

# SAULT COLLEGE

## CDDBBS OOTLXMS

**Course Title:** Heavy Equipment II Theory  
**Code Ho.:** HED 111  
**Program:** Heavy Equipment Diesel  
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**Author:** Jack Bowes/B. Tucker

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**Mdt** Of Appfed Aits

## Heavy Equipment II theory

**I PHILOSOPHY/GOALS:**

The purpose of this program is to provide the student with a basic knowledge of equipment encountered in construction, forestry, mining and on highway. This course encompasses electrical principles, test meters, batteries, engine combustion requirements, governors, fuel systems, principles of hydraulics, overall engine performance, powershift transmission, steering, brakes undercarriage and final drives.

**II STUDENT PERFORMANCE OBJECTIVES:**

Upon successful completion of this course the student will:

Be able to use analog and digital test meters on conventional cranking and wiring circuits, analyze lead acid battery condition and potential. Engine performance and fuel injection systems are covered in such a manner as to enable the student to analyze, field test and diagnose related problems with a minimum of test equipment. A sound knowledge of injection and engine basics will serve the broad industry spectrum.

Be able to analyse a basic hydraulic system, to use hydraulic system basic testing tools. The student will be able to understand the major parts of a hydraulic system, understand the operation of different powershift transmissions and torque converters. He will also understand the basic brake system, crawler undercarriage and final drives.

# HEAVY EQUIPMENT DIESEL

## Heavy Equipment II theory

### III TOPICS TO BE COVERED:

- 1 Principles Of Hydraulics
- 2 Hydraulic Fluids
- 3 Strainers And Filters
- 4 Oil Coolers And Heat Exchangers
- 5 Reservoirs
- 6 Hydraulic Hose, Tubing And Fittings
- 7 Hydraulic Pumps
- 8 Directional Control Valves
- 9 Pressure Control Valves
- 10 Flow Control Valves
- 11 Hydraulic Cylinders
- 12 Hydraulic Cylinders
- 13 Rotary Manifolds
- 14 Special Hydraulic Circuits
- 15 Hydraulic Schematics
- 16 Flow Meter And Gauges
- 17 Diagnose And Test Hydraulic Systems
- 18 Fluid Couplings And Torque Converters
- 19 Powershift Transmissions
- 20 Powershift Transmission Shift Control Mechanisms
- 21 Powershift Transmission General Maintenance
- 22 Powershift Transmission Troubleshooting
- 23 Brakes
- 24 Tires, Tire Chains, Wheels And Ballast
- 25 Steering
- 26 Final Drives
- 27 Undercarriage
- 28 Electricity
- 29 Electrical Test Equipment
- 30 Voltage Drop Testing
- 31 Lead Acid Batteries
- 32 Combustion
- 30 Voltage Drop Testing
- 34 Air Filters
- 35 Compression
- 36 Governors
- 37 Engine Performance
- 38 Diesel Fuel
- 39 Pressure Time Fuel Systems
- 40 Single And Multiple Plunger Fuel Injection Pumps
- 41 Hydraulic Fuel Injectors
- 42 Unit Injector Fuel System
- 43 Rotary Distributor Fuel Injection Pump
- 44 Combustion And Diesel Smoke

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IV LEARNING ACTIVITIES:

Topic 1 Principles Of Hydraulics

- 1.1 Define the terms, hydrostatic and hydrodynamic.
- 1.2 Define Pascals Law in relation to Static fluids.
- 1.3 Explain the relationship between pressure, force & area.
- 1.4 Describe mechanical advantage.
- 1.5 Explain how pressure is created.
- 1.6 Explain the effect of atmospheric pressure, head pressure and vacuum on hydraulic systems.
- 1.7 Calculate weight, measures and capacities.
- 1.8 Define laminar and turbulent flow.
- 1.9 Explain how force multiplication takes place in a hydraulic system.
- 1.10 Differentiate between absolute and gauge pressure.
- 1.11 Complete assignment.

