BRAKE REMOVAL AND INSTALLATION

Brake System Basic Operating Principle

This short course was developed as a resource material for trainer in the non-formal sector to train men, women and youth in the communities of Papua New Guinea. The course developed is demand oriented and aims to provide opportunities for participants to acquire relevant knowledge and skills in the brake system of a motor vehicle. This module covers the practical skills and procedure of brake operating principle, removal, installation and service. The course is part of a bridging program between the non formal and formal sector to fill up the gap and creates linkages in to motor mechanic tradesman skills, and to provide lower income earners to save cost and be able to understand the brake system and perform to a skill level where they will do it themselves in repair and maintenance of the brake system.

The trainee will be specialized skilled and while he/she does at home brake system work the benefit comes from labour charge to make money for a living or opportunity into starting a small scale repair shop.

The development of this short course was sponsored by the ADB-PNG EMPLOYMENT ORIENTED SKILLS DEVELOPMENT PROJECT (EOSDP) and produced by curriculum officers at the SKILLS TRAINING RESOURCES UNIT (STRU)
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Module 5:
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### COMPETENCY PROFILE: Brake basic operating principle

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<th>Duties/Area of Responsibility</th>
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| **A. Brake system basic operating principles** | A1. Basic operating principles of the brake system  
2 hours | A2. Identify and explain the function of the disc brake system  
2 hours | A3. Identify and explain the function of the drum brakes system  
2 hour |  
| **B. Brake light switch** | B1. Identify components of the brake light switch  
2 hours | B2. Remove the brake light switch  
3 hours | B3. Installation the brake light switch  
3 hours |  
| **C. Master cylinder** | C1. Identify and name components of master cylinder  
2 hours | C2. Remove the master cylinder  
3 hours | C3. Install the master cylinder  
3 hours |  
| **D. Power booster** | D1. Identify and name the components of power booster  
3 hours | D2. Removal of power booster  
3 hours | D3. Installation of power booster  
3 hours |  
| **E. Brake hoses and lines** | E1. Brake hoses and lines inspection information  
2 hours | E2. Removal of hoses and lines.  
3 hours | E3. Installation of hoses and lines.  
3 hours |  
| **F. Bleeding the brake system.** | F1. Demonstrate procedure of bleeding brake  
4 hours | F2. Explain procedure of bleeding brake  
2 hours |
A guide to brake system basic operating principle

CURRICULUM GUIDE

Program: MOTOR VEHICLE MECHANIC
Course: BRAKE REMOVAL AND INSTALLATION
Module code: T017i
Module name: A guide to brake system basic operating principle
Duration: 8 hours course, 3 hour theory test.
Purpose: After successful completion of this module participants should be able to explain the brake operating principle and the functions of disc brakes and drum brakes.

Content:

A1. Basic operating principles of the brake system
- function of hydraulic system
- advantage of hydraulic system
- function of master cylinder
- components of master cylinder
- steel lines and function
- distinguish use of steel line and flexible tubes
- function of drum brake system
- components of drum brake and functions
- function of drum disc cylinder
- components of the piston and the functions
- function of the piston
- operation of the hydraulic system
- components of the hydraulic system
- operation of the brake pedal system
- operation of the dual circuit master cylinder
- operation of the dual circuit system

A2. Identify and explain function of the disc brake system
- operating system of the disc brake
- components of the disc brake

A3. Identify and explain function of the drum brake system
- operating procedure of the drum brake system
- components of the drum brake

Pre-requisite: There is no prerequisite for this module.

Evaluation: The participant needs to be able to read and write and demonstrate ability of the module learning outcomes with consideration as a beginner.

Suggested delivery method: This module should be delivered using the following teaching methods
- Lecture
- Demonstration
- Discussion
- Practical project
Instructor: The ideal instructor will have a trades certificate in Automotive Mechanic. New instructors wish to refer to the STRU publication “Trainer Guide” (available free of charge).

Assessment method: A holistic approach is to be taken with assessment of the learning outcome using one or more of the following:
- Questioning (oral, multiple or matching answers)
- Demonstration of practical tasks

Assessment condition: Assessment will be conducted in a workshop environment. The condition of assessment includes:
- Model of motor vehicle brake system
- Information on brake system basic operating principles (refer to specific learning outcome).

