SD80MAC

Operator's Manual

CONRAIL QUALITY

Road Numbers 4100 thru 4127

ELECTRO-MOTIVE
General Motors Corporation

Electro-Motive SD80MAC

LOCOMOTIVE OPERATION MANUAL

Consolidated Rail Corporation
Road Numbers 4100 thru 4127

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Electro-Motive Division
General Motors Corporation
La Grange, Illinois 60525 USA
Telex: 270041 McCook, IL USA
Cable: ELMO DIV La Grange, IL USA
Telephone: 708-387-6000
Tele-Fax: 708-387-5795

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FOREWORD

The purpose of this manual is to act as a guide in the operation of the SD80MAC locomotive and its equipment. The equipment selected for coverage was chosen as representative of this model. When special extra equipment is involved, consult specific drawings or instructions as provided by the railroad. Information contained in this manual is based on data available when released for printing. Minor equipment differences are due to changes made after the manual was published.

These instructions do not claim to cover all details or variation in equipment or to provide for every possibility in connection with installation, operation, or maintenance. Should more information be desired or particular problems arise which are not covered for the purchaser's purposes, the matter should be referred to the Electro-Motive Division. Information about adjustment, testing, and maintenance of locomotive equipment may be provided in other publications such as the Locomotive Service Manual and Maintenance Instructions.

This manual is intended for railroad personnel who may operate the General Motors SD80MAC diesel-electric locomotive. The SD80MAC is equipped with a microprocessor based computer control system. In keeping with current terminology the microprocessor will be referred to as the "computer." The locomotive control computer, designated EM2000, is programmed to monitor and control locomotive traction power, record and indicate faults, and allow diagnostic testing. The EM2000 must be accessed through the Integrated Cab Electronics (ICE) display system.

Two ICE display panels, mounted in the lower control console, provides an interface between the locomotive engineer and the locomotive control and support systems.

This manual was intended to be read in sequence - it is divided into five sections as follows:

1. GENERAL INFORMATION

Provides general technical data and descriptions of principal equipment for SD80MAC locomotive.

2. SAFETY PRECAUTIONS

Provides safety information for operating personnel.

3. CONTROL EQUIPMENT

Controls to operate the locomotive and indicating devices to monitor locomotive systems.

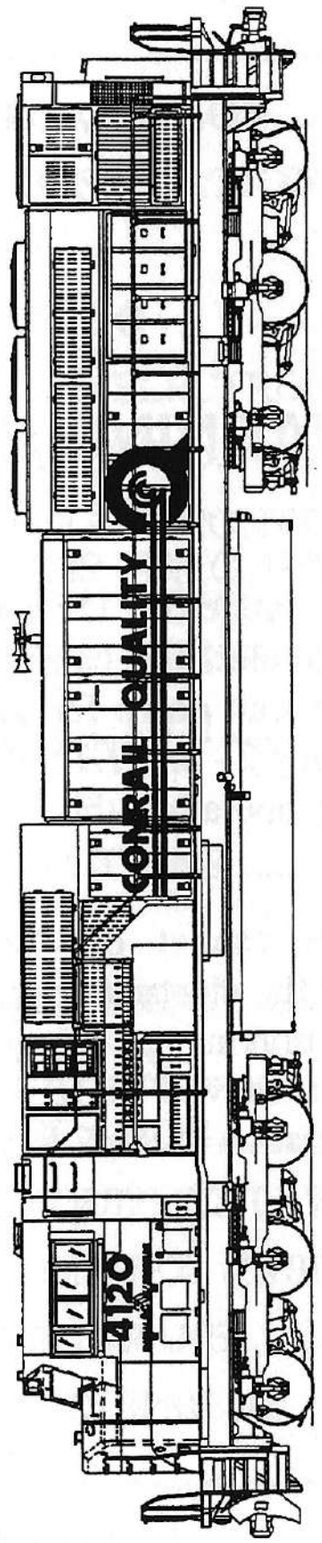
4. OPERATION

Procedures for locomotive operation.

Note: Equipment used to ***operate*** the locomotive is highlighted in this manual. A more detailed explanation of equipment may be provided in the Locomotive Service Manual.

SPECIAL NOTICE:

The term "Engineman" as used herein, relates to the crew member responsible for the operation of the locomotive. **- Railroads may call this crew member "Operator", "Engineer", or "Driver."**



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TYPICAL SD80MAC LOCOMOTIVE

********* WARNING **********

This locomotive power system operates with a very high and potentially dangerous DC Link voltage that could be present in the electrical cabinets even after the locomotive has been shut down for an extended time period. Refer to Section 2 - ***SAFETY PRECAUTIONS*** before inspecting or operating this locomotive or its equipment.

AC traction motors cannot be "plugged" in the traditional sense but the electrical control system will apply full dynamic braking automatically if a unit's directional handle is moved to REVERSE position while in forward operation above 2.5 mph.

TABLE OF CONTENTS

Section 1. GENERAL INFORMATION

Locomotive Model Designation SD80MAC
Locomotive Type ..... (C-C) 0660
Locomotive Power (Nominal).....5000 HP

POWER PLANT

Engine Type..... Turbocharged Two-stroke Diesel
Model.....710G3B-ES
Number of Cylinders.....20
Full Speed .....904 RPM
Idle Speed, Normal .....274 RPM
Idle Speed, Low.....200 RPM

ELECTRICAL SYSTEM

MODEL TA22/CA8B MAIN GENERATOR

TA22 Traction Alternator Rectified Output :
Maximum Potential.....2600 VDC
Max. Continuous Current .....8100 A

CA8A Companion Alternator Output:
Nominal Potential ..... 200 VAC

AC AUXILIARY GENERATOR

Model..... A8589
Rectified Potential .....74 VDC
Maximum Power Output..... 18 kW

TRACTION MOTORS

Model..... 1TB2830
Number 6
Type..... 3 Phase AC Induction

LOCOMOTIVE BATTERIES

Model . . . . . EXIDE LMUD660
Number 2
Number of Cells (Each) 16
Potential (Each Battery) . . . . . 32 VDC
Rating (8 Hour) . . . . . 660 Amp. Hr.

AIR BRAKE SYSTEM

Type . . . . . Wabco
Type . . . . . Wabco EPIC 3102
Schedule 26L

AIR COMPRESSOR

Model . . . . . WLA
Type 2-Stage
Number of Cylinders 4
Displacement @ 900 RPM . . . . . 254 Cu. Ft./ Min.
Cooling Medium . . . . . Engine Coolant
Lube Oil Capacity (20 Wt.) . . . . . 17.5 U.S. Gal.

SPEED LIMITATIONS

Limits are based on original equipment consisting of 83:16 gear ratio and 45 in. diameter wheels

Maximum Speed (computer limited) . . . . . 75 MPH

TRACTIVE EFFORT LIMITATIONS

Continuous . . . . . 147,000 lbf @11.1 MPH
Stall . . . . . 185,000 lbf

SUPPLIES/ CAPACITIES

LUBE OIL SYSTEM

Capacity . . . . . 510 U.S. Gal.

COOLING SYSTEM

Capacity . . . . . 342 U.S. Gal.

SANDING SYSTEM

Capacity . . . . . 40 Cu. Ft. (20 Cu. Ft./ End)

FUEL CAPACITY

Fuel Tank . . . . . 5800 U.S. Gal.
Retention Tank † . . . . . 100 U.S. Gal.

† Retention tank reduces fuel tank capacity by approximately 100 U.S. gallons.

NOMINAL DIMENSIONS

LENGTH . . . . . 80 ft. 2 in.
WIDTH . . . . . 10 ft. 3.5 in.
HEIGHT . . . . . 15 ft. 5 in.

WEIGHT

Nominal . . . . . 420,000 lbs.
Weight on Drivers 100%

NOMINAL CLEARANCES

Over Cooling Fan Guards . . . . . 15' 7.60"
Over Dynamic Brake Fan Guard . . . . . 15' 7.18"

Over Dust Bin Blower Hatch	15' 7.71"
Over Air Horn	15' 11.16"
Over Underframe	10' 0.75"
Over Snowplow	10' 1.00"
Over Wind Deflectors	10' 11.25"

SD80MAC MINIMUM CURVE NEGOTIATION

Following data is based on original equipment "E" type couplers.

Single Unit:

209 Ft. Radius - 27.4° Curve

Single Unit Coupled to 50 Ft. Box Car:

361.3 Ft. Radius - 15.9° Curve

Two Coupled ("E") Units,:

270.0 Ft. Radius - 21.2° Curve

INTRODUCTION

An SD80MAC locomotive is equipped with a turbo-charged 20 cylinder diesel engine to drive the main generator. The main generator changes diesel engine mechanical power into alternating current electrical power. Internal rectifier banks in the main generator convert alternating current to direct current. Refer to fold-out illustrations on the following page for equipment locations.

DC power produced by the main generator is distributed, through a DC link, to DC to AC inverters in the Traction Control (TC) cabinet.Traction inverters supply 3-phase AC power to six traction motors based on inputs from the EM2000 locomotive computer. The EM2000 responds to input signals from operating controls and feedback signals from the power equipment. Refer to Figure 1-1, page 1-12.

NOTE-The term Traction Control *Converter* (**TCC**) refers to an electrical device that can convert AC to DC (dynamic brake) ***and*** invert DC into AC (traction power). The terms converter and inverter are used interchangeably in this manual.

Each traction motor is geared directly, with a single pinion, to a pair of driving wheels. The maximum speed of the locomotive is set by the locomotive gear ratio (wheel/motor) and wheel size.

The locomotive is arranged so that the short hood or cab end is considered the front (or forward) although the unit can be operated in either direction.

NOTE

The console type controls on this locomotive dictate that the cab end be positioned to the front or forward when operated as a lead unit. When operated as a trailing unit, the locomotive may be positioned with cab facing either front or rear.

SD80MAC locomotives can be combined with AC or DC traction motor locomotives in multiple unit (MU) operation to increase load capacity. Operating controls are trainlined so that the lead unit can simultaneously control the other locomotives in consist.

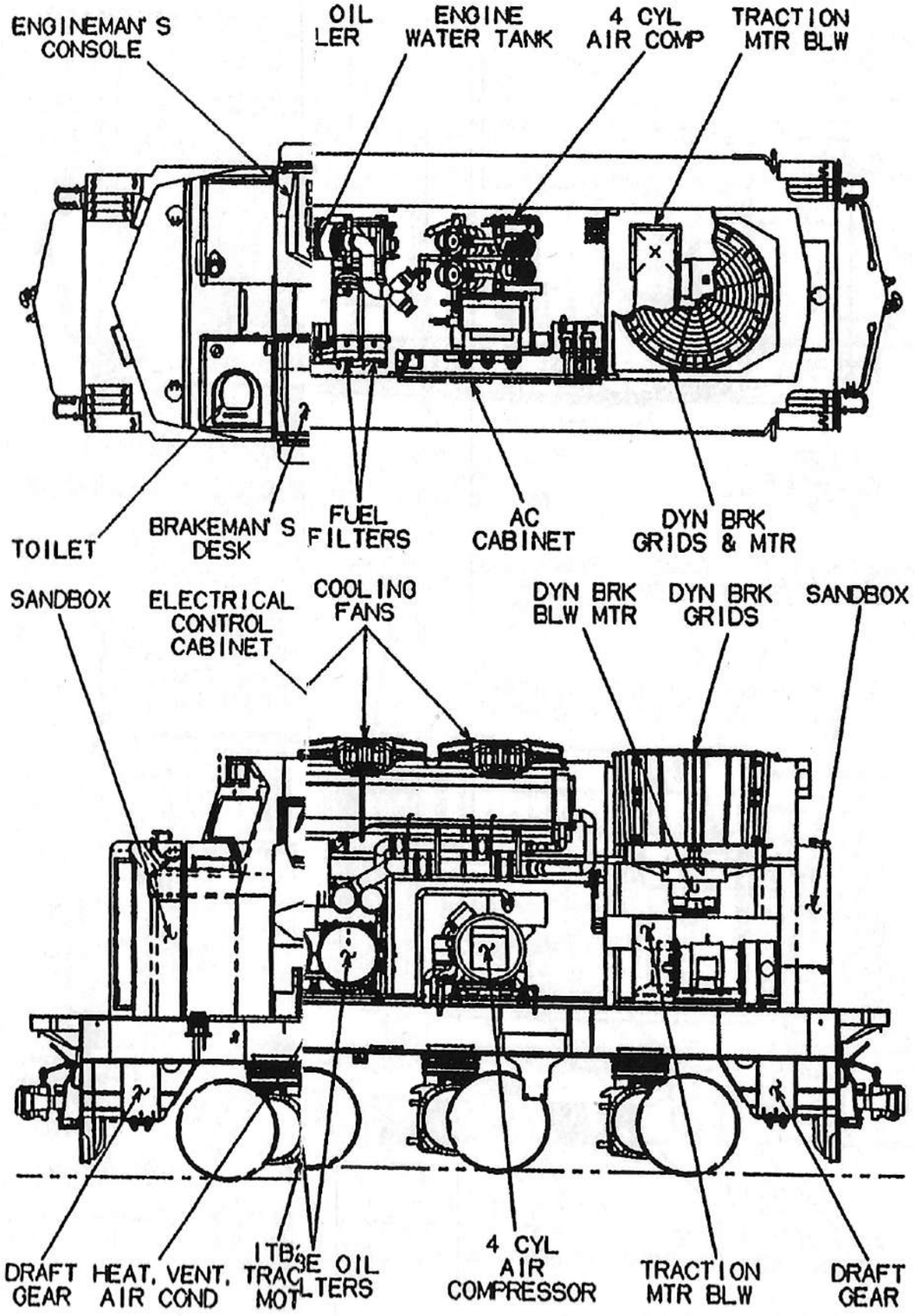
WARNING

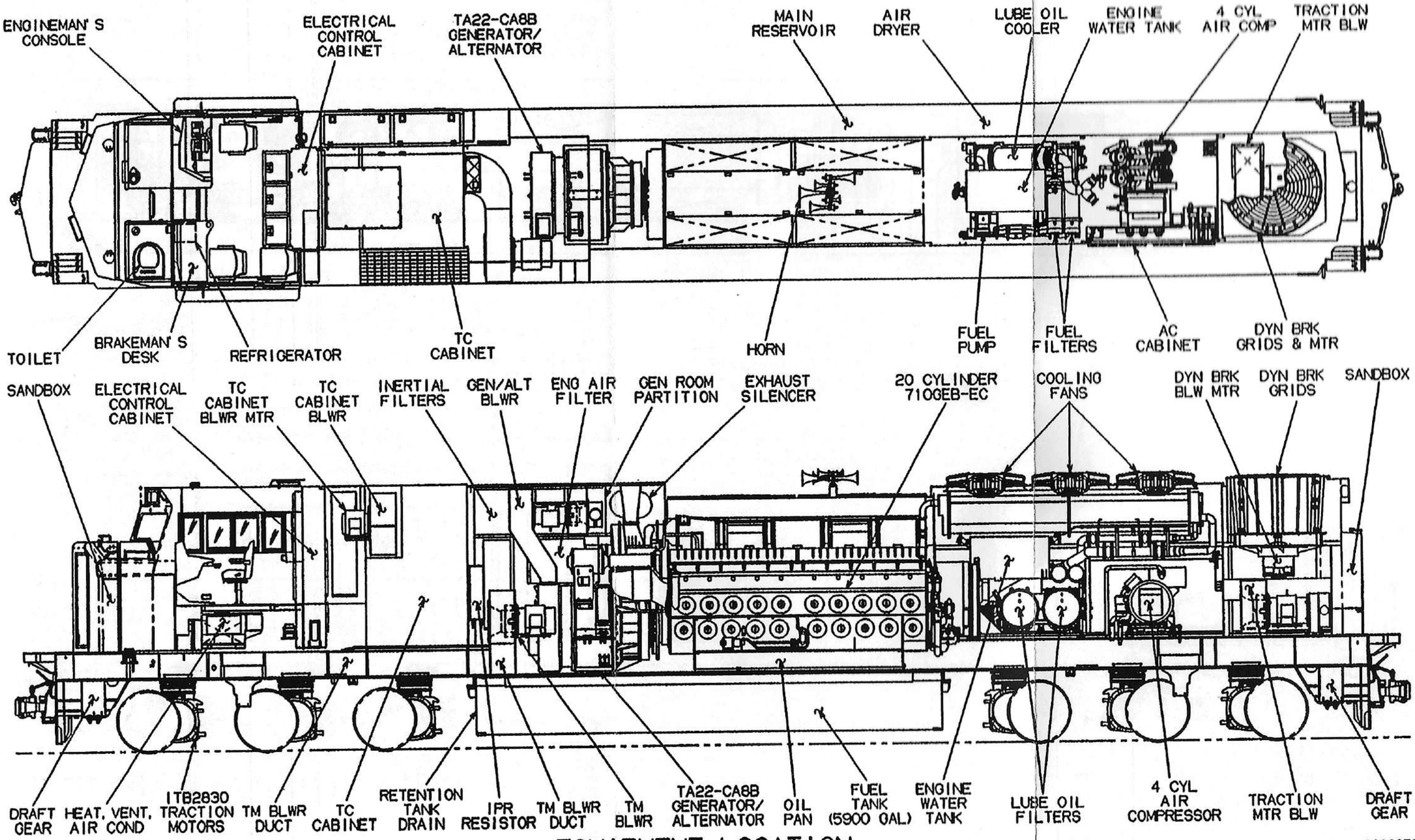
When AC locomotives are combined with DC locomotives in a multiple unit consist, the DC units **must all be in the lead position of the consist.**

The ICE display panels in the engineer's lower console indicate EM2000 locomotive operating conditions, system faults, and troubleshooting information.

NOTE

SD80MAC locomotives for Consolidated Rail Corp. order #946501 are equipped with a combined electric/air assist engine starting system at this time. Future locomotives may be equipped with an inverter/generator start feature.





EQUIPMENT LOCATION

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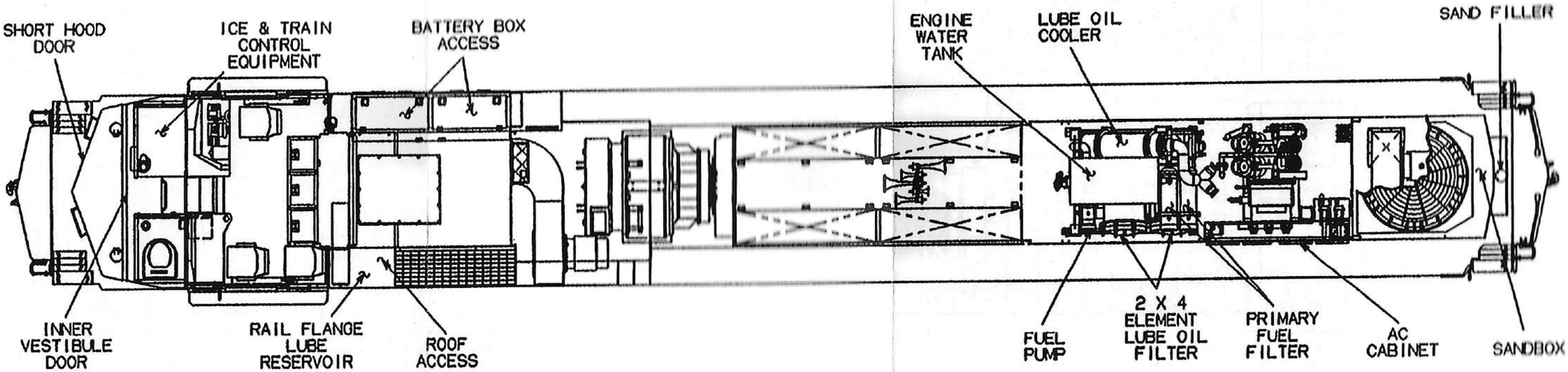

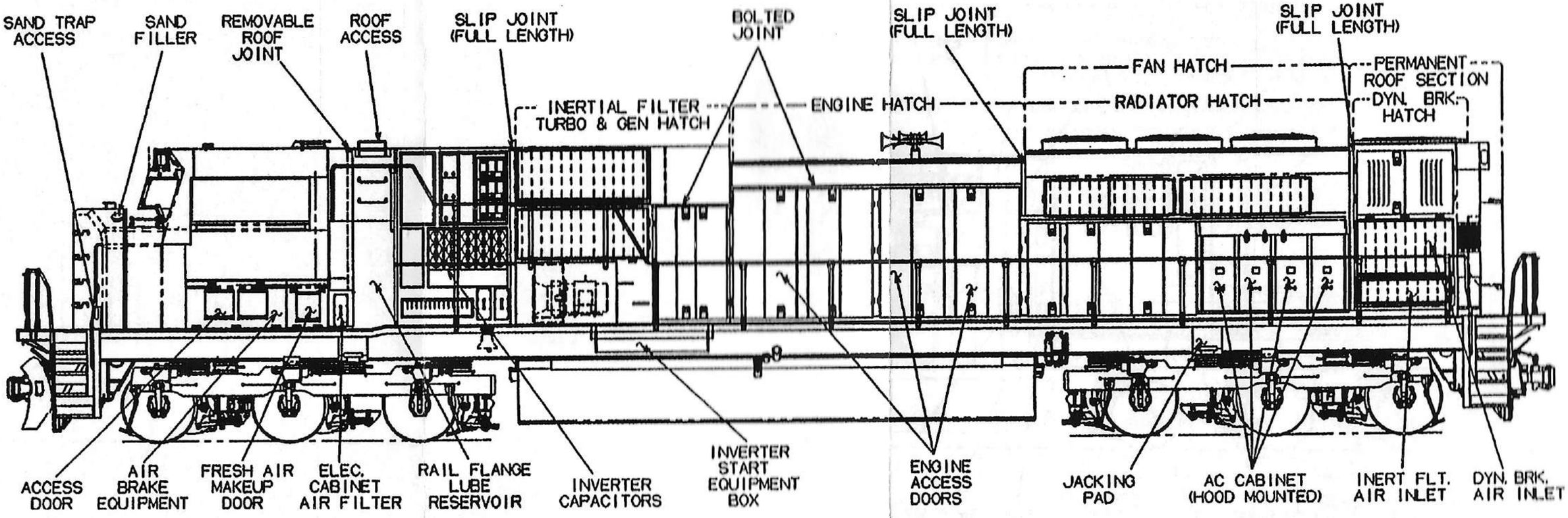

MAINTENANCE ACCESS

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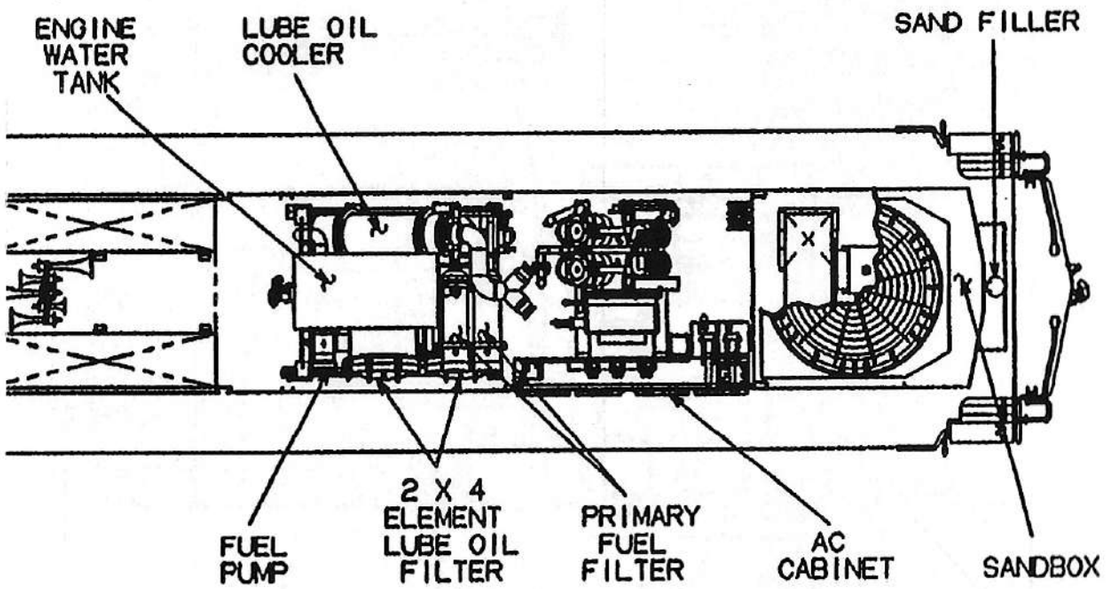