Topic 2 Hydraulic Fluids

- 2.1 List the four primary purposes of hydraulic fluids.
- 2.2 List the most important properties of hydraulic fluids.
- 2.3 Explain how viscosity is measured.
- 2.4 Explain the meaning of viscosity index.
- 2.5 Describe the effect of fluid temperature on viscosity.
- 2.6 Name the causes of corrosion and fluid oxidization.
- 2.7 Compare various types of hydraulic fluids.
- 2.8 Identify the benefits of scheduled oil samples.
- 2.9 Analyze and compare oil sample test results.

Topic 3 Strainers And Filters

- 3.1 Differentiate between a strainer and a filter.
- 3.2 Name the contaminants found in a hydraulic system.

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IV LEARNING ACTIVITIES:

- 3.3 Compare the mounting locations of filters and strainers.
- 3.4 Explain micron and mesh ratings.
- 3.5 Explain the effect of oil contamination.
- 3.6 Define beta ratio.

Topic 4 Oil Coolers And Heat Exchangers

- 4.1 Name the types of oil coolers and heat exchangers.
- 4.2 Describe the operation of oil coolers and heat exchangers.
- 4.3 Explain the control mechanisms of oil coolers and heat exchangers.
- 4.4 Compare locations of oil coolers and heat exchangers.

Topic 5 Reservoirs

- 5.1 Explain the function of fluid reservoirs.
- 5.2 Explain the size, construction and locations of reservoirs for various applications.
- 5.3 Explain the purpose of reservoir baffles.
- 5.4 Discuss important accessories and their purpose with hydraulic reservoirs.
- 5.5 Differentiate between pressurized and vented hydraulic reservoirs.

Topic 6 Hydraulic Hose. Tubing And Fittings

- 6.1 Explain the different types of hydraulic hoses and their applications.
- 6.2 Explain the different types of hydraulic fittings and their applications.
- 6.3 Explain the different types and applications of hydraulic piping and tubing,
- 6.4 Determine & select the proper type of hydraulic hose and its correct applications.
- 6.5 Determine and select the proper type of hydraulic fittings for their correct applications.

IV LEARNING ACTIVITIES:

- 6.6 Determine and select the different types of hydraulic tubing and the correct applications.
- 6.7 Correct procedure for making new hose assemblies.
- 6.8 Establish causes of hose assembly failure.
- 6.9 Distinguish between the safe and unsafe removal of hydraulic hose assemblies, tubing and piping.
- 6.10 Compare correct and incorrect hose, tubing and pipe installations.

Topic 7 Hydraulic Pumps

- 7.1 Name the main classifications of hydraulic pumps.
- 7.2 Define cavitation and aeration.
- 7.3 Discuss the most common types of positive displacement pumps.
- 7.4 Describe the operation of the most common types of positive displacement pumps.
- 7.5 Define pump displacement.
- 7.6 Define pump volume.
- 7.7 Explain pump rating and efficiency.
- 7.8 Compare different classifications of hydraulic pumps.

Topic 8 Directional Control Valves

- 8.1 Explain the classification of directional control valves.
- 8.2 Describe how manually operated directional control valves work.
- 8.3 Describe pilot operated directional control valves and their control mechanisms.
- 8.4 Explain the difference between open centre and closed centre valves.
- 8.5 Describe the different flow paths found in hydraulic valves.
- 8.6 Discuss the locations of main relief valves and line relief valves.
- 8.7 Discuss the locations of lift check valves.

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IV LEARNING ACTIVITIES;

- 8.8 Discuss the locations of anti-cavitation valves.
- 8.9 Describe the operation of main relief valves, line relief valves, lift check valves and anti-cavitation valves.
- 8.10 Describe series and parallel connections.
- 8.11 Establish safe and correct adjustment procedures for main reliefs and line reliefs.

Topic 9 Pressure Control Valves

- 9.1 Describe the operating principles, functions and flow paths of pressure control valves.
  - A - simple relief valve
  - B - pilot operated relief
- 9.2 Name the installation locations of pressure relief valves.
- 9.3 Describe the operating principles, functions and flow paths of pressure reducing valves.
- 9.4 Name the installation locations of pressure reducing valves.
- 9.5 Explain pressure override and how it occurs.
- 9.6 Define delta pressure.

