

SD38-2

**OPERATOR'S
MANUAL**

Electro-Motive Division
La Grange, Illinois



SD38-2

**O P E R A T O R ' S
M A N U A L**

November, 1972

SERVICE DEPARTMENT

Electro-Motive Division
La Grange, Illinois

Litho in U.S.A.

INTRODUCTION

NOTICE

The data appearing in this manual is intended as a guide and as an aid in explaining the locomotive equipment used during operation. It is generally applicable to the basic locomotive, that is, a locomotive without optional extra equipment. Some data is also included for a number of the more frequently used extras. When special extra equipment is involved, consult specific drawings or instructions as provided by the railroad.

The information contained in this manual is based on data available when released for printing.

Minor differences encountered in equipment are due to changes made after the manual was sent to press. These changes will be covered in subsequent editions of this manual.

CAUTION

Do not disengage any circuit modules or operate any test switches during locomotive operation.

Do not disengage the VR module unless the diesel engine is completely stopped.

This manual has been prepared to serve as a guide to railroad personnel engaged in the operation of the 2000 horsepower General Motors Model SD38-2 diesel-electric locomotive.

The contents are divided into four sections as follows:

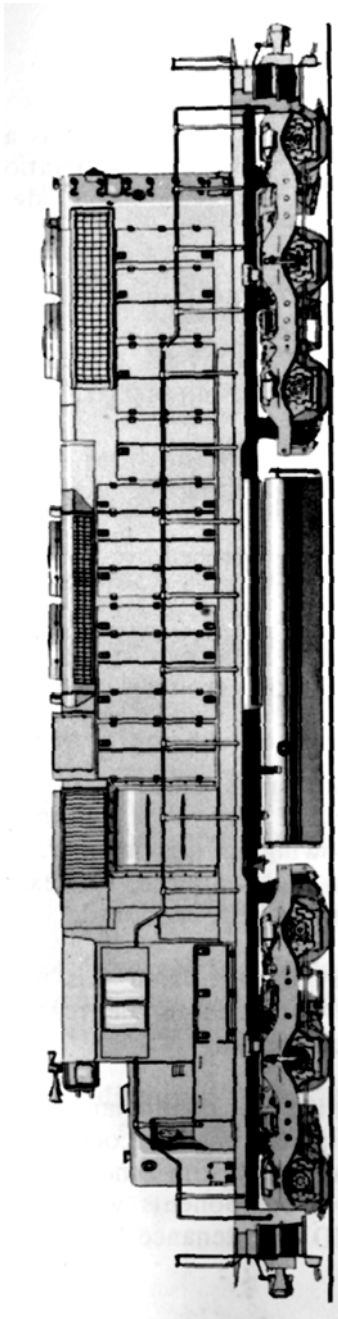
1. General Description -- Provides general description of principal equipment components.
2. Cab Controls - Explains functions of cab control equipment used in operating the locomotive.
3. Operation - Outlines procedures for operation of the locomotive.
4. Trouble Shooting - Describes cause, location and correction of possible troubles occurring during operation.

A block of page numbers is allocated to each section, Section 1 starting with page 1-1, Section 2 with 2-1 and the others following in this manner. Figures are identified by section and sequence. For example: Fig. 2-3 is the third figure used in Section 2.

To obtain the most benefit from this manual, it is recommended that the sections be read in the sequence in which they appear.

Information pertaining to maintenance, adjustment, and testing is contained in the Locomotive Service Manual. Instructions for testing and maintenance of individual locomotive components will remain a part of the standard EMD Maintenance Instruction bulletin series.

GENERAL DATA



Model Designation	SD38-2
Locomotive Type	(C-C) 0660
Locomotive Horsepower	2000
Diesel Engine	
Model	645E
Type	Blower Aspirated
Number Of Cylinders	16
Cylinder Arrangement	45° "V"
Cylinder Bore And Stroke	9-1/16" x 10"
Operating Principle	2 Stroke Cycle, Blower Aspirated, Unit Injection, Water Cooled
Full Speed	900 RPM
Idle Speed	315 RPM
Main Generator Model	AR 10 - D14
Traction Alternator (Rectified Output)	AR 10
Number Of Poles	10
Nominal Voltage (DC)	600
Frequency (At 900 RPM)	75 cps
Companion Alternator	D 14
Nominal Voltage (AC)	215
Number Of Poles	16
Frequency (At 900 RPM)	120 cps
Auxiliary Generator	
Voltage (DC)	74
Rating	10 KW
Traction Motors	
Model	D77
Number	6
Type	DC, Series Wound Axle Hung
Driving Wheels	
Number	6 Pair
Diameter	40"
Tread	Tapered

GENERAL DATA (Cont'd)

Maximum Speed Options With Gear Ratio

Gear Ratio	Top Speed* MPH	Minimum Continuous MPH
62:15	65	6.8
61:16	70	7.4
60:17	76	8.0
59:18	82	8.6

*Based on rated RPM of traction motors.

Air Compressor

Type	2 Stage
Number Of Cylinders	3
Capacity (At 900 RPM)	254 Cu. Ft./Min.
Air Compressor Cooling	Water
Lube Oil Capacity	10-1/2 Gal.

Storage Battery

Number Of Cells	32
Voltage	64
Rating (8 Hour)	420 Amp Hr.

Supplies

Lubricating Oil Capacity	243 Gal.
With Deep Sump Oil Pan	395 Gal.
Cooling Water Capacity	240 Gal.
Fuel Capacity (Basic)	3200 Gal.
With Extra Capacity	4000 Gal.
Sand	56 Cu. Ft.

Air Brakes	Type 26L
Approximate Weight On Rails	368,000 lbs.
Weight On Drivers	100%

GENERAL DATA (Cont'd)

Major Dimensions

Width Over Cab Sheeting	10' 0-1/8"
Width Over Basic Arm Rests	10' 3-1/8"
Height, Top Of Rail To Top Of Cooling Fan Guards	15' 7-1/4"
Distance Between Coupler Faces	68' 10"
Distance, Pulling Face Of Coupler To Bolster Centerline	12' 8"
Distance Between Bolster Centers	43' 6"

Minimum Curve Negotiation Capability

193 Ft. Radius -- 30° Curve - Single Unit With Single Shoe Or Clasp Brakes.
262 Ft. Radius -- 22° Curve - Two Units Coupled.
359 Ft. Radius - 16° Curve - Unit Coupled To Standard 50 Ft. Box Car.

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SECTION 1

GENERAL DESCRIPTION

INTRODUCTION

The General Motors Model SD38-2 locomotive, illustrated in Fig. 1-1, is equipped with a diesel engine that delivers 2000 horsepower to the main generator for tractive purposes. This power is then distributed to the traction motors, each of which is directly geared to a pair of driving wheels.

The basic locomotive is arranged and equipped so that the short hood or cab end is considered the front or forward part of the unit. However, the locomotive operates equally well in either direction, and on special order controls may be arranged so that the long hood end is forward, or dual controls may be provided.

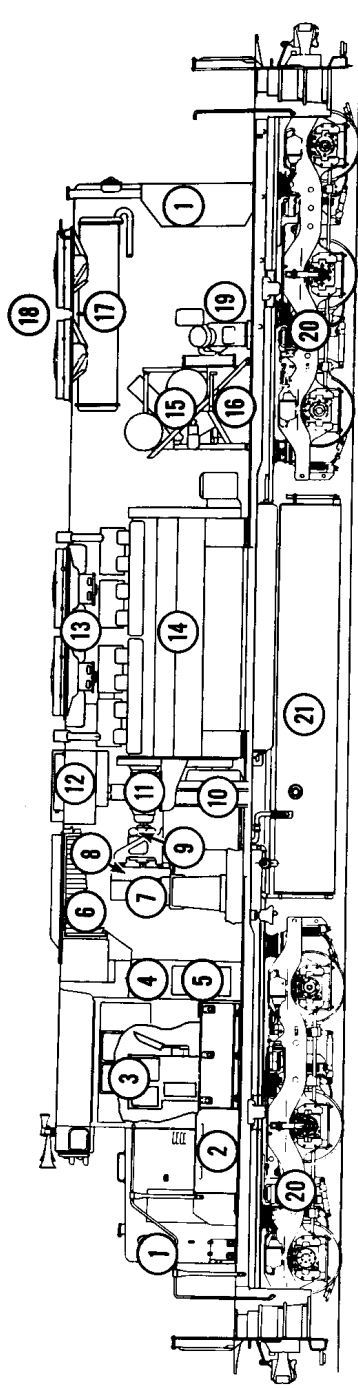
The locomotive may consist of one or more individual units, each of which is a completely functional power plant. When coupled together for multiple unit operation, all can be simultaneously controlled from a single set of controls located in the cab of the lead unit. This is accomplished through jumper cables connected between the units.

The general arrangement of equipment used on the locomotive is shown in Fig. 1-1. Each of the more important equipment components is numbered and identified in this illustration.

On special order, the locomotive can be equipped with a steam generator for use in passenger service. The fuel tank is divided into a combination fuel tank and water tank and the gear ratio at the traction motor pinion will generally be suitable for high speed operation.

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|----------------------------------|---------------------------|--------------------|
| 1. Sand Box | 8. Main Generator Blower | 15. Equipment Rack |
| 2. Battery | 9. Auxiliary Generator | 16. AC Cabinet |
| 3. Control Stand | 10. Main Generator | 17. Radiators |
| 4. Electrical Cabinet | 11. Engine Blower | 18. Cooling Fans |
| 5. Electrical Cabinet Air Filter | 12. Engine Air Filter | 19. Air Compressor |
| 6. Inertial Filter | 13. Dynamic Brake Blowers | 20. Truck |
| 7. Traction Motor Blower | 14. Diesel Engine | 21. Fuel Tank |

Fig. 1-1 -- General Arrangement, SD38-2 Locomotive

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Operating instructions are the same, except for those operations relating to the steam generator. Instructions for operation of the steam generator are provided by the manufacturer of that equipment.

HOW THE LOCOMOTIVE OPERATES

1. The fuel pump is driven by an electric motor which, for fuel priming, uses current from the storage battery. Once the engine is started and running, the fuel pump motor uses current directly from the auxiliary generator. The fuel pump transfers fuel from the fuel tank under the locomotive to the engine injectors.
2. The diesel engine is started by means of two cranking motors that engage the flywheel ring gear when starting current is applied. The storage battery supplies electric current to engage the starting pinions and rotate the cranking motors.
3. When the engine is running, it supplies mechanical power through shafts and couplings to directly drive three electrical generators, the air compressor, motor and generator blowers, and engine mounted lube oil and cooling water pumps.
4. The auxiliary generator charges the storage battery and supplies low voltage direct current for the control and lighting circuits. The companion alternating current generator furnishes power to the static exciter, various transducers, the radiator cooling fans, and the inertial separator blower motor. The main traction alternator supplies high voltage AC to a power rectifier assembly which then delivers high voltage DC to the traction motors for locomotive pulling power.

5. By means of the cab controls, low voltage circuits are established to actuate the engine governor and the switchgear in electrical cabinets. This switchgear controls generator excitation and distribution of power.
6. Traction motors are located under the locomotive. Each traction motor is directly geared to an axle and pair of driving wheels. These motors are located in two trucks which support the locomotive weight and distribute it to the driving wheels.
7. The throttle electrically controls speed and power by actuating a governor mounted on the engine and by tying the response of the locomotive power control system to throttle position. The main generator converts the engine's mechanical power to electrical power, which is then distributed to the traction motors through circuits established by the various switchgear components in the electrical cabinet.
8. At locomotive start the throttle controls electrical devices that provide rapid power response at a level consistent with smoothly controlled starting.
9. If the locomotive is equipped for performance control, either basically or on special order, electrical devices operating within traction motor capabilities control power at an optimum level. This is done to achieve the desired minimum continuous speed capability at full power and the desired short time power rating. The load regulator, however, remains the main power controlling device, and through most of the operating range of the locomotive maintains power output at the specific level called for by throttle position.

GENERAL DESCRIPTION

10. The air compressor supplies, to the reservoirs, air under pressure used primarily for the air brakes. The air brakes are controlled by the operator through suitable equipment in the cab.
11. Except for manual operation of the cab controls, the locomotive operation is completely automatic. Various alarms and safety devices will alert the operator should any operating difficulties occur.

SECTION 2

ENGINE STARTING AND CAB CONTROLS

INTRODUCTION

A switch for fuel priming and engine cranking is located at the equipment rack in the engineroom. All other basic control equipment used during locomotive operation is at four locations within the cab, Fig. 2-0.

1. Switch And Fuse Panel
2. Circuit Breaker Panel
3. Engine Control Panel
4. Locomotive Control Stand

ENGINE STARTING CONTROLS, Fig. 2-1

Fuel Prime And Engine Start Switch

This switch, located on the equipment rack in the engineroom, is a three-position rotary switch used for fuel priming and engine starting. Before attempting to start the diesel engine, the isolation switch in the locomotive cab must be placed in the START position. The rotary switch must then be placed in the FUEL PRIME position and held there for 10 to 15 seconds to operate the fuel pump. The layshaft lever must then be positioned and the rotary switch placed in the ENGINE START position and held (for no longer than 20 seconds) until the engine starts.

