying lever to travel approximately one-half of its maximum range. The parking brake shall be adequate to hold the vehicle or combination of vehicles stationary on any grade on which it is operated under all conditions of loading on a surface free from snow, ice or loose material. In any event, the parking brake shall be capable of locking the braked wheels to the limit of traction.

(10) Move Vehicle and Check a Stop. At this point it is advisable to move the vehicle and try an easy, rolling stop. "Pedal fight" (uncomfortable vibration against the foot) during brake application is an indication of out-of-round drums requiring reconditioning. This reaction will be minimized if the vehicle is equipped with power brakes.

c. Disc Brake Inspection.

(1) Wheel Removal. Before removing any wheels, rock all wheels to check for any looseness or indications revealing improper wheel bearing adjustment, worn ball joints, or worn tie rod ends, etc.

Disc brake inspection usually requires removal of the wheels; however removal of the rotors is not usually required. If the rotor is removed, on reassembly the rotor retaining nut must be torqued to manufacturer's specifications for proper wheel bearing clearance.

(2) Hub. Examine wheel bearing races and general condition of bearings. Grease, other than in the wheel hub, suggests a leaking seal.

(3) Toothed Ring, Sensor and Wiring (if equipped). Check for broken, bent, or missing teeth on the toothed ring. Check sensor adjustment, wiring connectors, wire routing and condition.

(4) Caliper. Check the caliper for damage and inside leakage and at piston seals. Check for leakage at inlet and crossover connections. Check for elongated or worn guide pins, mounting holes, cracks in the casting, worn mounting surfaces, etc. Verify that floating type calipers slide freely from side to side.

(5) Mounting Bolts. Check for loose or damaged mounting bolts or guide pins and for loose or missing shoe retaining pins or clips.

(6) Splash Shield. Check splash shield for damage or looseness.

(7) Linings. Check pad linings for proper thickness. Generally, the lining should be more than 1/32" thick for bonded or more than 1/64" above rivets on riveted linings, or follow the manufacturer's

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recommendations if available. Inspect for contamination with grease, brake fluid or other material. Check the lining for security on the pad. Follow manufacturer's specifications. The adjuster shall inform the customer of the amount of braking material left on pads. It is also a good practice to write this information on the customer's invoice.

(8) Rotor. Check rotor for thickness variations (parallelism) side to side wobble (lateral run-out), excessive ridges, grooves or cracks. Some signs that indicate needed service include a squeal or screeching sound during braking, a pull to one side when stopping, or the brake pedal pulsing when the brakes are applied.

NOTE: The rotor inspection should be accomplished last since any defects in the foregoing checks could limit free rotation of the rotor. When installing the wheel onto the rotor, the lug nuts should always be torqued to manufacturer's specifications to prevent warping the rotor.

d. Drum Brake Inspection. Before removing a wheel and drum, rock all wheels to check for any bumps or other indications of looseness revealing improper wheel bearing adjustment, worn ball joints (or kingpins), worn tie rod ends, etc. The technician should remove all wheels and drums to check the following conditions:

(1) Lining Wear Pattern. Brake lining should be replaced if the remaining lining on vehicles equipped with riveted linings is less than 1/64" above rivet heads on passenger cars; more on trucks. Bonded

lining should be replaced if worn to within 1/32" of the shoe. Follow the vehicle or brake lining manufacturer's specifications regarding acceptable lining wear.

The lining thickness at both sides of the shoe table should be worn about the same amount, indicating that shoe alignment is square. On brakes with fixed adjustable anchors, the anchor adjustment may be assumed correct if the secondary lining (servo brake) or forward lining (non-servo) is worn thinnest near the center of the shoe arc. On brakes with self-centering sliding type anchors, the lining wear pattern is more affected by operating conditions. Mountains or flat terrain, city or country use, weight of load, and driver habits are all factors which influence the wear pattern. Linings should indicate good contact with the drum, but there can be more wear at either end than near the center. For this reason, it is better to compare wear on left and right brake shoes and on front and rear axles. Then an odd wear pattern on one brake bears further checking to determine the cause.

(2) Check Condition of Linings. "Charring," grease soaking, faulty riveting, brake fluid, or imbedded foreign particles usually necessitate a relining job. A "glassy" type of glaze or random cracking of the lining surface suggests overheating; however, a glaze can also form from light service. These conditions also apply to disc brake linings.

(3) Check Condition of the Drums. A drum will have to be resurfaced or discarded if it is out of round,

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bell-mouthed, or barrel shaped, or if it shows heat-check cracks, score marks, excessive wear patterns, or other obvious faults. When a drum is resurfaced, also inspect the condition of the lining.

Before you reline any brakes, measure the drum diameter with a micrometer. It is recommended that you do not machine a drum to exceed the maximum diameter as identified on the drum. It is also recommended that an older drum not identified with a maximum drum diameter should not be machined to exceed 0.060 inches inside diameter over its original size. If the vehicle or brake parts manufacturer provides a specification, such specification may be used. This recommendation applies to light-duty passenger vehicles, including light trucks.

