

INTRODUCTION TO GM LOCOMOTIVES & ITS SYSTEMS

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DIESEL TRACTION– A Journey

- 1961 Setting-up of DLW
- 1964 First Diesel Locomotive with DC-DC traction arrangement
- 1994 Introduction of AC-DC technology
- 1999 Introduction of EMD Locos AC-AC technology with GTO based TCC's
- 2006 Introduction of AC-AC technology with IGBT based TCC's

WDG4(GT46MAC) - A VARIANT OF SD70 EMD

GT46MAC

Single Cab

Turbocharged

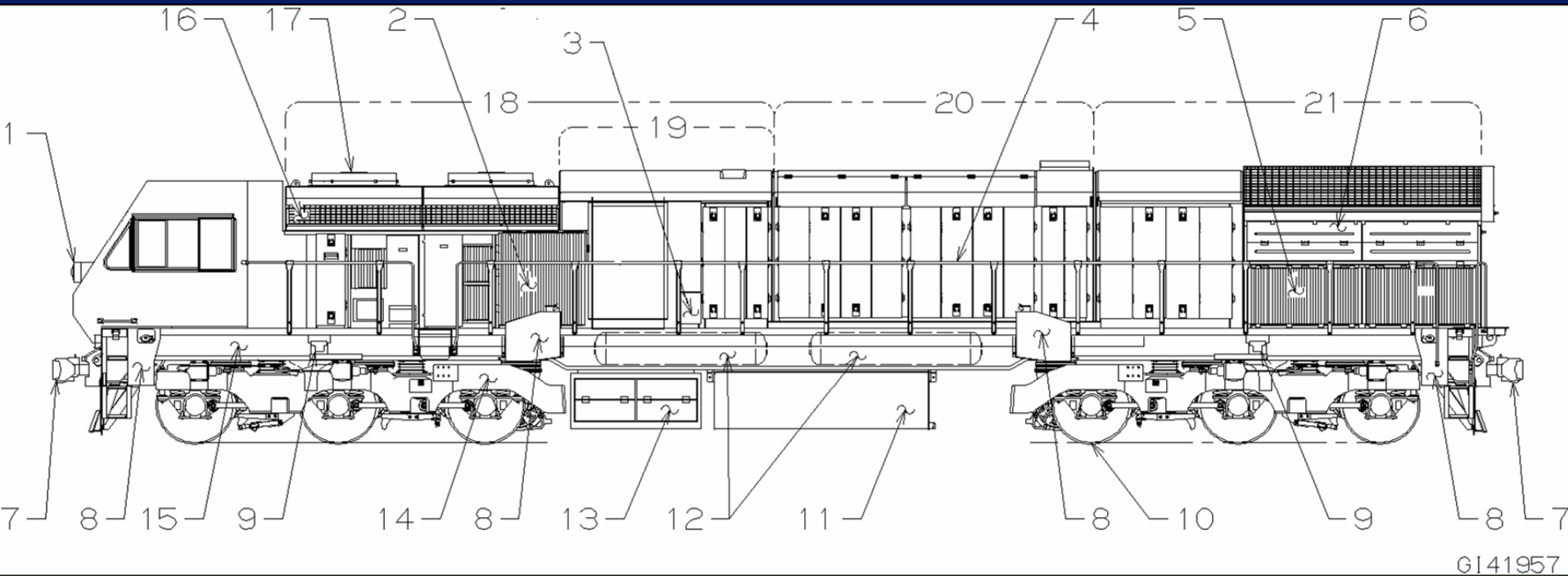
16 Cylinder

Full Width
Cab

A C



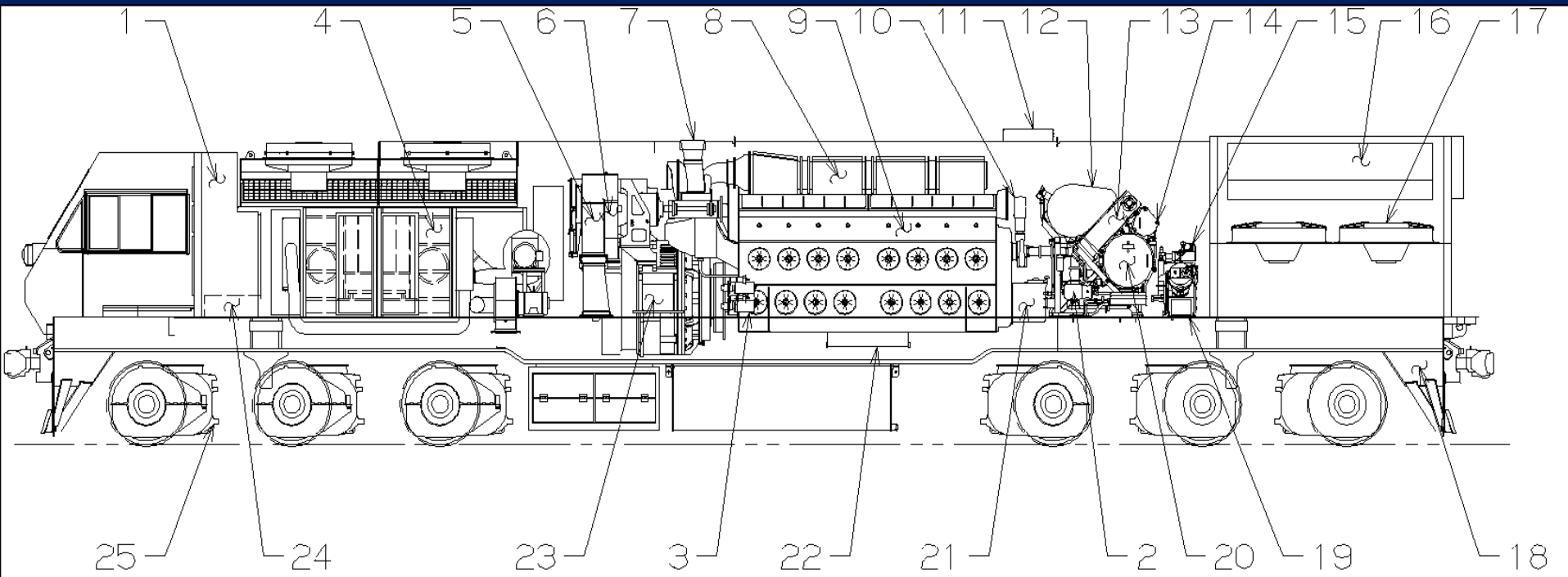
GT46MAC - LAYOUT



G141957

- 1) Head light
- 2) Inertial Filter Air Inlet
- 3) Starting Fuse and Battery Knife Switch
- 4) Handrails
- 5) Cooling System Air Inlet
- 6) Radiator and Fan Access
- 7) Coupler "E" Type
- 8) Sanding Box (8)
- 9) Jacking Pads (4)
- 10) Wheels (6)
- 11) Fuel Tank
- 12) Compressed Air System Main Reservoirs
- 13) Battery Box
- 14) Trucks (3 axle 3 motor HTSC type) Qty. 2
- 15) Underframe
- 16) Dynamic Brake Grids
- 17) Dynamic Brake Fans (2)

GT46MAC - LAYOUT



1. #1 Electrical Control Cabinet
2. Fuel Pump
3. Engine Starting Motors (Qty. 2)
4. Traction Control Cabinet
5. Traction Motor Cooling Blower
6. Main Gen. Assembly Blower
7. Engine Exhaust Stack
8. Engine Exhaust Manifold
9. Diesel Engine
10. Governor
11. Engine room Vent
12. Engine Water Tank
13. Lube Oil Cooler

14. Primary Fuel Filter
15. Air Compressor
16. Radiators
17. AC Radiator Cool. Fans (Qty. 2)
18. Draft Gear
19. Compressor Filter
20. Lube Oil Filter Tank
21. Lube Oil Strainer
22. Lube Oil Sump
23. Main Generator Assembly
24. No.1 Elect. Cntrl. Cab't Air Filt.
25. Traction Motors (Qty. 6)

MAIN FEATURES

- Two stroke turbo charged diesel engine.
- AC-AC Traction systems with AC generation & AC traction motor.
- Locomotive consists of four microprocessors.
 1. One loco control computer MAS 696/EM2000
 2. Two Traction computers ASG
 3. One Air brake computer CCB
- Sturdy, Bolsterless HTSC bogie with Huck fastening arrangement.

MAIN FEATURES(Contd..)