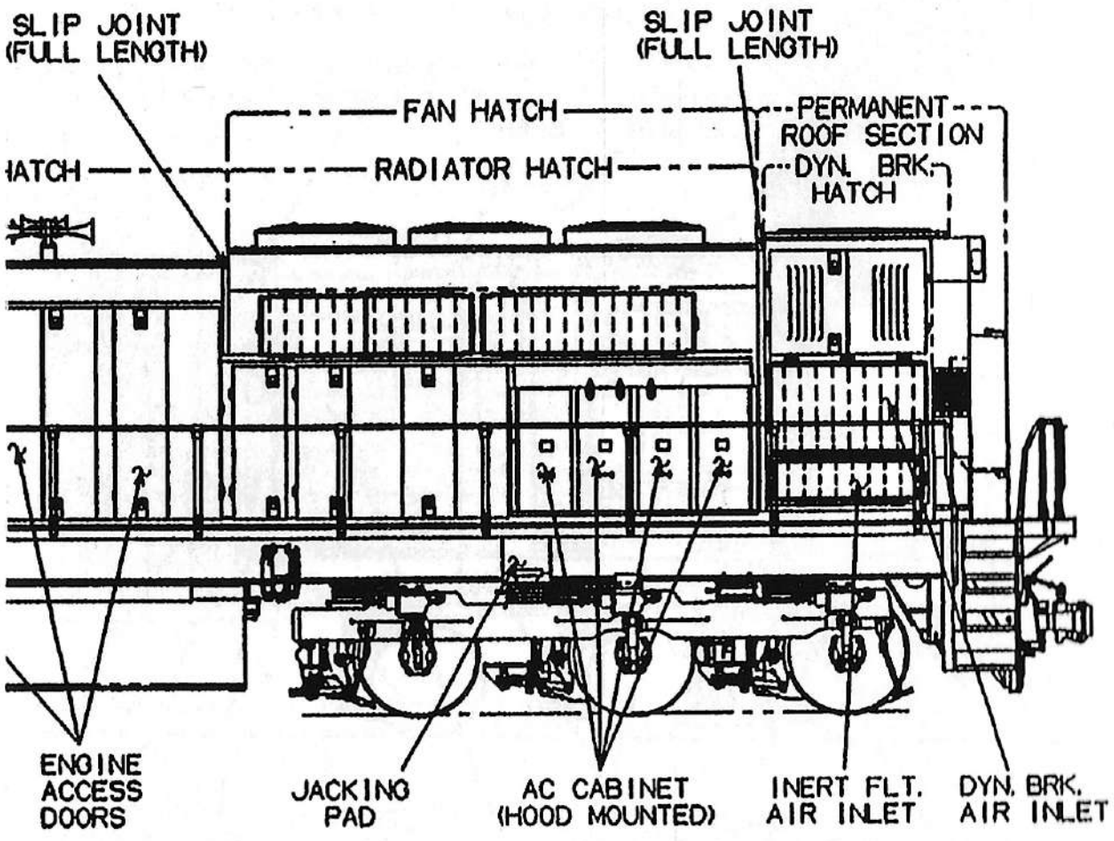

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OPERATION

Operating the engine start switch (**START SWITCH**) on the engine control panel of the electrical control cabinet provides a START signal input to the EM2000 locomotive computer. The EM2000 initiates the engine starting cycle which includes -

- Two ***electrical*** starting motors that engage the diesel engine and go through an Engine Purge sequence. This sequence rotates the diesel engine several revolutions at a speed below 25 RPM to purge the cylinders of any accumulated liquids before speeding up the diesel engine for starting.
- After the engine purge cycle is completed, two ***air*** starting motors engage the diesel engine flywheel and provide enough additional torque to bring the engine up to starting speed. **NOTE:** The #1 main air reservoir must be ***at least 130 psi*** to provide compressed air for these air motors to assist starting the diesel engine.

Storage batteries provide the energy required to turn the diesel engine for the purge cycle. Two starting motor solenoids mounted at the lower rear right hand (brakeman)side of the engine. These electrical solenoids engage the starting motor pinions with the engine ring gear. When both pinions are engaged, battery power is applied to the starting motors to crank the diesel engine through an engine purge cycle. When the purge cycle is completed, air motors engage the engine ring gear and increase the diesel engine cranking speed to where the engine will start.

The EM2000 provides a FUEL PRIME signal to start the fuel pump. This signal causes battery power to be applied to the fuel pump (inverter) which pressurizes

the injector system with fuel. The fuel pump moves the fuel from the fuel tank under the locomotive to the injectors. After the entire system has been supplied fuel and the EMDEC system has positioned the injectors the engine should start when cranked. With the engine running, the AC fuel pump motor inverter is supplied directly by the auxiliary generator.

Major components of the diesel-electric power system take power from the diesel engine. The electrical nature of this system is seen in the conversion, application, and control of that power.

The main generator supplies high voltage electrical energy to the Traction Converter (TC) electrical cabinet. This cabinet establishes the distribution of power to the traction inverters by means of internal motor operated switches. Relays, and control devices in the low voltage cabinet direct the flow of power as dictated by the control computer. The response of the computer is determined by locomotive operating conditions and the set up of the controls in the cab.

The DC output from the main generator is called the DC link voltage and is applied to two traction inverters. DC link voltage varies with throttle position from 600 VDC at IDLE to 2600 VDC at TH8. Refer to Figure 1-1, page 1-12.

There is one traction inverter for each set of three parallel traction motors (one inverter per truck). Traction inverter TCC1 (front truck) and traction inverter TCC2 (rear truck) invert the DC link voltage into ***variable*** voltage, ***variable*** frequency, 3 phase AC power for the traction motors. Each inverter is controlled by its own computer - TCC1 and TCC2 computers.

Both inverters are in turn controlled by the EM2000 locomotive computer that is displayed on the two ICE screens. Each traction control computer is mounted in the TC cabinet with the inverter that it controls.

Actual operating conditions create varying tractive load requirements. A computer controlled load management system balances electrical load with mechanical diesel engine power by modifying engine speed, regardless of throttle position, or changing generator excitation.

If a fault occurs in computer control, then the load regulator function in EMDEC can act to reduce generator excitation. Reducing excitation can prevent an overload condition regardless of the engine power level set by the engineman with the throttle. EMDEC will hold engine speed constant for each throttle position by changing the position of the injector racks.

Moving the throttle to a higher position signals causes the EMDEC computer to raise engine speed and the EM2000 allows more current through the main generator field. Increased excitation current results in an increased DC link voltage which supplies more power to the traction inverters. An increase in traction inverter power increases AC power to the traction motors. In this way, engine speed and DC link power are increased progressively in throttle steps.

In dynamic brake the energy of the moving train is translated into rotating energy in the traction motors. AC motor energy is converted to DC by the traction inverters (converter) and provided to the DC link. The DC link voltage is then applied to brake grids which dissipate the electrical power in the form of heat.

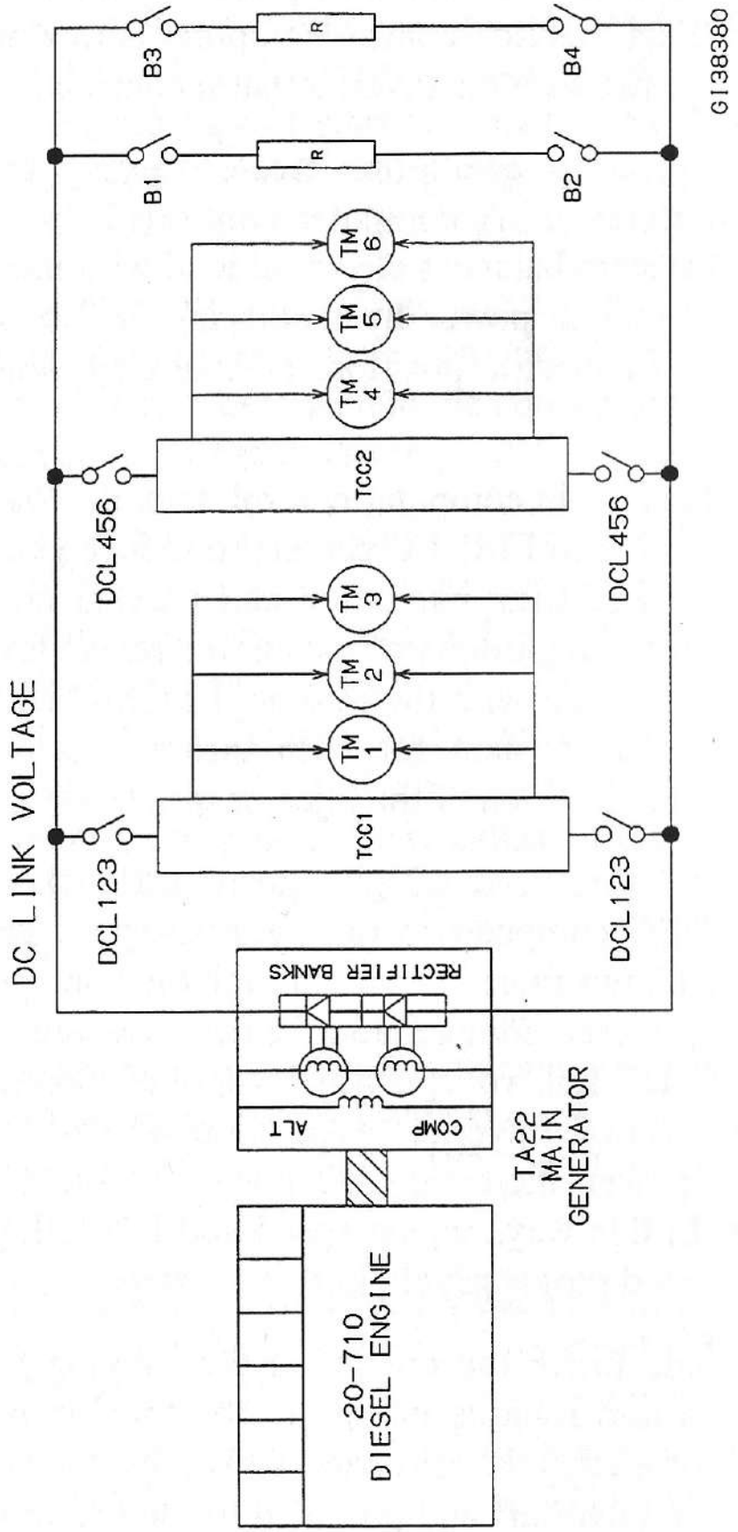


Figure 1-1. Power Distribution Diagram

This loss of energy causes the train to slow down (brake). The inverter computers (TCC1,TCC2) monitor and control each inverter to maintain the braking effort requested by the EM2000 locomotive control computer. The EM2000 maintains braking effort as requested by the engineman and in some cases may ***increase*** main generator excitation.

Other control and protective functions are programmed into the EM2000 - it monitors critical functions in the locomotive power system and, if a fault occurs, provides a display message through the EM2000 and in some cases an audible alarm. The computer will also change diesel engine speed in response to certain improper operating conditions such as low coolant temperature or low main reservoir pressure.

NOTE: Most faults will automatically reset themselves or can be reset by pressing the reset button on the ICE screen. If the fault doesn't reset in this manner, then a service technician must inspect the unit.

Each of six axle hung AC traction motors is geared directly to the axle on which it is mounted. These motors are supplied AC power from the traction inverters - one traction inverter for each three motor truck.

NOTE: AC traction motors are more resistant to mechanical shock and commutator related damage associated with DC traction motors. This will be seen throughout this manual in such areas as eliminating throttle reductions over rail crossings and the 10 second delay when changing between power and dynamic brake operation. Refer to Operation - Section 4 for more information.

The diesel engine is the source of locomotive power. When the engine is running, it directly drives three electrical generators and their associated cooling fans, the water and lube oil pumps. The engine-driven components in the locomotive system convert the engine mechanical power to other forms to perform their individual functions:

1. The main generator rotates at engine speed generating alternating current AC power. The AC power is then converted to direct current power by rectifier banks within the generator assembly and applied to the DC link. Switchgear and contactors apply DC link voltage to traction inverter circuits that convert the DC link voltage to 3-phase AC power for the traction motors.
2. The companion alternator couples directly to the main generator within the main generator assembly housing. It supplies current to excite the main generator field and to power the air compressor, radiator cooling fans, traction motor and inertial filter blower motors, and various transductors and control devices.
3. The auxiliary generator is driven by the engine gear train at three times engine speed. AC power from the auxiliary generator is supplied to an external 3-phase full-wave rectifier in a battery charging assembly. There it is converted to 74 volt DC power for companion alternator excitation, control system operation, and to charge the locomotive batteries. The auxiliary generator also supplies 74 volt DC operating power for the engine fuel and turbocharger lube oil pump circuits, cab heating and air conditioning, locomotive lighting and other miscellaneous equipment.
4. A large motor-driven blower, located in the top of the locomotive carbody behind the inertial filters, is ducted to the main generator to provide cooling air to the main generator and companion alternator.
5. The air compressor is driven by a 2-speed AC motor. The compressor pressurizes the main air reservoirs which supply air to operate the locomotive and train brakes, and other pneumatic devices such as sanders, windshield wipers, shutter operating cylinders and horn.
6. The engine gear train drives two centrifugal water pumps - one circulates coolant through the diesel engine and one circulates coolant through the turbocharger aftercooler.
7. A lube oil pump is also connected in the engine gear train to supply lubricating oil to critical operating surfaces throughout the engine.

With the engine running the fuel pump motor circuit is supplied directly by the auxiliary generator.

The main generator supplies electrical energy to the Traction Converter (TC) cabinet that houses electrical power switchgear. Power contactors and switchgear in the TC cabinet control power distribution to the traction motors. The EM2000 computer, located in the electrical control cabinet, controls the TC cabinet devices based on engineman control settings, computer routines, and operating conditions.

A major part of locomotive control system operation involves the interrelated functions of the throttle, engine speed control, and load regulator functions. These functions are performed using the electronic interface circuitry of the Electro-Motive Diesel Engine Control System (EMDEC) as follows -

- The throttle handle position (engine speed reference) is a Digital to Analog circuit using integral voltage ramping. This throttle position reference is used by EMDEC to control the *amount* of fuel supplied to the cylinders. The EMDEC engine "governor" function holds the engine speed at a constant RPM as set by the throttle position.

- Changing operating conditions create change in the diesel engine loading level. When engine load changes or engine output power level changes, engine speed will change. The EMDEC load regulator function is a discrete simulated circuit in the interface that acts to balance the engine speed setting (referenced from throttle position) with the engine power level determined by the load.

- EMDEC communicates the amount of fuel being consumed through a digital link to the locomotive EM2000 computer. The EM2000 determines if the engine is operating properly and can cut back on the load to maintain engine speed.

- As the throttle handle is advanced, electrical control causes more current to flow through the main generator field. This increased excitation current results in an increase in power to the traction motors - locomotive power, as well as engine speed, increases progressively in throttle steps.

Most control and protective functions are programmed into the EM2000 locomotive computer that monitors critical functions in the locomotive power system and provides display messages if a fault occurs. For serious faults, the computer also sounds the alarm bell and takes corrective action.

EQUIPMENT DESIGNATIONS AND SYSTEM REFERENCES

APS: Air Pressure Switch - Engine Starting System

B1, B2, B3, B4: Brake Contactors

GB1,GB2,GB3,GB4: Brake Grid Relays

DCL 123,456: DC Link Transfer Switches

EPIC: Wabco Computerized Air Brake System

EM2000: Locomotive Control Computer

EMDEC: EMD Electronic Unit Injection

GFC: Generator Field Contactor

GTO: Gate Turn Off Thyristor

ICE: Integrated Cab Electronics

PCR: Pneumatic Control Relay

PCS: Pneumatic Control Function

RE GRID 1,2,3,4,5,6: - Dynamic Brake Grids

TA22: Main Generator

TCC1,TCC2: - Traction Control Converters

SPECIAL FEATURES

Some equipment used on this locomotive model may be unique to EMD "80 Series" models with AC traction motors -

Diesel engine starting by air(motor) assisted electric starting motors.

- Radial trucks.
- No traction motor cutout - ***truck*** (inverter) lockout through EM2000 computer display.
- 83/16 wheel to traction motor gear ratio.
- EMD Electronic Unit Injection (EMDEC)
- KLS Wheel Flange Lube System
- Microprocessor controlled air brake system.
- High capacity two-speed air compressor motor.
- AC traction motors with roller support bearings.
- EM2000 locomotive control system computer.
- Road Crossing Lights
- Integrated Cab Electronics (ICE)

WARNING

AC traction motors cannot be "plugged" in the traditional sense but the electrical control system will apply full dynamic braking automatically if a unit's directional handle is moved to REVERSE position while in forward operation above 2.5 mph.

INTRODUCTION TO INTEGRATED CAB ELECTRONICS

An increasing number of cab controls and indicating devices created a need for a unifying approach to cab equipment. Many types of indications could be conveniently observed through an electronic display screen but a separate screen for each indication would be prohibitive in cost and in interpretation by the engineman. An Integrated Cab Electronics (**ICE**) system was developed to serve this purpose. The implementation of the ICE concept as it applies to an SD80MAC locomotive is shown in Figure 1-2.

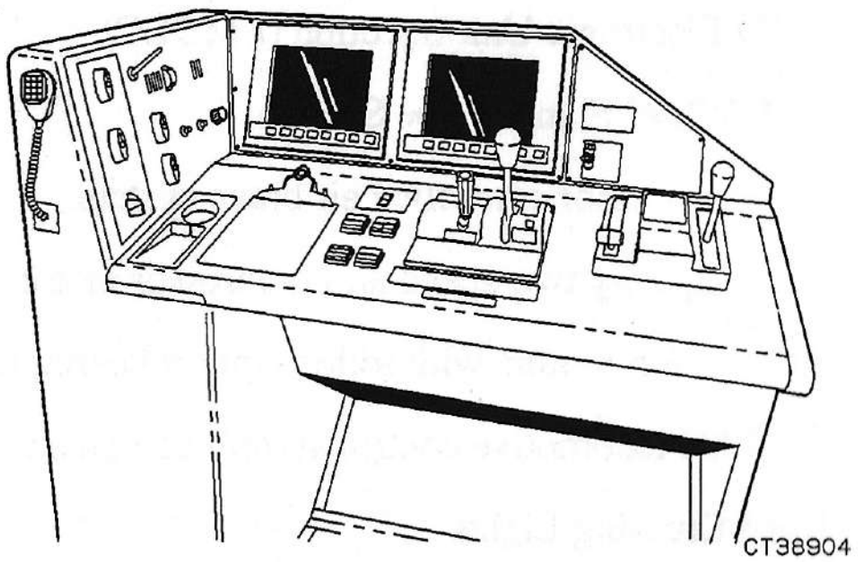


Figure 1-2. ICE Equipped Lower Control Console

ICE is a computer controlled system that replaces most of the usual engineman control switches, gauges, and indicators with two display panel assemblies. These two display screens provide an interactive system that allows viewing all pertinent data and provide control input signals to the locomotive control and air brake systems. This system consolidates the interfaces between the usual engineman controlled electronics and cab stand functions with the display screens. Two major locomotive control systems that previously operated independently through their own display screens are now integrated into the ICE display system -

1. **Wabco EPIC Computerized Air Brake**
2. **EMD EM2000 Locomotive Control Computer**

CHANGE IN EQUIPMENT FOR ICE

Some locomotive equipment has been modified for ICE as follows -

1. Addition of two display panels mounted in the front vertical section of the lower control console.
2. Addition of a three position **SCREEN SELECT** switch on the Left Side Switch/CB Panel (top left vertical section of the lower control console).
3. Addition of some new electrical and pneumatic equipment in the short hood equipment vestibule and the cab sub-base.
4. Elimination of the EMD computer display on the Electrical Cabinet (formerly called the High Voltage Cabinet) or on the overhead console on some models.
5. Incorporation of Wabco computer controlled air brake equipment -
    a. Replacement of pneumatic automatic and independent brake valves with handle actuated electrical signals to the computer.
    b. Consolidation of pneumatic devices on two laminates in the cab sub-base.
    c. Addition of an air brake control system circuit breaker labelled **AIR BRAKE** on the circuit breaker panel

d. Replacement of MU valve, cut off pilot valve, and regulator valve (feed valve) with set up keys in the ICE system

NOTE: The ICE display panels may also be referred to as Train Situation Indicators (TSIs).

ICE SYSTEM DESIGNATIONS

Many new equipment items are provided as part of the total ICE system. These components have been given designations derived from the initials of each word in the name of that device. This simplifies text and shortens the nomenclature on drawings. Some of these designations are provided as follows with their system application in brackets:

{ICE=*Integrated Cab Electronics*, A/B=*EPIC Air Brake System*}

AVU - Audio Visual Unit {ICE}
BCU - Brake Control Unit {A/B}
EPIC - Computer Controlled Brake {A/B}
CCC - Cab Consolidation Computer {ICE}
CCU - Cab Control Unit {A/B}
CRU - Computer Relay Unit {A/B}
CSTC - Cab Signal Train Control {ICE}
EOT - End Of Train device {ICE}
ICE300 - ICE/EM2000 Interface {ICE}
PCU - Pneumatic Control Unit {A/B}
SLIC - Serial Link Identification Card {ICE}
TEU - Train Enclosure Unit {ICE}
TPS - Train Power Supply {ICE}
TSI - Train Situation Indicator (Display) {ICE}
VCU - Voltage Conditioning Unit.

The lower control console, Figure 1-3, is equipped with most of components of the ICE system that are used for locomotive operation

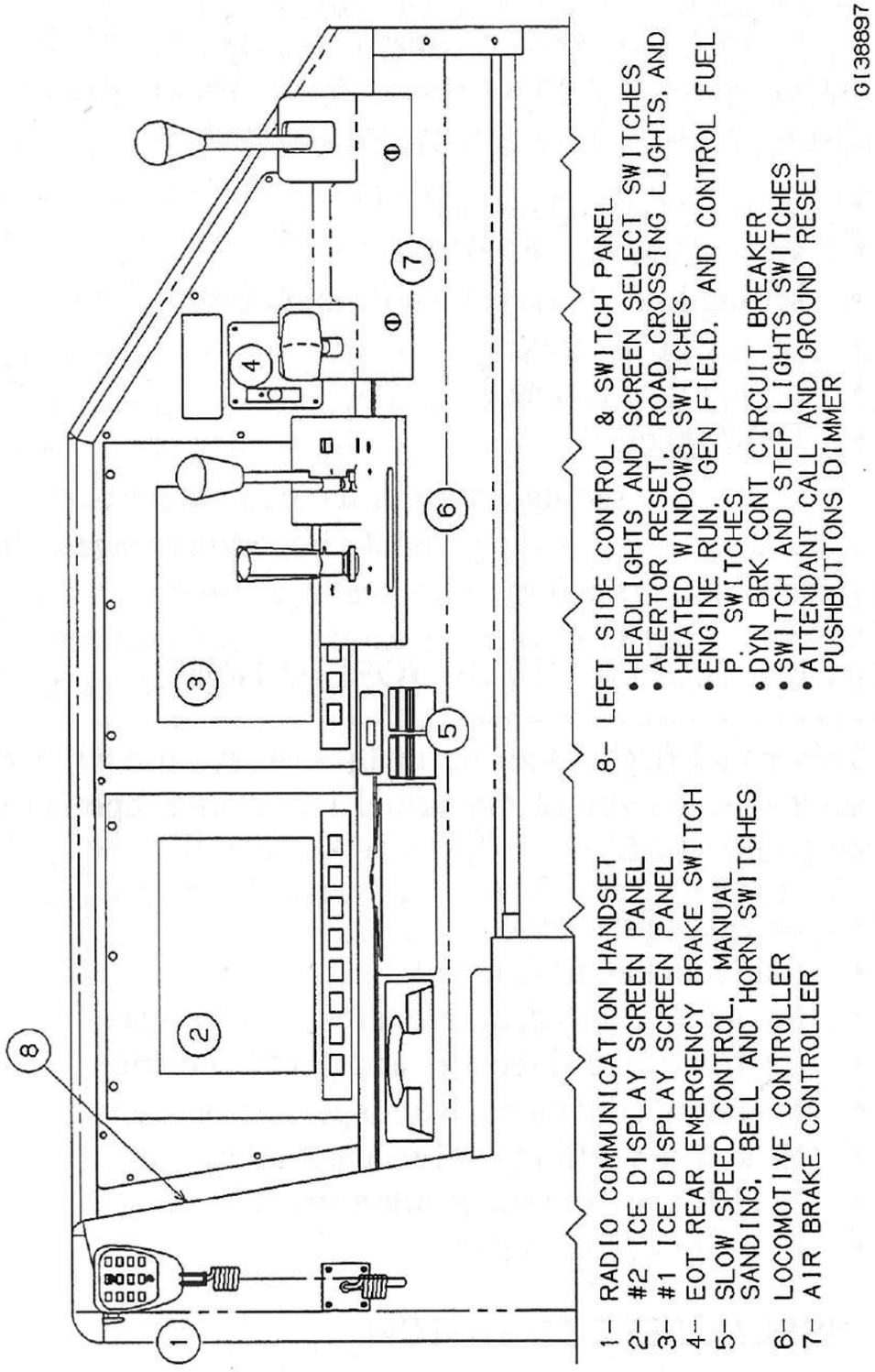


Figure 1-3. Lower Console ICE Related Equipment

#2 ICE DISPLAY PANEL (SET UP)

This panel (left side) normally displays the #2 ICE screen which is used for setting up the locomotive and displaying EM2000 locomotive data, such as -

- viewing cab signal data
- view alertor test menu
- setting End Of Train identification code
- setting up air brakes
- setting time and date
- EM2000 display:
  - setting slow speed control values
  - reviewing fault history/messages in memory

#1 ICE DISPLAY PANEL (OPERATIONS)

This panel (right side) normally displays the #1 ICE screen which shows the actual locomotive operating conditions such as -

- air brake pressures
- road number, train length
- locomotive speed, acceleration, and weight
- tractive effort, direction, and throttle position
- operating conditions, warnings, alertor status
- slow speed setting, air brake cut in/cut out
- EOT ID, marker status, train status
- Cab signal/LSL status

DISPLAY SELECT SWITCH

In normal operation the display select switch is set in the **BOTH** position which activates the right side (operations) and left side (set up) ICE display screens.