(4) Check Hydraulic Wheel Cylinder. Any stains suggest fluid leaks. The rubber boots should not be brittle or cracked. (Do not disturb boots unless identified as part of the manufacturer's procedure.) The actual presence of fluid, other than mere dampness, indicates a fluid leak. Therefore, leaking wheel cylinder(s) must be rebuilt or replaced. When you rebuild a wheel cylinder, be sure to clean the cylinder bore and inspect it for scoring, pitting, and corrosion. Follow manufacturer's specifications and recommendations for wheel cylinder honing or replacement procedures. Check the clearance between the cylinder bore wall and the piston by placing a strip of feeler shim lengthwise between the cylinder bore and piston. The feeler shim should be 1/4" wide and the following measurements

should be used if the vehicle or wheel cylinder manufacturer's specifications are not available:

3/4" through 1 3/16" i.d. = 0.006"

1 1/4" through 1 7/16" i.d. = 0.007"

1 1/2" and larger = 0.008"

If the piston can be inserted with the shim in place, the cylinder is oversize and should be replaced or resleeved.

(5) Check Springs and Hold-Downs. Damaged retraction springs, hold-downs, and other visible abnormalities should be noted.

(6) Check Backing Plates and Anchors. Loose, bent, or distorted shoe pads and galled anchors should be replaced. Rusty or dirt-coated shoe pads suggest an alignment fault. If wear marks on alignment pads exceed 0.005" in depth, they should be resurfaced or replaced.

(7) Condition of Automatic Adjusters and Parking Brake Linkages, When Used. Always check an automatic adjuster pawl, engaging a star wheel. Poor alignment will hinder adjustment. Parts should be cleaned, lubricated, and adjusted to allow movement as designed.

(8) Condition of Wheel Bearings and Grease Seal. Examine wheel bearing races and general condition of bearings. Grease, other than in the wheel hub, suggests a leaking seal.

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(9) When Inspection Reveals No Fault. If inspection reveals no fault, replace drum and wheel and perform the brake adjustment. A variation in drag suggests an out-of-round drum. If any out-of-round condition seems extreme, remove that wheel and drum for another inspection.

e. Parking Brake Check.

(1) Cables. If rear brakes are equipped with a parking brake mechanism, pull on cables by hand to determine if they are free and if brakes can be applied and released by manipulating the cables. Adjust parking brake cables to remove any excess slack caused by adjustment of the service brakes. Lubricate if specified by the manufacturer.

(2) Drive-Shaft. Where a drive-shaft parking brake is used, check visually for condition of brake and operating cable. Apply the hand-brake lever to determine if adjustment is correct.

f. Chassis Inspection.

(l) Suspension. Perform a visual inspection to determine the general condition of chassis parts such as springs, shock absorbers, torsion suspension rods, steering linkage, etc. Check for any faults which might affect brake performance.

A Certificate of Adjustment cannot be withheld for a defective suspension part unless it directly affects vehicle's brake performance; however, the customer should be informed of any defects found.

(2) Leaks. Inspect outside of backing plate, drum and inner sidewall of the tire for stains and dampness which would indicate leakage of hydraulic brake fluid, wheel bearing grease, or gear oil. In some cases the nature of a leak can be determined by the odor of the residue.

(3) Tubes and Hoses. Inspect tube and hose connections for stains around fittings or wet spots around hoses which indicate fluid leakage. Tighten these connections. Replace all damaged tubes and hoses. Some hoses are held in position by a suspension spring; if these springs have been damaged or lost, replace them.

(4) Hydraulic Lines. On hydraulic brake lines, follow the tubes back to the master cylinder while checking for indications of leaks, dents, kinks, damaged fittings and/or hold-down clips.

g. Driving Test Procedures and Conditions.

(1) "Dive" Condition. "Dive" is the result of braking torque being imparted into the vehicle suspension system, tending to cause the front end to "dip," which is a normal reaction to braking. When dive seems abnormally heavy or "one sided," it will be due to a pull or grab if the brakes are at fault. However, it is generally better to check the condition of front steering and suspension before performing extensive brake work.

(2) "Pull" and "Grab" Conditions. "Pull" or "grab" is often the symptom of some

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improper condition of front end alignment, spring suspension, shock absorber, steering, or tires; especially if noticed in conjunction with excessive front end dive. Faulty wheel bearing adjustment can be a cause.

(a) If braking is at fault, "pull" results from normal braking on one side with a reduction in braking on the opposite side. This reduction usually occurs from lubricants getting on the lining, due to over greased wheel bearings; a faded lining, with over-heated areas due to improper, spotty lining contact; a failure of shoes to "wrap" into proper self energization, because of a bind or an improper adjustment; or particularly after relining, an improper lining or shoe centering alignment which locates shoe leverage too close to the anchor. Less frequently a reduction in controlling force occurs, due to a sticking wheel cylinder piston or a blocked hydraulic line or hose. In addition, drums can influence pull when (on the same axle) they are turned to different diameters or have different surface finishes. Thin drums can cause improper spotty lining contact with over-heated areas.