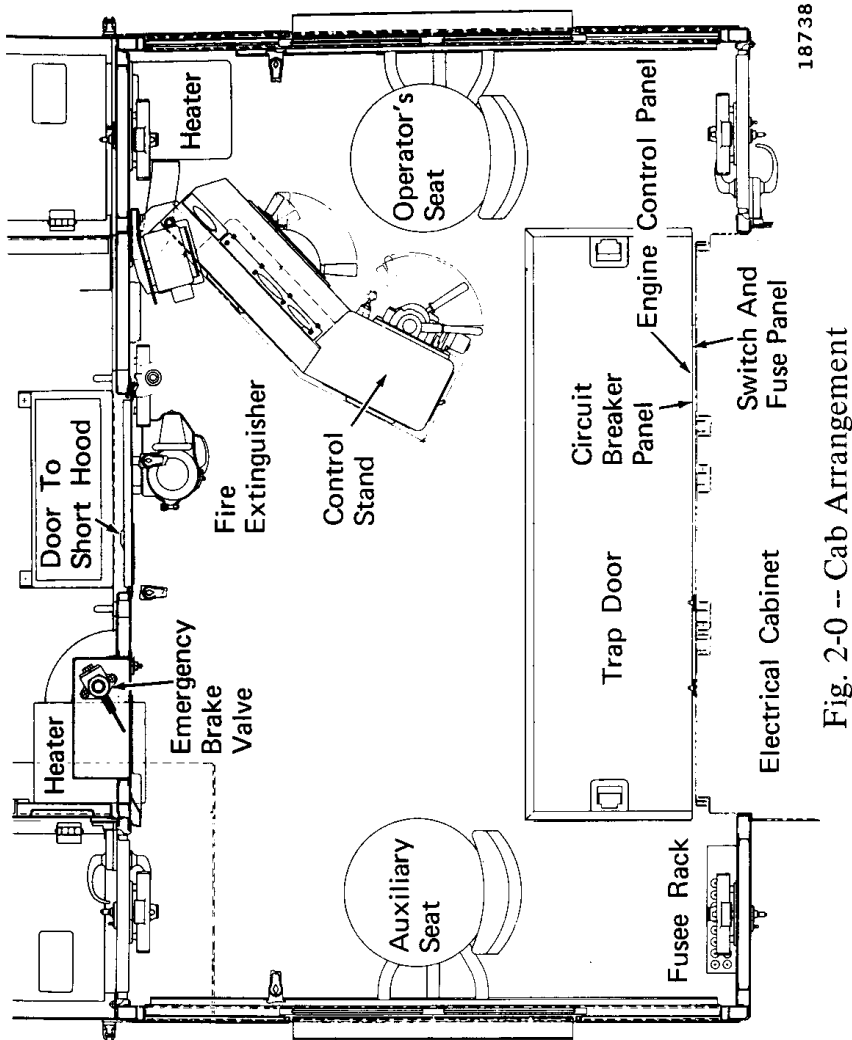
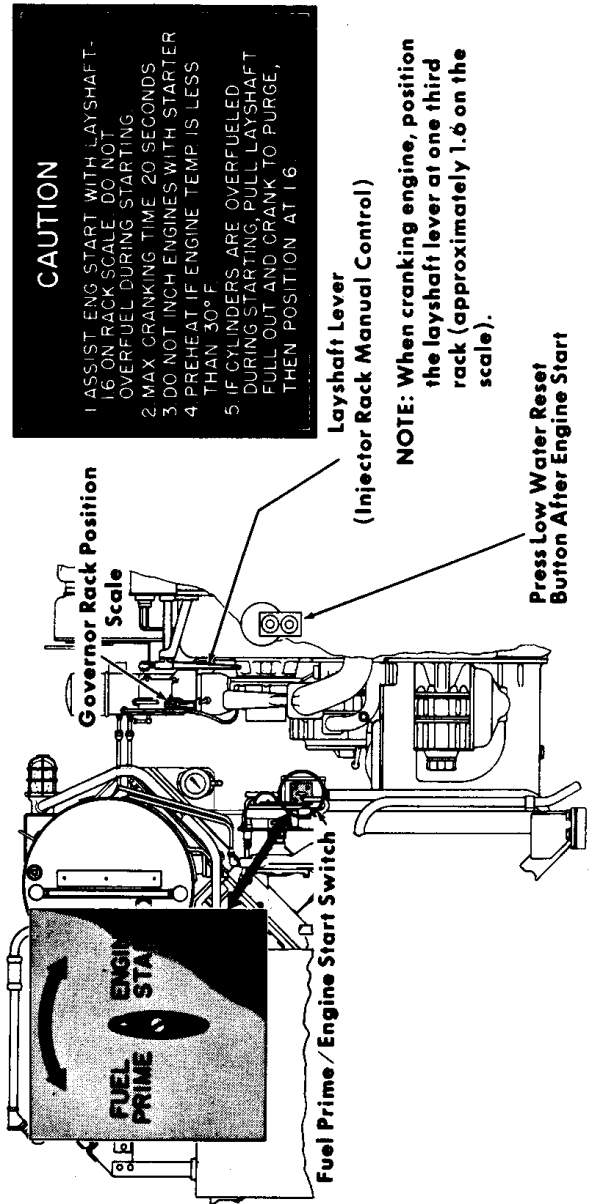


Fig. 2-0 -- Cab Arrangement



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Fig. 2-1 – Engine Starting Controls

Layshaft Lever

This engine mounted hand operated lever operates the injector racks. It is used to position the injector racks during engine cranking, thereby providing an immediate supply of fuel to the cylinders.

Low Water Reset Pushbutton

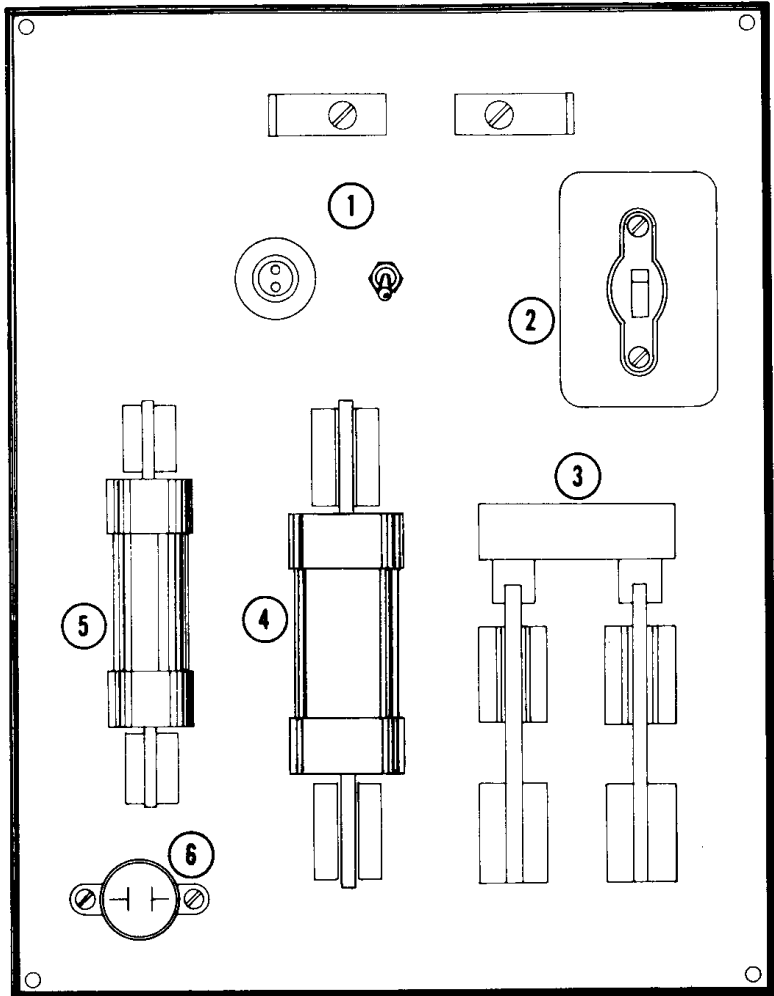
The low water detector will often trip during engine starting, especially when the engine is cold or when the water tank pressure cap has been removed to add water. The detector should be reset as soon as the engine starts and is idling, or else the engine will shut down after a time delay established by the governor. Check the low water reset pushbutton after every engine start.

NOTE: The reset buttons on some detectors will not latch in when the engine is shut down. If such a condition is encountered, reset the device after engine start.

SWITCH AND FUSE PANEL, Fig. 2-2

This panel is located within the electrical cabinet that forms the rear wall of the locomotive cab. Its position is directly below the engine control panel which is located in the upper left hand corner of the electrical cabinet.

NOTE: There is no D14 alternator field fuse. If a short occurs in the alternator field circuit, the auxiliary generator being a self excited machine will not support the short. Voltage will come down, and the machines will not be harmed. A "no power" alarm will be given, and engine speed and power will be reduced to idle condition.



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1. Fuse Test Equipment
2. Ground Relay Cutout Switch
3. Main Battery Switch
4. Starting Fuse
5. Auxiliary Generator Fuse
6. 74 V DC Receptacle

Fig. 2-2 -- Switch And Fuse Panel

Fuse Test Equipment

To facilitate the testing of fuses, a pair of fuse test blocks, a test light and a test light toggle switch are installed on the fuse panel. Fuses may be readily tested as follows. First, move the toggle switch to the ON position to make sure the fuse test light is not burned out. Extinguish the light by moving the toggle switch to the OFF position. Place a fuse across the test blocks so that the metal ends of the fuse are in firm contact with the blocks. If the fuse is good, the light will come on. If the fuse is burned out, the light will not come on and a new fuse is required.

It is always advisable to test fuses before installing them in their circuits. Always isolate the circuits in question by opening their switches before changing or replacing fuses.

Ground Relay Cutout Switch

The purpose of the ground relay cutout switch is to eliminate the ground protective relay from the locomotive circuits during certain shop maintenance inspections. It **MUST ALWAYS BE KEPT CLOSED** in normal operation. When this multiple pole toggle switch is open, it prevents excitation of the main generator and speedup of the diesel engine in addition to cutting out the ground protective relay.

Auxiliary Generator Fuse

This fuse connects the auxiliary generator to the low voltage system. It protects against excessive current demands. A 150 ampere

fuse is installed for the basic auxiliary generator and a 250 ampere fuse is installed for the heavy duty generator. In the event that the fuse is burned out, it stops auxiliary generator output to the low voltage system and also stops fuel pump operation. An alternator failure (no power) alarm would then occur. The engine will go to idle speed and then stop from lack of fuel.

CAUTION: The 250 ampere fuse is of the same physical size as the starting fuse. Do not interchange these fuses.

Starting Fuse

The starting fuse is in use only during the period that the diesel engine is actually being started. At this time, battery current flows through the fuse and starting contactor to the cranking motors.

Although this fuse should be in good condition and always left in place, it has no effect on locomotive operation other than for engine starting. A defective fuse can be detected when attempting to start the engine, since at that time (even though the starting contactors close) the cranking circuit is open.

CAUTION: Depending upon the type of cranking motor circuit employed, locomotives are equipped with either 400 or 800 ampere starting fuses. The two fuses are of the same physical size. Observe fuse panel marking. Do not use an incorrectly rated fuse.

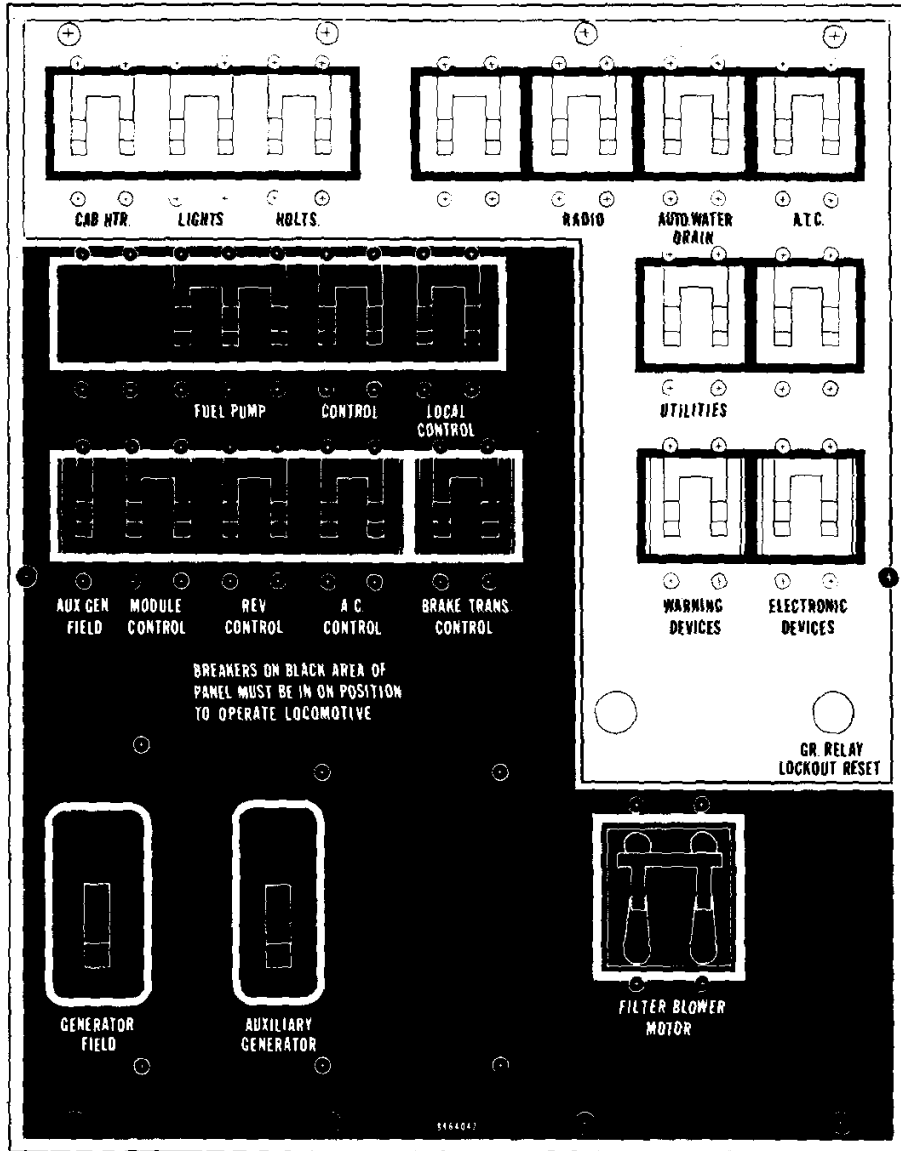
Main Battery Knife Switch

The large double-pole single-throw knife switch at the lower portion of the fuse panel is the main battery switch. It is used to connect the battery to the locomotive low voltage system and should be kept closed at all times during operation.

This switch may be opened during certain shop maintenance procedures and in instances where the engine is shut down and the locomotive taken out of service for an extended layover. This will prevent the battery from being discharged in the event the lights or other low voltage devices are inadvertently left operating during the layover.

CIRCUIT BREAKER PANEL, Fig. 2-3

This panel is located in the electrical cabinet, directly below the engine control panel. The panel is divided into two sections, one containing those circuit breakers that must be in the ON position to operate the locomotive, and the second section containing those breakers for lights and miscellaneous devices that are used as conditions require.



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Fig. 2-3 -- Circuit Breaker Panel

BREAKERS REQUIRED ON FOR LOCOMOTIVE OPERATION

Fuel Pump Motor Circuit Breaker

This three pole breaker protects the fuel pump motor circuit. A fuel filter bypass valve is provided to prevent overloading the fuel pump motor if the fuel filter becomes clogged.

Control Circuit Breaker

This circuit breaker sets up the fuel pump and control circuits for engine starting. Once the engine is running, power is supplied through this breaker from the auxiliary generator to maintain operating control.

Local Control Circuit Breaker

This circuit breaker establishes "local" power from the auxiliary generator to operate heavy duty switchgear and various control devices.

Auxiliary Generator Field Circuit Breaker

The field excitation circuit of the auxiliary generator is protected by this breaker. In the event that this breaker trips, it stops auxiliary generator output to the low voltage system and also stops fuel pump operation. An alternator failure (no power no battery charge) alarm occurs. The engine will go to idle speed and then stop from lack of fuel.

Module Control Circuit Breaker

Electrical control circuits are assembled on plug-in circuit modules to facilitate maintenance. Local control power is supplied to many of the circuit boards. This breaker protects the local control circuit to the boards.

Rev. Control Circuit Breakers

This double pole breaker is located in the feed to the operating motor of the multi-pole, motor operated, ganged switches that control the direction of current flow through the traction motor fields and thus control the direction of locomotive travel. Since control power is required to move the RV transfer switchgear from any position to any other position, the RV breaker must be closed for power transfer to take place. An open RV breaker does not prevent switchgear from already being in position to properly conduct traction motor current, but interlocking prevents an operating setup in conflict with transfer switch position.

AC Control Circuit Breaker

The **D14** alternator is the power supply for various excitation and wheel slip control devices. The breaker is employed to protect the circuitry. The No AC Voltage relay NVR is also located in this circuit. If the breaker trips during locomotive operation, a NO POWER alarm will be given.

Brake Trans. Control Circuit Breaker

On units equipped with dynamic brakes, this double pole breaker is located in the feed to the operating motor of the multi-pole, motor operated, ganged switches that control the motor field and armature

connections for either dynamic braking or power operation. Since control power is required to move the MB transfer switchgear from any position to any other position, the MB breaker must be closed for power transfer to take place. An open MB breaker does not prevent switchgear from already being in position to properly conduct motor or braking current, but interlocking prevents an operating setup in conflict with transfer switch position.

