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Manual Cover

Title Page

NOTICE

The data appearing in this manual is intended as a guide in explaining the locomotive equipment used during operation. It is generally applicable to a 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 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 published. These changes will be covered in subsequent editions of this manual.

INTRODUCTION

This manual has been prepared as a guide for railroad personnel engaged in the operation of the 1500 horsepower General Motors Model GP15-1 diesel-electric locomotive.

The contents are divided into four sections as follows:

1. General Description - Provides general description of principal equipment components.

2. Controls - Explains functions of controls used to start and operate the locomotive.

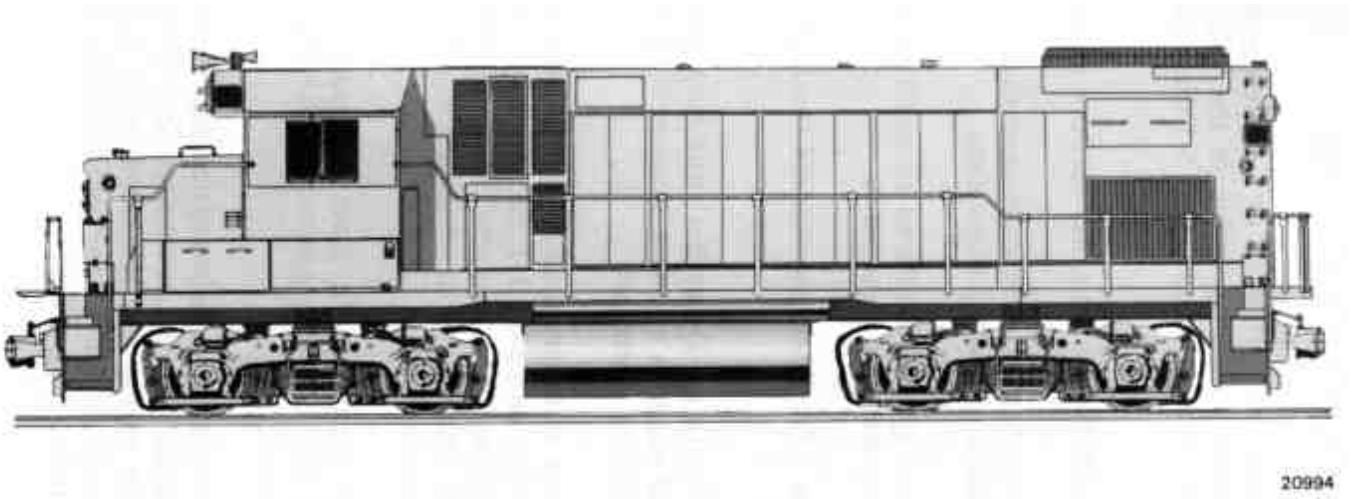
3. Operation - Outlines procedures for locomotive operation.

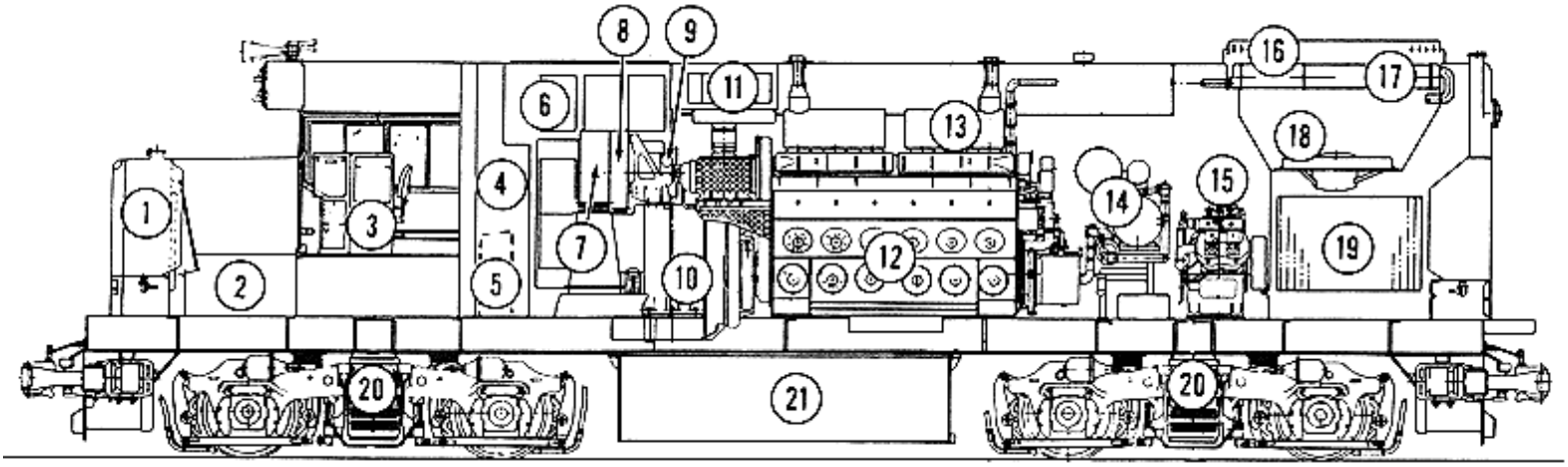
4. Troubleshooting - Describes condition, probable causes, and suggests operator's response to troubles occuring during operation.

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 are a part of the standard EMD Maintenance Instruction series.





1.	Sand Box	8.	Generator Blower	15.	Air Compressor
2.	Battery	9.	Aux. Generator	16.	Roof Shutters
3.	Control Stand	10.	Main Generator	17.	Radiators
4.	Electrical Cabinet	11.	Engine Air Filter	18.	Cooling Fan
5.	Cabinet Air Filter	12.	12-645E Engine	19.	Cooling Air Inlet
6.	Carbody Air Filter	13.	Exhaust Manifold	20.	Truck-Clasp Brakes
7.	Traction Motor Blower	14.	Equipment Rack	21.	Fuel Tank

GENERAL DATA

Model Designation	GPI5-1
Locomotive Type	(B-B) 0440
Locomotive Horsepower	1500
Diesel Engine	
- Model	645E
- Number Of Cylinders	12

- Cylinder Arrangement	45 deg - "V"
- Cylinder Bore And Stroke	230 x 254 mm (9-1/16" x 10")
- Operating Principle	Blower Scavenged 2 Stroke Cycle Unit Fuel Injection Water Cooled
Engine Speed	
- Full	904 RPM
- Idle	318 RPM
- Low Idle	255 RPM
Main Generator Model	D32
- Number Of Poles	12
- Nominal Voltage (DC)	600
- Maximum Continuous Current	2350 Amperes
Companion Alternator	D14
- Number Of Poles	16
- Nominal Voltage (AC)	215
- Frequency (At 900 RPM)	120 Hz
Auxiliary Generator	
- Basic Rating	10 kW
- Voltage DC	74
Traction Motors	
- Model	D77
- Number	4
- Type	DC, Series Wound, Axle Hung
- Maximum Continuous Current With 62:15 Gearing	920 Amperes
Driving Wheels	4 Pairs
- Diameter	1 016 mm (40")
Air Compressor	
- Type	Two Stage
- Number Of Cylinders	3
- Displacement at 900 RPM	7.19 m3 (254 Cu. Ft.)/Min.
- Lube Oil Capacity	38 Litres (10 Gal.)
Storage Battery	
- Number Of Cells	32
- Voltage	64
- Rating - 8 Hour	420 Ampere Hour
Supplies	
- Engine Lubricating Oil Capacity	624 Litres (165 Gal.)
- Cooling Water Capacity	870 Litres (230 Gal.)
Sand	
- Basic	1.58 in3 (56 Cu. Ft.)
- Special	2.04 m3 (72 Cu. Ft.)

Fuel	
- Basic	9 085 Litres (2,400 Gal.)
Major Dimensions	
- Track Gauge	1.435 in (4' 8-1/2")
- Distance Between Coupler	
- - Pulling Faces	16.739 in (54' 11")
- Maximum Height Over Rail	4.636 m (15' 2-1/2")
- Maximum Width Over	
- - Flag Brackets	3.150 m (10' 4")
- - Underframe	3.127 m (10' 3-1/8")
- Approximate Weight On Rails	108 864 kg (240,000 lbs)
Weight On Drivers	100%

Curve Negotiation

Truck swing limits single unit curve negotiation to a 49 deg or 36.6 m (120 ft.) radius curve.

Two units coupled are limited by coupler swing to a 34 deg or 51.8 in (170 ft.) radius curve.

Locomotive coupled to 50 ft. car is limited by coupler swing to a 23 deg or 74.7 in (245 ft.) radius curve.

TABLE OF NOMINAL SPEEDS

Gear Ratio	Minimum Continuous Speed At Full Power		Maximum Speed	
	MPH	KPH	MPH	KPH
62:15	**9.3**	15	**65***	**105***

*Based on Rated RPM of traction motors.

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SECTION 3- OPERATION

SECTION 1

GENERAL DESCRIPTION

INTRODUCTION

The General Motors Model GP15-1 locomotive is equipped with a Model 645E engine that delivers power to the main generator for tractive purposes. This power is then distributed to four traction motors, each of which is directly geared to a pair of driving wheels.

Basically the locomotive is designed for single unit operation, but on special order it can be equipped for multiple unit operation. When locomotives are equipped for multiple unit operation they may be operated independently or coupled with other units to form a consist. When equipped and coupled together for multiple unit operation, all units are simultaneously controlled through jumper cables from the control station located in the cab of the lead unit. The end-to-end arrangement of units in a consist in no way affects operation.

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 Model GP15-1 locomotive and the general arrangement of its equipment are illustrated in the Introduction. Some of the equipment components are numbered and intentified in the general arrangement drawing. Some of the items are described in detail in other sections of this manual. The Table Of Contents should be consulted to locate such information.

LOCOMOTIVE OPERATION

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 the direct coupled main generator which is temporarily used as a starting motor. A storage battery supplies the electric current to rotate the generator and start the engine.
3. When the engine is running, it supplies mechanical power through shafts and couplings to directly drive these electrical generators, the air compressor, a traction motor and generator blower, and engine mounted lube oil and cooling water pump.
4. The auxiliary generator charges the storage battery and supplies low voltage direct current for the control, lighting, and main generator excitation circuits.
5. The main generator converts the engine’s mechanical power to high voltage direct current, which is then distributed to the traction motors through circuits established by various switchgear components for locomotive pulling power. The main generator is also used to crank the engine during engine starting.
6. The companion alternator (D 14) provides three phase power for the radiator blower motor and the inertial filter blower motor on units so equipped.
7. By means of the cab controls, low voltage circuits are established to actuate the engine governor and electrical switchgear.
8. Four 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.
9. 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.
10. At locomotive start the throttle controls electrical devices that provide rapid power response at a level consistent with smoothly controlled starting.
11. 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.

Except for manual operation of the cab controls, locomotive operation is completely automatic. Various alarms and safety devices will alert the operator should any operating difficulties occur.

SECTION 2

CONTROLS AND INDICATING DEVICES

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 located within the cab, Fig. 2-1.

- 1. The Fuse And Switch Panel
- 2. Circuit Breaker Panels
- 3. The Engine Control Panel
- 4. The Locomotive Control Console

ENGINE STARTING CONTROLS

FUEL PRIME/ENGINE START SWITCH

This switch, Fig. 2-2, located on the equipment rack in the engineroom, is a three position rotary switch used for fuel priming and engine starting.

When placed in the FUEL PRIME position, the switch energizes the fuel pump which supplies fuel to the injectors. This fuel priming action also purges air bubbles from the fuel lines.

The ENGINE START position of the switch is used to supply power from the storage battery to the starting winding of the main generator to crank the engine.

INJECTOR RACK MANUAL CONTROL 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.