Reference:
1. TITLE: Basic Operating Principles
   Ford Ranger/Explorer/Mountaineer 1991-1999
   Training manual, Niu Ford, Waigani, PNG
A guide to brake system basic operating principle

OVERVIEW OF ELEMENTS OF COMPETENCE AND PERFORMANCE CRITERIA

<table>
<thead>
<tr>
<th>Element</th>
<th>Performance Criteria</th>
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<tbody>
<tr>
<td>1. Basic operating principles of the brake system</td>
<td>1.1 Explain and classify the basic operating principles of the brake system</td>
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<tr>
<td></td>
<td>• main function of the hydraulic system</td>
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<td>• advantage of the hydraulic system in vehicles brake system</td>
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<td>• function of master cylinder</td>
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<td>• types and main components of master cylinder</td>
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<td>• function of steel lines in brake system</td>
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<td>• operation of the hydraulic system</td>
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<td>• components of the hydraulic system</td>
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<td>• operation of the brake pedal system</td>
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<td>• operation of the dual circuit master cylinder</td>
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<td>• operation of the dual circuit system</td>
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<td>2. Identify and explain the function of the disc brake system</td>
<td>2.1 Describe the operating system of the disc brake.</td>
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<td>3. Identify and explain the function of the drum brake system</td>
<td>3.1 Describe the operating procedure of the drum brake system.</td>
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<td>3.2 Name the components of the drum brake.</td>
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INSTRUCTION FOR THE TRAINER/INSTRUCTOR

Setup all the training aids on a workstation. The trainees must have access to:
1. Protective clothing’s and equipment - gloves, boot and overall
2. Practical model of motor vehicle brake system

Part one of this module is the curriculum guide.

Learning activities for the trainees relates to three elements of competence in column one (1) of the overview table. In column two (2) the performance criteria show the required level of performance expected as resultant of each element. In delivery of the module the instructor follows the appendix training and assessment guide below.

Part two of this module consists of the training resource kit or instructional materials.

In line with the elements of competence resource information on the skills and knowledge informed have been compiled. The additional support material is provided for both, the instructor to use in discussion and explanation, and the trainee to have additional hand out notes to read or write in exercise books.
APPENDIX 1. Training and Assessment Guide
Element 1

Task A1: Basic operating principles of the brake system.
Suggested minimal instructional time: 2 hours

Learning outcome A1: Identify and explain basic operating principles of the brake system.

Teaching strategy:
Learning activities for the trainee must include the instructor to:

1. Explain and classify the basic operating principles of the brake system.
   • main function of the hydraulic system;
   • advantage of the hydraulic system in vehicles brake system;
   • function of master cylinder;
   • types and main components of master cylinder;
   • function of steel lines in brake system;
   • uses of steel lines and flexible tubes;
   • function of the drum brake system;
   • components of the drum brake and their functions;
   • function of cylinder in the brake disc;
   • components of a piston and their function;
   • function of the piston;
   • operation of the hydraulic system;
   • components of the hydraulic system.

Assessment methods:
Written verbal questioning and observation.

Assessment condition:
The trainee must be given access to instructional notes on principle of brake system.

Assessment criteria:
The trainee has correctly:
- explained function of the hydraulic system of brake system;
- explained function of the cylinder in the brake disc;
- named components of the piston and their function;
- described operation of the hydraulic system;
- named components of the hydraulic system;
- described operation of the brake pedal system;
- described operation of the dual circuit master cylinder;
- described operation of the dual circuit system.

APPENDIX 2: Training and Assessment Guide
Element 2.

Task A2: Identify the function of the disc brake system.
Suggested minimal instructional time: 2 hours

Learning outcome A2. Describe disk brake operating system.

Teaching strategy:
Learning activities for the trainee must include the instructor to:

2.1 describe operating procedure of the drum brake system.
2.2 name components of the disk brake.
2.3 explain function of each component.

Assessment methods:
Written verbal questioning and observation.

Assessment condition:
The trainee must be given access to:
- instructional notes on principle of brake system.

Assessment criteria:
The trainee has correctly:
- described operating system of the disc brake;
- named components of the disc brake;
- explained function of each component.
APPENDIX 3: Training and Assessment Guide.
Element 3.

Task A3: Identify and explain the function of the drum brake system.
Suggested minimal instructional time: 2 hours

Learning outcome A3.
Describe drum brake operating system.

Teaching strategy:
Learning activities for the trainee must include
the instructor to;
3.1 describe operating system of the drum brake.
3.2 name components of the drum brake.
3.3 explain function of each component.

Assessment methods:
Written verbal questioning and observation.

Assessment condition:
The trainee must be given access to;
• instructional notes on principle of brake system

Assessment criteria:
The trainee has correctly:
☑ described operating procedure of the drum brake system;
☑ named components of the drum brake.

Assessment procedure
1. Do interval testing on each element of competence at the end of one topic session to find out the trainee progress in learning. Test knowledge orally or written. Test skills for mastery of performance standard in a demonstration performing a range of task.
2. Do a summary test of all lessons covered at the end of the course. Practical test at the end of the short course must be conducted to corroborate a trainee competent of the skills trained.
3. Learning Outcome.
You attend a training course to learn new information and gain new skills that you can use in your workplace or community.
For this course a set assessment guide evidently supports your learning of the skills in training. Find in the assessment guide the topic elements have one learning outcome. The core-learning outcome is a resultant of one-element performance criteria. To measure your learning the core learning outcome becomes the mastery test of skills and objectives of the performance criteria.