Generator Field Circuit Breaker

The AR 10 generator receives its excitation through a pair of slip rings connected to the D14 alternator output through a controlled rectifier. The circuit breaker is provided to protect the controlled rectifier and the generator field windings.

Auxiliary Generator Circuit Breaker

On special order this breaker is applied in place of the auxiliary generator fuse.

Filter Blower Motor Circuit Breaker

A blower is used to evacuate dirty air from the central air compartment inertial filters. This breaker is provided to protect the blower motor circuit.

MISCELLANEOUS CIRCUIT BREAKERS

Cab Heater Circuit Breaker

Protects the circuit to the cab heater blower motors.

Lights Circuit Breaker

This breaker switch must be ON to supply power for the individual switches provided for number, class, platform, cabinet, hood, controller, and ground and gauge lights.

Headlights Circuit Breaker

This breaker protects the headlight circuits. It must be ON to provide current to the front headlight circuit and through the trainline to the light at the rear of a consist.

Water Cooler Circuit Breaker

When an electric water cooler is provided, this breaker protects the circuit.

Toilet Circuit Breaker

When a flush type toilet is provided, an electric immersion heater prevents freezing of flush tank water. This breaker protects the circuit.

Overspeed Circuit Breaker

Train overspeed, sensed by the locomotive speed recording instrument, brings about a penalty application of the brakes and operation of a pneumatic control switch to drop locomotive power. When the overspeed breaker is applied, it protects the overspeed magnet valve circuit.

Radio Circuit Breaker

Protects radio circuits.

A.T.C. Circuit Breaker

When automatic train control is applied, this breaker protects the circuits.

Automatic Water Drain Circuit Breaker

On units equipped for automatic draining of the engine cooling system, a temperature switch in cab heater piping under the cab energizes automatic drain valves when the temperature at the switch approaches freezing and the engine is shut down. This breaker protects the circuit. The breaker can also be used to nullify temperature switch response and allow filling a cold engine with cold water.

CAUTION: Make certain that the breaker is closed after engine warmup following a newly filled system, and always make certain that cab heater supply and return valves, Fig. 3-7, are open during freezing weather.

Warning And Electronic Devices Circuit Breakers

Provision is made for application of circuit breakers to protect special warning or electronic devices.

Ground Relay Lockout Reset Pushbutton

On special order the locomotive may be equipped for lockout of the ground relay reset after a specific number of ground relay actions. This pushbutton releases the lockout.

Open Circuit Protection Reset Switch

Units with extended range dynamic brakes are equipped with a latching relay that operates when an open exists in the dynamic braking resistor grid circuit. This switch resets the latching relay.

CAUTION: This circuit is to be reset only by qualified maintenance personnel after a thorough inspection of the dynamic braking grids, cables, blowers, and grid shorting contactors.

ENGINE CONTROL PANEL, Fig. 2-4

The engine control panel is located at the upper left hand corner of the electrical cabinet that forms the rear wall of the cab. This panel contains various switches and alarm lights, along with a battery charging meter or light. Since all of these items will be used at one time or another during operation, a brief description of their individual functions is provided.

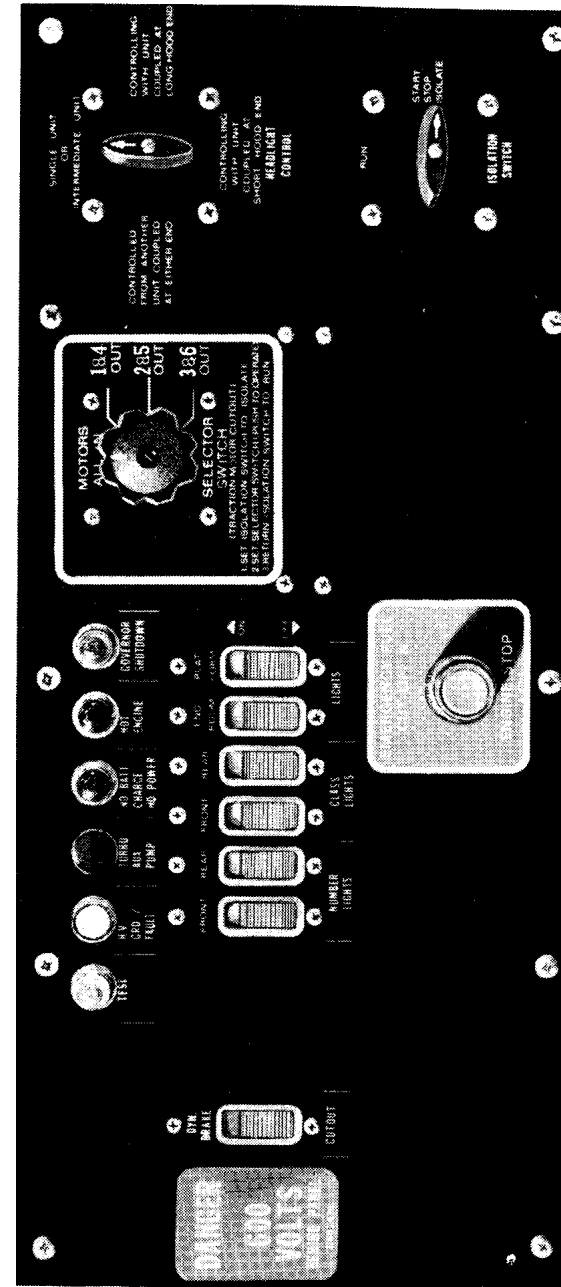
Note that an alarm bell accompanies an alarm signal light indication. The bell will ring in all units of a locomotive consist, but the light will come on only in the affected unit.

TEST Light

The test light comes on when the test panel rotary test switch is placed in the LOAD TEST position and the isolation switch is in RUN position. The light indicates that the locomotive circuits are set up for load testing when the reverser handle is centered. On special order the unit can be equipped to automatically load on its own dynamic braking resistor grids. On basic units the generator buses must be connected to an external loading resistor.

CAUTION: Do not perform automatic loading on a unit moving in a consist or train.

On basic units the main generator will be open circuited if a load box is not connected during load test setup.



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Fig. 2-4 -- Engine Control Panel With Typical Extras

H.V. GRD./FAULT Light

This light indicates that an electrical path to ground has occurred, or that a group of five diodes in the main generator has failed. When the light comes on and the alarm sounds, the operator should wait 10 seconds, then press the ground reset button located on the control stand. Power will then reapply. It is not necessary to isolate the unit, nor is it necessary to have the throttle in idle while pressing the button.

If there is no ground reset button on the control stand, the locomotive will be equipped with special automatic ground relay reset, and the operator need take no action to reset the relay. Such automatic reset devices are equipped for lockout, and automatic reset will be nullified after either a specific number of trips or after a given number of trips with a time period. On the basic locomotive, when the high voltage ground/fault alarm occurs for the third time after using the ground reset button twice, the affected unit should be isolated.

CAUTION: Always report ground fault light indications to proper maintenance personnel.

NO BATT. CHARGE NO POWER Light

This light will come on and the alarm bell will sound whenever D14 alternator output stops - normally at engine shutdown. The indication can also be caused by true D14 failure or failure of the DC auxiliary generator. A tripped AC Control circuit breaker will also bring about the indication. In each case the locomotive will fail to deliver power.

HOT ENGINE Light

This light operates in conjunction with the alarm bell to warn the operator that engine cooling water has reached an excessive temperature. When the light is on, engine speed and power are automatically reduced until the hot engine condition is corrected. If the cooling system has failed, a hot lubricating oil detector will shut the engine down before serious engine damage occurs. If hot engine shutdown occurs, do not attempt to restart the engine.

GOVERNOR SHUTDOWN Light

This light comes on when the engine governor has shut the engine down for one of the following reasons.

1. True low oil pressure.
2. Hot engine oil.

3. Low cooling water pressure.

4. Crankcase (oil pan) overpressure.

A mechanism to detect low engine lubricating oil pressure is built into the engine governor. This mechanism is actuated by true oil pressure failure or by dumping oil from the engine oil line leading to the governor. In either event a small button will pop out of the governor body, indicating that the mechanism has tripped the low oil alarm switch. The light on the engine control panel will come on to indicate that the low oil mechanism has tripped.

When a governor shutdown indication occurs, it is necessary to determine whether the crankcase pressure-low water detector has tripped to dump engine oil from the line leading to the governor, or whether a true oil failure has occurred. This can be determined by checking the crankcase pressure-low water detecting device, Fig. 3-2, for protruding reset buttons. A protruding upper button indicates excessive oil pan pressure; a protruding lower button indicates low water.

WARNING: When it is determined that the crankcase pressure detector has tripped, make no further engine room inspections. Do not attempt to restart the engine, Isolate the unit and drain the cooling system in accordance with railroad regulations.

If neither the crankcase pressure nor the low water pressure detector has tripped, and engine oil level is satisfactory with a hot engine condition apparent, do not attempt to restart the engine. Report engine shutdown circumstances to authorized maintenance personnel.

Remote Traction Motor Cutout Switch (If Provided)

The traction motor cutout switch operates to cut out the defective motor. This permits operation with remaining good motors. The power control system automatically limits power to prevent overloading the operative motors. Make certain that *all wheels rotate freely* before operating with a motor or motors cut out.

Miscellaneous Switches

Switches are included in circuits for various lights and devices on the locomotive. The switches are closed as desired to operate the class lights, the number lights, the engine room lights, and the platform lights.

Dynamic Brake Cutout Switch

On units so equipped, when this switch is placed in the CUTOUT position, the individual unit will not operate in dynamic braking. It will however, continue to operate normally under power. The switch can be used to limit the number of units in a consist that will operate in dynamic braking, or it may be used to cut out a unit that is defective in dynamic braking, yet allow it to operate under power.

Emergency Fuel Cutoff And Engine Stop Pushbutton

The diesel engine will stop whenever the engine stop pushbutton is pressed. The reaction to the pushbutton is immediate and it need not be held in until the engine stops.

Headlight Control Switch

The twin sealed-beam front and rear headlights are controlled by the front and rear headlight switches on the locomotive control stand. A dimming switch is mounted on the right side of the controller. Before

these switches will function, the 30-ampere headlight circuit breaker must be placed ON.

On locomotives equipped for multiple unit operation, a remote headlight control switch is mounted on the engine control panel. This remote headlight control switch provides for operation of the rear unit headlight from the lead unit. The switch positions are set on each unit as follows:

1. On Lead Unit

If only a single locomotive unit is being used, place the switch in SINGLE UNIT position.

In multiple unit service, if trailing units are coupled to the No. 2 or long hood end of the lead unit, place the switch in the CONTROLLING - COUPLED AT LONG HOOD END position.

In multiple unit service, if trailing units are coupled to the No. 1 or short hood end of the lead unit, place switch in CONTROLLING - COUPLED AT SHORT HOOD END position.

2. On Intermediate Units

On units operating in between other units in a multiple unit consist, place the switch in the SINGLE UNIT position.

3. On Trailing Units

The last unit in a multiple unit consist should have the headlight control switch placed in the CONTROLLED -- COUPLED AT EITHER END position.

Isolation Switch

The isolation switch has two positions, one labeled START/STOP/ISOLATE, the other labeled RUN. The functions of these two positions are as follows:

1. START/STOP/ISOLATE Position

The isolation switch is placed in this position whenever the diesel engine is to be started. The start switch is effective only when the isolation switch is in this position.

The START position is also used to isolate the unit, and when isolated the unit will not develop power or respond to the controls. In this event the engine will run at idle speed regardless of throttle position. This position will also silence the alarm bell in the event of a no power or low lube oil alarm. It will not, however, stop the alarm in the event of a hot engine.

If the locomotive is equipped with the remote traction motor cutout switch feature, the isolation switch must be placed in the ISOLATE position before the cutout switch can be operated.

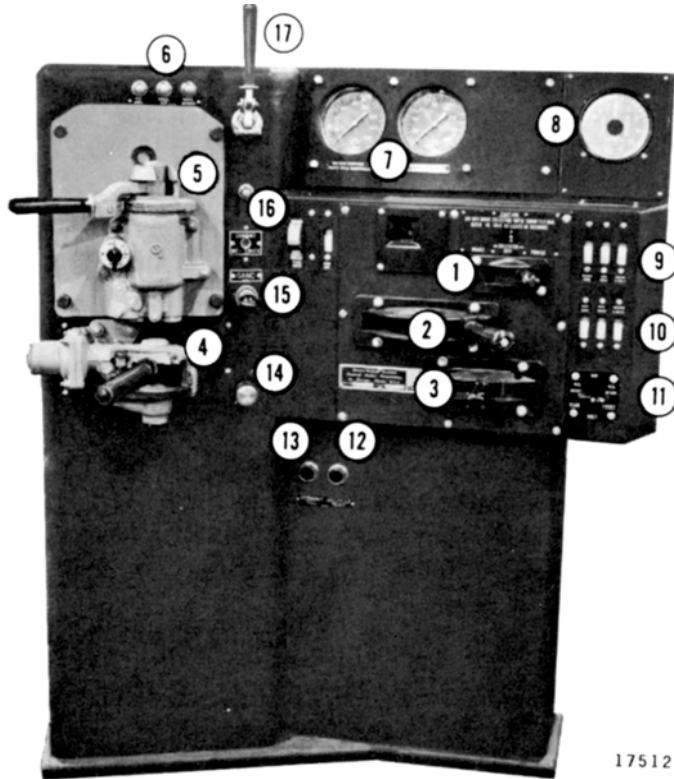
2. RUN Position

After the engine has been started, the unit can be placed "on the line" by moving the isolation switch to the RUN position. The unit will then respond to control and will develop power in normal operation.

Battery Charging Indicator

This indicator may be applied on special order. It indicates current flowing to or from the storage battery. It does not indicate output of the auxiliary generator. Since the storage battery is usually well charged, the

indicator in normal operation should read zero or slightly in the green area. The pointer should never be in the red area with the diesel engine running, even at idle speed. Such a reading indicates that the battery is discharging, which if allowed to continue could lead to failure of the locomotive unit.



- | | |
|----------------------------------|------------------------------|
| 1. Selector Handle | 9. Control Switches |
| 2. Throttle Handle | 10. Light Switches |
| 3. Reverser Handle | 11. Headlight Dimming Switch |
| 4. Independent Brake Handle | 12. Ground Reset Button |
| 5. Automatic Brake Handle | 13. Attendant Call Button |
| 6. Indicating Lights | 14. Bell Ringer |
| 7. Air Gauges | 15. Sanding Switch |
| 8. Load Current Indicating Meter | 16. Lead Axle Sanding Switch |
| | 17. Air Horn Valve |

Fig. 2-5 - Locomotive Control Stand

LOCOMOTIVE CONTROL STAND, Fig. 2-5

The locomotive control stand contains the switches, gauges, and operating handles used by the operator during operation of the locomotive. The individual controller components are described, together with their functions, in the following paragraphs.

Controller, Fig. 2-6

The following operating handles are located on the controller panel.

Selector Handle

The selector handle is applied on locomotive units equipped for dynamic braking. The handle has three operating positions which are indicated in a window directly above the handle.

1. PWR - Handle positioned to the right for power operation.
2. OFF - Handle centered. This position is used for locking the controller in unattended or trailing units.
3. "B" - Handle positioned to the left for dynamic braking.

The selector handle remains in the position to which it is moved. It has *no spring return* to the centered position.