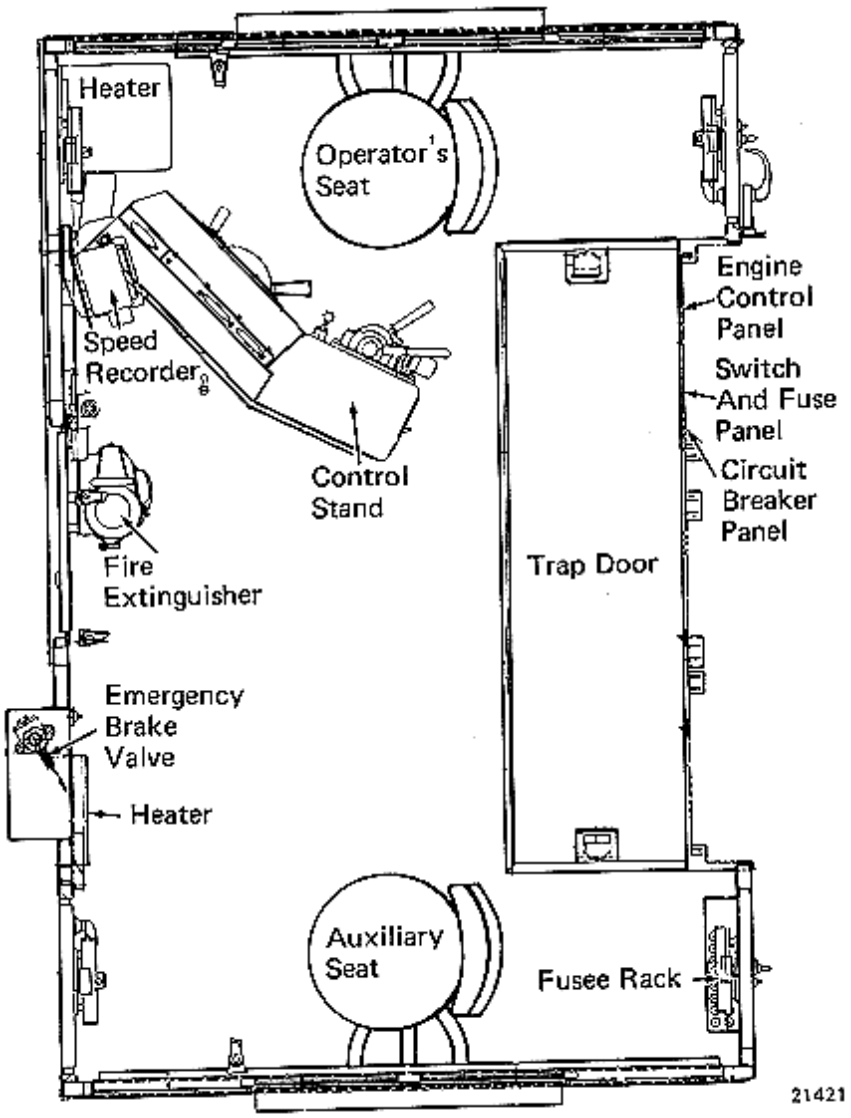
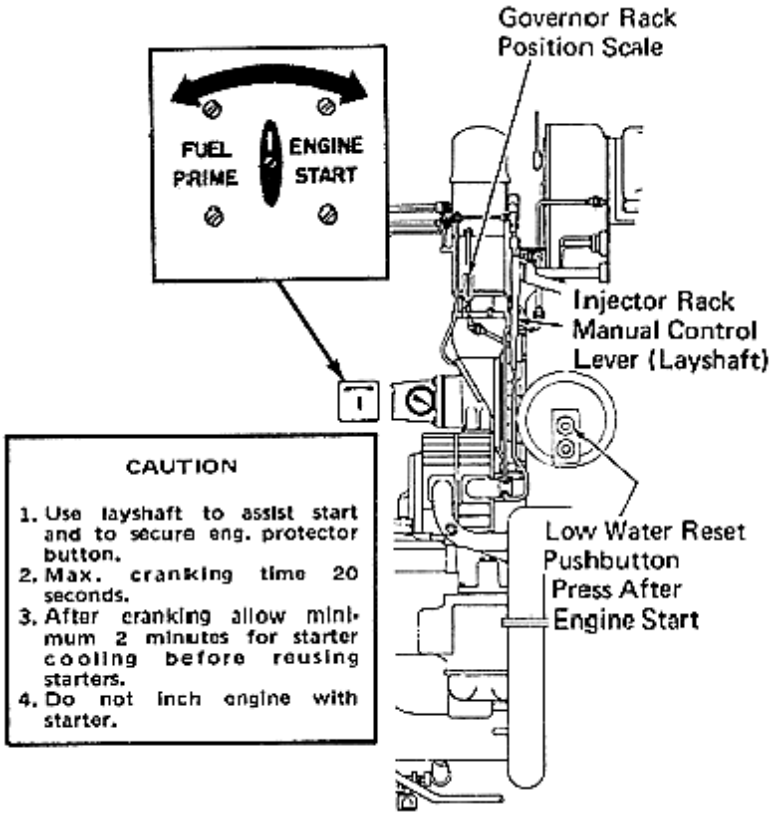


Fig.2-1 - Cab Arrangement

LOW WATER RESET PUSHBUTTON

Check the low water reset button within 50 seconds after engine start. The low water detector will often trip during engine starting, especially on starting after filling a completely drained system. It may also trip after starting a cold engine or one that has had cooling system pressure released. The detector should be reset as soon as the engine starts and is idling.



NOTE: When cranking engine, position the injector rack manual control lever at one third rack (approximately 1.6 on the scale). Do not speed up engine until oil pressure is confirmed.

Fig.2-2 - Engine Starting Controls

NOTE

If the detector is difficult to reset after engine start, position the injector rack manual control lever to increase engine speed for a short time, then press the reset button. Do not speed up engine until oil pressure is confirmed.

The reset button on some detectors will not latch when the engine is shut down. If such a condition exists, the detector will probably function correctly if it can be reset after engine start.

FUSE AND SWITCH PANEL

The fuse and switch panel, Fig. 2-3, contains the equipment described in the following paragraphs.

NOTE

There is no D14 alternator field fuse. If a short occurs in this circuit, auxiliary generator voltage will come down, and the machine will not be harmed. A NO POWER! CHRG alarm occurs.

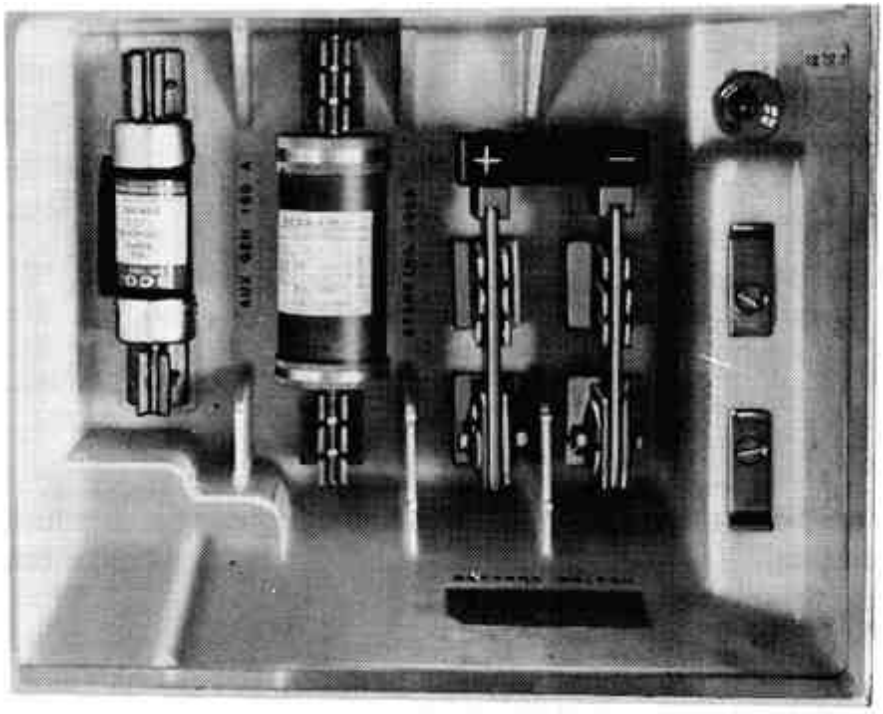


Fig.2-3 - Fuse And Switch Panel

AUXILIARY GENERATOR FUSE

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

Auxiliary generator power to the cab heaters is taken from the generator side of the fuse. Therefore, current to the cab heaters does not flow through the fuse.

AUXILIARY GENERATOR CIRCUIT BREAKER (IF PROVIDED)

This breaker performs the same function as fuse (above). However, unlike other breakers on the panel that trip to the full off position, this breaker will trip to the center position. After a period for cooling, the breaker must be placed in the full off position before resetting to the on position.

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.

NOTE

There is no D14 alternator field fuse. If a short occurs in this circuit, auxiliary generator voltage will come down and the machine will not be harmed. A NO BAIT. CHARGE/NO POWER alarm will be given and traction power will reduce to zero.

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 starting 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 starting circuit is open.

CAUTION

The locomotive is equipped with series connected starting motors which require a 400 ampere starting fuse. Certain other model locomotives require an 800 ampere starting fuse. The two fuses are of the same physical size. Observe fuse panel marking. Do not use an incorrectly rated fuse.

MAIN BATTERY KNIFE SWITCH

This switch is used to connect the batteries to the locomotive low voltage electrical system and should be kept closed at all times during operation.

The main battery knife 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 PANELS

The three circuit breaker panels contain circuit breakers and controls used to protect engine, control systems, lights, and miscellaneous devices that are used as conditions require. These circuit breakers can be operated as switches, but will trip open when an overload occurs.

NO. 1 CIRCUIT BREAKER PANEL

This panel contains circuit breakers that protect customer requested extras. The No. 1 circuit breaker panel, Fig. 2-4 has provisions for twelve circuit breakers.

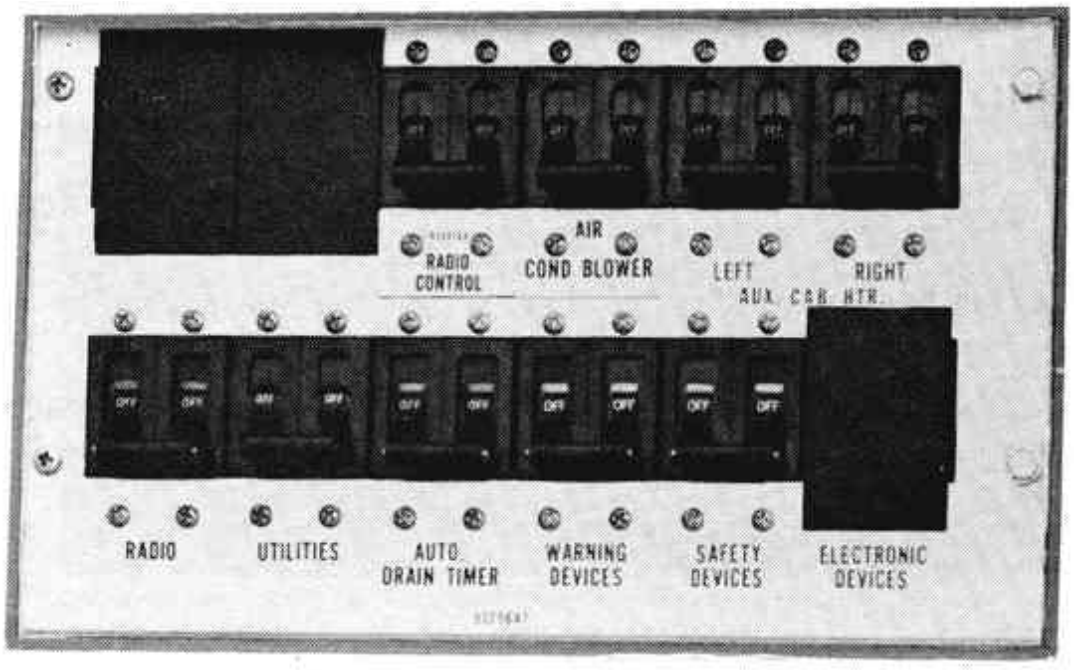


Fig.2-4 - Typical No. 1 Circuit Breaker Panel

The following paragraphs contain a brief description of typical circuit systems protected by breakers on this panel.

RADIO CONTROL

When equipped for remote radio control this breaker protects radio control circuits.

AIR COND. BLOWER

When equipped with air conditioning this breaker protects the blower fan motor circuits. A separate breaker for the air conditioner compressor is located on No. 3 circuit breaker panel.

AUX. CAB HTR.

These breakers protect the left and right auxiliary cab heaters. Heat control is provided by switches located at each heater.

RADIO

Protects circuits that supply the radio, when equipped.

UTILITIES

When equipped, this breaker protects the toilet immersion heater, or similar devices.

AUTO. DRAIN TIMER

Protects circuits that control automatic operation of drain valves in the compressed air system.

WARNING DEVICES

This breaker protects the signal light circuits, when equipped. This breaker may also be used to protect similar devices.

SAFETY DEVICES

Train overspeed brings about a penalty application of the brakes and operation of the pneumatic control switch to drop locomotive power. This breaker protects the overspeed magnet valve circuit. This breaker may also be used to protect similar devices.

NO. 2 CIRCUIT BREAKER PANEL

The No. 2 circuit breaker panel, Fig. 2-5 contains circuit breakers and switches that protect basic locomotive equipment and control systems. The panel is divided into three sections. The shaded middle section indicates breakers required on for locomotive operation. Breakers in the unshaded section are used as conditions require.