Topic 10 Flow Control Valves

- 10.1 List the different types of flow control valves.
- 10.2 Describe the operating principles, functions and flow paths of flow control valves.
- 10.3 Describe meter in, meter out and bleed off circuits.
- 10.4 Define pressure intensification.
- 10.5 Describe how it occurs.

Topic 11 Hydraulic Cylinders

- 11.1 Describe the purpose of a hydraulic cylinder.
- 11.2 List the different types of hydraulic cylinders.
- 11.3 Explain the operation of different hydraulic cylinders.
- 11.4 Explain the types of seals and packing used in hydraulic cylinders.

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IV LEARNING ACTIVITIES:

11.5 Explain the operation of piston type bypass cylinders and cushion type cylinders,

11.6 Establish the correct diagnose and repair procedure for hydraulic cylinders.

Topic 12 Hydraulic Cylinders

Accumulators

12.1 Name the different types of accumulators.

12.2 Describe the operation of the different types of accumulators.

12.3 Identify circuit locations where accumulators may be found.

12.4 Demonstrate the correct procedures for pre-charging, unloading, and dismantling the units safely.

12.5 Explain the hazards when working with accumulators.

Topic 13 Rotary Manifolds

13.1 List the different types of rotary manifolds.

13.2 Explain the function & operation of rotary manifolds.

13.3 Determine the location of rotary manifolds.

13.4 Discuss possible failures in the operation of rotary manifolds.

13.5 Describe the safe and correct removal, repair and installation of rotary manifolds.

Topic 14 Special Hydraulic Circuits

14.1 Describe a regenerative circuit.

14.2 Explain the purpose of a regenerative circuit.

14.3 Determine the application of a regenerative circuit.

14.4 Explain the operation of a regenerative hydraulic circuit.

14.5 Describe a power beyond hydraulic circuit.

14.6 Explain the purpose of a power beyond hydraulic circuit.

14.7 Determine the application of a power beyond hydraulic circuit.

IV LEARNING ACTIVITIES:

14.8 Explain the operation of a power beyond hydraulic circuit.

Topic 15 Hydraulic Schematics

15.1 Explain the benefits of hydraulic schematics.

15.2 Distinguish between pictorial and symbol schematics.

15.3 How individual symbols lead to a schematic.

15.4 Read and interpret hydraulic system symbols, schematics and technical data.

15.5 Diagnose hydraulic systems using proper schematics.

15.6 Define industry colour coding for hydraulic schematics.

Topic 16 Flow Meter And Gauges

16.1 List different types of hydraulic gauges and snubbers.

16.2 Demonstrate the proper use of hydraulic gauges.

16.3 Identify the function of flow meters.

16.4 Describe the safe and correct installation of flow meters.

16.5 Determine the cause of system failure by connecting, operating and interpreting test results taken from test instruments.

16.6 Perform pressure conversion calculations.

Topic 17 Diagnose **And** Test Hydraulic Systems

17.1 Interpret a trouble shooting guide in a service repair manual.

**17.2** Establish a safe step by step trouble shooting procedure.

17.3 Explain the procedure of connecting and interpreting test instruments.

17.4 Determine the causes of system failure and malfunctions.

17.5 Examine failed components.

17.6 Explain the safe and correct removal replacement and adjustments of new components.

17.7 Interpret new test conclusions and compare with manufacturer service manual.

IV LEARNING ACTIVITIES:

Topic 18 Fluid Couplings And Torque Converters

- 18.1 Name two types of hydraulic drives.
- 18.2 Explain the difference between hydrostatic and hydrodynamic drives.
- 18.3 Explain rotary and vortex flow.
- 18.4 Discuss the components of a fluid coupling.
- 18.5 Explain the operation of a fluid coupling.
- 18.6 Discuss the components and classifications of torque converters.
- 18.7 Explain the operation of a torque converter.
- 18.8 Distinguish the physical differences of a fluid coupling and torque converter.
- 18.9 Describe the different operating characteristics and internal oil flow of a fluid coupling and a torque converter.
- 18.10 Define torque converter phases and stages.
- 18.11 Distinguish the difference between wet and dry type torque converters.
- 18.12 Compare engine mounted, midship mounted and remote mounted torque converter installations.
- 18.13 Explain the types and function of stators.
- 18.14 Explain torque converter stall.
- 18.15 Analyze torque converter checks and tests.
- 18.16 Outline general maintenance procedures of torque converters.