When transferring from power operation to dynamic braking, always place and hold the throttle in idle position for 10 seconds before moving the selector handle from PWR to OFF and then to "B" position. This delay is required for proper response from older units that may be trailing

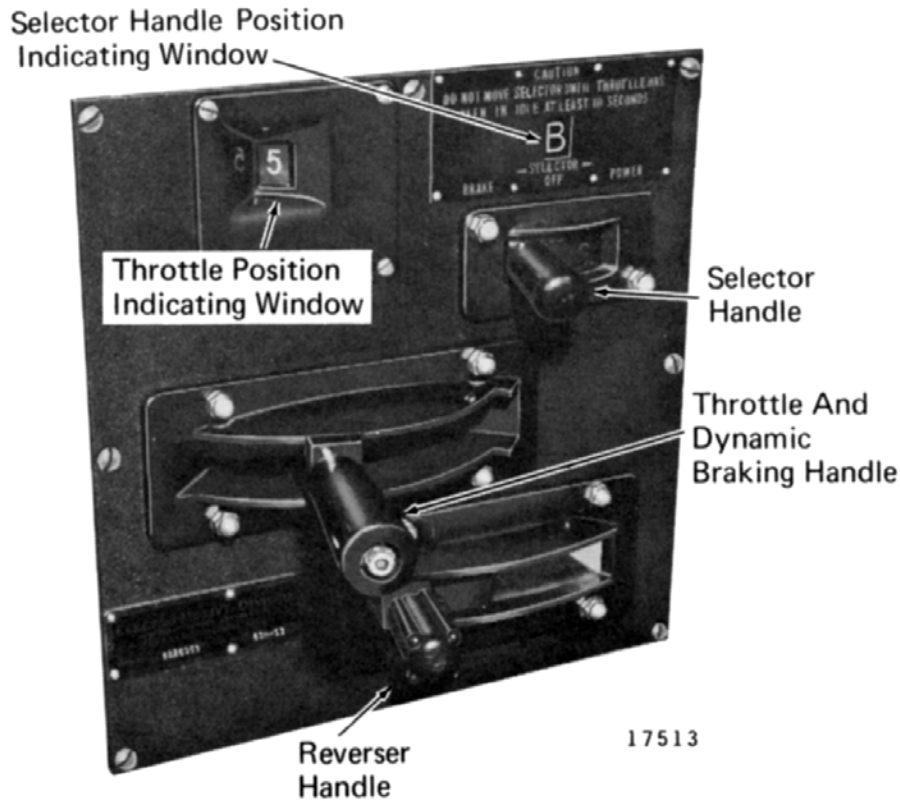


Fig. 2-6 - Locomotive Controller

in a consist. On units delivered after December, 1969, an automatic delay prevents completion of the dynamic braking circuits until electrical conditions have stabilized for safe transfer. Do not misinterpret the delay as a fault in the system. If the dynamic braking handle (throttle) is already open at the time the delay is completed, braking effort will automatically increase at a safe rate.

WARNING: Do not fail to observe the 10 second pause with the throttle in idle. It is possible for a sudden surge of braking effort to occur in a multiple consist if the dynamic braking handle (throttle) is open when the automatic delay times out.

Manual Transition Control

Provision for manual transition control of old units in a multiple unit consist will be applied only on special order by the railroad. In such cases a rotary snap switch will be applied to the control stand.

Throttle Handle, Fig. 2-7

The throttle handle actuates switches within the controller to establish low voltage electrical circuits to the engine governor and electrical control circuits to control engine power and speed. The throttle has ten positions namely, STOP, IDLE and running speeds 1 through 8 as shown. Each of these positions is shown in the illuminated indicator in the upper left hand corner of the controller.

To stop all engines, the throttle is pulled out away from the controller and then moved one step beyond IDLE to the STOP position. The IDLE position is as far forward as the handle can be moved without pulling it away from the controller.

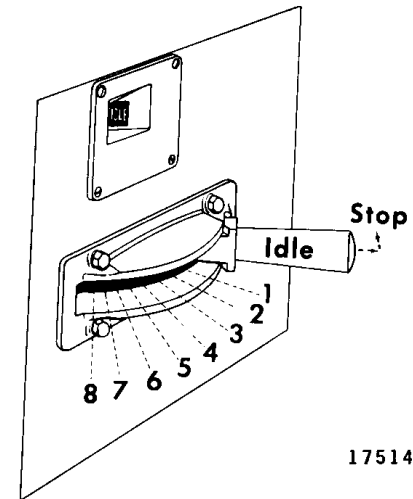


Fig. 2-7 - Throttle Handle

Each running notch on the throttle increases locomotive power by increasing generator excitation or engine speed or both. At time of locomotive start each notch provides a fixed and immediate level of generator excitation. This level brings about an immediate and fixed response to throttle position during starting.

When operating in dynamic braking (selector in "B") the throttle serves as a braking handle. It moves freely without notching to control dynamic braking.

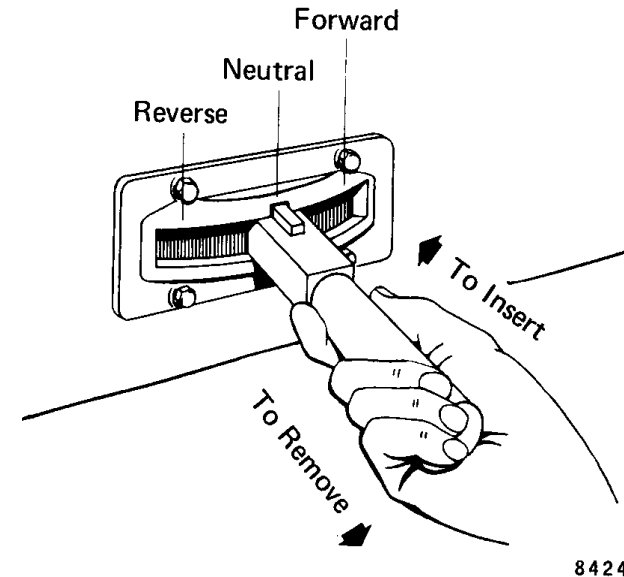
When the locomotive is equipped with the basic dynamic brake control system, maximum braking current of 700 amperes can occur over a wide range of braking handle positions. This range allows braking effort to increase as train speed increases. The tendency is to hold train speed relatively constant for a given braking handle position when conditions result in less than the maximum allowable current.

On special order "Grid Current Trainline Control" of dynamic braking may be provided. On such units, maximum braking current is limited by braking handle position, and the maximum of 700 amperes is obtainable only with the handle in maximum position. This system ensures a low level of braking effort regardless of train speed when the braking handle is opened to a low position. Braking current will generally be at or near the maximum obtainable at the given handle position, and the tendency for train speed to hold steady for a given handle position is not as effective as with the basic brake.

Reverser Handle, Fig. 2-8

The reverser handle has three positions; forward, neutral and reverse. The direction in which the locomotive moves is controlled by movement of this handle to the forward or reverse position. With the lever in neutral, no power will be developed if the throttle is opened. The reverser handle should be moved **ONLY** when the locomotive is standing still.

The reverser handle can be removed from the controller only when it is in neutral position, the throttle is in IDLE and the selector is in OFF. Removal of the reverser handle locks the operating controls in the controller. The handle should be removed from the controllers in all but the lead unit of a multiple unit locomotive consist.



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Fig. 2-8 - Reverser Handle Positions

MECHANICAL INTERLOCKS ON THE CONTROLLER

The handles on the controller are interlocked so that

1. With reverser handle in neutral -
 - a. Throttle can be moved to any position.
 - b. Selector can be moved to any position.

2. Reverser handle in forward or reverse -
 - a. Throttle can be moved to any position.
 - b. Selector can be moved to any position.
3. Throttle in IDLE position -
 - a. Reverser handle can be moved to any position.
 - b. Selector can be moved to any position.
4. Throttle in STOP position -
 - a. Reverser handle can be moved to any position, but can not be removed from the controller.
 - b. Selector can be moved to any position.
5. Throttle above IDLE position -
 - a. Reverser handle position can not be changed.
 - b. Selector can not be moved out of "B" into OFF or from PWR to OFF.
6. Selector in OFF position -
 - a. Reverser handle can be moved to any position and removed from controller if throttle is in IDLE position.
 - b. Throttle can be moved between IDLE and STOP only.
7. Selector in "B" position -
 - a. Reverser handle can not be moved.
 - b. Throttle can be moved to any position.

AIR BRAKE EQUIPMENT, Fig. 2-9

Basic locomotives are equipped with the type 26L air brakes. Since type 26L is standard equipment, only that type of air brake will be discussed in this manual. The 26L air brake control equipment is located to the left of the controller. This equipment consists of an automatic brake, independent brake, multiple unit valve (when MU control is installed), cutoff valve and a trainline air pressure adjustment device. The dead engine feature is a part of the 26L equipment. The cock is accessible from outside the locomotive through side doors provided. The pressure regulator is set at the maintenance point and is not to be set by the operator

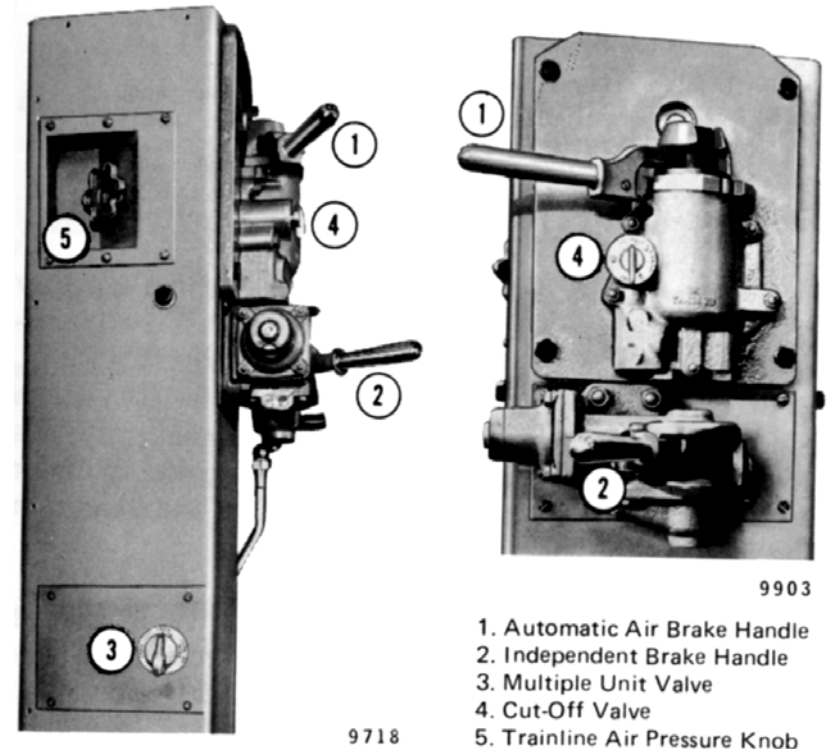


Fig. 2-9 - Air Brake Equipment

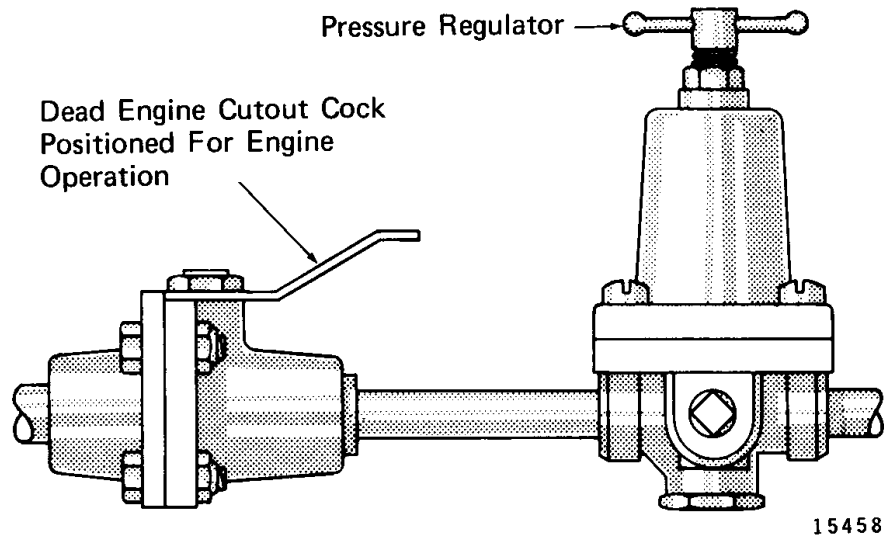


Fig. 2-10 - Dead Engine Cutout Cock And Pressure Regulator

Automatic Brake Valve, Fig. 2-11

The automatic brake valve handle may be placed in any of six operating positions.

Independent Air Brake, Fig. 2-12

The independent air brake handle is located directly below the automatic brake handle. It has two positions; namely, RELEASE and FULL APPLICATION. Between these two positions is the application zone. Since this is a self-lapping brake, it automatically laps off the flow of air and maintains brake cylinder pressure corresponding to the position of the handle in the application zone.

Depression of the independent brake valve handle when in the RELEASE position causes release of any automatic brake application existing on the locomotive.

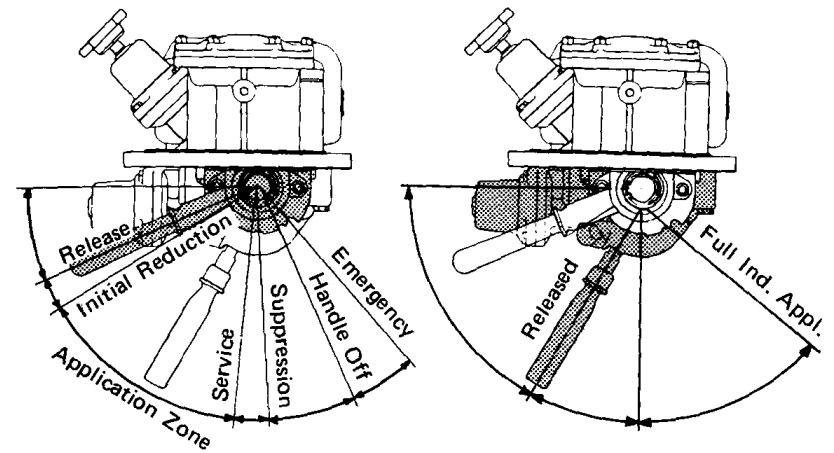
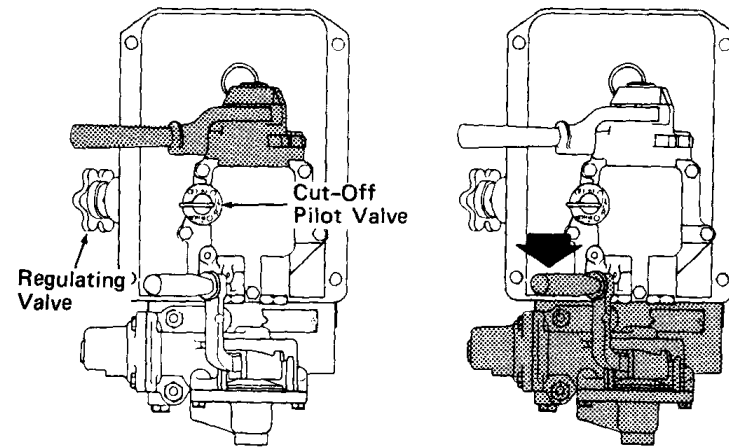


Fig. 2-11 -Automatic Brake Handle Positions



Press Lever Down To Release Automatic Application Of Locomotive Brakes

Fig. 2-12 - Independent Brake Handle Positions

Multiple Unit Valve

The multiple unit (MU-2) valve is located on the left hand side of the air brake stand. Its purpose is to pilot the F 1 selector valve which is a device that enables the air brake equipment of one locomotive unit to be controlled by that of another unit.