(b) "Grab," on the other hand, is an uncontrollable increase in braking on one side. It can be caused by dirt, grease, or brake fluid spots on lining; a loose or distorted backing plate, or distorted shoe, affecting the shoe alignment; a loosely mounted shoe due to a weakened retracting spring or shoe hold-down; loose lining; loose shoe anchor; drum faults, usually an out-of-round condition or high hard spots;

"morning sickness" which is the temporary effect of moisture settling overnight on some linings. Particularly after relining, "grab" can result from an oversized lining arc or from an improper lining or shoe centering alignment which locates shoe leverage too far from the anchor.

(3) Squeal and Other Noises. Brake squeal or other similarly occurring noises are the audible result of vibrations transmitted through the shoe and lining or the drum to their contacting surfaces and amplified by resonance within the drum enclosure. Quite often noise vibrations will originate at some point on the chassis such as a loose spring bolt, shackle, rubbing spring leaf, or wheel stud, and be telegraphed through the axle to the brake and drum. This may require locating their origin and dampening the oscillations at some convenient point before they enter the brake or drum.

(a) Turned drums (less rigid) may increase the possibility of noise as will high hard spots on the drum. Some drums are wrapped with a coil ("screen door") type spring which has the effect of changing the frequency of vibrations so they become inaudible. Sometimes thin steel leaves are placed under the coil spring.

Other drum faults, roughness, heat checks, out-of-square or out-of round are factors which contribute to the probability of squeal.

(b) Within the brake, unbalanced stresses increase the vibration of the

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shoe. Proper distribution of contact pressure requires a good lining fit and is essential in the reduction of squeal. Particularly on new relined brakes, too great a lining thickness at either the toe or heel end of the shoe will cause an excessive "pinching" pressure, a major cause of squeal. Any other binding or distorting condition such as bent shoe or backing plate, faulty anchor, weak retracting spring, loose hold-down, even rust or dirt may cause a shoe alignment problem contributing to noise. On total contact type brakes, there is close clearance between the shoe web and the support plates, and if a web bind exists, it can cause squeal-producing vibrations.

- (c) Sometimes a brake, with good drum and lining contact, develops a squeal when the car is moving very slowly or is at the point of halt. In this situation the shoes lose support as the driver eases foot pressure, and even a minor bind or distortion can then cause vibration. Lubrication of metal friction points will usually remedy the condition.
- (d) Linings are designed to have a sound dampening effect. However, almost any lining can be noisy under certain conditions, but they are not always the direct cause of squeal unless their surface is changed by drastic over-heating or by grease or brake fluid contamination. It should be realized, however, that types of lining which adhere precisely to the shoe with little or no air gap require a superior drum fit for best results.

(4) Control and Stopping Requirements.

The service brakes of every motor vehicle or combination of vehicles shall be adequate to control the movement of and to stop and hold such vehicle or combination of vehicles under all conditions of loading on any grade on which it is operated.

Every motor vehicle or combination of vehicles, at any time and under all conditions of loading, shall, upon application of the service brake, be capable of stopping from an initial speed of 20 miles per hour (MPH) according to the following requirements:

	Maximum Stopping Distance (feet)
(1) Any passenger vehicle.....	25
(2) Any single motor vehicle with a manufacturer's gross vehicle weight rating of less than 10,000 lbs	30
(3) Any combination of vehicles consisting of a passenger vehicle or any motor vehicle with a manufacturer's gross vehicle weight rating of less than 10,000 lbs. In combination with any trailer, semitrailer or trailer coach.....	40
(4) Any single motor vehicle with a manufacturer's gross vehicle weight rating of 10,000 lbs. or more, or any bus.	40
(5) All other combinations of vehicles.....	50

NOTE: The above procedures are offered as a guide to assist the technician in making a complete inspection of a braking system. See Title 16, Section 3321, California Code of Regulations.

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CHAPTER 6 - TRUCK POWER BRAKE SYSTEMS

General Description.

Many trucks have disc brakes, similar to those on automobiles. However, many large truck tractors and trailers are equipped with drum-type brakes. The systems are either full power or power-assisted, utilizing either hydraulics, vacuum, compressed air, or combinations thereof. (See Figure 1)

Vacuum/Hydraulic System.

This system is very similar to the power-assisted system of passenger cars and light trucks. The location of the power unit can be a significant difference. It is often located in this system between the master cylinder and the wheel cylinders and uses vacuum from either the intake manifold or a vacuum pump to increase hydraulic pressure from the master cylinder to the wheel cylinders.

a. Inspection. This system is inspected the same as the passenger car and light truck system except a force of 40 to 60 pounds should be applied for checks made with the brake pedal.

b. Gauges and Warning Devices. Installations on the larger trucks (generally over 14,000 pounds GVWR) are required

to have vacuum gauges and low-vacuum warning devices located in the driver's compartment. These should be tested as part of the brake inspection. The warning device, which may be either audible or visible, actuates when the vacuum drops to an unsafe level, 8 inches of mercury or less. A vacuum/hydraulic system on a light truck or passenger car usually will not include the vacuum gauge and low-vacuum warning device (see Vehicle Code Section 26521).

Air/Hydraulic System.