Topic 19 Powershift Transmissions

- 19.1 Name two classifications of powershift transmissions.
- 19.2 Explain the different characteristics of each classification.
- 19.3 Identify the operating characteristics of a countershaft powershift transmission.

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IV LEARNING ACTIVITIES:

- 19.4 Explain the operation and power flow of the internal & external components of different powershift transmissions.
- 19.5 Compare the operation and power flow of the internal and external components of different countershaft powershift transmissions.
- 19.6 Explain design characteristics that permit counter-rotation of final drives.
- 19.7 Explain the different hydraulic control circuits used in countershaft powershift transmissions.
- 19.8 Distinguish the difference in hydraulic control circuits used in countershaft powershift transmissions.
- 19.9 Compare the different hydraulic controls used in countershaft powershift transmissions.
- 19.10 Compare performance characteristics of different countershaft powershift transmissions.

**Topic 20 Powershift Transmission Shift Control Mechanisms**

- 20.1 Name different shift control methods.
- 20.2 Explain the function and operation of various shift control methods.
- 20.3 Distinguish the difference in shift control methods.
- 20.4 Compare the difference in shift control methods.
- 20.5 Compare performance characteristics of shift control methods.

**Topic 21 Powershift Transmission General Maintenance**

- 21.1 Outline general maintenance procedures and service intervals of powershift transmissions.
- 21.2
  - A) Purpose of scheduled oil sampling.
  - B) How and when to take correct transmission scheduled oil samples.
  - C) Analyze and compare transmission and torque converter oil sample test results.
- 21.3 Explain the consequences and the effect of the continued operation of incorrect oil levels, incorrect grade of oil, and incorrect temperature.

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IV LEARNING ACTIVITIES:

Topic 22 Powershift Transmission Troubleshooting

- 22.1 Interpret different operation & trouble shooting guides in different manufacture service manuals.
- 22.2 Establish a step-by-step trouble shooting procedure.
- 22.3 How to safely and correctly connect test gauge and meters.
- 22.4 Analyze test results.
- 22.5 Determine the causes of system failure and malfunction.
- 22.6 Establish safe and correct field and shop repair and adjustment procedures.
- 22.7 Compare new test conclusion with the applicable manufacturer service manual.

Topic 23 Brakes

- 23.1 Explain the types, function and principles of brake operations.
- 23.2 Explain the operation and actuating mechanisms of different types of master and wheel cylinder assemblies.
- 23.3 Explain the operation of brakes chambers, brake adjusters, brake shoes, brake lining and related control mechanisms.
- 23.4 Establish safe and correct brake adjustment and repair procedures.
- 23.5 Outline proper troubleshooting procedures.
- 23.6 Discuss visual and operational brake checks.
- 23.7 Explain the operation of air compressors and their related control mechanisms.

Topic 24 Tires, Tire Chains. Wheel Balancing. Ballast

- 24.1 Name different types of tires and wheels.
- 24.2 Describe their construction and characteristics (eg. load rating).
- 24.3 Explain their functions and applications.
- 24.4 Explain the need of tire and wheel balancing.

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IV LEARNING ACTIVITIES:

- 24.5 List and describe the safe and correct service procedures required when working with wheel counterweights (eg. weights and tire ballasts).
- 24.6 Explain the safe and correct tire inflation procedure.
- 24.7 Name and describe different types of chains used on off road tires.
- 24.8 Explain their function and application.

Topic 25 Steering

- 25.1 Name different types of steering systems.
- 25.2 Describe their construction and operating characteristics.
- 25.3 Explain their function and operation.
- 25.4 Compare each type of steering system.
- 25.5 Explain and discuss steering terminology and wheel alignment adjustments.
- 25.6 Establish safe and correct service and adjustment procedures.

Topic 26 Final Drives

- 26.1 Name different types of final drives.
- 26.2 Describe the characteristics and construction of each type.
- 26.3 Explain and compare the operating principles of each type.
- 26.4 Establish the safe and correct method of using hydraulic pullers.
- 26.5 Explain and discuss safe and correct disassembly, inspection, overhaul and adjustment procedures.
- 26.6 Outline general maintenance procedures.