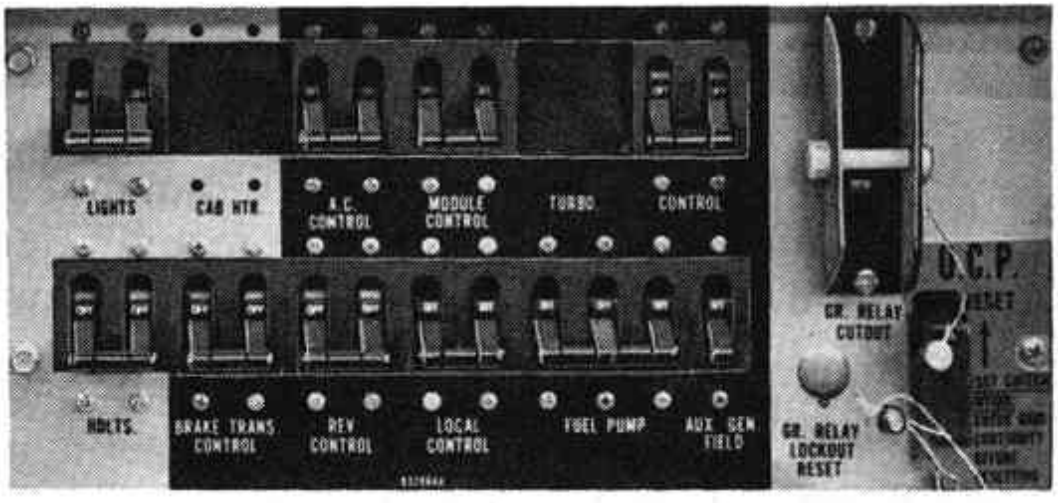


Fig.2-5 - No. 2 Circuit Breaker Panel

AC. CONTROL

This breaker protects the portion of the sensor module receiving A.C. power from the D14 alternator. The sensor module controls main generator field excitation current level. The no AC. voltage relay (NVR) is also connected in this circuit. If the breaker trips during locomotive operation, the main generator will not develop power and the no power! charge light on the engine control panel will come on indicating no D 14 output.

MODULE CONTROL

This breaker protects the local control circuit that supplies power to the circuit modules and miscellaneous control system devices.

CONTROL

The 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.

BRAKE TRANS. CONTROL

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 transfer switchgear from any position to any other position, the breaker must be closed for power transfer to take place. An open 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.

REV. CONTROL

This 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, this breaker must be closed for power transfer to take place. An open 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.

LOCAL CONTROL

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

FUEL PUMP

This 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.

AUX. GEN. FIELD

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 stop from lack of fuel.

MISCELLANEOUS CIRCUIT BREAKERS

LIGHTS

his breaker must be on to supply power to switches that control miscellaneous locomotive lights.

CAB HTR.

These breakers provide protection for electrical cab heaters, when applied.

HDLTS.

This breaker must be on to provide current to the front headlight circuit and through the trainline to the light at the rear of the consist.

NO. 3 CIRCUIT BREAKER PANEL

The No. 3 circuit breaker panel, Fig. 2-6, has provisions for four circuit breakers. The panel also contains a sealed section. This section contains a test panel intended for use by maintenance personnel during maintenance and testing procedures. A 74 volt receptacle and fuse test switch are also part of this panel.

The circuit breaker portion of the panel is divided into two sections. Breakers in the shaded section are required on for locomotive operation. Breakers in the unshaded section are to be used as conditions require.

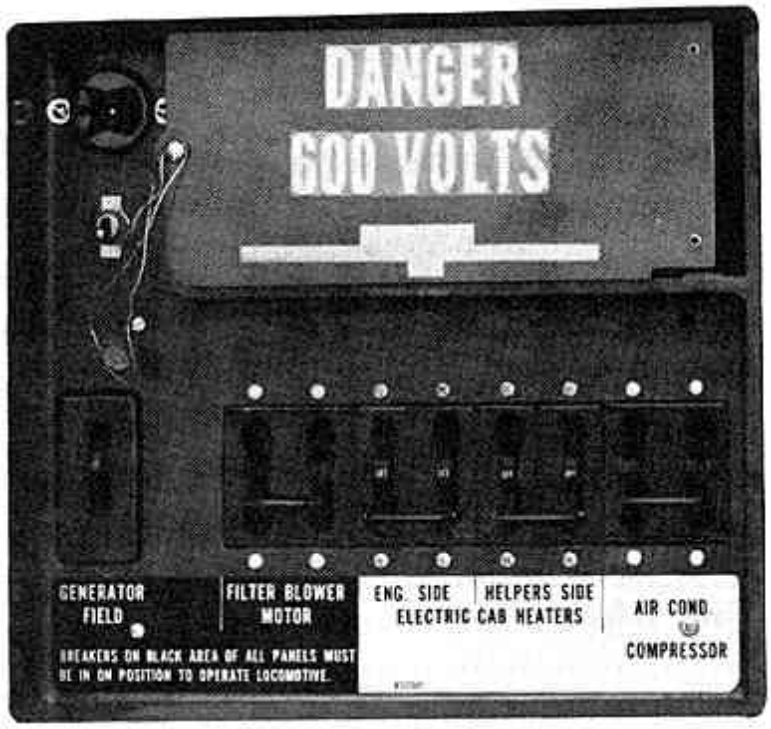


Fig.2-6 - No. 3 Circuit Breaker Panel

GENERATOR FIELD

The main generator receives excitation current through a controlled rectifier from the companion alternator. This breaker is provided to protect the controlled rectifier and both generators as well as associated circuitry.

NOTE

Unlike other breakers on the panel that trip to the full off position, the generator field circuit breaker will trip to the center position. After a period for cooling, the breaker must be placed in full off position before resetting to the on position.

This breaker protects the inertial filter blower motor circuit. The blower is used to evacuate dirt loaded air from the central air compartment inertial filters.

When equipped, the FILT. MOTOR TRIP light on the engine control panel will come on if this breaker trips open or is inadvertantly left in the off position. If tripped open, operation may continue to the nearest maintenance point.

MISCELLANEOUS CIRCUIT BREAKERS

ELECTRIC CAB HEATERS

ENG. SIDE

Protects circuits to the cab heater at the engineer's station.

HELPERS SIDE

Protects circuits to the cab heater at the helper's side of the cab.

AIR COND. COMP.

When equipped with air conditioning, this breaker protects the air compressor circuits. A separate breaker for the air conditioner blower fan motor is located on the No. 1 circuit breaker panel.

FUSE TEST SWITCH

Refer to Fuse Test Equipment paragraph under the Fuse And Switch Panel section.

This receptacle makes 74 volts D.C. available for maintenance or testing purposes. Power is supplied to the receptacle when the main battery switch and the LIGHTS circuit breaker are closed.

ENGINE CONTROL PANEL

The engine control panel, Fig. 2-7, contains various switches and indicator lights, along with a battery charging indicator 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.

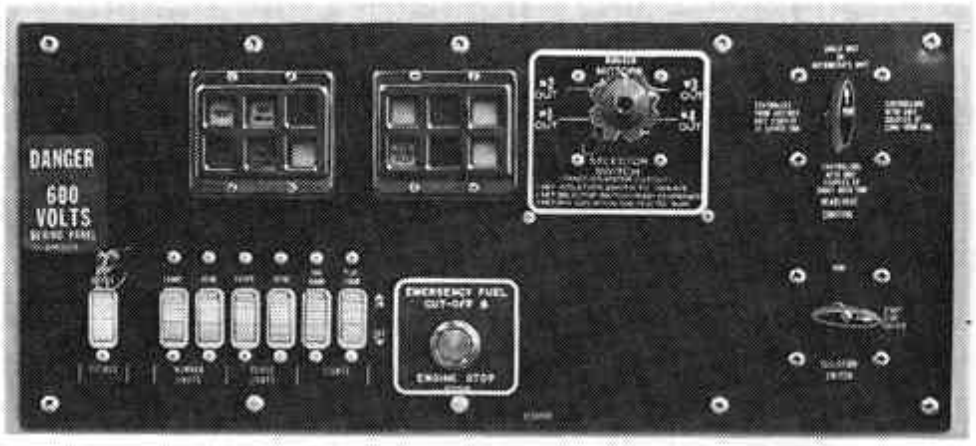


Fig.2-7 - Typical Engine Control Panel

INDICATOR LIGHTS

Basic locomotives are equipped with indicator lights to alert the operator to various operating conditions. On special order, an indicator light panel, Fig. 2-8, may be substituted for the six basic indicator lights.

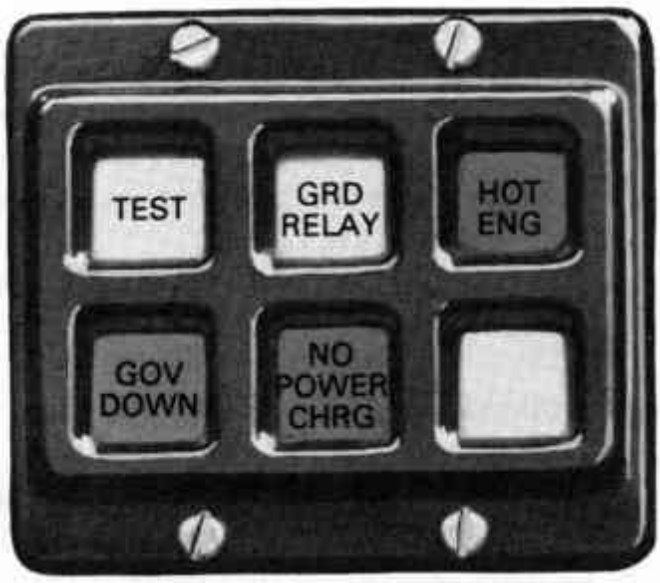


Fig.2-8 - No. 1 Indicator Light Panel

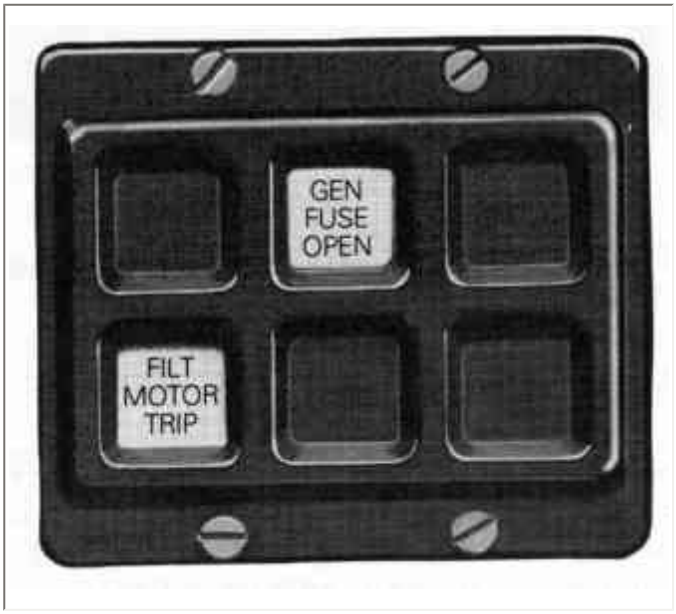


Fig.2-9 - Typical No. 2 Indicator Light Panel

Each indicator light panel has provisions for six push-to-test indicator lights. When equipped, a second indicator light panel, Fig. 2-9, will contain one to six additional indicator lights.

NOTE

Indicator light panels are equipped with push-to-test lights. This feature allows testing of the lamp circuit alone isolated from its operation in the power control system. When the lens cap is depressed, voltage is supplied to the lamp circuit. After a one second delay the light should go on.

NO. 1 INDICATOR LIGHT PANEL

The No. 1 indicator light panel, Fig. 2-8, contains the six basic indicator lights.

TEST LIGHT

The test light comes on when the test switch is placed in the CIRCUIT CHECK, LOAD TEST NO.1, or LOAD TEST NO. 2 position. The light indicates that the locomotive circuits are set up for either load testing or a circuit check. 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

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

2. Do not move test switch to NORMAL position while operating under load.

GRD RELAY LIGHT

This light indicates that an electrical path to ground has occurred, or that diodes in the main generator have failed. When the light comes on and the alarm sounds, the operator should wait 10 seconds, then press the ground reset pushbutton 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 when 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 within a time period. On basic locomotives, when the high voltage ground/fault alarm occurs for the third time after being reset twice, the affected unit should be isolated.

CAUTION

Always report ground relay light indications to proper maintenance personnel.

HOT ENG LIGHT

The hot engine alarm light (red) operates in conjunction with the alarm bell to warn the operator that engine cooling water has reached an excessive temperature. Engine speed and power remain normal, but the engine and water system should be checked if the alarm continues. If the light does not go out in a reasonable length of time, shut the engine down.

Upon special request of the customer, a power reduction circuit may be provided. This circuit automatically reduces engine speed and power when a hot engine is detected.