In the event of a fault in one of the display screens, then this switch allows the data that would have been displayed on the faulted screen to be shown on the other screen. The data from both screens is combined to produce a composite of all the display information (operations + set up) on the non-faulted screen. A diagram showing ICE input and output signals is provided in Figure 1-4, page 1-26.

Operation of the ICE display can be simplified by referring to the keypad roadmap shown in Figure 1-5, page 1-27. This diagram shows the menus and sub-menus available in the ICE system.

NOTE

The function keys are only active on the display where the key functions are shown at the bottom of the screen.

Typical ICE screens are shown in Figure 1-6, page 1-28, Figure 1-7, page 1-29, and Figure 1-8, page 1-30.

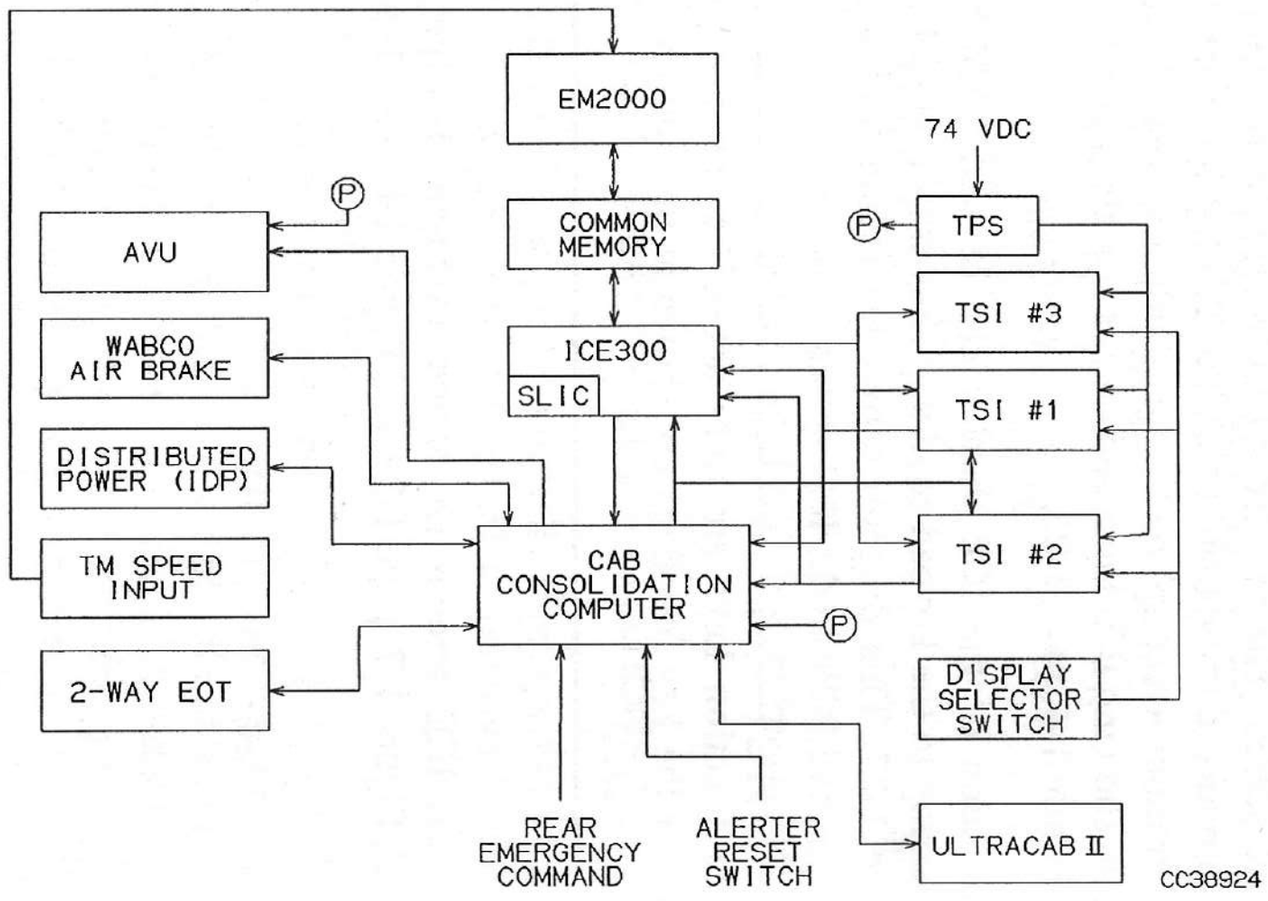


Figure 1-4. Typical ICE System Architecture

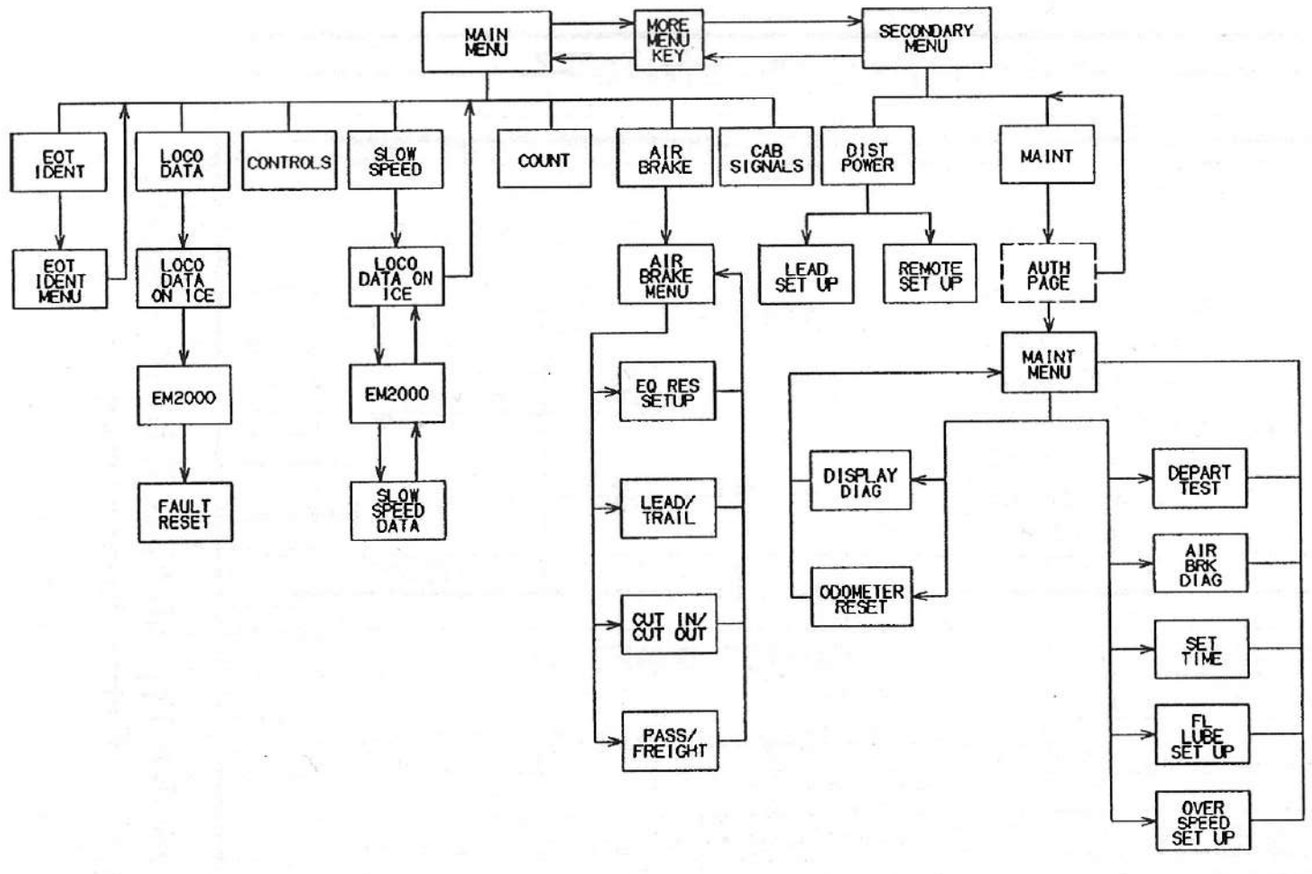


Figure 1-5. Typical ICE Keypad Roadmap

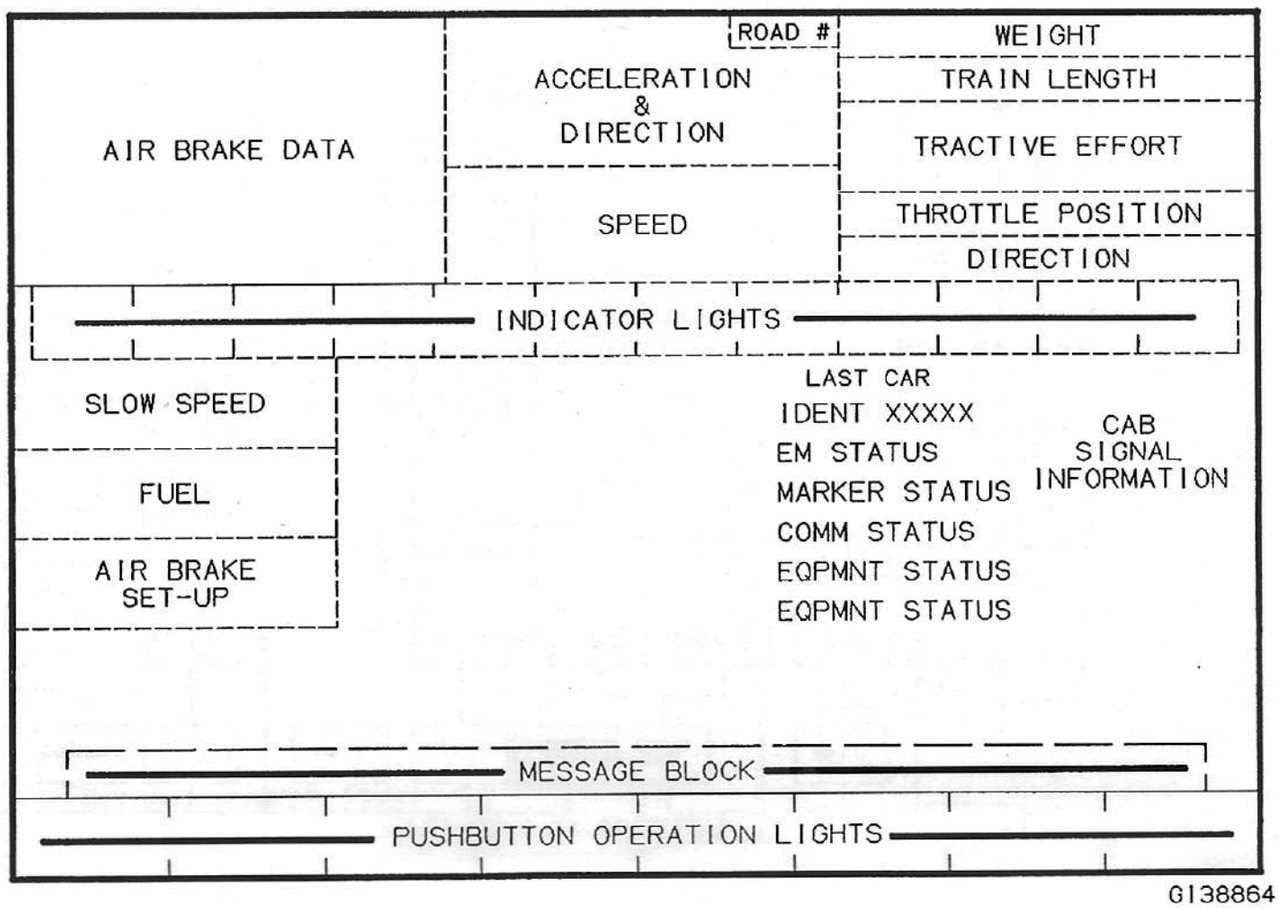


Figure 1-6.Typical #1 ICE Display Panel - Generalized Screen

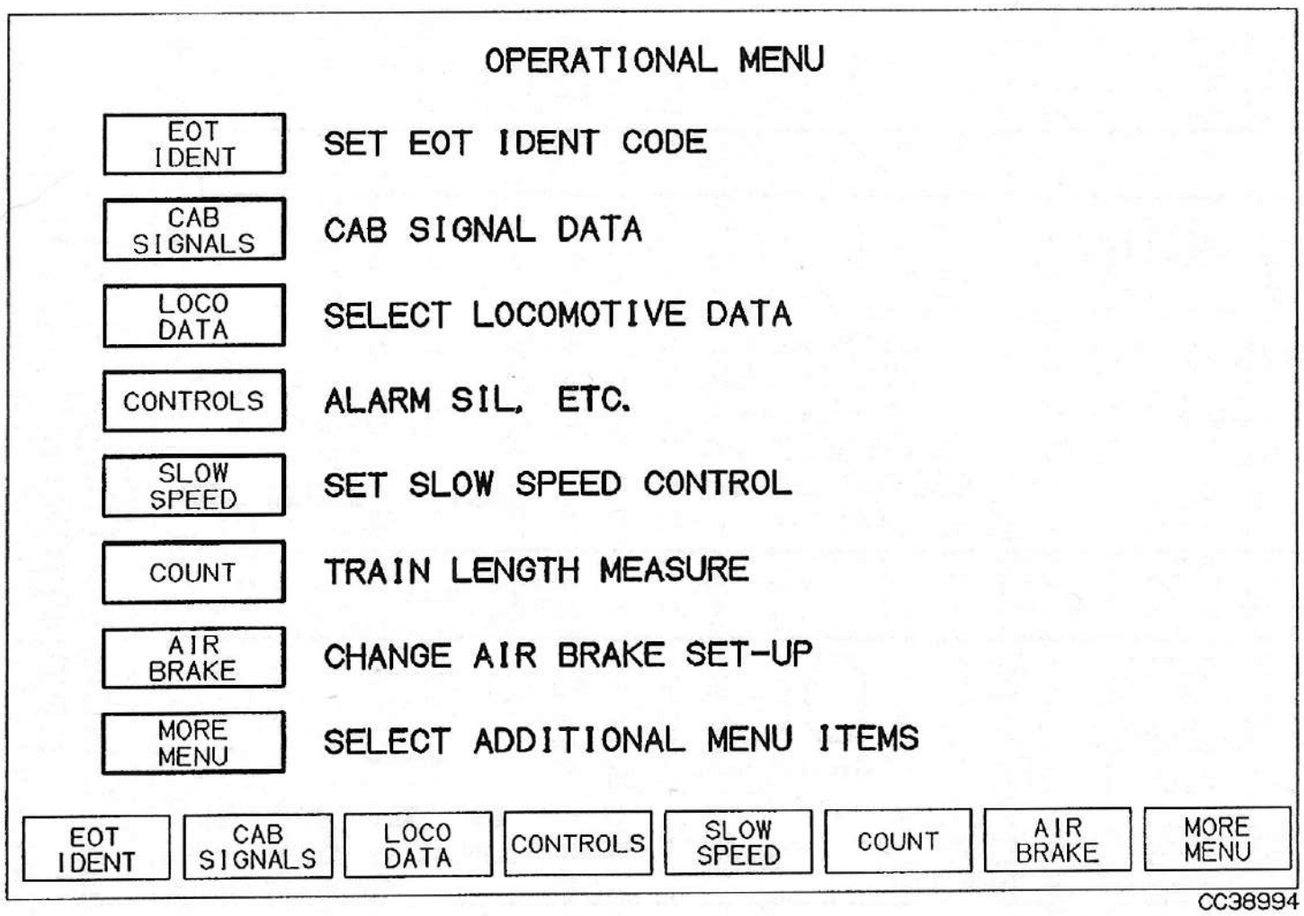


Figure 1-7.Typical #2 ICE Display Panel - SET UP MENU

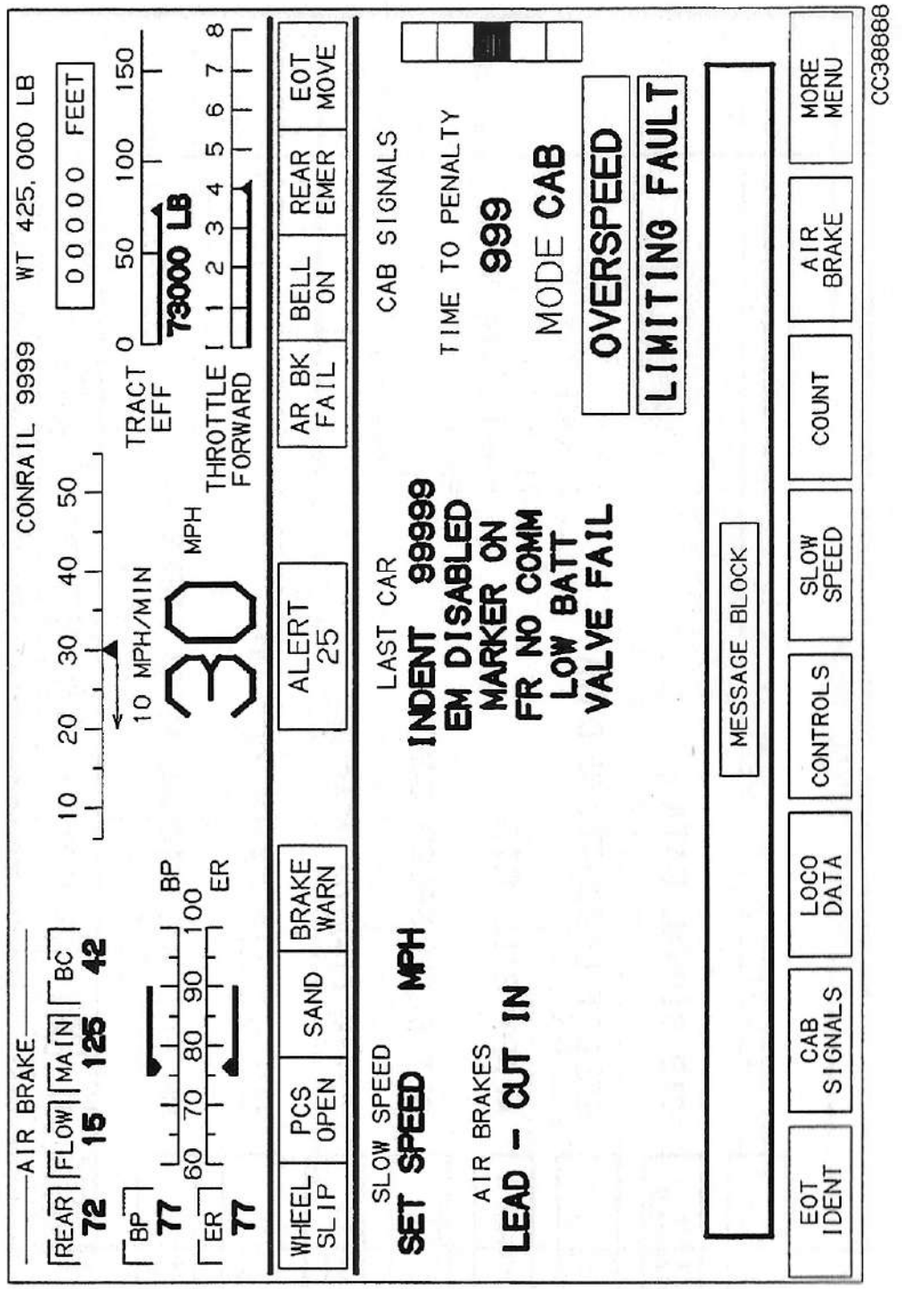


Figure 1-8.(Combined Display Operation - OPERATIONS (#1) + SET UP (#2)

INTRODUCTION TO EM2000 LOCOMOTIVE COMPUTER

The EM2000 locomotive computer display is incorporated into the ICE system and can be accessed by selecting **LOCO DATA** from the Main Menu on the #2 (left side) ICE display screen. The EM2000 display panel is made up of a 6 line, 40 column display that is operated with 4 of the 8 ICE pushbutton keys. This display, combined with the locomotive control computer, is referred to as the Display Diagnostic System (DDS) because it can provide locomotive operating, maintenance, and troubleshooting data.

The Display Diagnostic System was designed to be "user friendly" for a locomotive operator with little or no computer experience. Do not let the detailed discussion which follows cause undue concern about the complexity of this system - actual DDS ***use*** is much easier than the technical details might imply.

The Display Diagnostic System is an interactive device that provides an interface between the control computer and locomotive operator or maintenance person. Access to the locomotive control computer is provided through the ICE display screen and keypad. The user observes the display screen and can input to the computer through the ICE keypad. The computer directs operator input by providing "messages" on the screen. These messages indicate locomotive control and maintenance functions.

IMPLEMENTATION OF EM2000 THROUGH ICE

The ICE system is equipped with eight hard pushbutton key switches located under the display panel. On ***non-ICE*** locomotives, the EM2000 locomotive computer is usually equipped with a 16 hard key keypad. In order to accommodate the EM2000 to the 8 hard key ICE restriction, the ICE screen keypad area was divided into two 8 key row configurations that could be illuminated or highlighted separately. The **SHIFT** keys switch illumination from one row to the other with only one row active at a time. Refer to Figure 1-10, page 1-35 and Figure 1-11, page 1-36.

KEYPAD

The ICE characterization of the EM2000 uses two on-screen rows of 4 spaces each which are related to 4 of the 8 hard keys under the screen. The following list defines the purpose of each key on the screen keypad area as they are used for the EM2000 display.

- ***F1***, ***F2***, ***F3***, ***F4*** are **function** keys. The term "function" key is used to specify keys that are not defined in the same way for every screen. The purpose of these keys is to provide greater flexibility in menu selection. On any given screen the function keys represent an instruction to the control computer such as, reset a fault, cut out an inverter, request more information about other stored data, etc. The function keys are located under the actual display screen with pointer lines showing which key affects that function. The bottom line on the screen provides the definition for the function keys that are active on that screen.

There are 4 function (globally undefined) keys available on the ICE display and 10 dedicated keys. These dedicated keys are defined as follows -

- **Cursor Arrow Keys** are used to move the on-screen cursor to a different position.

> **NOTE**
> The "cursor" on an EM2000 display screen is actually a highlighted box -the background behind the area of the selection is reverse colored black/white.

- **M MENU** returns screen to main menu in one keystroke.
- **SLOW SPD** is used to select the SLOW SPEED display screen which replaces the Pace-setter box used on older models. The slow speed screen displays the target speed required and the present locomotive speed. A speed setting is made with the slow speed control switch located on the lower control console.
- **CREW** returns screen to crew message function in one keystroke.
- **HELP** provides information about the current screen and explains available options.
- **SHIFT** key "toggles" the illumination of the **active** key row upper or lower in the keypad assigned space.

DISPLAY SCREENS

Display screens are limited to three classifications described as follows.

