TRAINING SUPPORT PACKAGE (TSP)

TSP Number / Title	091-91L10-ITRO-F-1 / Brake Systems
Effective Date	01 Jan 2011
Supersedes TSP(s) / Lesson(s)	All previous 612-91L10 and 612-91L10, ITRO, Brake System TSPs
TSP Users	612-91L10 / M0313B2, ITRO, Construction Equipment Repairer
Proponent	The proponent for this document is the Engineer School.
Improvement Comments	Users are invited to send comments and suggested improvements on DA Form 2028, *Recommended Changes to Publications and Blank Forms.* Completed forms, or equivalent response, will be mailed or attached to electronic e-mail and transmitted to: US Army Engineer School ATTN: ATSE-DT 320 MANSCEN Loop, Suite 370 Fort Leonard Wood, MO 65473-8929 Telephone (Comm): (573) 563-4112 Telephone (DSN): 676-4112
Security Clearance / Access	Unclassified
Foreign Disclosure Restrictions	FD5. This product/publication has been reviewed by the product developers in coordination with the Fort Leonard Wood, MO / Maneuver Support Center foreign disclosure authority. This product is releasable to students from all requesting foreign countries without restrictions.

PREFACE

Purpose

This Training Support Package provides the instructor with a standardized lesson plan for presenting instruction for:

Task Number	Task Title
Individual	
091-91L-1601	Adjust the Brake Shoes on an Item of Construction Equipment
091-91L-1602	Replace a Master Cylinder on an Item of Construction Equipment
091-91L-1603	Replace a Brake Booster on an Item of Construction Equipment
091-91L-1604	Replace a Treadle Valve on an Item of Construction Equipment
091-91L-1605	Replace a Brake Air Compressor on an Item of Construction Equipment
091-91l-1606	Replace a Slack Adjuster on an Item of Construction Equipment
091-91L-1607	Replace a Brake Cylinder on an Item of Construction Equipment
091-91L-1608	Replace the Brake Lines on an Item of Construction Equipment
091-91L-1609	Replace the Brake Shoes on an Item of Construction Equipment
091-91L-1610	Replace the Brake Pads on an Item of Construction Equipment
091-91L-1611	Replace the Brake Drums on an Item of Construction Equipment
091-91L-1612	Replace the Brake Rotors on an Item of Construction Equipment
091-91L-1613	Replace a Moisture Separator on an Item of Construction Equipment
091-91L-1614	Replace an Air Pressure Gauge on an Item of Construction Equipment.
091-91L-1615	Repair a Brake Air Compressor on an Item of Construction Equipment

091-91L-1616	Repair a Brake Caliper on an Item of Construction Equipment
091-91L-1617	Replace an Air Brake Safety Valve on an Item of Construction Equipment.
091-91L-1618	Repair an Air Brake Safety Valve on an Item of Construction Equipment.
091-91L-1619	Replace a Brake Chamber on an Item of Construction Equipment.
091-91L-1616	Repair a Brake Caliper on an Item of Construction Equipment
091-91L-1617	Replace an Air Brake Safety Valve on an Item of Construction Equipment.
091-91L-1618	Repair an Air Brake Safety Valve on an Item of Construction Equipment.
091-91L-1619	Replace a Brake Chamber on an Item of Construction Equipment.
091-91L-	Repair a Wet Disc Brake System on an Item of Construction Equipment.

This TSP Contains

TABLE OF CONTENTS

Brake System Fundamentals
91L10F01 / Version 1
01 Jan 2011

SECTION I. ADMINISTRATIVE DATA

	Course Number	Version	Course Title
All Courses Including This Lesson	612-91L10	1	Construction Equipment Repairer

	Task Number	Task Title
Task(s) Taught(*) or Supported		**INDIVIDUAL**
	091-91L-1601	Adjust the Brake Shoes on an Item of Construction Equipment
	091-91L-1602	Replace a Master Cylinder on an Item of Construction Equipment
	091-91L-1603	Replace a Brake Booster on an Item of Construction Equipment
	091-91L-1604	Replace a Treadle Valve on an Item of Construction Equipment
	091-91L-1605	Replace a Brake Air Compressor on an Item of Construction Equipment
	091-91L-1606	Replace a Slack Adjuster on an Item of Construction Equipment
	091-91L-1607	Replace a Brake Cylinder on an Item of Construction Equipment
	091-91L-1608	Replace the Brake Lines on an Item of Construction Equipment
	091-91L-1609	Replace the Brake Shoes on an Item of Construction Equipment
	091-91L-1610	Replace the Brake Pads on an Item of Construction Equipment
	091-91L-1611	Replace the Brake Drums on an Item of Construction Equipment
	091-91L-1612	Replace the Brake Rotors on an Item of Construction Equipment
	091-91L-1613	Replace a Moisture Separator on an Item of Construction Equipment
	091-91L-1614	Replace an Air Pressure Gauge on an Item of Construction Equipment.
	091-91L-1615	Repair a Brake Air Compressor on an Item of Construction Equipment
	091-91L-1616	Repair a Brake Caliper on an Item of Construction Equipment
	091-91L-1617	Replace an Air Brake Safety Valve on an Item of Construction Equipment.
	091-91L-1618	Repair an Air Brake Safety Valve on an Item of Construction Equipment.
	091-91L-1619	Replace a Brake Chamber on an Item of Construction Equipment.
	091-91L-	Repair a Wet Disc Brake System on an Item of Construction Equipment.

Reinforced Task(s)

Task Number	Task Title

Academic Hours

The academic hours required to teach this lesson are as follows:

	Resident Hours/Methods
	2 hrs 30 mins / Conference / Discussion
	30 mins / Tutorial
	1 hrs 00 mins / Simulators
	4 hrs 00 mins / Practical Exercise(Performance)
Test	0 hrs
Test Review	0 hrs
Total Hours:	8 hrs

Test Lesson Number

	Hours	Lesson No.
Testing (to include test review)		N/A

Prerequisite Lesson(s)

Lesson Number	Lesson Title
91L10A01	Course Introduction
91L10A02	Shop Safety Procedures
91L10A03	Environmental Awareness Procedures
91L10A04	Identify Computer Software and Hardware Components
91L10A05	AKO Procedures
91L10A06	Troubleshooting Logic Tree
91L10A07	The Levels of Maintenance and Their Responsibility
91L10A08	Utilize Maintenance and Repair Parts Technical Manuals
91L10A09	Utilize Maintenance Forms and Records
91L10A10	Battlefield Damage Assessment and Repair (BDAR)
91L10A11	Identify Items of Construction Equipment
91L10A12	Identify Test, Measurement and Diagnostic Equipment (TMDE), general mechanics and special tools.
91L10A13	Shop Operations Examination
91L10B01	The Fundamentals of Electricity
91L10B02	Wiring Diagrams, Schematics, and Automotive Batteries.
91L10B03	Identify Test, Measurement and Diagnostic Equipment (TMDE)
91L10B04	Starting and Charging Systems
91L10B05	Electrical Systems Examination
91L10C01	Diesel Engine Principles
91L10C02	Disassembly/Assembly of a Diesel Engine
91L10C03	Diesel Engine Component Replacement Performance Evaluation
91L10C04	Diesel Engine Systems Written Examination
91L10C05	Diesel Engine Test and Adjustment Procedures
91L10C06	Diesel Engine Systems Performance Evaluation
91L10D01	Hydraulic System Fundamentals
91L10D02	Hydraulic Cylinders and Lines
91L10D03	Hydraulic Pumps and Control Valves
91L10D04	Hydraulic Accumulators
91L10D05	Hydraulic Schematics
91L10D06	Hydraulic Systems Examination
91L10E01	Power Train Gears, Bearings and Seals

91L10E02	Torque Converters, Transmissions, Planetary Gears and Clutches
91L10E03	Differentials and Axles
91L10E04	Final Drives
91L10E05	Power Train Systems Examination

Clearance Access

Security Level: Unclassified
Requirements: There are no clearance or access requirements for the lesson.

Foreign Disclosure Restrictions

FD5. This product/publication has been reviewed by the product developers in coordination with the Fort Leonard Wood, MO / Maneuver Support Center foreign disclosure authority. This product is releasable to students from all requesting foreign countries without restrictions.

References

Number	Title	Date	Additional Information
29 CFR 1910.1200	Hazard Communication	01 Jul 2003	
29 CFR 1910.132	Personnel Protective Equipment - General Requirements	01 Jul 2003	
29 CFR 1910.133	Eye and Face Protection	01 Jul 2003	
29 CFR 1910.136	Foot Protection	01 Jul 2003	
29 CFR 1910.138	Hand Protection	01 Jul 2003	
29 CFR 1910.95	Occupational Noise Exposure	01 Jul 2003	
AR 385-10	The Army Safety Program	23 Aug 2007	
EM 385-1-1	Safety and Health Requirements.	03 Nov 2003	Public Domain
FM 3-100.4	Environmental Considerations in Military Operations. MCRP 4-11B.	15 Jun 2000	Public Domain
FM 5-19 (FM 100-14)	Composite Risk Management.	21 Aug 2006	Public Domain
TM 9-243	Use and Care of Hand Tools and Measuring Tools. TO 32-1-101/ M6290-AJ-MAN-010/ TM-10209-10/1.	12 Dec 1983	Public Domain
TM 9-8000	Principles of Automotive Vehicles.	25 Oct 1985	Public Domain

Student Study Assignments

None

Instructor Requirements

ITC certified instructors, MOS 91L20/1341 and above or civilian equivalent.

Additional Support Personnel Requirements

Name	Stu Ratio	Qty	Man Hours
None			

Equipment Required for Instruction

Id Name	Stu Ratio	Instr Ratio	Spt	Qty	Exp
*11H118 Universal Maintenance Training Simulator (UMTS) Device	1:32		No	32	No
4910-00-357-5342 Table, Work, Automotive Maintenance	1:4		No	8	No
2530-00-323-8538 Axle assembly M105 trailer	1:4		No	4	No
11022-02849 Micrometer, inside	1:4		No	4	No
4910-00-357-5342 Ruler Machinist	1:2		No	16	No
4710-00277-5527 Tool KT General Mechanics	1:4		No	8	Yes
5180-01-483-0249 Brake Bleeder Ball	1:16		No	2	No
5120-01-367-3941 Brake spring tool Snap on	1:4		No	8	No
5210-00-540-2973 Caliper, Micrometer, Outside	1:2		No	16	No
Wrench Torque 0-175 Ft LBS Screen Controller	1:6		Yes	6	No
7000-21-000-0354 150" Video Screens			Yes	4	No
7000-21-000-0355 Screen Controller			Yes	4	No
7000-21-000-0356 Crestron Audio / Video Controller			Yes	1	No
7000-21-000-0357 Power Supply			Yes	1	No
7000-21-000-0358 Crestron Com Card			Yes	3	No
7000-21-000-0359 LCD Projection System			Yes	4	No
7000-21-000-0360 8x8 RGB Routing Switcher			Yes	1	No
7000-21-000-0361 Creston Ethernet Card			Yes	1	No
7000-21-000-0362 Creston Input/Output Card			Yes	2	No
7000-21-000-0363 Crestron Volume Control Card			Yes	2	No
7000-21-000-0364 Crestron Relay Card			Yes	1	No
7000-21-000-0365 Crestron RS-232/IR Control Card			Yes	1	No
7000-21-000-0366 Crestron Infrared Transmitter			Yes	2	No

7000-21-000-0367 Ceiling Speaker System	Yes	16	No
7000-21-000-0368 Crestron Lighting Controller	Yes	2	No
7000-21-000-0369 Crestron 12" Video Touch Panel	Yes	2	No
7000-21-000-0385 Projector Mounting System	Yes	4	No
7000-21-000-0386 Audio Power Amplifier	Yes	4	No
7000-21-000-0387 Headset Microphone	Yes	2	No
7000-21-000-0388 Condenser Microphone	Yes	2	No
7000-21-000-0389 Microphone Base	Yes	2	No
7000-21-000-0390 Power Conditioner	Yes	2	No
7000-21-000-0391 8x8 Audio Video Routing Switcher	Yes	1	No
7000-21-000-0392 VCR / DVD Player	Yes	2	No
7000-21-000-0393 VCR / DVD Control Module	Yes	2	No
7000-21-000-0394 Wireless Microphone System	Yes	2	No
7000-21-000-0395 Lavaliere Microphone	Yes	2	No
7000-21-000-0396 Audio Dynamics Processor	Yes	1	No
7000-21-000-0397 Microphone Mixer	Yes	2	No
7000-21-000-0398 Audio Routing Mixer	Yes	1	No
7000-21-000-0399 20 Space Security Door	Yes	1	No
7000-21-000-0400 2-Space Vented Security Panel	Yes	2	No
7000-21-000-0401 Document Camera	Yes	2	No
7000-21-000-0402 Wireless Mouse	Yes	2	No
7000-21-000-0403 1x2 RGB Distribution Amplifier	Yes	2	No
7000-21-000-0404 Audio/Video/Control Cable and Assemblies	Yes	2	No
7000-21-000-0405 Control System Design	Yes	40	No
7000-21-000-0406 Smart Board Display Monitor	Yes	2	No
7000-21-000-0407 Documentation for Installation Schematics	Yes	10	No
7000-21-000-0408 Rack	Yes	1	No

7000-21-000-0409 Instructor PC		Yes	2	No
7110-01-202-3674 Board, Marker, Dry, Erasable Type	1:1	No	1	No
7195-00-477-5699 Stand, Lecture	1:1	No	1	No

* Before Id indicates a TADSS

Materials Required

Instructor Materials:
Lesson F01
Visitor's Book

Student Materials:
Student Study Guide

Classroom, Training Area, and Range Requirements

AUTO-AID INST, 1400 SF (Classroom XXI)
VEH MAINT INST 6490 SF(Maintenance Bay)

Ammunition Requirements

Id	Name	Exp	Stu Ratio	Instr Ratio	Spt Qty
None					

Instructional Guidance

NOTE: Before presenting this lesson, instructors must thoroughly prepare by studying this lesson and identified reference material.

Before presenting this lesson:

a. Ensure classroom is available and ready for training.

b. Ensure computer systems and simulator are prepared for operation.

c. Ensure materials are on hand and in quantities needed.

d. Read and understand Lesson F01 prior to conducting training.

e. Conduct an Environmental Risk Assessment for this lesson IAW FM 3-100.4, Environmental Considerations in Military Operations.

1) The assessment is to be recorded on the Risk Management Worksheet found in appendix F of FM 3-100.4. FM 5-19, Composite Risk Management, has more information on this worksheet.

2) During the assessment instructors should look for environmental hazards including all activities that may pollute, generate hazardous or solid waste, create negative noise-related effect, degrade archaeological, cultural resources, or negatively affect threatened or endangered species' habitats.

3) Ensure instructor check Contemporary Operational Environment web site for latest updates.

https://sp.wood.army.mil/sites/Manscen/ENG/1bde/554/ACO2/COA/Tab4.aspx

f. In accordance with AR 385-10, Army Safety Program, Chapter 16, Occupational Safety and Health Program (Workplace Safety):

1) OSHA programs and national consensus standards shall be applicable to and integrated into all Army equipment, systems, operations, and workplaces, CONUS and OCONUS.

2) Military design, specifications, and deployment requirements will comply with OSHA standards where feasible. When no standard exists for military application or the application is not feasible, the Army component will apply mishap risk management component of CRM.

3) Military and Army civilian officials at each management level shall promote strong safety programs, safe working conditions, and safe performance to prevent accidents, injuries, and occupational illnesses.

Module Briefing.

NOTE: Show Slide# 1

a. Inform students where training locations and formations will be held and latrine facilities

b. Fire and tornado safety brief, location and what to do

c. Privileges, Breaks, Smoking areas, Break truck

d. Inform students where and when they may have food and drinks; Food and drinks will not be consumed around the simulator or during training areas.

e. No gum chewing except during break times.

f. Inform students about clean up.

g. Inform students about attention to the instructor and professionalism.

h. Answer any questions students may have

Inform students where the facilities and break areas are located.

NOTE: Show Slides #2 and 3

Inform students about critical tasks.

Proponent Lesson Plan Approvals

Name	Rank	Position	Date
Shankland, Steven	SSG	Developer/Writer	01 Jan 2011
King, Ronnie	YC-02	Chief, Construction Engineer Branch	01 Jan 2011
Rutledge, Jesse	YC-02	Chief, Individual Training Division	01 Jan 2011

SECTION II. INTRODUCTION

Method of Instruction: Conference / Discussion
Instructor to Student Ratio is: 1:32
Time of Instruction: 15 mins
Media: Large Group Instruction

Motivator

NOTE: Show Slide # 1

Brake systems are the most critical element of a vehicle. You have to be able to stop a vehicle that weighs several tons to protect yourself and those around you. You can NEVER cut corners when troubleshooting and repairing brake system components.

NOTE: Show Slides # 2&3

Terminal Learning Objective

NOTE: Inform the students of the following Terminal Learning Objective requirements.

At the completion of this lesson, you [the student] will:

Action:	Identify the types, actions, and functions of friction brake systems
Conditions:	In a contemporary operational environment, given a presentation and instruction on brake systems, a student study guide and a pen or pencil.
Standards:	Identify brake system components, functions of braking action, special tools used to repair brake systems, safety considerations while working on brake systems and the principles of brake systems.

Safety Requirements

Remove all jewelry to include ID tags and wedding bands when working on equipment. Use caution around moving parts. The use of Personal Protective Equipment (PPE) by students and instructors is mandatory. Further guidance concerning PPE can be found in OSHA regulations 29 CFR 1910.132; 29 CFR 1910.133; 29 CFR 1910.136; 29 CFR 1910.138; and 29 CFR 1910.95.

Risk Assessment Level

Low - Review the deliberate risk assessment, perform a daily risk assessment, and ensure it is recorded on appropriate forms, signed by authorized command authority, and posted at the training site.

Environmental Considerations

NOTE: It is the responsibility of all Soldiers and DA civilians to protect the environment from damage.
Instructors should complete a risk assessment before conducting training, operations, or logistical activities. Risk assessments assist instructors in identifying potential environmental hazards, develop controls, make risk decisions, implement controls, and ensure proper supervision and evaluation.

Evaluation

Achieve a minimum score 80% on a written examination in the time allotted and achieve a GO on a performance evaluation in the time allotted.

Instructional Lead-In

NOTE: Allow one to two minutes for the lesson introduction.

NOTE: Introduce yourself as the instructor.

SECTION III. PRESENTATION

1. Learning Step / Activity 1.Friction type brake systems.

Method of Instruction: Conference / Discussion
Instructor to Student Ratio: 1:32
Time of Instruction: 2 hr 15 mins
Media: Large Group Instruction

NOTE: Contemporary Operational Environment

At various times during the class, the instructor will stress the importance of the topic by conveying personal experience related to the topic of discussion. The instructor will also answer any questions relating to the experience.

a. Principles of Brake Systems.

NOTE: Show Slide #4

1) The principles of braking systems give you the background and knowledge of friction- type brake systems, basic hydraulic system manuals, and general shop safety. Braking systems have changed significantly over the past century. In the beginning, most brake systems were hand- or foot-lever operated. Bands attached to these levers clamped around the axle housing when applied. These braking systems were hard to maintain and needed repair often. As vehicle weights and speeds increased, other more efficient and complex braking methods were introduced; such as the air brake system and the assisted brake system. These systems are still widely used today's cars, trucks and construction equipment.

NOTE: Show Slide #5

2) Discuss how brakes can be actuated

a) Braking systems can be actuation by Hydraulic actuation. Hydraulic actuation uses fluid pressure to operate a cylinder that applies the brakes Typical Drum

b) Pneumatic actuation: Pneumatic actuation uses controlled compressed air to operate a rotating cam that applies the brakes.

c) Combination of the two: used in power and assisted brake systems. A mechanical device between the seals and diaphragms transfers the pressure from one system to the other for the braking action.

.

NOTE: Show Slide #6

3) Friction Type Braking Systems

a) Friction type braking, combines **rotating** and **non-rotating** members with hydraulic or pneumatics force to create friction. Friction is used to overcome the vehicles momentum by applying foot pressure from the brake pedal converting mechanical to fluid pressures to the calipers and wheel cylinders or Pneumatic pressures to the air chambers. Where the fluid or air pressure is converted back to mechanical force to engage the rotating and non rotating members for the braking action.

NOTE: Show Slide #7

4) **Discuss Braking Action**

a) Is the use of a controlled force to accomplish the three basic tasks of reducing speed, stopping and holding an object in a stationary position. Brake systems are designed not only to stop a vehicle, but in the shortest time possible while still maintaining the control of the vehicle. Each piece of equipment has a different braking requirement due to its size, speed or weight, to provide the maximum retardation from the braking surfaces to the terrain. Operator's reaction time is not taken in account for creating a vehicles braking system.

NOTE: Show Slide #8

5) Discuss Maximum Retardation

a) **Maximum Retardation**: is reached when friction between the tire and the traveling surface just before the brakes lock up. Maximum braking depends on the six factors of relative values of the coefficients of friction between the braking surfaces and between the tire and the traveling surface

6) Discuss Factors That Affect Braking

a) Maximum braking depends on the six factors of relative values between the braking surfaces, wheels, and the traveling surface.

1) The pressure exerted on the rotating and non-rotating braking surfaces.

2) The weight carried on a wheel.

3) The overall radius of a wheel. The overall radius of a wheel is the distance from the center of the wheel to the outer tread surface of the tire.)

4) The radius of the brake drum or rotor.

5) The amount of friction between the braking surfaces. (Material and braking surface areas)

6) The amount of friction between the tire and the traveling surface. (Contact area between tire and the terrain surface)

NOTE: Show Slide #9

7) Discuss Brake Fade

a) Brake systems must be constructed to dissipate heat even under heavy braking conditions which may cause brake induced fires or brake fade.

b) **Brake Fade:** is a reduction in braking power due to lessening of friction between the brake shoes and drum or pads and rotor. This often occurs from heat buildup due to repeated or prolonged braking applications. Look for white and black spots or bluing of metal on brake drum and rotor surfaces.

NOTE: Show Slide #10

b) Basic Hydraulic System.

a. Consists of the master cylinder, brake lines, wheel cylinder,

b. **Hydraulic Brake System**: Uses a mechanical actuated linkage (Brake Pedal) to convert mechanical force to fluid pressure in a single or dual master cylinder. This fluid pressure is transferred though seamless steel lines or high pressures hoses able to the wheel cylinders. The wheel cylinders convert the fluid pressure back to mechanical force. This energy is applied to the brake shoes forcing contact and friction with the drum or hub to overcome the vehicles momentum, and perform the braking action. This braking system is not considered power brakes since it does not assist the operator in the brake action.

c. ***Note: Safety covered in AR385-10*** **: STATES BRAKE FLUID LEAKS CAN NOT BE CLASSIFIED INTO LEAK CATAGORIES AND THAT ANY MALFUNCTION IN THE BRAKE SYSTEM IS A DEAD LINE!**

NOTE: Show Slide #11

9) Brake fluids

a. Must have certain properties and characteristics. They must be able to control the amount of swelling and damage to cups and seals. Resist evaporation at high temperatures from 104 to 500 degrees F. Brake fluids must also incorporate lubricating qualities while combating rust and corrosion in the brake system.

b. Dots 3, 4, are hydroscopic Brake fluids (absorbs Moisture). Keep reservoirs and containers tightly close to prevent moisture from being absorbed from the atmosphere.

c. Dot 5(Silicone Brake Fluid) and 10w hydraulic fluids do not absorb moisture, but should be covered to prevent other foreign matter from entering the system.

i. **Never reuse old brake fluid!**

ii. **Note: ONLY USE THE APPROVED FLUID RECOMMENDED.**

NOTE: Show Slide #12

10) Master Cylinder

a. THE MASTER CYLINDER TRANSFERS MECHANICAL ENERGY INTO HYDRAULIC FORCE

b. Using a confined liquid with applied pressure to create hydraulic force. Hydraulic fluid is trapped by the piston assembly in the lower reservoir. The fluid moving under pressure flows through the one way check valve though lines to the wheel cylinder. When the applied force is removed, the fluid returns to the master cylinder by pushing the one way check valve and collapsing the return spring. Fluid will continue returning to the master cylinder from the wheel cylinders as long as 8- 16 PSI of line pressure is present. The return spring will close the one way check valve on its seat preventing air to be drawn into the hydraulic system.

Click to show animation of the master cylinder.

c. The reservoir carries enough reserve fluid to allow for expansion and contraction of the brake shoes, but also allows the cavities behind the pistons in the disk brake caliper to be filled as brake linings wear out.

NOTE: Show Slide #13

11) Hydraulic Brake Lines

a. Hydraulic Brake lines or tubes are used to connect components together. Fluid from the master cylinder travels through the brake lines to the caliper, or wheel cylinder. Hydraulic lines are made of seamless steel tubing Used for fixed placement and better durability or flexible high pressure hose to allow for movement between the body and suspension.

WARNING: When replacing lines and hoses, DO NOT CHANGE INSIDE HOSE DIAMETERS, IMPROPER BRAKING WILL RESULT!

NOTE: Show Slide #14

12) Duel Master Cylinders

a. As a safety precaution, brake systems today are split into two sections. This simply means that there are two separate reservoirs that supply fluid to the master cylinder. If one fails, for example if a line

ruptures in one half of the system, the other half of the system will continue to operate to stop the vehicle.

b. There are two 'splits' used on modern braking systems:

c. **Front and rear split**: If a leak occurs in either the primary or secondary brake reservoirs, the vehicle would only lose the front or rear brakes depending on the location of the malfunction. This would allow the vehicle to maintain some of its braking power, as opposed to losing it all.

NOTE: Show Slide # 15

d. **Diagonal split:** If a leak occurs in either the primary or secondary brake reservoirs, the driver loses one front brake and one rear brake. One front brake and one rear brake on opposite sides would still function. This system allows the operator to maintain better control of the vehicle.

NOTE: Show Slide # 16

13) Wheel Cylinder.

a. The **Wheel cylinder is** a hydraulic actuator that converts fluid pressure back to mechanical force

b. It is used in hydraulic assisted and non assisted drum type braking systems.

c. A spring is located inside to keep the cups centered in the housing and keep the fluid passages open.

d. The rubber dust boot is to prevent foreign matter from entering the wheel cylinder.

e. Fluid leaking on the backing plate is a sign that the wheel cylinder is leaking and needs to be rebuild or replaced.

f. Emery cloth or cylinder hone may be used to resurface the inside of the wheel cylinder housing, reassemble using clean brake fluid only.

c). **Special Tools.**

NOTE: Show Slide # 17

14) Special tools

a. These are items not found in a common tool kit. When used properly, these tools save the mechanic time and prevent unnecessary damage to items when performing maintenance or during disassembly and reassembly of components. Here are a few used during brake repair.

NOTE: Show Slide # 18

15) Brake spring pliers

a. Comes in various shapes and sizes. They aid in the removal and assembly and prevent unnecessary wear or over stretching to the brake shoe retaining springs.

NOTE: Show Slide # 19

16) Snap ring pliers

a. are used for internal or external retaining device. They also come in various shapes and sizes and the correct one will depend on the size of the snap ring being removed.

NOTE: Show Slide # 20

17) Measurement Devices:

a. ruler, dial vernier caliper, and micrometer are items used to measure inside or outside diameters or thickness of components.

b. Special care is needed when using and storing these devices.

c. Clean your hands and the item to be measured.

d. Do not drop the measuring devices.

e. **Never store measuring devices completely closed or without a light coat of oil to prevent measuring surfaces from rusting.**

NOTE: Show Slide # 21

18) Discuss tube and flaring kit:

a. Tube cutting and flaring kit can be used on brass or stainless steel lines in repairing or constructing new air or hydraulic brake lines.

b. Three Types of Flares:

1) Single Flare (Air lines and Low Pressure fuel line)

2) .Double Flare (Strengthened Air Lines) and Hydraulic lines for higher system pressures

3) Bubble Flare used in metric braking application

Note: (double flare brake lines and bubble flare brake lines are not interchangeable Due to their seating properties)

a. Care and use of flaring kit

b. Clean and de-burr all flaring surfaces.

c. When using flaring dies use oil to minimize wear on mating surfaces.

d. Keep all kit components clean and lightly oiled

e. When creating a new brake line you must use the correct inside diameter tubing Size (5/16 1/4/3/8 Ect) the correct type (copper or steel tubing) depending on the application, the correct length of tubing and the type of flare needed (Single, Double, or Metric).