The power unit uses compressed air supplied by a compressor. The air compressor is usually belt-driven on a vehicle with a gasoline engine and may be either gear or belt driven on a vehicle with a diesel engine. A typical air/hydraulic brake system consists of a pedal operated hydraulic master cylinder and an air-powered unit containing a hydraulic cylinder whose output port is connected to each hydraulic wheel cylinder (See Figure 2).

a. Operation. When the master cylinder is operated, hydraulic pressure is applied to the power cylinder. The hydraulic pressure operates an internal control valve which regulates the air pressure in the power

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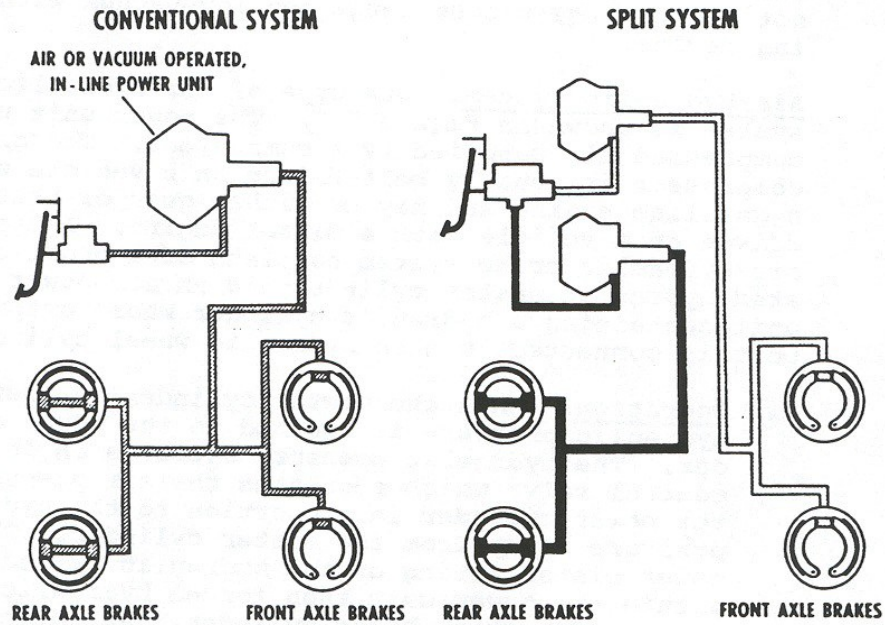


Figure 1-Power Assisted Hydraulic System

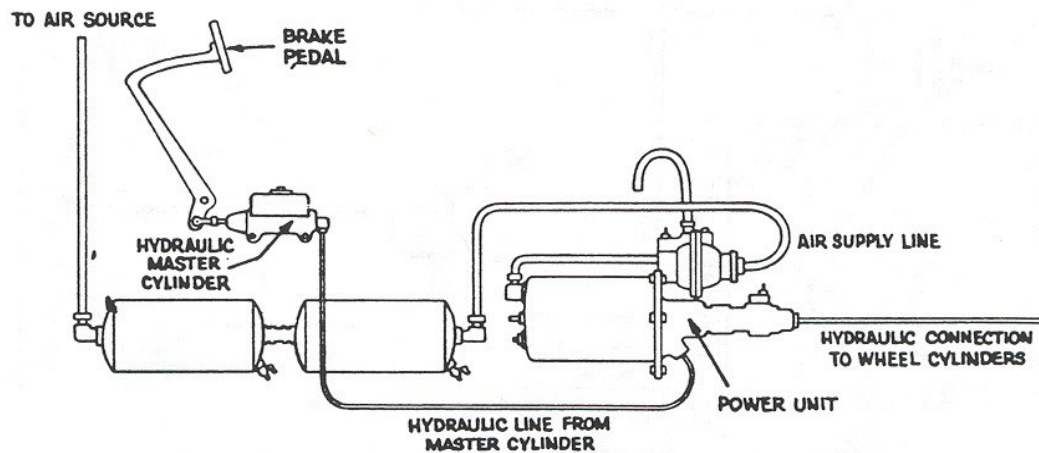


Figure 2 - Air Hydraulic Brake System for Large Trucks

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cylinder in proportion to the hydraulic pressure input from the master cylinder. The power piston acting on the hydraulic cylinder within the power unit then forces hydraulic pressure to each wheel brake cylinder. An increase in master cylinder pressure results in a corresponding increase in power cylinder output. The operator has complete control and "pedal feel" throughout the amount of braking action required to operate the vehicle brakes.

b. Inspection. This type of system is inspected the same as the vacuum/hydraulic system. The system must include an air gauge and a low-air warning device, both of which must be tested during the brake inspection.

Air Brake System.

A full air brake system is commonly found on large buses, trucks, truck tractors, and trailers.

Beginning January 1, 1975, the Federal Motor Vehicle Safety Standard, Section 121 (FMVSS) established performance and equipment requirements for braking systems on vehicles equipped with air brake systems.

FMVSS 121 applies to all trailers manufactured and sold after January 1, 1975, and all motor vehicles after March 1, 1975. Many manufacturers began equipping vehicles to comply with FMVSS 121 prior to the effective dates.