If the cooling system has failed and the engine is allowed to run, a hot lubricating oil detector will dump oil from the low oil pressure detector in the engine governor and bring about engine shutdown. There is no other indication for such a shutdown except a very hot engine condition.

WARNING

When low oil shutdown follows a hot engine warning, and a very hot engine condition is observed, make no further engineroom inspections. Do not attempt to restart the engine. Leave the engineroom area, and report circumstances to authorized maintenance personnel.

NO POWER CHRG LIGHT

Indicates that no AC power is being delivered from the auxiliary alternator to a voltage sensing relay. This may be due to a tripped generator field circuit breaker, engine shutdown, alternator failure, or failure of the DC auxiliary generator which excites the alternator. If the light is on for reasons other than engine shutdown, engine speed and power are reduced to idle conditions.

GOV DOWN 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, or any condition which causes the differential pressure across the water pump to drop below airbox 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 wil 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 pressurelow 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 differential low water crankcase pressure detector, Fig. 3-2, for protruding reset buttons. A protruding lower button indicates excessive oil pan pressure; a protruding upper button indicates low water.

WARNING

When it is determined that the crankcase pressure detector has tripped, make no further engineroom 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.

FILT MOTOR TRIP LIGHT

When equipped, this light indicates that the carbody inertial filter blower motor is not receiving power. Check for a tripped filter blower motor circuit breaker on the No. 3 circuit breaker panel. If the breaker will not reset, operation may continue to the nearest maintenance point.

GEN FUSE OPEN LIGHT

When equipped, this light indicates a failure within the main generator. Locomotive power may be lost in part or totally, depending on severity of the failure. This automatic function prevents further damage to locomotive systems.

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 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.

OPEN GRID CIRCUIT RESET

This button is used to reset the open grid circuit protective relay (OCP) on units equipped with extended range dynamic braking. If an open circuit occurs in the dynamic braking grids or cabling the OCP relay will pickup, locking out dynamic braking.

CAUTION

Do not reset the OCP relay. The OCP relay should only be reset by maintenance personnel following a thorough inspection of the dynamic brake grids and cabling.

EMERGENCY FUEL CUTOFF & ENGINE STOP PUSHBUTTON

The switch on the engine control panel is wired in series with emergency fuel cutoff switches located at the fuel filler openings. Pressing any one of the pushbuttons will cause the engine to stop immediately. The switches are spring loaded and do not need to be reset.

The switch operates to stop only the engine in the unit in which the switch is located. In an emergency if it is necessary to stop all engines in a multiple unit consist, pull out on the throttle lever and position it fully to the right.

BATTERY CHARGING INDICATOR (WHERE PROVIDED)

With the main battery knife switch closed, the battery charging indicator is connected into the low voltage circuits to indicate the extent of current flowing to and from the storage battery. The indicator does not indicate the 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.

A very strong discharge at time of engine shutdown, followed by blown fuses, indicates a shorted battery charging rectifier. When a very strong discharge is indicated, exercise care before opening the main battery switch.

As an extra modification, a battery charging light may be applied in lieu of the indicator.

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:

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 low lube oil alarm. It will not, however, stop the alarm in the event of a hot engine.

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.

DYN. BRAKE CUTOUT SWITCH (IF PROVIDED)

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.

MISCELLANEOUS SWITCHES

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

HEADLIGHT CONTROL SWITCH

The twin sealed-beam front and rear headlights are controlled by the front and rear headlight switches on the locomotive control panel. A dimming switch is mounted on the right side of the controller. Before these switches will function, the 35-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:

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.

ON INTERMEDIATE UNITS

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

ON TRAILING UNITS

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

REMOTE TRACTION MOTOR CUTOUT SWITCH (IF PROVIDED)

The traction motor cutout switch operates to electrically isolate a defective traction motor. This permits operation with the remaining good motors. The power control system automatically limits power to prevent overloading the operative motors. The isolated motor will continue to rotate as the train moves.

To operate the motor cutout switch it is first necessary to place the isolation switch on the engine control panel in ISOLATE position.

The switch is then pressed in and turned to cut out the defective motor. Make certain that all wheels rotate freely before operating with a motor cut out.

LOCOMOTIVE CONTROL STAND

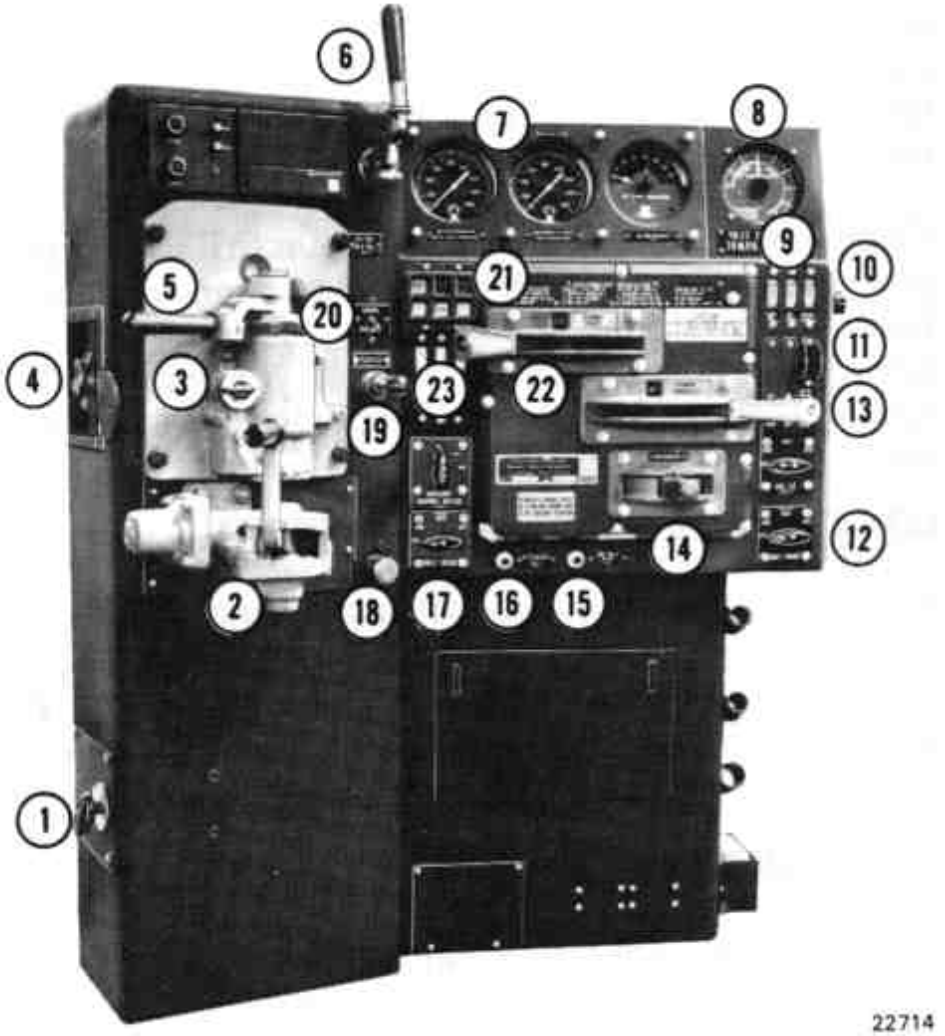
The locomotive control stand, Fig. 2-10, contains the switches, gauges, and operating handles used by the operator during operation of the locomotive. The individual controller components are described, together with their functions, in the following paragraphs.

CONTROLLER

The following operating handles are located on the controller, Fig. 2-11.

DYNAMIC BRAKE HANDLE (WHERE PROVIDED)

A separate handle, Fig. 2-12, is provided for control of dynamic brakes. It is uppermost on the controller panel and is moved from left to right to increase braking effort. The handle grip is somewhat out-of-round with the flattened surfaces vertical to distinguish it from the throttle handle, which has its flattened surfaces horizontal. The brake handle has two detent positions; OFF and SETUP, and an operating range I through FULL 8, through which the handle moves freely without notching. Mechanical interlocking prevents the dynamic brake handle from being moved out of the OFF position unless the throttle is in IDLE and the reverser is positioned for either forward or reverse operation.



1.	Multiple Unit Valve	12.	Headlight Switch-Front
2.	Independent Brake Valve	13.	Throttle Handle

3.	Cut-Off Valve	14.	Reverser Handle
4.	Trainline Air Pressure Adjustment Valve	15.	Ground Reset
		16.	Attendant Call Button
5.	Automatic Brake Valve	17.	Headlight Switch-Rear
6.	Air Horn Valve	18.	Bell Ringer Valve
7.	Air Gauges	19.	Manual Sand Lever Switch
8.	Load Current Indicating Meter	20.	Lead Truck Sand Switch
9.	Control And Operating Switches	21.	Indicator Light Panel
10.	Light Dimmer	22.	Dynamic Brake Handle
11.	Dynamic Brake Circuit Breaker	23.	Ground And Gauge Light Switches

Fig.2-10 - Locomotive Control Stand 2-26

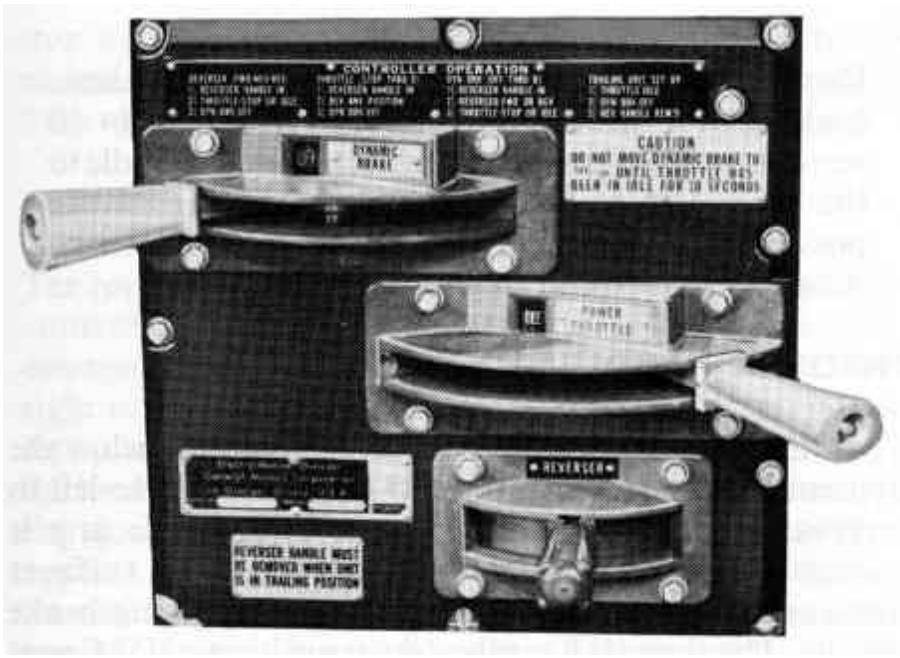


Fig.2-1 1 - Locomotive Controller

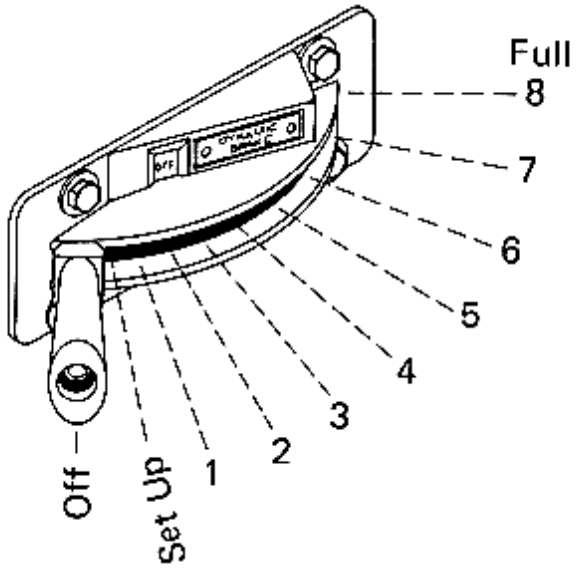


Fig.2-12 - Dynamic Brake Handle

CAUTION

During transfer from power operation to dynamic braking, the throttle must be held in IDLE for 10 seconds before moving the dynamic brake handle to the SET UP position. This is to eliminate the possibility of a sudden surge of braking effort with possible train run-in or motor flashover.

THROTTLE HANDLE

The throttle handle, Fig. 2-13, is located just below the dynamic brake handle. It is moved from right to left to increase engine speed and power. The handle grip is somewhat out-of-round, with the flattened surfaces horizontal to distinguish it from the dynamic brake handle. The throttle has nine detent positions; IDLE, and 1 through 8 plus a STOP position, which is obtained by pulling the handle outward and moving it to the right beyond IDLE to stop all engines in a locomotive consist. Mechanical interlocking prevents the throttle handle from being moved out of IDLE into power positions when the dynamic brake handle is advanced to SET UP or beyond, but it can be moved into STOP position to stop all engines in the consist. The throttle cannot be moved when the reverser handle is centered and removed from the controller.