NOTE: Show Slide # 22

19) Discuss Hydraulic Brake Bleeder

a. Uses pressurized fluid to remove the air from the hydraulic brake systems. This simplifies the process by needed only one mechanic to perform the bleeding operation without the vehicle running.

b. Care and use Hydraulic Bleeder Ball

c. **Goggles will be used at all time when filling and using Brake bleeder ball.**

d. Ensure all pressure is relived before removing the filler cap.

e. Do not mix brake fluids, brake bleeder should be marked by. Type

f. Use a Long Dull object when pressing down diaphragm.

g. **Never pressurized brake bleeder more than 50 PSI, Explosion and serious injury may occur.**

h. Never store Brake bleeder ball with pressure when not in use. Damage to bleeder diaphragm may occur.

NOTE: Show Slide # 23

NOTE: Conduct a check on learning and summarize the learning activity.

Determine if students have learned the material presented by:

1. Soliciting student questions and explanations.
2. Asking questions and receiving answers from the students.
3. Correcting student misunderstandings.

2. Learning Step / Activity 2. Operate the Brake System Simulator.

Method of Instruction: Tutorial
Instructor to Student Ratio: 1:16
Time of Instruction: 15 mins
Media: Computer Based Instruction (CBI)

NOTE: Learning Steps #2, 3 and 4 will be done as one continuous lesson.

NOTE: Instructors should reference "62B Brake System Simulation Instructor's Guide" for detailed instructions on operating the simulator.

a. To access the simulator the student must double-click on the "Brake Systems Simulator" Icon (Crossed Wrenches).

NOTE: The Simulator program that can be accessed when double-clicking on the Internet Explorer Icon is not covered.

b. The Mouse:

1) Do not allow the students to double click the right mouse button to reassemble the parts. The computer will not recognize this.

2) Do not allow the students to right click – "attach parts" or "attach all parts". The computer will not recognize this.

c. Questions and Answers:

1) Questions are listed as seen on the module screen and can be identified by "Q:"

2) The correct answer is provided for each question and can be identified by "A" and the answer will be underlined.

NOTE: In most modules, if the student answers the question incorrectly, the instructor must reload the page unless otherwise noted. Some pages require the instructor to press the CTRL key and then click on the cartoon mechanic.

d. Tutorial:

1) Page 2:

Student may click on the three areas of the simulation window to learn more about them.

2) Page 3:

a) Student learns how to manipulate the 3D images by using the various controls on the mouse.

b) Student must click on the 3D button and remove the right engine access panels.

c) Student must rotate the vehicle so the left side is visible and remove the left rear engine access panels.

d) Student must rotate the vehicle so the bottom of the vehicle is showing and remove the two jack stands.

e) Student must rotate the vehicle so the left front tire is centered in the window and zoomed completely in. Student must remove the tire by removing the lug nuts then the tire.

3) Page 4:

a) Student is shown how to navigate throughout the model using links that are located on parts, as well as, how to install parts.

b) Student must click on the left rear tire.

NOTE: Student must click once without moving the mouse to see the note.

c) Student must rotate the vehicle so the bottom is showing to find the link that is located on the axle.

d) Student must double-click on the axle to go to the next image.

e) Student must double-click on one of two links on the calipers. Student must attach four bolts then return to the axle and then to the loader.

f) Student must remove both right engine access panels.

NOTE: Conduct a check on learning and summarize the learning activity.

Clarify any questions the students have about navigating through the simulation.

3. Learning Step / Activity 3. Correct a Hydraulic Brake System Malfunction.

Method of Instruction: Practical Exercise (Performance)
Instructor to Student Ratio: 1:16
Time of Instruction: 1hr 0 mins
Media: Computer Based Instruction (CBI)

Practical Exercise Instructions.

a. Give detailed instructions on what is expected during each practical exercise IAW Appendix C.

b. Ensure students have required materials and references IAW Appendix C.

c. Clarify students' questions.

d. Conduct the practical exercise IAW Appendix C.

e. Check on students' progress and provide assistance as necessary throughout the exercise.

f. Ensure students complete the practical exercise within the allotted time.

g. Provide solutions to the practical exercise.

NOTE: Conduct a check on learning and summarize the learning activity.

4. Learning Step / Activity 4. Brake System Bleeder Ball Operation.

Method of Instruction: Demonstration
Instructor to Student Ratio: 1:16
Time of Instruction: 15 mins
Media: Film/Training Aids

Student will watch a video on the operational use of the brake system bleeder ball. The student will then answer questions about the video after the video ends.

Questions:

Q. What do you use to press down the bleeder ball diaphragm?
A. Finger.

Q. How much air pressure do you fill the bleeder ball with?
A. 25-30 psi.

Q. You will bleed the brake fluid until you see _____?
A. Clear fluid with no bubbles.

Q. The last thing you need to do to the bleeder valve after bleeding the brake system is?
A. Relieve air pressure from the bleeder ball.

NOTE: Conduct a check on learning and summarize the learning activity.

5. Learning Step / Activity 5. Utilize Special Tools and TMDE.

Method of Instruction: Practical Exercise (Performance)
Instructor to Student Ratio: 1:8
Time of Instruction: 4 hrs 00 mins
Media: Training Aid

Practical Exercise Instructions.

a. Give detailed instructions on what is expected during each practical exercise IAW Appendix C.

b. Ensure students have required materials and references IAW Appendix C.

c. Clarify students' questions.

d. Conduct the practical exercise IAW Appendix C.

e. Check on students' progress and provide assistance as necessary throughout the exercise.

f. Ensure students complete the practical exercise within the allotted time.

g. Provide solutions to the practical exercise.

NOTE: Conduct a check on learning and summarize the learning activity.

Determine if students have learned the material presented by:

1. Soliciting student questions and explanations.

2. Asking questions and receiving answers from the students.

3. Correcting student misunderstandings.

SECTION IV. SUMMARY

Method of Instruction: Conference / Discussion
Instructor to Student Ratio is: 1:32
Time of Instruction: 5 mins
Media: Large Group Instruction

Check on Learning

Determine if the students have learned the material presented by soliciting student questions and explanations. Ask the students questions and correct misunderstandings.

Review / Summarize Lesson

Restate the Terminal Learning Objective (TLO) requirements (**Identify the types, actions, and functions of brake systems**). Summarize the Learning Steps/Activities.

1. **Identify the Principles of Brake Systems.**
2. **Operate the Brake System Simulator.**
3. **Correct a Hydraulic Brake System Malfunction.**
4. **Identity Brake System Bleeder Ball Operation.**
5. **Utilize Special Tools and TMDE.**

SECTION V. STUDENT EVALUATION

Testing Requirements	**NOTE:** Describe how the student must demonstrate accomplishment of the TLO. Refer student to the Student Evaluation Plan.
Feedback Requirements	**NOTE:** Feedback is essential to effective learning. Schedule and provide feedback on the evaluation and any information to help answer students' questions about the test. Provide remedial training as needed.

Air Brake Systems
91L10F02 / Version 1
01 Jan 2010

SECTION I. ADMINISTRATIVE DATA

All Courses Including This Lesson

Course Number	Version	Course Title
612-91L10	1	Construction Equipment Repairer

Task(s) Taught(*) or Supported

Task Number	Task Title
	INDIVIDUAL
091-91L-1601 (*)	Adjust the Brake Shoes on an Item of Construction Equipment
091-91L-1604 (*)	Replace a Treadle Valve on an Item of Construction Equipment
091-91L-1605 (*)	Replace a Brake Air Compressor on an Item of Construction Equipment
091-91L-1606 (*)	Replace a Slack Adjuster on an Item of Construction Equipment
091-91L-1609 (*)	Replace the Brake Shoes on an Item of Construction Equipment
091-91L-1610 (*)	Replace the Brake Pads on an Item of Construction Equipment
091-91L-1611 (*)	Replace the Brake Drums on an Item of Construction Equipment
091-91L-1613 (*)	Replace a Moisture Separator on an Item of Construction Equipment
091-91L-1614 (*)	Replace an Air Pressure Gauge on an Item of Construction Equipment.
091-91L-1615 (*)	Repair a Brake Air Compressor on an Item of Construction Equipment
091-91L-1618 (*)	Repair an Air Brake Safety Valve on an Item of Construction Equipment.
091-91L-1619 (*)	Replace a Brake Chamber on an Item of Construction Equipment.

Reinforced Task(s)

Task Number	Task Title

Academic Hours

The academic hours required to teach this lesson are as follows:

	Resident Hours/Methods
	3 hrs 0 mins / Conference / Discussion
	2 hrs 0 mins / (Simulation)
Test	6 hrs 0 mins / Practical Exercise(performance)
Test Review	0 hrs
Total Hours:	11 hrs

Test Lesson Number

	Hours	Lesson No.
Testing (to include test review)		N/A

Prerequisite Lesson(s)

Lesson Number	Lesson Title
91L10A01	Course Introduction
91L10A02	Shop Safety Procedures
91L10A03	Environmental Awareness Procedures
91L10A04	Identify Computer Software and Hardware Components
91L10A05	AKO Procedures
91L10A06	Troubleshooting Logic Tree
91L10A07	The Levels of Maintenance and Their Responsibility
91L10A08	Utilize Maintenance and Repair Parts Technical Manuals
91L10A09	Utilize Maintenance Forms and Records
91L10A10	Battlefield Damage Assessment and Repair (BDAR)
91L10A11	Identify Items of Construction Equipment
91L10A12	Identify Test, Measurement and Diagnostic Equipment (TMDE), general mechanics and special tools.
91L10A13	Shop Operations Examination
91L10B01	The Fundamentals of Electricity
91L10B02	Wiring Diagrams, Schematics, and Automotive Batteries.
91L10B03	Identify Test, Measurement and Diagnostic Equipment (TMDE)
91L10B04	Starting and Charging Systems
91L10B05	Electrical Systems Examination
91L10C01	Diesel Engine Principles
91L10C02	Disassembly/Assembly of a Diesel Engine
91L10C03	Diesel Engine Component Replacement Performance Evaluation
91L10C04	Diesel Engine Systems Written Examination
91L10C05	Diesel Engine Test and Adjustment Procedures
91L10C06	Diesel Engine Systems Performance Evaluation
91L10D01	Hydraulic System Fundamentals
91L10D02	Hydraulic Cylinders and Lines
91L10D03	Hydraulic Pumps and Control Valves
91L10D04	Hydraulic Accumulators
91L10D05	Hydraulic Schematics
91L10D06	Hydraulic Systems Examination
91L10E01	Power Train Gears, Bearings and Seals
91L10E02	Torque Converters, Transmissions, Planetary Gears and Clutches
91L10E03	Differentials and Axles
91L10E04	Final Drives
91L10E05	Power Train Systems Examination
91L10F01	Brake System Fundamentals

Clearance Access

Security Level: Unclassified
Requirements: There are no clearance or access requirements for the lesson.

Foreign Disclosure Restrictions

FD5. This product/publication has been reviewed by the product developers in coordination with the Fort Leonard Wood, MO / Maneuver Support Center foreign disclosure authority. This product is releasable to students from all requesting foreign countries without restrictions.

References

Number	Title	Date	Additional Information
29 CFR 1910.1200	Hazard Communication	01 Jul 2003	
29 CFR 1910.132	Personnel Protective Equipment - General Requirements	01 Jul 2003	
29 CFR 1910.133	Eye and Face Protection	01 Jul 2003	
29 CFR 1910.136	Foot Protection	01 Jul 2003	
29 CFR 1910.138	Hand Protection	01 Jul 2003	
29 CFR 1910.95	Occupational Noise Exposure	01 Jul 2003	
AR 385-10	The Army Safety Program	23 Aug 2007	
EM 385-1-1	Safety and Health Requirements.	03 Nov 2003	Public Domain
FM 3-100.4	Environmental Considerations in Military Operations. MCRP 4-11B.	15 Jun 2000	Public Domain
FM 5-19 (FM 100-14)	Composite Risk Management.	21 Aug 2006	Public Domain
ISBN0-8273-7287-6	Todays Technician Medium and Heavy Truck	None	Delmar Publishing
TM 5-3805-248-23-1	Unit and Direct Support Maintenance for Scraper, Earth Moving, Motorized, Diesel Engine Driven Model 621B (NSN 3805-01-153-1854) (EIC: EH3).	15 Feb 2006	EM 0115; Public Domain
TM 5-3805-248-23-2	Unit and Direct Support Maintenance for Scraper, Earth Moving, Motorized Diesel Engine Driven Model 621B.	15 Feb 2006	EM 0115; Public Domain
TM 9-2320-363-20-1	Unit Maintenance Manual for Truck, Tractor, Line Haul 52,000 GVWR, 6x4, M915A2 . . . Volume 1 of 2.	11 Jun 1992	Public Domain
TM 9-2320-363-20-2	Unit Maintenance Manual for Truck, Tractor, Line Haul 52,000 GVWR, 6x4, M915A2 (NSN 2320-01-272-5029) Truck Tractor, Light Equipment Transporter (LET) 68,000 GVWR, 6x6, w/Winch, M916A1 (2320-01-272-5028) Truck Tracter, Light Equipment...	12 Jun 1992	Public Domain

Student Study Assignments

None

Instructor Requirements

ITC certified instructors, MOS 91L20 / 1341 and above or civilian equivalent.

Additional Support Personnel Requirements

Name	Stu Ratio	Qty	Man Hours
None			

Equipment Required for Instruction

Id Name	Stu Ratio	Instr Ratio	Spt	Qty	Exp
*11H118 Universal Maintenance Training Simulator (UMTS) Device	1:32		No	32	No
*2520-01-326-4640 Axle, Assembly, Automotive, Driving	1:4		No	4	No
*2530-01-202-3594 Dryer Assembly, Air	1:2		No	8	No
*2530-01-348-4443 Hub, Wheel, Vehicular	1:4		No	6	No
*2530-01-348-6386 Hub, Wheel, Vehicular	1:4		No	6	No
*3110-00-100-4218 Bearing, Roller, Tapered	1:4		No	8	No
*3110-01-331-1340 Bearing, Roller, Tapered	1:4		No	8	No
5120-00-293-1439 Vise Machinist 4In	1:4		No	10	No
4240-00-022-2946 Protector, Hearing	1:1	1:1	No	38	Yes
4240-00-052-3776 Goggles, Industrial	1:1	1:1	No	38	Yes
4310-00-542-4563 Compressor Unit, Reciprocating	1:32		No	1	No
5120-00-640-6364 Wrench, Torque 175 FT-LB	1:8		No	8	No
*5120-01-374-1939 Wrench Torque 600 FT-LB	1:4		No	4	No
5180-01-548-7634 Tool Kit, General Mechanic	1:4		No	8	No
*5330-01-117-1014 Seal, Plain Encased	1:4		No	8	No
*L-TAABST-FLW Model 6430 ATech Air Brake trainer	1:4	1:5	No	6	No
*6910-00-T54-0155 Brake Air Board	1:32	1:5	Yes	1	No
7000-21-000-0354 150" Video Screens			Yes	4	No
7000-21-000-0355 Screen Controller			Yes	4	No
7000-21-000-0356 Crestron Audio / Video Controller			Yes	1	No
7000-21-000-0357 Power Supply			Yes	1	No
7000-21-000-0358 Crestron Com Card			Yes	3	No
7000-21-000-0359 LCD Projection System			Yes	4	No
7000-21-000-0360			Yes	1	No

8x8 RGB Routing Switcher			
7000-21-000-0361 Creston Ethernet Card	Yes	2	No
7000-21-000-0362 Creston Input/Output Card	Yes	2	No
7000-21-000-0363 Crestron Volume Control Card	Yes	2	No
7000-21-000-0364 Crestron Relay Card	Yes	1	No
7000-21-000-0365 Crestron RS-232/IR Control Card	Yes	2	No
7000-21-000-0366 Crestron Infrared Transmitter	Yes	16	No
7000-21-000-0367 Ceiling Speaker System	Yes	16	No
7000-21-000-0368 Crestron Lighting Controller	Yes	2	No
7000-21-000-0369 Crestron 12" Video Touch Panel	Yes	2	No
7000-21-000-0385 Projector Mounting System	Yes	4	No
7000-21-000-0386 Audio Power Amplifier	Yes	4	No
7000-21-000-0387 Headset Microphone	Yes	2	No
7000-21-000-0388 Condenser Microphone	Yes	2	No
7000-21-000-0389 Microphone Base	Yes	2	No
7000-21-000-0390 Power Conditioner	Yes	2	No
7000-21-000-0391 8x8 Audio Video Routing Switcher	Yes	1	No
7000-21-000-0392 VCR / DVD Player	Yes	2	No
7000-21-000-0393 VCR / DVD Control Module	Yes	2	No
7000-21-000-0394 Wireless Microphone System	Yes	2	No
7000-21-000-0395 Lavaliere Microphone	Yes	2	No
7000-21-000-0396 Audio Dynamics Processor	Yes	1	No
7000-21-000-0397 Microphone Mixer	Yes	2	No
7000-21-000-0398 Audio Routing Mixer	Yes	1	No
7000-21-000-0399 20 Space Security Door	Yes	1	No
7000-21-000-0400 2-Space Vented Security Panel	Yes	2	No
7000-21-000-0401 Document Camera	Yes	2	No
7000-21-000-0402	Yes	2	No

Wireless Mouse					
7000-21-000-0403 1x2 RGB Distribution Amplifier			Yes	2	No
7000-21-000-0404 Audio/Video/Control Cable and Assemblies			Yes	2	No
7000-21-000-0405 Control System Design			Yes	40	No
7000-21-000-0406 Smart Board Display Monitor			Yes	2	No
7000-21-000-0407 Documentation for Installation Schematics			Yes	10	No
7000-21-000-0408 Rack			Yes	1	No
7000-21-000-0409 Instructor PC			Yes	2	No
7110-01-202-3674 Board, Marker, Dry, Erasable Type		1:1	No	0	No
7125-01-084-6955 Cabinet, Storage	1:32		No	0	No
7195-00-477-5699 Stand, Lecture		1:1	No	0	No
5120-00-789-0492 Pliers Snap Ring	1:4		Yes	8	No
OTC 1914 Wheel Bearing Socket 4In	1:4		Yes	8	No
8430-00-624-3135 Boots, Safety, Men's, Size 10 Regular	1:1		Yes	0	No
8435-01-475-6874 Boots, Safety, Women's, Size 8 Regular	1:1		Yes	0	No
5mW43 Extension 4in ¾ Dr	1:4		No	8	No
4431 Breaker bar ¾ Dr	1:4		No	8	No
11022-02849 Micrometer Inside	1:4		No	4	Yes
4440 -01-080-0933 Parts Kit Air Drier	1:2		No	16	No

* Before Id indicates a TADSS

Materials Required

Instructor Materials:

TM 5-3805-248-23-1
TM 5-3805-248-23-2
TM 9-2320-363-20-1
TM 9-2320-363-20-2
TM 9-243
Eye Protection
Visitor's Book

Student Materials:

TM 5-3805-248-23-1
TM 5-3805-248-23-2
TM 9-2320-363-20-1
TM 9-2320-363-20-2
TM 9-243
Pens and Pencils

Coveralls
Safety Boots
Eye Protection

Classroom, Training Area, and Range Requirements

AUTO-AID INST, 1400 SF (Classroom XXI)
VEH MAINT INST 6490 SF Maintenance Bay

Ammunition Requirements

Id	Name	Exp	Stu Ratio	Instr Ratio	Spt Qty
None					

Instructional Guidance

NOTE: Before presenting this lesson, instructors must thoroughly prepare by studying this lesson and identified reference material.

Before presenting this lesson:

a. Ensure classroom is available and ready for training.

b. Ensure computer system and simulator are prepared for operation.

c. Ensure materials are on hand and in quantities needed.

d. Read and understand Lesson F02 prior to conducting training.

e. Ensure equipment is available and on site.

f. Conduct an Environmental Risk Assessment for this lesson IAW FM 3-100.4, Environmental Considerations in Military Operations.

1) The assessment is to be recorded on the Risk Management Worksheet found in appendix F of FM 3-100.4. FM 5-19, Composite Risk Management, has more information on this worksheet.

2) During the assessment, instructors should look for environmental hazards including all activities that may pollute, generate hazardous or solid waste, create negative noise-related effect, degrade archaeological, cultural resources, or negatively affect threatened or endangered species habitats.

3) Ensure instructor check Contemporary Operational Environment web site for latest updates.

https://sp.wood.army.mil/sites/Manscen/ENG/1bde/169/ACO2/COA/Tab4.aspx

g. In accordance with AR 385-10, Army Safety Program, Chapter 16, Occupational Safety and Health Program (Workplace Safety):

1) OSHA programs and national consensus standards shall be applicable to and integrated into all Army equipment, systems, operations, and workplaces, CONUS and OCONUS.

2) Military design, specifications, and deployment requirements will comply with OSHA standards where feasible. When no standard exists for military application or the application is not feasible, the Army component will apply mishap risk management component of CRM.

3) Military and Army civilian officials at each management level shall promote strong safety programs, safe working conditions, and safe performance to prevent accidents, injuries, and occupational illnesses.

Proponent Lesson Plan Approvals

Name	Rank	Position	Date
Shankland, Steven	SSG	Developer/Writer	07 Jan 2008
King, Ronnie	YC-02	Chief, Construction Engineer Branch	07 Jan 2008
Rutledge, Jesse	YC-02	Chief, Individual Training Division	07 Jan 2008

SECTION II. INTRODUCTION

Method of Instruction: Conference / Discussion
Instructor to Student Ratio is: 1:32
Time of Instruction: 5 mins
Media: Large Group Instruction

Motivator

NOTE: Show Slide #1

So far, you have learned the fundamentals of a braking system and how friction is required to stop a vehicle. You know a rotating and non-rotating member is required.

Why do we use air brakes rather than basic hydraulic brake systems in our larger vehicles? Well, one reason is that very minor leaks are not critical because the compressor continually supplies more air pressure. This can be a major problem in a hydraulic system as when the fluid has partially or completely leaked out of the system; a loss of braking force will occur.

NOTE: Show Slides #2 & 3

Terminal Learning Objective

NOTE: Inform the students of the following Terminal Learning Objective requirements.

At the completion of this lesson, you [the student] will:

Action:	Identify Air Brake System Components and Their Functions.
Conditions:	In a contemporary operational environment, given simulated air brake system malfunctions, items of construction equipment, training aids, a general mechanics tool kit, special tools, TMDE, PPE and technical manuals applicable to each item of equipment.
Standards:	Identify air brake system components, their functions and correct air brake system malfunctions without damage to the equipment or injury to personnel.

Safety Requirements

Risk of skin and eye injury exists while working with air and hydraulic pressure. You will wear eye protection when working with brake systems. Remove all jewelry to include ID tags and wedding bands when working on equipment. Use caution around moving parts. The use of Personal Protective Equipment (PPE) by students and instructors is mandatory. Further guidance concerning PPE can be found in OSHA regulations 29 CFR 1910.132; 29 CFR 1910.133; 29 CFR 1910.136; 29 CFR 1910.138; and 29 CFR 1910.95.

Risk Assessment Level

Medium - Review the deliberate risk assessment, perform a daily risk assessment, and ensure it is recorded on appropriate forms, signed by authorized command authority, and posted at the training site(s).

Environmental Considerations

NOTE: It is the responsibility of all Soldiers and DA civilians to protect the environment from damage.

There is a possibility of environmental contamination by petroleum oil, lubricants, fuel, and cleaning solvents. You will be briefed on the proper disposal of POL products and how to properly clean up spills prior to each practical exercise.

	Ensure spill kits are available and there location identified. Instructors should complete a risk assessment before conducting training, operations, or logistical activities. Risk assessments assist instructors in identifying potential environmental hazards, develops controls, make risk decisions, implement controls, and ensure proper supervision and evaluation.
Evaluation	Practical Exercise
Instructional Lead-In	**NOTE: Allow one to two minutes for the lesson introduction.** **NOTE: Introduce yourself as the instructor.**

SECTION III. PRESENTATION

1. Learning Step / Activity 1. Identify Air Brake System Components and Their Functions.

Method of Instruction: Conference / Discussion
Instructor to Student Ratio: 1:32
Time of Instruction: 2 hr 55 mins
Media: Large Group Instruction

NOTE: Contemporary Operational Environment

At various times during the class, the instructor will stress the importance of the topic by conveying personal experience related to the topic of discussion. The instructor will also answer any questions relating to the experience.

NOTE: Show Slide #4

1) **Air Brake System:** Uses compressed air moving though copper and plastic and rubber tubing connecting the components together. The compressed air is stored in reservoirs until needed by the brake valve. When the brake valve is depressed compressed air flows through a series of valves to the brake chambers. At this point air pressure is converted to mechanical force to a push rod that connects to a slack adjuster that actuates the brakes. The air brake system has three sub-systems that we will be discussing.

NOTE: Show Slide #5

2) **The three sub systems**: The Charging system, Control System, and the Foundation Brake System.

1) The **charging system** provides and stores the compressed air required to perform the braking action. The charging system is responsible for building pressure, monitoring that pressure, maintaining the pressure, and maintaining the air moisture level. During this lesson you will learn the operation of the air compressor, compressor unloader valve, governor, air reservoir, and safety valve.

2) The **control system** consists of a series of pneumatic valves that direct air and control pressure to appropriate components.

3) The **foundation brake system** involves the use of properly supplied and controlled air to stop a vehicle. When the brake pedal is depressed, air pressure is directed to brake chambers at each wheel end that engage to slow or stop the vehicle.

NOTE: Show Slide #6

3) **The Charging System:** The charging system provides and stores the compressed air required to perform the braking action. The charging system is responsible for building pressure, monitoring that pressure, maintaining the pressure, and maintaining the air moisture level.

a. The charging system is comprised of an air compressor, governor, moisture control, and air reservoirs.

NOTE: Show Slide #7

4) The air compressor, like the hydraulic pump, is the heart of the air brake system.

a) All air compressors operate continuously while the vehicle engine is running. They are most commonly driven by a common drive belt on the front of the engine but can be gear driven.

b) Air compressors are usually single acting reciprocating piston units with one, two, or three pistons. The number of pistons a compressor contains depends on the volume and pressure of the air required by the system.

c) The standard for volume displacement in an air system is cubic feet per minute (cfm). The standard for system pressure is pounds per square inch (psi).

d) All air compressors are either self-lubricated, or lubricated by the engine lubrication system.

e) All air compressors require cooling of the head. Some heads are liquid cooled by the engine cooling system. Other heads are designed for air cooling. You will notice an air cooled compressor will have fins on the head.

f) Notice how this air compressor (cut away) has some of the same components as a small engine. It has a crankshaft, connecting rod with a piston, piston rings, and intake and exhaust valves.

NOTE: Show Slide #8

g) This slide shows the compressor head assembly.

h) The down stroke of the air compressors piston creates a suction which opens the inlet valve allowing air to enter into the chamber. The suction will also close the exhaust valve.

i) The up stroke of the air compressor's piston closes the inlet valve compressing the air in the chamber. The exhaust valve then opens allowing the compressed air to be released into the air system.

NOTE: Show Animation. Press the Green Compress button to show air being compressed

j) An un-loader valve inside the compressor works in conjunction with the governor to control the supply of air to the system. When the air pressure reaches maximum operating pressure the governor, which we will discuss in a moment, sends air pressure back to the compressor to the un-loader valve. The air pressure then holds the un-loader piston down allowing air to enter and exit the chamber through the intake valve, circulating freely. This stops the creation of compressed air.