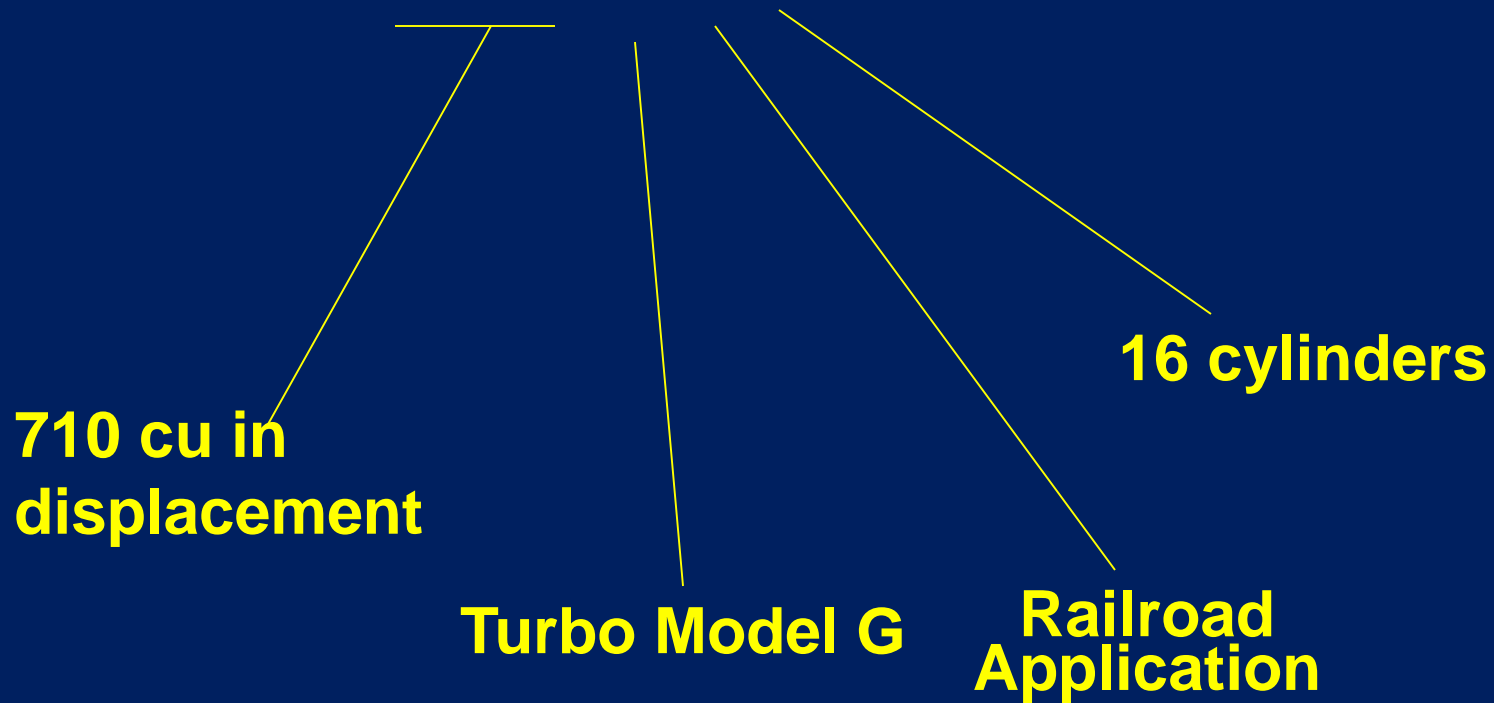
- High Tractive Effort due to state of the art Creep Control
- Maximum tractive effort of 53 tonnes.
- Highly effective Dynamic Braking System available up to near stand still.
- Maximum dynamic braking effort of 27 Tonnes.
- The despatchable adhesion of 43%.
- Longer trips – 90 days
- Very low engine idle RPM 200.

BENEFITS OF GM LOCO

- Lower Maintenance means smaller shed infrastructure
- Fewer locos mean fewer running staff
- Higher HP and tractive effort mean longer and faster trains
- Longer trips mean greater operational flexibility

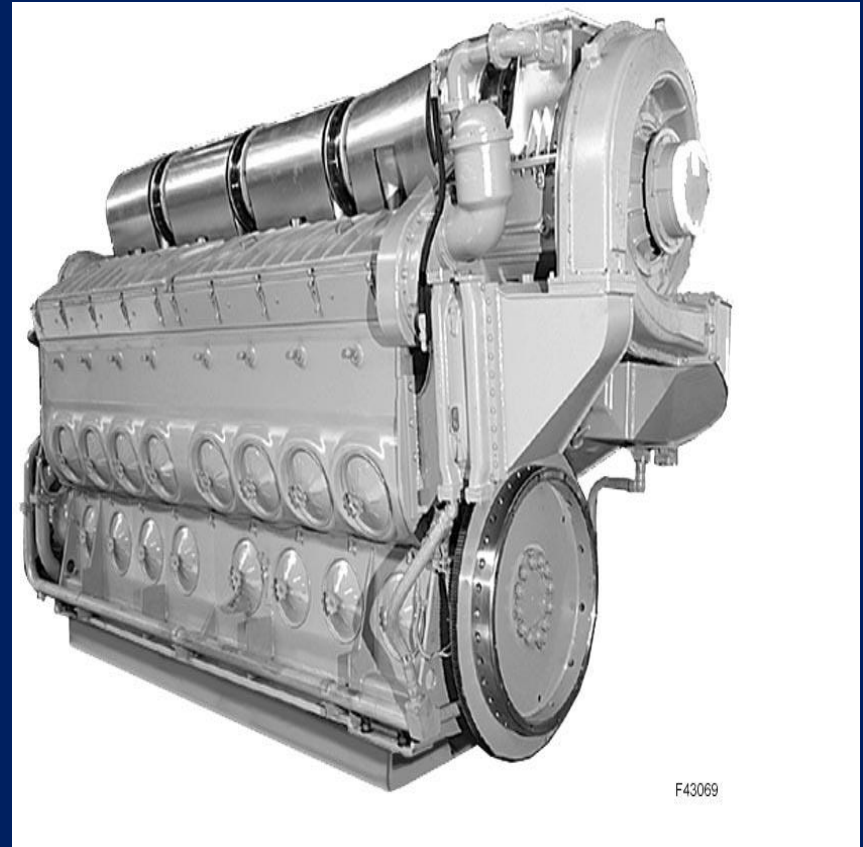
SALIENT FEATURES

710 G3B ENGINE

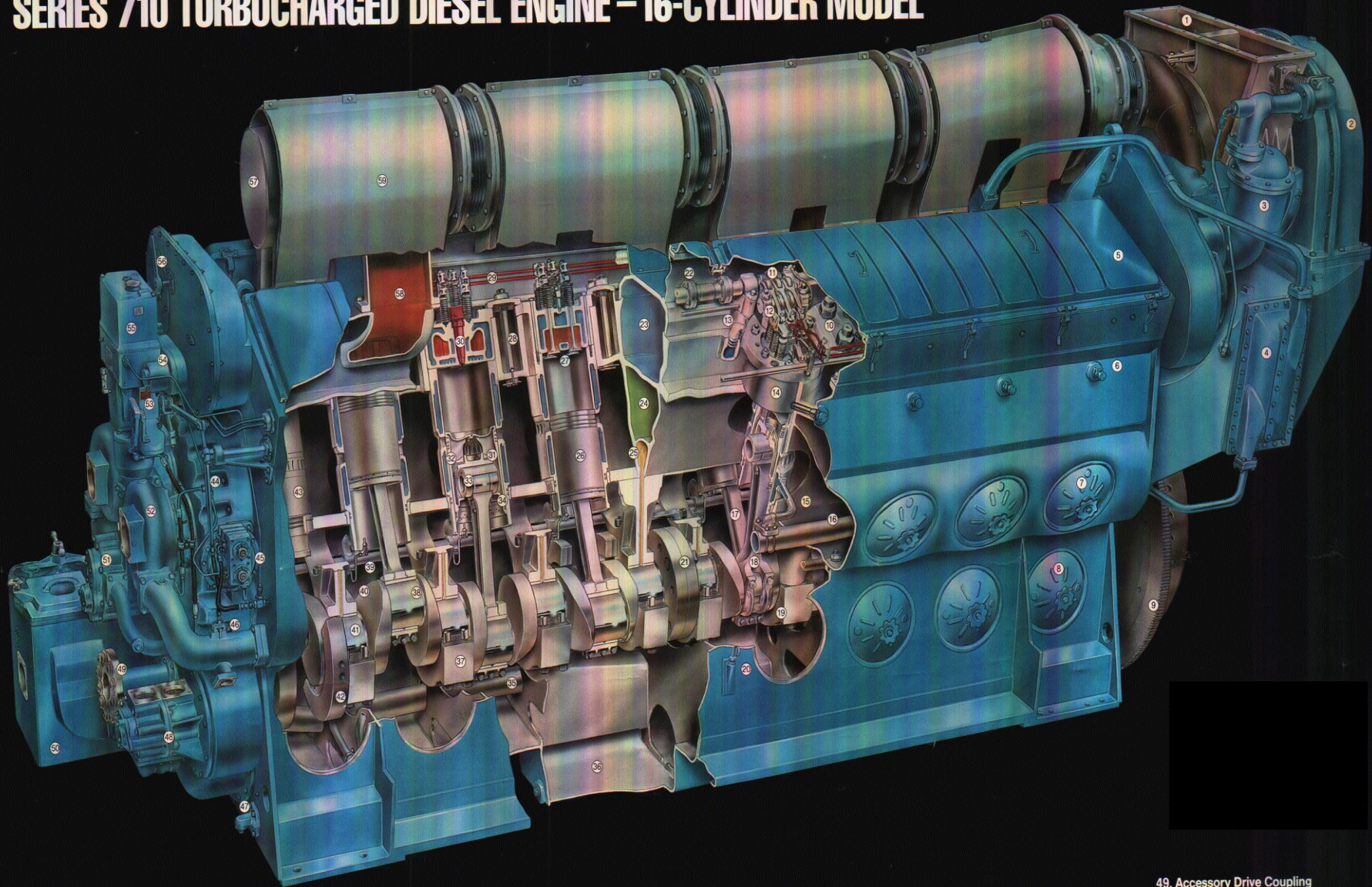


THE ENGINE-710G3B

- 16 Cylinder two stroke 45 degrees V Engine.
- Compression ration 1:16.
- Swept volume 710 cubic inches.
- Engine control through Woodward Governor.
- Equipped with mechanical unit injectors.
- Unit replacement facility for power assemblies.
- No valve seat inserts.