1. **CREW MESSAGES** - replaces annunciator module and fault indicator lights used on previous model locomotives.
2. **MAIN MENU** - user menu options for service, maintenance, and troubleshooting functions.
3. **SLOW SPEED** - replaces former speed control systems, such as Pacesetter system, etc.

The display screen has six (6) horizontal lines which are designated for reference as shown in.

. . . . . *line 1* . . . . . .
. . . . . *line 2* . . . . . .
. . . . . *line 3* . . . . . .
. . . . . *line 4* . . . . . .
. . . . . *line 5* . . . . . .
. . . . . *line 6* . . . . . .

Figure 1-9. Display Screen Layout

NOTE

CREW MESSAGES actually display normal operating conditions as well as problems that occur on the locomotive, such as:

- engine speedup for low water temperature
- locomotive is not properly set up for the current required mode of operation
- power is limited
- some piece of equipment or system has failed and a protective function is active.

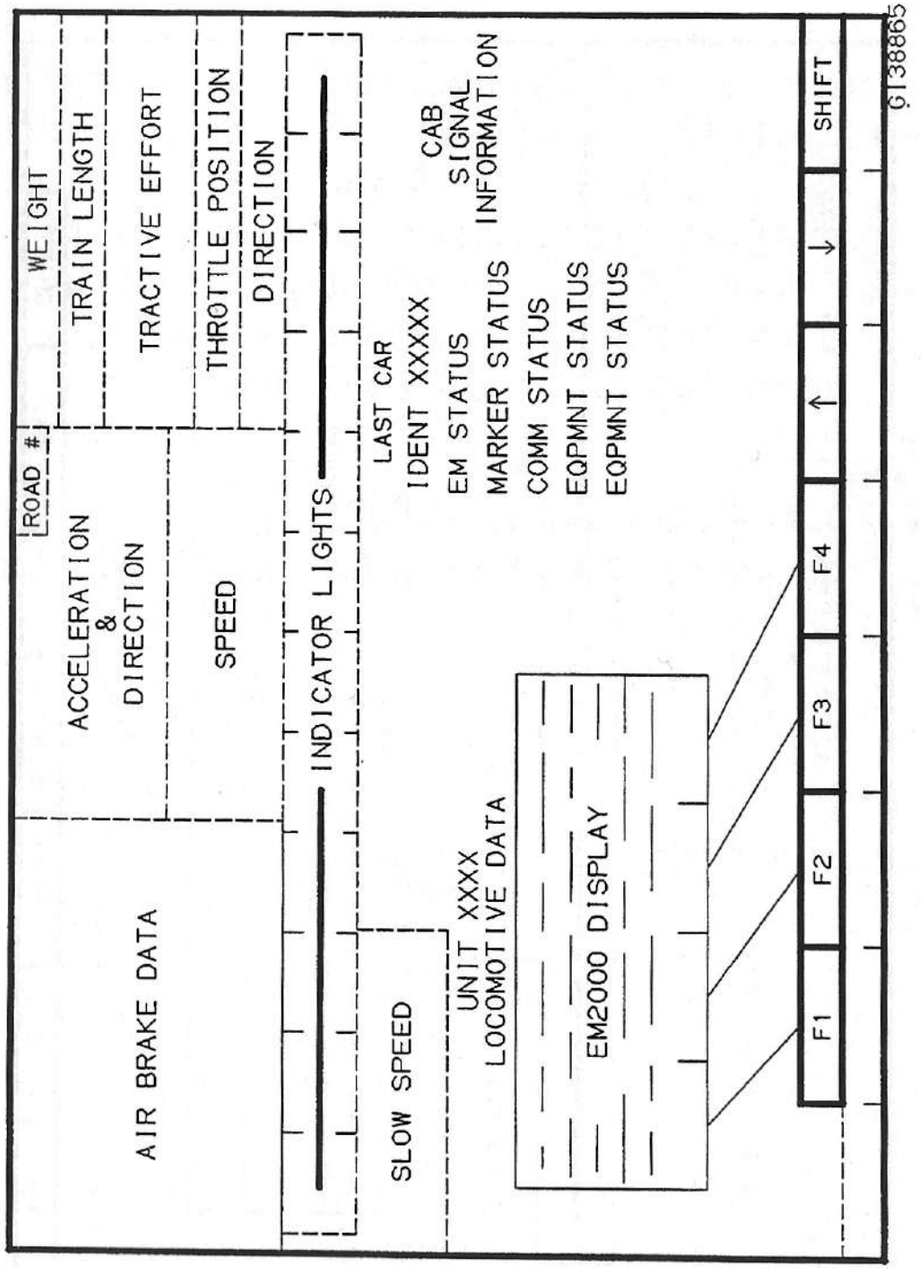


Figure 1-10. Typical EM2000 On ICE, Generalized #1 Screen -Shifted Top Row

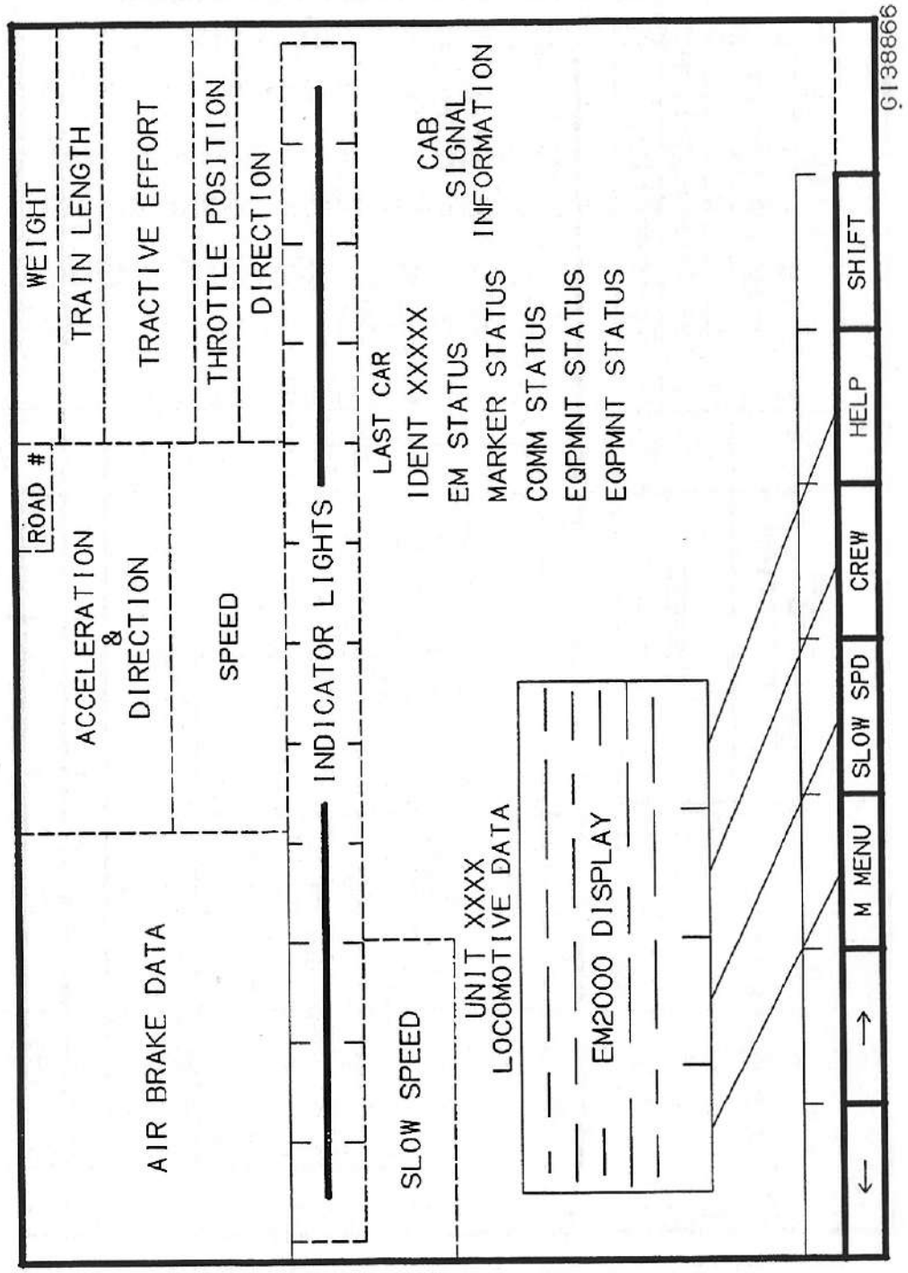


Figure 1-11. Typical EM2000 On ICE, Generalized #1 Screen -Shifted Bottom Row

INTRODUCTION TO ELECTRONIC ENGINE CONTROL EMDEC

The Electro-Motive Division Electronic Engine Control system makes use of a computer to control the amount of fuel that is injected into the engine. Changes to the previous system to incorporate the EMDEC system are listed as follows -

- Elimination of the governor and injector racks.
- Addition of a computer controlled solenoid-actuated valve to meter fuel to each injector.
- Application of 2 EMDEC controllers - one for each bank of cylinders.

Figure 1-12, page 1-38 is a generalized EMDEC diagram and Figure 1-13, page 1-39 is a more specific EMDEC diagram.

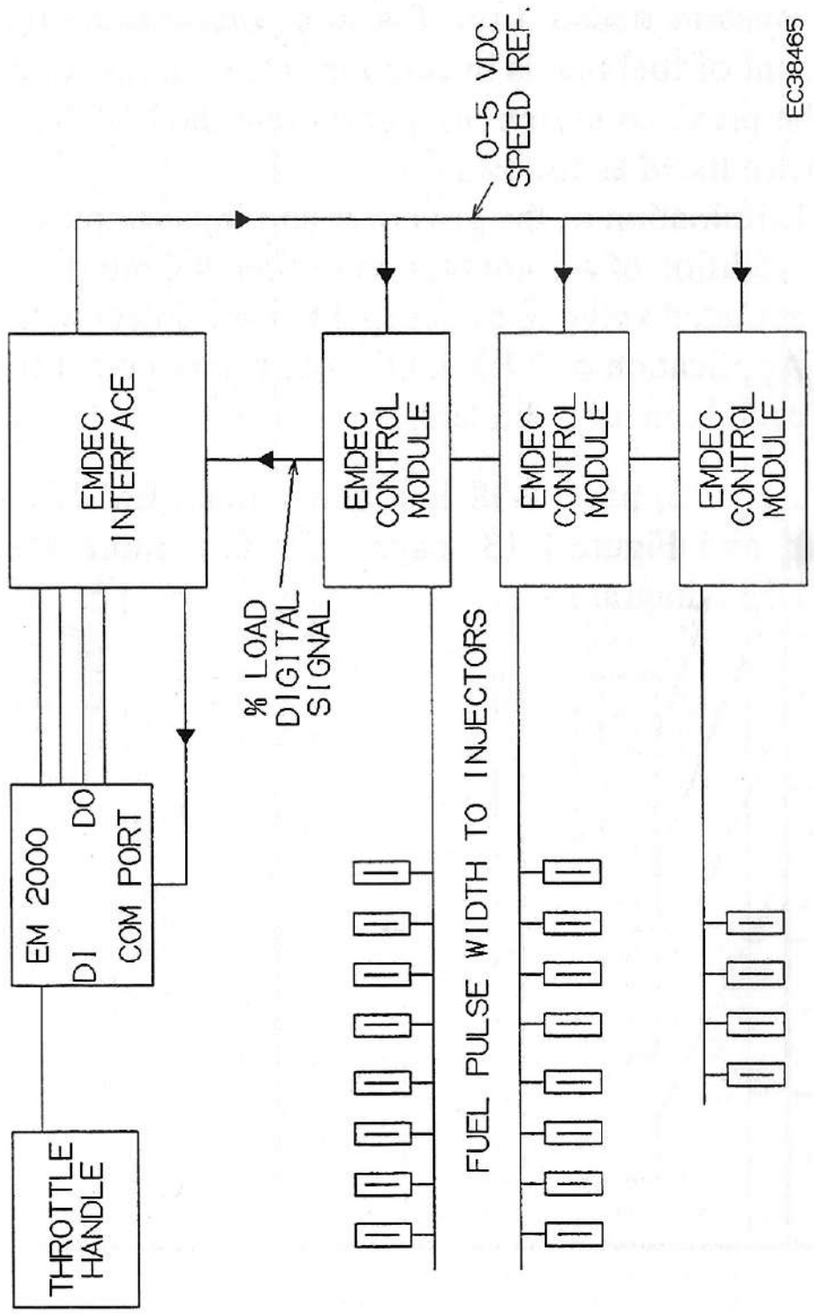
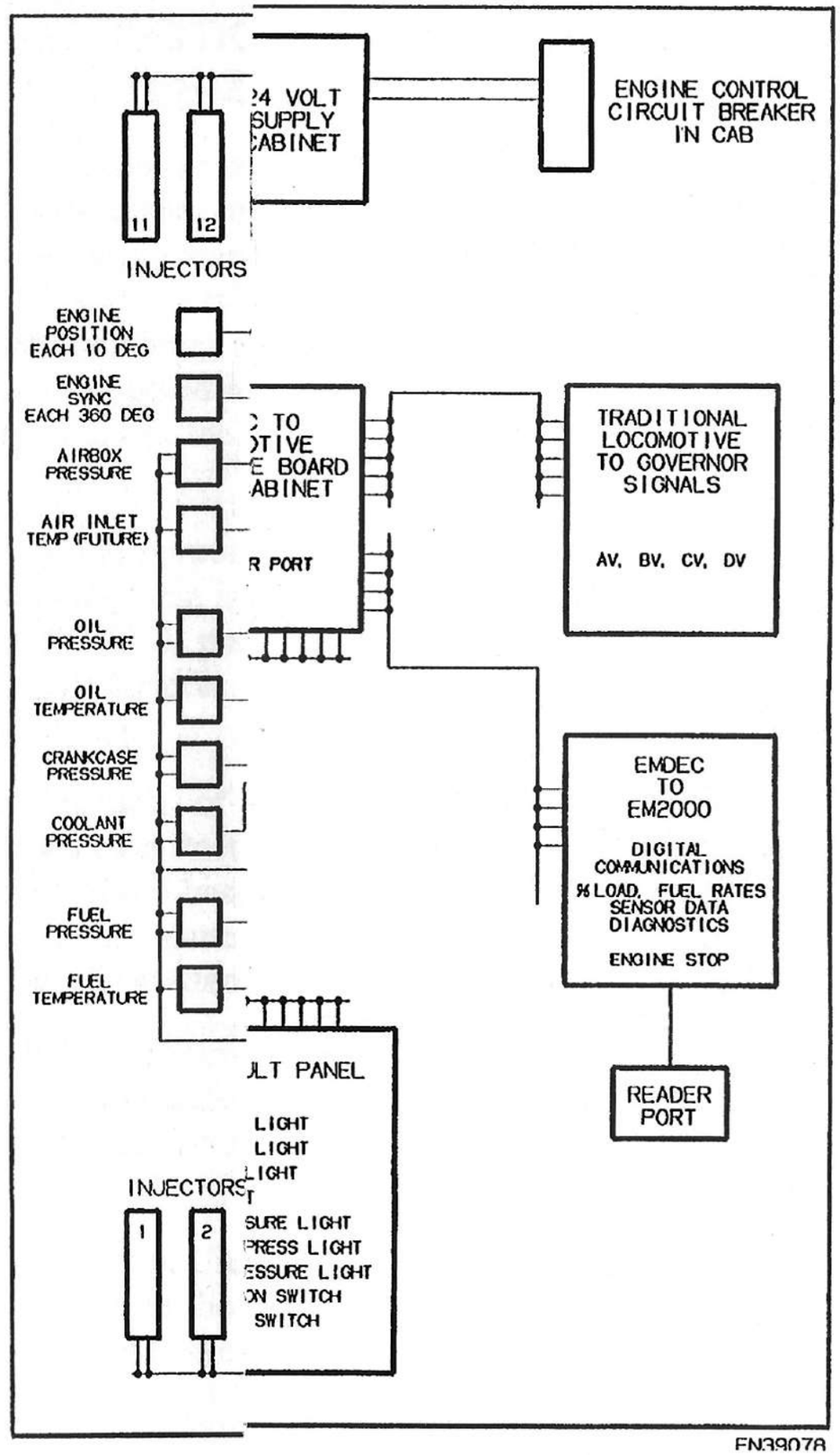


Figure 1-12. EMDEC Generalized Diagram



EMDEC More Specific Diagram

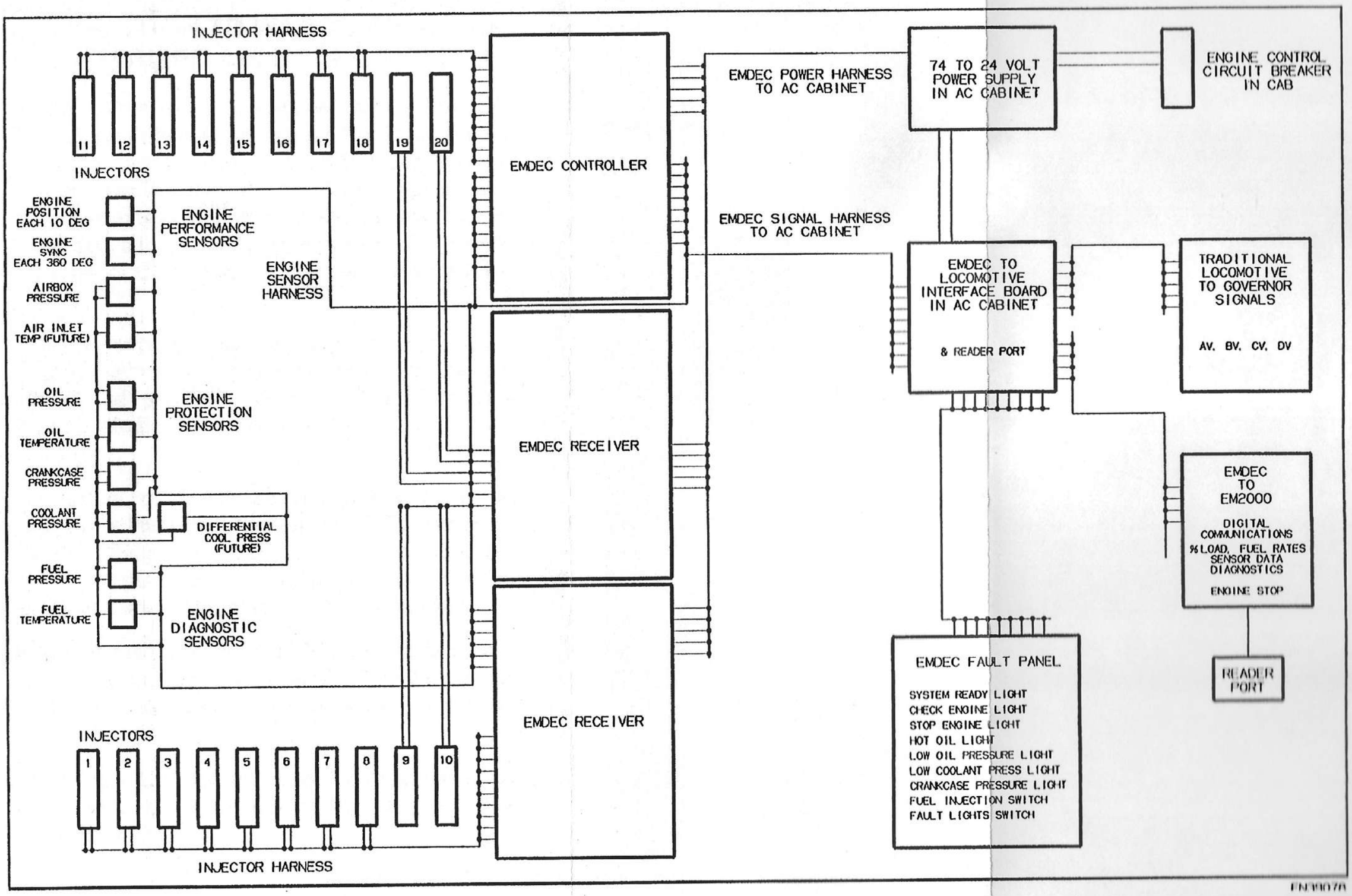


Figure 1-13. EMDEC More Specific Diagram

INTRODUCTION TO WABCO EPIC 3102 COMPUTERIZED AIR BRAKE SYSTEM

This locomotive model is equipped with a WABCO microprocessor (computer) controlled air brake system that has been incorporated into the ICE display system. The EPIC 3102 is a computer based electro-pneumatic system providing control of air brakes on locomotives and cars coupled in trains. An overview of this system is provided in the interaction schematic, Figure 1-14, page 1-42.

The overall purpose of using a computer to control the air brake system is to eliminate as many of the discrete electrical and pneumatic devices as possible thus reducing periodic maintenance and simplifying troubleshooting.

The function of pneumatic relays and valves is replaced by a Pneumatic Control Unit (PCU) mounted in the cab sub-base. The PCU is a fabricated structure made up of a panel for mounting of pneumatic devices formerly at scattered locations on the locomotive.

The PCU is controlled by the EPIC air brake computer - it can connect its inputs together in different ways and provides an interface for electrical and pneumatic devices.

A Cab Control Unit, located on the top right side of the lower console, houses controls for the automatic and independent brake systems.

AIR BRAKE EQUIPMENT

A Cab Control Unit (brake valve) is located on the top right side of the lower console and most brake equipment is mounted on a laminated panel under the cab floor on the engineman's side. engineman related air brake values and readouts are shown on the ICE screens. Refer to Figure 1-14 for interaction schematic.

The electrical Cab Control Unit (brake valve) has two handles -

1. Automatic Brake Valve function

2. Independent Brake Valve function

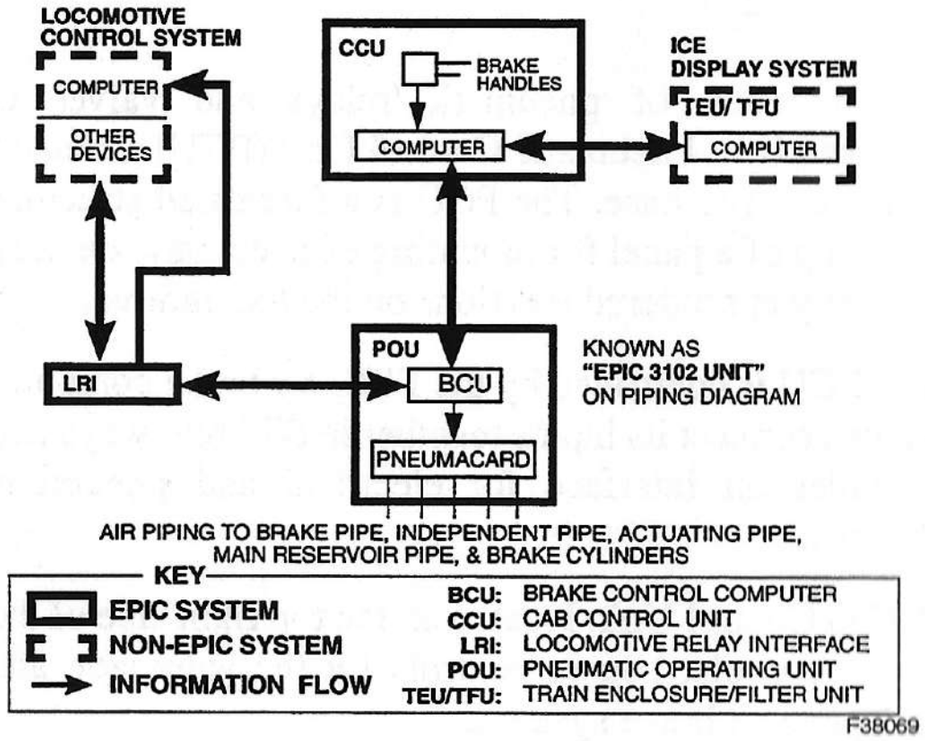


Figure 1-14.Air Brake/EM2000/ICE Interface

INTRODUCTION TO KLS FLANGE LUBE SYSTEM

The KLS rail lubrication system is designed to reduce friction between the locomotive's wheel flanges and the rails by applying a controlled amount of lubricant to the "throat" area of selected wheels during locomotive operation. This system uses a pump at the grease reservoir to move the grease to each individual wheel where flange lube is to be provided and compressed air to atomize and propel the grease onto the wheel flange.