NOTE: Show Animation. Press the Green Unload button to show the compressor unloading.

NOTE: Show Slide #9

5) Brake Lines or tubes are used to connect components together. Plastic tubing may be used in today's modern air brake systems that once only used metal and rubber tubing. The plastic tubing must adhere to SAE standards to include having enough strength to withstand high pressures in any braking situation. Hydraulic lines are made of steel tubing or flexible high pressure hose.

Note: <u>WARNING: When replacing lines and hoses, DO NOT CHANGE INSIDE HOSE DIAMETERS! IMPROPER BRAKING WILL RESULT</u>.

NOTE: Show Slide #10

6) The Governor.

a) The governor interacts with the un-loader valve to regulate the minimum and maximum air pressure. The governor is a sensing device that relieves compression when air pressure in the reservoir reaches a preset limit. This is accomplished when reservoir pressure overcomes spring pressure in the governor. The pressure is then allowed to flow back to the compressor and activate the un-loader valve. If system pressure does not reach the preset limit, the governor might be incorrectly adjusted

b) The governor is an adjustable component of the air brake system. By adjusting the governor, you can change the minimum and maximum pressures within the system. Adjustments are made by loosening the adjustment screw locknut, and turning the adjustment screw counter- clockwise to lower system pressure and clock-wise to increase system pressure.

NOTE: Show Animation. Press the Green Play Button to show the governor in operation

NOTE: Show Slide #11

7) Moisture Removing Systems

a. Moisture is a serious problem for air brake systems and must be removed. Moisture is developed because of condensation that is created when the air is compressed in the system. The act of compressing air creates heat that is then cooled rapidly as it moves through the system. Moisture can rust or corrode component parts as well as freeze in cold weather environments. Some air brake systems are equipped with moisture removing systems.

b. There are three types of systems in use today, the wet tank, the alcohol evaporator system and the air dryer system.

NOTE: Show Slide #12

8) Wet Tank: Is the first tank in the system

i. Allows the moisture to collect in the first air reservoir (wet tank) which can then be released through a drain valve located at the bottom of the tank. Vehicles equipped with this system must have the operator drain the air tanks daily.

NOTE: Show Slide #13

9) Alcohol evaporator system uses de-natured alcohol to remove the moisture from the air. Compressed air travels through a canister filled with alcohol. The alcohol then removes the moisture from the air before it reaches the air reservoir. It relies on the operator to remember to maintain the correct level of alcohol in the bottle.

NOTE: Show Slide #14

10) The Air Dryer: Used to remove moisture from the air by using a moisture collecting material called desiccant The air dryer can also collect and remove contaminants from the air before it reaches the first reservoir. Air dryers can come in various styles: the screw-on canister (similar to an oil filter) or the serviceable type

NOTE: Show animation: "air dryer housings disappear"

c. The serviceable type of air dryer is comprised of a canister filled with desiccant, which is the material that can absorb moisture of about 7 times its size.

NOTE: Show animation: "inlet air and air circulating"

d. As air passes from the inlet port through the desiccant canister, moisture is pulled from the air then the dry air is released into the system through the outlet port

e. At the same time, any oil in the air is removed by an oil filter and placed in the purge valve.

NOTE: Show animation: "air being pushed up and out of the air dryer"

f. Spring tension that is constantly pressing the desiccant between two perforated plates is attempting to squeeze moisture out from the desiccant**.**

NOTE: Show animation: "arrows showing pressure on the desiccant and moisture moving to the bottom"

g. When the system pressure has been reached and the un-loader valve has stopped the compressing of air, the governor will pressurize the purge valve

NOTE: Show animation: "air inlet from the governor and moisture being purged"

h. to remove the oil and moisture during the compressor unloading cycle into the atmosphere. A heater and thermostat is located next to the purge valve to keep the moisture from freeze during operation in a cold weather environment.

i. A vehicle that is equipped with an air dryer has moisture in the air reservoir, may be caused by two possible problems. One, the desiccant in the air dryer is over saturated with moisture. This would make the air dryer ineffective. The second possible cause is the air dryer is failing to purge the moisture. This could be caused by a clogged purge valve or even lack of air from the governor or the system itself.

j. Over saturation (Symptom: water is found in the vehicle's reservoirs) occurs when the desiccant material requires replacement or the air dryer is failing to purge.

NOTE: Show Slide #15

11) SINGLE CHECK VALVES

a. On the primary and secondary air reservoirs, you can see there is a **single check valve**. This single check valve prevents pressurized air in the reservoirs from passing back through the compressor when the vehicle is not running. If the air pressure is lost in the supply reservoir, the single check valves close and trap air in the primary and secondary reservoirs.

NOTE: Show Slide #16

12) The Air Reservoir or Air Tank

a) The air reservoir stores the compressed air until it is needed to actuate the brakes. Most air brake systems have three air reservoirs which separate into two sub-air systems, the primary and secondary air systems. This design ensures safety. If the air pressure in the primary system was to fail the secondary system would provide the air pressure.

NOTE: Show animation: "Safety Valve is shown".

b) The air reservoir has a safety valve that protects the air system from over pressurizing.

NOTE: Show Slide #17

13) Safety Valve

a. The spring holds the ball in place as long as pressure in the tank does not exceed the preset limit. When air pressure exceeds the spring force, the ball is moved off its seat and the excess pressure is exhausted.

NOTE: Show animation: "ball valve moves"

b. Non-adjustable safety valves must be replaced with the same relief pressure rating as the old one. The PSI relief rating is stamp somewhere on the safety valve.

NOTE: Show animation; "Some safety valves are adjustable"

c. They can be adjusted by adding or removing shims to increase or reduce the spring tension.

<u>WARNING:</u> If the safety valve blows off (relieves pressure), stop the vehicle immediately and investigate the safety valve or the governor for incorrect setting.

NOTE: Show Slide #18

14) The control system

a. **The control system** consists of a series of pneumatic valves that control and direct air pressure to the actuators. The control system is comprised of the Double check valve, dash control valve, brake treadle and valve, quick release valve, service brake relay valve,

NOTE: Show Slide #19

15) Double check valves

a. Is responsible for supplying the highest pressure from the primary or secondary air reservoirs to the outlet side of the valve to the treadle or service brake relay valves. The double check valve consists of a plunger that moves from side to side. In the double check valve, air applied by the dominate air source (usually the primary air system) will close off the other inlet side by pushing on the plunger.

b. The reverse will occur when the second air source becomes dominate, in the case of an air failure, and will push the plunger to the opposite side. This protects the air system by not allowing both the primary and secondary air systems to combine

NOTE: When installing a double check valve, the plunger must be able to move horizontally.

NOTE: Show Slide #20

16) Dash Controls.

a. Dash controls such as the low air warning switch, air pressure gauges, audible and visual alarms help the operator to know the status of the air supply. The low air pressure switch operates the audible and visual alarms when air pressure falls below the minimum operating pressure.

NOTE: Show Slide #21

17) Parking Brake Control Valve

a. Is a dash mounted control valve used for applying and releasing the vehicle and trailer parking brake. This valve controls the air flow to the parking brakes by directing the air pressure to the duel brake chambers that releases the parking brakes. When the minimum operating pressure is reached, the operator may push in allowing the air to travel though the valve assembly.

b. **Parking Brake (Engaged)** If sufficient pressure remains present, the force of the spring will be countered, the exhaust port will be sealed, and the air will be allowed passage through the valve inlet and outlet ports to the brake chambers. If sufficient pressure is present, the force of the spring will continue to hold the valve assembly seated.

c. **Parking Brake Released** When the system pressure drops below a predetermined level, the spring in the parking brake control valve automatically engages which will apply the brakes by sealing off the air supply to the brake chambers and exhausting any air pressure in the parking brake side of the service and parking brake chamber. The service and parking brake chamber is a part of the foundation brake system.

NOTE: Show Slide # 22

18) Brake Treadle and Valve

a. Located in the central location of the air system in the operator's compartment. Movement of the brake treadle and valve controls the air from the reservoirs. The foot pedal operation of the inlet and exhaust valves controls the air pressure delivered to and from the brake chambers. In order to apply the service brakes, air pressure must be applied. To release the service brakes, the air pressure must be exhausted.

NOTE: Show Slide # 23

19) Treadle Valve Animation

a. When the pedal is depressed, the brake valve lever moves toward its applied position. The plunger is forced down, closing the exhaust port, before opening the intake valve. When the intake valve opens, air from the reservoir is allowed to flow through the brake valve to the brake chambers to apply the brakes. (Slow And Stop)

NOTE: Show next animation

b. When the air pressure below the intake valve is equal to the operators foot pressure the piston moves and closes the intake port maintaining the system in the holding position. Further depression of the pedal puts additional force allowing further brake application. (Hold)

NOTE: Show next animation

c. When the pedal is released, the inlet valve closes and opens the exhaust valve, allowing all of the air from the brake chamber to the treadle valve to exhaust.

NOTE: Show Slide #24

20) The Quick Release Valve

a. **The Quick Release Valve:** Used to reduce the time it takes to release the brakes. In this instance, the air in the brake chamber is allowed to dump quickly through this valve instead of having to travel back to the brake treadle and valve. A quick release valve may be found on each axle. When the driver steps on the brake treadle and valve, air pressure is supplied to the quick release valve. This pressure moves the diaphragm down and closes off the exhaust port and the air flows out to the brake chambers. Is used to reduce the time it takes to release the brakes. In this instance, the air in the brake chamber is allowed to dump quickly through this valve instead of having to travel back to the brake treadle and valve. A quick release valve may be found on each axle.

Click slide animation:

b. When the operator releases the brakes, the spring force under the diaphragm lifts up and opens the exhaust port in the quick release valve. This allows the air pressure from the brake chamber to exhaust and release the brake linings from the drum. You should check this valve if brakes release slowly or not at all. This valve is necessary to reduce brake lining wear and drum overheating.

NOTE: Show Slide # 25 **25**

21) The service brake relay valve is located on the rear axle since it is located furthest from the brake treadle and valve. This allows for simultaneous front and rear brake application and release.

NOTE: Show Slide #26

a. .The service brake relay valve is located on the rear axle,

NOTE: Show animation: "Internal view"

b. During a brake application, it uses a pilot line to supply the air from the treadle valve to the service port on the relay valve.

c. Air pressure delivered to the service port moves the piston down.

NOTE: Show animation: "inlet air and diaphragm moving down"

d. When the air pressure is applied to the service port, the valve supplies air pressure for the supply port to the rear wheel brake chambers.

e. When the brakes are released, the service brake relay valve also has an exhaust port to quickly release the brake.

NOTE: Show Slide #27

22) The Foundation Brake System.

a. Foundation brakes system involves the use of properly supplied and controlled air to stop a vehicle. When the brake pedal is depressed, air pressure is directed to the brake chambers at each wheel end which engages to stop or slow the vehicle. The foundation brakes system is comprised of the brake chamber, slack adjuster, S-cam, Brake shoe return spring brake shoes and drum.

NOTE: Show Slide #28

23) The Brake Chamber. (Service)

a. The **brake chamber** is where pneumatic pressure is converted into mechanical force to apply the brakes. There are two types of brake chambers we will be discussing. The service brake chamber and the service and parking brake chamber.

b. We will start with the **service brake chamber**. This chamber is usually found on the front axles and they control the service brakes only.

c. The service brake chamber consists of a diaphragm and a spring-loaded piston attached to a push rod.

NOTE: Show animation: Service Brake Chamber (Brake Released)

d. When the brake pedal is released, air is exhausted from the system which allows the spring-loaded piston to push on the diaphragm and force the air to exhaust from the chamber. At this time, the push rod is retracted and the brakes are release.

NOTE: Show animation: Service Brake Chamber (Brake Engaged)

e. When the brakes are applied in a service brake chamber, air pressure enters the chamber through an inlet at the top or rear of the chamber. That air forces the diaphragm to compress the spring-loaded piston, making the push rod move outward and activating the mechanical link. The mechanical link is connected to the slack adjuster, which rotates the S-cam operating the expanding brake shoes.

NOTE: Show Slide #29

24) . The Duel Acting Brake Chamber Parking Brake Engaged)

a. Plays a dual role in operating both the service and parking brakes. This chamber is also capable of applying the vehicles brakes in the event of a sudden loss of air pressure. It consists of two air chambers (service and parking), two diaphragms, a spring loaded piston, and a spring brake. In. order to release the parking brake, air must be applied.

NOTE: Show Slide #30

25) The Duel Acting Brake Chamber (Parking Brake Released)

a. This air pressure will compress the spring-brake allowing the pushrod to move inward, releasing the brakes, which are acting as the parking brake.

b. The parking brake is engaged when air is exhausted from the chamber. Mechanical force from the spring brake extends the push rod applying the parking brakes. The force from the spring brake holds the vehicle.

Note: If the parking brake control system loses air pressure, the spring brake will apply the parking brakes. This will stop the vehicle.

NOTE: Show Slide #31

26) The Duel Acting Brake Chamber (Service Brake Chamber Engaged)

c. Under normal conditions with the parking brakes released, the service brake side of the service and parking brake chamber acts the same as the service brake chamber. Air is delivered by the brake treadle and valve to the service brake side. The air pressure forces the diaphragm to compress the spring-loaded piston, making the push rod move outward and activating the mechanical link. This applies the service brakes to stop or slow the vehicle.

NOTE: Show Slide #32

27) CAGING THE BRAKES

a. When servicing the air brake system or moving a disabled vehicle, Caging the brake chamber may be necessary

.

b. To Cage the brake chamber, remove the dust cap and insert cage bolt in to rear housing aligning the notch in the pressure plate.

c. Rotate Cage bolt 90 degrees in either direction locking the bolt in the pressure plate. Attach washer and nut and center bolt in housing, tighten nut on caging bolt until the threaded rod exceeds 3” from the top of the nut.

WARNING! DONT DISSASEMBLE SPRING BRAKE CHAMBER, INJURY TO PERSONAL MAY RESULT!

NOTE: Show Slide #33

28) SLACK ADJUSTER

a. (brake adjuster) Is connected to the brake chamber by a mechanical link. Inside is a worm gear meshed with a gear on the end of a camshaft. The slack adjuster is an adjustable component that provides a means to adjust the clearance between the brake lining and drum, and may be adjusted either manually or automatically. Any time you install a new set of brake shoes, you must manually adjust the slack adjuster.

NOTE: Show Slide #34

29) The S-Cam

a. The slack adjuster splines turn the S-cam causing the brakes shoes to expand and retract to and from the drum. The rollers on the brake shoes prevent binding and excessive wear as the brakes are applied.

NOTE: Show next animations:

a. Click “brake shoes and s-cam appear”

b. Click “S-cam rotates and shoes expand”

c. Click “S-cam rotates and shoes retract”

d. Click “S-cam rotates and shoes expand”

NOTE: Show Slide #35

30) BRAKE SHOE AND LINING

a. The brake shoe a Non- rotating member is composed of three parts.

   a. Shoe –which supports the lining

   b. Lining, - which provides a replaceable wearable surface

   c. Steel rivets are used to hold the lining on the shoe.

b. The Heavy metallic composites are used to retard heavy industrial load vehicles

c. Metallic brake linings operate at high temperatures of up to 2000 degrees.

NOTE: Show Slide #36

31) Brake Drum:. Drums provide a Rotating frictional surface for the brake shoes or bands that are mechanically force against it. The drums are made of heavy cast or steel to handle the higher temperatures the linings create during the braking applications

NOTE: Show Slide #37

32) SELF ENERGIZED/EXPANDING TYPE BRAKES

d. The air brake system uses expanding type brakes. These are self-energizing brakes because each of these shoes has an anchoring pin. The drum is the rotating member and the brake shoes with linings are the non-rotating member.

NOTE: Press the Green Start Button to make the drum spin and the brakes will engage.

e. The brake shoes expand outward applying pressure against the rotating drum applying friction and slowing or stopping the vehicle.

f. The self-energizing action is produced as each brake shoe

engages the rotating brake drum independently. As the brake actuating mechanism forces the shoes outward, the top of the brake shoe tends to stick or wedge to the rotating brake drum. This effect on brake-shoes greatly reduces the amount of effort required to overcome the momentum of the vehicle

g. The return spring is used to release the shoes from the drum when the mechanical force is released.

NOTE: Show Slide #38

33) Troubleshooting.

a. Now that you understand how each component operates and how they relate to each other, you will need to know how to effectively troubleshoot the system. Before you can fix a malfunctioning air brake problem, you must first be able to find the fault. Faults are not always as easy as a leaking or broken air line. Schematics are often required to help trace the vehicles air flow to find the fault.

b. Air schematics are an important tool for troubleshooting an air brake system. They show us how air pressure flows through a system, how it is controlled, and how it is applied.

c. When looking for air leaks, use all of your senses and not just your ears. You may be able to hear an air leak by running the engine to charge the system and then shutting it off, but if the leak is small, you may not be able to hear it. Use your hands to feel for the leak or use soapy water to see air escaping at air line fittings or anywhere else you believe an air leak exists.

d. Things to remember with an air system: Air is required to apply service brakes and air must be exhausted to release service brakes.

e. The complete opposite is true for the parking brakes. Air is required to release the parking brake and air must be exhausted to engage the parking brake.

NOTE: Show Slide #39

NOTE: Conduct a check on learning and summarize the learning activity.

Determine if students have learned the material presented by:

1. Soliciting student questions and explanations.

2. Asking questions and receiving answers from the students.

3. Review questions located in the student study guide

1. Learning Step / Activity 2. Correct Air Brake System Malfunctions.

Method of Instruction: Practical Exercise (Performance)
Instructor to Student Ratio: 1:4
Time of Instruction: 5 hrs 45 mins
Media: Training Aid

Practical Exercise Instructions.

a. Give detailed instructions on what is expected during each practical exercise IAW Appendix C.

b. Ensure students have required materials and references IAW Appendix C.

c. Clarify students' questions.

d. Conduct the practical exercise IAW Appendix C.

e. Check on students' progress and provide assistance as necessary throughout the exercise.

f. Ensure students complete the practical exercise within the allotted time.

g. Provide solutions to the practical exercise.

NOTE: Conduct a check on learning and summarize the learning activity.

Determine if students have learned the material presented by:

1. Soliciting student questions and explanations.

2. Asking questions and receiving answers from the students.

3. Correcting student misunderstandings.

2. Learning Step / Activity 2. Repair and Air Dryer

Method of Instruction: Practical Exercise (Performance)
Instructor to Student Ratio: 1:16
Time of Instruction: 2 hr
Media: Training Aids

Practical Exercise Instructions.

a. Give detailed instructions on what is expected during each practical exercise IAW Appendix C.

b. Ensure students have required materials and references IAW Appendix C.

c. Clarify students' questions.

d. Conduct the practical exercise IAW Appendix C.

e. Check on students' progress and provide assistance as necessary throughout the exercise.

f. Ensure students complete the practical exercise within the allotted time.

g. Provide solutions to the practical exercise.

NOTE: Conduct a check on learning and summarize the learning activity.

2. Learning Step / Activity 2. Correct Air Brake System Malfunctions. (Simulator)

Method of Instruction: Practical Exercise (Performance)
Instructor to Student Ratio: 1:16
Time of Instruction: 3 hrs
Media: Computer Based Instruction (CBI)

NOTE: If Brake Systems Simulator is not available, PE will be conducted using applicable brake systems with a 1:4 instructor to student ratio. All safety and environmental considerations and precautions will be implemented.

Practical Exercise Instructions.

a. Give detailed instructions on what is expected during each practical exercise IAW Appendix C.

b. Ensure students have required materials and references IAW Appendix C.

c. Clarify students' questions.

d. Conduct the practical exercise IAW Appendix C.

e. Check on students' progress and provide assistance as necessary throughout the exercise.

f. Ensure students complete the practical exercise within the allotted time.

g. Provide solutions to the practical exercise.

NOTE: Conduct a check on learning and summarize the learning activity.

Determine if students have learned the material presented by:

1. Soliciting student questions and explanations.

2. Asking questions and receiving answers from the students.

3. Correcting student misunderstandings.

2. Learning Step / Activity 5. Correct Air Brake System Malfunctions. (Simulator)

Method of Instruction: Practical Exercise (Performance)
Instructor to Student Ratio: 1:16
Time of Instruction: 3 hrs
Media: Computer Based Instruction (CBI)

NOTE: If Brake Systems Simulator is not available, PE will be conducted using applicable brake systems with a 1:4 instructor to student ratio. All safety and environmental considerations and precautions will be implemented.

Practical Exercise Instructions.

a. Give detailed instructions on what is expected during each practical exercise IAW Appendix C.

b. Ensure students have required materials and references IAW Appendix C.

c. Clarify students' questions.

d. Conduct the practical exercise IAW Appendix C.

e. Check on students' progress and provide assistance as necessary throughout the exercise.

f. Ensure students complete the practical exercise within the allotted time.

g. Provide solutions to the practical exercise.

NOTE: Conduct a check on learning and summarize the learning activity.

Determine if students have learned the material presented by:

1. Soliciting student questions and explanations.

2. Asking questions and receiving answers from the students.

3. Correcting student misunderstandings.

SECTION IV. SUMMARY

Method of Instruction: Conference / Discussion
Instructor to Student Ratio is: 1:32
Time of Instruction: 5 mins
Media: Large Group Instruction

Check on Learning

Determine if the students have learned the material presented by soliciting student questions and explanations. Ask the students questions and correct misunderstandings.

Review / Summarize Lesson

Restate the Terminal Learning Objective (TLO) requirements (**Identify Air Brake System Components and Their Functions**). Summarize the Learning Steps/Activities.

1. **Identify Air Brake System Components and Their Functions.**
2. **Correct Air Brake System Malfunctions. (Hands On).**
3. **Correct Air Brake System Malfunctions. (Simulator).**

SECTION V. STUDENT EVALUATION

Testing Requirements	**NOTE:** Describe how the student must demonstrate accomplishment of the TLO. Refer student to the Student Evaluation Plan.
Feedback Requirements	**NOTE:** Feedback is essential to effective learning. Schedule and provide feedback on the evaluation and any information to help answer students' questions about the test. Provide remedial training as needed.

Assisted Brake Systems
91L10F03 / Version 1
01 Jan 2010

SECTION I. ADMINISTRATIVE DATA

All Courses Including This Lesson

Course Number	Version	Course Title
612-91L10	1	Construction Equipment Repairer

Task(s) Taught(*) or Supported

Task Number	Task Title
	INDIVIDUAL
091-91LB-1602 (*)	Replace a Master Cylinder on an Item of Construction Equipment
091-91L-1603 (*)	Replace a Brake Booster on an Item of Construction Equipment
091-91L-1607 (*)	Replace a Brake Cylinder on an Item of Construction Equipment
091-91L-1608 (*)	Replace the Brake Lines on an Item of Construction Equipment
091-91L-1612 (*)	Replace the Brake Rotors on an Item of Construction Equipment
091-91L-1616 (*)	Repair a Brake Caliper on an Item of Construction Equipment
091-91L-1617 (*)	Replace an Air Brake Safety Valve on an Item of Construction Equipment.

Reinforced Task(s)

Task Number	Task Title

Academic Hours

The academic hours required to teach this lesson are as follows:

	Resident Hours/Methods
	2 hr 0 mins / Conference / Discussion
	2 hr 0 mins / Simulator
	9 Hr 0 mins / Practical Exercise / (Performance)
Test	0 hrs
Test Review	0 hrs
Total Hours:	13 hrs

Test Lesson Number

	Hours	Lesson No.
Testing (to include test review)		N/A

Prerequisite Lesson(s)

Lesson Number	Lesson Title
91L10A01	Course Introduction
91L10A02	Shop Safety Procedures
91L10A03	Environmental Awareness Procedures
91L10A04	Identify Computer Software and Hardware Components
91L10A05	AKO Procedures
91L10A06	Troubleshooting Logic Tree
91L10A07	The Levels of Maintenance and Their Responsibility

91L10A08	Utilize Maintenance and Repair Parts Technical Manuals
91L10A09	Utilize Maintenance Forms and Records
91L10A10	Battlefield Damage Assessment and Repair (BDAR)
91L10A11	Identify Items of Construction Equipment
91L10A12	Identify Test, Measurement and Diagnostic Equipment (TMDE), general mechanics and special tools.
91L10A13	Shop Operations Examination
91L10B01	The Fundamentals of Electricity
91L10B02	Wiring Diagrams, Schematics, and Automotive Batteries.
91L10B03	Identify Test, Measurement and Diagnostic Equipment (TMDE)
91L10B04	Starting and Charging Systems
91L10B05	Electrical Systems Examination
91L10C01	Diesel Engine Principles
91L10C02	Disassembly/Assembly of a Diesel Engine
91L10C03	Diesel Engine Component Replacement Performance Evaluation
91L10C04	Diesel Engine Systems Written Examination
91L10C05	Diesel Engine Test and Adjustment Procedures
91L10C06	Diesel Engine Systems Performance Evaluation
91L10D01	Hydraulic System Fundamentals
91L10D02	Hydraulic Cylinders and Lines
91L10D03	Hydraulic Pumps and Control Valves
91L10D04	Hydraulic Accumulators
91L10D05	Hydraulic Schematics
91L10D06	Hydraulic Systems Examination
91L10E01	Power Train Gears, Bearings and Seals
91L10E02	Torque Converters, Transmissions, Planetary Gears and Clutches
91L10E03	Differentials and Axles
91L10E04	Final Drives
91L10E05	Power Train Systems Examination
91L10F01	Brake System Fundamentals
91L10F02	Air Brake Systems

Clearance Access	Security Level: Unclassified Requirements: There are no clearance or access requirements for the lesson.
Foreign Disclosure Restrictions	FD5. This product/publication has been reviewed by the product developers in coordination with the Fort Leonard Wood, MO / Maneuver Support Center foreign disclosure authority. This product is releasable to students from all requesting foreign countries without restrictions.

References

Number	Title	Date	Additional Information
29 CFR 1910.1200	Hazard Communication	01 Jul 2003	
29 CFR 1910.132	Personnel Protective Equipment - General Requirements	01 Jul 2003	
29 CFR 1910.133	Eye and Face Protection	01 Jul 2003	
29 CFR 1910.136	Foot Protection	01 Jul 2003	
29 CFR 1910.138	Hand Protection	01 Jul 2003	
29 CFR 1910.95	Occupational Noise Exposure	01 Jul 2003	
AR 385-10	The Army Safety Program	23 Aug 2007	
EM 385-1-1	Safety and Health Requirements.	03 Nov 2003	Public Domain
FM 3-100.4	Environmental Considerations in Military Operations. MCRP 4-11B.	15 Jun 2000	Public Domain
FM 5-19 (FM 100-14)	Composite Risk Management.	21 Aug 2006	Public Domain
TM 09135B-24/2	Texex Shop Manual Light Capability Rough Terrain Forklift TX51-19M	2001	
TM 5-3805-262-20	Organizational Maintenance, Loader, Scoop Type, DED, 4x4, Articulated Frame Steer, 2 1/2 Cubic Yard, (J.I. Case Model MW24C) (NSN 3805-01-150-4814).	01 Sep 1987	Public Domain
TM 5-3805-262-34	Direct Support and General Support Maintenance Manual for Loader, Scoop Type, DED, 4x4, Articulated Frame Steer, 2-1/2 Cubic Yard (J.I. Case Model MW24C) (NSN 3805-01-150-4814).	01 Sep 1987	Public Domain
TM 9-2330-213-14&P	Operator's, Unit, Direct Support and General Support Maintenance (Including Repair Parts and Special Tools Lists) for Trailer, Chassis: 1 1/2-Ton, 2-Wheel, M103A1, M103A3, and Trailer, Cargo: 1 1/2-Ton, 2-Wheel, M105A1, M105A2 . . .	09 Oct 1990	Public Domain

Student Study Assignments

None

Instructor Requirements

ITC certified instructors, MOS 91L20 / 1341 and above or civilian equivalent.