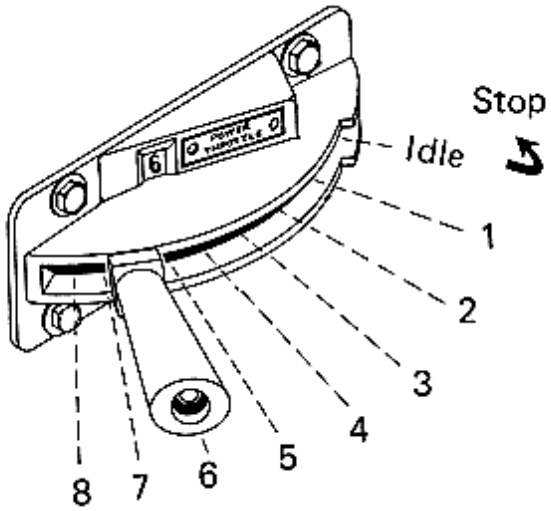


Fig.2-13 - Throttle Handle

REVERSER HANDLE

The reverser handle, Fig 2-14, is the lowest handle on the controller panel. It has three detent positions; left, centered, and right. When the handle is moved to the right toward the short hood end of the unit, circuits are set up for the locomotive to move in that direction. When the handle is moved to the left toward the long hood end, the locomotive will move in that direction when power is applied. With the reverser handle centered, mechanical interlocking prevents movement of the dynamic brake handle, but the throttle handle can be moved to increase engine speed. In such case, power will not be applied to the traction motors.

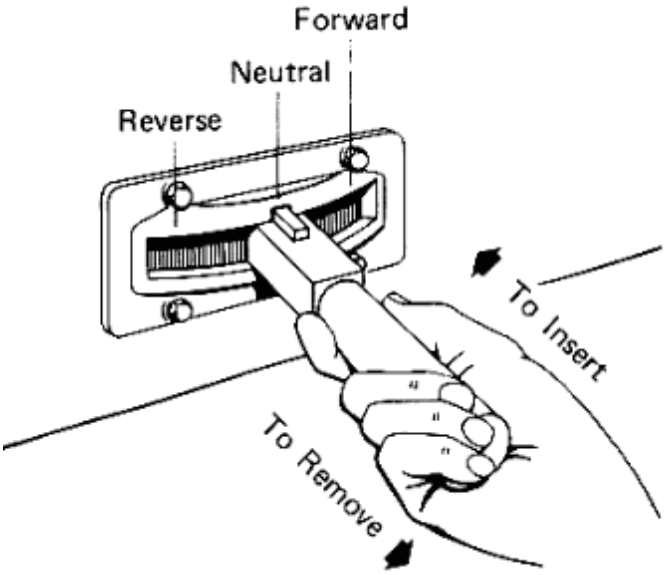


Fig.2-14 - Reverser Handle

The reverser handle is centered and removed from the panel to lock the throttle in IDLE position and the dynamic brake handle in OFF position.

MECHANICAL INTERLOCKS ON THE CONTROLLER

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The handles on the controller are interlocked so that:

- 1. With reverser handle in neutral (centered) -
  - a. Dynamic brake handle cannot be moved out of OFF position.
  - b. Throttle can be moved to any position.
  - c. Reverser handle can be removed from controller if throttle is in IDLE position.
- 2. Reverser handle in forward or reverse —
  - a. Throttle can be moved to any position if dynamic brake handle is in OFF position.
  - b. Dynamic brake handle can be moved to any position if throttle is in IDLE position.
- 3. Reverser handle removed from controller -
  - a. Throttle locked in IDLE position.
  - b. Dynamic brake handle locked in OFF position.
- 4. Throttle in IDLE position -
  - a. Dynamic brake handle can be moved to any position if reverser is in forward or reverse position.
  - b. Reverser handle can be placed in neutral, forward, or reverse position if dynamic brake handle is in OFF position.
- 5. Throttle above IDLE position -
  - a. Dynamic brake handle cannot be moved.
  - b. Reverser handle cannot be moved.
- 6. Dynamic brake handle in OFF position -
  - a. Throttle can be moved to any position.

- b. Reverser handle can be moved to any position if throttle is in IDLE position.

- 7. Dynamic brake handle moved out of OFF position -
  - a. Throttle cannot be moved out of IDLE position into power positions, but can be moved into STOP position.
  - b. Reverser handle cannot be moved out of forward or reverse into OFF position.

AIR BRAKE EQUIPMENT

Type 26L air brake equipment, Fig. 2-15, is commonly applied. 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.

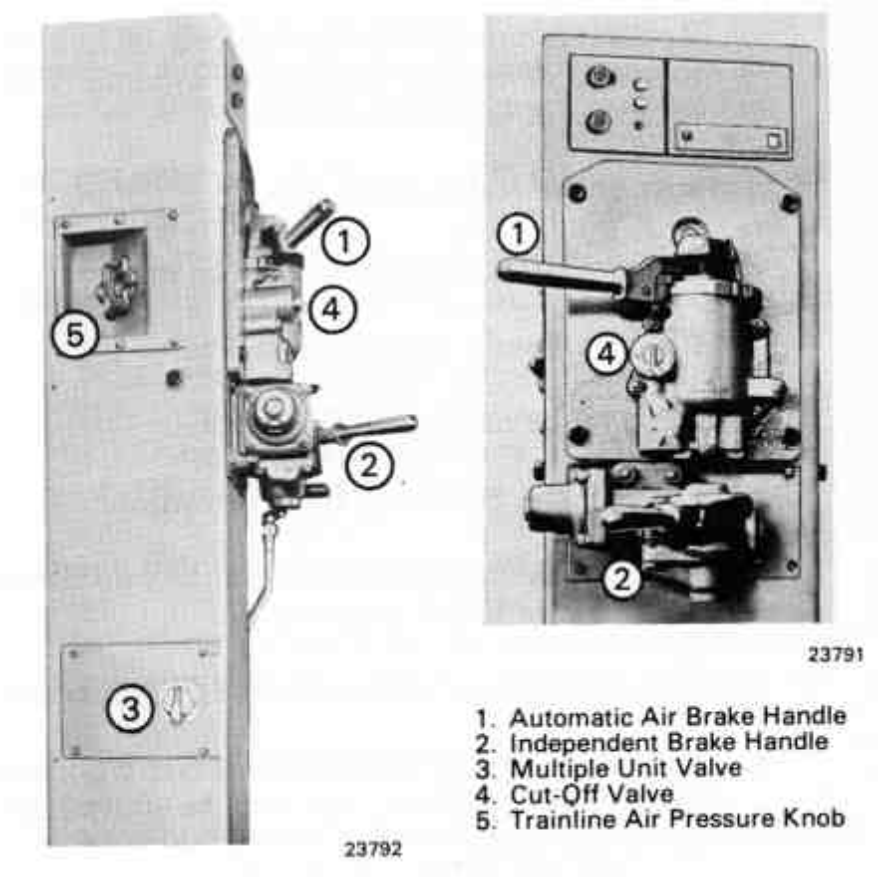


Fig.2-15 - Air Brake Equipment

The dead engine feature (not shown in Fig. 2-15) is also part of the 26L equipment. the dead engine cutout cock and pressure regulator, Fig. 2-16, are 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.

AUTOMATIC BRAKE VALVE

The automatic brake valve handle, Fig. 2-17, controls the application and release of both the locomotive and train brakes. The brake valve is of the “pressure maintaining type”, which will hold brake pipe reductions constant against nominal brake pipe leakage.

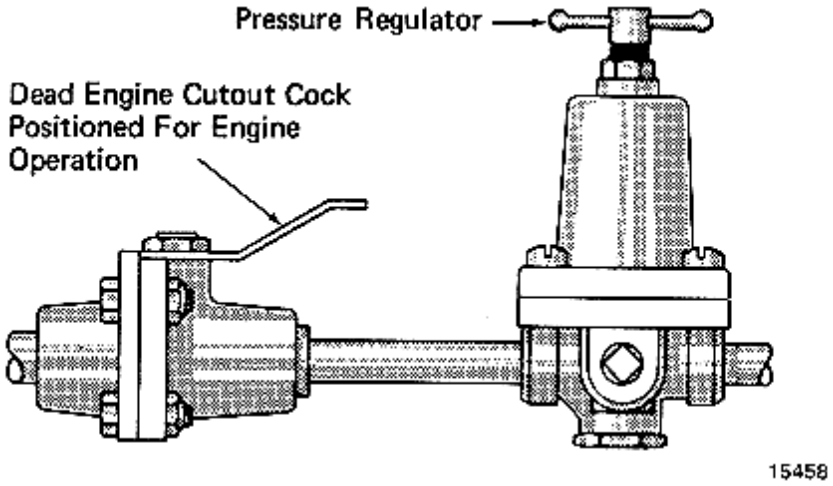


Fig.2-16 - Dead Engine Cutout Cock And Pressure Regulator

RELEASE POSITION

This position is for charging the equipment and releasing the locomotive and train brakes. It is located with the handle at the extreme left of the quadrant.

MINIMUM REDUCTION POSITION

This position is located with the handle against the first raised portion on the quadrant to the right of release position. With the handle moved to this position, minimum braking effort is obtained.

SERVICE ZONE

This position consists of a sector of handle movement to the right of release position. In moving the handle from left to right through the service zone, the degree of braking effort is increased until, with the handle at the extreme right of this sector, the handle is in full service position and full service braking effort is obtained.

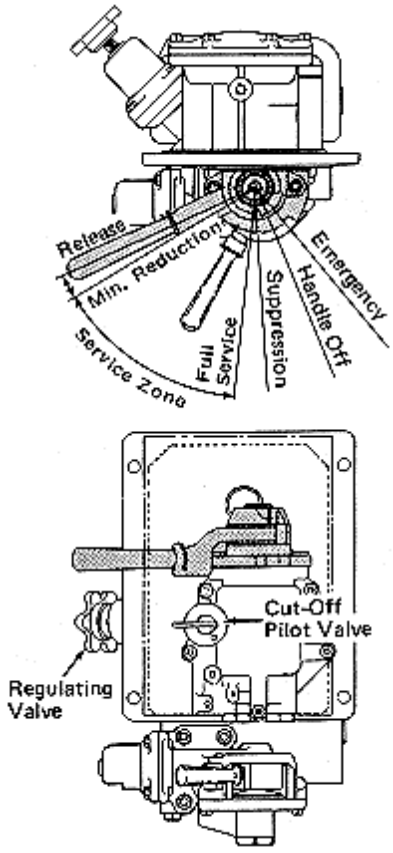


Fig.2-17 - Automatic Brake Handle Positions

SUPPRESSION POSITION

This position is located with the handle against the second raised portion of the quadrant to the right of release position. In addition to providing full service braking effort, as with the handle in full service position, suppression of overspeed control and safety control application, if equipped, is obtained.

HANDLE OFF POSITION

This position is located by the first quadrant notch to the right of suppression position. If so equipped, the handle is removable in this position. This is the position in which the handle should be placed in trailing units of a multiple-unit consist or on locomotives being towed "dead" in a train.

EMERGENCY POSITION

This position is located to the extreme right of the brake valve quadrant. It is the position that must be used for making brake valve emergency brake applications and for resetting after any emergency application if break-in-two feature is provided.

INDEPENDENT AIR BRAKE

The independent air brake handle, Fig. 2-18, 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. Depression of the independent brake handle when in the service zone will release the automatic application of the locomotive brakes to the value corresponding to the position of the independent brake valve handle.

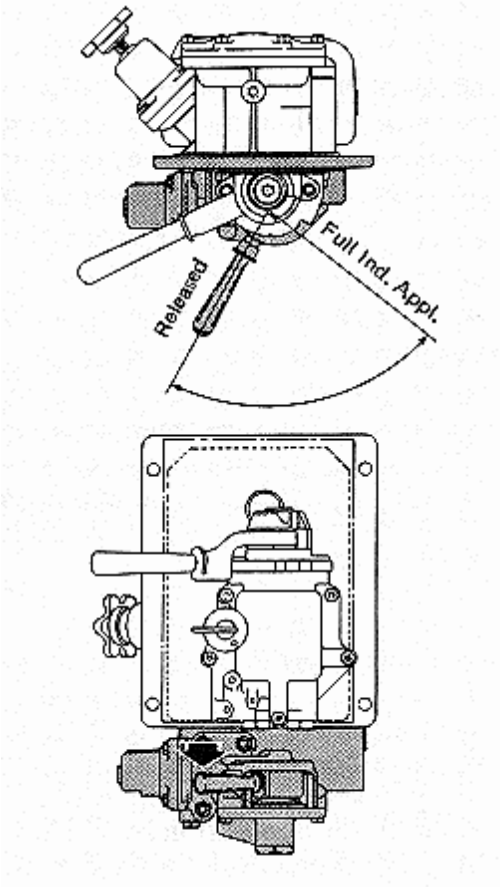


Fig.2-18 - Independent Brake Handle Positions

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 F1 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 open to atmosphere. This is necessary to prevent the inadvertent loss of air brakes due to possible pressure built-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. 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. With the automatic brake valve handle in release position, it is used to obtain the brake pipe pressure desired. The automatic brake valve will maintain the selected pressure against overcharge or leakage.