The basic MU-2 valve has three positions which are:

1. LEAD or DEAD
2. TRAIL 6 or 26*
3. TRAIL 24

The valve is positioned by pushing in and turning to the desired setting.

*Whenever the MU-2 valve is in the TRAIL 6 or 26 position, and if actuating trainline is not used, then the actuating end connection cutout cock must be opened to atmosphere. This is necessary to prevent the inadvertent loss of air brakes due to possible pressure build-up in the actuating line.

Cut-Off Valve

The cut-off valve is located on the automatic brake valve housing directly beneath the automatic brake valve handle. This valve has the following three positions:

1. CUT-OUT
2. FRT (Freight)
3. PASS (Passenger)

Trainline Pressure Adjustment

The trainline air pressure adjusting knob is located behind the automatic brake valve at the upper portion of the brake stand.

BRAKE EQUIPMENT POSITIONS, Fig. 2-13

When operating locomotives equipped with 26L air brakes, the brake equipment should be positioned according to the information given in the equipment position chart.

Bell Ringer

When the bell ringer is operated, compressed air is directed to the locomotive warning bell operator.

Sanding Switches

1. SANDING NO. 1 TRUCK Toggle Switch

The signal from this switch is not trainlined. The switch provides sand to only the number 1 axle of the lead unit of a consist. This method of sanding dresses the rail and is adequate for most conditions.

2. SAND Lever Switch

When the sanding switch lever is operated, electrical energy is directed through interlocks of reverser switchgear to operate either the forward or reverse sanding magnet valves in all units of a consist. The basic switch may be operated in any direction for correct sanding and it is non-latching. A directional sanding switch may be provided as an optional extra, and the switch may be latching if requested by the railroad.

Type Of Service	Automatic Brake Valve	Independent Brake Valve	Cutoff Valve	Dead Engine Cutoff Cock	26D Control Valve	26F Control Valve	MU2 Valve	Overspeed Cutoff Cock	Deadman Cutoff Cock
SINGLE LOCOMOTIVE EQUIPMENT									
Lead	Release	Release	Passenger Freight	Closed		Graduated Direct	Lead	Open	Open
Double Heading	Handle Off Position	Release	Cutoff	Closed	Relief Valve At Control Reservoir 73±2 Lbs.	Graduated Direct	Lead	Open	Open
Shipping Dead In Train	Handle Off Position	Release	Cutoff	Open		Direct	Dead	Closed	Closed
MULTIPLE LOCOMOTIVE EQUIPMENT AND EXTRAS									
Lead	Release	Release	Passenger Freight	Closed		Graduated Direct	Lead	Open	Open
Trail	Handle Off Position	Release	Cutoff	Closed		Graduated Direct	*Trail 6 or 26 Trail 24	Open	Open
Shipping Dead In Train	Handle Off Position	Release	Cutoff	Open	Relief Valve At Control Reservoir 73±2 Lbs.	Direct Release	Dead	Closed	Closed
Double Heading	Handle Off Position	Release	Cutoff	Closed		Graduated Direct	Lead	Open	Open
Dual Control:									
Operative Station	Release	Release	Passenger Freight	Closed		Graduated Direct	Lead	Open	Open
Non-Operative Station	Handle Off Position	Release	Cutoff						

*Whenever the MU2A valve is in "Trail 6 or 26" Position and if the actuating train line is not used, then the actuating end connection cutoff cock must be open to atmosphere; so as to prevent the inadvertent loss of air brakes due to possible pressure buildup in the actuating line.
NOTE: By ARR standard all cocks in the brake system except brake pipe end cocks have handles perpendicular to pipe when open.

Fig. 2-13 -- Brake Equipment Positions

Electrically controlled sanding is the basic system used but since the locomotive may be operated in multiple with older units that are equipped only for pneumatic control of sanding, trainlined pneumatic control of sanding may be provided as an optional extra in addition to electrical control. In such cases, trainlined actuating pipes must be connected between units.

Indicating Lights

Four or more indicating lights are installed to provide a visual warning of operating difficulties. The four basic lights are wheel slip, PCS open, brake warning, and sand. The functions of these lights are as follows:

1. Wheel Slip light

Intermittent flashing of the wheel slip light indicates that the wheel slip control system is doing its job and is correcting the slips. The throttle and locomotive power should not be reduced unless severe lurching threatens to break the train.

Note that minor slips or wheel creep will not activate the wheel slip light, but automatic sanding may take place along with regulation of power to the wheels. Do not misinterpret this power control as loss of power due to a fault.

WARNING: A wheel slip light flashing slowly and persistently or burning continuously may indicate a pair of sliding wheels or circuit difficulty. Stop the locomotive and make a careful inspection to ascertain that there are no locked sliding wheels.

2. PCS OPEN Light

The PCS or pneumatic control switch functions to automatically reduce locomotive power in the event that an emergency or safety control air brake application occurs. It does so by reducing the speed of ALL engines to idle.

CAUTION: The engine run switch should be in the OFF position in all trailing units, or (depending on the type and position of locomotives in the consist) it is possible that the PCS switch of the lead unit will not act to reduce engine speeds to idle.

When the switch is tripped the PCS OPEN indicating light on the controller will come on. This light is extinguished and locomotive power restored by resetting the PCS switch. This occurs automatically, provided that:

- a. Control of the air brake is recovered.
- b. The throttle is returned to IDLE position.

3. Brake Warning

A brake warning light is installed on units equipped with dynamic brakes and functions in conjunction with a brake warning relay. The purpose of the relay and light is to indicate excessive braking current when operating in dynamic braking.

Due to the use of an automatic brake limiting regulator, the warning light should seldom if ever come on and then only momentarily. Correction for excessive current generally occurs automatically and quite rapidly.

In the event that the brake warning light comes on and does not go out quickly, the braking strength should be immediately reduced to prevent possible equipment damage. Excessive braking strength can be reduced by moving the throttle toward idle position.

4. Sand

This light comes on to indicate that the SANDING No. 1 TRUCK switch is closed and that sand is being applied to the No. 1 axle. The light is not affected by the manual, emergency, or wheel slip sanding circuits.

Air Gauges

Air gauges to indicate main reservoir air pressure as well as various pressures concerned with the air brakes are prominently located along the top of the controller.

Load Current Indicating Meter

Locomotive pulling force is indicated by the load current indicating meter at the upper right portion of the control stand. The meter is graduated to read amperes of electrical current, with 1500 being the maximum reading on the scale. A red area on the meter face indicates when current levels are too high for continuous operation. A short time rating plate near the meter gives the time limitations at various current levels. The times are non-accumulative; that is, considering the conditions under which a locomotive operates it is not necessary to add intermittent periods requiring high current operation. The meter is connected so as to indicate the current flowing through the No. 2 traction motor. Since the amperage is the same in all motors, each motor will carry the amount shown on the meter.

On special order the meter may be color coded to indicate operating time limits at various meter pointer positions.

On locomotives equipped for dynamic braking, a zero center type meter is applied, Fig. 2-14. The meter needle swings to the right of zero to indicate load current during power operation, and it swings to the left of zero to indicate dynamic braking current, with 800 amperes being the maximum reading on the braking portion of the meter.



Fig. 2-14 - Load/Brake Current Indicating Meter

Since the dynamic brake regulator controls maximum braking current, the meter should seldom if ever indicate more than 700 amperes, which is the rating of the dynamic braking resistor grids.

NOTE: The IDAC wheel slip control system functions to correct slips by instantaneous reduction of power in small increments and by application of sand. The cumulative effect of a large number of

power reductions in rapid succession is to cause the locomotive to maintain power at a level where adhesion can be maintained. Do not misinterpret this loss of power as a defect in the control system.

Operating Switches

A group of switches is located along the front face of the controller, each identified by a name plate indicating switch function. The switches are in the ON position when moved upward.

Before the engine is to be started, the control and fuel pump switch must be placed ON. To obtain power from the locomotive, the generator field switch must be ON. To obtain control of engine speed, the engine run switch must be ON. These three important switches are grouped at the right side of the controller. They must be placed in the OFF position on controllers of trailing units.

Other switches control sanding, attendant call, and various lights. They are placed on as needed.

Headlight Dimming Switch

A five position switch is located on the controller to the right of the throttle. In one position it provides for dim headlights on both ends of the locomotive. In the other four positions it provides for a bright or medium headlight at either the front or the rear of the locomotive.

For this switch to function, the headlight switches on the controller as well as the headlight circuit breaker must be placed ON.

High Voltage Ground/Fault Reset Pushbutton

The ground relay detects high voltage grounds during operation under power. When it trips, the alarm bells ring in all units of a consist. On the unit affected, generator excitation is lost, the diesel engine goes to idle speed, and the high voltage ground/fault light on the engine control panel comes on.

To reset the ground relay and restore locomotive power, wait 10 seconds and press the high voltage ground reset pushbutton on the locomotive control stand. It is not necessary to isolate the unit nor is it necessary to place the throttle in idle position before pressing the reset button unless the locomotive is at a standstill.

Repeated resetting of the ground relay is permissible, but instructions as issued by the railroad regarding repeated resetting must be followed. However, in the absence of definite instructions to the contrary, isolate a unit when the ground/fault light comes on for the third time after resetting.

CAUTION: Always report high voltage ground/fault light indications to proper maintenance personnel.

OPERATION

INTRODUCTION

This section of the manual covers recommended procedures for operation of the locomotive. The procedures are briefly outlined and do not contain detailed explanations of equipment location or function.

The information in this section is arranged in sequence, commencing with inspections in preparation for service, and with instructions for starting the engine, handling a light locomotive, coupling to train, and routine operating phases. The various operating situations and special features such as dynamic braking are also covered.

PREPARATION FOR SERVICE GROUND INSPECTION

Check locomotive exterior and running gear for:

1. Leakage of fuel oil, lube oil, water or air.
2. Loose or dragging parts.
3. Proper hose connections between units in multiple.
4. Proper positioning of all angle cocks and shut-off valves.
5. Air cut-in to truck brake cylinders.
6. Satisfactory condition of brake shoes.
7. Adequate supply of fuel.
8. Proper installation of control jumper cables between units.

LEAD UNIT CAB INSPECTION

On the lead or control unit, the control locations described in Section 2 should be checked and the equipment positioned for operation as follows:

Fuse And Switch Panel

1. Main battery switch closed.
2. Ground relay switch closed.
3. All fuses installed and in good condition.

Circuit Breaker Panel

1. All breakers in black area of panel in ON position.
2. Other circuit breakers ON as required.

Engine Control Panel

1. Isolation switch in START position.
2. Headlight control switch in proper position for lead unit operation.
3. Dynamic brake cutout switch in DYN. BRAKE (up) position (if provided).
4. Miscellaneous switches positioned as required.

CAUTION: The electrical cabinet is pressurized with filtered air. Cabinet doors must be securely closed during locomotive operation.

Remote Traction Motor Cutout Switch

On locomotives equipped with remote panel mounted traction motor cutout switch, the panel instructions adjacent to the switch must be followed exactly when a traction motor is to be cut out. The cutout switch can not be turned unless the unit is isolated and the local control circuit breaker is closed. Make certain that all *wheels rotate freely* before operating with a motor or motors cut out.

Locomotive Controller

The controller switches and operating levers should be positioned as follows:

1. Place control and fuel pump switch in ON (up) position.
2. Place engine run switch and the generator field switch in the OFF (down) position.
3. Position heater, lights, and miscellaneous switches as desired.
4. Make certain that the throttle remains in idle position and that the reverser handle is removed from the controller.

Air Brakes - Type 26L

1. Insert automatic brake valve handle (if removed) and place in SUPPRESSION position. This will nullify the application of any safety control equipment used.
2. Insert independent brake valve handle (if removed) and move to FULL APPLICATION position.
3. Position cutoff valve to either FRGT or PASS depending on make-up of train.

- Place MU valve in LEAD position.

ENGINE ROOM INSPECTION

The engine can be readily inspected by opening the access doors along the sides of the long hood end of the locomotive.

- Check air compressor for proper lubricating oil supply.
- Observe for proper water level on tank sight glass.
- Check all valves for proper positioning.
- Observe for leakage of fuel oil, lubricating oil, water or air.

ENGINE INSPECTION

The engine should be inspected before as well as after starting. After inspection and engine start, all engine room doors should be closed and latched securely, as engine room is pressurized during operation.

- Check to see that engine overspeed lever is set, Fig. 3-1.
- Observe that governor low oil pressure trip plunger, Fig. 3-1, is set and that there is oil visible in the governor sight glass.
- Observe that the crankcase (oil pan) pressure and low water detector reset buttons are set (pressed in). If the buttons protrude, press and hold for 5 seconds immediately after engine starts, Fig. 3-2.
- Observe that engine top deck, air box, and oil pan inspection covers are in place and are securely closed.

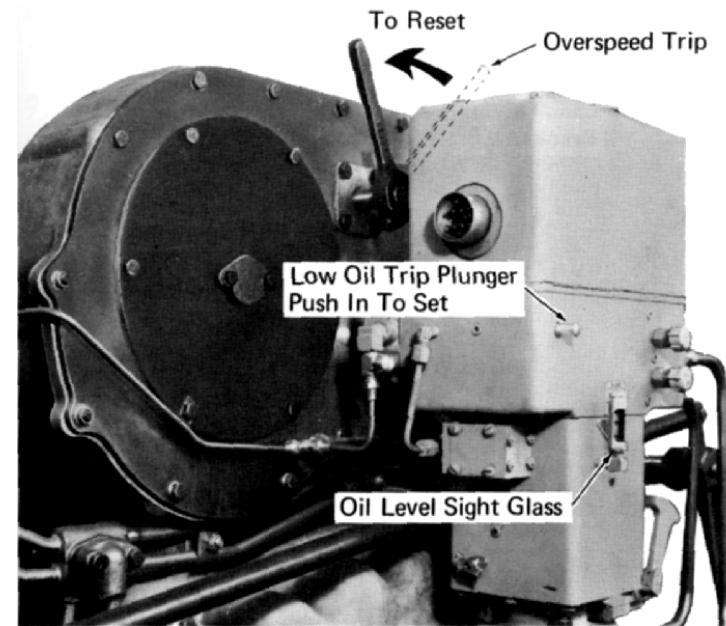


Fig. 3-1 - Engine Overspeed Trip And Low Oil Pressure Trip Plunger

STARTING THE DIESEL ENGINE

After the preceding inspections have been completed, the diesel engine may be started. Starting controls are located at the accessory end of the engine in the area of the equipment rack. See Fig. 2-1.

Perform the following:

NOTE: If engine temperature is 30° F. or less, preheat the engine before attempting to start.

- Check oil levels in the engine governor and air compressor. Check engine coolant level.