Topic 27 Undercarriage

- 27.1 Explain the purpose and function of undercarriages.
- 27.2 Name the types and their applications.
- 27.3 Explain and discuss undercarriage components.

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IV LEARNING ACTIVITIES:

- 27.4 Compare different types of undercarriages.
- 27.4 Establish safe and correct measuring, service and adjustment procedures.
- 27.6 Analyze undercarriage wear patterns.
- 27.7 Recognize incorrect track adjustment.

Topic 28 Electricity

- |  |  |
|--|--|
| 28.1 Listen to teacher presentation on:<br>atomic structure<br>electron movement<br>conductors<br>producing electricity<br>electron theory of electricity<br>convention <b>theory of electricity</b><br>volts<br><b>amperes</b><br><b>ohms</b><br><b>watts</b><br>Ohms's Law<br>electrical schematic symbols | <b>REQUIRED RESOURCES</b><br><b>HED2EL2T6</b><br><b>Diesel Fundament als</b><br><b>Thiessen/Dales</b><br><b>p. 589-604</b> |
| 28.2 Calculate <b>amperage, ohm's resistance, and volts of:</b><br>. <b>simple circuits</b><br>. <b>series circuits</b><br>. <b>parallel circuits</b><br>. <b>series parallel circuits</b>   |  |

Topic 29 Electrical Teat Equipment

- |  |            |
|--|------------|
| 29 Listen to teacher presentation on construction, operation and proper test procedures for electrical test equipment. | Class Demo |
|--|------------|

Topic 30 Voltage Drop Testing

- |   |                         |
|---|-------------------------|
| 30 Listen to teacher presentation on troubleshooting faulty electrical systems using voltage drops as an indicator. | HED2EL2T6<br>Class Demo |
|---|-------------------------|

Topic 31 Lead Acid Batteries

- |   |   |
|---|---|
| 31 Listen to teacher presentation on purpose, construction, operation and maintenance of lead acid batteries for the heavy equipment trade. Included in this topic are: | HED2EL3T29<br>Diesel Fundamentals<br>p. 575-587 |
|---|---|

Heavy Equipment II theory

IV LEARNING ACTIVITIES:

REQUIRED RESOURCES

- ratings
- charging
- state of charge testing
- high rate discharge testing
- charge testing
- boosting

Class Demo

Topic 32 Combustion

- 32 Discuss the requirements for proper combustion in all internal combustion engines.

HED2EN4T2  
Diesel Fundamentals  
p. 63

Topic 33 Voltage Drop Testing

- 33.1 Air Induction Systems

HED2EN5T18

- 33.2 Follow teacher presentation on:

- . atmospheric pressure and naturally aspirated engines
- . volumetric efficiency

Diesel Fundamentals  
p. 76, 82

- 33.3 Observe presentation and demonstration on supercharging diesel engines including:

Class Demo  
CAT 3406

- blowers
- turbochargers
- aftercooling - (i) jacket water  
(ii) air to air
- series turbocharging
- turbocharging troubleshooting
- installation and maintenance

Diesel Fundamentals  
p. 265-278

Topic 34 Air Filters

HED2EN6T14

- 34.1 Discuss engine air filtering through recent history including oil wick, oil bath, and dry element types.

Diesel Fundamentals  
p. 259-263  
p. 284-295  
1/2" VHS Video  
"That Engines May Live" (Clean Air)

- 34.2 Trace air flow through various air filtration systems including:

Lab Engine Tour

- . single stage filters
- . two stage filters
- . three stage filters

- 34.3 Follow discussion and demonstration of measuring air flow restriction in naturally aspirated and turbo-charged diesel engines.

Diesel Fundamentals  
p. 279-282  
Cat 3406  
Manometer Demo

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IV LEARNING ACTIVITIES:

REQUIRED RESOURCES

Topic 35 Compression

HED2EN7T5

- 35.1 Listen to teacher presentation on the importance of adequate compression and what influences compression pressure, and what engine performance is affected by compression variables.
- 35.2 Discuss compression test procedures following manufacturers pressure and rpm specifications, cylinder balance limits and also safety considerations to technician and engine.