Additional Support Personnel Requirements

Name	Stu Ratio	Qty	Man Hours
None			

Equipment Required for Instruction

Id Name	Stu Ratio	Instr Ratio	Spt	Qty	Exp
*11H118 Universal Maintenance Training Simulator (UMTS) Device	1:32	1:5	No	33	No
*144609 TEREX Front Axle, PN 144609	1:4		No	4	No
*2520-01-496-0049 Axel, Front	1:8		No	0	No
*2530-00-323-8538 Axle, Vehicular, Nondriving	1:4		No	4	No
*2530-01-191-1397 Axle Assembly, Vehicular, Nondriving	1:4		No	4	No
5120-00-892-4946 Wrench Flare Nut 3/8-7/16	1:2		No	16	Yes
4240-00-052-3776 Goggles, Industrial	1:1	1:1	No	38	Yes
5120-01-367-3941 Brake Spring Tool	1:2		No	16	No
5120-01-065-9037 3lb Mallot Dead Blow	1:2		No	16	No
5180-01-548-7634 Tool Kit, General Mechanic	1:2		No	16	No
5810-01-523-6682 Computer, Laptop, Ruggedized (MIL-STD -810f Compliant), Workstation KG-235	1:4		No	0	No
7000-21-000-0354 150" Video Screens			Yes	4	No
7000-21-000-0355 Screen Controller			Yes	4	No
7000-21-000-0356 Crestron Audio / Video Controller			Yes	1	No
7000-21-000-0357 Power Supply			Yes	1	No
7000-21-000-0358 Crestron Com Card			Yes	3	No
7000-21-000-0359 LCD Projection System			Yes	4	No
7000-21-000-0360 8x8 RGB Routing Switcher			Yes	1	No
7000-21-000-0361 Creston Ethernet Card			Yes	1	No
7000-21-000-0362 Creston Input/Output Card			Yes	2	No
7000-21-000-0363 Crestron Volume Control Card			Yes	2	No
7000-21-000-0364 Crestron Relay Card			Yes	1	No
7000-21-000-0365 Crestron RS-232/IR Control Card			Yes	1	No

7000-21-000-0366 Crestron Infrared Transmitter	Yes	2	No
7000-21-000-0367 Ceiling Speaker System	Yes	16	No
7000-21-000-0368 Crestron Lighting Controller	Yes	2	No
7000-21-000-0369 Crestron 12" Video Touch Panel	Yes	2	No
7000-21-000-0385 Projector Mounting System	Yes	4	No
7000-21-000-0386 Audio Power Amplifier	Yes	4	No
7000-21-000-0387 Headset Microphone	Yes	2	No
7000-21-000-0388 Condenser Microphone	Yes	2	No
7000-21-000-0389 Microphone Base	Yes	2	No
7000-21-000-0390 Power Conditioner	Yes	2	No
7000-21-000-0391 8x8 Audio Video Routing Switcher	Yes	1	No
7000-21-000-0392 VCR / DVD Player	Yes	2	No
7000-21-000-0393 VCR / DVD Control Module	Yes	2	No
7000-21-000-0394 Wireless Microphone System	Yes	2	No
7000-21-000-0395 Lavaliere Microphone	Yes	2	No
7000-21-000-0396 Audio Dynamics Processor	Yes	1	No
7000-21-000-0397 Microphone Mixer	Yes	2	No
7000-21-000-0398 Audio Routing Mixer	Yes	1	No
7000-21-000-0399 20 Space Security Door	Yes	1	No
7000-21-000-0400 2-Space Vented Security Panel	Yes	2	No
7000-21-000-0401 Document Camera	Yes	2	No
7000-21-000-0402 Wireless Mouse	Yes	2	No
7000-21-000-0403 1x2 RGB Distribution Amplifier	Yes	2	No
7000-21-000-0404 Audio/Video/Control Cable and Assemblies	Yes	2	No
7000-21-000-0405 Control System Design	Yes	40	No
7000-21-000-0406 Smart Board Display Monitor	Yes	2	No
7000-21-000-0407 Documentation for Installation Schematics	Yes	10	No

7000-21-000-0408 Rack			Yes	1	No
7000-21-000-0409 Instructor PC			Yes	2	No
7110-01-202-3674 Board, Marker, Dry, Erasable Type		1:1	No	0	No
7125-01-084-6955 Cabinet, Storage	1:32		No	0	No
7195-00-477-5699 Stand, Lecture		1:1	No	0	No
11022-02329 3 Piece Probe Set	1:4		No	8	No
5210-00-540-2973 Micrometer 0-1 Inch	1:2		No	16	No
8430-00-624-3135 Boots, Safety, Men's, Size 10 Regular	1:1	1:1	Yes	37	No
8435-01-475-6874 Boots, Safety, Women's, Size 8 Regular	1:1	1:1	Yes	37	No
*DVC 09-135 Backhoe Loader (BHL) Wet Brakes Training Device	1:4		No	6	No
5120-00-640-6364 Wrench Torque Wrench 0-175 FT LB	1:4		No	8	No
2530-01-180-0986 Seal Kit	1:4		No	8	No
9150-01-102-9455 Brake Fluid, Silicone	1:4		No		
4940-00-333-5541 Gun Air Blow	1:4		No	8	Yes

* Before Id indicates a TADSS

Materials Required

Instructor Materials:
TM 09135B-24P-3, TEREX F/L
TM 5-3805-262-20
TM 5-3805-262-34
TM 9-2330-213-14&P
Lesson F03
Instructor's Simulation Handbook
PPE

Student Materials:
TM 09135B-24P-3, TEREX F/L
TM 5-3805-262-20
TM 5-3805-262-34
TM 9-2330-213-14&P
Student Guide
Maintenance Forms
PPE
Pens and Pencils

Classroom, Training Area, and Range

AUTO-AID INST, 1400 SF (Classroom XXI)
VEH MAINT INST 6490SF (Maintenance Bay)

Requirements

Ammunition Requirements

Id	Name	Exp	Stu Ratio	Instr Ratio	Spt Qty
None					

Instructional Guidance

NOTE: Before presenting this lesson, instructors must thoroughly prepare by studying this lesson and identified reference material.

Before presenting this lesson:

a. Ensure classroom is available and ready for training.

b. Ensure computer system and simulator are prepared for operation.

c. Ensure materials are on hand and in quantities needed.

d. Read and understand Lesson F03 prior to conducting training.

e. Ensure equipment is available and on site.

f. Conduct an Environmental Risk Assessment for this lesson IAW FM 3-100.4, Environmental Considerations in Military Operations.

1) The assessment is to be recorded on the Risk Management Worksheet found in appendix F of FM 3-100.4. FM 5-19, Composite Risk Management, has more information on this worksheet.

2) During the assessment instructors should look for environmental hazards including all activities that may pollute, generate hazardous or solid waste, create negative noise-related effect, degrade archaeological, cultural resources, or negatively affect threatened or endangered species' habitats.

3) Ensure instructor check Contemporary Operational Environment web site for latest updates.

https://sp.wood.army.mil/sites/Manscen/ENG/1bde/169/ACO2/COA/Tab4.aspx

g. In accordance with AR 385-10, Army Safety Program, Chapter 16, Occupational Safety and Health Program (Workplace Safety):

1) OSHA programs and national consensus standards shall be applicable to and integrated into all Army equipment, systems, operations, and workplaces, CONUS and OCONUS.

2) Military design, specifications, and deployment requirements will comply with OSHA standards where feasible. When no standard exists for military application or the application is not feasible, the Army component will apply mishap risk management component of CRM.

3) Military and Army civilian officials at each management level shall promote strong safety programs, safe working conditions, and safe performance to prevent accidents, injuries, and occupational illnesses.

Proponent Lesson Plan Approvals

Name	Rank	Position	Date
Shankland, Steven	SSG	Developer/Writer	07 Jan 2008
King, Ronnie	YC-02	Chief, Construction Engineer Branch	07 Jan 2008
Rutledge, Jesse	YC-02	Chief, Individual Training Division	07 Jan 2008

SECTION II. INTRODUCTION

Method of Instruction: Conference / Discussion
Instructor to Student Ratio is: 1:32
Time of Instruction: 5 mins
Media: Large Group Instruction

Motivator

NOTE: Show Slide #1

Brakes have changed greatly in design. Disc brakes, used for years for front wheel applications, are fast replacing drum brakes on the rear wheels of modern cars. This is generally due to their simpler design, lighter weight and better braking performance. All newer vehicles have dual systems, with two wheels' brakes operated by each subsystem. That way, if one subsystem fails, the other can provide reasonably adequate braking power. Safety systems like this make modern brakes more complex, but also much safer than earlier braking systems. The greatest advantage of disc brakes is that they provide significantly better resistance to "brake fade" compared to drum type braking systems.

NOTE: Show Slides #2 & 3

Terminal Learning Objective

NOTE: Inform the students of the following Terminal Learning Objective requirements.

At the completion of this lesson, you [the student] will:

Action:	Identify assisted brake systems components and their functions
Conditions:	In a contemporary operational environment, given simulated assisted brake system malfunctions, items of construction equipment, training aids, a general mechanics tool kit, special tools, TMDE, PPE and technical manuals applicable to each item of equipment.
Standards:	Identify assisted brake system components, their functions and correct assisted brake system malfunctions without damage to the equipment or injury to personnel.

Safety Requirements

Risk of skin and eye injury exists while working with pressurized fluids. You will wear eye and foot protection when working with brake systems. Use three points of contact when mounting or dismounting equipment. Remove all jewelry to include ID tags and wedding bands when working on equipment. The location and use of emergency eyewash stations will be identified and demonstrated to students. In case of eye contact with brake fluids, an eye wash will be used immediately. Use caution around moving parts. You will be provided and required to wear hearing protection while equipment is running. The use of Personal protective Equipment (PPE) by students and instructors is mandatory. Further guidance concerning PPE can be found in OSHA regulations 29 CFR 1910.132; 29 CFR 1910.133; 29 CFR 1910.136; 29 CFR 1910.138 and 29 CFR 1910.95.

Risk Assessment Level

Medium - Review the deliberate risk assessment, perform a daily risk assessment, and ensure it is recorded on appropriate forms, signed by authorized command authority, and posted at the training site(s).

Environmental Considerations	**NOTE:** It is the responsibility of all Soldiers and DA civilians to protect the environment from damage. There is a possibility of environmental contamination by petroleum oil, lubricants, fuel, and cleaning solvents. You will be briefed on the proper disposal of POL products and how to properly clean up spills prior to each practical exercise. Ensure spill kits are available and there location identified. Instructors should complete a risk assessment before conducting training, operations, or logistical activities. Risk assessments assist instructors in identifying potential environmental hazards, develop controls, make risk decisions, implement controls, and insure proper supervision and evaluation.
Evaluation	Practical Exercise
Instructional Lead-In	**NOTE: Allow one to two minutes for the lesson introduction.** **NOTE: Introduce yourself as the instructor.**

SECTION III. PRESENTATION

1. Learning Step / Activity 1. Identify Assisted Brake System Components.

Method of Instruction: Conference / Discussion
Instructor to Student Ratio: 1:32
Time of Instruction: 1 Hr 55 mins
Media: Large Group Instruction

NOTE: Contemporary Operational Environment

At various times during the class, the instructor will stress the importance of the topic by conveying personal experience related to the topic of discussion. The instructor will also answer any questions relating to the experience.

NOTE: Show Slide #4

1) Power braking System: Assist the operator by providing maximum braking pressure with minimum operator effort, and can be actuated by combining two separate pressure systems. Using seals and diaphragms to prevent each system from coming in direct contact of each other. A mechanical device between the seals and diaphragms transfers the pressure from one system to the other to create the braking force to the actuator.

a. **Air/Hydraulic Brake systems**: use mechanical force, pneumatic, and hydraulic fluid pressures to complete the braking action.

b. **Hydraulic/Hydraulic brake systems** : use two separate hydraulic fluid systems to complete the braking action

c. **Full disk brakes**: Uses mechanical force and hydraulic pump pressures to compress the disks and plates together to complete the braking action.

NOTE: Show Slide #5

2) Air over Hydraulic Brake Systems

a. Typically uses the same process as the air brake system and hydraulic brake system combined.. Air is still supplied from the compressor and stored in reservoirs until needed by the brake valve. When the brake valve is depressed, air is sent to the power cluster consisting of an air chamber and master cylinder.

NOTE: Show Slide #6

3) Air-Hydraulic Cylinder (Power Cluster)

a. In the air chamber the air pressure is converted to mechanical force by a push rod connected to the master cylinder converting it into fluid pressure.

NOTE: Show Slide #7

The fluid pressure moving though high pressure brake lines actuate the pistons in the calipers or wheel cylinders. The calipers and wheel cylinders convert the fluid pressure back to mechanical force as the piston applies pressure to the brake pads or shoes. The brake pads or shoes under force apply to the rotors or drums to complete the braking action.

NOTE: Show Slide #8

a. Some equipment is equipped with dual 2 air-hydraulic cylinders (Power Clusters). This is a safety feature: one will control the front brakes, and the other one will control the rear brakes. That way if one should fail, the vehicle would have 50 percent or half of the braking power to stop the vehicle.

4) Brake Caliper.

a. The non-rotating member that is responsible for changing fluid pressure back to mechanical force in the disc brake system. The caliper has internal seals and is fitted with one or more pistons that are hydraulically actuated by fluid pressure. The brake pads or linings are designed to fit into the caliper and provide a frictional surface to engage the rotor during braking.

b. In the disc brake system, brake fluid is supplied through the hydraulic lines to each piston cavity of the caliper. Once the brake pedal is depressed, fluid enters the calipers and begins to force the pistons outward. This outward movement forces the brake pads against the moving rotor. The greater the fluid pressure, the tighter the brake pads will be forced against the rotor. Therefore, the caliper is responsible for converting the hydraulic force back to mechanical force.

NOTE: Show Slide #9

5) Brake Pads

a. Are constructed of 3 parts, pad, lining and the rivets. They still provide the wearable friction surface for the braking action and only differ in design from the brake shoe.

b. Disc brakes do not need to be adjusted. Lining wear is compensated automatically by Hydraulic Fluid Pressure in the caliper: as the brake lining wears out, the piston cavity fills with brake fluid taking up the excess space.

c. When the brakes are released, the rotor turns freely between the brake linings in the caliper. In the released position, the lining on the pads may lightly contact the disc surface to help keep the braking surface clean.

d. A wear indicator gives a audible sound of metal to metal contact when the pad needs to be replaced. Use a steel ruler to measure the thickness of the brake pad linings when a wear indicator is not used.

NOTE: Show Slide #9

6) The Disc/Rotor: The rotating member of the disc brake system which is typically attached to the wheel assembly may also be part of a hub or detachable by the use of bolts. The disc may be solid or could be vented to allow for faster heat dissipation. They provide a significantly better resistance to "Brake Fade" when compared to drum type braking systems. A micrometer is used to measure the thickness of the rotor to determine if it is serviceable. Like the drum it must not exceed the manufactures minimum thickness measurement or be heat cracked scored, or warp beyond the tolerance of .006 thousands of an inch.

NOTE: Show Slide #10

7) Advantages of the disc brake system:

a. Open design allows for rapid heat dissipation.

b. Automatically compensates for lining wear

c. Brake lining dust does not collect in the system

NOTE: Show Slide #11

8) Operation of the Anti-lock brake system

a) Automatic Braking Systems (ABS) Helps maintain control of the vehicle during heavy braking operations. The exciter ring and sensor monitor the rotation of the wheel and transmits the signal to the ECU. the ECU sends a signal to the modulator valve to release that particular brake. During heavy braking, the brakes will release and grab until the lock up condition no longer exists. The wheel speed senor also monitors the speed of the vehicle. So, under normal stopping, the anti-lock brake system does not function and allows the vehicle to stop normally and prevent the brakes from releasing when you are at a complete stop.

b) Components

1) Exciter ring and wheel speed sensors- Monitors the rotation and speed of the wheel.

2) ECU-Receives signal from the wheel speed sensors and processes it for use at the modulator valve.

3) Modulator valves-Releases the brakes, as needed, to prevent the wheels from locking up.

NOTE: Show Slide #12

9) Hydraulic over Hydraulic Brake system (Power Booster)

a. Hydraulic over Hydraulic Brake system: Uses hydraulic fluid pressure from the Power Steering Pump. The pump is belt or gear driven by the engine and creates the oil flow. During normal use, only 20 percent of the power from the power steering pump is used for the sake of power steering. This system allows a reduced foot pressure to complete the braking action

b. The two components of the power booster is the Hydraulic booster and master cylinder

c. The Hydraulic booster is connected to the brake pedal by a mechanical linkage.

d. Power Booster: This is the component that will put the power steering fluid to work in assisting braking action. It is mounted in between the brake pedal and the master cylinder. Both the power booster and master cylinder are sealed units. This means the power steering fluid and brake fluid will not mix. The only connection is mechanical push rod.

e. The power steering fluid is directed through hydraulic lines to the Hydraulic booster to assist the operator in the braking action.

NOTE: Show Slide #13

f. While the brakes are not being used, the power steering fluid is routed through a cavity in-between a linkage to the brake pedal and the push rod piston. When the operator depresses the brake pedal, the cavity is closed, and pressure begins to build on the pedal linkage side.

g. The Pressure against the piston and linkage in the Hydraulic booster assists the master cylinder in creating the fluid pressure used by the wheel cylinders and/or calipers

NOTE: Show Slide #14

h. When the pressure builds to a pre-set limit, a relief valve opens and the excess pressure is routed through the push rod side of the booster and back to the reservoir.

i. When the operator removes the pressure from the brake pedal, a spring forces the brake pedal rod out of the cavity. This action allows the fluid to once again flow freely through the cavity in the piston, and the piston is forced to the pedal side by a return spring.

j. If the power steering pump or power booster unit fails, an increase of manual pressure will be needed to stop the vehicle.

NOTE: Show Slide #15

10) Full Disk Brake System.

a. The full disk brake system, or wet disk brake system, was designed to maintain high levels of **torque** and **braking power**. It is similar to a multiple disk clutch pack in the power shift transmission and usually out lasts the life of the vehicle.

b. The full disk brake system is made up of a series of plates and discs. The plates are the non-rotating members, which are externally splined to the axle housing or ring gear assembly. The disks are the rotating member and are internally splined to the axle shaft. Full disk brakes are completely enclosed in the axle housing providing maximum protection from the elements.

c. When hydraulic pressure is applied to the pistons on the full disk brake system, the pistons compress the disks and plates together to apply friction and create the braking action. Since the disks and plates are covered in oil, the amount of friction between each disk and plate is reduced; however, when more than one set of disks and plates are combined, the amount of surface area is increased.

d. When the hydraulic pressure is released the piston is returned by a return spring mounted on the rear of the piston assembly inside the piston assembly. This allows the disks and plates to separate, minimizing disk wear.

e. Automatically compensates for disc wear and is self adjusting by hydraulic fluid pressure.

NOTE: If the brakes are overheating, a possible cause is low oil in the axle. The oil helps to reduce heat caused by the friction between the disks and plates.

NOTE: Show Slide #16

NOTE: Conduct a check on learning and summarize the learning activity.

Determine if students have learned the material presented by:

1. Soliciting student questions and explanations.
2. Asking questions and receiving answers from the students.
3. Correcting student misunderstandings.

2. Learning Step / Activity 3. Correct Power Brake System Malfunctions. (Disk Brake)

Method of Instruction: Practical Exercise (Performance)
Instructor to Student Ratio: 1:4
Time of Instruction: 3 hrs 45 mins
Media: Training Aid

Practical Exercise Instructions.

a. Give detailed instructions on what is expected during each practical exercise IAW Appendix C.

b. Ensure students have required materials and references IAW Appendix C.

c. Clarify students' questions.

d. Conduct the practical exercise IAW Appendix C.

e. Check on students' progress and provide assistance as necessary throughout the exercise.

f. Ensure students complete the practical exercise within the allotted time.

g. Provide solutions to the practical exercise.

NOTE: Conduct a check on learning and summarize the learning activity.

Determine if students have learned the material presented by:

1. Soliciting student questions and explanations.

2. Asking questions and receiving answers from the students.

3. Correcting student misunderstandings.

3. Learning Step / Activity 3. Correct Power Brake System Malfunctions. (Full Disk Brake)

Method of Instruction: Practical Exercise (Performance)
Instructor to Student Ratio: 1:4
Time of Instruction: 4 hrs 45 mins
Media: Training Aid

Practical Exercise Instructions.

a. Give detailed instructions on what is expected during each practical exercise IAW Appendix C.

b. Ensure students have required materials and references IAW Appendix C.

c. Clarify students' questions.

d. Conduct the practical exercise IAW Appendix C.

e. Check on students' progress and provide assistance as necessary throughout the exercise.

f. Ensure students complete the practical exercise within the allotted time.

g. Provide solutions to the practical exercise.

NOTE: Conduct a check on learning and summarize the learning activity.

Determine if students have learned the material presented by:

1. Soliciting student questions and explanations.

2. Asking questions and receiving answers from the students.

3. Correcting student misunderstandings.

4. Learning Step / Activity 4. Correct Power Brake System Malfunctions. (Simulator)

Method of Instruction: Practical Exercise (Performance)
Instructor to Student Ratio: 1:16
Time of Instruction: 2 hrs
Media: Computer Based Instruction (CBI)

Practical Exercise Instructions.

NOTE: If Brake Systems Simulator is not available, PE will be conducted using applicable brake systems with a 1:4 student to instructor ratio. All safety and environmental considerations and precautions will be implemented.

a. Give detailed instructions on what is expected during each practical exercise IAW Appendix C.

b. Ensure students have required materials and references IAW Appendix C.

c. Clarify students' questions.

d. Conduct the practical exercise IAW Appendix C.

e. Check on students' progress and provide assistance as necessary throughout the exercise.

f. Ensure students complete the practical exercise within the allotted time.

g. Provide solutions to the practical exercise.

NOTE: Conduct a check on learning and summarize the learning activity.

Determine if students have learned the material presented by:

1. Soliciting student questions and explanations.

2. Asking questions and receiving answers from the students.

3. Correcting student misunderstandings.

SECTION IV. SUMMARY

Method of Instruction: Conference / Discussion
Instructor to Student Ratio is: 1:32
Time of Instruction: 5 mins
Media: Large Group Instruction

Check on Learning

Determine if the students have learned the material presented by soliciting student questions and explanations. Ask the students questions and correct misunderstandings.

Review / Summarize Lesson

Restate the Terminal Learning Objective (TLO) requirements (**Identify assisted brake systems components and their functions**). Summarize the Learning Steps/Activities.

1. **Identify Assisted Brake System Components.**
2. **Correct Assisted Brake System Malfunctions. (Simulator).**
3. **Correct Assisted Brake System Malfunctions. (Hands On).**
4. **Correct Assisted Brake System Malfunctions. (Simulator).**

SECTION V. STUDENT EVALUATION

Testing Requirements	**NOTE:** Describe how the student must demonstrate accomplishment of the TLO. Refer student to the Student Evaluation Plan.
Feedback Requirements	**NOTE:** Feedback is essential to effective learning. Schedule and provide feedback on the evaluation and any information to help answer students' questions about the test. Provide remedial training as needed.

Brakes Systems Examination
91L10F04 / Version 1
01 Jan 2010

SECTION I. ADMINISTRATIVE DATA

All Courses Including This Lesson

Course Number	Version	Course Title
612-91L10	1	Construction Equipment Repairer

Task(s) Taught(*) or Supported

Task Number	Task Title
	INDIVIDUAL
091-91L-1601	Adjust the Brake Shoes on an Item of Construction Equipment
091-91L-1602	Replace a Master Cylinder on an Item of Construction Equipment
091-91L-1603	Replace a Brake Booster on an Item of Construction Equipment
091-91L-1604	Replace a Treadle Valve on an Item of Construction Equipment
091-91L-1605	Replace a Brake Air Compressor on an Item of Construction Equipment
091-91L-1606	Replace a Slack Adjuster on an Item of Construction Equipment
091-91L-1607	Replace a Brake Cylinder on an Item of Construction Equipment
091-91L-1608	Replace the Brake Lines on an Item of Construction Equipment
091-91L-1609	Replace the Brake Shoes on an Item of Construction Equipment
091-91L-1610	Replace the Brake Pads on an Item of Construction Equipment
091-91L-1611	Replace the Brake Drums on an Item of Construction Equipment
091-91L-1612	Replace the Brake Rotors on an Item of Construction Equipment
091-91L-1613	Replace a Moisture Separator on an Item of Construction Equipment
091-91L-1614	Replace an Air Pressure Gauge on an Item of Construction Equipment.
091-91L-1615	Repair a Brake Air Compressor on an Item of Construction Equipment
091-91L-1616	Repair a Brake Caliper on an Item of Construction Equipment
091-91L-1617	Replace an Air Brake Safety Valve on an Item of Construction Equipment.
091-91L-1618	Repair an Air Brake Safety Valve on an Item of Construction Equipment.
091-91L-1619	Replace a Brake Chamber on an Item of Construction Equipment.

Reinforced Task(s)

Task Number	Task Title

Academic

The academic hours required to teach this lesson are as follows:

Hours

		Resident Hours/Methods
		10 mins / Conference / Discussion
Test	7 hrs	10 mins
Test Review		30 mins
Total Hours:	10 hrs	

Test Lesson Number

	Hours	Lesson No.
Testing (to include test review)		N/A

Prerequisite Lesson(s)

Lesson Number	Lesson Title
91L10A01	Course Introduction
91L10A02	Shop Safety Procedures
91L10A03	Environmental Awareness Procedures
91L10A04	Identify Computer Software and Hardware Components
91L10A05	AKO Procedures
91L10A06	Troubleshooting Logic Tree
91L10A07	The Levels of Maintenance and Their Responsibility
91L10A08	Utilize Maintenance and Repair Parts Technical Manuals
91L10A09	Utilize Maintenance Forms and Records
91L10A10	Battlefield Damage Assessment and Repair (BDAR)
91L10A11	Identify Items of Construction Equipment
91L10A12	Identify Test, Measurement and Diagnostic Equipment (TMDE), general mechanics and special tools.
91L10A13	Shop Operations Examination
91L10B01	The Fundamentals of Electricity
91L10B02	Wiring Diagrams, Schematics, and Automotive Batteries.
91L10B03	Identify Test, Measurement and Diagnostic Equipment (TMDE)
91L10B04	Starting and Charging Systems
91L10B05	Electrical Systems Examination
91L10C01	Diesel Engine Principles
91L10C02	Disassembly/Assembly of a Diesel Engine
91L10C03	Diesel Engine Component Replacement Performance Evaluation
91L10C04	Diesel Engine Systems Written Examination
91L10C05	Diesel Engine Test and Adjustment Procedures
91L10C06	Diesel Engine Systems Performance Evaluation
91L10D01	Hydraulic System Fundamentals
91L10D02	Hydraulic Cylinders and Lines
91L10D03	Hydraulic Pumps and Control Valves
91L10D04	Hydraulic Accumulators
91L10D05	Hydraulic Schematics
91L10D06	Hydraulic Systems Examination
91L10E01	Power Train Gears, Bearings and Seals
91L10E02	Torque Converters, Transmissions, Planetary Gears and Clutches
91L10E03	Differentials and Axles
91L10E04	Final Drives
91L10E05	Power Train Systems Examination
91L10F01	Brake System Fundamentals
91L10F02	Air Brake Systems

	91L10F03 Assisted Brake Systems
Clearance Access	Security Level: Unclassified Requirements: There are no clearance or access requirements for the lesson.
Foreign Disclosure Restrictions	FD5. This product/publication has been reviewed by the product developers in coordination with the Fort Leonard Wood, MO / Maneuver Support Center foreign disclosure authority. This product is releasable to students from all requesting foreign countries without restrictions.