SYSTEM OPERATION

The KLS rail lube system consists of 4 main assemblies-

1. The System Controller is a microprocessor based subsystem that optimizes the flange lube cycle by distance traveled and curves. This unit receives signals from the locomotive controls to determine when to apply lubricant and the rate of application. It also receives signals from a curve sensing device which causes the distribution system to apply a higher rate of lubricant to the wheels as the locomotive is going through a curve.

2. The Lubricant Distribution System has a reservoir (tank) containing the lubricant supply and pump located at the rear (long hood) end of the locomotive.

3. Four lubricant spray nozzles are mounted adjacent to (and aimed at) the flange "throat" area of the appropriate wheels. +74 VDC signals from the locomotive control system trigger magnet valves that use locomotive compressed air to operate (trigger) the nozzles and as a lubricant propellant (atomizer). Metering valves and solenoids control the flow of air and lubricant to the nozzles upon receiving electrical signals from the controller.

4. A curve sensor provides a signal to the KLS controller to provide more lubricant to the wheel flanges on curves.

NOTE

The KLS system is equipped with a 15 minute disable switch, located on the #1 circuit breaker panel, that automatically disables the flange lube system for a 15 minute time interval.

For more information about the KLS Flange Lube system refer to the Locomotive Service Manual.

INTRODUCTION TO HARMON ULTRA-CAB II

Thr Harmon Ultra Cab II is a microprocessor based Cab Signal/Train Control system. Modular design provides high reliability and ease of unit repair and is expandable for multi-territory capabilities and advanced train control.

LSL/Cab Signal tests have been combined under one operating function key on the ICE display called **LSL/TEST**. When the Ultra Cab II is in **Non-Cab** or **Cab Mode**, the Ultra Cab II will perform a combined LSL and Cab Signal self-test. When the Ultra Cab II is in the **CS only mode**, it will only perform a a standard Cab Signal self-test.

The LSL self-test has an internal speed generator integrated into the Ultra Cab II system to allow testing for overspeed and overspeed penalty. It is no longer necessary for an external speed source to verify Ultra Cab operation.

When in Non-Cab or Cab mode the LSL/CS test will run as follows:

- Software Version
- Copyright
- Annunciator Test
- Aspect Speed Test
- Approach: 20-22mph
- App. Med.: 30-32mph
- Clear 50-52mph
- overspeed at 53mph
- with Penalty Brake application.
- Reset Air and Release the Automatic Brake.

The Cab Signal test while in Non-Cab, Cab, and CS only:

- After the automatic air is recovered, the Ultra Cab II will perform a traditional on-board CS Test in the same way as current LSLs and Ultra Cabs.
- As stated in the preceding text, when in **CS Only Mode**, only a Cab Signal self-test will be performed when the LSL/CS function key is pressed.

New Ultra Cab II features:

- The CPU board has two momentary toggle switches labeled Monitor/Run/Calibrate and Scroll/Select. **Monitor** is used for downloading the Cab Signal event and fault logs. **Calibrate** is used for calibrating the Cab Signal Receiver pickup current. **NOTE:** The second switch is not used.
- Auto-calibration for Cab Signal pickup setting - there are no calibratiion potentiometers (pots) to set the Cab Signal pickup current or the low sensitivity adjustment for the self-test.

Section 2. SAFETY PRECAUTIONS

WARNING: These SAFETY PRECAUTIONS apply **only to an SD80MAC locomotive.** When dealing with any other DC or AC locomotive, such as an SD60MAC or SD70MAC follow only those safety precautions that were provided for that particular model.

The SD80MAC is a new locomotive model that has some equipment not found on previous locomotives with DC traction motors. Following unique safety precautions is required before inspecting or operating the equipment. The general areas of concern are noted as follows:

- **High DC link voltage on a shutdown locomotive.**

  and

- **"Plugging" traction motors in an emergency situation.**

A more specific explanation of each situation is provided.

DC LINK VOLTAGE

Both of the traction inverters have input filter capacitors. These capacitors filter the main generator (TA22) output voltage, which is the DC link voltage, before it is applied to the inverters (TCC1, TCC2). These capacitors operate at the DC link voltage which could be as high as 3000 VDC. When the locomotive is shut down these capacitors could retain this high voltage for a long period of time causing a severe safety hazard to operating and maintenance personnel.

WARNING

The DC link voltage is present on ***all*** equipment connected to the output of the main generator. This includes main generator output terminals and cabling connections, capacitor cabinets, and DCL switchgear.

THE DC LINK DISCHARGE PROCEDURE IS NOT REQUIRED IN NORMAL OPERATION. THE LOCOMOTIVE ENGINEMAN SHOULD NOT ACCESS ANY DEVICES WITHIN THE TC CABINET, DUE TO RESIDUAL HIGH VOLTAGE. ACCESS IS LIMITED TO MAINTENANCE INDIVIDUALS THAT ARE KNOWLEDGEABLE IN THE SPECIAL HIGH VOLTAGE CABINET ACCESS PROCEDURE. This restriction does not apply for access to electrical panels used in normal operation.

A procedure has been developed to discharge this high voltage automatically into the dynamic brake grids thereby minimizing the possibility of injury.

DC LINK VOLTAGE DISCHARGE

An automatic discharge is accomplished by the locomotive engineman or maintenance personnel in the normal course of shutting down the unit. Upon shutdown, excitation to the main generator is disabled and main generator output voltage will approach zero but the DC link filter capacitors may still be at operating voltage. The automatic discharge procedure is performed as follows:

1. Through the EM2000 locomotive computer ICE screen make certain that both inverters - TCC1 and TCC2 are ***CUT IN***. If an inverter is cut out, then toggle that inverter through the display to ensure that both inverters are cut in.

2. When the Isolation switch is moved to the START/STOP/ISOLATE position, DC link voltage will automatically (by the EM2000 computer) be connected across the dynamic brake grids causing the DC link energy to be dissipated on the grids.

   After a time period of 10 seconds the DC link can be considered discharged.

WARNING

If a cut out inverter cannot be cut in because of a fault in the computer control system, then a time period of **at least 2 minutes with the locomotive shut down** must be allowed before inspection or maintenance can be performed.

SAFETY CONTROL SYSTEM

The safety control system uses an alertor to monitor engineman activity. A red alertor indication **ALERT** is shown on the ICE screen with a digital count timer. The alertor can be reset by operating any one of the following -

1. Throttle or Dynamic Brake
1. Horn or Bell
1. Alerter RESET Whisker Switch
1. Reverser Handle Movement
1. Any brake application
1. Any ICE system display key
1. Engineman's Cab Signal Acknowledge Pedal
1. Manual Sanding

If the alertor does not detect any engineman activity within a predetermined interval, a penalty brake application will result with removal of locomotive traction power and the reduction of brake pipe pressure to zero psi at a service rate.

PLUGGING TRACTION MOTORS IN AN EMERGENCY SITUATION

AC traction motors cannot be "plugged" in the traditional sense. If the directional handle is moved to the direction opposite the direction of train movement at speeds above 2.5 mph, the locomotive will command full dynamic braking until the locomotive comes to almost a complete stop.

WARNING

If an SD80MAC locomotive is involved in any type of crash or accident, special precautions must be taken before working on the locomotive. Notify EMD personnel immediately for special assistance.

Section 3. CONTROL EQUIPMENT

CONTROL CONSOLES

Most operating equipment is on the **upper** and **lower** control consoles shown in Figure 3-1.

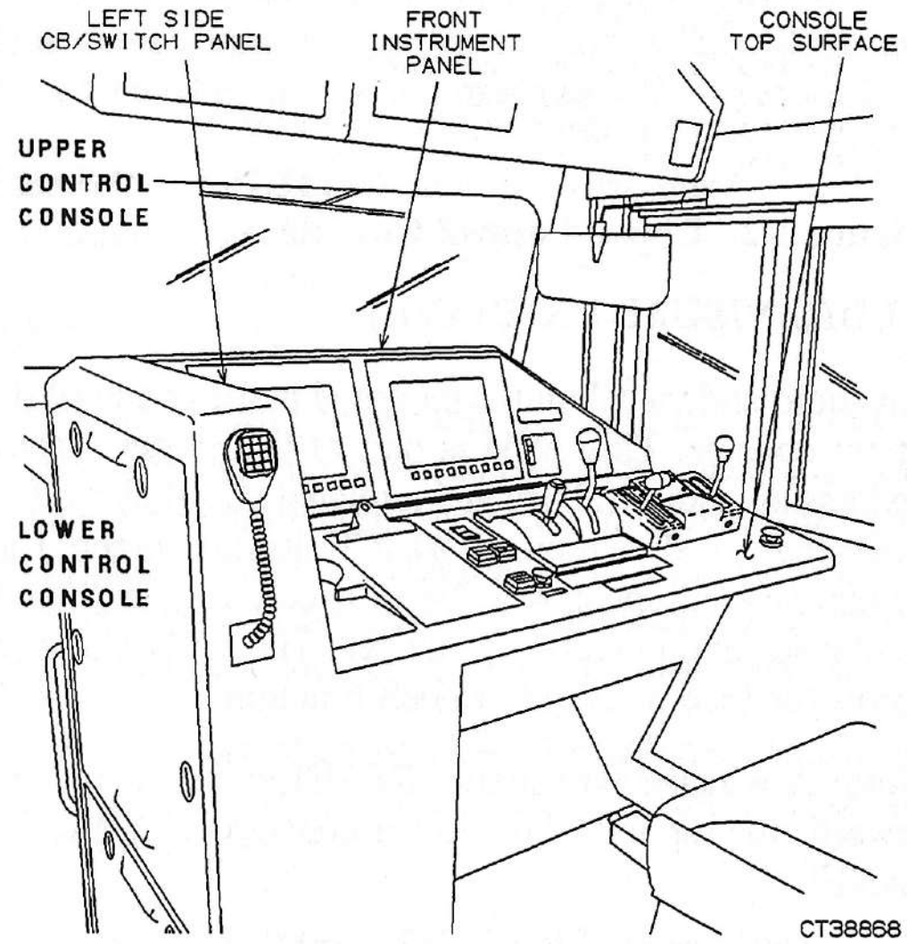
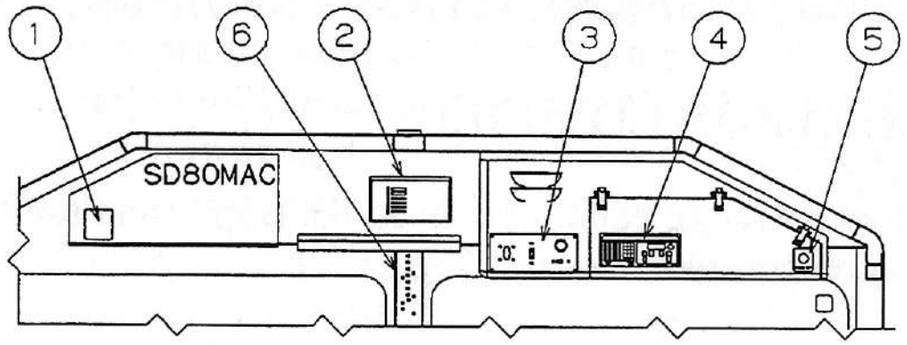


Figure 3-1. Control Consoles.

UPPER (Overhead) CONTROL CONSOLE

Some equipment used by the engineman and brakeman is located on the upper control console, Figure 3-2, page 3-2, which is attached to the front bulkhead. This equipment is described in the following text.



1- BRAKEMAN' S READING LIGHT SWITCH/DIMMER
2- ALERTER AUDIO/VISUAL UNIT
3- HEATER/AC SWITCH PANEL
4- RADIO TRANSCEIVER
5- MULTIPLE UNIT RUN/STOP SWITCH
6- CAB SIGNAL DISPLAY

CC38898

Figure 3-2. Upper Control Console.

AUDIO/VISUAL UNIT (AVU)

An audio and visual unit is mounted in the center of the upper console. This AVU is part of the alerter system and has an audible alarm and a related visual alarm and timer that are shown on the #1 ICE display screen. Use of alerter equipment is to be in accordance with railroad rules and operating practices. The AVU also performs the locomotive alarm bell function.

Note: A whisker type alerter RESET switch is located towards the top left of the lower console CB/SWITCH PANEL.

HEATER-A/C SWITCH PANEL

This switch panel is located above the engineman at the center right side of the overhead console and contains the following devices:

HEATER-A/C Switch

This switch controls the cab heating and air conditioning system and has eight positions - OFF, LOW FAN, HIGH FAN, LOW HEAT, MED HEAT, HIGH HEAT, LOW COOL, and HIGH COOL.

SHORT HOOD LIGHTS Switch

This switch controls the short hood lights which are turned **on** when the switch is moved UP.

READING LIGHT Switch and Dimmer (engineman's side)

RADIO

A two-way radio control unit is located immediately in front of the engineman in the overhead console. It contains the necessary controls to communicate with other trains and wayside installations. This equipment is utilized through a communication handset mounted at the engineman's left side of the lower control console.

Note: A remote radio speaker with volume control and hand microphone are also provided at the left (brakeman's) side of the cab.

MU ENG STOP (Multiple Unit Engine Stop) Switch

This pushbutton switch is to be used to stop all engines in a consist. It is a **PUSH ON-PUSH OFF** switch with two distinct divided areas. **To stop all engines in a consist, depress the red section identified STOP.** During normal operation, or to restart engines, depress the black section identified RUN.

NOTE: The Multiple Unit Engine Stop switch will **not** shut down -

1. units that are isolated
2. units that are not in IDLE.

CAUTION

The locomotive **controller** on this model locomotive does **NOT** have a STOP position for the THROTTLE/DYNAMIC BRAKE handle and consequently no multiple unit (MU) engine stop function on that handle.

LOWER CONTROL CONSOLE

The lower control console, Figure 3-3, page 3-6, contains frequently used engineman equipment on several panels which are listed here and described in the following text.

1. LEFT SIDE CB/SWITCH PANEL
2. FRONT INSTRUMENT PANEL
3. CONSOLE TOP SURFACE

LEFT SIDE CB/SWITCH PANEL

The left side CB/switch panel, Figure 3-4, page 3-7, is located at the left upper section of the engineman's control console and contains the following devices:

HEADLIGHT Switches

In a multiple unit consist only the lead unit controls the headlights. The headlight control switches in trailing units must be properly positioned. Two rotary switches provide independent control of the front and rear headlights - **HDLTS REAR** Switch has OFF, DIM, MED, and BRT positions. **HDLTS FRONT** Switch has OFF, DIM, MED, and BRT positions.

ALERTOR RESET Switch

This whisker switch is used to reset the alertness control system when an alertness control violation has occurred - the alertness control system is reset to prevent a time-out and consequent penalty brake application. **Use of this equipment is to be in accordance with railroad rules and operating practices.**

ENGINE RUN Switch

This switch must be ON to obtain throttle control of engine speed. If the engine run switch is in the OFF position, the engine will run at idle speed regardless of the throttle handle position (except in load test).

GEN. (Generator) FIELD Switch

AC traction technology uses the main generator to power a DC link rather than the traction motors directly. This difference affects generator field switch operation - the generator field switch must be ON to enable traction motor excitation. If the switch is in the OFF position, the main generator is still excited but the motors will not develop power.

CONTROL FUEL P. (Pump) Switch

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

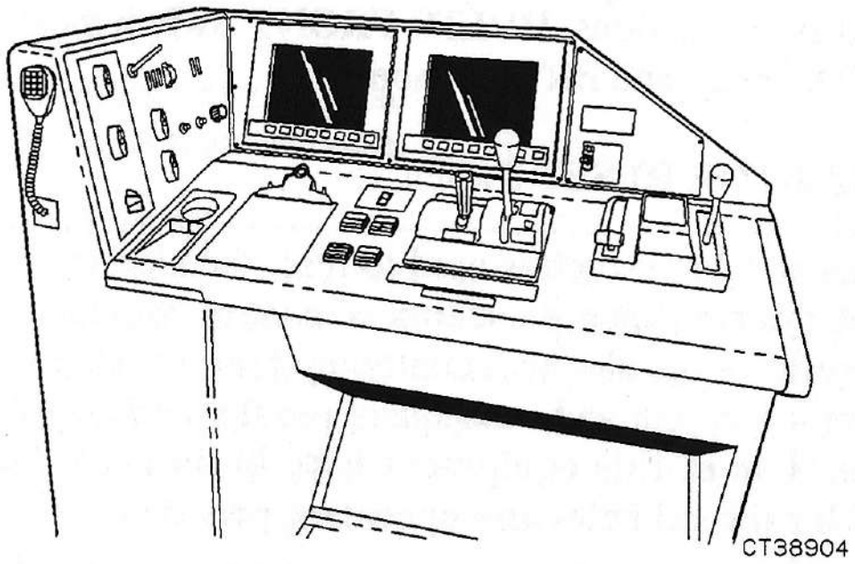


Figure 3-3. Typical Lower Control Console.

NOTE

These three (3) operating switches in the center of the panel must be set in the ON position when the unit leads in a consist, and set in the OFF position if the unit is trailing or dead in a consist. The switches snap into the ON position when moved upward.

DYN BRK CONT CB Circuit Breaker

This circuit breaker protects 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, during dynamic brake testing, more than one dynamic brake handle in a locomotive consist was out of OFF position.

SWITCH AND STEP Lights

Switches for the switch lights and step lights are located next to the dynamic brake circuit breaker. The lights are on when the switches are in the UP position.

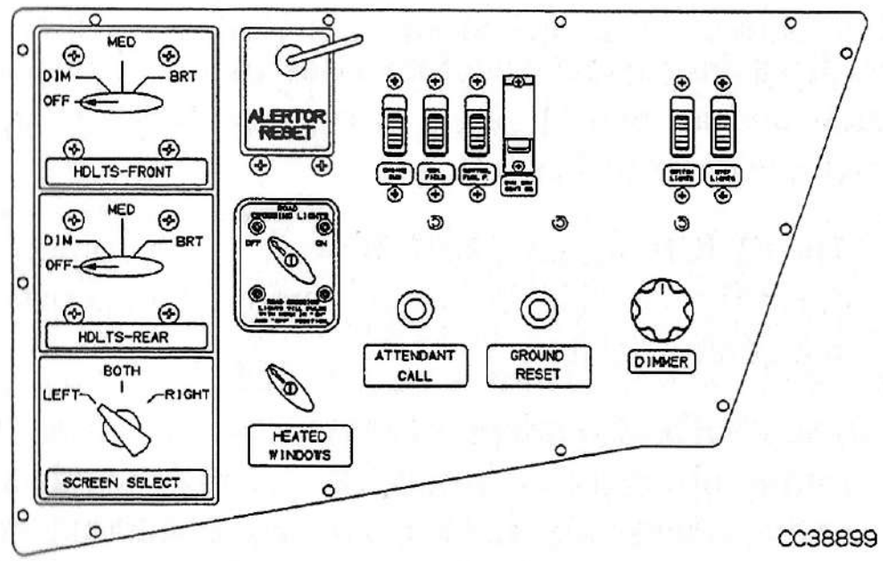


Figure 3-4. Left Side Switch/CB Panel .

SCREEN SELECT SWITCH

The screen select switch is used to move the display information from one display screen to the other in the event of a display screen failure. Refer to "DISPLAY SELECT SWITCH," page 1-24 for more information.

ROAD CROSSING LIGHTS

This switch controls the road crossing lights.

ATTENDANT CALL

The attendant call pushbutton is used to sound the alarm bell in all units coupled in consist.

DIMMER

This dimmer rheostat is used to control the brightness of lights for gauges and in the switches for the locomotive bell, engineman's horn, brakeman's horn, and manual and lead truck sand.

FRONT INSTRUMENT PANEL

The front instrument panel contains two ICE display panels and an End Of Train emergency brake switch which are described as follows.

1. The #1 ICE display panel shows actual locomotive operating variables as well as train characteristics and control set up.

2. The #2 ICE display panel shows a set up menu for setting up various locomotive systems such as air brake, slow speed, and access to the EM2000 locomotive computer. Refer to Figure 1-6, page 1-28, Figure 1-7, page 1-29, and Figure 1-8, page 1-30 for more information.

3. The E.O.T. REAR EMERG BRAKE Switch is used to electrically initiate an emergency brake starting at the rear end of the train.

CONSOLE TOP SURFACE

CUPHOLDER, PAD, AND CLIPBOARD

Devices are for the convenience of the engineman.

SLOW SPEED CONT (CONTROL) Switch

This switch is used to set train speed when operating in slow speed control.

MANUAL SANDING SWITCHES

Manual sand is cut out when the locomotive is operating in power in wheel creep mode and moving above 9 MPH. If a wheel creep equipped locomotive is

in consist with older units, pressing the manual sand switch will supply a trainlined signal to the older units and sand will be applied. **Manual sanding is available in dynamic braking at all speeds.**

MANUAL SAND Pushbutton Switch:This non-latching pushbutton switch provides a signal to the sanding input of the control computer and causes the SAND light on the #1 ICE display screen to turn on. The computer determines which direction the locomotive is moving and directs the trainlined signal to the appropriate (forward or reverse) sanding magnet valves.

LEAD TRUCK SAND Switch :This latching type switch with separate ON/OFF pushbuttons provides a sanding signal to the control computer and turns on the SAND light in the ICE display. The computer directs a signal to the appropriate sanding magnet valve at the lead truck position only.

NOTE

In power, lead truck sanding is cut out above 11 MPH and manual sanding is cut out above 9 MPH.

BELL Pushbutton Switch

This pushbutton switch operates the locomotive signal bell.

HORN Pushbutton Switch

This switch is a non-latching pushbutton device used to activate the horn, bell, and road crossing lights.

LOCOMOTIVE CONTROLLER

The locomotive controller, located at about the center of the console top surface, has two operating handles which control three different functions. The handle to the left, called the DIRECTIONAL HANDLE or REVERSER, controls the direction in which the locomotive will move. The handle located on the right side, called the THROTTLE/DYNAMIC BRAKE, controls the throttle and dynamic brake responses.

DIRECTIONAL HANDLE

The directional (reverser) handle has three detent positions; neutral (centered), forward, and reverse (backward).

When the handle is moved forward 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 backward toward the long hood end, the locomotive will move in that direction when power is applied. With the handle centered, mechanical interlocking prevents movement of the THROTTLE/ DYNAMIC BRAKE handle to a dynamic braking position, however, it can be moved to a throttle position. In such a case, power will not be applied to the traction motors.

Note: Mechanical interlocking assures that the directional handle can be moved only when the THROTTLE/DYNAMIC BRAKE handle is in the IDLE position.

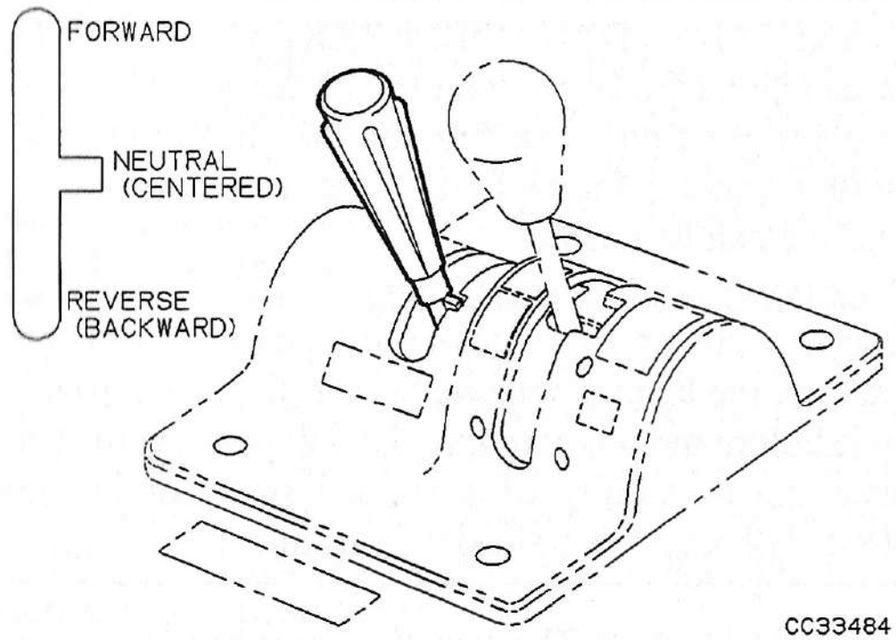


Figure 3-5. Directional Handle.

CONSISTS WITH DC UNITS

Damage to traction motors in trailing DC units may occur if the directional handle is moved from forward to reverse or reverse to forward while the locomotive is in motion - the handle position should be changed only when the locomotive is completely stopped.

The directional handle,Figure 3-5, is centered and removed from the controller to lock the THROTTLE/DYNAMIC BRAKE handle in the IDLE position.