This handbook does not contain all of the inspection procedures relative to issuance

of a Certificate of Compliance - Brake Adjustment. Technicians are expected to follow the vehicle manufacturer's inspection instructions. If manufacturer's instructions are not available, the adjuster must obtain the inspection instructions for the type of vehicle being inspected in a repair manual approved by BAR or follow procedures listed in the Federal Motor Vehicle Safety Standards (FMVSS), Code of Federal Regulations, Title 49, Section 571.121. Title 49 is available on the Internet at http://www.access.gpo.gov/nara/cfr/waisidx_01/49cfr571_01.html.

a. Basic System. Air-operated service brakes are air applied and spring released. Energy to apply the brakes is provided by compressed air from an engine driven compressor. When the engine is started, air is pumped into an air reservoir. The pressure in the reservoir is controlled by an air compressor governor which should be set between a minimum of 85 pounds cut-in pressure and 130 pounds (150 pounds maximum) cut-out pressure. When the foot pedal valve is depressed, a modulated flow of compressed air is supplied to the wheel air chambers where its energy is converted to mechanical force to provide a controlled application of the shoes to the drums (See Figure 3).

b. More Complicated Systems. While all air brake systems generally perform the same basic functions, many variations in the design of individual components and their arrangement in the system may be encountered (See Figure 4).

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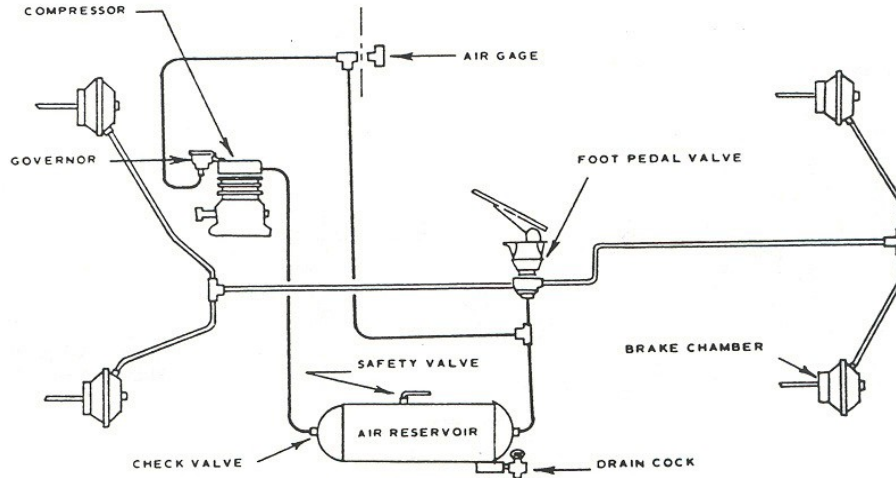


Figure 3- Basic Air Brake System

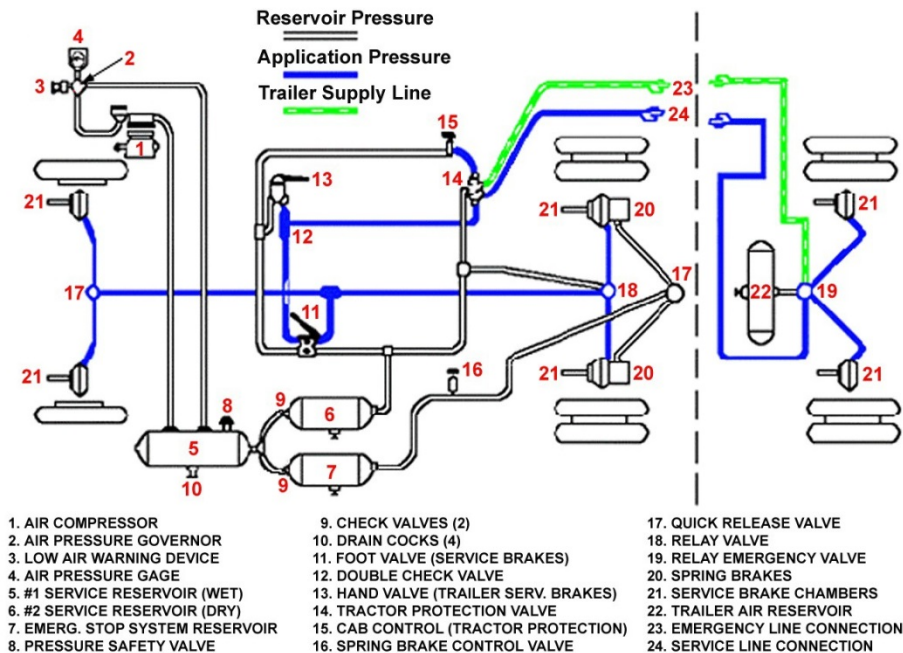


Figure 4 - Typical Truck-Tractor and Semi-Trailer Air Brake System

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(1) The service brakes are air-applied and spring-released while the spring brake emergency stopping system is spring-applied and air-released. Energy to operate the brakes is provided by compressed air from an engine-driven air compressor. The air pressure for the service brake system is stored in reservoirs, and the pressure in the reservoirs is controlled by the air compressor governor. The service brakes are applied by the driver depressing the foot valve which permits air pressure to flow through the various brake lines to air brake chambers at the wheels. The system may also include a relay valve to speed the application and release of air pressure at the wheel air chambers.