References

Number	Title	Date	Additional Information
29 CFR 1910.1200	Hazard Communication	01 Jul 2003	
29 CFR 1910.132	Personnel Protective Equipment - General Requirements	01 Jul 2003	
29 CFR 1910.133	Eye and Face Protection	01 Jul 2003	
29 CFR 1910.136	Foot Protection	01 Jul 2003	
29 CFR 1910.138	Hand Protection	01 Jul 2003	
29 CFR 1910.95	Occupational Noise Exposure	01 Jul 2003	
AR 385-10	The Army Safety Program	23 Aug 2007	
EM 385-1-1	Safety and Health Requirements.	03 Nov 2003	Public Domain
FM 3-100.4	Environmental Considerations in Military Operations. MCRP 4-11B.	15 Jun 2000	Public Domain
FM 5-19 (FM 100-14)	Composite Risk Management.	21 Aug 2006	Public Domain
TM 5-3805-248-23-1	Unit and Direct Support Maintenance for Scraper, Earth Moving, Motorized, Diesel Engine Driven Model 621B (NSN 3805-01-153-1854) (EIC: EH3).	15 Feb 2006	Public Domain
TM 5-3805-248-23-2	Unit and Direct Support Maintenance for Scraper, Earth Moving, Motorized Diesel Engine Driven Model 621B.	15 Feb 2006	Public Domain
TM 5-3805-262-20	Organizational Maintenance, Loader, Scoop Type, DED, 4x4, Articulated Frame Steer, 2 1/2 Cubic Yard, (J.I. Case Model MW24C) (NSN 3805-01-150-4814).	01 Sep 1987	Public Domain
TM 5-3805-262-34	Direct Support and General Support Maintenance Manual for Loader, Scoop Type, DED, 4x4, Articulated Frame Steer, 2-1/2 Cubic Yard (J.I. Case Model MW24C) (NSN 3805-01-150-4814).	01 Sep 1987	Public Domain
TM 9-2320-363-20-1	Unit Maintenance Manual for Truck, Tractor, Line Haul 52,000 GVWR, 6x4, M915A2 . . . Volume 1 of 2.	11 Jun 1992	Public Domain
TM 9-2320-363-20-2	Unit Maintenance Manual for Truck, Tractor, Line Haul 52,000 GVWR, 6x4, M915A2 (NSN 2320-01-272-5029)	12 Jun 1992	Public Domain

	Truck Tractor, Light Equipment Transporter (LET) 68,000 GVWR, 6x6, w/Winch, M916A1 (2320-01-272-5028) Truck Tracter, Light Equipment...		
TM 9-2330-213-14&P	Operator's, Unit, Direct Support and General Support Maintenance (Including Repair Parts and Special Tools Lists) for Trailer, Chassis: 1 1/2-Ton, 2-Wheel, M103A1, M103A3, and Trailer, Cargo: 1 1/2-Ton, 2-Wheel, M105A1, M105A2 . . .	09 Oct 1990	Public Domain

Student Study Assignments

None

Instructor Requirements

ITC certified instructors, MOS 91L20 / 1341 and above or civilian equivalent.

Additional Support Personnel Requirements

Name	Stu Ratio	Qty	Man Hours
None			

Equipment Required for Instruction

Id Name	Stu Ratio	Instr Ratio	Spt	Qty	Exp
*2520-01-093-5841 Axle Assembly, Automotive, Driving	1:8		No	4	No
*2520-01-496-0049 Axel, Front	1:8		No	6	No
4235-01-432-7909 Spill Clean-Up Kit, Hazardous Material	1:32		No	0	Yes
4240-00-022-2946 Protector, Hearing	1:1	1:1	No	0	Yes
4240-00-052-3776 Goggles, Industrial	1:1	1:1	No	0	Yes
4910-00-273-3658 Filler and Bleeder, Hydraulic System	1:32		No	1	No
4910-00-357-5342 Table, Work, Automotive Maintenance	1:4		No	8	No
5180-01-548-7634 Tool Kit, General Mechanic	1:2		No	16	No
5210-00-540-2973 Caliper, Micrometer, Outside	1:2		No	16	No
5810-01-523-6682 Computer, Laptop, Ruggedized (MIL-STD -810f Compliant), Workstation KG-235	1:4		No	0	No
7000-21-000-0354 150" Video Screens			Yes	4	No
7000-21-000-0355 Screen Controller			Yes	4	No
7000-21-000-0356 Crestron Audio / Video Controller			Yes	1	No

7000-21-000-0357 Power Supply	Yes	1	No
7000-21-000-0358 Crestron Com Card	Yes	3	No
7000-21-000-0359 LCD Projection System	Yes	4	No
7000-21-000-0360 8x8 RGB Routing Switcher	Yes	1	No
7000-21-000-0361 Creston Ethernet Card	Yes	1	No
7000-21-000-0362 Creston Input/Output Card	Yes	2	No
7000-21-000-0363 Crestron Volume Control Card	Yes	2	No
7000-21-000-0364 Crestron Relay Card	Yes	1	No
7000-21-000-0365 Crestron RS-232/IR Control Card	Yes	1	No
7000-21-000-0366 Crestron Infrared Transmitter	Yes	2	No
7000-21-000-0367 Ceiling Speaker System	Yes	16	No
7000-21-000-0368 Crestron Lighting Controller	Yes	2	No
7000-21-000-0369 Crestron 12" Video Touch Panel	Yes	2	No
7000-21-000-0385 Projector Mounting System	Yes	4	No
7000-21-000-0386 Audio Power Amplifier	Yes	4	No
7000-21-000-0387 Headset Microphone	Yes	2	No
7000-21-000-0388 Condenser Microphone	Yes	2	No
7000-21-000-0389 Microphone Base	Yes	2	No
7000-21-000-0390 Power Conditioner	Yes	2	No
7000-21-000-0391 8x8 Audio Video Routing Switcher	Yes	1	No
7000-21-000-0392 VCR / DVD Player	Yes	2	No
7000-21-000-0393 VCR / DVD Control Module	Yes	2	No
7000-21-000-0394 Wireless Microphone System	Yes	2	No
7000-21-000-0395 Lavaliere Microphone	Yes	2	No
7000-21-000-0396 Audio Dynamics Processor	Yes	1	No
7000-21-000-0397 Microphone Mixer	Yes	2	No
7000-21-000-0398 Audio Routing Mixer	Yes	1	No

7000-21-000-0399 20 Space Security Door			Yes	1	No
7000-21-000-0400 2-Space Vented Security Panel			Yes	2	No
7000-21-000-0401 Document Camera			Yes	2	No
7000-21-000-0402 Wireless Mouse			Yes	2	No
7000-21-000-0403 1x2 RGB Distribution Amplifier			Yes	2	No
7000-21-000-0404 Audio/Video/Control Cable and Assemblies			Yes	2	No
7000-21-000-0405 Control System Design			Yes	40	No
7000-21-000-0406 Smart Board Display Monitor			Yes	2	No
7000-21-000-0407 Documentation for Installation Schematics			Yes	10	No
7000-21-000-0408 Rack			Yes	1	No
7000-21-000-0409 Instructor PC			Yes	2	No
7110-01-202-3674 Board, Marker, Dry, Erasable Type		1:1	No	0	No
7125-01-084-6955 Cabinet, Storage	1:32		No	0	No
8405-00-131-6508 Coveralls, Men's OG 46M	1:1		Yes	0	No
8415-00-268-7868 Gloves, Work, Men's and Women's	1:1		Yes	0	No
8430-00-624-3135 Boots, Safety, Men's, Size 10 Regular	1:1		Yes	0	No
8435-01-475-6874 Boots, Safety, Women's, Size 8 Regular	1:1		Yes	0	No
*DVC 09-135 Backhoe Loader (BHL) Wet Brakes Training Device	1:8		No	0	No
*L-TAABST-FLW Atech Air Brake System Trainer	1:4		No	6	No

* Before Id indicates a TADSS

Materials Required

Instructor Materials:

TM 5-3805-248-23-1
TM 5-3805-248-23-2
TM 5-3805-262-20
TM 5-3805-262-34
TM 9-2320-363-20-1
TM 9-2320-363-20-2
TM 9-2330-213-14&P
Lesson F04
PPE

Student Materials:

TM 5-3805-248-23-1
TM 5-3805-248-23-2
TM 5-3805-262-20

TM 5-3805-262-34
TM 9-2320-363-20-1
TM 9-2320-363-20-2
TM 9-2330-213-14&P
Student Guide
Pens and Pencils
PPE

Classroom, Training Area, and Range Requirements

AUTO-AID INST, 1400 SF (Classroom XXI)
VEH MAINT INST

Ammunition Requirements

Id	Name	Exp	Stu Ratio	Instr Ratio	Spt Qty
None					

Instructional Guidance

NOTE: Before presenting this lesson, instructors must thoroughly prepare by studying this lesson and identified reference material.

Before presenting this lesson:

a. Ensure classroom is available and ready for training.

b. Ensure computer, computer projector and screen are on hand.

c. Ensure materials are on hand and in quantities needed.

d. Read and understand Lesson F04 prior to conducting training.

e. Ensure equipment is available and on site.

f. Conduct an Environmental Risk Assessment for this lesson IAW FM 3-100.4, Environmental Considerations in Military Operations.

1) The assessment is to be recorded on the Risk Management Worksheet found in appendix F of FM 3-100.4. FM 5-19, Composite Risk Management, has more information on this worksheet.

2) During the assessment instructors should look for environmental hazards including all activities that may pollute, generate hazardous or solid waste, create negative noise-related effect, degrade archaeological, cultural resources, or negatively affect threatened or endangered species' habitats.

3) Ensure instructor check Contemporary Operational Environment web site for latest updates.

https://sp.wood.army.mil/sites/Manscen/ENG/1bde/169/ACO2/COA/Tab4.aspx

g. In accordance with AR 385-10, Army Safety Program, Chapter 16, Occupational Safety and Health Program (Workplace Safety):

1) OSHA programs and national consensus standards shall be applicable to and integrated into all Army equipment, systems, operations, and workplaces, CONUS and OCONUS.

2) Military design, specifications, and deployment requirements will comply with OSHA standards where feasible. When no standard exists for military application or the application is not feasible, the Army component will apply mishap risk management component of CRM.

3) Military and Army civilian officials at each management level shall promote strong safety programs, safe working conditions, and safe performance to prevent accidents, injuries, and occupational illnesses.

Proponent Lesson Plan Approvals

Name	Rank	Position	Date
Shankland, Steven	SSG	Developer/Writer	07 Jan 2008
King, Ronnie	YC-02	Chief, Construction Engineer Branch	07 Jan 2008
Rutledge, Jesse	YC-02	Chief, Individual Training Division	07 Jan 2008

SECTION II. INTRODUCTION

Method of Instruction: Conference / Discussion
Instructor to Student Ratio is: 1:32
Time of Instruction: 5 mins
Media: Large Group Instruction

Motivator

Explain the importance of passing this test.

Terminal Learning Objective

NOTE: Inform the students of the following Terminal Learning Objective requirements.

At the completion of this lesson, you [the student] will:

Action:	Complete a Brake Systems Examination.
Conditions:	In a contemporary operational environment, given a written examination and hands-on evaluation, selected items of construction equipment or training aids, TMDE, required tools, PPE and applicable references.
Standards:	Identify the fundamentals of brake systems, air brake and assisted brake system components and their functions. Correct air brake and assisted brake system malfunctions by troubleshooting, adjusting, repairing or replacing faulty components without damage to the equipment or the environment and without injury to personnel.

Safety Requirements

Risk of skin and eye injury exists while working with pressurized air and fluids You will wear eye and foot protection when working with brake systems. Use three points of contact when mounting or dismounting equipment. Remove all jewelry to include ID tags and wedding bands when working on equipment. The location and use of emergency eyewash stations will be identified and demonstrated to students. In case of eye contact with brake fluids, an eye wash will be used immediately. Use caution around moving parts. You will be provided and required to wear hearing protection while equipment is running. The use of Personal protective Equipment (PPE) by students and instructors is mandatory. Further guidance concerning PPE can be found in OSHA regulations 29 CFR 1910.132; 29 CFR 1910.133; 29 CFR 1910.136; 29 CFR 1910.138; and 29 CFR 1910.95.

Risk Assessment Level

Medium -

Environmental Considerations

NOTE: It is the responsibility of all Soldiers and DA civilians to protect the environment from damage.

There is a possibility of environmental contamination by petroleum oil, lubricants, fuel, and cleaning solvents. You will be briefed on the proper disposal of POL products and how to properly clean up spills prior to each practical exercise. Ensure spill kits are available and there location identified. Instructors should complete a risk assessment before conducting training, operations, or logistical activities. Risk assessments assist instructors in identifying potential environmental hazards, develops controls, make risk decisions, implement controls, and insure proper supervision and evaluation.

Evaluation	Achieve a minimum score of 80% on a written examination in the time allotted and achieve a GO on a performance evaluation in the time allotted.
Instructional Lead-In	State the TLO action, conditions and standards.

SECTION III. PRESENTATION

1. Learning Step / Activity 1. Complete a Brake Systems Written Examination

Method of Instruction: Test
Instructor to Student Ratio: 1:32
Time of Instruction: 1 hr 30 mins
Media: Large Group Instruction

a. Give detailed instructions on test procedures IAW Appendix B.

b. Ensure students have required materials and references IAW Appendix B

c. Clarify students' questions.

d. Conduct the test IAW Appendix B.

e. Check on students' progress and provide assistance as necessary during the exam

f. Ensure students turn test booklets and tests in within the allotted time IAW Appendix B

g. Conduct a test review IAW Appendix B.

NOTE: Conduct a check on learning and summarize the learning activity.

2. Learning Step / Activity 2. Complete a Brake Systems Written Examination Review

Method of Instruction: Test Review
Instructor to Student Ratio: 1:32
Time of Instruction: 20 mins
Media: Large Group Instruction

a. **Test Review.**

1) Have students return to the classroom.

2) Explain the purpose of the test review.

b. **Conduct a test review IAW Appendix B.**

NOTE: Conduct a check on learning and summarize the learning activity.

3. Learning Step / Activity 3. Complete a Brake Systems Performance Evaluation

Method of Instruction: Test
Instructor to Student Ratio: 1:4
Time of Instruction: 7 hrs 30 mins
Media: Training Aid

a. Give detailed instructions on what is expected during the evaluation IAW Appendix B.

b. Ensure students have required materials and references IAW Appendix B.

c. Clarify students' questions.

d. Conduct the evaluation IAW Appendix B.

e. Check on students' progress and provide assistance as necessary throughout the evaluation.

f. Ensure students complete the evaluation within the allotted time IAW Appendix B.

g. Complete student evaluation and review IAW Appendix B.

NOTE: Conduct a check on learning and summarize the learning activity.

4. Learning Step / Activity 4. Complete a Brake Systems Performance Evaluation Review

Method of Instruction: Test Review
Instructor to Student Ratio: 1:4
Time of Instruction: 10 mins
Media: Large Group Instruction

NOTE: Conduct a check on learning and summarize the learning activity.

SECTION IV. SUMMARY

Method of Instruction: Conference / Discussion
Instructor to Student Ratio is: 1:32
Time of Instruction: 5 mins
Media: Large Group Instruction

Check on Learning

Determine if the students have learned the material presented by soliciting student questions and explanations. Ask the students questions and correct misunderstandings.

Review / Summarize Lesson

Restate the Terminal Learning Objective (TLO) requirements (**Complete the Brakes Annex Examination**). Summarize the Learning Steps/Activities.

1. **Complete the Brakes Annex Written Examination.**
2. **Complete the Brakes Annex Written Examination Review.**
3. **Complete the Brakes Annex Performance Evaluation.**
4. **Complete the Brakes Annex Performance Evaluation Review.**

SECTION V. STUDENT EVALUATION

Testing Requirements

NOTE: Describe how the student must demonstrate accomplishment of the TLO. Refer student to the Student Evaluation Plan.

Achieve a minimum score of 80% on a written examination in the time allotted and achieve a GO on a performance evaluation in the time allotted. One hour 30 minutes is allotted for the written test and seven hours and 30 minutes is allotted for the performance evaluation.

Feedback Requirements

NOTE: Feedback is essential to effective learning. Schedule and provide feedback on the evaluation and any information to help answer students' questions about the test. Provide remedial training as needed.

Appendix A - Viewgraph Masters (N/A)

Appendix B - Test(s) and Test Solution(s)

TEST QUESTION(S) FOR LESSON 4: 91L10F04 version 1

1. TLO (1) [1] Multiple Choice / 1.6 {-}
   a. **Introduction.**

   1) Introduction of the instructor.

   2) Motivational statement.

   3) State the TLO action, conditions and standards.

NOTE: Show Slide #86

b. **Test Administration Procedures.**

(1) Distribute tests and answer sheets.

(2) 1. The identity of every student is supposed to be verified before they are issued their test. The answer is they are verified using their ID card. I know that every annex, if any annex, is not doing this at this time. This must be done during accreditation and really should be done at all times. The simple answer is to stand at the door as the students are coming in and check them off the roster. No ID Card, no test.

(3) Inform students of the following:

a. Inform students not to open test booklet until told to do so.

b. They will not acquire or be provided inappropriate assistance before, during or after any test, except as instructed.

c. They will report any unauthorized assistance of which they may have knowledge.

d. You must achieve a minimum score of 80% on this test. If you fail to receive a minimum score of 80%, you will be counseled and re-tested. If you pass the re-test, the highest score you will receive is 80%. If you fail the re-test, you will be referred to the Chief Instructor recommending restart with another class.

e. On the answer sheet provided, fill in your response to each of the questions contained in the exam.

f. This is an open note, open book test. All course materials can be used.

g. **DO NOT WRITE IN THIS TEST BOOKLET.**

h. No talking during the examination.

i. Do not begin until told to do so

(4) When you have completed the exam, turn in the test booklet, TM extract and your answer sheet to the instructor. Move to the break area until told to return to the classroom.

(5) Ask students if they have any questions pertaining to the test.

(6) Have students begin the test

(7) Post the START and STOP times where the students can see them.

(8) Ensure a minimum of one instructor is present in classroom during testing.

(9) As students finish, collect their test materials and send them to the break area.

(10) When time expires, have remaining students immediately stop testing. Collect all test material and send students to the break area.

(11) Grade all remaining tests.

c. **Conduct a Test Review.**

Ask the following questions and allow appropriate time for responses:

1) Was all the test information understood?

2) Were all the questions on the examination understood?

3) Did the test reflect the contents of the lesson plan and the information taught?

4) Does any portion of the class need more or less time, clarification, or practical exercise?

5) What percentage of students missed any one question? Check each question and clarify as needed.

6) Was the time for the examination adequate?

d. **Post the Test Results.**

Record each student's performance on the student performance record and maintain in the course office.

2. TLO (3) [3] Performance / 7.5 {-}

Test Administration Guide

TSP: 091-91L10-ITRO-F-1

Module: Brakes

Examination Number: 1

Focus Area: Brake Systems

Test Sites: 1

Testing Period: 8 hours

Evaluator to Student Ratio: 1 to 4

Students Per Test Site: 2

Task: Correct a Brake Malfunction

Tasks Referenced	Method of testing	Task Title
091-62B-1601	Performance Evaluation	Adjust the Brake Shoes on an Item of Construction Equipment
091-62B-1606	Performance Evaluation	Replace a Slack Adjuster on an Item of Construction Equipment
091-62B-1607	Performance Evaluation	Replace a Brake Cylinder on an Item of Construction Equipment
091-62B-1608	Performance Evaluation	Replace Brake Lines on an Item of Construction Equipment
091-62B-1609	Performance Evaluation	Replace Brake Shoes on an Item of Construction Equipment
091-62B-1610	Performance Evaluation	Replace Brake Pads on an Item of Construction Equipment
091-62B-1611	Performance Evaluation	Replace Brake Drums on an Item of Construction Equipment
091-62B-1613	Performance Evaluation	Replace a Moisture Separator on an Item of Construction Equipment
091-62B-1616	Performance Evaluation	Repair a Brake Caliper on an Item of Construction Equipment

1. Administrative Procedures.

a. Evaluators will prepare the test evaluation site prior to administering the examination.

Testing site preparation requirements.

QTY	Number	Title
8 EA	4910-00-357-5342	Table Work Automotive Maintenance
2 EA	2520-01-326-4640	Axle, Automotive, Driving
2 EA	2520-01-326-4641	Axle, Automotive, Driving
4 EA	2530-01-191-1397	Axle, Automotive, Driving
4 EA	2530-00-323-8538	Axle, Automotive, Non-Driving
12 EA	01-180-0799	Kit, Disk Pad, Brake
8 EA	01-176-4090	Calipers, Brake
8 EA	5180-00-177-7033	Tool Kit, General Mechanics
16 EA	5210-00-540-2973	Micrometer, 1in scale
32 EA	4240-00-022-2946	Aural, Protector, Sound
32 EA	4240-00-052-3776	Goggles safety
4 EA	TM 9-2320-363-20	Technical Manual: Truck, Tractor, (915A2)
8 EA	5988E & LTI	Maintenance work sheet with recorded faults
4 EA	2520-01-496-0049	Axle, Forklift, TEREX

b. Testing site preparation setup.

1) Evaluators will insure all tools have been placed at each training site prior to testing.

2) Testing work station will consist of the following items:

a) Table, Work, Automotive Maintenance.

b) Tool Kit, General Mechanics.

c) Micrometer, 1 in scale.

d) Aural , Protector, Sound.

e) Goggles, Safety.

f) Technical Manual.

g) Maintenance work sheet with recorded faults.

3) Repair Parts.

Ensure the required number of replacement parts are maintained in the parts cabinet.

2. Performance Steps.

a. The evaluator will divide the students in to teams of two and then proceed with the briefing on the general procedures and safety governing the administration of the test.

b. This test was designed to measure your mechanical skills and problem solving techniques. You will be assigned a work station, with a general mechanic tool box, technical manuals, and a 5988-E or LTI. The evaluator will determine each teams start time. You will have one hour to complete four performance evaluation faults listed on your 5888-E and receive a GO. Use eye protection and correct lifting procedures when performing the tasks. Any safety violation that may cause injury to personal or damage to equipment will result in immediate termination of the test and an automatic no go for the task.

Students receiving a 1st time NO GO will be retrained and retested on the same day. A second time failure will result in an immediate counseling using DA Form 4856-R. The student will be required to retest the following morning on a different task. If all tasks are completed successfully they will receive a GO and continue with their class. A 3rd failure will result in a recommendation to the command to retain the student for additional training in the next class.

3. Evaluation.

Evaluators will provide the following information at the test sites:

a. A go on all performance measures is required to receive a go for that task.

b. Students must receive a go on all performance tasks.

c. Student will ask evaluator for replacement parts.

d. Allow students to ask questions.

e. Critique student's performance rating with them.

4. Evaluation Test Sheets.

References:

TM 5-3805-248-23-1
TM 5-3805-248-23-2
TM 5-3805-262-20
TM 5-3805-262-34
TM 9-2320-363-20-1
TM 9-2320-363-20-2
TM 9-2330-213-14&P

5. Lessons Learned Questions.

a. What worked well—or didn't work well—either for this task or with the team?

b. What needs to be done over or differently?

c. What surprises did the team have to deal with?

d. What task circumstances were not anticipated?

Tasks Referenced	Method of testing	Task Title
091-62B-1601	Performance Evaluation	Adjust the Brake Shoes on an Item of Construction Equipment
091-62B-1606	Performance Evaluation	Replace a Slack Adjuster on an Item of Construction Equipment
091-62B-1607	Performance Evaluation	Replace a Brake Cylinder on an Item of Construction Equipment
091-62B-1608	Performance Evaluation	Replace Brake Lines on an Item of Construction Equipment
091-62B-1609	Performance Evaluation	Replace Brake Shoes on an Item of Construction Equipment
091-62B-1610	Performance Evaluation	Replace Brake Pads on an Item of Construction Equipment
091-62B-1611	Performance Evaluation	Replace Brake Drums on an Item of Construction Equipment
091-62B-1613	Performance Evaluation	Replace a Moisture Separator on an Item of Construction Equipment
091-62B-1616	Performance Evaluation	Repair a Brake Caliper on an Item of Construction Equipment

Task Success	Factors That Supported Success

Task Shortcoming	Recommended Solutions

Reviewed By:

_____

Annex Chief

_____

Chief Instructor Maintenance Training Division

Evaluator:

a. On command to begin from the evaluator, the student will have one hour to complete the 4 faults on their assigned 5988-E or LTI. While completing the tasks, the evaluators will observe the students during repairs ensuring all performance measures are met. Evaluators will score each team member separately by a GO or NO GO rating. When the students have completed their 5988-E or LTI, the observer will grade the performance measure test sheets and provide the students feedback on their performance. If the student fails any of the performance steps, the student will be retrained and retested in the tasks they received a NO GO in.

b. The observers and student will sign the performance measure test sheet after their critique.

c. All student performance measure test sheet will be retained for a period of one year.

Action:	Complete a Brake Systems Performance Evaluation.
Condition:	Given a hands-on evaluation, selected items of construction equipment or training aids, TMDE, required tools, PPE and applicable references.
Standard:	Correct air brake and assisted brake system malfunctions by troubleshooting, adjusting, repairing or replacing faulty components without damage to the equipment or the environment and without injury to personnel.

Evaluation Sheet 1

Replace wheel cylinder on an Item of Construction Equipment or Training Aid

NAME _____ **CLASS NO.** _____

UNIT _____ **ATTEMPT NO.** _____

RESULTS _____

Performance Measures	**GO**	**NO GO**
1. Utilized proper reference.	_____	_____
2. Removed hub and drum assembly.	_____	_____
3. Inspected / Removed brake shoes.	_____	_____
4. Removed wheel cylinder.	_____	_____
5. Installed new wheel cylinder.	_____	_____
6. Installed brake shoes.	_____	_____
7. Installed brake drum and hub assembly.	_____	_____
8. Rotated drum while tightening the adjusting nut.	_____	_____
9. Specified torque for jam nut.	_____	_____
10. Adjusted brake shoes.	_____	_____
11. Evaluator's overall rating	_____	_____

Evaluation Guidance: Score the Soldier GO if all steps are passed (P). Score the Soldier NO-GO if any step is failed (F). If the Soldier fails any step, show the Soldier how to do it correctly.

References:

Required	**Related**
DA Form 5988-E	AR 750-1
TM 9-2330-213-14&P	DA Pam 750-8

Evaluator's Comments:

Evaluator's Signature: _____ **Date:** _____

Evaluation Sheet 2

Replace brake shoes and slack adjuster on an Item of Construction Equipment or Training Aid

NAME _____ **CLASS NO.** _____

UNIT _____ **ATTEMPT NO.** _____

RESULTS _____

Performance Measures	**GO**	**NO GO**
1. Utilized proper reference.	_____	_____
2. Caged the brakes.	_____	_____
3. Removed hub and drum assembly.	_____	_____
4. Removed brake shoes.	_____	_____
5. Inspected brake drum and shoes.	_____	_____
6. Removed slack adjuster.	_____	_____
7. Replaced slack adjuster.	_____	_____
8. Installed brake shoes.	_____	_____
9. Installed brake drum and hub assembly.	_____	_____
10. Rotated drum while tightening the adjusting nut.	_____	_____
11. Specified torque for jam nut.	_____	_____
12. Un-caged brakes.	_____	_____
11. Evaluator's overall rating	_____	_____

Evaluation Guidance: Score the Soldier GO if all steps are passed (P). Score the Soldier NO-GO if any step is failed (F). If the Soldier fails any step, show the Soldier how to do it correctly.