Diesel Fundamentals  
p. 571  
HED Compression  
Test Kit

Topic 36 Governors

HED2EN8T8

- 36.1 Follow teacher presentation on the need, purpose, construction and operation of a mechanical governor.
- 36.2 Discuss the terms and their definitions concerning engine governing, including:
  - . speed droop (percent regulation)
  - . isochronous
  - . sensitivity
  - , stability
  - . promptness
  - . work capacity
  - . governor hunting
- 36.3 Compare the various types of governors used and their applications and operating principles including:
  - . mechanical governors
  - . hydraulic governors
  - . pneumatic governors
  - . velocity governors
  - . electronic governors

Diesel Fundamentals  
p. 335-377  
Library FS/CASS  
TJ012B "Diesel  
Injection &  
Governing"  
also Lab Tour

HED2EN9T4

Topic 37 Engine Performance

Diesel Fundamentals  
p. 78-82  
16mm Film "Motors"  
(Cummins)  
"Understanding and  
Measuring Power"  
(Tool Crib)  
HED2EN10T13

- 37.1 Follow teacher presentation on engine performance terminology and fill in definitions for:
  - . work
  - . torque
  - . power - (i) horsepower  
(ii) watts
- 37.2 Discuss with teacher proper definitions for all the power ratings that may or may not include accessories.

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IV LEARNING ACTIVITIES:

REQUIRED RESOURCES

- Calculate torque, horsepower or R.P.M. unknowns according to the given H.P. formula.
- Discuss how the engine H.P. formula is derived from force, distance and time factors and define:
- . maximum horsepower
  - . intermittent horsepower
  - . continuous horsepower
- 37.3 Listen to teacher presentation on Brake Specific Fuel Consumption and calculate fuel used at various loads and r.p.m. at full throttle. Diesel Fundamentals p. 84
- 37.4 Discuss construction and operating principles of:
- . prony brake dynamometer
  - . hydraulic water brake
  - . electric dynamometer
- Topic 38 Diesel Fuel HED2FU11T12
- 38.1 Discuss with teacher, the five minimum requirements that any diesel fuel injection system must provide to the engine. Diesel Fundamentals p. 301-308
- 38.2 Listen to teacher presentation on diesel fuel characteristics and qualities, including:
- . grades
  - . cetane number and rating
  - . viscosity
  - . sulphur content
  - . cloud point
  - . crystallization point
  - . pour point
  - . caloric value
  - . flash point
- 38.3 Follow the handout and instructors presentation on the need for fuel conditioning to safeguard the precision delivery system. Discuss contaminants such as:
- . water
  - . abrasive
  - . bacteria
- 38.4 Trace the flow of diesel fuel through a well designed fuel delivery system. Discuss and define:
- . strainers
  - . water traps
  - . vents
- Class Demo
- HED2FU11T12  
Diesel Fundamental  
p. 309-315

Heavy Equipment II theory

IV LEARNING ACTIVITIES:

REQUIRED RESOURCES

- . primary fuel filters
- . transfer pumps
- . secondary fuel filters
- . watchdog filters
- . water separators
- . fuel heaters
- . diesel drain oil blending

Fuel System  
Components Demo

1/2" VHS "Arctic Fox  
Fuel Heaters"

Topic 39 Pressure Time Fuel Systems

HED2FU12T16

- 39.1 Listen to teacher presentation on physical characteristics of a typical Cummins engine using a PT fuel system including:

Diesel Fundamentals  
p. 453-475

- . comb, chamber
- . mechanical injector
- . roller lever cam followers
- . unique cam profile
- . PT fuel pump
- . low pressure fuel lines

- 39.2 Follow the overall fuel paths for the PT fuel system and their maintenance points.

- 39.3 Follow teacher overview of PTG pump internal operation and the mechanical injector operation and their combined relationship to the pressure-time fuel metering theory.  
Discuss it's capability to vary (meter) fuel according to engine load and speed.

- 39.4 Listen to teacher presentation and discuss the torque method tune-up for some Cummins engines.