Operation of the foot valve provides a modulated air signal to the relay valve which provides an equally modulated application of air pressure to the air chambers from the service air reservoir.

(2) The driver can elect to either apply the trailer service brakes alone by operating the hand-control valve, or when he/she steps on the foot pedal valve, air is applied not only to the tractor brakes but is also routed through the double check valve, through the tractor protection valve, and the service line gladhand connection to the relay emergency valve on the trailer, which applies air pressure from the trailer reservoir to the brake chambers at the trailer wheels.

(3) Air brake systems consist of many safety devices; vehicles with air brakes are required to be equipped with emergency stopping systems which may

be applied by the operator in the case of failure in the service air brake systems. Most emergency systems, which also serve as the parking brake, consist of a check valve, a protected air reservoir, a dash-control valve and spring-applied, air-released brake actuators referred to as spring brakes. The check valve protects the reservoir from a pressure loss in the event of a decrease of pressure in the service air brake system.

(4) A spring brake unit is a device which generally consists of a cylinder (chamber), spring and piston. The springs are compressed and held in the released position by air pressure and automatically apply the brakes when air pressure in the chambers is reduced to a point below that force exerted by the springs. This may occur either by a reduction of pressure in the protected reservoir or by operation of the parking/emergency brake dash control valve which shuts off and vents the control line, exhausting the air in the chambers.

(5) When the compressor supplies air to the service brake reservoirs, air is also automatically delivered to the protected emergency reservoir. Upon operation of the parking-emergency brake control valve, air pressure from the protected air reservoir goes through the control valve and the quick-release valve to the spring brake chambers and compresses the springs, releasing the brakes.

(6) If this motor vehicle is designed to tow a trailer, the brake system is equipped with a tractor protection valve. This valve is another safety device which will retain

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the motor vehicle's air supply in the event of an excessive decrease in pressure in the trailer's emergency (supply) line. A tractor protection valve automatically shuts off the air supply to both trailer air lines when the service air pressure in the towing vehicle's air system is reduced to a fixed pressure, typically between 20 and 45 psi. This shut-off may also be performed manually by operation of the valve's dash control to exhaust the air in the trailer supply line. Closing of the valve, either automatically or manually, and the venting of air pressure from the emergency air line automatically actuates the emergency function of the trailer's relay emergency valve, thereby applying the trailer brakes. Either the automatic or manual reopening of the tractor protection valve permits air pressure to again charge the emergency supply line, flowing through gladhand connectors and the trailer relay emergency valve into the trailer reservoir and releases the brakes.

(7) Another required safety device is a low pressure warning device. The device shall be readily visible or audible to the driver and shall give a satisfactory continuous warning when the air supply pressure drops below a fixed pressure, which shall not be more than 75 pounds per square inch nor less than 55 pounds per square inch with the engine running. This is considered the minimum for safe operation of the vehicle's service brakes.

(8) The trailer relay emergency valve functions as both a relay valve and an emergency feature of the trailer's air brake system. This valve normally works as a relay valve to apply the air from the

trailer reservoir to the trailer brake chambers when the trailer service brakes are applied by either the foot valve or the hand valve which controls the trailer brakes. The emergency function of this valve automatically applies air pressure to the trailer service brake chambers when the air in the emergency (supply) line drops below a predetermined pressure or upon a sudden decrease in pressure in this line, either accidentally or upon manual venting by operating the tractor protection valve.

(9) Some air brake systems may have devices such as filters or after coolers installed in the compressor discharge line to clean and cool the air from the compressor, a front-wheel limiting valve to limit the amount of air pressure applied to the front brake chambers during inclement weather, and numerous other devices.

WHEEL BRAKE ASSEMBLIES.

There are three basic types of air operated wheel brake assemblies for large trucks and trailers.

(1) S-Type Cam Brake. The most common type of wheel brake assembly is referred to as the S-type cam brake. With this type, the brake shoes are applied against the drum by an S-type cam installed on one end of a shaft which is rotated by a lever attached by a pushrod to the service air brake chamber. The brake shoes on this type of wheel assembly are adjusted for wear by the use of the lever as a slack adjuster. Some slack adjusters have a feature of

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automatically adjusting for brake lining wear.

(2) Wedge Brake. The second type of wheel brake assembly is referred to as the wedge brake. With this type, a pushrod, actuated by an air chamber, forces a wedge between opposing plungers located at one end (single actuated) or both ends (double actuated) of the brake shoes to spread the shoes outward against the brake drum. If double actuated, each assembly will incorporate two air chambers, pushrods and wedges. The wedge brake does not have a camshaft as the air chambers are mounted directly on the plunger housing. This type of brake is usually equipped with automatic adjusters.

(3) Disc Brakes. The third type of wheel brake assembly is the disc brake system. Disc brakes that are used on trucks work much in the same way as systems on cars and light trucks. Wheel assemblies have a rotor and caliper assembly that is generally actuated by the vehicle's air system.

SERVICING AIR BRAKE SYSTEMS.

Use of Manufacturers' Manuals.