Participants upon successful completion of each element performance criteria should demonstrate the task of each learning outcome of the element. In this topic there are three elements and each has a core-learning outcome. These three core-learning outcomes make up a checkpoint or summary test to be conduct on completion of training of the topic, brake system basic operating principles.

Do interval testing on each element of competence at the end of one topic session to find out the trainee progress in learning. Test knowledge orally or written. Test skills for mastery of performance standard in a demonstration performing a range of task.

Do a summary test of all lessons covered at the end of the course. Practical test at the end of the short course must be conducted to corroborate a trainee competent of the skills trained.

To test participants conduct a summary test of the three core learning outcomes written below.

Learning Outcomes A-1, 2, 3
A1 Identify and explain basic operating principles of the brake system.
A2 Describe disk brake operating system. A3 Describe drum brake operating system.

Assessing your learning
When you attend a training course, you expect to learn many things. You want to know about your learning and your mind is full of questions like:
• do I really understand what I am being told?
• will I be able to use this new knowledge when I return to my place of work or my community?
• am I doing this new skill correctly?
Assessing yourself is about answering these questions. It shows you and your facilitator about your progress. It also tells the facilitator about their teaching. If all participants find a topic difficult, then the facilitators know that they must teach it again or try something new to support the teaching.

Recognized Training
The Employment Oriented Skill Development Project recognizes the training and you will receive a certificate when you have successfully completed this training.
APPENDIX 4: INSTRUCTIONAL NOTES

A1: Basic operating principles of the brake system

1. Basic operating principles of the brake system
Hydraulic system is used to actuate the brakes of all modern automobiles. The system transports the power required to force the frictional surfaces of the braking system together from the pedal to the individual brake units at each wheel. A hydraulic system is used for two reasons.

1.2 Fluid under pressure
First, fluid under pressure can be carried to all parts of an automobile by small pipes and flexible hoses without taking up a significant amount of room or posing routing problems.

1.3 Great mechanical advantage
Second, a great mechanical advantage can be given to the brake pedal end of the system, and the foot pressure required to actuate the brakes can be reduced by making the surface area of the master cylinder pistons smaller than that of any of the pistons in the wheel cylinders or calipers.

1.4 Master cylinder
The master cylinder consists of a fluid reservoir along with a double cylinder and piston assembly. Double type master cylinders are designed to separate the front and rear braking systems hydraulically in case of a leak. The master cylinder converts mechanical motion from the pedal into hydraulic pressure within the lines. This pressure is translated back into mechanical motion at the wheels by either the wheel cylinder (drum brakes) or the caliper (disc brakes).

1.5 Steel lines
Steel lines carry the brake fluid to a point on the vehicle’s frame near each of the vehicle's wheels. The fluid is then carried to the calipers and wheel cylinders by flexible tubes in order to allow for suspension and steering movements.

1.6 Drum brake systems
In drum brake systems, each wheel cylinder contains two pistons, one at either end, which push outward in opposite directions and force the brake shoe into contact with the drum.

1.7 Cylinder of the disc brake
In disc brake systems, the cylinders are part of the calipers. At least one cylinder in each caliper is used to force the brake pads against the disc.

1.8 Pistons
All pistons employ some type of seal, usually made of rubber, to minimize fluid leakage. A rubber dust boot seals the outer end of the cylinder against dust and dirt. The boot fits around the outer end of the-piston on disc brake calipers, and around the brake actuating rod on wheel cylinders.

1.9 Operation of hydraulic system
The hydraulic system operates as follows: When at rest, the entire system, from the piston(s) in the master cylinder to those in the wheel cylinders or calipers, is full of brake fluid. Upon application of the brake pedal, fluid trapped in front of the master cylinder piston(s) is forced through the lines to the wheel cylinders. Here, it forces the pistons outward, in the case of drum brakes, and inward toward the disc, in the case of disc brakes. The motion of the pistons is opposed by return springs mounted outside the cylinders in drum brakes, and by spring seals, in disc brakes.

1.10 Brake pedal system
Upon release of the brake pedal, a spring located inside the master cylinder immediately returns the master cylinder pistons to the normal position. The pistons contain check valves and the master cylinder has compensating ports drilled in it. These are uncovered as the pistons reach their normal position. The piston check valves allow fluid to flow toward the wheel cylinders or calipers as the pistons withdraw. Then, as the return springs force the brake pads or shoes into the released position, the excess fluid reservoir through the compensating ports. It is during the time the pedal is in the released position that any fluid that has leaked out of the system will be replaced through the compensating ports.