References:

Required	**Related**
DA Form 5988-E	AR 750-1
TM 9-2520-363-20-1	
TM 9-2320-363-20-2	
DA Pam 750-8	

Evaluator's Comments:

Evaluator's Signature: _____ **Date:** _____

Evaluation Sheet 3

Replace / service an air dryer on an Item of Construction Equipment or Training Aid

NAME _____ **CLASS NO.** _____

UNIT _____ **ATTEMPT NO.** _____

RESULTS _____

Performance Measures	**GO**	**NO GO**
1. Utilized proper reference.	_____	_____
2. Inspected the equipment and verified its condition.	_____	_____
3. Disassembled the air dryer.	_____	_____
4. Determined reusable parts and parts that need replacing.	_____	_____
5. Filled to proper level with desiccant.	_____	_____
6. Reassembled the air dryer.	_____	_____
7. Explained steps to replace an air dryer.	_____	_____
8. Evaluator's overall rating	_____	_____

Evaluation Guidance: Score the Soldier GO if all steps are passed (P). Score the Soldier NO-GO if any step is failed (F). If the Soldier fails any step, show the Soldier how to do it correctly.

References:

Required	**Related**
DA Form 5988-E	AR 750-1
TM 5-3805-248-23-1	
TM 5-3805-248-23-2	
DA Pam 750-8	

Evaluator's Comments:

Evaluator's Signature: _____ **Date:** _____

Evaluation Sheet 4

Repair a Brake Caliper on an Item of Construction Equipment or Training Aid

NAME _____ **CLASS NO.** _____

UNIT _____ **ATTEMPT NO.** _____

RESULTS _____

Performance Measures	**GO**	**NO GO**
1. Utilized proper reference to perform task.	_____	_____
2. Performed preliminary tasks.	_____	_____
3. Inspected / removed brake lines.	_____	_____
4. Removed brake pads.	_____	_____
5. Removed the brake caliper.	_____	_____
6. Replaced brake caliper.	_____	_____
7. Replaced brake pads.	_____	_____
8. Replaced brake line & Bleed system	_____	_____
9. Measure Plates and disk correctly	_____	_____
10. Install Tire and remove jack Stands	_____	_____
11. Correctly Fill out DA Form 5988	_____	_____
12. Evaluator's overall rating	_____	_____

Evaluation Guidance: Score the Soldier GO if all steps are passed (P). Score the Soldier NO-GO if any step is failed (F). If the Soldier fails any step, show the Soldier how to do it correctly.

References:

Required	**Related**
DA Form 5988-E	AR 750-1
TM 5-3805-262-20	
TM 5-3805-262-34	
DA Pam 750-8	

Evaluator's Comments:

Evaluator's Signature: _____ **Date:** _____

TEST ANSWER(S) FOR LESSON 4: 91L10F04 version 1

1. TLO (1) [1]

2. TLO (3) [3]

Appendix C - Practical Exercises and Solutions

PRACTICAL EXERCISE(S)/SOLUTION(S) FOR LESSON 1: 91L10F01 version 1

PRACTICAL EXERCISE SHEET 91L10F01PE1

Title	Correct a Hydraulic Brake System Malfunction.
Lesson Number / Title	91L10F01 version 1 / Brake System Fundamentals
Introduction	Introduction of the instructor and the lesson topic.
Motivator	A construction equipment repairer, you must have a basic knowledge and understanding of brake system malfunctions in order to be effective in a combat and peacetime environment.
Learning Step/Activity	**NOTE:** The instructor should inform the students of the following Learning Step/Activity requirements. (TLO Step 3) At the completion of this lesson, you [the student] will: **Action:** Correct a Hydraulic Brake System Malfunction.
Safety Requirements	There is no safety considerations associated with this practical exercise using computer based instruction. Safety alerts, warnings, and reinforcements will be inserted at appropriate teaching points in the lesson where safety issues arise.
Risk Assessment	Low - Review the deliberate risk assessment, perform a daily risk assessment, and ensure it is recorded on appropriate forms, signed by authorized command authority, and posted at the training site.
Environmental Considerations	There are no environmental considerations associated with this practical exercise using computer based instruction.
Evaluation	Inform the students that during this practical exercise they will be evaluated on the following critical tasks: Replace a master cylinder and replace a brake booster.
Instructional Lead-In	**NOTE: Allow one to two minutes for the lesson introduction.** **NOTE: Introduce the students to the computer based lesson to be conducted.**
Resource Requirements	**Instructor Materials:** TM 5-3805-262-20 TM 5-3805-262-34 TM 9-8000 Lesson F01 Necessary Maintenance Forms Visitor's Book **Student Materials:** TM 5-3805-262-20 TM 5-3805-262-34 Student Guides Necessary Maintenance Forms Pens and Pencils

Special Instructions

a. Have students log on to the computers using the student user name and password.

b. Students must fill out the simulation chart found in the student guide at the end of the air brake chapter.

c. Refer to the instructor's simulation handbook for explanation of each simulation.

d. Ensure each station is functioning and the student is logged in properly or as required.

e. Ensure all additional materials are available.

f. Explain to the students:

1) They are responsible for their workstation and will be held accountable for any actions that may occur while logged into the workstations.

2) Each module will be accomplished in the sequence as dictated by the instructor and ample opportunity will be given to correct the malfunction.

Procedures

Scenario:

You are a construction equipment repairer stationed in Baghdad, Iraq, with the 9th Engineer Battalion. You have received a DA Form 5988E from your supervisor, SSG Fixmaster. He states the operator was operating a MW24C Bucket Loader while demolishing a building and the brakes started to act up. The stopping distance seems to take twice the distance than it did before he started to demolish the building. The operator states he saw fluid under the rear axle.

Maximum Wrenches Awarded: 3 Wrenches

Page 2

5988E shows faults: 1. Brake slow to stop, 2. Fluid leak

Page 3

Choose troubleshooting procedure

Poor Braking Action

Page 4

Student must click on the toolbox to receive a tip and then click on the wrench to check the air pressure level.

Page 5

Student must remove the two left engine panels. NOTE: Sometimes the computer does not recognize this action and the page need to be reloaded and the task performed again.

Page 6

Student must click on the toolbox and then on the 3D button.

Student must double-click on each of the two hydraulic reservoirs (marked in yellow) to check the brake flood levels. The rear reservoir is low (notice the direction of the brake pedals to determine the front from the rear).

Page 7

Student must click on each TM to read the steps.

Read each TM page then choose which procedure you will do next.

Inspect for leaks – takes the student to page 9

Bleed air from the brakes – takes the student to page 8 (This is not the correct answer)

Page 8

Bleed air from the brakes – Students see a video showing how to properly use the Hydraulic brake bleeder ball.

Bleeding the brakes **did not** fix the problem

Page 9

Inspect for leaks – the student must click on the wrench to see an animation showing the service transport link being engaged.

Page 10

Student must inspect the vehicle for leaks.

Student must double-click on each axle to perform inspections. The student is taken to an image that shows only the axle chosen to inspect for leaks. NOTE FAULT: On the Rear axle the right brake line is cracked and leaking.

Page 11

Q: What is your diagnosis?

A: D. Found a leak in the right rear brake line

Page 12

Student must read the TM then click on the highlighted are to continue.

Student must drag the drain pan to the right rear of the vehicle and then click on the DONE button.

Page 13

Student must click on the play button to see the video of the line bracket being removed.

Page 14

Q: Now you will replace the brake line. Click on the kind of brake line to use.

A: C. Seamless steel line with double flaring

Page 15

Student is shown a video of the brake line bracket being installed.

Page 16

Q: What should you do next?

A: D. Fill the rear reservoir.

Page 17

Student must click on the play button to see the video on how to bleed the brake system using a brake bleeder ball.

Page 18

Q: What will you do next?

A: A. Ensure the reservoirs are full

Page 19

Student must click on the wrench to test drive the vehicle.

Page 20

Q: You finished fixing the problem, good for you. What will you do next?

A: A. Close out the worksheet

Page 22

Click on the Rank to continue.

Feedback Requirements	

SOLUTION FOR
PRACTICAL EXERCISE SHEET 91L10F01PE1

Solutions for all simulated practical exercises are found within the simulation software program.

PRACTICAL EXERCISE SHEET 91L10F01PE2

Title	Utilize Special Tools and TMDE.
Lesson Number / Title	91L10F01 version 1 / Brake System Fundamentals
Introduction	Introduction of the instructor and the lesson topic.
Motivator	Inform students of the importance of understanding and being able to properly use hand tools to troubleshoot brake system malfunctions.
Learning Step/Activity	**NOTE:** The instructor should inform the students of the following Learning Step/Activity requirements. (TLO Step 5) At the completion of this lesson, you [the student] will: **Action:** Utilize Special Tools and TMDE.
Safety Requirements	Risk of cutting fingers on sharp edges of cut tubing. Remove all jewelry to include ID tags and wedding bands when working on equipment. Use caution around moving parts. The use of Personal Protective Equipment (PPE) by students and instructors is mandatory. Further guidance concerning PPE can be found in OSHA regulations 29 CFR 1910.132; 29 CFR 1910.133; 29 CFR 1910.136; 29 CFR 1910.138; and 29 CFR 1910.95.
Risk Assessment	Low - Review the deliberate risk assessment, perform a daily risk assessment, and ensure it is recorded on appropriate forms, signed by authorized command authority, and posted at the training site.
Environmental Considerations	There is a possibility of environmental contamination by petroleum oil, lubricants, fuel, and cleaning solvents. You will be briefed on the proper disposal of POL products and how to properly clean up spills prior to each practical exercise. Ensure spill kits are available and there location identified. Instructors should complete a risk assessment before conducting training, operations, or logistical activities. Risk assessments assist instructors in identifying potential environmental hazards, develops controls, make risk decisions, implement controls, and insure proper supervision and evaluation.
Evaluation	Practical Exercise
Instructional Lead-In	**NOTE: Briefly review the general safety requirements, risk assessments, and environmental considerations associated with this lesson.** Explain to the students: a. They will be divided into two groups. b. Each group will have two hours to perform each task. c. Each person in the group will be given an opportunity to perform each task. d. Stations will be done in round robin style. e. The instructor will conduct a ten minute review with the groups upon completion of the exercise.

f. At Station One, you will be required to properly single-flare and double-flare a piece of copper tubing.

g. At Station Two, you will be required to demonstrate proper use and state accurate measurements utilizing the micrometer and vernier caliper. The instructor will demonstrate the proper use of torque wrenches.

Resource Requirements

Instructor Materials:

29 CFR 1910.1200	Hazard Communication	01 Jul 2003
29 CFR 1910.132	Personnel Protective Equipment – General Requirements	01 Jul 2003
29 CFR 1910.133	Eye and Face Protection	01 Jul 2003
29 CFR 1910.136	Foot Protection	01 Jul 2003
29 CFR 1910.138	Hand Protection	01 Jul 2003
29 CFR 1910.95	Occupational Noise Exposure	01 Jul 2003

TM 9-243

Student Materials:

TM 9-243
Student Guides
Pens and Pencils
Eye Protection
Work Gloves

Special Instructions

a. Ensure each station has the applicable TMs and manufacturer's references as required.

b. Ensure all PPE is available at the appropriate station.

c. Ensure all required tools are at each station.

d. Ensure all stations have the appropriate copy of the Practical Exercise sheet.

NOTE: During this practical exercise, enforce the usage of safety procedures and proper wearing of required safety equipment. The class will be divided into two separate groups. Tubing and flaring and use of a micrometer classes will rotate at end of each practical exercise. All students will be proficient in measuring and flaring at the end of the practical exercise. Instructors will demonstrate to students the use of the tubing and flaring kit and the micrometer. After the demonstration, the class will be divided into a 1:8 ratio for measuring and tubing and flaring. Students must understand the importance as it relates to brakes measuring rotor thickness and lining wear.

Procedures

a. Demonstrate the proper procedures for using the tube cutter to cut a piece of copper tubing then using the flaring tool, make a single and double flare.

1) Use the TM.

2) Inspect the tools you will be using.

3) Select the proper size die block.

4) Use the tube cutter to properly cut a specified length of tubing.

5) Properly use the reamer to remove any burrs from cutting.

6) Properly position the tubing in the die block.

7) Perform a single flare IAW the TM.

8) Turn the piece of tubing over and complete a double flare IAW the TM.

9) Select the proper adapter and make a double flare to the tubing.

10) Inspect the flares for breakage or cracks.

11) Re-flare the tubing, if it is cracked or broken.

12) Clean and secure all tools when the exercise is complete.

b. Demonstrate the proper procedures for the use of measuring devices: micrometer and machinist ruler.

1) The caliper can be used to make 3 different measurements, inside, outside, and depth. The caliper breaks each inches down into 10 sections, each small number on the scale is equal to 1 tenth of an in. (.1). The larger numbers on the scale are inches. The dial on the caliper indicates thousands of an inch (.001). To get the final measurement of the object your measuring take your largest number (inches) add the smaller number (tenths), and add what's on the dial (thousandths) to get your final measurement.

2) The micrometer is a one inch micrometer broken into 40 measuring increments. One rotation of the barrel is .025 (25 thousandths) of an inch, two rotations .050 (50 thousandths) three rotations is .075 (75 thousandths) and the fourth rotation is one tenth of an inch (.1) forty rotations would be equal to one inch.

3) The machinist ruler is broken down into 4 precise measurements: 8ths 16ths 32^{nd} and 64^{th}.

c. Demonstrate the proper procedures for the use of the brake spring removal tool.

Feedback Requirements

SOLUTION FOR
PRACTICAL EXERCISE SHEET 91L10F01PE2

Each student will measure the thickness of a given brake pad utilizing a Machinist ruler and micrometer to show proficiency of accurate measurement with each device.

Each student will remove and install 2 brake return spring on a M105 axle.

PRACTICAL EXERCISE(S)/SOLUTION(S) FOR LESSON 2: 91L10F02 version 1

PRACTICAL EXERCISE SHEET 91L10F02PE1

Title	Correct Air Brake System Malfunctions(Simulator)
Lesson Number / Title	91L10F02 version 1 / Air Brake Systems
Introduction	Introduction of the instructor and the lesson topic.
Motivator	Inform students of the importance of understanding and being able to troubleshoot and repair an air actuated brake system.
Learning Step/Activity	**NOTE:** The instructor should inform the students of the following Learning Step/Activity requirements. (TLO Step 2) At the completion of this lesson, you [the student] will: **Action:** Correct Air Brake System Malfunctions. (Simulator)
Safety Requirements	There is no safety considerations associated with this practical exercise using computer based instruction. Safety alerts, warnings, and reinforcements will be inserted at appropriate teaching points in the lesson where safety issues arise.
Risk Assessment	Medium - Review the deliberate risk assessment, perform a daily risk assessment, and ensure it is recorded on appropriate forms, signed by authorized command authority, and posted at the training site(s).
Environmental Considerations	There are no environmental considerations associated with this practical exercise using computer based instruction.
Evaluation	Practical Exercise.
Instructional Lead-In	Allow one to two minutes for the lesson introduction. Introduce the students to the brake system simulations that will be used during the practical exercise.
Resource Requirements	**Instructor Materials:** Instructor's Simulation Handbook Lesson F02 **Student Materials:** Student Study Guide Pen or Pencil
Special Instructions	a. Have students log on to the computers using the student user name and password. b. Students must fill out the simulation chart found in the student guide at the end of the air brake chapter. c. Refer to the instructor's simulation handbook for explanation of each simulation. d. Ensure each station is functioning and the student is logged in properly or as required.

e. Ensure all additional materials are available.

f. Explain to the students:

1) They are responsible for their workstation and will be held accountable for any actions that may occur while logged into the workstations.

2) Each module will be accomplished in the sequence as dictated by the instructor and ample opportunity will be given to correct the malfunction.

Procedures

Module 1

Scenario:

You are stationed in Baghdad with the 20th Engineer Battalion and your supervisor, SFC Serrani, has given you a DA Form 5988-E with an unusual fault of poor brake action. He tells you that the operator says he only notices the fault when he has a full load in the dump truck, and that it now takes much longer to stop than it did when he had a full load before.

Maximum Wrenches Awarded: 4 Wrenches

Page 2

5988 shows fault: Poor Brake Action with Full Load

Page 3

Choose troubleshooting procedure:

Vehicle does not slow down quickly enough when brakes are applied.

Page 4

Q: Which one of the steps below do you want to start first?

A: A: CORRECT ANSWER – Lubricate the slack adjuster – a grease gun is shown lubricating the slack adjuster. GOTO page 4 (Answer A) below.

A: B: INCORRECT ANSWER – Check for heat damaged brake linings – allows the student to check each wheel's brake linings (The student will loss one wrench by choosing this answer). GOTO Page 4 (Answer B) Below.

Page 4 (Answer A)

Animation shows foundation brake system being lubricated.

Page 4 (Answer B)

Student must click on a wheel to inspect. Then remove the wheels and drum to inspect the brake linings.

Click once on the first lining on a wheel assembly to see the note: No heat damage.

The animations will not advance until both linings on each wheel have been clicked. As each wheel has been clicked, that wheel will be marked as viewed on the dump truck.

Page 5

Animation shows slack adjuster being adjusted.

Page 6

Animation shows inspection of slack adjuster adjustment. Distance shown is 1.25 inches.

Q: Do you need to readjust the brakes?

A: No.

Page 7

Q: You just adjusted the brakes on a front wheel, what should you do next?

A: D. Adjust the brakes on the other front wheel.

Page 8

Click on the tool box to continue.

Student must click on each set of tires. The distance of travel is shown.

Page 9

Student must click on the adjusting screw of the slack adjuster shown on the right.

Page 11

Q: You have finished fixing the problem, good for you. What will you do next?

A: A. Close out the worksheet.

Page 13

Click on the Rank to continue.

Module 2:

Scenario:

While stationed in Korea, a dump truck that has returned from Iraq pulls to the left every time the brakes are applied. The operator states that this has been going on for quite a while. SSG Nelo is shorthanded on wheel mechanics and has tasked you to begin inspecting the rear wheels.

Maximum Wrenches Awarded: **4 Wrenches**

Page 2

5988E shows fault: When Braking pulls left.

Page 3

Choose troubleshooting procedure.

Brakes are uneven, drag, or pull when applied.

Page 4

Student must click on the yellow parking brake button to release the brakes.

Page 5

Student places jack stands in proper location. Then choose a wheel to inspect the slack adjuster. Student should select one of the right wheels to inspect the brake adjustment.

If the student chooses the left wheels, a note appears explaining how this selection is incorrect. "This is not a good choice. The vehicle is pulling to the left which means that the brakes on the right side are malfunctioning. Therefore, there is a stronger braking action on the left side which causes the vehicle to pull to the left."

Page 6

Slack adjuster inspection shown. Total distance of travel shown is 2.50 inches. (Correct travel distance is .5 to 1.75 inches).

Q: Do you need to readjust the brakes?

A: Yes – (the travel distance is to great).

Student clicks on yes and the total distance of travel is still 2.50 inches. **The brakes will not adjust.**

Slack Adjuster Inspection.

Students must inspect the slack adjuster by rotating the wheel assembly to inspect. This simulates climbing under the vehicle to look at the slack adjuster.

Fault: The slack adjuster is broken where the brake chamber pushrod connects to the slack adjuster.

Click done when finished inspecting.

Page 7

Q: You just performed an inspection, what is your conclusion?

A: C. Found damage on the slack adjuster, replace it.

Page 8

Remove Slack Adjuster.

Student must remove the slack adjuster by removing parts in sequence. The wheel assembly does not have to be removed.

Page 9

Click on telephone to get instructions.

Page 10

Replace the Slack Adjuster.

Student must install the slack adjuster in the correct sequence using the manual.

Page 11

Q: You just replace the slack adjuster, what should you do next?

A: A. Adjust the slack adjuster.

Page 13

Q: You finished fixing the problem, good for you. What will you do next?

A: A. Close out the worksheet.

Page 15

Click on the Rank to continue.

Module 3

Scenario:

Your supervisor, SSG Goff, tells you that there is a M917 Dump Truck he wants you to fix. The truck was used to haul rocks for a road construction job in northern Afghanistan, and the operator said his brakes have become weaker and weaker with every load. He also said every time he gets to the road construction site the truck smells like something is burning, but it goes away by the time he dumps his rock.

Maximum Wrenches Awarded: **5 Wrenches**

Page 2

5988E shows fault: Breaks weak and burn smell.

Page 3

Choose troubleshooting symptom.

Vehicle does not slow down quickly enough when brakes are applied.

Page 4

Q: Which one of the following steps do you want to perform first?

A: B. Check for heat-damage in brake linings/brake drums (CORRECT ANSWER) GOTO Page 5.

A: A. Check for lubrication and brakes adjustment (INCORRECT ANSWER) Student will lose one wrench for this answer. Takes student to the animation of the foundation brakes being lubricated. GO TO Page 5.

Page 5

Inspect Brake Linings and Brake Drums.

Student must click on each wheel to inspect all six brake assemblies.

When the student clicks on a wheel, they will have to disassemble the wheel and hub assembly and look for damage (cracking on the brake linings and heat (bluing) on the drum). When the student completes the inspection and clicks Done the wheel on the other side of the axle appears (the animation **NOT** repeating itself).

Fault is the Rear-Left Brake Assembly. Brake linings are cracked and bluing (heat damage) can be seen in the drum.

Page 6

Q: What did you find?

A: B. Heat damage to the drum and brake shoes at the back axle.

Page 7

Q: There are plenty of parts on hand, how many brake drums and brake-shoes/linings do you need to complete this job?

A: A. 1 drum, 4 brake-shoes/linings.

Page 8

Student must remove the hub assembly in proper sequence by the TM. Caution: Tapered Washers are hard to see.

Screen Note: Good, you have removed the hub. Now read the TM, and then remove the brake-shoes/linings.

Student must remove brake shoes from the brake assembly in proper sequence by the TM. May have to explain that some of the steps can not be performed, such as, lifting up on the brake shoe to pull out the retaining clip.

Page 9

Student must install new brake shoes/linings in proper sequence using the TM.

Page 10

Student must install hub assembly and drum in proper sequence using the TM.

Page 11

Q: What should you do next?

A: D. Adjust the brakes.

Page 12

Q: You finished fixing the problem, good for you. What will you do next?

A: A. Close out the worksheet.

Page 15

Click on the Rank to continue.

Module 4

Scenario:

You are stationed at Camp Casey, Korea, with the 18th Engineers, and your supervisor, SSG Clark, has given you a DA Form 5988-E. He states that the operator said the brakes are sluggish, they don't respond well, and the air pressure drops very quickly each time the brakes are applied. He also states that the operator has to drain the air tanks six times a day to keep the brakes working properly.

Maximum Wrenches Awarded: **2 Wrenches**

Page 2

5988-E shows fault: 1. Sluggish Brakes, Air Pressure drop when braking. 2. Frequently drain air tanks.

Page 3

Student must click on all of the components of the air brake system to receive a status of the component being inspected.

1. Front Air Tanks.
2. Brake Chambers.
3. Air Dryer (This is the Faulty Component – "Air dryer vents have large amount of water").
4. Air Lines.
5. Air Compressor (Bottom Portion).
6. Air Compressor (Top Portion).

Page 4

Q: Inspection diagnosis – What did you find?

A: D. Air dryer filter is soaked (saturated).

NOTE: If the student selects the wrong answer they will not be able to continue until an instructor releases the program by pressing the CTRL button and clicking on the mechanic shown right (Do Not allow the student to see this action).

Page 5

Remove Air Dryer. Student must remove the air dryer filters by first double clicking on the link on the air dryer. The link takes the student to a larger image of the air dryer.

Student removes each filter.

Page 6

Student must install two new filters. When students are having difficulty getting the filters to lock in place explain that they must put the filters so the center is lined up with the top of the air dryer housing.

Page 7

Q: What is the biggest enemy of the air brake system?

A: A. Moisture.

Student must click on the toolbox to continue. Note tells the student to purge the air tank for 15 minutes.

Student must click on the wrench to show the animation of the air tanks being drained.

Page 8

Student must click on the wrench to test drive the vehicle.

Page 9

Q: You finished fixing the problem, good for you. What will you do next?

A: A. Close out the worksheet.

Page 11

Click on the Rank to continue.

Module 5

Scenario:

While in Fort Greely, Alaska, your supervisor, SSG Charles, has given you a DA form 5988-E that has an M917 dump truck deadlined for brake problems. The operator told your supervisor that the brakes seem to take a long time to activate after pressing the brake pedal, there seems to be an excessive amount of air leaking in the cab, and the brakes do not fully engage until the air leak stops.

Maximum Wrenches Awarded: **2 Wrenches**

Page 2

5988-E shows faults: 1. Braking action time lags. 2. Excessive air leak in cab. 3. Brake fully engages at end of air leak.

Page 3

Student must click on the starter button to start the engine and observe the air pressure building.

Student must click on the 3D button to inspect all major components for air leaks.

Student must click on each component without moving the mouse so the item tag will show. Each tag will show “No air leak noted”. There is no air leak to find.

What do you want to do?

Tell the NCO you cannot find an air leak.

Page 4

Student must click on the NCOs legs to here instructions. NCO will ask the student if they inspected the components while an assistant was pressing the pedal.

Page 5

Students have 5 seconds each time they press on the pedal to perform inspections of components. Student clicks on the pedal to start the time and while clicking on each component listens for a difference in sound. The louder sound indicates an air leak. The leaking component is the Brake Valve (Treadle Valve).

Page 6

Which component is bad? Student must click on the component they found to be bad.
(CORRECT ANSWER: Brake Valve (Treadle Valve)).

Page 7

Q: What must you do before replacing the treadle valve?

A: C. Shut down the engine and drain air from the system.

Student must click on the key to shut down the engine.

Page 8

Student must remove the treadle valve by first double-clicking on the treadle valve. This takes the student to a larger picture of the treadle valve.

Student must remove the treadle valve in the correct sequence using the TM.

Student must remove six lines first. Note: Students often miss one air line. After the two mounting screws have been removed and the valve is separated from the fire wall the student must click on the next button.

Page 9

Student must install the treadle valve in the correct sequence using the TM.

Page 10

Student must click on the wrench to check for air leaks.

Audio and animation describes how to check for air leaks using soapy water.

Page 11

Student clicks on the wrench to test drive the vehicle.

Page 12

Q: You finished fixing the problem, good for you. What will you do next?

A: A. Close out the worksheet.

Page 15

Click on the Rank to continue.

Feedback Requirements	

SOLUTION FOR
PRACTICAL EXERCISE SHEET 91L10F02PE1

Solutions for all simulated practical exercises are found within the simulation software program.

PRACTICAL EXERCISE SHEET 91L10F02PE2

Title	Correct Air Brake System Malfunctions.
Lesson Number / Title	91L10F02 version 1 / Air Brake Systems
Introduction	Introduction of the instructor and the lesson topic.
Motivator	Inform students of the importance of understanding and being able to troubleshoot and repair an air actuated brake system.
Learning Step/Activity	**NOTE:** The instructor should inform the students of the following Learning Step/Activity requirements. (TLO Step 3) At the completion of this lesson, you [the student] will: **Action:** Correct Air Brake System Malfunctions.
Safety Requirements	Risk of eye injury exists while working with air brakes. You will wear eye and foot protection when working with brake systems. Caution will be taken when lifting heavy objects. Use three points of contact when mounting or dismounting equipment. Remove all jewelry to include ID tags and wedding bands when working on equipment. The location and use of emergency eyewash stations will be identified and demonstrated to students. In case of eye contact with brake fluids, an eye wash will be used immediately. Use caution around moving parts. You will be provided and required to wear hearing protection while equipment is running. The use of Personal protective Equipment (PPE) by students and instructors is mandatory. Further guidance concerning PPE can be found in OSHA regulations 29 CFR 1910.132; 29 CFR 1910.133; 29 CFR 1910.136; 29 CFR 1900.138; and 29 CFR 1910.95.
Risk Assessment	Medium - Review the deliberate risk assessment, perform a daily risk assessment, and ensure it is recorded on appropriate forms, signed by authorized command authority, and posted at the training site(s).
Environmental Considerations	There is a possibility of environmental contamination by petroleum oil, lubricants, fuel, and cleaning solvents. You will be briefed on the proper disposal of POL products and how to properly clean up spills prior to each practical exercise. Ensure spill kits are available and there location identified. Instructors should complete a risk assessment before conducting training, operations, or logistical activities. Risk assessments assist instructors in identifying potential environmental hazards, develops controls, make risk decisions, implement controls, and insure proper supervision and evaluation.
Evaluation	Practical Exercise
Instructional Lead-In	Explain to the students: a. They will be divided into two groups. b. Each group will have three hours to correct two malfunctions. c. Each person in the group will be given an opportunity to correct the malfunction.

d. Stations will be done in round robin style.

e. The instructor will conduct a ten minute review with the groups upon completion of the exercise.

f. At Station One, you will be required to correct two air brake systems malfunctions.

g. At Station Two, you will be required to service an air dryer assembly and correct an air brake system malfunction.