BRAKE EQUIPMENT POSITION

When operating locomotives equipped with 26L air brakes, the brake equipment should be positioned according to the information given in the equipment position chart, Fig. 2-19.

SWITCHES AND LIGHTS ON THE CONTROL STAND

BELL RINGER

When the bell air valve is operated, compressed air is directed to the locomotive signal bell.

SANDING SWITCHES

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. The SAND light will be on when this switch is in the on (up) position.

SANDING WOBBLE STICK

Movement of this device closes a switch that initiates directional sanding on all units of a locomotive consist.

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.

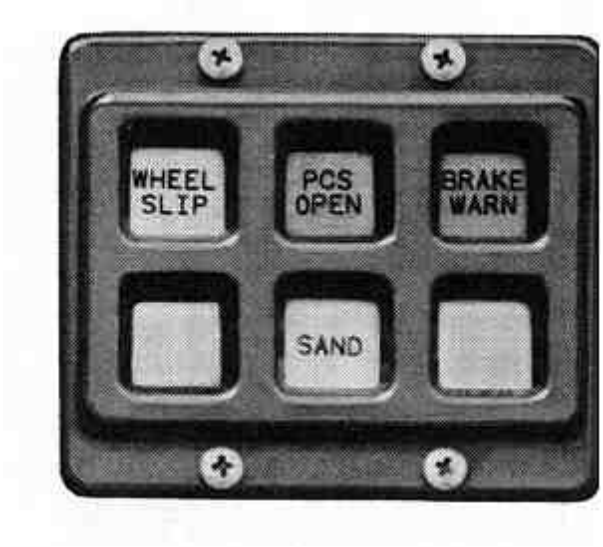
Type Of Service	Automatic Brake Valve	Independent Brake Valve	Cutoff Valve	Dead Engine Cutout Cock	26D Control Valve	26F Control Valve	MU2 Valve	Overspeed Cutout Cock	Deadman Cutout Cock
SINGLE LOCOMOTIVE EQUIPMENT									
Lead	Release	Release	Passenger Freight	Closed		Graduated Direct	Lead	Open	Open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

*Whenever the MU-2 valve is in "Trail 6 or 26" Position and if the actuating train line is not used, then the actuating end connection cutout 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 AAR standard all cocks in the brake system except brake pipe end cocks have handles perpendicular to pipe when open.

Fig.2-19 - Brake Equipment Positions

INDICATING LIGHTS PANEL

This assembly, Fig. 2-20, is located adjacent to the upper left corner of the controller. The purpose of the assembly is to provide a visual warning of operating difficulties. The unit has provisions for six press-to-test lights covered by either white or colored lens caps identified by black block letters.



NOTE
A delay of about one second occurs between pressing the indicating lens cap and illumination of the indicator.

Fig.2-20 - Indicating Lights Panel

The four basic lights installed are wheel slip, PCS open, brake warning, and sand. The functions of these lights are as follows:

WHEEL SLIP

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.

WARNING

A wheel slip light flashing 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.

On locomotives equipped with the locked wheel detection system, a continuous wheel slip light accompanied by the alarm indicates a locked wheel. The LOCK WHEEL light on the engine control panel will also be on. Observe the locked wheel indication instruction plate.

PCS OPEN

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 (down) 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 light will come on. This light is extinguished and locomotive power restored by resetting the PCS switch. This occurs automatically, provided that:

1. Control of the air brake is recovered.

2. The throttle is returned to IDLE position.

BRAKE WARN (IF PROVIDED)

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.

In the event that the brake warning light comes on and does not go out quickly, reduce braking handle position immediately to decrease braking strength and prevent possible equipment damage. If the brake warning indication repeats, place the dynamic brake cutout switch on the engine control panel of the affected unit in the CUTOUT position. The unit will then operate normally under power, but not in dynamic braking. Total braking effort of the consist will be reduced.

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 1,500 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

12. 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 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. 2-21. 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.2-21 - 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 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.

CONTROL AND OPERATING SWITCHES

A group of three operating switches, Fig. 2-22, is located at the upper right corner of the control stand. They snap into the on position when moved upward. The switches must be on in the lead unit of a locomotive consist, and must be off in trailing units.

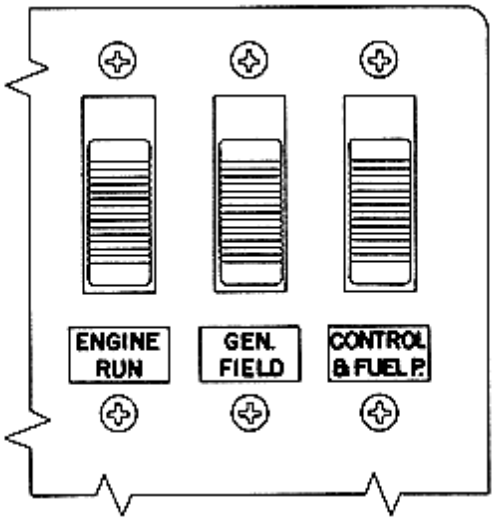


Fig.2-22 - Control And Operating Switches

CONTROL & FUEL P. SWITCH

Provides power to various low voltage control circuits. The switch must be on to start the engine and operate the fuel pump.

ENGINE RUN SWITCH

Must be on to obtain control of engine speed.

GEN. FIELD SWITCH

Must be on to obtain power from the locomotive.

HEADLIGHT SWITCHES

Two four-position rotary snap switches are provided for independent control of the front and rear headlights. Each switch has OFF, DIM, MED, and BRT positions. All positions of each switch are operative, but in a multiple unit consist, the headlight control switches on the engine control panels of each unit in a consist must be properly positioned, and only the lead unit controls the headlights.

For these switches to function, the headlight circuit breaker must be on.

MISCELLANEOUS SWITCHES

Switches for the ground lights, step lights, and gauge lights are provided at the left side of the controller. The lights are on when the switches are in the up position.

DYNAMIC BRAKE CONTROL CIRCUIT BREAKER (IF PROVIDED)

On locomotives equipped for dynamic braking, this circuit breaker is provided to protect against a faulty operating or test setup. The circuit breaker should be in the on (up) position for normal operation. A tripped circuit breaker generally indicates that at some time during makeup of a locomotive consist more than one dynamic brake handle was out of OFF position at one time.

ATTENDANT CALL PUSHBUTTON

When this button is pressed in any unit of a locomotive consist, the alarm bells ring in all units of the consist.

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.

Available on special order, the ground relay can also be used to detect braking grid grounds that occur during dynamic braking.

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.

An automatic ground relay reset assembly can be provided upon special request of the customer. This assembly automatically resets the ground relay circuit within 10 seconds on first, second, and third operation, but locks out the system if a fourth operation occurs within a period of 12 or 15 minutes.

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.

SECTION 3

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 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 into truck brake cylinders.

6. Satisfactory condition of brake shoes.

7. Adequate supply of fuel.

8. Proper installation of control jumper cables between units.

LEAD OR SINGLE 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. All fuses installed and in good condition.

CIRCUIT BREAKER PANELS

1. All breakers in the black area of the panels in on position.

2. Other circuit breakers on as required.

3. At the No. 2 circuit breaker panel, verify that the ground relay cutout switch is closed.

ENGINE CONTROL PANEL

1. Isolation switch in START position.

2. Headlight control switch in proper position for lead unit operation.

3. Traction motor cutout switch in NORMAL position, if provided.

4. Dynamic brake cutout switch in DYN. BRAKE (up) position, if provided.

5. Miscellaneous switches and circuit breakers on 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 cannot 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 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 service position.

3. Position cut-off valve to either FRT or PASS depending on make-up of train.

4. Place MU valve in LEAD position.

ENGINEROOM INSPECTION

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

1. Check air compressor for proper lubricating oil supply.

2. Observe for proper water level on tank sight glass.

3. Check all valves for proper positioning.

4. 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 engineroom doors should be closed and latched securely.

1. Check to see that engine overspeed lever is set, Fig. 3-1.

2. Observe that governor low oil pressure trip plunger, Fig. 3-1, is set and that there is oil visible in the governor sight glass.

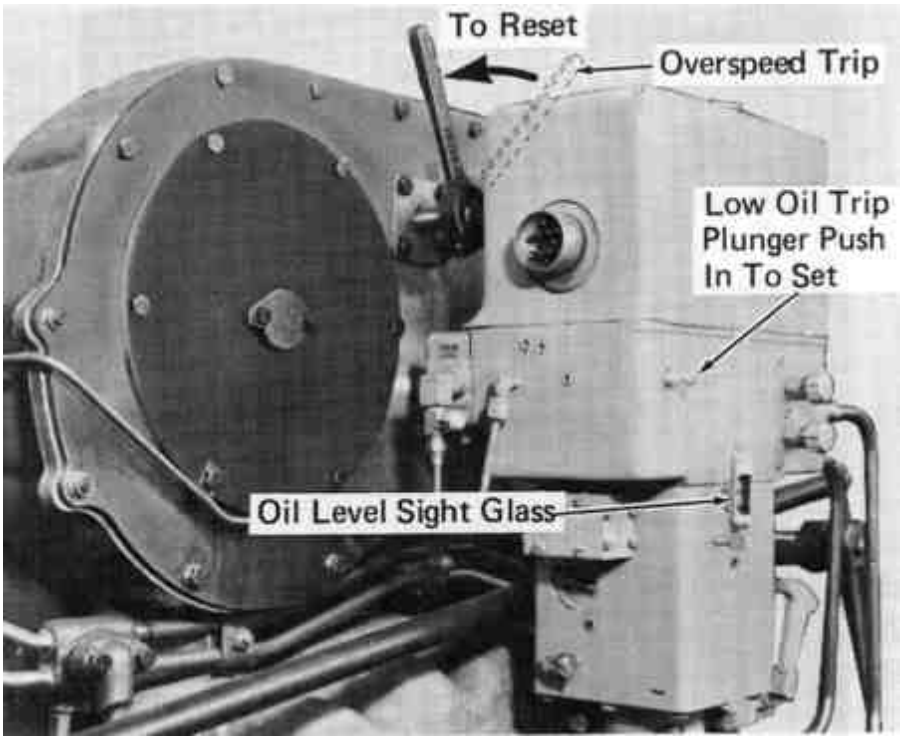


Fig.3-1 - Engine Overspeed Trip And Low Oil Pressure Trip Plunger

3. Observe that the crankcase (oil pan) pressure detector reset button, Fig. 3-2, is set (pressed in). Since the engine must be running, and

the cooling system vented in order to permit latching of the low water reset button, refer to Step 12 under "Starting The Diesel Engine."

4. Observe that engine top deck, air box and oil pan inspection covers are in place and are securely closed.

5. Check that engine oil is at proper level on the dipstick and that lube oil strainer is full of oil (open square cover).

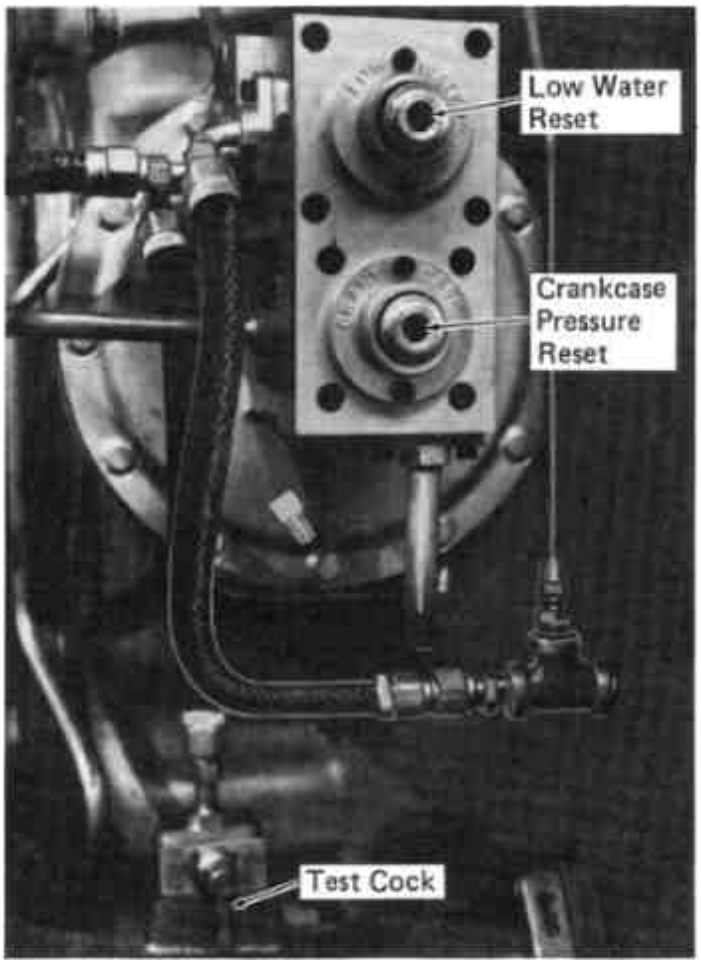


Fig.3-2 - Differential Low Water And Crankcase (Oil Pan) Pressure Detector

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. 2-2.