1.11 Dual circuit master cylinders
Dual circuit master cylinders employ two pistons, located one behind the other, in the same cylinder. The primary piston is actuated directly by mechanical linkage from the brake pedal through the power booster. The secondary piston is actuated by fluid trapped between the two pistons. If a leak develops in front of the secondary piston, it moves forward until it bottoms against the front of the master cylinder, and the fluid trapped between the pistons will operate the rear brakes. If the rear brakes develop a leak, the primary piston will move forward until direct contact with the secondary piston takes place, and it will force the secondary piston to actuate the front brakes. In either case, the brake pedal moves farther when the brakes are applied, and less braking power is available.
1.12 Dual circuit systems
All dual circuit systems use a switch to warn the driver when only half of the brake system is operational. This switch is usually located in a valve body which is mounted on the firewall or the frame below the master cylinder.

A hydraulic piston receives pressure from both circuits, each circuit’s pressure being applied to one end of the piston. When the pressures are in balance, the piston remains stationary.

When one circuit has a leak, however, the greater pressure in that circuit during application of the brakes will push the piston to one side, closing the switch and activating the brake warning light.

1.13 Disc brake systems
In disc brake systems, this valve body also contains a metering valve and, in some cases, a proportioning valve. The metering valve keeps pressure from travelling to the disc brakes on the front wheels until the brake shoes on the rear wheels have contacted the drums, ensuring that the front brakes will never be used alone. The proportioning valve controls the pressure to the rear brakes to lessen the chance of rear wheel lock-up during very hard braking.

1.14 Warning lights test
Warning lights may be tested by depressing the brake pedal and holding it, while opening one of the wheel cylinder bleeder screws. If this does not cause the light to go on, substitute a new lamp, make continuity checks, and, finally, replace the switch as necessary.

1.15 Checking hydraulic system for leaks
The hydraulic system may be checked for leaks by applying pressure to the pedal gradually and steadily. If the pedal sinks very slowly to the floor, the system has a leak.

This is not to be confused with a springy or spongy feel due to the compression of air within the lines. If the system leaks, there will be a gradual change in the position of the pedal with a constant pressure.

1.16 Check lines and cylinders for leaks
Check for leaks along all lines and at wheel cylinders. If no external leaks are apparent, the problem is inside the master cylinder.
3. Identify and explain Drum brake system

3.1 Drum brakes and shoes

Drum brakes employ two brake shoes mounted on a stationary backing plate. These shoes are positioned inside a circular drum, which rotates with the wheel assembly. The shoes are held in place by springs. This allows them to slide toward the drums (when they are applied) while keeping the lining and drums in alignment. The shoes are actuated by a wheel cylinder, which is mounted at the top of the backing plate.

When the brakes are applied, hydraulic pressure forces the wheel cylinder’s actuating links outward. Since these links bear directly against the top of the brake shoes, the tops of the shoes are then forced against the inner side of the drum. This action forces the bottoms of the two shoes to contact the brake drum by rotating the entire assembly slightly (known as servo action).

When pressure within the wheel cylinder is relaxed, return springs pull the shoes back away from the drum.

Most modern drum brakes are designed to self-adjust themselves during application when the vehicle is moving in reverse. This motion causes both shoes to rotate very slightly with the drum, rocking an adjusting lever, thereby causing rotation of the adjusting screw. Some drum brake systems are designed to self-adjust during application whenever the brakes are applied. This on-board adjustment system reduces the need for maintenance adjustments and keeps both the brake function and pedal feel satisfactory.

Note: The trainer/instructor before or during training should explain clearly the definition of each term to the students.

Clean, high quality brake fluid is essential to the safe and proper operation of the brake system. You should always buy the highest quality brake fluid that is available. If the brake fluid becomes contaminated, drain and flush the system, then refill the master cylinder with new fluid. Never reuse any brake fluid. Any brake fluid that is removed from the system should be discarded.
METHODOLOGY
This short course module, developed in Papua New Guinea, based on the competency-standard training model. The program was developed by a STRU curriculum officer, assisted by an international curriculum specialist and validated by a group of experience practitioners.

Their names are:

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<thead>
<tr>
<th>NAME</th>
<th>ORGANIZATION</th>
<th>LOCATION</th>
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<tbody>
<tr>
<td>Camilus Boage</td>
<td>Niu Ford</td>
<td>Waigani</td>
</tr>
<tr>
<td>Tau Kalogo</td>
<td>Boroko Motor</td>
<td>Waigani</td>
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<tr>
<td>Allan Hebei</td>
<td>Ela Motors</td>
<td>Badili</td>
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<td>Allan Kauri</td>
<td>Koki Vocational</td>
<td>Koki</td>
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The development of this short course was sponsored by the ADB-PNG EMPLOYMENT SKILLS DEVELOPMENT PROJECT (ESDLDP) and produced by curriculum officers at the SKILLS TRAINING RESOURCES UNIT (STRU).