Resource Requirements

Instructor Materials:
TM 5-3805-248-23-1
TM 5-3805-248-23-2
TM 9-2320-363-20-1
TM 9-2320-363-20-2
Lesson F02
Necessary Maintenance Forms

Student Materials:
TM 5-3805-248-23-1
TM 5-3805-248-23-2
TM 9-2320-363-20-1
TM 9-2320-363-20-2
Student Guides

Special Instructions

a. Ensure each station has the applicable TMs and manufacturer's references as required.

b. Ensure all PPE is available at the appropriate station.

c. Ensure all required tools are at each station.

d. Ensure each station has an adequate supply of necessary maintenance forms.

e. Ensure all stations have the appropriate copy of the Practical Exercise sheet.

Procedures

Station 1:

You are assigned to 94th Engineer Battalion as a Direct Support (Third Echelon) mechanic. You have been asked by your supervisor to service an air dryer. The air dryer has become over saturated and requires service.

a. Service Air Dryer.

NOTE: Inform students to separate all parts that will be reused and those that will be discarded before disassembly begins.

1) Students will disassemble air dryer IAW appropriate TM.

NOTE: Students will not remove check ball on cartridge (step 21) or check valve on air dryer tank (steps 22-27).

2) Students will empty desiccant from canister into bucket for later use.

NOTE: Students will not clean the disassembled parts with dry cleaning solvent or compressed air.

3) Once air dryer has been disassembled, students will separate all parts that will be discarded and those that will be reused.

NOTE: Instructor will give student appropriate kits before reassembly. Rebuild kits will be reused and replaced, when needed.

4) Reassemble air dryer IAW with appropriate TM.

b. Instructors will conduct a check on learning to insure students understand the importance of the air dryer and how to service it.

Station 2:

You are assigned to NATO forces in Kabul, Afghanistan, as an organizational mechanic. You have been assigned to work on a M915A2 Line Haul. The operator complains the brakes pull when applied. Students will troubleshoot utilizing appropriate TM to determine fault and repair or replace if applicable. Students will identify and annotate all deficiencies and work on a DA Form 5988E or a NAVMAC 10245.

a. Student will perform drum, hub and brake removal and inspection in accordance with TM 9-2320-363-20-2.

NOTE: Students will remove drum and hub together (skip step 1 and 2 on removal of rear hub and drum).

CAUTION: Inform students that the drum and hub assembly is heavy. Students will use proper lifting techniques. Two students will lift and set the assembly on floor with studs facing down.

NOTE: Students will not remove inner wheel bearing or oil seal (skip steps 9-14).

Inspect bearings, drum and seals for damage.

NOTE: Instructor will inform students the importance of cleaning and repacking bearings before reassembly. However, students will not perform these steps.

b. Rear brake shoe and lining removal.

1) Lift upper brake shoe and remove roller (ignore reference to clip).

2) Push down on lower brake shoe and remove roller (ignore reference to clip).

3) Lift lower brake shoe until spring has slack and remove center spring.

4) Rotate bottom brake shoe away from S-cam until the two side springs have slack.

5) Remove side springs and brake shoe.

NOTE: Students must inspect brake shoes in accordance with TM 9-2320-363-20-2, pg 4-414.

6) Brake lining thickness must be no less than ¼ inch.

7) There must be at least 1/32 in of clearance between rivet head and top of lining.

NOTE: Student will inform instructor that brake lining is sufficient and will move to next troubleshooting step, remove s-cam for inspection.

c. Remove S-cam IAW appropriate TM.

Inspect rollers and S-cam and replace if deemed necessary.

d. Install S-cam, slack adjuster, brake shoes, drum and hub IAW appropriated TM.

NOTE: Student will not utilize dial indicator for step 15 on replacement of S-cam.

e. Brake shoe adjustment.

1) Loosen and remove cage bolt.

2) While spinning hub, tighten slack adjuster until wheel stops.

3) Back slack adjuster ¼ turn, wheel should rotate.

4) Ensure adjustment is correct by placing screwdriver against and pulling away from brake chamber while measuring the total distance of travel.

5) Minimum travel of ½ inches and maximum travel of 1 ¾ inches. Students should comprehend that travel on the same axle should be approximately the same.

f. Practical exercise will only be complete when student has properly documented all work on appropriate form and inspected by the instructor.

Station 3:

You are assigned to 94th Engineer Battalion as an organizational mechanic. You have been assigned a M916A1 Tractor with air brake problems. The students will troubleshoot using the air brake boards to find faults induced by the instructor.

a. Students will be given a 5988 or NAVMC 10925 indicating the problem.

b. Students will use the appropriate TM to troubleshoot and identify faults.

c. Once a fault has been identified corrective actions will be taken.

d. Students will demonstrate proficiency in how the air brake system works.

Feedback Requirements

SOLUTION FOR
PRACTICAL EXERCISE SHEET 91L10F02PE2

Station 1:

Corrected brake malfunction IAW applicable TM.

NOTE: Air dryer service is performance step driven. Students must service the air dryer in proper sequence IAW the applicable technical manuals and identify all parts that require being replaced.

Station 2:

Troubleshot and corrected brake malfunctions IAW applicable TM.

NOTE: The problems will be induced by the instructor at random, and may consist of a fault the student cannot repair in the training scenario.

Station 3:

Correct brake malfunction IAW applicable TM.

NOTE: The problems will be induced by the instructor at random, and may consist of a fault the student cannot repair in the training scenario.

PRACTICAL EXERCISE SHEET 91L10F02PE3

Title	Correct Air Brake System Malfunctions (Simulator)
Lesson Number / Title	91L10F02 version 1 / Air Brake Systems
Introduction	Introduction of the instructor and the lesson topic.
Motivator	Inform students of the importance of understanding and being able to troubleshoot and repair an air actuated brake system.
Learning Step/Activity	**NOTE:** The instructor should inform the students of the following Learning Step/Activity requirements. (TLO Step 4) At the completion of this lesson, you [the student] will: **Action:** Correct Air Brake System Malfunctions. (Simulator)
Safety Requirements	There is no safety considerations associated with this practical exercise using computer based instruction. Safety alerts, warnings, and reinforcements will be inserted at appropriate teaching points in the lesson where safety issues arise.
Risk Assessment	Medium - Review the deliberate risk assessment, perform a daily risk assessment, and ensure it is recorded on appropriate forms, signed by authorized command authority, and posted at the training site(s).
Environmental Considerations	There are no environmental considerations associated with this practical exercise using computer based instruction.
Evaluation	Practical Exercise
Instructional Lead-In	Allow one to two minutes for the lesson introduction. Introduce the students to the brake system simulations that will be used during the practical exercise.
Resource Requirements	**Instructor Materials:** Instructor's Simulation Handbook Lesson F02 **Student Materials:** Student Study Guide Pen or Pencil
Special Instructions	a. Have students log on to the computers using the student user name and password. b. Students must fill out the simulation chart found in the student guide at the end of the air brake chapter. c. Refer to the instructor's simulation handbook for explanation of each simulation. d. Ensure each station is functioning and the student is logged in properly or as required. e. Ensure all additional materials are available.

f. Explain to the students:

1) They are responsible for their workstation and will be held accountable for any actions that may occur while logged into the workstations.

2) Each module will be accomplished in the sequence as dictated by the instructor and ample opportunity will be given to correct the malfunction.

Procedures

Module 1

Scenario:

You are stationed in Baghdad with the 20th Engineer Battalion and your supervisor, SFC Serrani, has given you a DA Form 5988-E with an unusual fault of poor brake action. He tells you that the operator says he only notices the fault when he has a full load in the dump truck, and that it now takes much longer to stop then it did when he had a full load before.

Maximum Wrenches Awarded: **4 Wrenches**

Page 2

5988 shows fault: Poor Brake Action with Full Load.

Page 3

Choose troubleshooting procedure:

Vehicle does not slow down quickly enough when brakes are applied.

Page 4

Q: Which one of the steps below do you want to start first?

A: A: CORRECT ANSWER – Lubricate the slack adjuster – a grease gun is shown lubricating the slack adjuster. GOTO page 4 (Answer A) below.

A: B: INCORRECT ANSWER – Check for heat damaged brake linings – allows the student to check each wheel's brake linings (The student will loss one wrench by choosing this answer). GOTO Page 4 (Answer B) Below.

Page 4 (Answer A)

Animation shows foundation brake system being lubricated.

Page 4 (Answer B)

Student must click on a wheel to inspect. Then remove the wheels and drum to inspect the brake linings.

Click once on the first lining on a wheel assembly to see the note: No heat damage.

The animations will not advance until both linings on each wheel have been clicked. As each wheel has been clicked that wheel will be marked as viewed on the dump truck.

Page 5

Animation shows slack adjuster being adjusted.

Page 6

Animation shows inspection of slack adjuster adjustment. Distance shown is 1.25 inches.

Q: Do you need to readjust the brakes?

A: No.

Page 7

Q: You just adjusted the brakes on a front wheel, what should you do next?

A: D. Adjust the brakes on the other front wheel.

Page 8

Click on the tool box to continue.

Student must click on each set of tires. The distance of travel is shown.

Page 9

Student must click on the adjusting screw of the slack adjuster shown on the right.

Page 11

Q: You have finished fixing the problem, good for you. What will you do next?

A: A. Close out the worksheet.

Page 13

Click on the Rank to continue.

Module 2:

Scenario:

While stationed in Korea, a dump truck that has returned from Iraq pulls to the left every time the brakes are applied. The operator states that this has been going on for quite a while. SSG Nelo is shorthanded on wheel mechanics and has tasked you to begin inspecting the rear wheels.

Maximum Wrenches Awarded: **4 Wrenches**

Page 2

5988E shows fault: When Braking pulls left

Page 3

Choose troubleshooting procedure

Brakes are uneven, drag, or pull when applied.

Page 4

Student must click on the yellow parking brake button to release the brakes.

Page 5

Student places jack stands in proper location. Then choose a wheel to inspect the slack adjuster. Student should select one of the right wheels to inspect the brake adjustment.

If the student chooses the left wheels, a note appears explaining how this selection is incorrect. "This is not a good choice. The vehicle is pulling to the left which means that the brakes on the right side are malfunctioning. Therefore there is a stronger braking action on the left side which causes the vehicle to pull to the left."

Page 6

Slack adjuster inspection shown. Total distance of travel shown is 2.50 inches. (Correct travel distance is .5 to 1.75 inches).

Q: Do you need to readjust the brakes?

A: Yes – (the travel distance is to great).

Student clicks on yes and the total distance of travel is still 2.50 inches. **The brakes will not adjust**.

Slack Adjuster Inspection.

Students must inspect the slack adjuster by rotating the wheel assembly to inspect. This simulates climbing under the vehicle to look at the slack adjuster.

Fault: The slack adjuster is broken where the brake chamber pushrod connects to the slack adjuster.

Click done when finished inspecting.

Page 7

Q: You just performed an inspection, what is your conclusion?

A: C. Found damage on the slack adjuster, replace it.

Page 8

Remove Slack Adjuster.

Student must remove the slack adjuster by removing parts in sequence. The wheel assembly does not have to be removed.

Page 9

Click on telephone to get instructions.

Page 10

Replace the Slack Adjuster.

Student must install the slack adjuster in the correct sequence using the manual.

Page 11

Q: You just replace the slack adjuster, what should you do next?

A: A. Adjust the slack adjuster.

Page 13

Q: You finished fixing the problem, good for you. What will you do next?

A: A. Close out the worksheet.

Page 15

Click on the Rank to continue.

Module 3

Scenario:

Your supervisor, SSG Goff, tells you that there is a M917 Dump Truck he wants you to fix. The truck was used to haul rocks for a road construction job in northern Afghanistan, and the operator said his brakes have become weaker and weaker with every load. He also said every time he gets to the road construction site the truck smells like something is burning, but it goes away by the time he dumps his rock.

Maximum Wrenches Awarded: **5 Wrenches**

Page 2

5988E shows fault: Breaks weak and burn smell.

Page 3

Choose troubleshooting symptom.

Vehicle does not slow down quickly enough when brakes are applied.

Page 4

Q: Which one of the following steps do you want to perform first?

A: B. Check for heat-damage in brake linings/brake drums (CORRECT ANSWER) GOTO Page 5.

A: A. Check for lubrication and brakes adjustment (INCORRECT ANSWER) Student will lose one wrench for this answer. Takes student to the animation of the foundation brakes being lubricated. GO TO Page 5.

Page 5

Inspect Brake Linings and Brake Drums

Student must click on each wheel to inspect all six brake assemblies.

When the student clicks on a wheel, they will have to disassemble the wheel and hub assembly and look for damage (cracking on the brake linings and heat (bluing) on the drum). When the student completes the inspection and clicks Done the wheel on the other side of the axle appears (the animation **NOT** repeating itself).

Fault is the Rear-Left Brake Assembly. Brake linings are cracked and bluing (heat damage) can be seen in the drum.

Page 6

Q: What did you find?

A: B. Heat damage to the drum and brake shoes at the back axle.

Page 7

Q: There are plenty of parts on hand, how many brake drums and brake-shoes/linings do you need to complete this job?

A: A. 1 drum, 4 brake-shoes/linings.

Page 8

Student must remove the hub assembly in proper sequence by the TM. Caution: Tapered Washers are hard to see.

Screen Note: Good, you have removed the hub. Now read the TM, and then remove the brake-shoes/linings.

Student must remove brake shoes from the brake assembly in proper sequence by the TM. May have to explain that some of the steps can not be performed, such as, lifting up on the brake shoe to pull out the retaining clip.

Page 9

Student must install new brake shoes/linings in proper sequence using the TM.

Page 10

Student must install hub assembly and drum in proper sequence using the TM.

Page 11

Q: What should you do next?

A**:** D. Adjust the brakes.

Page 12

Q: You finished fixing the problem, good for you. What will you do next?

A: A. Close out the worksheet.

Page 15

Click on the Rank to continue.

Module 4

Scenario:

You are stationed at Camp Casey, Korea, with the 18th Engineers, and your supervisor, SSG Clark, has given you a DA Form 5988-E. He states that the operator said the brakes are sluggish, they don't respond well, and the air pressure drops very quickly each time the brakes are applied. He also states that the operator has to drain the air tanks six times a day to keep the brakes working properly.

Maximum Wrenches Awarded: **2 Wrenches**

Page 2

5988-E shows fault: 1. Sluggish Brakes, Air Pressure drop when braking. 2. Frequently drain air tanks.

Page 3

Student must click on all of the components of the air brake system to receive a status of the component being inspected.

1. Front Air Tanks.
2. Brake Chambers.
3. Air Dryer (This is the faulty component – "Air dryer vents have large amount of water").
4. Air Lines.
5. Air Compressor (Bottom Portion).
6. Air Compressor (Top Portion).

Page 4

Q: Inspection diagnosis – What did you find?

A: D. Air dryer filter is soaked (saturated).

NOTE: If the student selects the wrong answer, they will not be able to continue until an instructor releases the program by pressing the CTRL button and clicking on the mechanic shown right (Do Not allow the student to see this action).

Page 5

Remove Air Dryer. Student must remove the air dryer filters by first double clicking on the link on the air dryer. The link takes the student to a larger image of the air dryer.

Student removes each filter

Page 6

Student must install two new filters. When students are having difficulty getting the filters to lock in place explain that they must put the filters so the center is lined up with the top of the air dryer housing.

Page 7

Q: What is the biggest enemy of the air brake system?

A: A. Moisture.

Student must click on the toolbox to continue. Note tells the student to purge the air tank for 15 minutes.

Student must click on the wrench to show the animation of the air tanks being drained.

Page 8

Student must click on the wrench to test drive the vehicle

Page 9

Q: You finished fixing the problem, good for you. What will you do next?

A: A. Close out the worksheet.

Page 11

Click on the Rank to continue.

Module 5

Scenario:

While in Fort Greely, Alaska, your supervisor, SSG Charles, has given you a DA form 5988-E that has an M917 dump truck deadlined for brake problems. The operator told your supervisor that the brakes seem to take a long time to activate after pressing the brake pedal, there seems to be an excessive amount of air leaking in the cab, and the brakes do not fully engage until the air leak stops.

Maximum Wrenches Awarded: **2 Wrenches**

Page 2

5988-E shows faults: 1. Braking action time lags. 2. Excessive air leak in cab. 3. Brake fully engages at end of air leak.

Page 3

Student must click on the starter button to start the engine and observe the air pressure building.

Student must click on the 3D button to inspect all major components for air leaks.

Student must click on each component without moving the mouse so the item tag will show. Each tag will show “No air leak noted”. There is no air leak to find.

What do you want to do?

Tell the NCO you cannot find an air leak

Page 4

Student must click on the NCOs legs to here instructions. NCO will ask the student if they inspected the components while an assistant was pressing the pedal.

Page 5

Students have 5 seconds each time they press on the pedal to perform inspections of components. Student clicks on the pedal to start the time and while clicking on each component listens for a difference in sound. The louder sound indicates an air leak. The leaking component is the Brake Valve (Treadle Valve).

Page 6

Which component is bad? Student must click on the component they found to be bad.
(CORRECT ANSWER: Brake Valve (Treadle Valve)).

Page 7

Q: What must you do before replacing the treadle valve?

A: C. Shut down the engine and drain air from the system.

Student must click on the key to shut down the engine.

Page 8

Student must remove the treadle valve by first double-clicking on the treadle valve. This takes the student to a larger picture of the treadle valve.

Student must remove the treadle valve in the correct sequence using the TM.

Student must remove six lines first. Note: Students often miss one air line. After the two mounting screws have been removed and the valve is separated from the fire wall the student must click on the next button.

Page 9

Student must install the treadle valve in the correct sequence using the TM.

Page 10

Student must click on the wrench to check for air leaks.

Audio and animation describes how to check for air leaks using soapy water.

Page 11

Student clicks on the wrench to test drive the vehicle.

Page 12

Q: You finished fixing the problem, good for you. What will you do next?

A: A. Close out the worksheet.

Page 15

Click on the Rank to continue.

Feedback Requirements

SOLUTION FOR
PRACTICAL EXERCISE SHEET 91L10F02PE3

Solutions for all simulated practical exercises are found within the simulation software program.

PRACTICAL EXERCISE(S)/SOLUTION(S) FOR LESSON 3: 91L10F03 version 1

PRACTICAL EXERCISE SHEET 91L10F03PE1

Title	Correct Assisted Brake System Malfunctions (Simulator)
Lesson Number / Title	91L10F03 version 1 / Assisted Brake Systems
Introduction	Introduction of the instructor and the lesson topic.
Motivator	Explain the importance of being able to identify assisted brake systems components and functions and the importance of being able to troubleshoot and repair the system.
Learning Step/Activity	**NOTE:** The instructor should inform the students of the following Learning Step/Activity requirements. (TLO Step 2) At the completion of this lesson, you [the student] will: **Action:** Correct Assisted Brake System Malfunctions. (Simulator)
Safety Requirements	There is no safety considerations associated with this practical exercise using computer based instruction. Safety alerts, warnings, and reinforcements will be inserted at appropriate teaching points in the lesson where safety issues arise.
Risk Assessment	Medium - Review the deliberate risk assessment, perform a daily risk assessment, and ensure it is recorded on appropriate forms, signed by authorized command authority, and posted at the training site(s).
Environmental Considerations	There are no environmental considerations associated with this practical exercise using computer based instruction.
Evaluation	
Instructional Lead-In	**Allow one to two minutes for the lesson introduction.**
Resource Requirements	**Instructor Materials:** TM 5-3805-262-20 TM 5-3805-262-34 TM 9-2320-280-20-1 TM 9-2320-280-20-2 TM 9-2320-363-20-1 TM 9-2320-363-20-2 Lesson F03 Instructor's Simulation Handbook **Student Materials:** TM 5-3805-262-20 TM 5-3805-262-34 TM 9-2320-280-20-1 TM 9-2320-280-20-2 TM 9-2320-363-20-1 TM 9-2320-363-20-2 Student Guide

Pens and Pencils

Special Instructions

a. Have students log on to the computers using the Student User name and password.

b. Explain to the students they will be performing Modules 1 to 5 of Assisted Brake Systems on the brake simulator.

c. Students must fill out the Simulation Chart found in the student guide at the end of the Assisted Brake Chapter.

d. Refer to the Instructor's Simulation Handbook for explanation of each simulation.

e. Explain to the students:

1) They are responsible for their workstation and will be held accountable for any actions that may occur while logged into the workstations.

2) Each module will be accomplished in the sequence as dictated by the instructor and ample opportunity will be given to correct the malfunction.

f. Ensure each station is functioning and the student is logged in properly or as required.

g. Ensure all additional materials are available.

Procedures

Module 1:

Scenario:

You are stationed at Camp Humphreys, South Korea, as an organizational mechanic. Your supervisor, SSG Santiago, has given you a DA Form 5988-E. SSG Santiago further states that the operator thinks he damaged something when he hit a huge pot hole. He tried to stop at an intersection and had to pump the brakes several times to get any braking action. The operator further states that he looked under the vehicle, but did not see any leaks or anything wrong.

Maximum Wrenches Awarded: **4 Wrenches**

Page 2

5988E shows fault: Pump brake several times to stop.

Page 3

Student must inspect the vehicle for leaks.

NOTE: No leaks will be found.

Student must click on the DONE link when inspection is completed.

Page 4

Q: You found no leaks, what should you do next?

A: A. Check the brake fluid level.

Page 5

Q: What should you do next?

A: C. Manually bleed the brakes.

NOTE: If the student selects B, check brake pedal linkage, an animation will show the brake pedal travel being inspected. It will return to the original question.

Student must click on the toolbox to continue.

Page 6

Student must test drive the vehicle. Student must click on the ignition switch and then on the brake pedal to stop the vehicle. The student will have to depress the brake pedal several times to stop the vehicle (pumping the brakes).

Page 7

Q: You have checked most major components of the brake system except for the master cylinder and the hydro booster (power booster). Which of these two components do you suspect is the cause of the problem?

A: A. Master Cylinder.

Page 8

Student must place the drip pan under the vehicle.

Student must remove the master cylinder by first double-clicking on the master cylinder. This will take the student to a larger image of the master cylinder.

Student must remove the master cylinder in the correct sequence using the TM.

Page 9

Q: SSG Santiago has handed you a new master cylinder, and has told you to install it. Is there something you must do before installing the master cylinder?

A: A. Yes (The master cylinder must be bleed before installing it).

Page 10

Student must install the master cylinder in the correct sequence using the TM.

Page 11

Q: How long did you let the master cylinder sit before installing?

A: C. 30 Minutes.

Page 12

Q: What should you do next?

A: C. Fill the reservoir.

Page 13

Student must click on the toolbox to continue.

Page 14

Student must click on the wrench to test drive the vehicle.

Page 15

Q: You finished fixing the problem, good for you. What will you do next?

A: A. Close out the worksheet.

Page 17

Click on the rank to continue.

Module 2:

Scenario:

While stationed at Fort Drum, New York, with the 710th Brigade Support Battalion and preparing to deploy to Camp Fallujah, Iraq, the operator of a HMMWV noticed she was having lots of problems with the brakes. She said that the brakes still work, but they are very difficult to depress. It takes much more leg pressure to get the same amount of braking action than it used to.

Maximum Wrenches Awarded: **3 Wrenches**

Page 2

Student must click on four different items on the graphic to perform inspections.

a. Brake System.

b. Caliper.

c. Fluids.

d. Brake Linkage.

Brake System – Student clicks on a hydraulic line. The image changes and then the student must double click on the different hydraulic lines to look for leaks. Student must click DONE when finished.

Caliper – Student clicks on a caliper. The image changes and then the student must double clicks on each caliper to inspect them. No fault will be noted. Student must click DONE when finished.

Fluids – Student clicks on the reservoirs. The image changes and then the student must click on the master cylinder and the power steering pump to check fluid levels. NOTE: The student must click on both. Student must click DONE when finished.

Brake Linkage – Student must click on the wrench to continue. An animation of the brake pedal moving appears so the student can inspect the pedal travel. Student must click DONE when finished.

NOTE: Sometimes the student misses a step. Usually click on the DONE link or the two reservoirs. This makes all four systems to be checked on the clip board, but does not allow the student to go to the next page. Have the student go through again and ensure the student clicks on all proper links.

Page 4

Q: What might be the possible cause of the problem based on the symptoms and the inspection you have already conducted?

A: B. Power Booster (hydro booster) failed.

Page 5

Q: The hydro booster is bad and you will need to replace it. What item must be removed in order for you to get to the hydro booster?

A: A. Master Cylinder.

Page 6

Student must move the drain pan under the vehicle

Student must remove the master cylinder in proper sequence using the TM.

Page 7

Student must remove the hydro booster in proper sequence using the TM.

Page 8

Student must install the hydro booster in proper sequence using the TM.

Page 9

Student must click on the wrench to bleed the power steering system.

Page 10

Q: What should you do next?

A: C. Manually bleed the brakes.

Student must click on the toolbox to continue.

Page 11

Student must click on the wrench to continue.

Page 12

Q: You finished fixing the problem, good for you. What will you do next?

A: A. Close out the worksheet.

Page 14

Click on the rank to continue.

Module 3:

Scenario:

Your supervisor, SSG Cooley, received a DA Form 5988-E from the operator of a MW24C Bucket Loader. The 5988-E states the vehicle groans and squeaks excessively when the vehicle is stopping. He further states that the vehicle has missed two services and has logged many hours since it has been in Baghdad. SSG Cooley wants you to troubleshoot and repair the problem so they can complete the bridge reconstruction over the Tigris River.

The operator states that the groaning increases in intensity when he carries more weight in the bucket.

Maximum Wrenches Awarded: **2 Wrenches**

Page 2

5988-E shows fault: Brakes squeak/groan at stop.

Page 3

Choose the troubleshooting step.

Service brakes squeak or groan at end of stop.

Student must click on the wrench to install the service transport link.

Page 4

Student must choose which axle to start inspecting by clicking on the front or rear wheel.

Front Axle Inspection – Student must place the jack-stands in the proper location.

Student must choose which wheel to inspect.

Student must remove the wheel and double-click on the caliper to inspect the caliper.

Student must click on each brake shoe to measure the lining by moving the ruler.

a. Left front lining is BAD.

NOTE: Students often get confused with this. They want to measure the shoe as if it was the lining. Explain to the student the difference between the two when that occurs.

b. Right front lining is GOOD.

Student then goes to Page 5

Rear Axle Inspection – Student must place the jack-stands in the proper location.

Student must choose which wheel to inspect.

Student must remove the wheel and double-click on the caliper to inspect the caliper.

Student must click on each brake shoe to measure the lining by moving the ruler.

a. Left rear lining is GOOD.

b. Right rear lining is GOOD.

Student then must inspect the front axle

Page 5

Student must click on the wrench to continue. This page shows the inspection of the rotor.

Page 6

Brake pads replacement, student must remove the brake shoes in proper sequence using the TM.

Page 7

The student must click on the wrench to continue. The student will hear instructions on how to compress the pistons to make room for the new brake shoes. Student must click on the green button to continue.

The student must click on the green button to pry the pistons back. The student is shown the pistons being pried back. The student must click on the green button to continue.