When all components are considered, such as the required safety devices, alternate controls and emergency stopping systems, the modern truck air brake system is a complex series of devices. A study of each device within the system will reveal that most of the air valves are not overly complex in operation. A thorough understanding of each valve's operation will

make troubleshooting easier. Manufacturers' maintenance and repair manuals generally contain detailed descriptions of the devices on the vehicles they manufacture. These manuals should be used as guides to the understanding of the operation of the various devices.

Safety Precautions.

Some of the components of an air brake system may present a safety hazard if proper procedures are not practiced when they are disassembled for repair. This is particularly true of spring brake units as the springs are under varying degrees of compression within the chambers at all times. Follow manufacturer's recommended procedures in working on any device in an air brake system to avoid personal injury or damage to the system.

Check Out Procedures.

Note: Air brake systems vary and therefore, one specific inspection procedure cannot be provided. However, the following information is given as a guide.

Overview. With the air brake system charged, open the drain cocks in each reservoir, carbon trap, or filter that is used in the system; close the drain cocks. With the air system at zero gauge pressure, check the pressure buildup, running the engine at fast idle, and then record the time to raise the air pressure from 5 to 90 psi on the gauge. Check pressures at which the light, buzzer, or flag connected to the low pressure indicator is no longer visible or

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audible. Continue running the engine until the governor cuts out and observe the pressure gauge reading. With the engine idling, reduce the pressure in the system by making a series of brake applications and observe the pressure at which the governor cuts in. With the system fully charged, stop the engine and check for air leakage by recording the pressure drop in pounds per square inch (psi) per minute with brakes released and also with the brakes fully applied. Inspect for restricted, abraded, collapsed, improperly supported, or broken hoses and tubes and audible leaks. Check the safety valve for freedom of action. If the compressor is belt driven, check the belt for tightness and observe the belt condition.

Inspect and Do Not Certify if:

- a. Brake light(s) does not operate at the rear of the vehicle / trailer (VC 24603).
- b. Breakaway brakes fail to operate correctly. Power brakes on any trailer or semitrailer manufactured after December 31, 1955, and required to be equipped with brakes shall be designed to be automatically applied upon breakaway from the towing vehicle and shall be capable of stopping and holding such vehicle stationary for not less than 15 minutes (VC26304).
- c. Service brakes configured improperly for vehicle type (VC26311).
- d. Vehicle (except motorcycle) not equipped with both a service brake

system and a parking brake system (VC26450).

e. Parking brake is not adequate to hold vehicle under all load conditions (VC26451).

f. Service brakes are not in good serviceable condition (VC26453).

g. Brakes not sufficient to control the movement of and to stop vehicle(s) under all conditions of loading on any grade on which it is operated (VC26454).

h. Vehicle does not pass the stop test per VC 26456.

i. Air brake system is not capable of providing full service brake application as specified in VC 26502.

j. Air compressor governor cut-in pressure is lower than 80 psi or cut-out pressure is higher than 150 psi (unless other values are provided by the vehicle manufacturer (VC26503).

k. Air pressure gauge does not read within 10 percent of the actual system pressure (VC26505).

l. Vehicle air pressure gauge does not function as required (VC26505).

m. Vehicle is not equipped with an operating air pressure warning device (VC 26506).

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CHAPTER 7 - INSPECTION OF BRAKES ON SPECIALLY CONSTRUCTED AND REMANUFACTURED VEHICLES.

Description of a Specially Constructed Vehicle.

The California Vehicle Code (Section 580) describes a "specially constructed vehicle" as a vehicle which is built for private use, not for resale, and is not constructed by a licensed manufacturer or remanufacturer. A specially constructed vehicle may be built from (1) a kit; (2) new or used, or a combination of new and used, parts; or (3) a vehicle reported for dismantling, as required by Section 5500 or 11520, which, when reconstructed, does not resemble the original make of the vehicle dismantled. A specially constructed vehicle is not a vehicle which has been repaired or restored to its original design by replacing parts.

Description of a Remanufactured Vehicle.

A "remanufactured vehicle" (Vehicle Code Section 507.5) is a vehicle that has been constructed by a licensed remanufacturer and consists of any used or reconditioned integral parts, including, but not limited to, frame, engine, transmission, axles, brakes, or suspension. Remanufactured vehicles may be sold under a distinctive trade name. An existing vehicle which is incidentally repaired, restored, or modified by replacing or adding parts or accessories is not a remanufactured vehicle.

Inspection Procedures.

Inspection of specially constructed and remanufactured vehicles for service brake condition prior to issuance of a brake certificate is as follows:

a. Disassemble the service brake system to allow verification of the thickness of the brake friction material on all wheels. Inspect the drums and/or rotors for dimensional compliance to the vehicle or brake system manufacturer's specifications. Examine all exposed service brake components for physical damage, leaks, wear, or heavy corrosion. Verify that components match side to side.

b. Verify that the brake pedal travel is within reason. There are no written specifications in the Vehicle Code, however, when depressing the pedal, it should become firm before reaching half of its full travel and must stop the vehicle within the distance as listed in the Vehicle Code.

c. Check the parking brake for proper operation.

d. Ensure that the stop lights are functioning properly.

e. Road test the vehicle to determine stopping distance.

f. Inform the customer of any marginal or defective conditions found during the inspection.

g. Do not certify the vehicle if (1) any drum or rotor exceeds the manufacturer's

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service limits, (2) the thickness of the brake lining (friction material) is found to be less than that specified in this handbook or manufacturer's service limits, (3) the vehicle fails to stop within the required distance, (4) the parking brake system is found to be inoperative, (5) the brake lights are inoperative, or any other condition is found that would make the service braking system unsafe.