SERIES 710 TURBOCHARGED DIESEL ENGINE – 16-CYLINDER MODEL



1. Exhaust Outlet
2. Turbocharger
3. Lube Oil Separator
4. Turbocharger Aftercooler
5. Top Deck Cover
6. Cylinder Relief Valve
7. Crankcase Handhole Cover
8. Oil Pan Handhole Cover
9. Ring Gear
10. Cylinder Head Retainer Plate

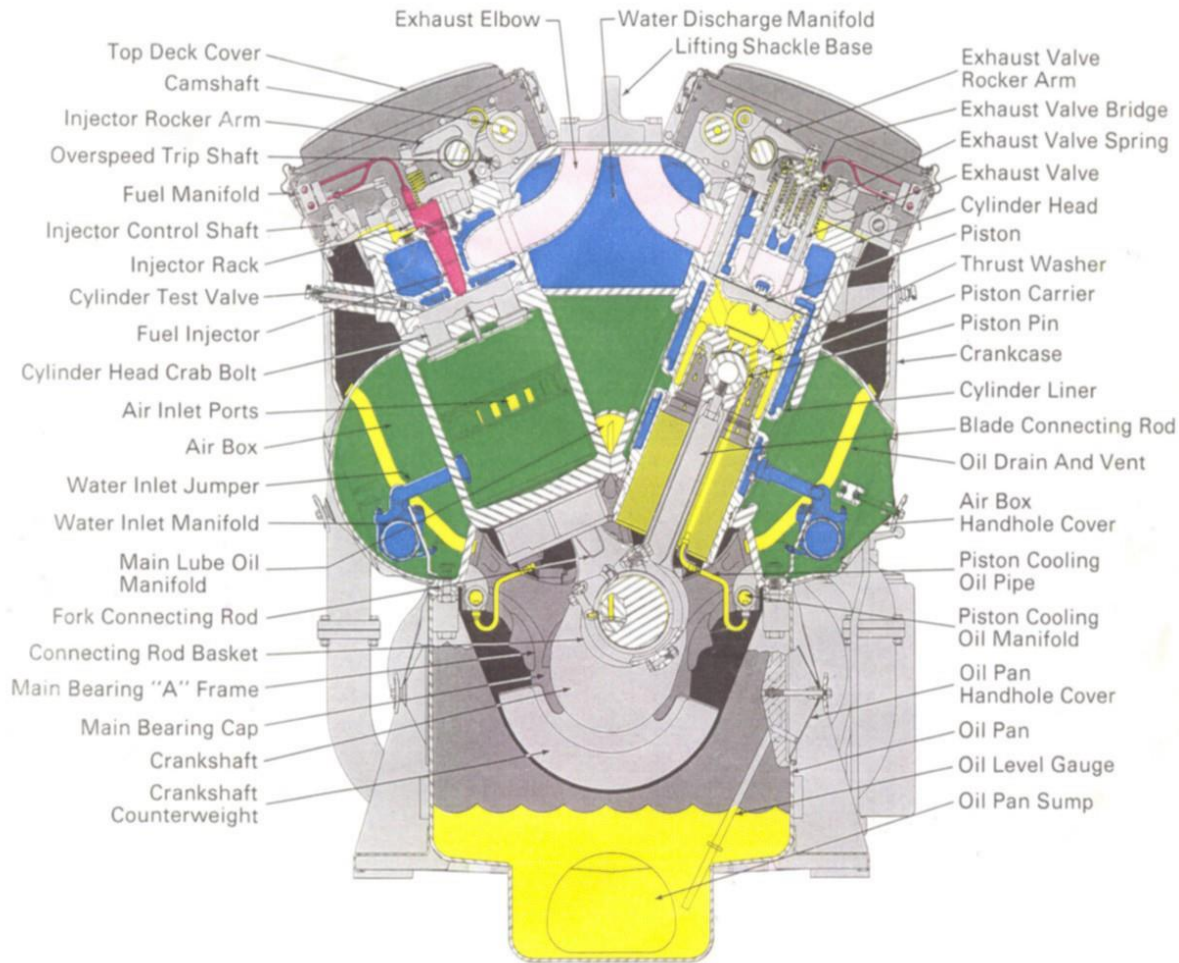
11. Rocker Arms-
Injector and Exhaust Valves
12. Exhaust Valve Bridge
13. Cooling Water Discharge Elbow
14. Cylinder Head
15. Cooling Water Inlet Jumper Line
16. Cooling Water Manifold
17. Connecting Rod-Blade
18. Connecting Rod-Fork
19. Fork Rod Basket

20. Oil Level Gauge
21. Crankshaft
22. Camshaft
23. Water Discharge Manifold
24. Airbox- Inner Vee
25. Main Lube Oil Gallery
26. "Fire-Ring" Piston
27. Exhaust Valves
28. Cylinder Head Retainer Bolt
29. Fuel Manifold

30. Fuel Injector
31. Piston Carrier
32. Thrust Washer-Carrier/Piston
33. Piston Carrier Insert Bearing
34. "Rocking" Piston Pin
35. Scavenging Oil Pump Intake
36. Oil Pan Sump
37. Main Bearing Cap
38. Connecting Rod Bearing
39. Piston Cooling Oil Manifold

40. Piston Cooling Oil Pipe
41. Main Bearing
42. Crankshaft Counterweight
43. Cylinder Liner
44. Injector Control Shaft Lever
45. Detectors-
Low Water and Crankcase Pressure
46. Low Water Detector Test Cock
47. Airbox Drain
48. Scavenging Oil Pump

49. Accessory Drive Coupling
50. Lube Oil Strainer
51. Main Lube/Piston Cooling Oil Pump
52. Cooling Water Pump
53. Governor Terminal Shaft Scale
54. Governor Integral Vane Servo
55. Governor
56. Overspeed Trip Lever
57. Exhaust Manifold
58. Cylinder Exhaust Outlet
59. Exhaust Manifold Heat Shield