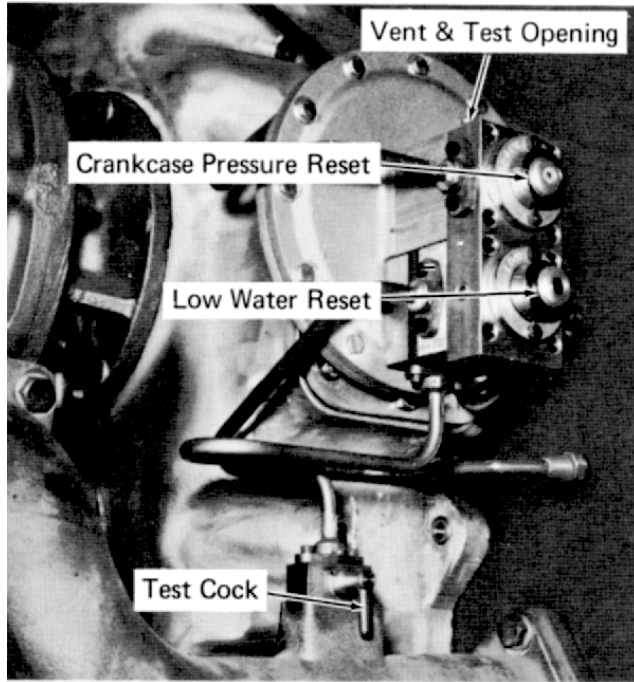


Fig. 3-2 - Low Water And Crankcase (Oil Pan) Pressure Detector

2. Open cylinder test cocks and bar over the engine at least one revolution; observe for leakage from test cocks. Close the test cocks.
3. Check that all fuses are installed and in good condition.

CAUTION: Make certain that the starting fuse is the correct rating as indicated on the panel.

4. Verify that the main battery switch is closed, and that the ground relay switch is closed.
5. Check that all circuit breakers in the black area of the circuit breaker panel are in the ON (up) position.

6. Check that the control and fuel pump switch on the control stand is in the ON (up) position.
7. Check that generator field and engine run switches are in the OFF (down) position.
8. Check that the isolation switch on the engine control panel is in the START position.
9. At the equipment rack in the engine room, place the Fuel Prime/Engine Start switch in the PRIME position until fuel flows in the return fuel sight glass clear and free of bubbles (normally 10 to 15 seconds). See Fig. 3-3.
10. Position the governor rack control lever (layshaft lever) at about one-third rack (about 1.6 on the scale), then move the Fuel Prime/Engine Start switch to the START position (not more than 20 seconds). Hold the switch in the START position until the engine fires and speed increases.
11. Release the rack control lever when the engine comes up to idle speed.
12. Check that the low water detector button is in. If it is not, press and hold for 5 seconds to reset.
13. Check that cooling water level, lube oil pressure, and governor oil level are satisfactory.

TRAILING UNIT CAB INSPECTION

Switches, circuit breakers, and control equipment located in the cab of a trailing unit should be checked for proper positioning as follows:

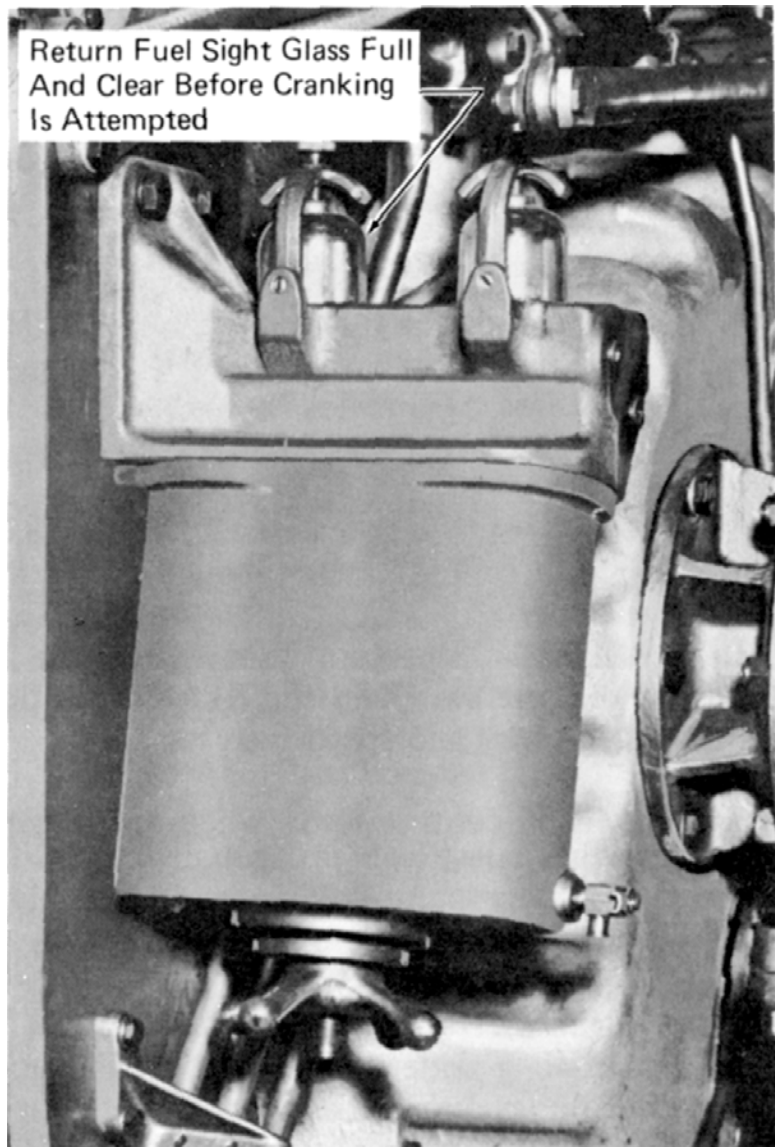


Fig. 3-3 - Fuel Oil Sight Glasses

Fuse And Switch Panel

1. All switches closed.
2. Fuses installed and in good condition.

Circuit Breaker Panel

1. All circuit breakers in the black area of the circuit breaker panel in the ON (up) position.
2. Other circuit breakers on as required.

Engine Control Panel

1. Isolation switch in START position, and headlight control switch in position to correspond with unit position in consist.
2. Other switches may be placed ON as needed.
3. Dynamic brake cutout switch positioned according to railroad operating procedures for trailing units.
4. Traction motor cutout switch normally in the **MOTORS ALL IN** position.

Locomotive Controller

The controller switches and operating handles should be positioned as follows:

1. Control and fuel pump switch, generator field switch, and engine run switch must be OFF.
2. Throttle in IDLE.
3. Selector handle in OFF.

4. Reverser handle placed in neutral and then removed from the controller to lock the other handles.

Air Brakes -- Type 26L

1. Place automatic brake valve handle in HANDLE OFF position. Remove handle (if so equipped).
2. Place independent brake valve handle in FULL RELEASE position. Remove handle (if so equipped).
3. Place MU valve in desired position for trailing unit operation.
4. Place cutoff valve in CUTOFF position.

STARTING TRAILING UNIT DIESEL ENGINES

Engines in trailing units are started in the same manner as the engine in the lead unit.

PLACING UNITS ON THE LINE

After the diesel engines are started and inspected, units may be placed on the line as desired by placing the isolation switch on the engine control panel in the cab in the RUN position. If the consist is at a standstill, be certain that the throttle handle in all units is in the idle position before placing any unit on the line.

PRECAUTIONS BEFORE MOVING LOCOMOTIVE

The following points should be carefully checked before attempting to move the locomotive under its own power:

1. **MAKE SURE THAT MAIN RESERVOIR AIR PRESSURE IS NORMAL** (approximately 130-140 pounds).

This is very important, since the locomotive is equipped with electro-magnetic switchgear which will function in response to control and permit operation without air pressure for brakes.

2. Check for proper application and release of air brakes.
3. Release hand brake and remove any blocking under the wheels.

CAUTION: It is desirable that engine water temperatures be 120° F. or higher before full load is applied to the engine. After idling at ambient temperature below 0° F., increase to full load level should be made gradually.

HANDLING LIGHT LOCOMOTIVE

With the engine started and placed "on-the-line" and the preceding inspections and precautions completed, the locomotive is handled as follows:

1. Place the engine run switch and generator field switch in ON (up) position.
2. Place headlight and other lights ON as needed.
3. Insert reverser handle and move it to the desired direction of travel, either forward or reverse.
4. Place selector handle in PWR position (if so equipped).

5. Depress safety control foot pedal (if so equipped).
6. Release air brakes.
7. Open throttle to Run 1, 2, or 3 as needed to move locomotive at desired speed.

NOTE: Locomotive response to throttle movement is almost immediate. There is little delay in power buildup.

8. Throttle should be in IDLE before coming to a dead stop.
9. Reverser handle should be moved to change direction of travel ONLY when locomotive is completely stopped.

DRAINING AIR RESERVOIRS AND STRAINERS

The air reservoirs and air strainers or filters should be drained at least once each day whether or not equipment is provided with automatic drain valves. Draining should be done at the time of crew change until a definite schedule is established by the railroad.

Drain valves should be operated as follows:

1. Momentarily operate the manual override lever on auxiliary main reservoir centrifugal filter, 2, Fig. 3-4 and Fig. 3-5.

NOTE: The solenoid drain valve plunger is inoperative when the drain valve solenoid is energized.

2. Momentarily operate the manual override lever on the main reservoir centrifugal filter, 1, Fig. 3-4 and Fig. 3-5.

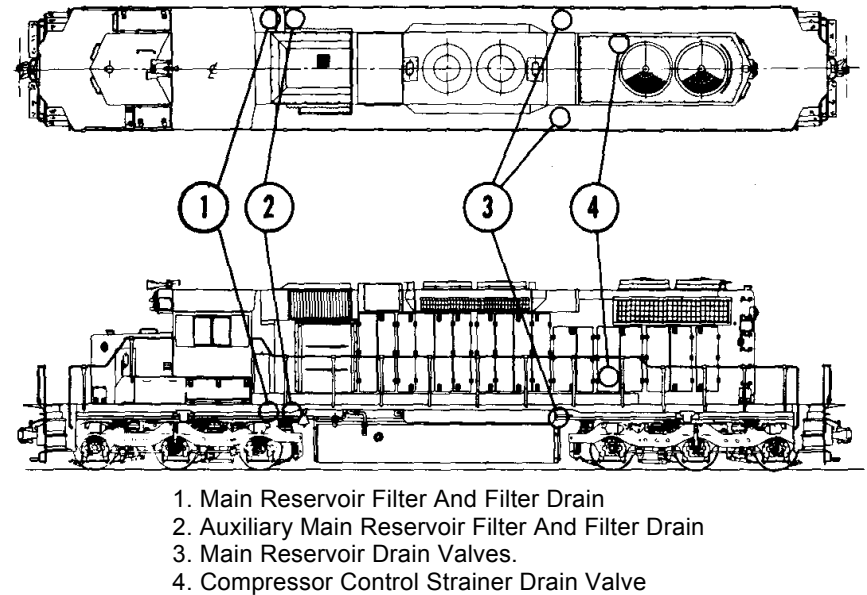


Fig. 3-4 - Compressed Air System Drain Valve Locations

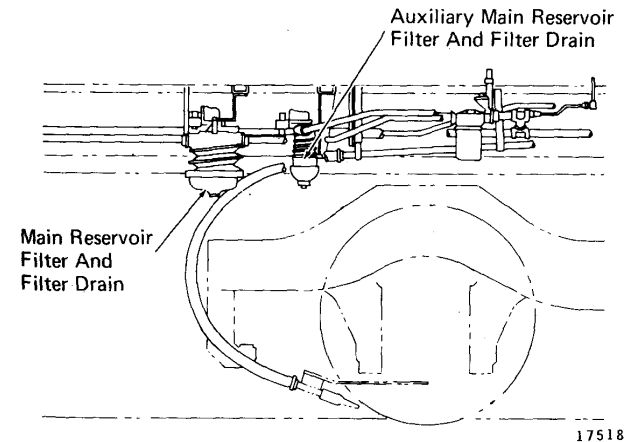


Fig. 3-5 - Main And Auxiliary Main Reservoir Centrifugal Filters And Filter Drains

3. Momentarily open the main reservoir drain valves, 3, Fig. 3-4.
4. Press up on the pushbutton at the base of the compressor control strainer drain, 4, Fig. 3-4 and Fig. 3-6.

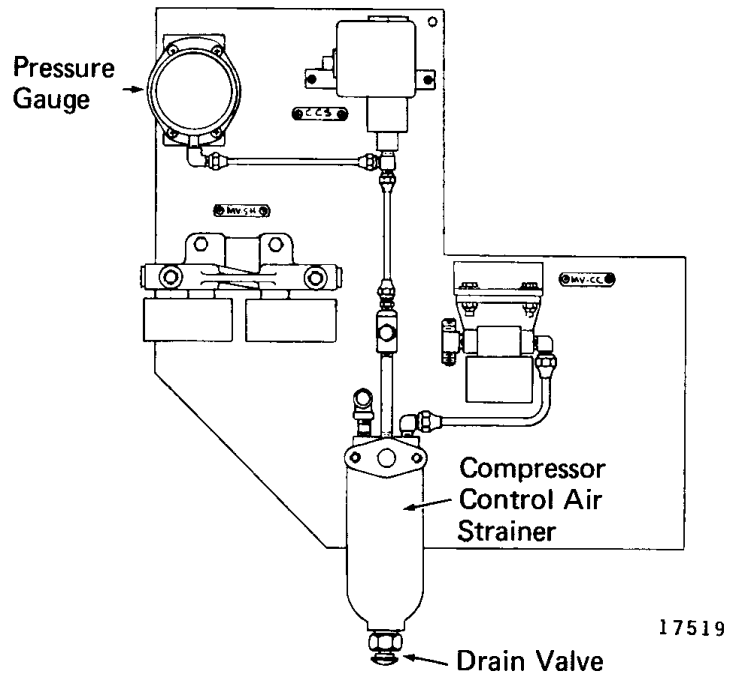


Fig. 3-6 - Compressor Control Strainer

ENGINE AIR BOX DRAIN

A metal casting mounted on the front end plate of the engine connects drain pipes from each side of the airbox to a common drain pipe. Pressures in opposition at the casting restrict airflow to a permissible amount, yet allow elimination of airbox contaminants. The system is completely automatic and requires no attention by the locomotive operator.

REMOTE TRACTION MOTOR CUTOUT SWITCH

On locomotives equipped with remote panel mounted traction motor cutout switches, the panel instructions adjacent to the switch must be followed exactly when a traction motor is to be cut out. The cutout switch can not be turned unless the unit is isolated and the local control circuit breaker is closed. Make certain that all *wheels rotate freely* before operating with a motor or motors cut out.

COUPLING LOCOMOTIVE UNITS TOGETHER

When coupling units together for multiple unit operation, the procedure below should be followed:

1. Couple and stretch units to ensure couplers are locked.
2. Install control cable between units.

NOTE: If the consist is made up with older units that are equipped only for pneumatic control of sanding, connect actuating pipes between all units in the consist.

3. Attach platform safety chains between units.
4. Perform ground, engineroom, and engine inspections as outlined in preceding articles.
5. Position cab controls for trailing unit operation as outlined in preceding articles.
6. Connect air brake hoses between units.
7. Open required air hose cutout cocks on both units.

COUPLING LOCOMOTIVE UNITS TOGETHER FOR DYNAMIC BRAKING IN MIXED CONSISTS

The locomotive, when equipped with basic dynamic brakes, makes use of electrical potential from the brake control rheostat to control braking strength by controlling excitation of the main generator field. This electrical potential is impressed upon a trainlined wire to control dynamic braking strength of all units in a consist equipped with potential line brake control. However, the total braking effort of a multi-unit consist can become quite high. Carefully observe railroad rules regarding multiple unit dynamic braking in critical service.

COUPLING LOCOMOTIVE TO TRAIN

Locomotive should be coupled to train using the same care taken when coupling units together. After coupling, make the following checks:

1. Test to see that couplers are locked by stretching connection.
2. Connect air brake hoses.
3. Slowly open air valves on locomotive and train to cut in brakes.
4. Pump up air if necessary, using the following procedure.