HED2FU12T16  
Class Demo

Describe:

- . cold set
- . hot set
- . injector hold down torque
- . crossheads & adjustment procedure
- . injector plunger adjustment procedure
- . valve clearance adjustment procedure and sequence necessity after injector adjustment
- . engine rotations following tune-up

Discuss the effects of improper adjustment n timing and metering of fuel to the -bustion chamber as well as neglected top tune up for extended periods of time.

discuss precautions of removing mechanical injectors from engine, and removing plungers

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IV LEARNING ACTIVITIES:

REQUIRED RESOURCES

39.6 Discuss precautions of removing mechanical injectors from engine, and removing plungers from injector bodies in engine.

Topic 40 Single And Multiple Plunger Fuel Injection Pumps

HED2FU13T14

40.1 Listen to teacher presentation on the manufacturers, benefits and overall characteristics of multi-plunger pumps and service procedure during normal engine oil change.

Diesel Fundamentals  
p. 379-414

Class Demo

40.2 Trace diesel fuel flow through a typical multi-plunger pump fuel circuit. Include:

Components

- tank
- filters
- transfer pump
- constant air bleed lines
- overflow valve
- return lines

40.3 Follow teacher presentation on transfer pumps, including:

- gear
- vane
- diaphragm
- piston

40.4 Follow the teachers presentation on the operating principles of a helix plunger and barrel.

HED2FU13T14

Diesel Fundamentals  
p. 379-414

Define:

- . constant plunger stroke
- . effective stroke
- . upper helix
- . lower helix
- . rack
- . delivery valve
- . variable beginning of injection
- . constant beginning of injection
- . timing advance unit
- . aneroid or air/fuel ratio control
- . phasing
- . calibration

Lab Fuel Bench Demo

IV LEARNING ACTIVITIES:

REQUIRED RESOURCES

40.5 Follow teacher presentation and discuss field testing and troubleshooting multi-plunger pumps and hydraulic injectors on engine. Differentiate between engine mechanical health and fuel injection system faults.

HED2FU13T14

Topic 41 Hydraulic Fuel Injectors

HED2FU14T8

41.1 Listen to teacher presentation on fuel injectors.

Diesel Fundamentals  
p. 321-333

Note the difference of mechanical types versus hydraulic types.

Fuel Lab Demo

Define:

- . closed nozzles
- . open nozzles
- . pintle type
- . hole type

41.2 Follow the teachers presentation and demonstration on testing hydraulic injector nozzles for:

- tip leakage
- opening pressure
- atomization
- distribution
- chatter
- back leakage

Topic 42 Unit Injector Fuel System

HED2FU15T12

42.1 Listen to teacher presentation on the history of the Detroit Diesel unit injection system and it's adaptation to some Cat and Waukeshau engines.

Diesel Fundament als  
p. 415-452

Also it's flexibility from mechanical governance to electronic microchip control.

Classroom Component  
Demo

42.2 Follow and discuss coverage of overall fuel circuit including:

- . primary and secondary filters and their maintenance and priming procedures
- . transfer pump construction and its reg. valve importance
- . return line restriction fitting importance

IV LEARNING ACTIVITIES:

REQUIRED RESOURCES

42.3 Follow teachers disassembly of a unit injector and trace fuel flow through the injector, noting two possible helixes and ports, and their effect on metering and timing fuel to the combustion chamber.

42.4 Watch instructor demonstration of tuning up a Detroit Diesel two stroke engine including:  
. bridge adjustment  
. valve lash adjustment  
. injector timing adjustment  
. rack bounce

HED2FU15T12

Lab Demo

Discuss neglect or improper tune-up adjustment on engine smoothness and startability.

42.5 Follow demonstration on isolating unit injectors on a running engine to diagnose smoke engine miss, or overfueling of unbalanced cylinders.

Topic 43 Rotary Distributor Fuel Injection Pump

HED2FU16T12

43.1 Follow teacher presentation on the history, necessity and physical construction of a typical stanadyne rotary distributor pump, including:  
overall external fuel circuit  
transfer pump and pressure regulator  
rotor and hydraulic head  
rollers, plungers and cam ring  
governor and metering valve  
speed or load sensitive advance units

Diesel Fundamentals  
p. 543-563

Classroom Components  
"Roosa DM Pump"

16mm Film

"Roosa Master Pump"

43.2 Follow and discuss the timing procedures for pump installation, checking proper advance operation and troubleshooting faulty engine/inj. pump/injector possibilities. Also follow discussion of precautions required for prevention of hand injury when timing these pumps, and precautions needed to ensure long pump life.