SCAVENGING
AIR



LUBRICATING
OIL



EXHAUST



WATER



FUEL OIL

710 SERIES DIESEL ENGINE

ELECTRO-MOTIVE



Division of General Motors Corporation

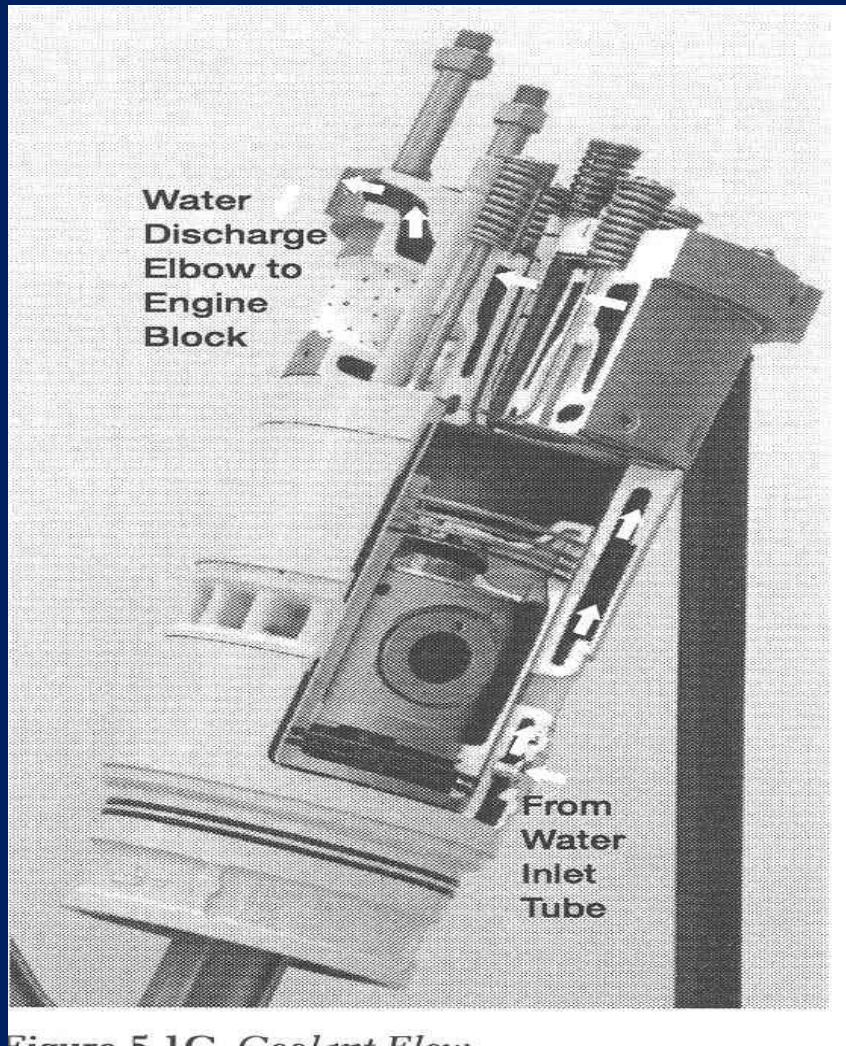


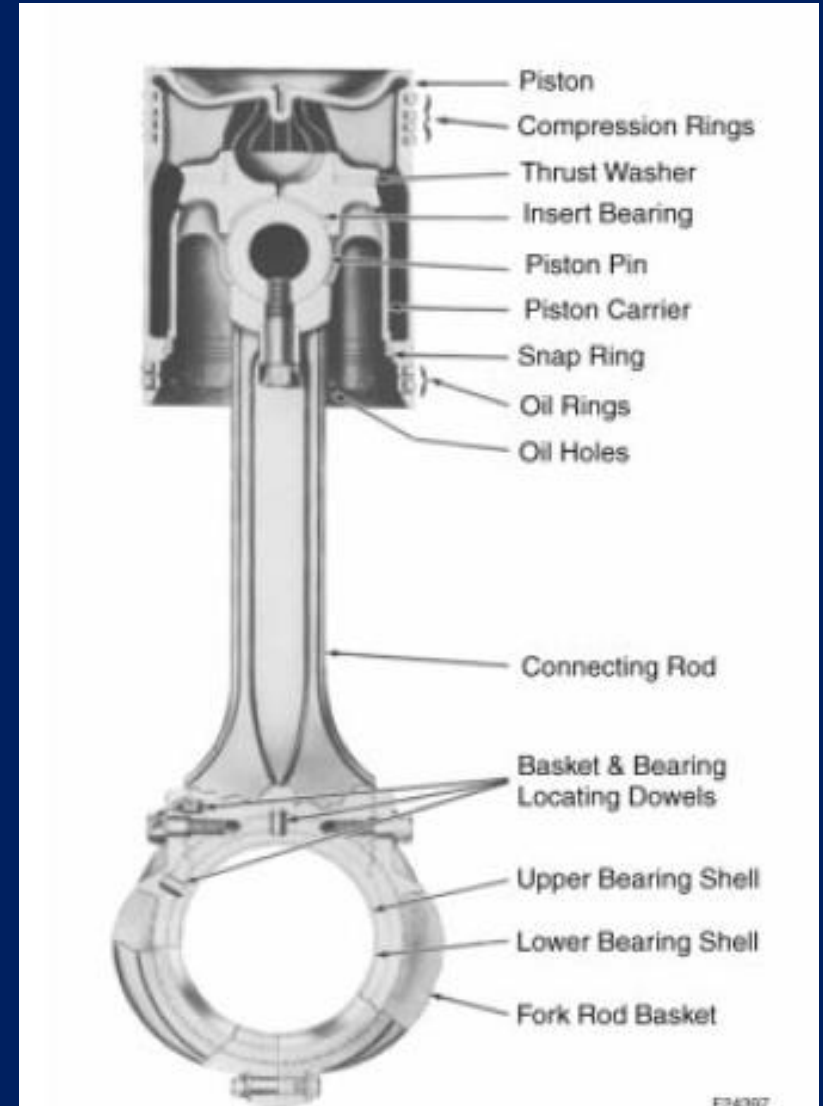
Figure 5-16. Coolant Flow

Unit exchange type Power assembly

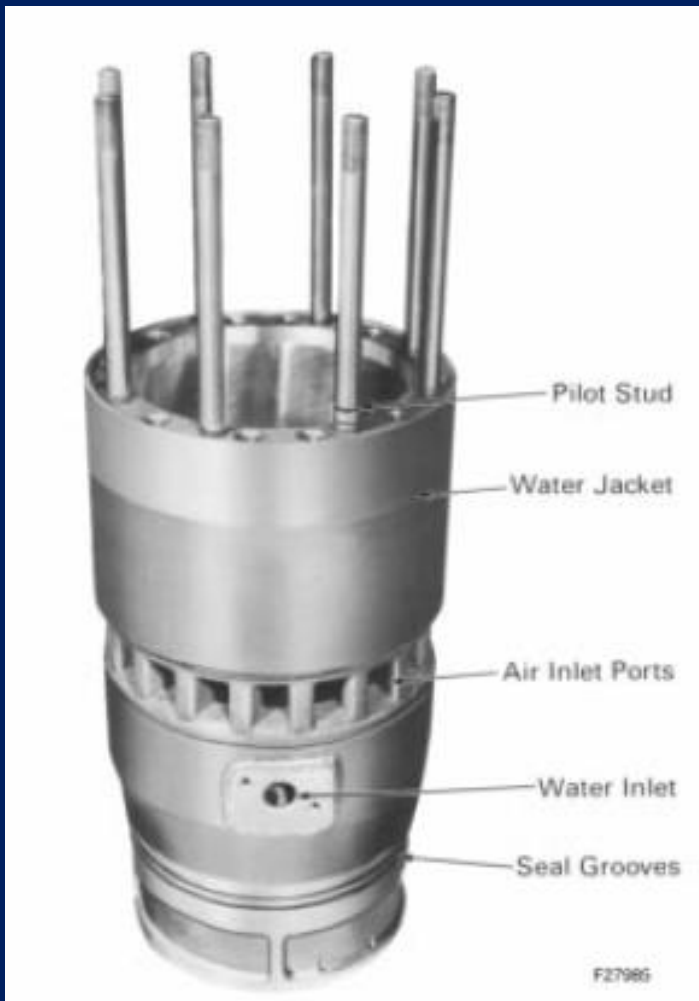
PISTON AND CON-ROD



Cast Steel Pistons
Simple Design
Splash Lubrication

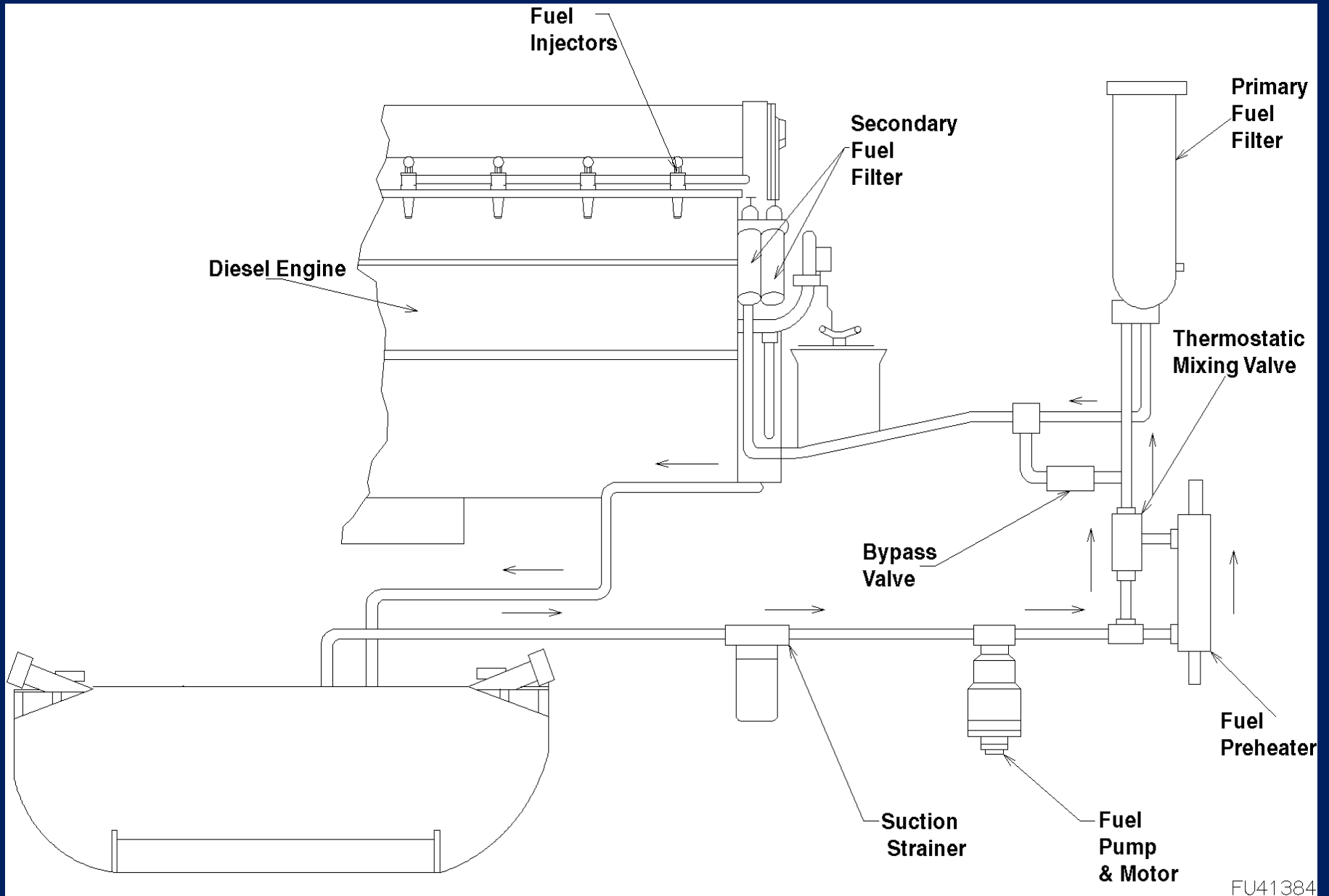


CYLINDER LINER

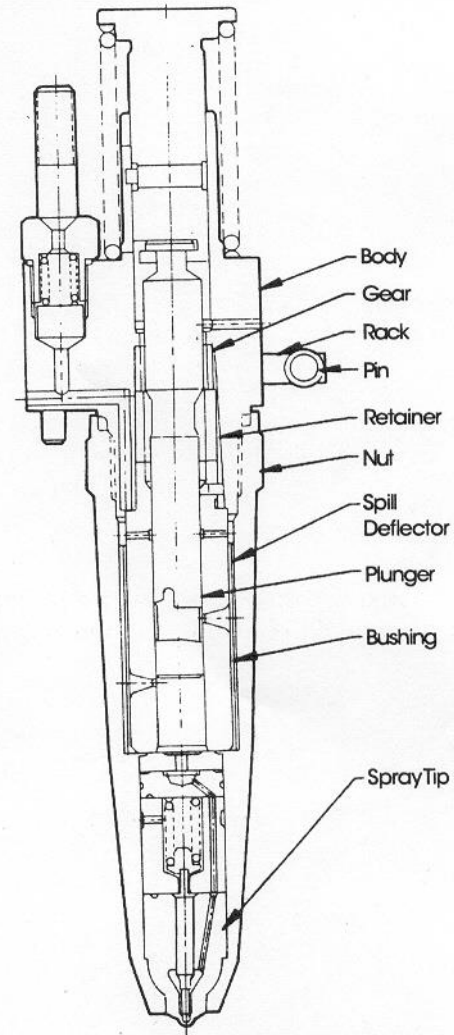
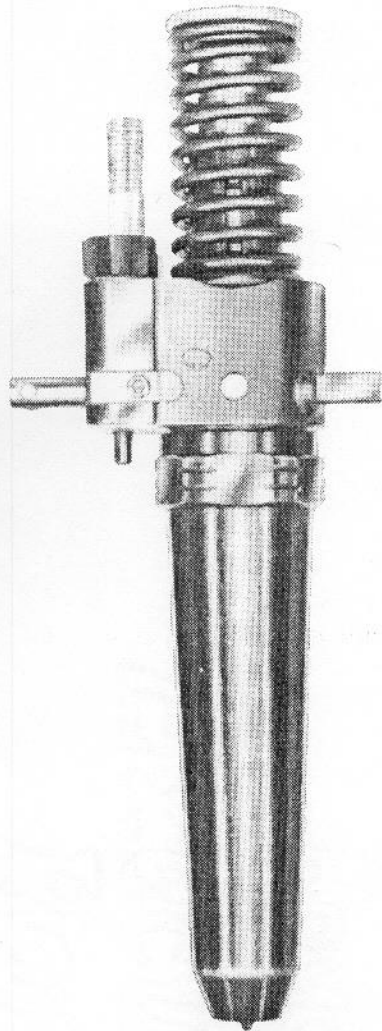