NOTE

If engine temperature is near freezing, preheat engine before attempting to start. Prelube if engine has been shut down for more than 48 hours. Refer to the Engine Maintenance Manual for prelube procedures.

Perform the following:

1. Check oil levels at the governor and air compressor. Check engine coolant level.

2. Open cylinder test valves and bar over the engine at least one revolution, observe for leakage from test valves. If fluid discharge is observed from any cylinder test valve, notify maintenance personnel before starting engine. Close the test valves.

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 engineroom, 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.

Fig.3-3 - Fuel Oil Sight Glasses

10. Position the injector rack manual control lever at about one-third rack (about 1.6 on the scale), then move the fuel prime! engine start switch to the position (not more than 20 seconds). Hold the switch in the START position until the engine fires and speed increases.

11. Release the injector control lever when the engine comes up to idle speed. Do not advance lever to increase engine speed until oil pressure is confirmed.

12. Check the low water reset button within 50 seconds after engine start. The low water detector will often trip during engine

starting, especially on starting after filling a completely drained system. It may also trip after starting a cold engine or one that has had cooling system pressure released. The detector should be reset soon after the engine starts and is idling, or else the engine will shut down after a time delay established by the engine governor.

NOTE

If the detector is difficult to reset after engine start, confirm oil pressure, then position the injector control lever to increase engine speed for a short time and depress the reset button.

13. Check that coolant level, lube oil pressure, and governor oil level are satisfactory.

CAB INSPECTION TRAILING UNIT

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

FUSE AND SWITCH PANEL

1. Main battery knife switch closed.

2. All fuses installed and in good condition, and of correct rating as indicated on panel.

CIRCUIT BREAKER PANEL

1. All breakers in the black area of the circuit breaker panels in on position.

2. Other circuit breakers on as required.

3. At the No. 2 circuit breaker panel, verify that the ground relay cutout switch is closed.

ENGINE CONTROL PANEL

1. Isolation switch in START position, and headlight control switch in position to correspond with unit position in consist.

2. Dynamic brake cutout switch (if provided) positioned according to railroad operating procedures for trailing units.

3. Traction motor cutout switch (if provided) normally in the MOTORS ALL IN position.

4. Other switches may be placed on as needed or left off, as they do not affect locomotive operation.

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. Dynamic brake handle in OFF position.

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

5. Light and miscellaneous switches positioned as desired.

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 OUT position.

STARTING TRAILING UNIT DIESEL ENGINES

Engines in trailing units are started in the same manner as the engine in the lead unit. However, if control jumper cables are already connected between units, ensure that the engine run and the control and fuel pump switches in trailing units are off (down).

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 handles in all units are in IDLE position before placing any unit on the line.

A OPERATION 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 896-956 kPa [130-140 psi]).

   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 49 deg C (120 deg F) or higher before full load is applied to the engine. After idling at ambient temperature below -18 deg C (0 deg 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. Depress safety control foot pedal (if so equipped).

5. Release air brakes.

6. 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.

7. Throttle should be in IDLE before coming to a dead stop.

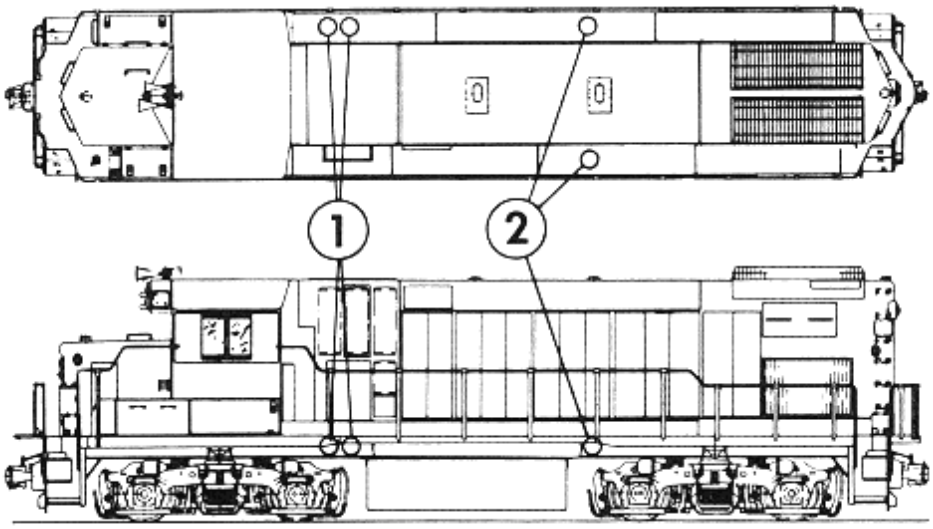
8. Reverser handle should be moved to change direction of travel ONLY when locomotive is completely stopped.

DRAINING OF AIR RESERVOIRS AND DIRT COLLECTORS

The air reservoirs and dirt collectors 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 at the following locations:

Momentarily operate the main reservoir and dirt collector drain valves, Fig. 3-4 and Fig. 3-5.



1. Main Reservoir Dirt Collector Drain Valve

2. Main Reservoir Drain Valve Locations

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

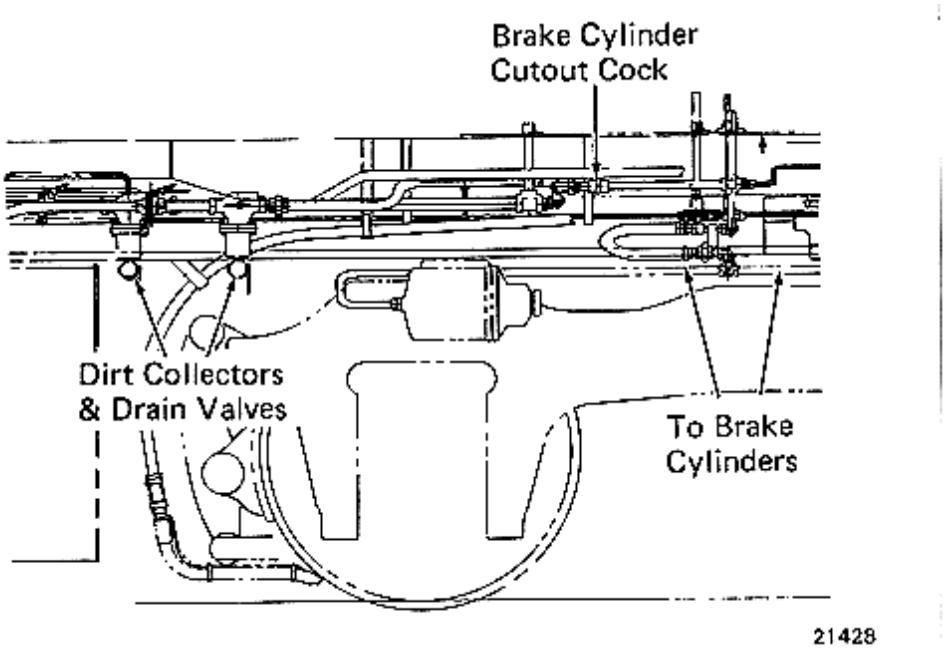


Fig.3-5 - Main Reservoir Dirt Collector And Drain Valve

OPERATION OF 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 cutout. The cutout switch cannot 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 cutout.

COUPLING LOCOMOTIVE UNITS TOGETHER

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

1. Remove reverser handles from all trailing units to lock the controls.

2. Couple and stretch units to ensure couplers are locked.

3. 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.

4. Attach platform safety chains between units.

5. Perform ground, engineroom, and engine inspections as outlined in preceding articles.

6. Position cab controls for trailing unit operation as outlined in preceding articles.

7. Connect air brake hoses between units.

8. 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 the 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 position 4 or 5 if necessary. Engine should not however be run unloaded (as in pumping up air) at speeds beyond throttle position 5.

BRAKE PIPE LEAKAGE TEST

Prior to operating the 26L brake equipment, a leakage test must be performed. Brake pipe leakage tests should be made in accordance with the railroad operating rules and Power Brake Law.

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 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 immediately. The strength of the increase is dependent upon throttle position and is modulated by the load regulator.

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. Move reverser handle to the desired direction, either forward or reverse.

2. Place engine run and generator field switches in the on (up) position.

3. Place engine run and generator field switches in the on position.

4. Release both automatic and independent air brakes.

5. Open the throttle one notch every few seconds as follows:

    a. To No. 1 - 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 position No. 1 and IDLE during starting.

    b. To No. 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 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.

After the train has been started, the throttle can be advanced as rapidly as desired to accelerate the train. 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.

Additional train acceleration is provided (on locomotives so equipped) by changing motor connections from seriesparallel to full-parallel. These changes take place automatically during throttle changes or after reaching full throttle. The changes in electrical circuits during acceleration take place automatically without any attention or action on the part of the operator.

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 locomotive comes to a stop.

POWER AT STALL

Do not hold the train at standstill on a grade or with the brakes applied and the throttle open for power. Extensive damage to the traction motors is possible.

OPERATING OVER RAIL CROSSING

When operating the locomotive at speeds exceeding 40 KPH (25 MPH), reduce the throttle to position 4 at least eight seconds before the locomotive reaches a rail crossing. If the locomotive is operating in position 4 or lower, or running less than 40 KPH (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 76 mm (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 3 to 5 KPH (2 to 3 MPH).

WHEEL SLIP LIGHT INDICATIONS

The momentary flashing of the wheel slip light on and off generally indicates a pair of wheels are slipping. Corrective wheel sup relay action automatically reduces the power output of the main generator which thereby reduces traction motor torque, stopping the slipping.

In most cases it will be unnecessary to reduce the throttle because of momentary wheel slip action, as the locomotive will automatically reduce its power to stop the slipping, and reapply the power after the slipping has stopped. However, under extreme rail conditions, slipping may occur repeatedly causing the unit to lurch. In such case the throttle should be reduced to a position that will apply the maximum power permissible without causing excessive slipping. Sand should be used to prevent slipping, not to stop it.

On units equipped to operate in multiple, the wheel slip light signal is trainlined. When any unit in a consist slips, the light indication appears in all units of the consist.

NOTE

Whenever possible, operation on grades should be at full throttle position. Throttle reduction during wheel slip is recommended only when:

1. Repeated wheel slip conditions cause 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 bill in two parts.)

2. In unusual conditions, simultaneous wheel slips may be incurred at low or stall speed. In this situation the performance of the equipment is directly related to the skill and judgment of the operator. Therefore, the operator must determine to apply sand to the rail and! or reduce throttle.

If the wheel slip light blinks on and off 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 dertermine 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 sup 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 recorded 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 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, operations 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 30 and 37 KPH (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.

WARNING

The 10 second delay must be accomplished before the braking handle is moved into SET UP position.

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

3. Move the braking handle to SET UP 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.

4. After the slack is bunched, the dynamic braking handle is moved to control dynamic braking strength. As it is advanced out of SET UP, it will be noted that the engine speed automatically increases.

5. Braking effort may be increased by slowly advancing the handle to FULL 8 position if desired. Maximum braking current, limited to 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.

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. 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.

6. 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 braking handle should be stopped until the light goes out.

7. If the light fails to go out after several seconds, move the braking handle back slowly until the light does go out. After the light goes out, the handle 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.

If brake warning indications are repeated, the locomotive should be taken out of dynamic braking and the dynamic brake cutout switch on the engine control panel of the affected unit should be placed in CUTOUT position. The locomotive consist will then operate normally under power and during dynamic braking, but with reduced total braking effort.

8. When necessary, the automatic brake may be used in conjunction with the dynamic brake. However, the independent brake must be KEPT FULLY RE- LEASED whenever the dynamic brake is in use, or the wheels may slide. As the speed decreases below 16 KPH (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 handle in OFF 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 not 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 wheel slip control system is available during dynamic braking as well as during power operation. The precise and immediate regulation maintained, 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 otherwise may not be detected.