Topic 44 Combustion And Diesel Smoke

HED2FU17T8

44.1 Follow teacher presentation on combustion quality and acceptable emissions.

IV LEARNING ACTIVITIES:

REQUIRED RESOURCES

- 44.2 Discuss the contents and possible causes of:
- . white diesel smoke
  - . black diesel smoke
  - . blue diesel smoke

V. EVALUATION METHODS:

HED 101 assessment is based on regularly tests and assignments. Attendance and homework checks are recorded and used as an aid for counselling.

The following grades will be assigned.

A+	(>90%)	(Numerical Equivalent 4.0)	- Consistently Outstanding
A	(85-90%)	(Numerical Equivalent 3.75)	- Outstanding Achievement
B	(75-84%)	(Numerical Equivalent 3.00)	- Consistently Above Average Achievement
	(65-74%)	(Numerical Equivalent 2.00)	- Satisfactory or Acceptable Achievement
	(<65%)	(Numerical Equivalent 0.00)	- Repeat - Objectives of course not achieved and course must be repeated

CR - Credit exemption

X - A temporary grade, limited to situation with extenuating circumstances, giving a student additional time to complete course requirements.

Your Semester Theory Letter Grade will be comprised of:

- 80% of Semester Theory Exam Average
- 20% of Semester Theory Assignment Average

A 65% Average of the total semester exam and assignment must be achieved to receive a passing grade in Heavy Equipment Diesel Theory.

A student can not rewrite a test to improve his mark.

If a test is missed by a student, without a good reason, an "Incomplete" grade is allotted.

VI. REQUIRED **STUDENT RESOURCES:**

Textbooks:

- Diesel Fundamentals (Second Edition) - Thiessen/Dales
- Diesel Equipment I - Schulz

VII. ADDITIONAL RESOURCE MATERIALS AVAILABLE IN THE COLLEGE LIBRARY:

See Attached List

Periodical Section

Suggested list of periodicals in the Library which are of interest to Heavy Duty Equipment Students:

Heavy Construction News

Engineering & Contract Record

Northern Logger

Construction Methods & Equipment

Diesel Equipment Superintendent

Hydraulics and. Pneumatics

Power

Bus and Truck Transport

Motor . .

E.M. (Heavy Duty "Equipment Maintenance") "—

Motor Truck

Diesel and Gas Turbine Progress

Audiovisual Section (Library Film Strip/Cassette Modules)

TJ 02a The crawler Tractor Operator Familiarization

TJ 02b Working The Crawler

TJ 03 Cummins Aneroids

TJ 04 Cummins Dial Indicator Tune-up

TJ 05 Cummins Piston Rings

TJ 06 Cummins PTD Fuel Injection

TJ 07 PTG AFC Theory and Operation

TJ 08 Diesel Truck History

TJ 09 Cummins Professional Driver Techniques

TJ 010 Drive Line Alignment

TJ 011 Driving With "Skid-Trol"

TJ 012 Introduction To Diesel

TJ 013 High Energy Ignition

TJ 014 Stopmaster Brake Troubleshooting

TJ 015 Oils For The 70'a

TJ 016 Theory and Operation of Fluid Drive

TJ 017 VE Pump Operation

VII. SPECIAL NOTES:

High.Top Safety Boots (CSA Approved)

Safety Glasses (CSA Approved)-, Impact ;--oftPrese^iption Lenses

Coloured Pencils (red, blue, green, yelldw)

Students with special ne\$ds (eg^./pJiy^^i^^imita^ionsH visual impairments , heiririg ~ impairments'/\_~'^ke^jai^'disa&ll j t ies) are encouraged to discuss required ^acptimfSS^^ with the instructor.

Your instructor reserves the ,ri^t./^-:it|^^\<-t^« ^ot^irse^a'9 he/she deems necessary to meet the need^of th^ j^t^a^\*- .