Cast Iron
Laser Hardened
Water Jacketed
Side Ports for 2-stroke Design

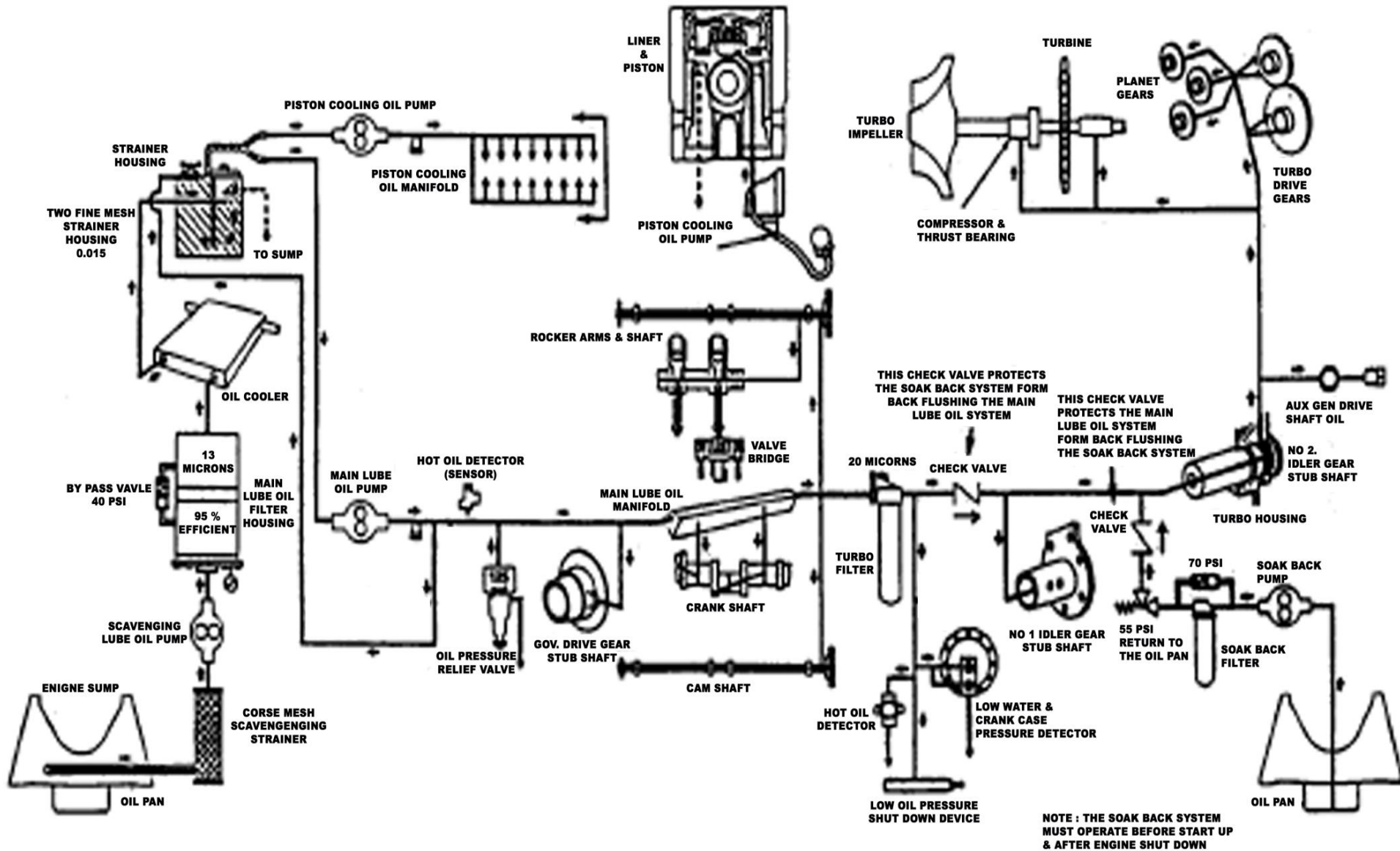
FUEL OIL SYSTEM



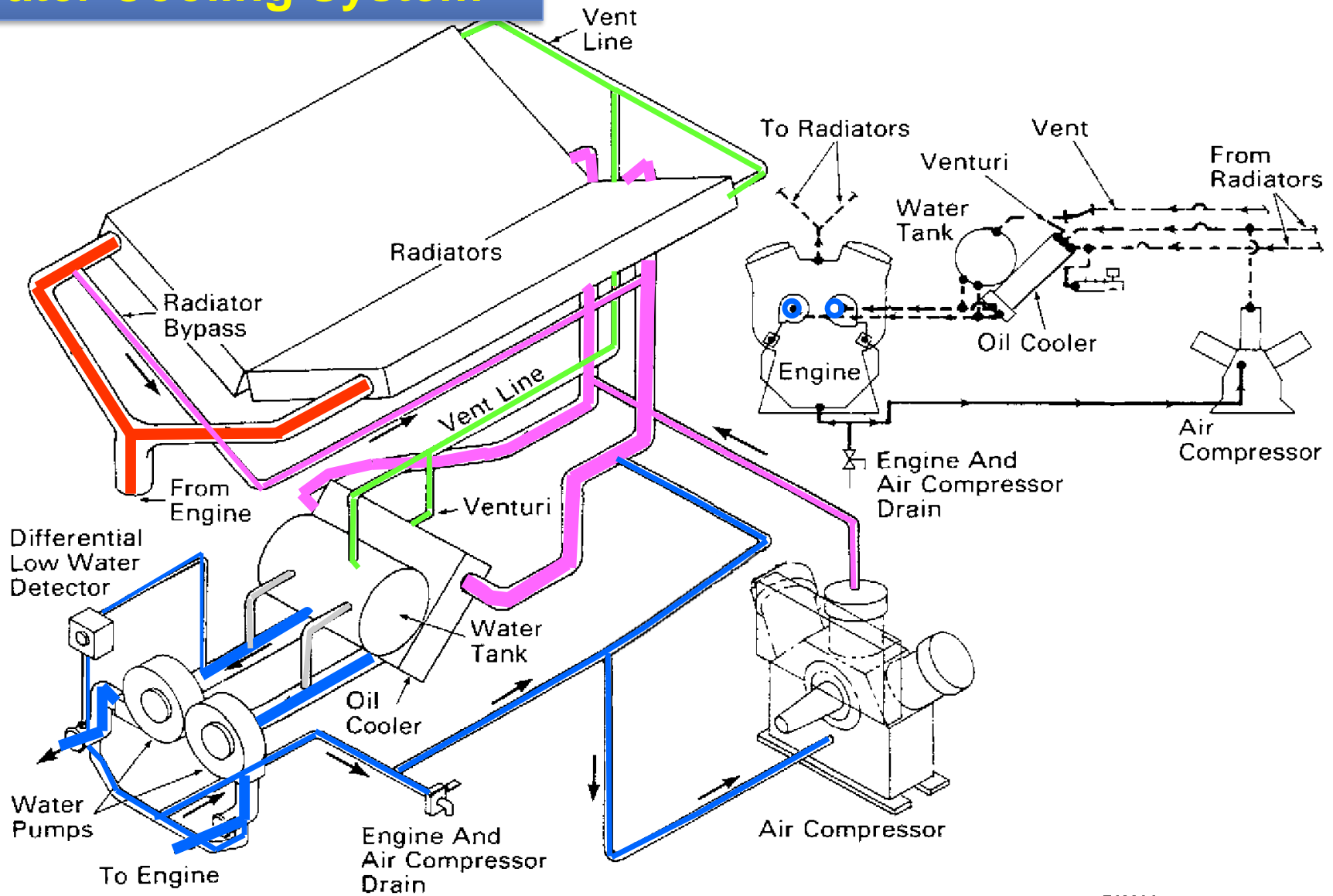
MU INJECTOR

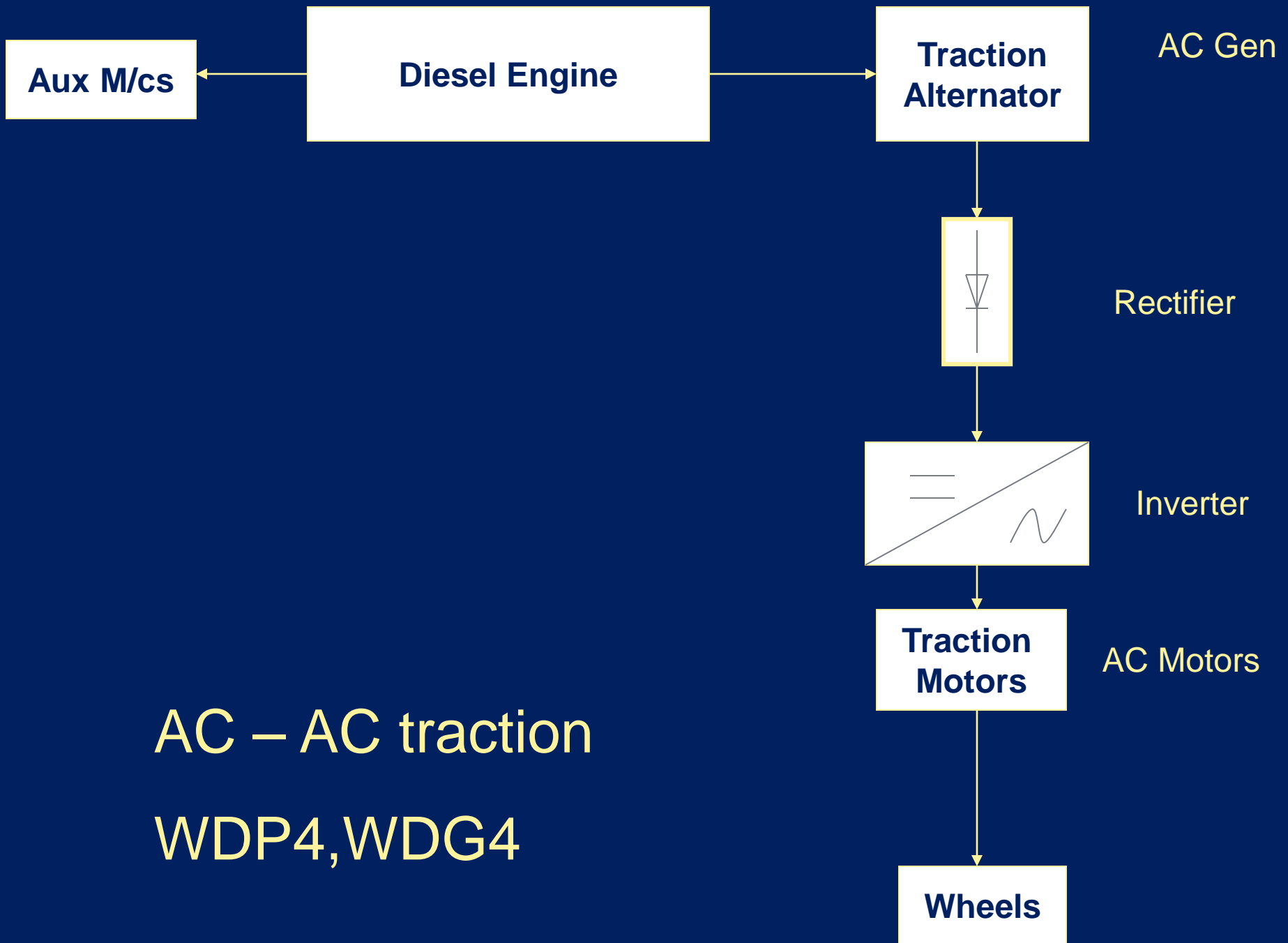


Lube Oil System

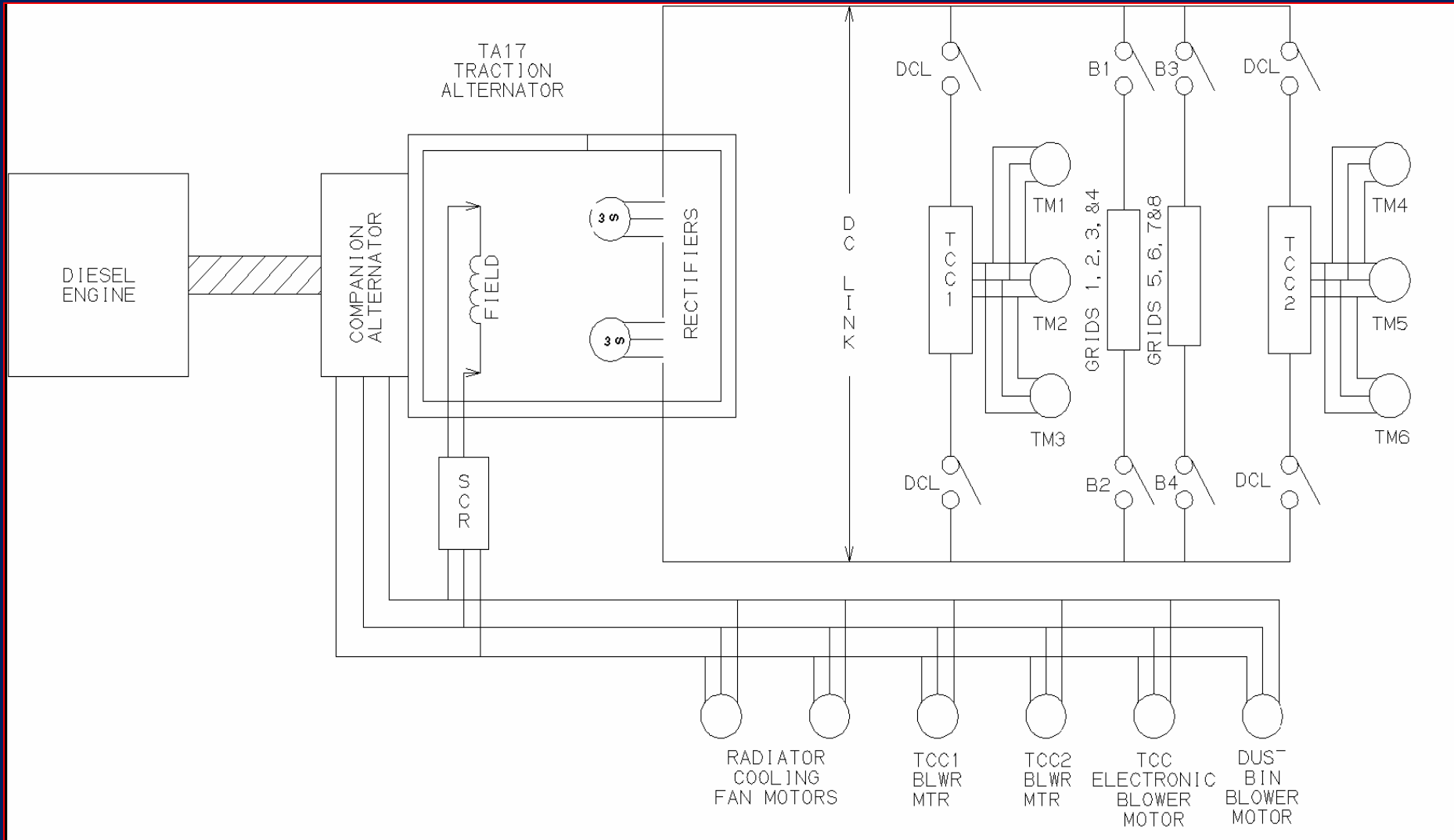


Water Cooling System





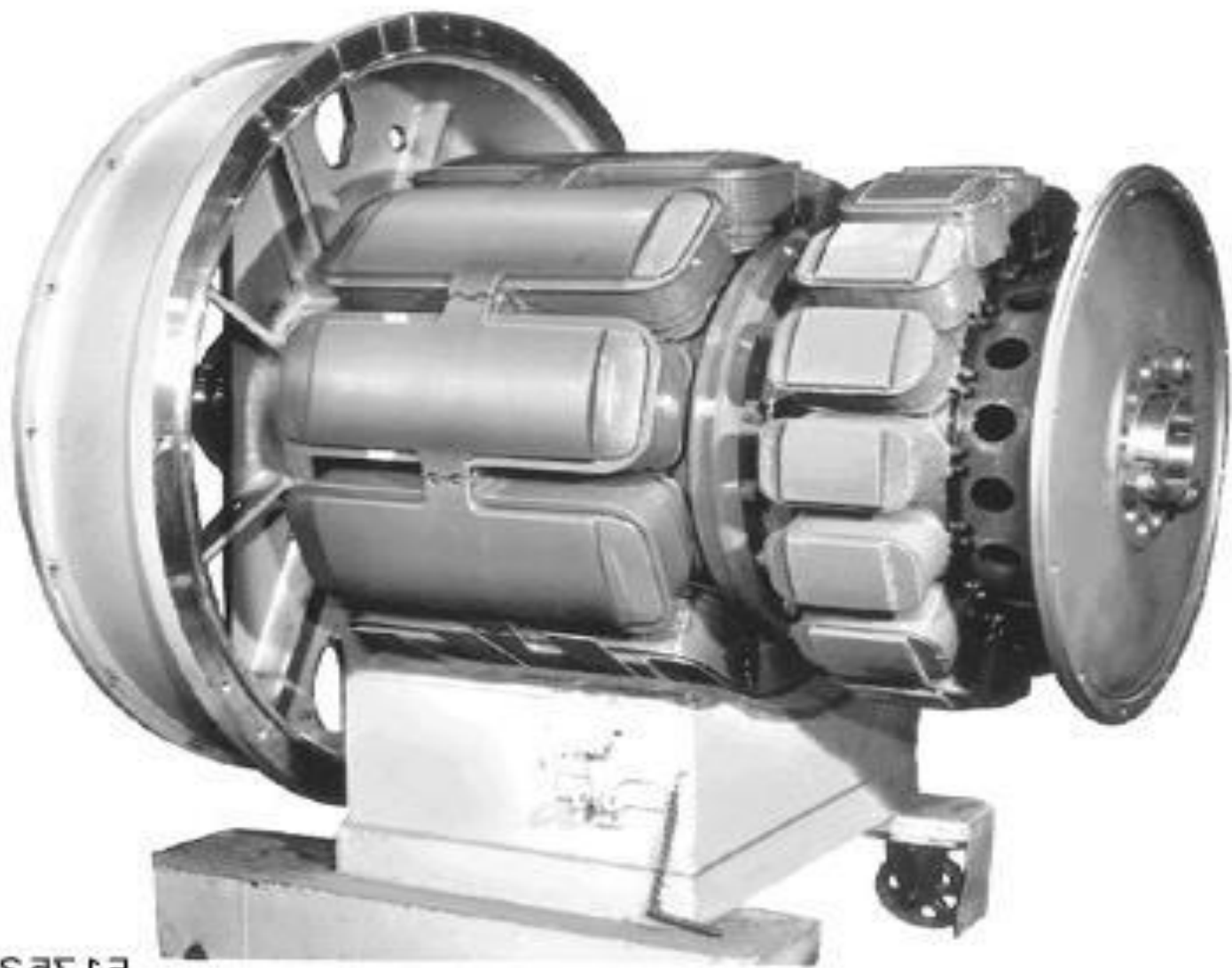
THE AC-AC SYSTEM OF EMD LOCOS



TRACTION ALTERNATOR

- ❖ Out put voltage ranges from 600 to 2600 Volts.
- ❖ Consists of two independent stator windings and a rotating field common to both the windings.
- ❖ AC output rectified to DC by rectifier banks and permanently connected in series.
- ❖ The output of traction alternator is used only for traction power.