Certification Criteria

Do not certify the vehicle if (1) any drum or rotor exceeds the vehicle or parts manufacturer's service limits, (2) the thickness of the brake lining (friction material) is found to be less than that specified by the manufacturer's service limits, (3) the vehicle fails to stop within the required distance, (4) the parking brake system is found to be inoperative, (5) brake components don't match side to side or any other condition is found that would make the service braking system unsafe.

CHAPTER 8 - BRAKE EQUIPMENT REQUIREMENTS AND REFERENCE DATA

This handbook is intended to provide guidance to Official Brake Stations and

Adjusters. However, this handbook is not all inclusive; therefore, station owners and adjusters must use acceptable reference manuals or electronic media to obtain the necessary vehicle or legal data. It is the station owner and adjuster's responsibility to follow lawful procedures when performing brake work and issuing Certificates of Compliance - Brake Adjustment. References that adjusters should use include the California Vehicle Code, available from the Department of Motor Vehicles (DMV), Title 13 (excerpted sections) and Title 16 of the California Code of Regulations, listed in the BAR Laws and Regulations booklet available free of charge from BAR. The Vehicle Code is also available on the Internet at www.leginfo.ca.gov. Titles 13 and 16 of the California Code of Regulations are available at www.oal.ca.gov.

Filling Out The Official Certificate

Use the example on page 40 to fill out the Official Certificate of Compliance - Brake Adjustment. Call the local BAR field office if additional information is required.

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Write the vehicle identification number or the registration number. (If the vehicle is a motor home, the DMV will have registered it by the identification number of the coach manufacturer, rather than the chassis manufacturer.)

Write the name of the registered owner or, if the vehicle is in the possession of a dealer, the name of the dealer.


Check the box(es) indicating the purpose of the brake inspection.

Check the box(es) indicating the condition or adjustment of required brake equipment.

CERTIFICATE OF COMPLIANCE—BRAKE ADJUSTMENT



DEPARTMENT OF CONSUMER AFFAIRS



**BUREAU OF
AUTOMOTIVE
REPAIR**

BC 0000000

VEHICLE IDENTIFICATION NO. _____

VEHICLE LICENSE NO. _____

NAME OF REGISTERED OWNER _____

MAKE _____ YR. MODEL _____

Applicable Items Shall Be Indicated (X) by Licensed Brake Adjuster

PURPOSE OF CERTIFICATION	Type	Insp.	Adj.	Repair
<input type="checkbox"/> Brake Adjustment	Air			
<input type="checkbox"/> Clearance of Enforcement Document # _____	Vacuum			
<input type="checkbox"/> Registration of Reconstructed Vehicle	Hydraulic			
<input type="checkbox"/> Other _____	Mechanical			
	Electric			

Boxes Checked Below Identify Satisfactory Condition or Adjustment of Required Equipment

<input type="checkbox"/> SERVICE BRAKE	<input type="checkbox"/> WARNING DEVICE/SYSTEM	<input type="checkbox"/> BREAKAWAY DEVICE
<input type="checkbox"/> PARKING BRAKE	<input type="checkbox"/> ANTILOCK BRAKE SYSTEM	<input type="checkbox"/> CHECK VALVE
<input type="checkbox"/> LINING AND SHOES	<input type="checkbox"/> EMERGENCY STOPPING SYSTEM	<input type="checkbox"/> AIR GOVERNOR
<input type="checkbox"/> DRUMS/ROTORS	<input type="checkbox"/> AIR/VACUUM GAUGE	<input type="checkbox"/> CONNECTIONS
Road Test—feet required to stop at 20 mph _____ ft.		<input type="checkbox"/> SAFETY VALVE

Vehicle Type _____ Weight _____

All items checked above are of an approved type and I have performed the applicable inspection, adjustment, or repair as specified by the Bureau of Automotive Repair and the vehicle manufacturer; and in accordance with Title 13 and Title 16 of the California Code of Regulations, the Vehicle Code, and the Business and Professions Code, I hereby certify under penalty under the laws of the State of California that the above is true and correct.

ADJUSTER'S SIGNATURE _____

DATE OF ISSUANCE _____

ADJUSTER'S LICENSE NO. _____

STATION LICENSE NO. _____

This certificate must be issued on the date of inspection and is valid for 90 days after issuance.

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Write the make and the year model. (If the vehicle is a motor home, write the year model of the coach, rather than of the engine or chassis.)

Check the box(es) indicating inspection, adjustment or repair.

Enter vehicle type: passenger car, truck or motor home and the gross vehicle weight rating if applicable.

Sign the certificate. Write down the date, your adjuster's license number, and the station's brake license number.

Give the white copy to the customer. Retain the yellow copy in the certification book. It must be kept available for at least three years from date of issue.