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 cut-off valve in OUT 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, whenever 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 to OFF. 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 138 kPa (20-pound) reduction.

2. After brake pipe exhaust stops, place cut-off valve in 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 dynamic brake handle in OFF position and throttle in IDLE.

7. Place reverser handle in neutral position and remove to lock controller.

8. At the controller, place all switches in the off (down) position. Be absolutely certain that the control and fuel pump switch, generator field switch, and engine run switch are in the off (down) 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 the cab of the new lead unit.

ON END BEING CUT IN

1. At the controller, make certain the generator field switch is off (down).

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, overspeed, 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 FRT 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 (up) 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 injector rack manual control lever.

The injector control 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 the 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 plunger 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. 3-6.

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

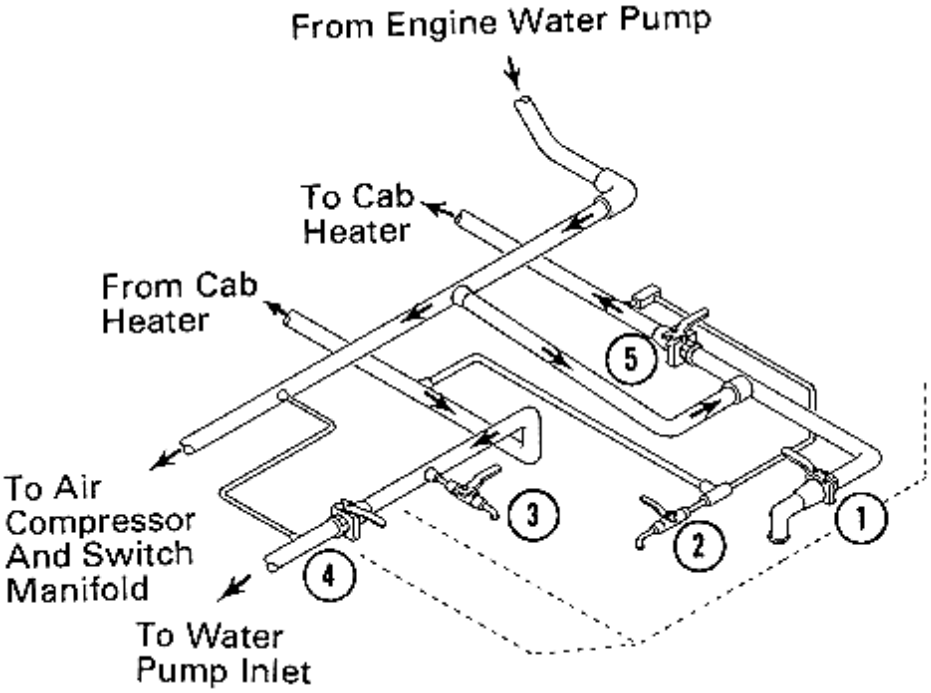
Make sure that the following valves are open.

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.



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

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Fig.3-6 - Engine And Cab Heater Drain Valve Locations

The above valves are located in engine drain sump, governor end of engine.

5. Preheater water supply (located at equipment rack, if so equipped).

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.

CAUTION

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

After system pressure is released, remove the water tank fill cap, Fig. 3-7, to allow drainage at an increased rate.

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 CAR WHEN REPLACING, HOLD FILL VALVE OPEN SO CAP CAN BE FULLY TIGHTENED AS SHOWN.

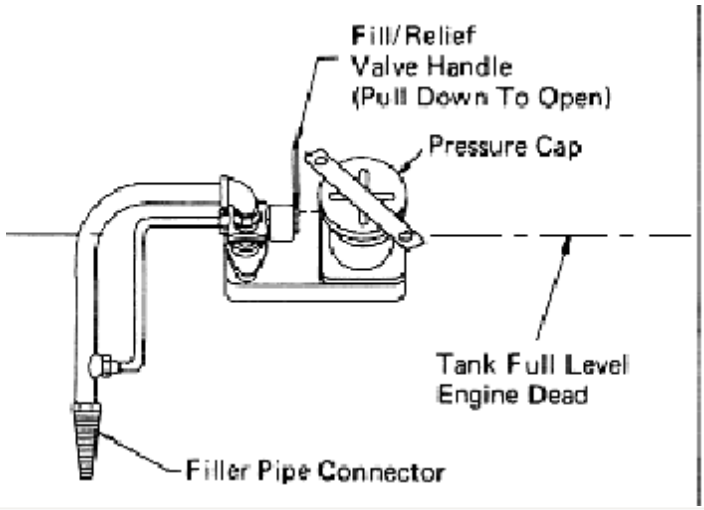

Fig.3-7 - Cooling System Pressure Cap And Filler/Relief Arrangement

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.

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:

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 cut-off valve in 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. 2-16, to open (900 to pipe) position. Dead engine cock is located beneath cab floor and may be reached through an access door of locomotive.

7. If a locomotive is to be towed dead in a consist, 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 in IDLE, dynamic brake handle in OFF position. Remove reverser handle to lock the controls.

8. If engine is to remain idling, switches should be positioned as follows:

    a. Isolation switch in START position.

    b. Battery switch and ground relay cutout switch closed.

    c. Generator field circuit breaker OFF.

    d. All breakers in black areas of circuit breaker panels in ON position.

    e. Starting fuse should be removed. Other fuses should be left in place.

    f. Control and fuel pump switch on (up).

    g. Fuel pump circuit breaker ON.

    h. Throttle in IDLE, dynamic brake handle in OFF position. Remove reverser handle from controller to lock the controls.

    i. Locked wheel switch (if provided) on engine control panel in LOCKED WHEEL position.

8. If a locomotive equipped with the locked wheel detection system is to be towed DEAD in a consist, observe the same setup as Step 7 above, but drain the cooling system if freezing conditions are possible. This setup is necessary to maintain the locked wheel detection and alarm circuits.

9. If a locomotive not equipped with locked wheel detection system is to be towed DEAD in a consist, switches should be positioned as follows:

a. Battery switch open.

b. All circuit breakers OFF.

c. All control switches OFF.

d. Starting fuse removed.

e. Throttle IDLE, dynamic brake handle in OFF position. Remove reverser from controller to lock the controls.

CAUTION

If there is danger of freezing, the engine cooling system shold be drained.

LEAVING LOCOMOTIVE UNAITENDED

If at any time it is necessary to leave the locomotive unattended while the engine is running, the following procedure should be adhered to.

1. Observe all railroad safety precautions.

2. Place engine run and generator field switches in the OFF (down) position.

3. Place throttle in IDLE and dynamic brake handle in OFF position. Remove reverser handle from controller to lock the controls.

SECTION 4

TROUBLESHOOTING

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

Lead unit HOT ENG. light on; alarm bell ringing; engine running, but engine speed and power reduced.	Temporary operating condition. This condition is more likely to occur during tunnel or desert operation.	No Action unless alarm persists. If alarm condinues for more than a few minutes, check that shutters are open and radiator blower motor is operating. Also check for proper coolant level. **NOTE** If it is necessary to shut down the engine in freezing weather, the cooling system should be drained or otherwise protected to prevent freezing.
	Low coolant level.	The unit should be shut down if coolant level is low or if there are coolant leakes.
	Shutters not operating properly.	If shutters are closed, set the manual shutter control valve to TEST position to open shutters. If shutters open, check for defective temperature switches. If shutters do not open, check for defective shutter operating pistons or binding shutters.
	Radiator blower motor not operating.	If radiator blower motor is not operating, the 200-ampere fuses, located in the AC cabinet, may be open. The unit must be shut down before replacing the fuses. The unit should be shut down if the blower motor does not operate.
Lead unit GRD RELAY light on; alarm bell ringing.	Lead unit ground relay operation.	If the unit is equipped with automatic ground relay reset, it will reset automatically within 10 seconds unless the total number of ground relays operations is excessive. If unit is not equipped with automatic ground relay reset, take no action for 10 seconds; then press the ground relay reset pushbutton on the control stand if so equipped. The ground relay pushbutton should not be pressed more than three times within any consecutive 30 minute period. If ground relay operation is caused by a traction motor flashover or weakened traction motor insulation, it may be possible to continue operation of the unit by cutting out the defective traction motor. The control circuits automatically reduce power of a unit having a traction motor cut out. The unit should be isolated and shut down if more than three ground relay operations occur within any consecutive 30 minutes period or if the automatic ground relay reset device locks out.

Lead unit NO BATT CHARGE NO POWER light on; alarm bell ringing; engine at idle speed or shutdown.	No D14 alternator output voltage.	If the unit shuts down, check the 15-ampere AUX. GEN. GIELD circuit breaker and the 150-ampere AUXILIARY GENERATOR fuse. Also check the engine overspeed trip lever. Replace the fuse, reset the circuit breaker, or reset the engine overspeed trip level and restart engine. If the overspeed trip lever or the circuit breakers trip again or the fuse opens, the unit should be isolated and shut down. If the unit remains at idle speed, check the 15-ampere AC CONTROL circuit breaker. If the above circuit breaker or fuse is not open and th eengine overspeed trip lever is set, the unit should be isolated and shut down.
Lead unit GOV. SHUTDOWN light on; alarm bell ringing; engine shutdown.	Low water detector button tripped.	If both the HOT ENG. and the GOV. SHUTDOWN lights are on, the unit should be isolated. Do not attempt to restart the engine. Report engine shutdown to authorized maintenance personnel. If the crankcase pressure detector button is set, but the low water detector button and the governor low oil plunger are tripped, perform thorough check of the following items. ❍ 1. Cooling water level satisfactory. ❍ 2. Cooling water temperature satisfactory. ❍ 3. No visable oil leaks or water leaks. ❍ 4. Governor oil level satisfactory. ❍ 5. Crankcase oil level satisfactory. If all items are normal, the engine may be restarted and placed on the line after resetting low water detector button and the governor low oil shutdown plunger. If the GOV. SHUTDOWN light comes on again, the unit should be isolated and shutdown.
	Hot oil or low governor oil.	If the low water detector button and the crankcase pressure detector button are set but the governor low oil plunger is tripped, do not attempt to restart the engine. Isolate the unit and notify authorized maintenance personnel.
	Crankcase pressure detector tripped.	**WARNING** If crankcase pressure detector has tripped, make no further engineroom inspections. Do not attempt to restart the engine. Isolated the unit. If freezing conditions are possible, drain the cooling system or otherwise protect the system from freezing.
Intermittent WHEEL SLIP light indicator.	Normal wheel slip correction.	No action required. Do not reduce throttle unless slipping is so severe that it threatens to break the train.

Excessive WHEEL SLIP light indications.	Locked sliding wheels.	Check that all wheels on the locomotive rotate freely. Do not operate a locomotive unless all wheels rotate freely.
PCS light on.	Penalty brake application	**NOTE** Observe railroad regulations after any penalty or emergency brake application. Move throttle to idle. Move automatci brake valve to suppresion position, then to release position.
	Emergency brake application (on locomotive equipped for PCS to open upon emergency brake application).	Move throttle to idle. Move automatic brake handle to emergency position and wait 45 seconds, then move automatic brake handle to release position.
Engine responds to throttle but no power is developed.	Battery field circuit breaker tripped.	Check battery field circuit breaker.
	Control breaker tripped	Check control circuit breaker.
	Reverser handle centered.	Place reverer handle in an operating position.
	Generator field switch off.	Check position of generator field switch; also position of isolation switch. Move throttle between idle and 1 and check pickupand dropout of generator field contactor BF.
	Electrical system fault.	If the unit develops no power with throttle at position 1, check position of load regulator. If load regulator is at maximum field position, there is a fault in the excitation system preventing excitation of the main generator. if the load regulator is at minimum field position, there is a fault in the control circuits.
Engine will not crank.	Circuit breakers or switches not in proper position.	Refer to Section 3 for engine starting procedures.
	400-ampere starting fuse defective.	Check fuse and replace if necessary.
	Control and fuel pump switch off.	Close control and fuel pump switch.
Alarm bell rings; No alarm lights on in lead unit.	Trailing unit hot engine. Trailing unit hot engine. Trailing unit low water detector button tripped. Trailing unit hot oil or low governor oil. Trailing unit crankcase detector button tripped. Trailing unit ground relay operation. Trailing unit - No D14 alternator output voltage.	Refer to lead unit HOT ENG. Refer to lead unit HOT ENG. Refer to lead unit GOV. SHUTDOWN. Refer to lead unit GOV. SHUTDOWN. Refer to lead unit GOV. SHUTDOWN. Refer to lead unit GRD RELAY light on. Refer to lead unit NO BATT CHARGE NO POWER light on.

Trailing units do not respond to throttle.	Local control breaker tripped in trailing units.	Reset breaker.
	Jumper cables between units not securely connected.	Check jumper cable connection.

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