PUMPING UP AIR

After cutting in air brakes on train, note the reaction of the main reservoir air gauge. If pressure falls below trainline pressure, pump up air as follows:

1. Place generator field switch in OFF (down) position.
2. Move reverser handle to neutral position.
3. Open throttle as needed to speed up engine and thus increase air compressor output.

NOTE: Throttle may be advanced to Run 4 if necessary. Engine should not, however, be run unloaded (as in pumping air) at speeds beyond throttle No. 4 position.

BRAKE PIPE LEAKAGE TEST

Prior to operating the 26L brake equipment, a leakage test must be performed. This is accomplished in the following manner.

1. The cutoff valve is positioned in either FRGT or PASS, depending on the equipment make up of the train.
2. Move the automatic brake valve handle gradually into service position until the equalizing reservoir gauge indicates that a 15 psi reduction has been made.
3. Without any further movement of the automatic brake valve handle, observe the brake pipe gauge until this pressure has dropped 15 psi and exhaust has stopped blowing.
4. At this moment turn the cutoff valve to CUT OFF position. This cuts out the maintaining function of the brake valve.

5. From the instant the cutoff valve is turned to CUT OFF position, the brake pipe gauge should be observed and any possible drop in brake pipe pressure should be timed for one minute. Brake pipe leakage must not exceed the rate established by railroad rules.
6. After checking trainline leakage for one minute and the results are observed to be within required limits, return the cutoff indicator to the required position (FRGT or PASS) and proceed to reduce the equalizing gauge pressure until the pressure is the same as brake pipe gauge pressure. This is accomplished by moving the automatic brake valve handle gradually to the right until a full service application has been obtained.
7. After pipe leakage test has been completed, return the automatic brake valve handle to RELEASE position.

STARTING A TRAIN

The method to be used in starting a train depends upon many factors such as, the type of locomotive being used; the type, weight and length of the train and amount of slack in the train; as well as the weather, grade and track conditions. Since all of these factors are variable, specific train starting instructions cannot be provided and it will therefore be up to the operator to use good judgment in properly applying the power to suit requirements. There are, however, certain general considerations that should be observed. They are discussed in the following paragraphs.

A basic characteristic of the diesel locomotive is its HIGH STARTING TRACTIVE EFFORT, which makes it imperative that the air brakes be completely released before any attempt is made to start a train. On an

average 100 car freight train having uniformly distributed leakage, it may take 10 minutes or more to completely release the brakes after a reduction has been made. It is therefore important that sufficient time be allowed after stopping, or otherwise applying brakes, to allow them to be fully released before attempting to start the train.

The locomotive possesses sufficiently high tractive effort to enable it to start most trains without taking slack. The practice of taking slack indiscriminately should thus be avoided. There will, however, be instances in which it is advisable (and sometimes necessary) to take slack in starting a train. Care should be taken in such cases to prevent excessive locomotive acceleration which will cause undue shock to draft gear and couplers, and lading.

Proper throttle handling is important when starting trains, since it has a direct bearing on the power being developed. As the throttle is advanced, a power increase occurs almost immediately, and power applied is at a value dependent upon throttle position. It is therefore advisable to advance the throttle one notch at a time when starting a train. A train should be started in as low a throttle position as possible, thus keeping the speed of the locomotive at a minimum until all slack has been removed and the train completely stretched. Sometimes it is advisable to reduce the throttle a notch or two at the moment the locomotive begins to move in order to prevent stretching slack too quickly or to avoid slipping.

When ready to start, the following general procedure is recommended:

1. Place the selector (if used) in the PWR position.

2. Move reverser handle to the desired direction, either forward or reverse.
3. Place engine run and generator field switches in the ON (up) position.
4. Release both automatic and independent air brakes.
5. Open the throttle one notch every few seconds as follows:
 - a. To Run 1 - The engine will quickly load, but the loading will stop at a specific low value. This may be noted on the load indicating meter. At an easy starting place the locomotive may start the train.

NOTE: The design of the locomotive power control system makes it generally unnecessary to apply locomotive independent brakes or to manipulate the throttle between Run 1 and Idle during starting.

- b. To Run 2, 3, or higher (experience and the demands of the schedule will determine this) until the locomotive moves.
6. Reduce throttle one or more notches if acceleration is too rapid.
7. After the train is stretched, advance throttle as desired.

NOTE: When operating at full throttle to climb a hill or to accelerate, the IDAC wheel slip control system reacts so rapidly to correct minor slips by means of power reduction and sanding that the

wheel slip light seldom comes on to indicate severe slips. This wheel slip corrective action is often seen at the load current indicating meter as a steady reduction of load current below that which is normally expected at full throttle for a given speed. Do not misinterpret this power reduction as a fault. It is merely the wheel slip control system doing its job and maintaining power at a level within the adhesion conditions established by track and grade.

ACCELERATING A TRAIN

After the train has been started, the throttle can be advanced as rapidly as desired to accelerate the train. The speed with which the throttle is advanced depends upon demands of the schedule and the type of locomotive and train involved. In general, however, advancing the throttle one notch at a time is desired to prevent slipping.

The load indicating meter provides the best guide for throttle handling when accelerating a train. By observing this meter it will be noted that the pointer moves toward the right (increased amperage) as the throttle is advanced. As soon as the increased power is absorbed, the meter pointer begins moving toward the left. At that time, the throttle may again be advanced. Thus for maximum acceleration without slipping, the throttle should be advanced one notch each time the meter pointer begins moving toward the left until full power is reached in throttle position 8.

AIR BRAKING WITH POWER

The method of handling the air brake equipment is left to the discretion of the individual railroad. However, when braking with power, it must be remembered that for any given throttle position, the draw bar pull rapidly

increases as the train speed decreases. This pull might become great enough to part the train unless the throttle is reduced as the train speed decreases. Since the pull of the locomotive is indicated by the amperage on the load meter, the operator can maintain a constant pull on the train during a slow down, by keeping a steady amperage on the load meter. This is accomplished by reducing the throttle a notch whenever the amperage starts to increase. It is recommended that the independent brakes be kept fully released during power braking. The throttle **MUST** be in Idle before the locomotives comes to a stop.

OPERATING OVER RAIL CROSSING

When operating the locomotive at speeds exceeding 25 MPH, reduce the throttle to a Run 4 position at least eight seconds before the locomotive reaches a rail crossing. If the locomotive is operating in Run 4 position or lower, or running less than 25 MPH, allow the same interval and place the throttle in the next lower position. Advance the throttle after all units of the consist have passed over the crossing. This procedure is necessary to ensure decay of motor and generator voltage to a safe level before the mechanical shock that occurs at rail crossings is transmitted to the motor brushes.

RUNNING THROUGH WATER

Under **ABSOLUTELY NO CIRCUMSTANCES** should the locomotive be operated through water deep enough to touch the bottom of the traction motors. Water any deeper than 3" above the rail is likely to cause traction motor damage.

When passing through any water on the rails, exercise every precaution under such circumstances and always go very slowly, never exceeding 2 to 3 MPH.

WHEEL SLIP CORRECTION

Instantaneous reduction of locomotive power together with automatic sanding functions to correct wheel slip. After adhesion is regained, a timed application of sand continues while power is smoothly restored. The system functions entirely automatically, and no action is required by the locomotive operator.

Depending upon the seriousness of the slipping condition, the wheel slip light may or may not flash on and off as the wheel slip control system functions to correct the slips. However, the IDAC wheel slip control system reacts so rapidly to correct minor slips that the wheel slip light seldom comes on to indicate severe slips. The wheel corrective action is often seen at the load current indicating meter as a steady reduction of load current below that which is normally expected at full throttle for a given speed. Do not misinterpret this power reduction as a fault. It is simply the wheel slip control system doing its job and maintaining power at a level within the adhesion conditions established by track and grade.

NOTE: Whenever possible, operation on grades should be at full throttle position. Throttle reduction during wheel slip is recommended only when wheel slip conditions are such that repeated wheel slip causes severe lurching that may pull a train apart. Such severe conditions may indicate the need for a helper or the need to take the train up the hill in two parts.

WHEEL SLIP LIGHT

If the wheel slip light blinks on and off slowly and persistently or burns continuously during locomotive operation, a pair of wheels may be sliding or circuit difficulty may exist. Due to the seriousness of sliding

wheels, under such indications the locomotive should be **IMMEDIATELY STOPPED** and an investigation made to determine the cause. The wheels may be sliding due to a locked brake, damaged traction motor bearings, or broken pinion or gear teeth.

Repeated ground relay tripping, accompanied by unusual noises such as thumping or squealing, may also indicate serious traction motor trouble that should be investigated at once.

Do not allow any unit that must be isolated due to repeated wheel slip or ground relay action to remain in a locomotive consist **UNLESS IT HAS BEEN ABSOLUTELY DETERMINED THAT ALL OF ITS WHEELS ROTATE FREELY.**

LOCOMOTIVE SPEED LIMIT

The maximum speed at which the locomotive can be safely operated is determined by the gear ratio. This ratio is expressed as a double number such as 62:15. The 62 indicates the number of teeth on the axle gear while the 15 represents the number of teeth on the traction motor pinion gear.

Since the two gears are meshed together, it can be seen that for this particular ratio the motor armature turns approximately four times for a single revolution of the driving wheels. The locomotive speed limit is therefore determined by the maximum permissible rotation speed of the motor armature. Exceeding this maximum could result in serious damage to the traction motors.

Various gear ratios are available to suit specific locomotive operating requirements. For each gear ratio, there is a maximum operating speed. This information is given in the "General Data" section at the beginning of this manual.

Although not basically applied, overspeed protective equipment is available for installation on locomotives. The equipment consists of an electro-pneumatic arrangement with many possible variations to suit specific requirements. In general, however, an electrical switch in the speed recorder is used to detect the overspeed. This switch in turn initiates certain air brake functions which reduce the train speed.

MIXED GEAR RATIO OPERATION

If the units of the consist are of different gear ratios, the locomotive should not be operated at speeds in excess of that recommended for the unit having the lowest maximum permissible speed. Similarly, operation should never be slower than the minimum continuous speed (or maximum motor amperage) for units having established short time ratings.

To obtain a maximum tonnage rating for any single application, Electro-Motive will, upon request, analyze the actual operation and make specific tonnage rating recommendations.

DYNAMIC BRAKING

Dynamic braking, on locomotives so equipped, can prove extremely valuable in retarding train speed in many phases of locomotive operation. It is particularly valuable while descending grades, thus reducing the necessity for using air brakes.

Depending on locomotive gear ratio, the maximum braking strength is obtained between 19 and 23 MPH. At train speeds higher than the optimum, braking effectiveness gradually declines as speed increases. For this reason, it is important that dynamic braking be started **BEFORE** train speed becomes excessive. While in dynamic braking, the speed of

the train should not be allowed to "creep" up by careless handling of the brake.

To operate dynamic brakes, proceed as follows:

1. The reverser handle must be positioned in the direction of the locomotive movement.
2. Return throttle to Idle and hold it in Idle for 10 seconds before proceeding.
3. Move selector to OFF position.

WARNING: The 10 second delay must be accomplished before the selector is moved to the "B" position.

On locomotives delivered after December, 1969, braking delay occurs automatically. Do not misinterpret the delay as failure of the dynamic braking system.

It is possible for a sudden surge of braking effort to occur if the dynamic braking handle (throttle) is open when the automatic delay times out.

5. Move the selector to the "B" or braking position. This establishes the dynamic braking circuits. It will also be noted that a slight amount of braking effort occurs, as evidenced by the load current indicating meter.
6. After the slack is bunched, the throttle is used to control dynamic braking strength. As it is advanced about 13° away from Idle it will be noted that the engine speed automatically increases.

7. Braking effort may be increased by slowly advancing the throttle to full 8th position if desired. Maximum braking current is automatically limited to 700 amperes by a dynamic brake current limiting regulator.

NOTE: On units equipped for "Grid Current Trainline Control" of dynamic braking, maximum current is limited by braking handle position, with 700 amperes obtainable only with braking handle in the maximum position.

8. With automatic regulation of maximum braking strength, the brake warning light on the controller should seldom give indication of excessive braking current. If the brake warning light does flash on however, movement of the throttle handle should be stopped until the light goes out.
9. If the light fails to go out after several seconds, move the throttle handle back towards Idle slowly until the light does go out. After the light goes out, throttle may again be advanced to increase braking effort.

NOTE: The brake warning light circuit is "trainlined" so that a warning will be given in the lead unit if any unit in the consist is generating excessive current in dynamic braking. Thus regardless of the load indicating meter reading or braking handle position (which may be less than maximum), whenever the warning light comes on, it should not be allowed to remain on for any longer than two or three seconds before steps are taken to reduce braking strength.

10. When necessary, the automatic brake may be used in conjunction with the dynamic brake. However, the independent brake must be

KEPT FULLY RELEASED whenever the dynamic brake is in use, or the wheels may slide. As the speed decreases below 10 MPH the basic dynamic brake becomes less effective. When the speed further decreases, it is permissible to completely release the dynamic brake by placing the selector lever in the OFF or PWR position, applying the independent brake simultaneously to prevent the slack from running out.

The locomotive can be operated in dynamic braking when coupled to older units that are not equipped with brake current limiting regulators. If all the units are of the same gear ratio, the unit having the lowest maximum brake current rating should be placed as the lead unit in the consist. The operator can then operate and control the braking effort up to the limit of the unit having the lowest brake current rating, without overloading the dynamic brake system of a trailing unit. The locomotive consist MUST always be operated so as not to exceed the braking current of the unit having the lowest maximum brake current rating. Units equipped with dynamic brake current limiting regulators can be operated in multiple with other locomotives in dynamic braking regardless of the gear ratio or difference in the maximum brake current ratings.

DYNAMIC BRAKE WHEEL SLIP CONTROL

During dynamic braking, each series group of two traction motors is connected in parallel with each dynamic braking resistor grid circuit and with the other series connected traction motors. With this arrangement, when a wheel slips it may be motored by other motors in the system. This in effect makes a wheel slip during dynamic braking somewhat self

correcting. However, the parallel arrangement of dynamic braking resistor grids and traction motors is such that the full response of the IDAC wheel slip control system is available during dynamic braking as well as during power operation. The precise and immediate regulation maintained by IDAC, plus the motoring effect created by the parallel arrangement, provides extremely stable dynamic brake operation.

In addition to the above, a bridge circuit is employed to protect against the possibility of simultaneous slips that may not be detected by IDAC.

When a pair of wheels is detected tending to rotate at a slower speed, the retarding effort of the traction motors in the unit affected is reduced (traction alternator field excitation is reduced in the unit affected) and sand is automatically applied to the rails. When the retarding effort of the traction motors in the unit is reduced, the tendency of the wheel set to rotate at a slower speed is overcome. After the wheel set resumes normal rotation, the retarding effort of the traction motors returns (increases) to its former value. Automatic sanding continues for 3 to 5 seconds after the wheel slide tendency is corrected.

DOUBLE HEADING

Prior to double heading behind another locomotive, make a full service brake pipe reduction with the automatic brake valve, and place the cutoff valve in CUTOFF position. Return the automatic brake valve handle to the release position and place the independent brake valve in release position. On 26L equipment place the MU valve in LEAD position.

The operation of the throttle is normal, but the brakes are controlled from the lead locomotive. An emergency air brake application may be made, however, from the automatic brake valve of the second unit. Also, the

brakes on this unit may be released by depressing the independent brake valve handle while it is in the release position.