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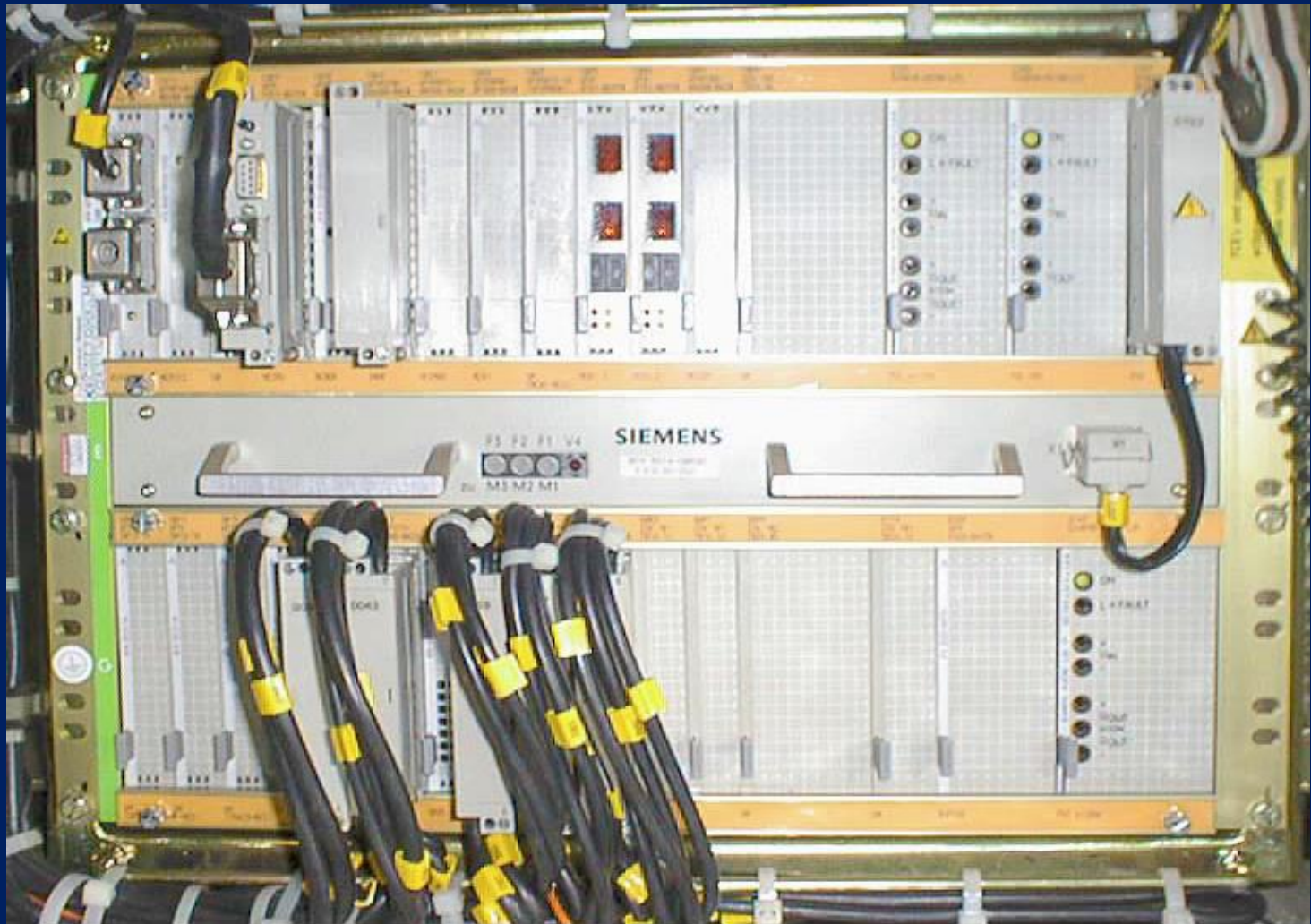
TRACTION CONTROL CABINET

- ONE INVERTOR PER TRACTION MOTOR
- CONVERTS DC INTO VARIABLE VOLTAGE VARIABLE FREQUENCY 3-PH POWER FOR TRACTION MOTOR
- CONVERTS AC FROM DYNAMIC BRAKING INTO DC

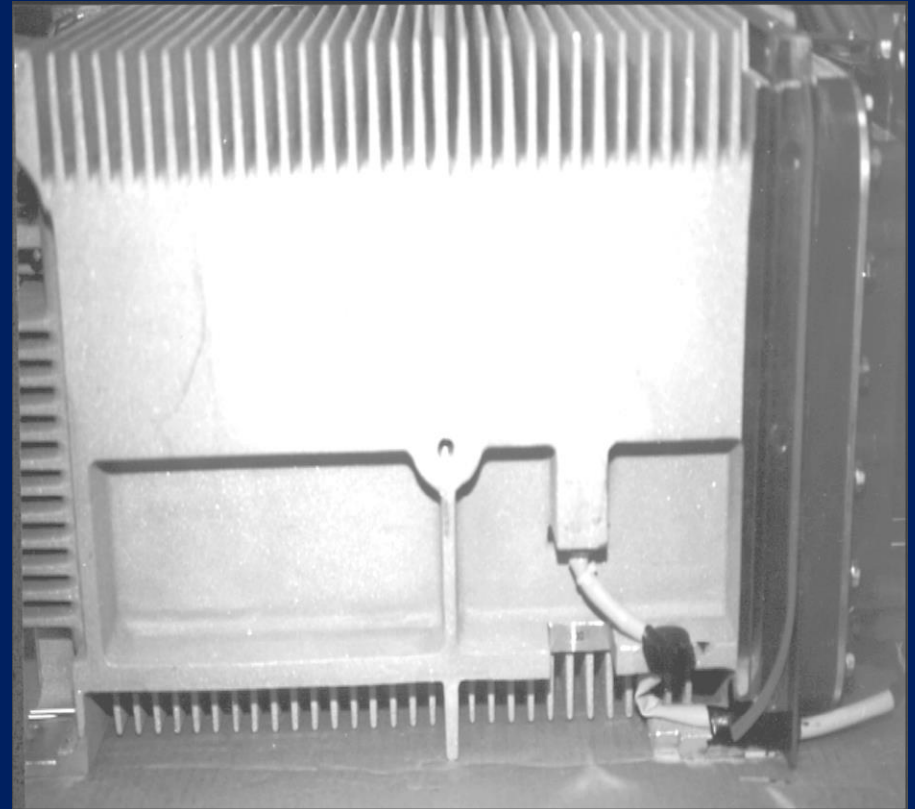
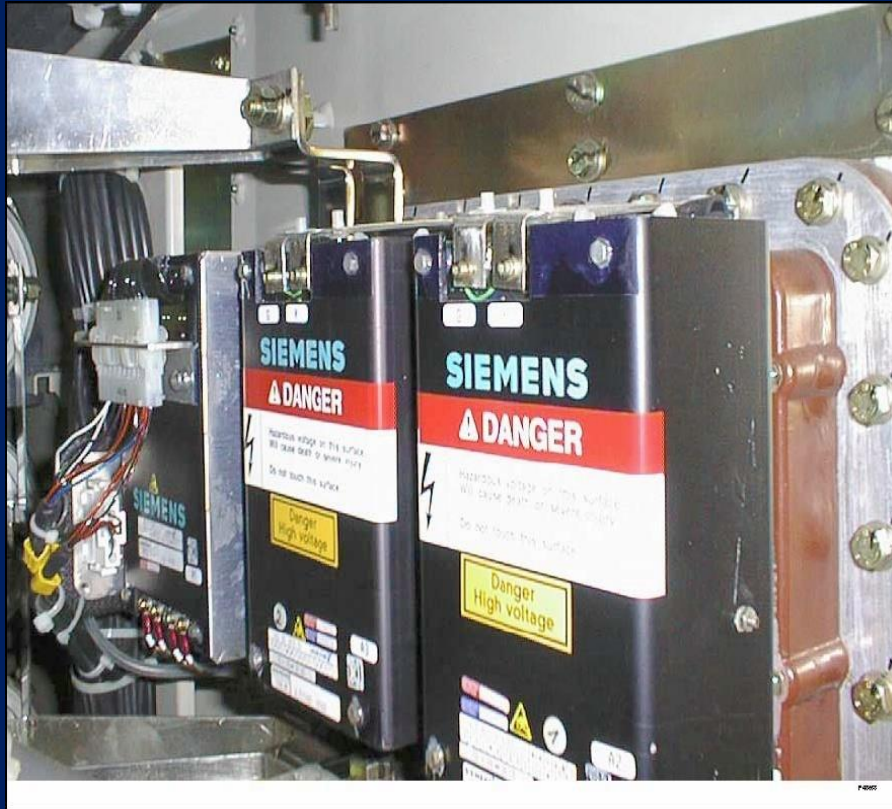
TCC COMPUTER

- This computer controls the actions of traction control converter.
- It interacts with the main locomotive control computer, i.e., LCC through RS 485 serial link.
- The control of traction power is established through this computer in coordination with LCC. It also monitors various other parameters like temperature of various components, voltages, current, status of relays etc.,
- The computer performs all these functions through a set of 28 electronic modules. Each electronic module performs different functions & monitor different parameters.