The student must click on the tool box to continue.

Page 8

The student must replace the brake shoes in proper sequence using the TM.

Page 9

The student must click on the appropriate graphic to bleed the reservoir. CORRECT: Front Reservoir.

The student must click on the play button to see the front reservoir being bled.

Page 10

Student must click on the wrench to continue. Student must replace the tire in the proper sequence using the TM.

Page 11

Student must click on the wrench to test drive the vehicle.

Page 12

Q: You finished fixing the problem, good for you. What will you do next?

A: A. Close out the worksheet.

Page 14

Click on the rank to continue.

Module 4:

Scenario:

You are assigned to 94th EN BN in Fallujah, and your maintenance chief, SSG Smith has given you a DA form 5988-E. The operator was building a defensive position around the ammunition supply point when he noticed that the loader's brakes were very weak. He also said that he noticed fluid on the inside of the left front tire while doing his after operations PMCS.

Maximum Wrenches Awarded: **4 Wrenches**

Page 2

5988-E shows the faults: 1. Brakes are weak. 2. Fluid front left tire.

Page 3

Choose the troubleshooting step.

Poor Brake Action.

Page 4

Student must click on the toolbox to continue. Student must click on the wrench to check the air pressure.

Page 5

Student must remove the left side engine access panels.

NOTE: The TM states to open the front access panel, but it does not open. Sometimes the computer does not recognize the panels being removed and the page must be reloaded.

Page 6

Student must click on the toolbox to continue.

Student must double-click on each of the brake reservoirs (colored in Yellow) to check the fluid levels. Front Reservoir is low.

Page 7

Student must read each TM. Student must choose which procedure to do next.

Inspect for leaks – CORRECT answer. Takes the student to Page 9.

Bleed air from brakes – takes the student to page 8.

Page 8

Student is shown how to bleed the brake system.

Page 9

Student must click on the wrench to continue. Student is shown the service transport link being installed.

Page 10

Student must select which axle to inspect.

Front Axle – Student must place the jack stands in the proper location. Student must click on the wheel to inspect.

Student must remove the wheel and double-click on the caliper to view the brake assembly for inspection.

a. Left Brakes – Caliper is leaking. Student is taken to Page 11.

b. Right Brakes – No Leak. Student is taken to the Left Wheel.

Rear Axle – Student must place the jack stands in the proper location. Student must click on the wheel to inspect.

Student must remove the wheel and double-click on the caliper to view the brake assembly for inspection.

a. Left Brakes – No Leak. Student is taken to the Right Wheel.

b. Right Brakes – No Leak. Student is taken to the Left Wheel.

Student must inspect the front axles.

Page 11

Student must replace the caliper in the proper sequence using the TM.

Page 12

Student must click on the telephone to talk to the supervisor and receive instructions to rebuild the caliper.

Page 13

Q: Which manual will you use to rebuild the caliper?

A: D. TM 5-3805-262-34.

Page 14

Student must disassemble the caliper in the proper sequence using the TM.

Page 15

Student must reassemble the caliper in the proper sequence using the TM.

Page 16

Q: Which TM will you use to install the caliper?

A: B. TM 5-3805-262-20.

Page 17

Student must install the caliper in the proper sequence using the TM.

Student must install the wheel in the proper sequence using the TM.

Page 18

Q: After installing the caliper you must tighten the capscrews. What is the torque specification?

A: C. 340-420 lb-ft.

Page 19

Q: You just installed the caliper. What should you do next?

A: A. Bleed air from brakes.

Student must click on the link "Click here to watch the video" to continue.

P**age 20**

Q: What will you do next?

A: A. Ensure the reservoirs are full.

Student must click on the wrench to test drive the vehicle.

Page 22

Q: You finished fixing the problem, good for you. What will you do next?

A: A. Close out the worksheet.

Page 24

Click on the rank to continue.

Module 5:

Scenario:

You are stationed at Camp Humphreys, South Korea, as an organizational mechanic. Your supervisor, SSG Ainsworth, has given you a DA Form 5988-E. SSG Ainsworth further states that the operator was working at an excavations site when his low air pressure buzzer sounded and his air pressure gauge dropped into the red. You have been dispatched in a contact truck to the vehicle's location to attempt repairs.

Maximum Wrenches Awarded: 3 Wrenches

Page 2

5988-E shows the faults: 1. Low air pressure warning sounds. 2. Low air pressure gauge needle drops.

Page 3

Choose the troubleshooting step.

Low air pressure (air pressure gage indicates in red zone and low air pressure buzzer sounds).

Page 4

Student must check that drain valve is fully closed by clicking on each link in sequence.

a. Start Engine – student must click on the key to start the engine.

b. Exit Cab.

c. Check Drain Valve – student must click on the loader to view the drain valve.

Page 5

Student must check the air compressor by clicking on the key and then remove the right engine access panels.

Student must inspect the tension on the air compressor drive belts by double-clicking on the air compressor.

Student clicks on the belt – the belt is tight and there is a hissing sound in the background. What do you want to do?

Investigate the source of the sound – CORRECT Answer: Takes student to page 6.

Check adjustment of air compressor governor – student must click on the wrench to continue.

Student is shown that the governor will not shut off the compressor because there is not enough air in the system. Student must fix all air leaks first.

Page 6

Student must find the source of the air leak on the air reservoir. The student must double-click on the Safety Valve, which is faulty.

Page 7

Student must click on the wrench to test the safety valve. Student must click on the safety valve to replace it.

Student must install the safety valve by dragging it to the proper location (On top of the air reservoir – if the student is having difficulty installing the part, have the student place the middle of the safety valve in line with mating surface).

Page 8

Q: You approached the operator to tell him that it's fixed, when the operator stated "What took you so long? All the other mechanics adjusted the governor and that was it. I was back to work in 5 minutes!" What should you do next?

A: C. Check the air governor to ensure that it's adjusted within specifications.

Page 9

Student must click on the wrench to see how the governor is tested and adjusted.

Page 10

Student must click on the wrench to road test the vehicle.

Page 11

Q: You finished fixing the problem, good for you. What will you do next?

A: A. Close out the worksheet.

Page 13

Click on the Rank to continue.

Feedback Requirements

SOLUTION FOR
PRACTICAL EXERCISE SHEET 91L10F03PE1

Solutions for all simulated practical exercises are found within the simulation software program.

PRACTICAL EXERCISE SHEET 91L10F03PE2

Title	Correct Assisted Brake System Malfunctions
Lesson Number / Title	91L10F03 version 1 / Assisted Brake Systems
Introduction	Introduction of the instructor and the lesson topic.
Motivator	Explain the importance of being able to identify assisted brake systems components and functions and the importance of being able to troubleshoot and repair the system.
Learning Step/Activity	**NOTE:** The instructor should inform the students of the following Learning Step/Activity requirements. (TLO Step 3) At the completion of this lesson, you [the student] will: **Action:** Correct Assisted Brake System Malfunctions.
Safety Requirements	Risk of skin and eye injury exists while working with pressurized fluids You will wear eye and foot protection when working with brake systems. Use three points of contact when mounting or dismounting equipment. Remove all jewelry to include ID tags and wedding bands when working on equipment. The location and use of emergency eyewash stations will be identified and demonstrated to students. In case of eye contact with brake fluids, an eye wash will be used immediately. Use caution around moving parts. You will be provided and required to wear hearing protection while equipment is running. The use of Personal protective Equipment (PPE) by students and instructors is mandatory. Further guidance concerning PPE can be found in OSHA regulations 29 CFR 1910.132; 29 CFR 1910.133; 29 CFR 1910.136; 29 CFR 1910.138; and 29 CFR 1910.95.
Risk Assessment	Medium - Review the deliberate risk assessment, perform a daily risk assessment, and ensure it is recorded on appropriate forms, signed by authorized command authority, and posted at the training site(s).
Environmental Considerations	There is a possibility of environmental contamination by petroleum oil, lubricants, fuel, and cleaning solvents. You will be briefed on the proper disposal of POL products and how to properly clean up spills prior to each practical exercise. Ensure spill kits are available and there location identified. Instructors should complete a risk assessment before conducting training, operations, or logistical activities. Risk assessments assist instructors in identifying potential environmental hazards, develops controls, make risk decisions, implement controls, and insure proper supervision and evaluation.
Evaluation	Practical Exercise
Instructional Lead-In	Explain to the students: a. They will be divided into two groups. b. Each group will have one hour to correct the malfunction. c. Each person in the group will be given an opportunity to correct the malfunction.

d. Stations will be done in round robin style.

e. The instructor will conduct a ten minute review with the groups upon completion of the exercise.

f. At Station One, the student will be required to correct a full disk brake system malfunction.

g. At Station Two, the student will be required to repair an air/hydraulic brake system malfunction.

Resource Requirements

Instructor Materials:
TM 09135B-24P-3, TEREX F/L
TM 5-3805-262-20
TM 5-3805-262-34
TM 9-2330-213-14&P
Lesson F03
PPE

Student Materials:
TM 09135B-24P-3, TEREX F/L
TM 5-3805-262-20
TM 5-3805-262-34
TM 9-2330-213-14&P
Student Guide
Maintenance Forms
PPE
Pens and Pencils

Special Instructions

a. Ensure each station has the applicable TMs and manufacturer's references as required.

b. Ensure all PPE is available at the appropriate station.

c. Ensure all required tools are at each station.

d. Ensure each station has an adequate supply of necessary maintenance forms.

e. Ensure all stations have the appropriate copy of the Practical Exercise sheet.

Procedures

Station #1:

At this station, you are in an field maintenance environment. You have an item of construction equipment with a full disk brake system with brakes that do not engage, special tools, all applicable TMs, and necessary maintenance forms. Using the applicable TMs, you will disassemble and inspect the full disk brake system. When the component causing the malfunction has been identified, you will reassemble the full disk brake assembly.

Station #2:

At this station, you are in a field maintenance environment. You have a MW24C Bucket Loader with erratic braking, special tools, all applicable TMs, and necessary maintenance forms. Using the applicable TMs, inspect the brake system of the vehicle to determine the cause of the malfunction using recommended inspection procedures. Malfunctions of major components will be correctly annotated on the necessary maintenance forms.

CAUTION: Inform students that the caliper is heavy and they will use two students to remove it. Also, remind them to pay attention to preliminary procedures that must be preformed before caliper removal.

a. Using appropriate TM look up troubleshooting for erratic braking.

b. Perform preliminary procedure for caliper removal; remove brake shoes and linings, and tubing. disconnected from brake caliper.

NOTE: Student will not remove tubing from frame; only remove brake line from caliper. Inform student to use a wrench to hold the banjo bolt while loosening brake line to prevent line from breaking.

c. Remove brake shoes and linings IAW appropriate TM.

d. Remove caliper IAW appropriate TM.

CAUTION: Skip step 1 of caliper removal. Ensure there are two students present, one to hold the caliper and the other to loosen bolts.

e. Inspect brake caliper, shoes and linings, and rotor. Measure rotor and brake linings.

f. Disassemble caliper IAW appropriate TM, replace all seals, and inspect components.

NOTE: If compressed air is not available, only the top two pistons will be removed by tapping with handle of dead blow hammer.

NOTE: Instructor will give student rebuild kit for caliper. All seals that were removed will go in rebuild kit box to be reused. Students will not clean parts with cleaning solvent, but ensure they know the importance of inspecting all components.

g. Reassemble brake caliper IAW appropriate TM.

h. Replace caliper on equipment IAW appropriate TM.

Station #3:

At this station, you are in a field maintenance environment. You have a M105 trailer with brakes that are not applying according to the operator, and brake fluid is present at the backing plate. You will use the appropriate TM to troubleshoot the deficiency and perform corrective action, if necessary.

a. Remove brake drum IAW appropriate TM.

b. Remove brake shoes and linings IAQ appropriate TM.

c. Inspect and measure brake shoe linings and drum.

d. Remove and replace wheel cylinder IAW appropriate TM.

e. Replace brake shoes and drum IAW appropriate TM.

Feedback Requirements

SOLUTION FOR
PRACTICAL EXERCISE SHEET 91L10F03PE2

Station #1:

Troubleshoot and correct full disk brake malfunction IAW applicable references.

NOTE: Brakes not engaging is indicative of several possible problems or faulty components. The problems will be induced by the instructor at random and may consist of a fault the student cannot repair in the training scenario.

Station #2:

Troubleshoot and correct hydraulic brake malfunction IAW applicable TM.

NOTE: Erratic braking is indicative of several possible problems or faulty components. The problems will be induced by the instructor at random, and may consist of a fault the student cannot repair in the training scenario.

Station #3:

Troubleshoot and correct hydraulic brake malfunction IAW applicable TM.

NOTE: Brakes not engaging is indicative of several possible problems or faulty components, and brake fluid on backing plate is indicative of a leaking wheel cylinder. The problems will be induced by the instructor at random and may consist of a fault the student cannot repair in the training scenario.

PRACTICAL EXERCISE SHEET 91L10F03PE3

Title	Correct Assisted Brake System Malfunctions (Simulator)
Lesson Number / Title	91L10F03 version 1 / Assisted Brake Systems
Introduction	Introduction of the instructor and the lesson topic.
Motivator	Explain the importance of being able to identify assisted brake systems components and functions and the importance of being able to troubleshoot and repair the system.
Learning Step/Activity	**NOTE:** The instructor should inform the students of the following Learning Step/Activity requirements. (TLO Step 4) At the completion of this lesson, you [the student] will: **Action:** Correct Assisted Brake System Malfunctions. (Simulator)
Safety Requirements	There is no safety considerations associated with this practical exercise using computer based instruction. Safety alerts, warnings, and reinforcements will be inserted at appropriate teaching points in the lesson where safety issues arise.
Risk Assessment	Medium - Review the deliberate risk assessment, perform a daily risk assessment, and ensure it is recorded on appropriate forms, signed by authorized command authority, and posted at the training site(s).
Environmental Considerations	There are no environmental considerations associated with this practical exercise using computer based instruction.
Evaluation	
Instructional Lead-In	**Allow one to two minutes for the lesson introduction.**
Resource Requirements	**Instructor Materials:** TM 5-3805-262-20 TM 5-3805-262-34 TM 9-2320-280-20-1 TM 9-2320-280-20-2 TM 9-2320-363-20-1 TM 9-2320-363-20-2 Lesson F03 Instructor's Simulation Handbook **Student Materials:** TM 5-3805-262-20 TM 5-3805-262-34 TM 9-2320-280-20-1 TM 9-2320-280-20-2 TM 9-2320-363-20-1 TM 9-2320-363-20-2 Student Guide Pens and Pencils

Special Instructions

a. Have students log on to the computers using the Student User name and password.

b. Explain to the students they will be performing Modules 1 to 5 of Assisted Brake Systems on the brake simulator.

c. Students must fill out the Simulation Chart found in the student guide at the end of the Assisted Brake Chapter.

d. Refer to the Instructor's Simulation Handbook for explanation of each simulation.

e. Explain to the students:

   1) They are responsible for their workstation and will be held accountable for any actions that may occur while logged into the workstations.

   2) Each module will be accomplished in the sequence as dictated by the instructor and ample opportunity will be given to correct the malfunction.

f. Ensure each station is functioning and the student is logged in properly or as required.

g. Ensure all additional materials are available.

Procedures

Module 1:

Scenario:

You are stationed at Camp Humphreys, South Korea, as an organizational mechanic. Your supervisor, SSG Santiago, has given you a DA Form 5988-E. SSG Santiago further states that the operator thinks he damaged something when he hit a huge pot hole. He tried to stop at an intersection and had to pump the brakes several times to get any braking action. The operator further states that he looked under the vehicle, but did not see any leaks or anything wrong.

Maximum Wrenches Awarded: **4 Wrenches**

Page 2

5988E shows fault: Pump brake several times to stop.

Page 3

Student must inspect the vehicle for leaks.

NOTE: No leaks will be found.

Student must click on the DONE link when inspection is completed.

Page 4

Q: You found no leaks, what should you do next?

A: A. Check the brake fluid level.

Page 5

Q: What should you do next?

A: C. Manually bleed the brakes.

NOTE: If the student selects B, check brake pedal linkage, an animation will show the brake pedal travel being inspected. It will return to the original question.

Student must click on the toolbox to continue.

Page 6

Student must test drive the vehicle. Student must click on the ignition switch and then on the brake pedal to stop the vehicle. The student will have to depress the brake pedal several times to stop the vehicle (pumping the brakes).

Page 7

Q: You have checked most major components of the brake system except for the master cylinder and the hydro booster (power booster). Which of these two components do you suspect is the cause of the problem?

A: A. Master Cylinder.

Page 8

Student must place the drip pan under the vehicle.

Student must remove the master cylinder by first double-clicking on the master cylinder. This will take the student to a larger image of the master cylinder.

Student must remove the master cylinder in the correct sequence using the TM.

Page 9

Q: SSG Santiago has handed you a new master cylinder, and has told you to install it. Is there something you must do before installing the master cylinder?

A: A. Yes (The master cylinder must be bleed before installing it).

Page 10

Student must install the master cylinder in the correct sequence using the TM.

Page 11

Q: How long did you let the master cylinder sit before installing?

A: C. 30 Minutes.

Page 12

Q: What should you do next?

A: C. Fill the reservoir.

Page 13

Student must click on the toolbox to continue.

Page 14

Student must click on the wrench to test drive the vehicle.

Page 15

Q: You finished fixing the problem, good for you. What will you do next?

A: A. Close out the worksheet.

Page 17

Click on the rank to continue.

Module 2:

Scenario:

While stationed at Fort Drum, New York, with the 710th Brigade Support Battalion and preparing to deploy to Camp Fallujah, Iraq, the operator of a HMMWV noticed she was having lots of problems with the brakes. She said that the brakes still work, but they are very difficult to depress. It takes much more leg pressure to get the same amount of braking action than it used to.

Maximum Wrenches Awarded: **3 Wrenches**

Page 2

Student must click on four different items on the graphic to perform inspections.

a. Brake System.

b. Caliper.

c. Fluids.

d. Brake Linkage.

Brake System – Student clicks on a hydraulic line. The image changes and then the student must double click on the different hydraulic lines to look for leaks. Student must click DONE when finished.

Caliper – Student clicks on a caliper. The image changes and then the student must double clicks on each caliper to inspect them. No fault will be noted. Student must click DONE when finished.

Fluids – Student clicks on the reservoirs. The image changes and then the student must click on the master cylinder and the power steering pump to check fluid levels. NOTE: The student must click on both. Student must click DONE when finished.

Brake Linkage – Student must click on the wrench to continue. An animation of the brake pedal moving appears so the student can inspect the pedal travel. Student must click DONE when finished.

NOTE: Sometimes the student misses a step. Usually click on the DONE link or the two reservoirs. This makes all four systems to be checked on the clip board, but does not allow the student to go to the next page. Have the student go through again and ensure the student clicks on all proper links.

Page 4

Q: What might be the possible cause of the problem based on the symptoms and the inspection you have already conducted?

A: B. Power Booster (hydro booster) failed.

Page 5

Q: The hydro booster is bad and you will need to replace it. What item must be removed in order for you to get to the hydro booster?

A: A. Master Cylinder.

Page 6

Student must move the drain pan under the vehicle

Student must remove the master cylinder in proper sequence using the TM.

Page 7

Student must remove the hydro booster in proper sequence using the TM.

Page 8

Student must install the hydro booster in proper sequence using the TM.

Page 9

Student must click on the wrench to bleed the power steering system.

Page 10

Q: What should you do next?

A: C. Manually bleed the brakes.

Student must click on the toolbox to continue.

Page 11

Student must click on the wrench to continue.

Page 12

Q: You finished fixing the problem, good for you. What will you do next?

A: A. Close out the worksheet.

Page 14

Click on the rank to continue.

Module 3:

Scenario:

Your supervisor, SSG Cooley, received a DA Form 5988-E from the operator of a MW24C Bucket Loader. The 5988-E states the vehicle groans and squeaks excessively when the vehicle is stopping. He further states that the vehicle has missed two services and has logged many hours since it has been in Baghdad. SSG Cooley wants you to troubleshoot and repair the problem so they can complete the bridge reconstruction over the Tigris River.

The operator states that the groaning increases in intensity when he carries more weight in the bucket.

Maximum Wrenches Awarded: **2 Wrenches**

Page 2

5988-E shows fault: Brakes squeak/groan at stop.

Page 3

Choose the troubleshooting step.

Service brakes squeak or groan at end of stop.

Student must click on the wrench to install the service transport link.

Page 4

Student must choose which axle to start inspecting by clicking on the front or rear wheel.

Front Axle Inspection – Student must place the jack-stands in the proper location.

Student must choose which wheel to inspect.

Student must remove the wheel and double-click on the caliper to inspect the caliper.

Student must click on each brake shoe to measure the lining by moving the ruler.

a. Left front lining is BAD.

NOTE: Students often get confused with this. They want to measure the shoe as if it was the lining. Explain to the student the difference between the two when that occurs.

b. Right front lining is GOOD.

Student then goes to Page 5

Rear Axle Inspection – Student must place the jack-stands in the proper location.

Student must choose which wheel to inspect.

Student must remove the wheel and double-click on the caliper to inspect the caliper.

Student must click on each brake shoe to measure the lining by moving the ruler.

a. Left rear lining is GOOD.

b. Right rear lining is GOOD.

Student then must inspect the front axle

Page 5

Student must click on the wrench to continue. This page shows the inspection of the rotor.

Page 6

Brake pads replacement, student must remove the brake shoes in proper sequence using the TM.

Page 7

The student must click on the wrench to continue. The student will hear instructions on how to compress the pistons to make room for the new brake shoes. Student must click on the green button to continue.

The student must click on the green button to pry the pistons back. The student is shown the pistons being pried back. The student must click on the green button to continue.

The student must click on the tool box to continue.

Page 8

The student must replace the brake shoes in proper sequence using the TM.

Page 9

The student must click on the appropriate graphic to bleed the reservoir. CORRECT: Front Reservoir.

The student must click on the play button to see the front reservoir being bled.

Page 10

Student must click on the wrench to continue. Student must replace the tire in the proper sequence using the TM.

Page 11

Student must click on the wrench to test drive the vehicle.

Page 12

Q: You finished fixing the problem, good for you. What will you do next?

A: A. Close out the worksheet.

Page 14

Click on the rank to continue.

Module 4:

Scenario:

You are assigned to 94th EN BN in Fallujah, and your maintenance chief, SSG Smith has given you a DA form 5988-E. The operator was building a defensive position around the ammunition supply point when he noticed that the loader's brakes were very weak. He also said that he noticed fluid on the inside of the left front tire while doing his after operations PMCS.

Maximum Wrenches Awarded: **4 Wrenches**

Page 2

5988-E shows the faults: 1. Brakes are weak. 2. Fluid front left tire.

Page 3

Choose the troubleshooting step.

Poor Brake Action.

Page 4

Student must click on the toolbox to continue. Student must click on the wrench to check the air pressure.

Page 5

Student must remove the left side engine access panels.

NOTE: The TM states to open the front access panel, but it does not open. Sometimes the computer does not recognize the panels being removed and the page must be reloaded.

Page 6

Student must click on the toolbox to continue.

Student must double-click on each of the brake reservoirs (colored in Yellow) to check the fluid levels. Front Reservoir is low.

Page 7

Student must read each TM. Student must choose which procedure to do next.

Inspect for leaks – CORRECT answer. Takes the student to Page 9.

Bleed air from brakes – takes the student to page 8.

Page 8

Student is shown how to bleed the brake system.

Page 9

Student must click on the wrench to continue. Student is shown the service transport link being installed.

Page 10

Student must select which axle to inspect.

Front Axle – Student must place the jack stands in the proper location. Student must click on the wheel to inspect.

Student must remove the wheel and double-click on the caliper to view the brake assembly for inspection.

a. Left Brakes – Caliper is leaking. Student is taken to Page 11.

b. Right Brakes – No Leak. Student is taken to the Left Wheel.

Rear Axle – Student must place the jack stands in the proper location. Student must click on the wheel to inspect.

Student must remove the wheel and double-click on the caliper to view the brake assembly for inspection.

a. Left Brakes – No Leak. Student is taken to the Right Wheel.

b. Right Brakes – No Leak. Student is taken to the Left Wheel.

Student must inspect the front axles.

Page 11

Student must replace the caliper in the proper sequence using the TM.

Page 12

Student must click on the telephone to talk to the supervisor and receive instructions to rebuild the caliper.

Page 13

Q: Which manual will you use to rebuild the caliper?

A: D. TM 5-3805-262-34.

Page 14

Student must disassemble the caliper in the proper sequence using the TM.

Page 15

Student must reassemble the caliper in the proper sequence using the TM.

Page 16

Q: Which TM will you use to install the caliper?

A: B. TM 5-3805-262-20.

Page 17

Student must install the caliper in the proper sequence using the TM.

Student must install the wheel in the proper sequence using the TM.

Page 18

Q: After installing the caliper you must tighten the capscrews. What is the torque specification?

A: C. 340-420 lb-ft.

Page 19

Q: You just installed the caliper. What should you do next?

A: A. Bleed air from brakes.

Student must click on the link "Click here to watch the video" to continue.

P**age 20**

Q: What will you do next?

A: A. Ensure the reservoirs are full.

Student must click on the wrench to test drive the vehicle.

Page 22

Q: You finished fixing the problem, good for you. What will you do next?

A: A. Close out the worksheet.

Page 24

Click on the rank to continue.

Module 5:

Scenario:

You are stationed at Camp Humphreys, South Korea, as an organizational mechanic. Your supervisor, SSG Ainsworth, has given you a DA Form 5988-E. SSG Ainsworth further states that the operator was working at an excavations site when his low air pressure buzzer sounded and his air pressure gauge dropped into the red. You have been dispatched in a contact truck to the vehicle's location to attempt repairs.

Maximum Wrenches Awarded: **3 Wrenches**

Page 2

5988-E shows the faults: 1. Low air pressure warning sounds. 2. Low air pressure gauge needle drops.

Page 3

Choose the troubleshooting step.

Low air pressure (air pressure gage indicates in red zone and low air pressure buzzer sounds).

Page 4

Student must check that drain valve is fully closed by clicking on each link in sequence.

a. Start Engine – student must click on the key to start the engine.

b. Exit Cab.

c. Check Drain Valve – student must click on the loader to view the drain valve.

Page 5

Student must check the air compressor by clicking on the key and then remove the right engine access panels.

Student must inspect the tension on the air compressor drive belts by double-clicking on the air compressor.

Student clicks on the belt – the belt is tight and there is a hissing sound in the background. What do you want to do?

Investigate the source of the sound – CORRECT Answer: Takes student to page 6.

Check adjustment of air compressor governor – student must click on the wrench to continue.

Student is shown that the governor will not shut off the compressor because there is not enough air in the system. Student must fix all air leaks first.

Page 6

Student must find the source of the air leak on the air reservoir. The student must double-click on the Safety Valve, which is faulty.

Page 7

Student must click on the wrench to test the safety valve. Student must click on the safety valve to replace it.

Student must install the safety valve by dragging it to the proper location (On top of the air reservoir – if the student is having difficulty installing the part, have the student place the middle of the safety valve in line with mating surface).

Page 8

Q: You approached the operator to tell him that it's fixed, when the operator stated "What took you so long? All the other mechanics adjusted the governor and that was it. I was back to work in 5 minutes!" What should you do next?

A: C. Check the air governor to ensure that it's adjusted within specifications.

Page 9

Student must click on the wrench to see how the governor is tested and adjusted.

Page 10

Student must click on the wrench to road test the vehicle.

Page 11

Q: You finished fixing the problem, good for you. What will you do next?

A: A. Close out the worksheet.

Page 13

Click on the Rank to continue.

Feedback Requirements

SOLUTION FOR
PRACTICAL EXERCISE SHEET 91L10F03PE3

Solutions for all simulated practical exercises are found within the simulation software program.

Appendix D - Student Handouts (N/A)