OPERATION IN HELPER SERVICE

Basically, there is no difference in the instructions for operating the locomotive as a helper or with a helper. In most instances it is desirable to get over a grade in the shortest possible time. Thus, wherever possible, operation on the grades should be in the full throttle position. The throttle can be reduced, however, where wheel slips cause lurching that may threaten to break the train.

ISOLATING A UNIT

When the occasion arises where it becomes advisable to isolate a locomotive unit, observe the following:

1. When operating under power, a unit may be isolated at any time, but discretion as to timing and necessity should be used.
2. When operating in dynamic braking, it is important to get out of dynamic braking before attempting to isolate the unit. This is done by reducing the braking handle (throttle) to idle. The isolation switch can then be moved to START position to eliminate the braking on that unit. If the braking is resumed, other units will function normally.

CHANGING OPERATING ENDS

When the locomotive consist includes two or more units with operating controls, the following procedure is recommended in changing from one operating end to the opposite end on locomotives equipped with 26L brakes.

ON END BEING CUT OUT

1. Move the automatic brake valve handle to service position and make a 20-pound reduction.
2. After brake pipe exhaust stops, place cutoff valve in CUT OUT position by pushing dial indicator handle in and turning to the desired position.
3. Place independent brake in fully released position.
4. Place MU valve in the desired TRAIL position, depending on brake equipment on trailing units. (MU valve is located on the left hand side of the air pedestal. Push dial indicator inward and turn to desired position.)
5. Position automatic brake valve in handle off position. (Handle may be removed if so equipped.)
6. Place selector in OFF position.
7. Place reverser handle in neutral position and remove to lock controller.
8. At the controller, place all switches in the OFF position. Be absolutely certain that the control and fuel pump switch, generator field switch, and engine run switch are in the OFF position.
9. At the engine control panel, place headlight control switch in proper position for trailing unit operation. Place other switches ON as needed.
10. At the circuit breaker panel, all circuit breakers in the black area are to remain in the ON position.
11. After completing the operations outlined in the preceding steps, move to the cab of the new lead unit.

ON END BEING CUT IN

1. At the controller, make certain throttle is in Idle, selector is in OFF, and the generator field switch is OFF.
2. Insert reverser handle and leave in neutral position.
3. Insert automatic brake valve handle (if removed) and place in **SUPPRESSION** position to nullify any safety control, over-speed, or train control used.
4. Insert independent brake valve handle (if removed) and move handle to full independent application position.
5. Position cutoff valve in either FRGT or PASS position depending on make up of the train.
6. Place MU valve in LEAD position.
7. At the circuit breaker panel, check that all circuit breakers in the black area are in the ON position.
8. At the engine control panel, place the headlight control switch in proper position, and other switches ON as needed.
9. At the controller, place the engine run, control and fuel pump, and generator field switch in ON position. Other switches may be placed ON as needed.

STOPPING ENGINE

There are six ways to stop the engine.

1. Press stop button on engine control panel.

When the locomotive is standing still or under power, the isolation switch should be placed in STOP position. The stop button can then be pressed in to stop the engine. Since the reaction of the stop button is instantaneous, it need not be held in.

2. Press emergency fuel cutoff button.

Emergency fuel cutoff pushbuttons are located near each fuel filter opening and on the engine control panel. These pushbuttons operate in the same manner as the STOP button and need not be held in nor reset.

3. Use layshaft lever.

The layshaft lever at the accessory end of the engine can be operated to override the engine governor and move the injector racks to the no fuel position.

4. Close the low water detector test cock.

When the low water detector trips, oil is dumped from the governor low oil shutdown device, stopping the engine.

5. Use throttle handle.

To stop all engines "on the line" in a consist simultaneously from the cab of the lead unit, move the throttle to the IDLE position, pull the lever out and away from the controller, and move it beyond IDLE to the STOP position.

6. Pull out low oil shutdown rod on the side of the governor.

NOTE: Observe freezing weather precautions whenever an engine is shut down during cold weather.

FREEZING WEATHER PRECAUTIONS

As long as the diesel engine is running, the cooling system will be kept adequately warm regardless of ambient (outside) temperatures encountered. It is only when the engine is shut down or stops for any reason that the cooling system requires protection against freezing.

When danger of freezing is present, the cooling system should be completely drained or have steam admitted. The basic valves are illustrated in Fig. 3-7.

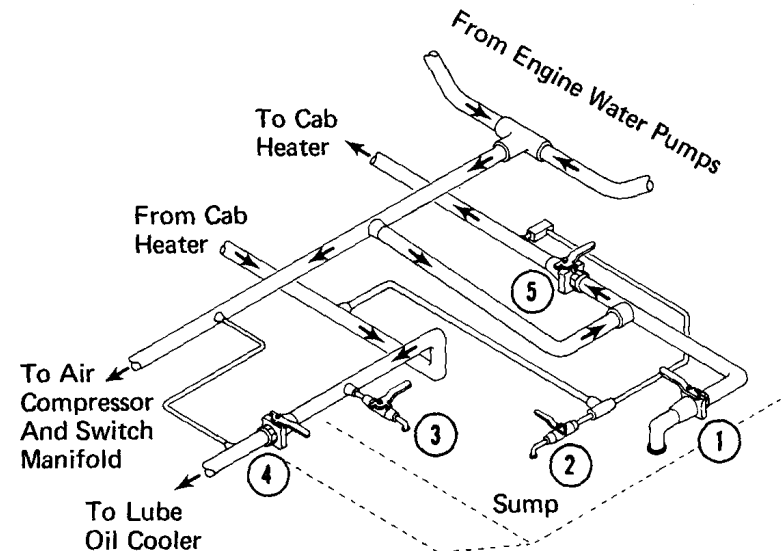
DRAINING THE COOLING SYSTEM

The engine cooling system should be drained in the event that the diesel engine is stopped and danger of freezing exists. The draining procedure is as follows:

Drain Engine Cooling And Cab Heater System

Make sure that the following valves are open.

1. Cab heater supply.
2. Cab heater drain valve and vent valve. Vent valve must remain open during entire draining period.
3. Cab heater return.
4. Engine water drain. The above valves are located in engine drain sump, governor end of engine.
5. Preheater water supply (located at equipment rack, if so equipped).



All Valves Shown In Closed Position

1. Cooling System Drain Valve
2. Cab Heater Drain Valve
3. Cab Heater Drain Vent Valve
4. Cab Heater Return Shutoff Valve
5. Cab Heater Supply Shutoff Valve

Fig. 3-7 - Engine And Cab Heater Drain Valve Locations

6. Preheater water return (located at equipment rack, if so equipped).

All valves are tagged as noted and open when handles are in line with piping.

After system pressure is released, remove the water tank fill cap to allow drainage at an increased rate.

CAUTION: If a hot engine is drained, always allow the engine to cool before refilling with fresh coolant.

Drain Cab Heater System, Only

1. Close cab heater supply and return valves.
2. Engine water drain valve is to remain closed.
3. Open cab heater drain valve and vent valve. Vent valve must remain open during entire draining period.

Drain Flush Toilet (If So Equipped)

1. Flush toilet until all water has drained from tank.
2. Turn off electric toilet tank heater (if so equipped).
3. Remove pipe plug from bottom of toilet flush piping.

Drain Water Cooler (If So Equipped)

1. Remove and empty water bottle.
2. Drain remaining water in cooler by holding in the spigot button.
3. Turn off electric power to water cooler (if so equipped).

CAUTION: On special order, heater shutoff valves are located in the piping at the cab heaters; these valves must be open when draining the system, and when the locomotive is operating during freezing weather.

On units equipped with special automatic cooling system drain, the automatic water drain circuit breaker must be in the ON position.

It may be necessary to open the automatic water drain circuit breaker when filling a cold system with cold water. Make certain that the breaker is closed after the engine has run long enough to warm the system.

COOLING SYSTEM

FOR NORMAL FILLING - DO NOT REMOVE PRESSURE CAP. ATTACH HOSE AT FILL CONNECTOR AND HOLD FILL VALVE OPEN. CAUTION - IF PRESSURE CAP MUST BE REMOVED, DO NOT ATTACH HOSE TO FILL PIPE. HOLD FILL VALVE OPEN UNTIL TANK IS COMPLETELY VENTED. THEN REMOVE CAP WHEN REPLACING, HOLD FILL VALVE OPEN SO CAP CAN BE FULLY TIGHTENED AS SHOWN.

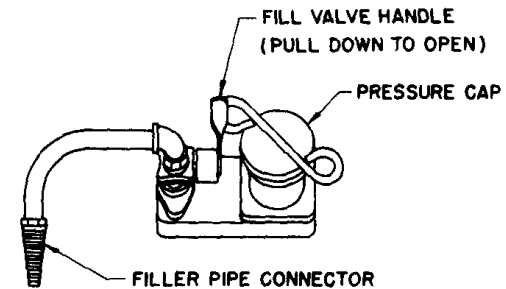


Fig. 3-8 - Cooling System Pressure Cap And Filler/Relief Arrangement

TOWING LOCOMOTIVE IN TRAIN

When a locomotive unit equipped with 26L air brakes is placed within a train consist to be towed, control and air brake equipment should be set as follows:

OPERATION

1. Drain all air from main reservoirs and air brake equipment unless engine is to remain idling.
2. Place the MU valve in DEAD position.
3. Place cutoff valve in CUT OUT position.
4. Place independent brake valve handle in release position.
5. Place automatic brake valve handle in handle off position.
6. Cut in dead engine feature by turning cutout cock, Fig. 2-10, to open (90° to pipe) position. Dead engine cock is located beneath cab floor and may be reached through an access door of locomotive.
7. If engine is to remain IDLING, switches should be positioned as follows:
 - a. Isolation switch in START position.
 - b. Main battery switch and ground relay cutout switch is closed.
 - c. Generator field circuit breaker OFF.
 - d. All breakers in black area of circuit breaker panel in ON position.
 - e. Starting fuse should be removed. Other fuses should be left in place.
 - f. Control and fuel pump switch ON.
 - g. Fuel pump circuit breaker ON.

OPERATION

- h. Throttle in Idle, selector in OFF reverse handle in NEUTRAL. *REMOVE REVERSE HANDLE FROM CONTROLLER* to lock controls.
8. If locomotive is to be towed DEAD in a train, switches should be positioned as follows:
 - a. Main battery switch open.
 - b. All circuit breakers OFF.
 - c. All control switches OFF.
 - d. Starting fuse removed.
 - e. Throttle should be in Idle, selector in OFF. *REVERSE HANDLE SHOULD BE REMOVED FROM CONTROLLER.*

NOTE: If there is danger of freezing, the engine cooling system should be drained.

SECTION 4

TROUBLE SHOOTING

INTRODUCTION

This section covers operational problems that may occur on the road and suggests action that may be taken by the operator in response to the trouble. Safety devices automatically protect equipment in case of faulty operation of almost any component. In general this protection is obtained by one of the following methods.

1. Complete shutdown of the diesel engine, or complete elimination of a function such as dynamic braking.
2. Unloading of the diesel engine and restriction to idle engine speed. In some instances manual resetting of the function may be necessary, or automatic resetting after a time delay may be provided.
3. Rough back-up regulation for protection of equipment.

Condition	Probable Cause	Suggested Operator's Response
Alarm bell rings – No alarm lights on in lead unit.	Trailing unit hot engine.	No action required unless alarm persists. If alarm continues for more than a few minutes, investigate the cause of the alarm in trailing units.
<p>NOTE: If governor low oil plunger trips to shut the engine down, but the crankcase and low water detector buttons remain set, check oil and water levels. If oil level is satisfactory and water level is marginal, the hot oil detector (on units so equipped) may have tripped. There is no indicator for such a trip except a very hot engine condition. Do not attempt to restart engine. Report engine shutdown circumstances to authorized maintenance personnel.</p>		
	Trailing unit reduced to idle speed and power or shut down.	No action for 10 seconds; then press the ground relay reset push button on the control stand if so equipped. In any case, if the alarm does not stop within a few minutes, investigate the cause of the alarm in trailing units.

Condition	Probable Cause	Suggested Operator's Response
High Voltage Ground/Fault light on. Alarm bell rings.	<p>Traction motor flashover.</p> <p>High voltage path to ground due to moisture or insulation failure.</p>	<p>After 10 seconds, press the ground relay reset button on the control stand if so equipped. The light will go out and power will be restored. This will occur automatically on units so equipped.</p> <p>Same response as above. If ground relay trip repeats only at high speed, temporary operation at lower throttle position may help to dry out the grounding circuit.</p>

Condition	Probable Cause	Suggested Operator's Response
<p>No Power/No Battery Charge light on or battery charging indicator (if so equipped) shows discharge with engine running. Engine will shut down from lack of fuel.</p>	<p>Tripped breaker or blown fuse. Engine shut down.</p>	<p>Isolate the unit. Check for -</p> <ol style="list-style-type: none"> 1. Tripped circuit breaker. 2. Blown fuse. 3. Engine overspeed trip. <p>Test and replace fuses as necessary, or reset circuit breaker. Reset engine overspeed trip lever if required. Restart engine and reapply power.</p> <p>If fuses again blow or breakers trip, shut down and isolate the unit.</p> <p>If overspeed trip again occurs, operation at lower throttle position may prevent further tripping.</p>

Condition	Probable Cause	Suggested Operator's Response
<p>Hot Engine light on; alarm ringing; Engine speed and power reduced on affected unit.</p> <p>(See note on first troubleshooting page)</p>	<p>Tunnel or desert operation</p>	<p>No action necessary unless alarm continues for more than a few minutes.</p> <p>If alarm continues, isolate the affected unit. If water level is too low, shut the engine down.</p> <p>If freezing conditions are possible, drain the cooling system in accordance with railroad regulations.</p>

Condition	Probable Cause	Suggested Operator's Response
Governor Shutdown light on.	Low water due to leak, or low oil due to leak, or crankcase pressure due to cracked piston or bad cylinder seals, or hot oil due to plugged oil cooler.	If shutdown is due to low water, the addition of water may permit continued operation. Otherwise place the isolation switch in ISOLATE position. If freezing conditions are possible drain the cooling system in accordance with the railroad regulations.
<p>WARNING: If crankcase pressure detector has tripped, make no further engineroom inspections. Do not attempt to restart the engine. Isolate the unit. If freezing conditions are possible, drain the cooling system in accordance with railroad regulations.</p>		
Repeated automatic sanding along with load current indicating meter dropping back.	Normal wheel slip correction under severe conditions.	No action required. Do not reduce throttle unless slipping is so severe that lurching threatens to break the train.

Condition	Probable Cause	Suggested Operator's Response
Intermittent wheel slip light indications.	Normal wheel slip correction under severe conditions.	<p>No action required. Do not reduce throttle unless slipping is so severe that lurching threatens to break the train.</p> <p>If the unit is so equipped, place the lead truck sanding switch in the ON position while climbing the hill.</p> <p>If the unit is so equipped, place the lead unit power reduction switch in the ON position and slightly reduce lead unit power to enable it to dress the rail without slipping.</p>

Condition	Probable Cause	Suggested Operator's Response
PCS light on.	Penalty brake application Emergency brake application	Move throttle to idle. Move brake to valve handle to handle off position and then return handle to release position. Move throttle to idle position. Move brake handle to emergency position and wait 45 seconds before moving handle to release position.
NOTE: Follow railroad regulations after any penalty or emergency brake application.		
Brake Warning Light.	Regulating system failure.	Place dynamic brake cutout switch on engine control panel of affected unit in the CUTOUT position.