Note: Directional handle must be removed when the locomotive is in trailing position.

THROTTLE/DYNAMIC BRAKE HANDLE

The throttle/ dynamic brake handle has two control areas or sectors labelled THROTTLE and DYNAMIC BRAKE separated by a gate. Refer to Figure 3-6., "Throttle/Dynamic Brake Handle" on page 3-12.

To move the handle from THROTTLE to DYNAMIC BRAKE or from DYNAMIC BRAKE to THROTTLE, the handle has to be passed through the gate, i.e., push handle to the right, then straight, then back to the left. An illuminated window to the right of the handle indicates the handle position.

CONSISTS WITH DC UNITS

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

THROTTLE SECTOR :The throttle sector has nine detent positions; IDLE, and 1 through 8 power positions. From the IDLE position, against the gate, the handle is pulled backward to increase engine speed and locomotive power.

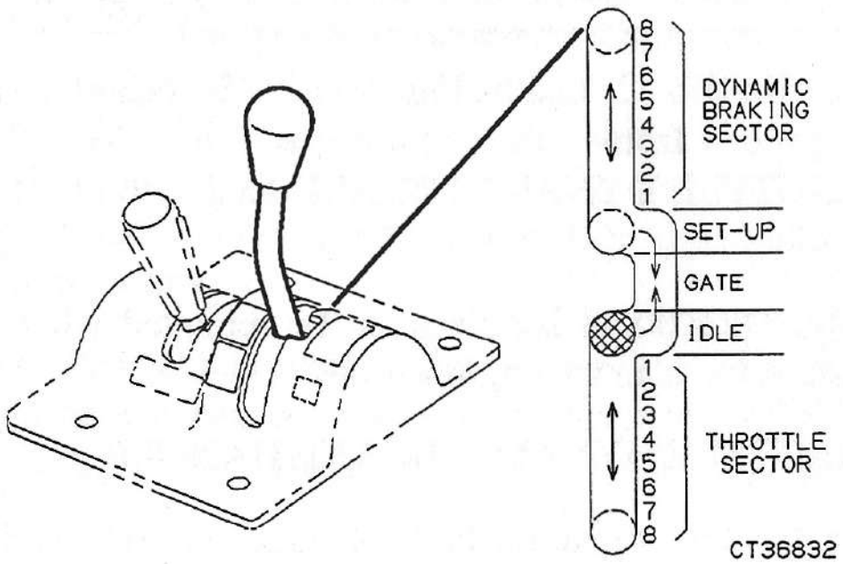


Figure 3-6. Throttle/Dynamic Brake Handle .

NOTE

Mechanical interlocking assures that the handle can be moved from throttle IDLE position to a position in the dynamic brake sector only when the directional handle is positioned for either FORWARD or REVERSE operation.

DYNAMIC BRAKE SECTOR :The dynamic brake sector has one detent position; SET-UP, and an operating range 1 through 8, through which the handle moves freely without "notching." From the SET-UP position, against the gate, the handle is pushed forward to increase dynamic braking.

MECHANICAL INTERLOCKS ON THE CONTROLLER :

The handles on the controller are interlocked so that:

1. With directional handle in neutral (centered) -
   a. THROTTLE/DYNAMIC BRAKE handle can only be moved to a position in the throttle sector.
   b. Dynamic brake sector not accessible.
   c. Directional handle can be removed from controller if THROTTLE/DYNAMIC BRAKE handle is in IDLE position of the throttle sector.
2. Directional handle removed from controller -
   a. THROTTLE/DYNAMIC BRAKE handle locked in IDLE position of the throttle sector.
   b. Dynamic brake sector not accessible.

3. Directional handle in forward or reverse -

   a. Throttle/dynamic brake handle can be moved to any position in the throttle or dynamic brake sectors. The design of the controller, however, is such that only one sector can be engaged at a time.

   b. Throttle/dynamic brake handle in dynamic brake sector, directional handle is locked in either forward or reverse.

   c. Throttle/dynamic brake handle in throttle sector, directional handle is locked in either forward or reverse.

   d. Throttle/dynamic brake handle in IDLE position of throttle sector, directional handle can be moved to forward or reverse position, or if centered in the neutral position, handle can be removed which will lock throttle/dynamic brake handle in IDLE position.

AIR BRAKE EQUIPMENT

An electrical Cab Control Unit (simulates brake valve) is located on the top right side of the lower console and most brake equipment is mounted on a laminated panel under the cab floor on the engineman's side. engineman related air brake values and readouts are shown on the ICE screens. The electrical Cab Control Unit ("brake valve") has two handles -

1. Automatic Brake Valve function
2. Independent Brake Valve function

IMPORTANT

The following air brake controls traditionally were implemented with discrete air brake components and are now incorporated into the ICE system and displayed on the ICE screens.

1. REGULATING VALVE (FEED VALVE)
2. MULTIPLE UNIT VALVE
3. CUT-OFF PILOT VALVE.

These devices have been replaced with computer controlled equipment- a device that replaces the pneumatic brake valve is described in the following text.

CAB CONTROL UNIT (BRAKE VALVE)

The automatic and independent brake system combines two controls in a single housing,Figure 3-7, page 3-16, located to the right on the top of the console. Handles are operated in a forward-backward motion, the brakes being released at the backward (towards the engineman) position. Operating positions are detented for positive location.

AUTOMATIC BRAKE HANDLE

The automatic brake handle 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 normal brake pipe leakage.

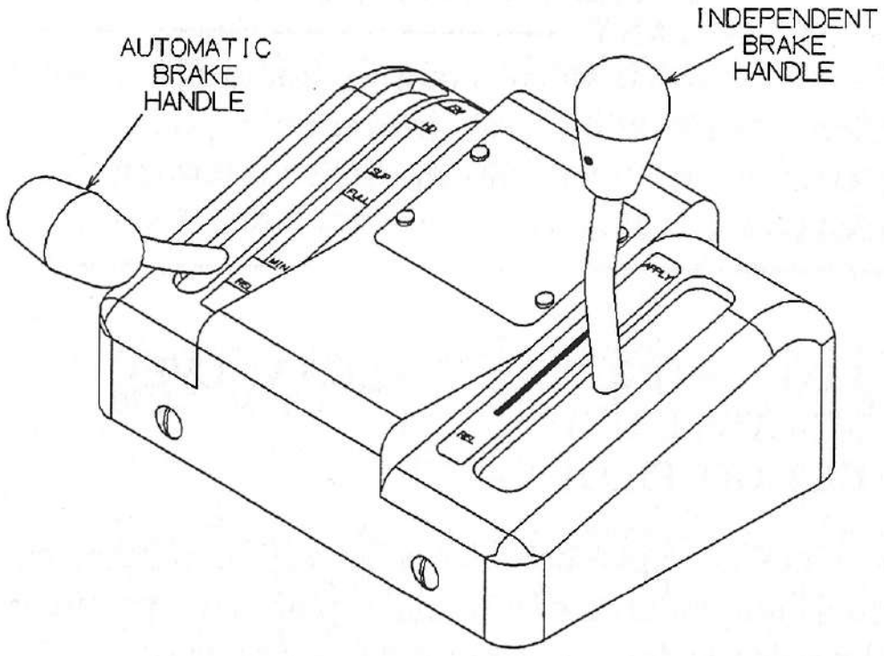


Figure 3-7.Cab Control Unit

The seven operating positions for the automatic brake valve handle are described as follows:

1. RELEASE position (**REL**) is for charging equipment and releasing the locomotive and train brakes. It is located with the handle moved to the first detent in the extreme backward position (toward the operator).

2. MINIMUM REDUCTION position (**MIN**) is located with the handle in the detent forward of the release position. With the handle moved to this position, minimum braking effort is obtained (5 to 7 psi reduction).

3. SERVICE ZONE is the sector of handle movement forward of the release position. In moving the handle forward through the service zone, the degree of braking effort is increased.

4. FULL SERVICE position (**FS**) is located by the handle in the second detent position. In this position, full service braking is obtained.

5. SUPPRESSION position (**SUP**) is located by the handle in the third detent forward of the 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 is obtained.

6. HANDLE OFF position (**HO**) is located by the handle in the fourth detent forward of the release position. This position is used when locomotive is to be used as a trailing unit or hauled DEAD in a train.

7. EMERGENCY position (**EMER**) is located by the handle in the extreme forward position (away from the operator). This position is used for emergency brake applications (with brake valve cut-in or cut-out) and for resetting after any emergency brake application has occurred.

INDEPENDENT BRAKE HANDLE

The independent brake handle is located directly to the right of the automatic brake valve handle. This handle provides independent control of the locomotive braking effort irrespective of train braking effort. The brake valve is self-lapping and will hold the brakes applied. Following is a description of the four operating positions of the handle:

1. ***RELEASE*** position (**REL**) is located with the handle moved to the extreme backward detent position (toward the operator). This position releases the

locomotive brakes, provided the automatic brake handle is also in the release position.

2. ***APPLICATION ZONE*** is sector of handle movement forward of the release position. In moving the handle forward through the application zone, the degree of locomotive braking effort is increased.
3. ***FULL APPLICATION*** position (**FULL**) is located with the handle moved to the extreme forward detent position (away from the operator). In this position, full independent brake cylinder pressure is obtained.
4. ***BAIL*** or ***ACTUATE*** function. Pushing the independent brake handle to the right, whenever the handle is in the release position, will cause the release of any automatic brake application existing on the locomotive.

   Pushing the independent brake handle to the right, when in the application zone, will release automatic application of the locomotive brakes to the value corresponding to the position of the independent brake handle.

DEAD ENGINE CUTOUT COCK :A dead engine cutout cock, located in the cab sub-base on the operator's side, is used to limit braking effort on a locomotive being hauled dead in a train. When the cutout cock is set for a dead locomotive, the pressure regulator (set at 25 psi) will charge the main reservoir at 25 psi from the brake pipe thus limiting brake cylinder pressure to 25 psi.

CAB SIGNAL ACKNOWLEDGER FOOT SWITCH

This foot switch is used to acknowledge the cab signal alerter system.

BRAKEMAN'S STATION

READING LIGHT Switch and Dimmer

This switch is on the upper console on the brakeman's side and controls the brakeman's side reading light.

#3 ICE DISPLAY SCREEN

The brakeman is provided with a third ICE display screen.

EMERGENCY BRAKE VALVE

An emergency brake valve is provided at the brakeman's station.

RADIO EQUIPMENT

A palm microphone with DTMF keypad and a radio speaker are provided.

SHORT HOOD EQUIPMENT VESTIBULE

The short hood equipment vestibule houses:

- Locomotive Speed Control And Cab Signal Cutout Switch Box

  This box is located in the short hood equipment vestibule on the engineman's side at the top left side of this compartment and contains both the Locomotive Speed Control And Cab Signal Cutout (**LSC & CS**) Switch and the Alerter Cutout Switch (**ALERTOR**).

- Train Enclosure Unit (TEU)
- ICE Blower
- Crossing Light Control Box
- Toilet
- Fusee Rack
- Ultracab II Equipment Rack
- Ultracab II Control Box

ELECTRICAL CONTROL CABINET

The electrical control cabinet, Figure 3-8, houses equipment used to power and control the locomotive.

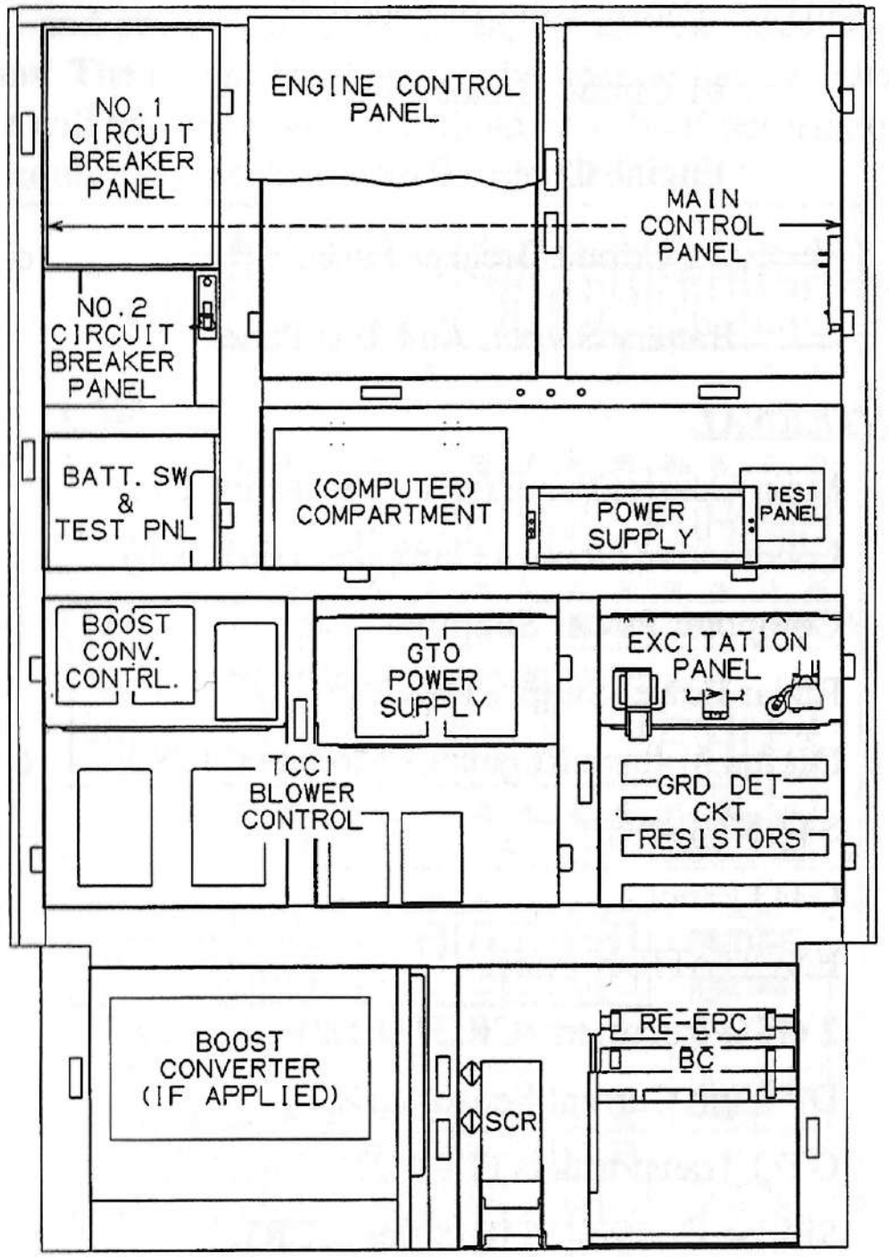


Figure 3-8. Electrical Control Cabinet.

WARNING: ***High voltage and current are present within this cabinet. Do not open a cabinet door except to access the Engineman Control panels. Refer to SAFETY PRECAUTIONS-Section 2.***

Equipment in the electrical cabinet includes -

EXTERNAL

- 4 (Engineman) Control Panels -

  #1 Circuit Breaker Panel

  Engine Control Panel

  #2 Circuit Breaker Panel

  Battery Switch And Test Panel

INTERNAL

- Main Control Panel (relays, resistors, etc.)
- Locomotive Control Computer (EM2000)
- Computer Power Supply
- Radar Power Supply PSRA
- Digital Voltage Regulator Module (DVR)
- START Panel
- GTO Panel
- EXCITATION Panel
- 2 GTO Rectifiers (CRGTO 1,2)
- DC Link Current Sensor (IDCL)
- GTO Transformers (T1-1,2)
- Silicon Controlled Rectifier (SCR)
- Battery Charging Rectifier (BC)
- GTO Power Supply (T1,CR GTO,GTO CB)
-
-

#1 CIRCUIT BREAKER PANEL

The #1 circuit breaker panel, Figure 3-9, page 3-23, contains circuit breakers and switches used in the control and protection of diesel engine and electrical systems. The circuit breakers can be operated as switches but will trip open when overloaded. A brief description of equipment on this panel is provided.

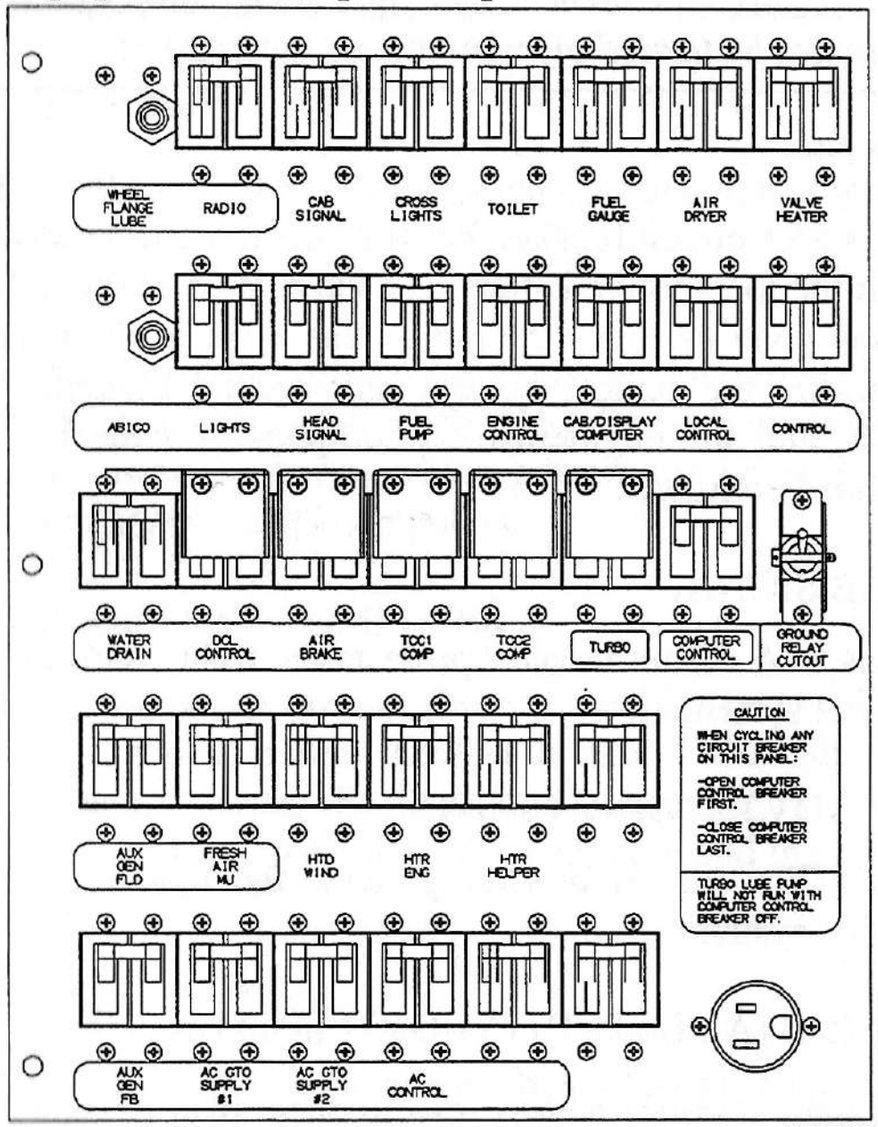


Figure 3-9. #1 Circuit Breaker Panel.

WHL FLG RAIL LUBE Switch

This switch is used to disable the wheel flange lube system for a **15 minute period**.

WHEEL FLG RAIL LUBE

This 15A circuit breaker protects the wheel flange lube system - valve panels, switches, lube controller, curve sensor, and the surge suppressor.

NOTE

The WHEEL FLANGE LUBE circuit breaker is a reset only type breaker-the wheel flange lube system ***cannot be turned off*** with this circuit breaker.

RADIO

This 15A circuit breaker, between the radio transceiver and the locomotive battery, is used to protect the radio transceiver system - the radio transceiver in the upper console, the remote control unit on the brakeman's side, and the engineman's microphone on the lower control console.

CAB SIGNAL

This 15A circuit breaker protects the train control/cab signal system.

ROAD CROSSING LIGHTS

This 20A circuit breaker protects the road crossing lights system.

ABICO (Air Brake IN Cut-Out) Circuit Breaker

Engine starting motors can reduce battery voltage below the air brake computer lowest threshold input value. ABICO circuit breaker contacts **prevent** dropping out the air brake computer due to low battery voltage while starting by providing a different battery voltage path.

LIGHTS

This breaker must be **ON** (lever up) to supply power to the switches for miscellaneous locomotive lights.

HEAD LIGHTS

This 35A circuit breaker protects the short hood and long hood headlights circuits.

FUEL PUMP

This 30A circuit breaker protects the fuel pump motor.

ENGINE CONTROL

This 30A circuit breaker protects the Electronic Unit Injection system - the Engine Interface circuit and the EUI Power Convertor which powers the primary and secondary EMDEC computers.

CAB/DISPLAY COMPUTER

This 30A circuit breaker protects the ICE system TEU blower and interface, ICE300 cabinet, CCU cab control unit, alerter, EOT antenna, emergency brake relays, AVU audio/video unit, data radio and the 3 ICE displays.

LOCAL CONTROL

This 30A circuit breaker establishes "local" (not train-lined) control with power from the locomotive battery to operate heavy switchgear, magnet valves, contactors, blowers, and the computer input/output modules.

CONTROL

This 40A breaker sets up the fuel pump and control circuits for engine starting. It is supplied battery power through the battery knife switch before an engine start. Once the engine is running, the auxiliary generator supplies power through this breaker to maintain operating control.

DATA RADIOS

This 10A circuit breaker protects the IDP data radios that broadcast locomotive control signals to remotely positioned trailing units.

DCL CONTROL

This 3A circuit breaker protects the DC Link (DCL) transfer switch motor and control circuits.

AIR BRAKE

This 10A circuit breaker connects the locomotive battery to the EPIC Air Brake Locomotive Interface.

TCC1 COMP

This 10A circuit breaker protects the traction inverter 1 (TCC1) computer and associated circuits.

TCC2 COMP

This 10A circuit breaker protects the traction inverter 2 (TCC2) computer and associated circuits.

TURBO

This breaker must be **ON** (lever up) to start engine and operate turbocharger auxiliary lube oil pump. It must remain **ON** to provide auxiliary lubrication to turbocharger at engine start and after engine shutdown. A safety guard is used over this breaker to discourage inadvertent actuations.

CAUTION

The **TURBO** breaker and the **COMPUTER CONTROL** breaker must both remain **ON** (lever up) at engine shutdown to enable turbocharger auxiliary lube oil pump operation.

COMPUTER CONTROL

This 15A circuit breaker protects the locomotive control computer (LCC) 24 VDC power supply and therefore the computer itself.

CAUTION

Both the **COMPUTER CONTROL** and **TURBO** circuit breakers must remain ON for 35 minutes after engine shutdown following load operation. This allows continued operation of the turbo lube pump to cool down the turbocharger bearings.

GROUND RELAY CUTOUT Switch

This switch disconnects the ground protection relay GR from the locomotive electrical circuits for maintenance inspections or troubleshooting. When this switch is open it cuts out the ground relay and prevents excitation of the main generator.

AUX GEN FLD

This 10A circuit breaker protects the auxiliary generator field and is equipped with two auxiliary contact sets.

FRESH AIR M/U

This circuit breaker is used to protect the cab fresh air make-up circuit - fresh air make-up switch, blower, etc. The fresh air system allows the engineman to provide a source of fresh air in the event of an air conditioner failure.

HEATED WIND

This circuit breaker protects the cab windshield defroster (heater) circuit.

ENGR AUX CAB HTR

This 15A circuit breaker protects the engineman's auxiliary cab heater.

HELPER AUX CAB HTR

This 15A circuit breaker protects the brakeman's auxiliary cab heater.

AUX GEN FB

This 10A circuit breaker protects the main generator field firing control circuit (FCD).

AC GTO #1 SUPPLY

This 15A circuit breaker protects the GTO power supply **PS GTO1** that provides the GTO DC supply input for the #1 inverter (TCC1).

AC GTO #2 SUPPLY

This 15A circuit breaker protects the GTO power supply **PS GTO2** that provides the GTO DC supply input for the #2 inverter (TCC2).

AC CONTROL

This circuit breaker protects that part of the ground relay protection system that is supplied 230 VAC from the companion alternator (CA8A) - the ground relay transductor (GRT) and the transformer (T2) that powers the ground relay bridge circuit.

PARKING BRAKE

This 5A circuit breaker protects the electric parking brake circuit.

REC 74V DC

This receptacle provides a +74 VDC output.