TRACTION CONTROL COMPUTER



GATE UNITS & PHASE MODULES



The units actually involved in the process of inverting DC into AC



AC Traction Motor

vs

DC Traction Motor

Size is considerably smaller

Much simpler

Coupled with suitable control system gives superior traction

LOCOMOTIVE TRUCK ASSEMBLY



LOCOMOTIVE TRUCK ASSEMBLY

- Uniform traction motor orientation and stiff secondary suspension improves weight transfer within the bogie for optimal adhesion.
- Primary suspension with coil springs for good ride quality.
- Secondary rubber springs (pads) also permit yaw on curves
- Provision of yaw dampers & vertical shock absorbers for better ride quality and stability at higher road speeds.
- Reduced no. of wear rubbing surfaces for extended maintenance intervals.

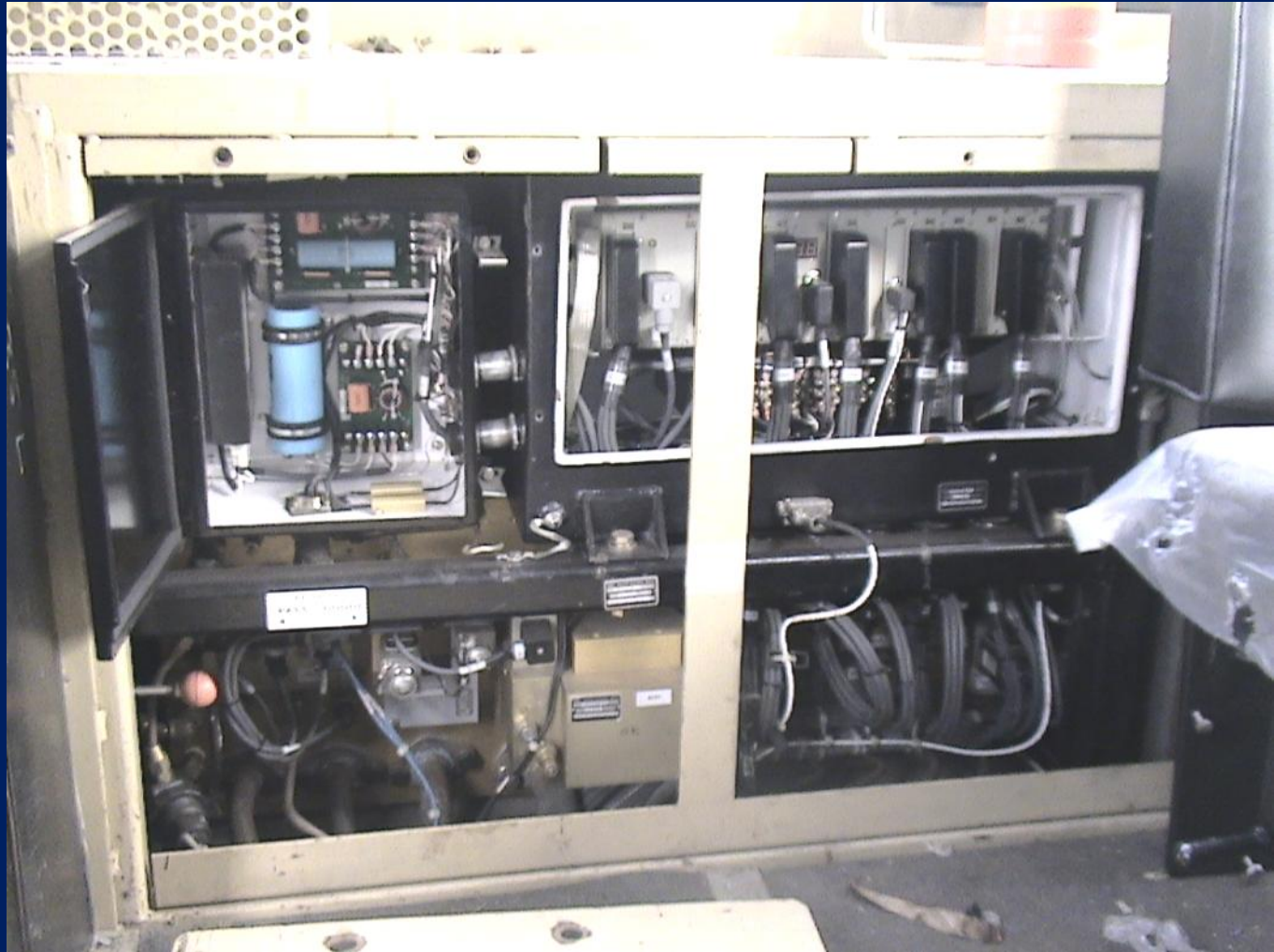
AIR BRAKE SYSTEM

- KNORR-NYAB CCB
- COMPUTER BASED ELECTROPNEUMATIC
- INTERFACE WITH LCC
- BLENDED BRAKE
- VARIABLE SPEED AEB

CCB COMPUTER

- It is an electro pneumatic micro processor based system.
- The CCB computer is also known as computer relay unit. Other units of CCB are known as voltage conditioning unit (VCU) and pneumatic control unit (PCU).
- The control of braking system is established through CCB computer directly with inputs by the Loco Pilot through the brake controller.
- CCB communicates with LCC through RS 485 serial link for displaying the data & recognising demands put by LCC on CCB system based on the inputs by the driver.

CCB

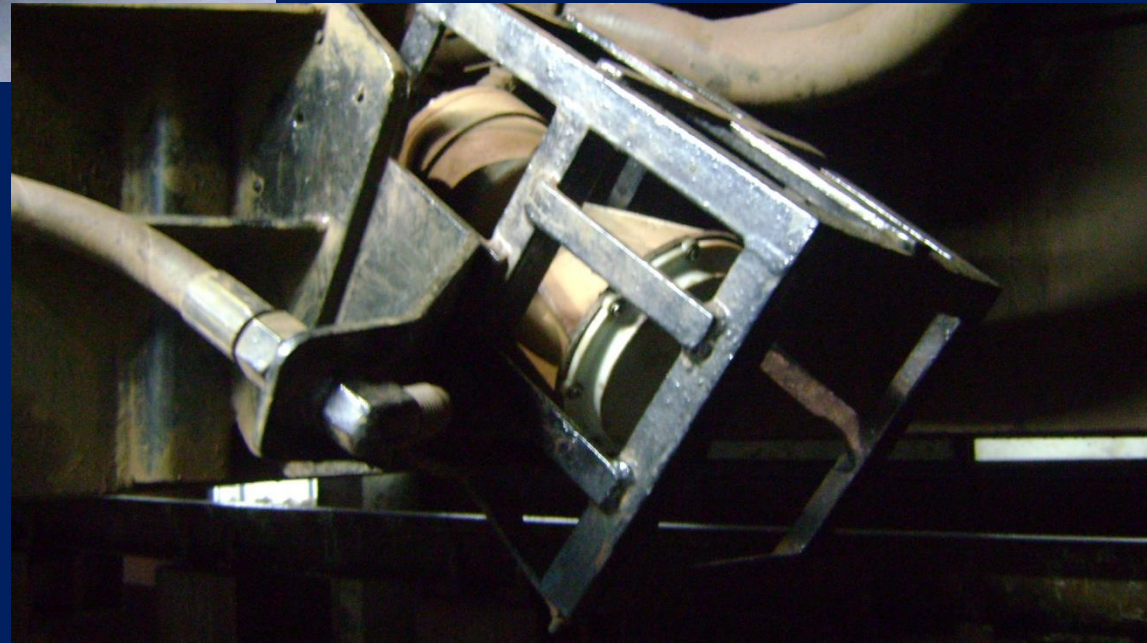


RADAR ASSEMBLY



Looks down at the ground and compares the linear speed of the loco with the Rotary speed of the wheels

Controlled creep of wheels on rail maximizes adhesion and makes it possible to utilise maximum torque of traction motor for traction



(WHEEL) CREEP CONTROL

The locomotive radar interacts with the loco computer.

Two sub functions

Wheel Creep Control - operates at all times in motoring and dynamic braking.

Improves tractive effort under adverse rail conditions (wet or oily rails) by adjusting wheel speed to maximize motor torque.

SCHEDULE PERIODICITY WDG4 & WDG3A

| Conventional sch | WDG4 | WDG3A |
|-------------------------|-----------------|----------------------|
| Trip | 90 Days | 15/30/40 Days |
| Quarterly | 1 year | M4, 8, 16,20 |
| Half Yearly | 3 Years | M12 |
| Yearly | 6 Years | M24, 48,72 |
| POH | 18 years | 8 years |

Authority: MP MISC 285 for WDG4
: MP MISC 140 &141 for WDG3A

COMPARISON OF WDG3A , WDG4 & WAG9

| Description | WDG3A | WDG4 | WAG9 |
|---|---------------------------------|------------------------|--|
| Length (Mtrs.) | 19.13 | 21.24 | 20.6 |
| Weight in Tons | 123 | 126 | 123 |
| Brake System | Pneumatic | Micro processor | Pneumatic/ micro processor |
| HP | 3100 | 4500 | 6000 |
| Starting Tractive effort(KN) | 398 | 520 | 460 |
| Continuous TE(KN) | 313 | 400 | 325 |
| Slip control | Wheel Slip relay control | Computerised | Relay control/ Computerised |
| Starting capability in 1/200 gradient(in tons) | 4400 | 5190 | 4700 |

COMPARE WITH OTHER LOCOS

STARTING LOAD ON 1/150 GRADIENT

| CLASS | LOAD | |
|-------------|-----------|-------------|
| | BOXN | TONNES |
| WDM 2 | 33 | 2700 |
| WDG 2 | 47 | 3850 |
| WAG 5 | 38 | 3110 |
| WAG 7 | 46 | 3767 |
| WAG9 | 52 | 4258 |
| WDG4 | 58 | 4750 |

THANK YOU