#2 CIRCUIT BREAKER PANEL

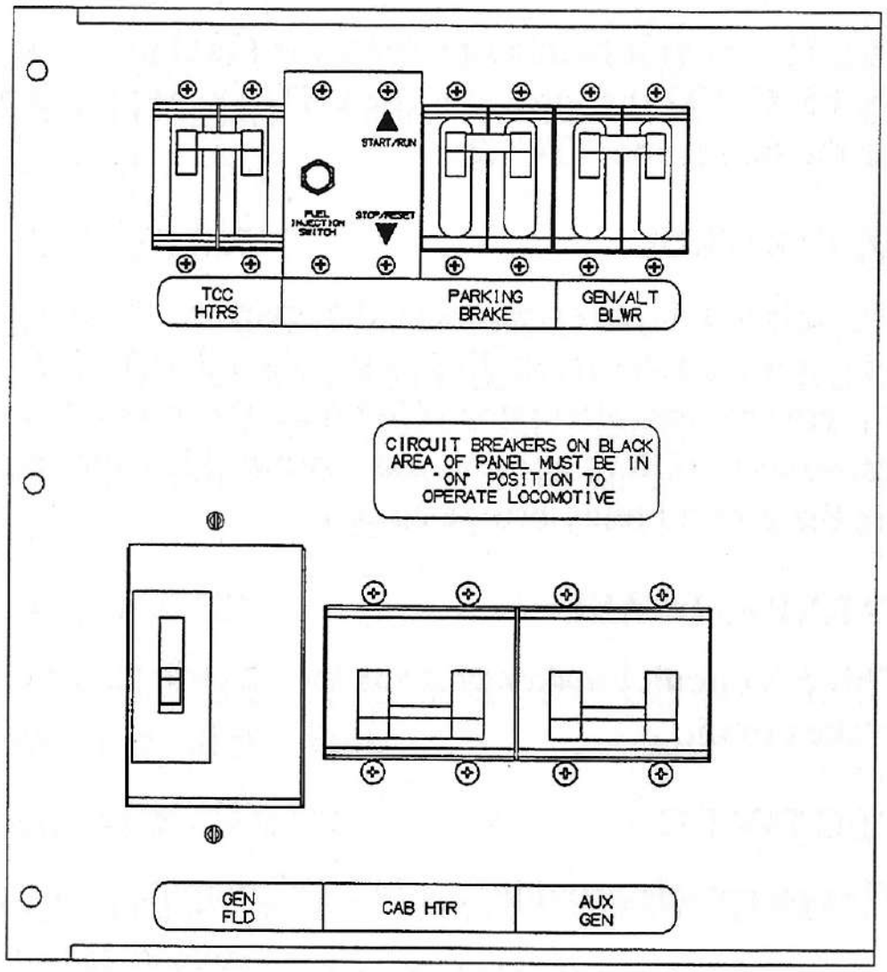
This panel, Figure 3-10, page 3-30, contains other important circuit breakers for locomotive operation.

TCC HTRS

This 50A breaker protects the TCC heater circuits.

FUEL INJECTION SWITCH

This switch, located on the #2 Circuuit Breaker Panel, is used to enable or disable the EMDEC electronic fuel injection system. The switch must be up (**START/RUN**) to start or operate the diesel engine and must be down (**STOP/RESET**) to stop the diesel engine or reset the EMDEC system.



CT38935

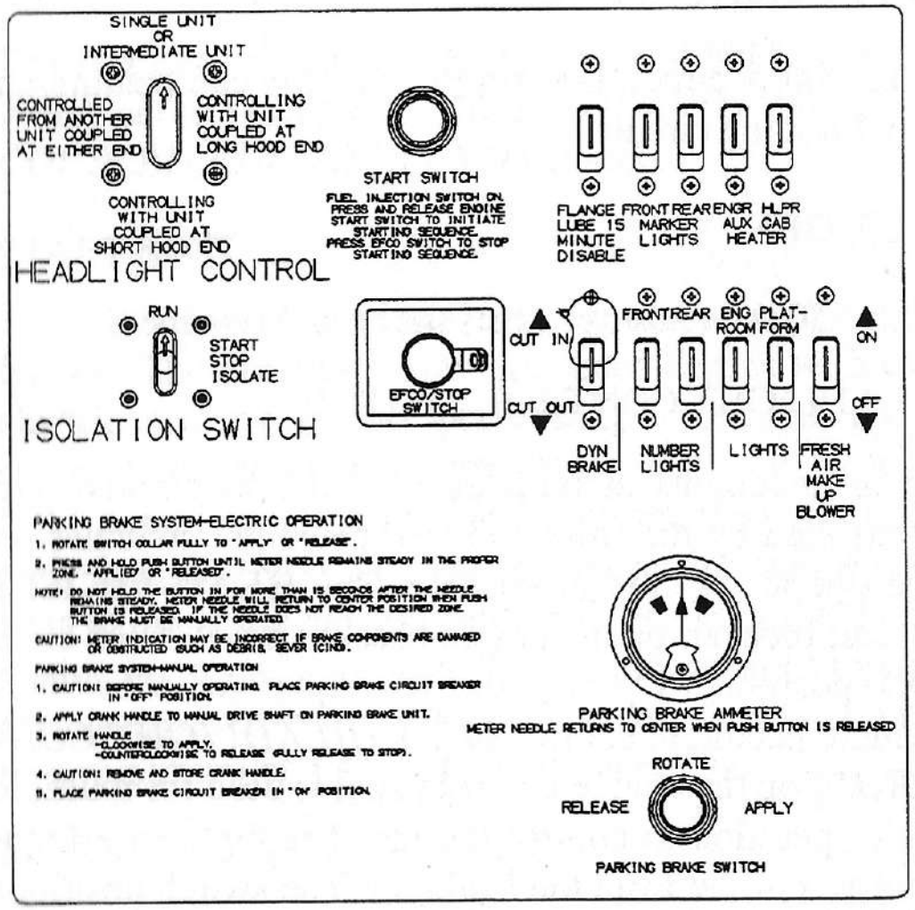
Figure 3-10.#2 Circuit Breaker Panel.

ENGINE CONTROL PANEL

Switches and indicators used by the locomotive engineman are mounted on the Engine Control Panel, Figure 3-11, and described as follows -

GEN/ALT BLWR

This 80A circuit breaker protects the generator/alternator blower circuit.



CT38941

Figure 3-11.Engine Control Panel.

GEN FLD

This 100 A circuit breaker protects the generator field circuit-the main generator receives excitation current from the companion alternator (CA8A) through silicon controlled rectifiers (SCR). This circuit breaker protects the silicon controlled rectifiers, both main and CA8A generators, the ground relay, and other associated circuitry. A current overload in the main generator field circuit causes an **EXCESSIVE GENERATOR FIELD CURRENT** message to appear on an ICE display panel. The message will disappear when field current drops to a safe level.

CAB HTR/AIR COND

This 200 A circuit breaker protects the cab heating/air conditioning circuit.

AUX GEN

This 250 A breaker protects the auxiliary generator.

HEADLIGHT CONTROL SWITCH

Twin headlights at both ends of the locomotive are controlled by the front and rear headlight switches on the operator's control console. The **HEAD LIGHTS** circuit breaker, on the circuit breaker panel, must be in ON position to power the headlight switches. This remote headlight control switch (***HEADLIGHT CONTROL***) on the engine control panel is used for multiple unit operation to control the rear headlight in a locomotive consist from the lead unit. The switch positions for each unit are set as follows:

SINGLE UNIT OR INTERMEDIATE UNIT

If operating a single locomotive or an intermediate unit between other units in a multiple unit consist, then set the switch to *SINGLE UNIT OR INTERMEDIATE UNIT* position.

If operating as a lead unit in multiple unit service with trailing units coupled to the long hood end, then set the switch to *CONTROLLING WITH UNIT COUPLED AT LONG HOOD END* position.

If operating as a lead unit in multiple unit service with trailing units coupled to the short hood end, then set the switch to *CONTROLLING WITH UNIT COUPLED AT SHORT HOOD END* position.

TRAIL UNITS

The last unit in multiple unit service should have the switch set to *CONTROLLED FROM ANOTHER UNIT COUPLED AT EITHER END* position.

START SWITCH

The Start Switch initiates the automatic engine start feature. The automatic start sequence begins with two electric starting motors performing an engine purge cycle. After the engine purge cycle has been successfully completed, the engine is automatically primed with fuel, and two air motors engage the engine ring gear to assist the electric motors in bringing the diesel engine up to starting speed. The air motors are supplied compressed air from the #1 main reservoir which must be a minimum of 130 psi to start the engine.

MARKER LIGHTS SWITCHES

These switches control the front and rear marker lights.

WHL FLNG LUBE (Disable) Switch

The wheel flange lube disable switch provides a time delayed cutout for the flange lube system - flange lube is disabled for 15 minutes after the switch is operated.

AUX CAB HEATER SWITCHES

These switches control the engineman (**ENG**) and brakeman (**HLPR**) auxiliary cab heaters.

ISOLATION SWITCH

The isolation switch is used to isolate the locomotive from other units in consist and has two positions -

- **RUN**
- **START/STOP/ISOLATE**

RUN Position : This position puts the locomotive on line after an engine start - the unit will load and respond to throttle control in a normal manner.

START/STOP/ISOLATE Position : The isolation switch must be in this position for engine start. The engine **START SWITCH** is cut out unless the isolation switch is in **START/STOP/ISOLATE**. This position also isolates the locomotive - the unit will not develop power and engine runs at idle speed in all throttle positions. This position will also silence the alarm bell in a no power or low lube oil condition but not for a hot engine alarm or traction motor bearing alarm.

EMERGENCY FUEL CUTOFF/STOP SWITCH

Press and hold this switch for one second to cause an immediate engine shutdown.

DYNAMIC BRAKE CUTOUT SWITCH

If this slide switch is moved to ***CUT OUT*** position (down), then the locomotive will not operate in dynamic brake. The locomotive will operate in power with normal air braking and no other units in consist are affected. The switch can be used to limit the number of units in a consist that will operate with dynamic braking or to cut out a unit with a defective dynamic brake system while allowing it to operate in power. This switch is normally safety wired in the ***CUT IN*** (up) position to discourage inadvertent actuations.

LIGHTS SWITCHES

Slide switches are provided for number, engineroom, and platform lights.

FRESH AIR MAKE UP BLOWER SWITCH

This switch controls the fresh air make-up blower that

is used to provide fresh air to the cab.

PARKING BRAKE Meter

This meter is used in conjunction with the Parking Brake Switch to electrically set the parking brake.

PARKING BRAKE Switch

This is a combination switch made up of a two position rotary switch and a momentary contact pushbutton switch. The rotary switch has only two positions labelled - **APPLY** and **RELEASE**.

BATTERY SWITCH AND TEST PANEL

Battery Knife Switch - This switch connects the batteries to the locomotive low voltage system and should be kept closed at all times during operation.

Test Panel - houses test points for main generator volts, alternator field amps, and alternator volts.

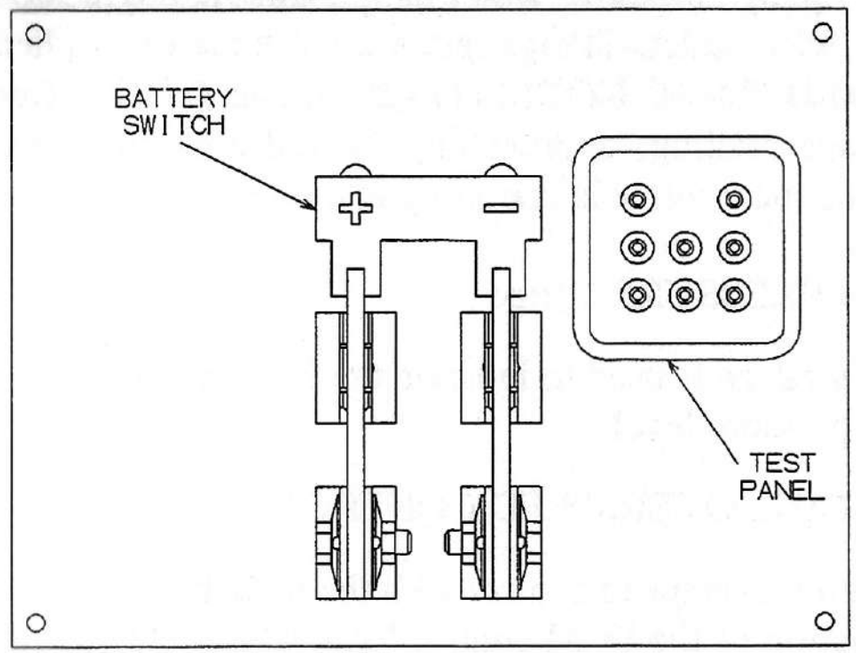


Figure 3-12.Battery Switch And Test Panel.

ENGINEROOM EQUIPMENT

Engine monitoring equipment is located in the engineroom and on the equipment rack at the front of the engine.

WATER LEVEL Sight Glass & Instruction Plate

An instruction plate is mounted next to sight gauge on the water tank. To check water level, open round valve handle at the bottom of the gauge. Read water level using the instruction plate as a gauge, then close valve. To avoid a false reading when the gauge is used the next time, drain the sight glass by means of small drain cock at the bottom of the gauge. Be sure to close drain cock after draining.

WATER TEMPERATURE Gauge

This gauge indicates water temperature at engine cooling water inlet. The gauge is color coded to indicate **COLD** (blue), **NORMAL** (green), and **HOT** (red). Gauge readings approaching the red zone may occur when locomotive is operating in a tunnel.

AIR PRESSURE Gauge

This gauge is used to indicate the No. 1 main reservoir air pressure level.

ENGINE OVERSPEED CONTROL

Engine overspeed control with the EMDEC system is a function of the ECM control logic which limits engine speed to a pre-programmed maximum. Any condition which could lead to an engine overspeed will cause the EMDEC system to reduce the fuel metering to the

injectors to maintain the maximum preset engine speed. EMDEC will not shut down the engine during such a condition unless another protected fault is detected.

MISCELLANEOUS DEVICES

MANUAL SHUTTER CONTROL Valve

The locomotive computer closes/ opens the air-operated engine cooling system radiator shutters by energizing/ de-energizing a solenoid valve that pressurizes/ exhausts air from the shutter operating cylinders.

During normal operation, this valve is set in the **OPERATION** position, which enables the computer to close the shutters by energizing the solenoid valve.

The shutters may be opened manually by moving the shutter control valve to the **TEST** position which will cut off and exhaust the air supplied by the solenoid valve, enabling spring pressure to open the shutters.

Section 4. OPERATION

This section covers recommended procedures for setup, preparation for service, and general operation of the locomotive. These procedures are briefly outlined and do not provide a detailed technical explanation of equipment. Refer to the Locomotive Service Manual for a more specific description of equipment location and operation. This section is arranged as follows -

a. Preparation For Service
   - Ground Inspection
   - Engineroom Inspection
   - Engine Inspection
   - Lead Unit Cab Inspection

b. Engine Start System Overview
c. Engine Starting Procedure
d. Stopping Engines
e. Parking Brake System
f. Parking Brake Operation
g. Trailing SD80MAC Cab Inspection
h. Various Operating Conditions

PREPARATION FOR SERVICE

GROUND INSPECTION

Check for the following:

Leakage of fuel oil, lube oil, water, or air.
Loose or dragging parts.
Proper hose connections between units in multiple.
Proper positioning of angle cocks and shut-off valves.
Air cut in to truck brake cylinders.
Satisfactory condition of brake shoes.
Fuel supply.
Proper installation of control cables between units.

ENGINEROOM INSPECTION

1. Open the doors along the sides of the locomotive long hood to access engineroom equipment. Check both Guro mechanical cold water (34-35 F) drain valves. Reset by pushing in if required.

2. Perform all engineroom inspections - check for fluid levels, valve positions and for air, oil, fuel, and water leaks. Check air compressor for proper lube oil supply. Add oil if necessary.

3. Level in water level sight gauge should be near the FULL (ENGINE DEAD) mark on the water level instruction plate.

NOTE

Recheck water level when engine is running - should be near *FULL (ENGINE RUNNING)* mark.

ENGINE INSPECTION

The diesel engine should be inspected before as well as after starting.

NOTE

EMDEC equipped engines have no mechanical governor, overspeed trip mechanism, layshaft or low water reset pushbutton.

1. Make certain that engine top deck, air box, and oil pan inspection covers are in place and closed securely.

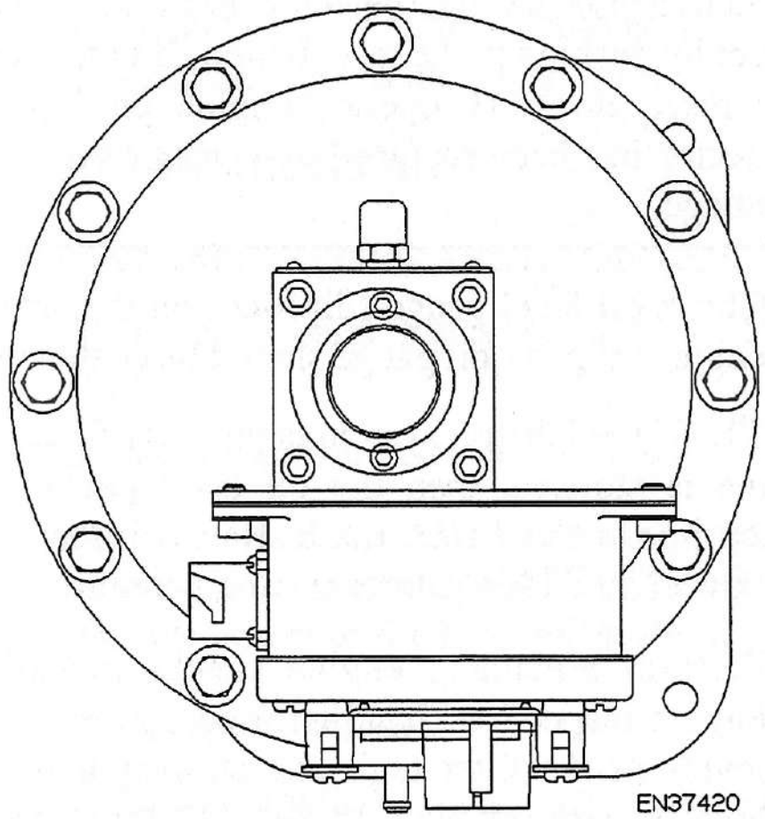


Figure 4-1. Crankcase Pressure Detector

NOTE

This crankcase pressure detector replaces the former crankcase pressure and low water pressure detector device which had two (2) reset buttons.

WARNING

Following an engine shutdown caused by actuation of the crankcase pressure detector, make no further engineroom inspections until engine has been allowed to cool off for at least two hours. The action of the pressure detector indicates the possibility of a condition within the engine that could ignite hot oil vapors with an explosive force. Do NOT attempt to restart the engine until the cause of the detector trip has been determined and corrected.

When activated, the detector must be manually reset by pushing in the reset button. If button cannot be reset, do NOT operate engine until pressure detector has been replaced as it may have internal damage.

2. Check oil level gauge (dipstick) on the side of the engine oil pan - oil gauge should be coated with oil.

NOTE: If the lube oil system is properly filled and the engine is stopped, then the oil level gauge will be coated *above* the *FULL* mark. Recheck the oil level with the engine idling at normal temperature.

3. Perform remaining engine checks including the engine inspection (handhole) covers, and lube oil levels in the filter tank and strainer housing- oil level in strainer housing should be maintained at the level of the housing overflow outlet.

4. Check that the crankcase pressure detector reset button is set (pressed in). If the button protrudes, press and hold it for five (5) seconds immediately after engine starts.

5. Check for fuel leaks at the EMDEC fuel system connections including those going to and from the 3 ECM cold plates at the front of the engine (where the governor used to be). Make sure that oil level gauge (dipstick), located on side of engine oil pan, is coated with lube oil.

LEAD UNIT CAB INSPECTION

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

On the lead or control unit, control locations should be checked and equipment positioned as follows:

#1 CIRCUIT BREAKER PANEL

- All circuit breakers in black area are ON (up).
- Verify that the Ground Relay Cutout switch is closed (up).
- Other circuit breakers are ON (up) as needed.

In addition to the circuit breakers normally placed in the **ON** position (up), close the **ENGINE CONTROL** breaker to provide power to the EMDEC system.

ENGINE CONTROL PANEL

- Parking Brake applied. Refer to "PARKING BRAKE SYSTEM," page 4-18.
- Headlight control (remote) switch set up for lead unit operation.
- Isolation switch in *START/STOP/ISOLATE* position.

#2 CIRCUIT BREAKER PANEL

- All circuit breakers in black area are ON (up).
- EMDEC Fuel Injection Switch is in **RUN**.
- CAB HEATER & AIR COND. circuit breaker in ON (up) position if needed.

BATTERY SWITCH AND TEST PANEL

- Auxiliary generator circuit breaker closed (up).
- Battery switch closed.

STARTING FUSE COMPARTMENT (located on the brakeman's side just below underframe and above fuel tank)

- Starting fuse correctly rated (400A) and installed.

ENGINE STARTING SYSTEM OVERVIEW

SD80MAC locomotives are equipped with a combination electric and air start system, with a provision for an inverter start system at a later date. Normal engine starting is with the combined air and electric system. A failure in either system can be overcome by using the ICE screens to check the status of both systems and selecting the non-faulted system for engine starting. The engine can be started using either air start only or electric start only. The starting method is selected from the EM2000 display panel. Refer to "FAILURE TO START," page 4-15. Combination starting is the default starting mode.

The engine is equipped with two electric starting motors and two air operated staring motors. The electric motors are located on the brakeman's side of the engine next to the engine flywheel ring gear, as on previous locomotive models. Two air starting motors are located on the engineman's side of the engine next to the engine flywheel ring gear. When the starting motors operate, their pinions engage the engine flywheel ring gear, then the starting motors crank the diesel engine.

Before starting, the diesel engine must be primed with fuel by operating the fuel pump. The fuel pump also operates during engine cranking (starting) and while the engine is running.

Pressing the **ENGINE START** button on the engine control panel starts the engine prime/start sequence. The prime/start sequence consist of a prime cycle, an engine start alert, then the engine start (**including**

engine purge) cycle. Once the engine prime/start cycle begins, it will continue until the engine starts, a fault occurs, or an engine stop button is pressed.

The prime cycle will last the shorter of 60 seconds or until EMDEC fuel sensors have detected sufficient fuel pressure for engine starting. Immediately after fuel priming ends, a warning will sound for 5 seconds in the engineroom to alert personnel of an impending engine start. When the warning stops, the engine start cycle will begin with engine purge and the engine should start shortly after the purge cycle.

ENGINE STARTING SETUP

After the preceding inspections have been completed, the diesel engine may be started (Close engineroom doors after engine is started). Proceed as follows:

NOTE

If engine water temperature is 10°C (50°F) or less, preheat engine before attempting to start. Prelube engine if it has been shut down for more than 48 hours. Refer to Engine Maintenance Manual for prelube instructions.

1. Put **FUEL INJECTION** Switch in **STOP**. Open cylinder test valves and bar over the engine at least one revolution. Check for leakage of fluids from test valves and notify maintenance personnel if any is observed.

2. Close cylinder test valves and return the **FUEL INJECTION** switch to the **RUN** (up) position.

NOTE

Placing the **FUEL INJECTION** switch in the **STOP** position also allows engine to be cranked without firing cylinders.

3. At the Lower Control Console, make certain that the **CONTROL & FUEL PUMP** switch is **ON** (up). The **ENGINE RUN** and **GENERATOR FIELD** switches should be **OFF** (down).

NOTE

When starting a trailing unit diesel engine, and control cables have been connected between units, the trailing unit's **CONTROL & FUEL PUMP** switch should remain **OFF** (down).

4. Check condition of the starting fuse at the Starting fuse Compartment located on the brakeman's side of the locomotive below the underframe and above the fuel tank.

5. At the Electrical Control Cabinet, check that the main battery knife switch, ground relay cutout switch and the Aux. Gen. circuit breaker are all closed. Also, make sure that all breakers in the shaded areas on the #1 and #2 circuit breaker panels are in the **ON** position (up). In addition, verify that the isolation switch on the engine control panel is in the **START/STOP/ISOLATE** position.

UPPER CONTROL CONSOLE

1. MU ENG STOP (multiple unit engine stop) switch in *RUN*.

ENGINE STARTING PROCEDURE

The starting sequence is now controlled completely by the EM2000 control computer. The engineman initiates the sequence by pressing the **START SWITCH** push-button on the Engine Control Panel in the cab. A brief description of the **normal** starting sequence follows:

1. EM2000 initiates the turbo lube pump and fuel pump. The turbo lube pump will operated for 2 minutes to build turbo prelube pressure and the fuel pump will run for 60 seconds or until sufficient fuel pressure has been established to run the engine. While this is happening the message **FUEL PRIME CYCLE IN PROGRESS-PRESS ENGINE STOP TO SUSPEND** will be displayed. At the same time, an alarm in the engineroom will sound for 5 seconds to warn personnel of the impending start. If fuel pressure does not build up in the 60 seconds the start will be aborted and the message **FUEL PRIME FAILURE - CHECK SYSTEM FOR LEAKS** will be displayed.

2. When fuel pressure is within operating limits, the message **FUEL PRIME COMPLETE - STARTING ENGINE** will appear followed by the electric starting motors pinions being engaged. If the starter pinions do not fully engage, the computer will wait for 1/2 second before retrying the sequence. If the starters still do not fully engage after the third attempt, the computer will abort the sequence, log a fault, and display the message **NO START-STARTER MOTOR ABUTMENT CONDITION, CHECK START FUSE. NOTE:** The air starter pinions are also engaged at this time even though these starters are not used.

3. As on past units, an engine purge cycle causes cranking speed to be limited by shunting starting resistors in and out of the starter circuit with the EPC contactor. Engine speed is maintained below 30 rpm until the engine has made 1.67 revolutions, then the engine cranking speed will be allowed to accelerate. If engine cranking speed acceleration falls below 5 rpm/second, assistance from the air system is required.

4. When assistance from the air system is required, the control computer will energize a starting magnet valve that provides a source of main reservoir air pressure to operate the starters if this air pressure exceeds 80 psi. **NOTE:** The Bendix mechanisms are already engaged and that the electric starting motors do not disengage, but normally work together with the air starters. If the thermal overload protection for the electric starters trips, air start will immediately be initiated, and the message **ENGINE TO BE CRANKED WITH AIR ONLY, ELECTRIC STARTER MOTOR OVERLOAD FAULT** will appear on the display.

When the engine speed exceeds 150 RPM, indicated by the engine speed pickup or companion output, all starters are disengaged to complete the sequence. **If any system fails to respond properly, or the engine fails to start, the EM2000 will abort the sequence and log a fault on the cab display**, for example:

a. If engine acceleration drops below 1/10 RPM /second with the air start engaged, the message **ENGINE START SEQUENCE ABORTED - ENGINE DID NOT START** will be displayed.

b. If main reservoir air pressure is below 80 psi when the air starters are required, an **ENGINE START SEQUENCE ABORTED - LOW AIR START PRESSURE** is displayed.

NOTE

Refer to "FAILURE TO START," page 4-15 for EM2000 procedures when a starting system failure occurs.

As on other locomotive models, it is possible to bypass the engine purge feature in case the system is malfunctioning. On an SD80MAC this is accomplished by using the starting screen on the ICE display. The screen displays the status of the electric start system, the air start system, and the engine purge control. Engine purge can be bypassed by toggling the status of purge control on the screen.

With Engine Purge control bypassed, the EPC contactor is held energized through the entire start sequence to bring cranking speed up quickly. In addition, the message **ENGINE STARTED WITH ENGINE PURGE OVERRIDDEN** is displayed and archived.

An SD80MAC is capable of starting with air alone or electric alone if a fault occurs in the other system.

If the locomotive batteries are low, it is possible to disable the electric starting system and crank the engine on the air starters only. If this mode is selected through the display, a crew and archive message **ENGINE STARTED WITH AIR MOTORS ONLY** is displayed once the engine has been started. If the air start mode has been selected and no start request is made within 5 minutes, then the system will revert to the normal starting mode.

If locomotive air pressure is low, it is possible to disable the air starting system. If this mode is selected through the display, a crew and archive message **ENGINE STARTED WTH ELECTRIC MOTORS ONLY** is displayed once the engine has been started. If the electric start mode has been selected and no start request is made within 5 minutes, then the system will revert to the normal starting mode.

NOTE: *If both start systems are disabled and a start request is made*, the message **NO START-ALL START SYSTEMS ARE DISABLED** will be displayed.

After engine starts -

Perform the normal fluid level checks with the engine running and at normal operating temperature.

CAUTION

Do **NOT** advance throttle to increase engine speed above IDLE until oil pressure is confirmed.

Engine water inlet temperature should reach 49°C (120°F) at idle before load is applied.

FAILURE TO START

If the combined engine starting system is unable to start the diesel engine due to a fault caused by a failure in either the air starting system (such as low MR) or the electrical starting system (such as dead battery), then a starting attempt can be made with the remaining start system. This can be accomplished by selecting Maintenance (**MAINT**) from an EM2000 Summary or Combined MAIN MENU screen, then selecting **Engine Start Options** which produces the Starting Options screen of Figure 4-3.

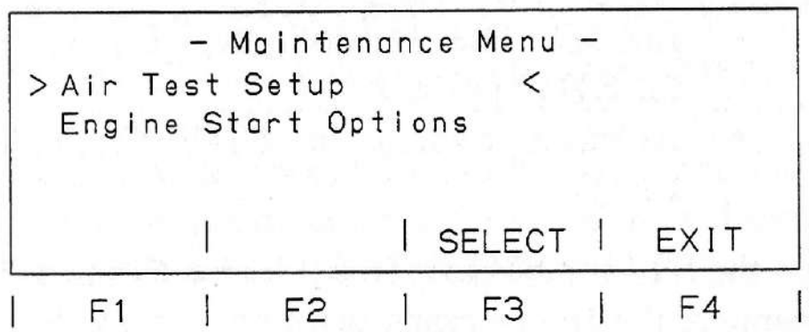


Figure 4-2. Maintenance Menu from MAIN MENU

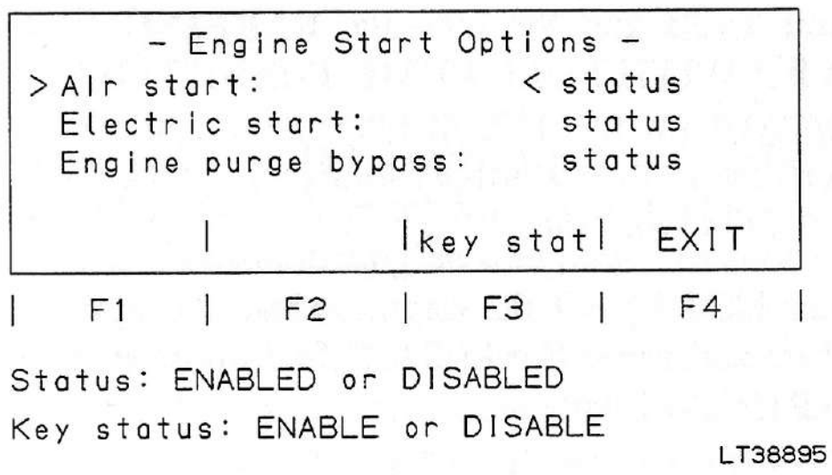


Figure 4-3. Starting Options Menu

ENGINE BLOW OUT

Although not condoned by Electro-Motive, it is common practice by some railroads to use the starter motors to "Blow Out" the engine (bar the engine over quickly with the cylinder test valves open).

NOTE: While this practice is extremely detrimental to starting motor service life, it is possible, but not recommended, to do this with an SD80MAC. To blow the engine out the following conditions must be satisfied:

- the engine must be stopped,
- Cylinder test valves open,
- EMDEC Fuel Injection switch must be in the STOP position,
- Isolation Switch in STOP/START/ISOLATE

When the **START SWITCH** on Engine Control Panel is operated, the engine crank warning alarm will sound for 5 seconds before the starters are engaged.

NOTE: In this case no air assist is used. Since the injection control switch is in STOP, there will be no prime cycle and the message **BARRING ENGINE OVER WITH FUEL PUMP TURNED OFF** will be displayed on the ICE display. During the blow out cycle, the electric starting motors will crank the engine for 1-2/3 revolutions.

After blowing out the engine, close the cylinder test valves and move the EMDEC fuel injection switch to the RUN position.

STOPPING ENGINES

EMDEC equipped engines <u>cannot</u> be shut down using safety functions of a governor or injector control lever (layshaft), as both of these mechanical devices have been eliminated. Normal engine stops can still be made using an Emergency Fuel Cut-Off (EFCO) switch or the M.U. Engine stop switch on the overhead console.

NOTE

Normal engine stops using EFCO or MU engine stop switches will cause an **EMERGENCY FUEL CUTOFF ACTIVATED** or an **MU ENGINE STOP REQUEST** message on the ICE screen.

In addition to the normal engine stop functions that have been retained, there are several new functions provided with the EMDEC equipment:

1. At the Engine Control Panel place the **FUEL INJECTION** switch in the **STOP** (down) position.
2. At the #1 Circuit Breaker Panel, place the **ENGINE CONTROL** circuit breaker in the **OFF** (down) position.

NOTE

Both the **FUEL INJECTION** switch and **ENGINE CONTROL** circuit breaker will cut off fuel injection to cause an immediate engine shut down. In addition, it is possible to switch off the **FUEL PUMP** circuit breaker to stop the engine by fuel starvation, however, this method is <u>not</u> recommended. It should only be used as an emergency stop if there is a problem stopping the engine in a normal manner.

PARKING BRAKE SYSTEM

OVERVIEW

The SD80MAC locomotive is equipped with a remote parking brake feature that allows the engineman to set the parking brake from the cab.

The parking brake system is powered by an electric motor supplied 64/74 VDC from the locomotive aux gen/battery system. The parking brake system has a separate circuit breaker on the circuit breaker panel which is independent of the battery knife switch. Controls for the parking brake are provided in the cab on the electrical control cabinet. A backup capability is provided for manual operation when electrical power is not available. The mechanical parking brake unit is located on the lead truck of the locomotive at the brakeman's side. Manual operation is accomplished from ground level at the parking brake unit.

The parking brake unit is connected to the conventional brake rigging with a short chain assembly. The parking brake actuates two brake shoes, one on each wheel, on the lead truck. Sufficient operating travel is provided to accommodate normal wear of the wheels and shoes and no special slack adjustments are necessary at the parking brake location. The parking brake unit is self locking in the position it is set; power (electric or manual) is only required to change from applied to released or vice versa.

NOTE

The parking brake draws no electrical power while in the fully applied or fully released position.

PARKING BRAKE ELECTRICAL OPERATION

WARNING

Do not operate the parking brake system electrically **with manual crank handle installed** as an injury may result.

Make certain that PARKING BRAKE circuit breaker on the #1 circuit breaker panel is in **ON** position.

Locate the Parking Brake Switch and Parking Brake Meter at the lower right side of the Engine Control Panel on the Electrical Control Cabinet.

ELECTRICAL APPLICATION

Rotate the collar of the parking brake switch fully clockwise to align the indicator mark on the collar to **APPLY**.

Press and hold the pushbutton to activate the parking brake. The meter indicator needle should deflect from center position, drop slightly, and remain off center while the parking brake applies. Hold the pushbutton until the indicator needle moves into the **APPLIED ZONE** (yellow). The parking brake is fully applied when the needle remains steady in the indicated zone.

CAUTION

Do not hold the pushbutton in for more than 15 seconds after the indicator needle remains steady.

The meter indicator needle will return to center position after the pushbutton is released. If the indicator needle does not reach the indicated zone, then manual application will be required to insure proper setting of the parking brake.

WARNING

The parking brake meter indication may be incorrect if the brake system or components are damaged or obstructed - for example by severe icing or debris. Under these circumstances, reduced or negligible parking brake holding capacity may occur. Visual verification of parking brake system actuation is recommended.

ELECTRICAL RELEASE

Rotate the collar of the parking brake switch fully counterclockwise to align the indicator mark on the collar to **RELEASE.**

Press and hold the pushbutton to release the parking brake. The meter indicator needle should deflect from center position, drop slightly, and remain off center while the parking brake releases. Hold the pushbutton until the needle moves into the indicated RELEASED ZONE (blue). The parking brake is fully released when the indicator needle remains steady in the indicated zone.

CAUTION

Do not hold the pushbutton in for more than 15 seconds after the indicator needle remains steady.

The meter indicator needle will return to center position when the pushbutton is released. If the indicator needle does not reach the indicated zone, manual release will be required to insure full release of the parking brake

WARNING

The parking brake meter indication may be incorrect if the brake system or components are damaged or obstructed - for example by severe icing or debris. Under theses circumstances, incomplete release of the parking brake can occur. Visual verification of parking brake release is recommended.

PARKING BRAKE MANUAL OPERATION

WARNING

Before manually operating the parking brake system, place the parking brake circuit breaker in **OFF** position or disconnect the parking brake motor plug from the underframe receptacle.

MANUAL APPLICATION

Locate the parking brake hand crank, P/N 40060592, and apply to the manual drive shaft of the parking brake unit located on the brakeman's side of the #1 truck (locomotive front).

Rotate the hand crank clockwise to apply the parking brake. The torque required to properly set the parking brake is 30-40 ft-lbs.

CAUTION

Do not overtighten manually as excessive forces can be generated which may damage brake equipment.

Remove and store the hand crank. Place parking brake circuit breaker in ON position or reconnect the parking brake motor plug.

MANUAL RELEASE

Locate the parking brake hand crank, P/N 40060592, and apply to the manual drive shaft of the parking brake unit located on the brakeman's side of the #1 truck (locomotive front).

Rotate the hand crank counterclockwise to release the parking brake. Rotate the hand crank until the parking brake unit shaft is fully extended to the internal stop. Maximum torque required to fully release is 20 -25 ft-lbs.

NOTE

Do not overtighten manually as excessive forces can be generated which may damage brake equipment.

Remove and store hand crank. Place **PARKING BRAKE** circuit breaker in **ON** position or reconnect the parking brake motor plug.

TRAILING SD80MAC CAB INSPECTION

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

#1 CIRCUIT BREAKER PANEL

- All circuit breakers in black area are ON (up).
- Verify that the Ground Relay Cutout switch is closed (up).
- Other circuit breakers are ON (up) as needed.

In addition to the circuit breakers normally placed in the **ON** position (up), close the **ENGINE CONTROL** breaker to provide power to the EMDEC system.

ENGINE CONTROL PANEL

- Parking Brake applied. Refer to "PARKING BRAKE SYSTEM," page 4-18.
- Headlight control (remote) switch set up for trail unit operation.
- Light switches on as needed.
- Isolation switch in *START/STOP/ISOLATE* position.

#2 CIRCUIT BREAKER PANEL

- All circuit breakers in black area are ON (up).
- EMDEC Fuel Injection Switch is in **RUN**.
- CAB HEATER & AIR COND. circuit breaker in ON (up) position if needed.

BATTERY SWITCH AND TEST PANEL

- Auxiliary generator circuit breaker closed (up).
- Battery switch closed.

STARTING FUSE COMPARTMENT (located on the brakeman's side just below underframe and above fuel tank)

- Starting fuse correctly rated (400A) and installed.

UPPER CONTROL CONSOLE

- MU ENG STOP (multiple unit engine stop) switch in *RUN*.

LOWER CONTROL CONSOLE

Move throttle/dynamic brake handle to *IDLE* (center gated position). Move reverser handle to neutral (center position) and remove the handle.

Set up EPIC brake equipment for TRAIL position in multiple consist or single unit, place handles and operate integrated display keys in the following sequence:

1. Independent fully applied.
2. Automatic handle to Full Service.

PRESS:

1. **Air Brake Setup**
2. **Lead Trail** for Trail (Cuts out Ind. & Auto. brake)
3. **Accept New**

4. Automatic handle to handle off.
5. Independent handle to release.
6. Note Brake cylinder pressure holds.

Pressing the **Exit** key returns to the function menu.

LEFT SIDE CB/SWITCH PANEL

1. Control and fuel pump switch, engine run switch, and generator field switch in off (down) position.
2. Dynamic brake circuit breaker closed (up).

STARTING TRAILING SD80MAC DIESEL ENGINES

Engines in trailing units are started in the same manner as the engine in the lead unit - refer to "ENGINE STARTING SYSTEM OVERVIEW," page 4-7.

NOTE

An important advantage of AC traction motors is that they are much more resistant to mechanical shock or other commutator related damage associated with DC traction motors. This will be seen throughout this section in such areas as eliminating the precaution of reducing throttle over rail crossings and eliminating the 10 second delay when changing between power and dynamic brake operation.
In both power and dynamic brake operation, diesel engine speed is ultimately controlled by the computer. Changes in engine speed can occur automatically, for no apparent reason, and should not be cause for alarm.

PLACING UNITS ON LINE

WARNING

Verify that the throttle/dynamic brake handle is in *IDLE* (center gated) position on all units in consist before placing a unit on line.

The control computer can modify diesel engine speed in response to certain operating conditions such as low main reservoir pressure or application of load. In these cases diesel engine speed may not be concisely related to the throttle position. After the diesel engine is started and inspected, the locomotive can be put on line by moving the isolation switch to *RUN* position.

PRECAUTIONS BEFORE MOVING LOCOMOTIVE

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

1. Make sure that main reservoir air pressure is normal.
2. Make sure that the brake system is set for LEAD/CUT-IN.
3. Check for proper application and release of air brakes.
4. Release hand brake and remove any blocking under the wheels.

CAUTION

It is desirable that engine water temperature is 120°F (49°C) or higher before full load is applied to the engine. After idling at ambient temperature below 0°F (-18°C), increase to full load level should be made gradually.

HANDLING LIGHT LOCOMOTIVE

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

1. Set the engine run switch and generator field switch in on (up).
2. Set the air brake system for LEAD/CUT-IN.
3. Set headlight and other lights on as needed.
4. Insert reverser handle and move it to the desired direction of travel, either forward or reverse.
5. Release air brakes.
6. Advance throttle 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. Reverser handle should be moved to change direction of travel only when locomotive is completely stopped.

DRAINING AIR RESERVOIRS AND STRAINERS

The air reservoirs and air strainers or filters should be drained periodically whether or not equipment is provided with automatic drain valves. Follow the maintenance schedule established by the railroad.

COUPLING LOCOMOTIVES TOGETHER

The following procedure should be observed when coupling locomotives together for multiple unit operation:

1. Couple and stretch units to ensure couplers are locked.
2. Install control cable between units.
3. Connect air brake hoses between units.
4. Perform the ground, engineroom, and engine inspections outlined in preceding sections.
5. Set cab controls for trailing unit operation as outlined in preceding sections. Remove reverser handles from all controllers to lock controls.
6. Open required air hose cutout cocks on each unit.
7. Using the automatic brake valve, apply the brakes on the consist to determine if brakes apply on each unit. Release the automatic brake valve, then make sure the brakes on each unit are released. Follow the same procedure to check the independent brake application. Also, release an automatic service application by pushing the independent brake handle to the right (automatic bail). Inspect all brakes in the consist to determine if they are released.

DYNAMIC BRAKING FOR UNITS IN CONSIST

The locomotive makes use of the voltage level from the brake control rheostat to control braking strength. This voltage level is applied to a trainlined wire to control dynamic braking strength of all units in a consist equipped for such dynamic braking control. However, the total braking effort of a multi-unit consist can become quite high. 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 using the following procedure.

PUMPING UP AIR

After cutting in air brakes on the train, note the reaction of the main reservoir air gauge. If pressure falls

below trainline pressure, pump up air as follows:

1. Set generator field switch in off position.
2. Move reverser handle to neutral position.
3. Advance throttle as needed to speed up engine and thus increase air compressor output.

BRAKE PIPE LEAKAGE TEST

For specific instructions, refer to railroad train handling rules and guidelines.

STARTING A TRAIN

The method to be used in starting a train depends upon many factors such as train type, weight, length, and amount of slack, track condition, grade, and weather conditions. Since all of these factors are variable, specific train starting instructions cannot be provided and it will therefore be up to the engineman 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.

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

Sometimes it is advisable to reduce the throttle a notch or two at the moment the locomotive begins to move in order to prevent stretching slack too quickly or to avoid slipping. When ready to start, the following general procedure is recommended.

1. Set isolation switch to *RUN* position.
2. Move reverser handle to the desired direction, either forward or reverse.
3. Set engine run and generator field switches in the on position. Release both automatic and independent air brakes.

NOTE

AC traction allows the throttle to be advanced to start the train **with the brakes applied** and wheel slip is controlled by the EM2000 not the engineman.

4. Advance the throttle one notch as required:

   a. To notch 1 - Loading will stop at a specific low value. This may be noted on the tractive effort meter. At an easy starting place the locomotive may start the train.

      NOTE

      The design of the locomotive power control system makes it unnecessary to manipulate the throttle between position notch 1 and *IDLE* during starting.

   b. To notch 2, 3, or higher until the locomotive moves. After 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 tractive effort meter as a steady reduction below that which is normally expected at full throttle for a given speed. ***Do not misinterpret this power reduction as a fault***- the wheel slip control system is maintaining power at a level within the adhesion conditions established by track and grade.

STARTING LOCOMOTIVE UP A HILL

NOTE

Unlike previous models, backwards movement of an SD80MAC while set up for forward power operation is <u>not</u> considered a fault and no power lockout occurs. If the reverser handle is moved to the position opposing locomotive travel and locomotive speed is greater than 2.5 MPH, then the control computer will apply full dynamic brakes until the locomotive comes to almost a full stop.

When starting a train going up a hill, apply independent brake and advance throttle handle until sufficient forward thrust is obtained to prevent the locomotive from rolling backwards. Release independent brake and advance throttle handle as required.

ACCELERATING A TRAIN

After the train has started, the throttle can be advanced as rapidly as desired to accelerate the train. The speed with which the throttle is advanced depends upon the demands of the schedule and the type of locomotive and train involved.

The tractive indicator provides a guide for throttle handling when accelerating a train. The pointer moves toward the right (increased tractive effort) as the throttle is advanced. As train speed increases, the pointer begins moving towards the left. At that time, the throttle may again be advanced. Thus for maximum smooth acceleration, the throttle should be advanced one notch each time the pointer begins moving toward the left until full power is reached in throttle notch 8.

Ultimately, throttle movement is controlled by the engineman's judgement. If the throttle is rapidly advanced, then because the EM2000 controls the rate of power increase, tractive effort will gradually follow until full effort is applied.

OPERATING OVER RAIL CROSSING

Note: The following procedure applies only if operating in consist with locomotives that have <u>DC</u> motors). An advantage of AC motor operation is that these motors can withstand much higher mechanical shock without damage thereby eliminating the precaution of reducing throttle over rail crossings.

When operating with a DC motor locomotive in consist at speeds exceeding 25 MPH, reduce the throttle to

No. 4 position at least 8 seconds before the locomotive reaches a rail crossing. If the locomotive is operating in No. 4 position or lower, or running less than 25 MPH, allow the same interval and place the throttle in the next lower position. Advance the throttle after all units of the consist have passed over the crossing. This procedure is necessary to ensure decay of motor and generator voltage to a safe level before the mechanical shock that occurs at rail crossings is transmitted to the motor.

RUNNING THROUGH WATER

It is recommended that the locomotive should not be operated through water deep enough to touch the bottom of the traction motors. Water any deeper than 3 inches above the rail may cause a traction motor moisture problem. When passing through any water on the rails, exercise every precaution under such circumstances and proceed slowly.

CAUTION

DC traction motor locomotives in consist must not be operated through water deep enough to touch the bottom of the motors or through water at speeds greater than 2 to 3 MPH.

WHEEL CONTROL SYSTEM

The wheel control system is two sub-systems that are directed at different powered wheel characteristics -

- Wheel Creep - is operational at all times in motoring and used to improve tractive effort under adverse rail conditions by adjusting wheel speed to maximize motor current.

The wheel creep system operates by permitting the ***fastest*** turning wheelset to rotate at a rate slightly faster than ground speed - it allows the wheels to "creep" in order to provide the most wheel traction.

- Wheel Slip - used as a backup system to the wheel creep system in the event of a failure in that system or if rail conditions are outside the parameters of wheel creep control. The wheel slip system is also operational in motoring below 1.5 MPH and in dynamic brake.

The control computer selects appropriate wheel control to suit the operating conditions and also applies sand in severe rail conditions. Operation of the wheel control system may cause the wheel slip light to flash.

WARNING

SOME FAULT CONDITIONS WHICH MAY BE DANGEROUS CAN CAUSE THE WHEEL SLIP INDICATOR LIGHT TO FLASH PERSISTENTLY OR LIGHT STEADILY. REFER TO THE FOLLOWING DATA.

WHEEL CONTROL INDICATIONS

Four conditions cause the wheel slip light to turn on. One of these, LOCKED WHEEL, is a possibly dangerous fault condition and requires immediate action by the crew. The other three, WHEEL SLIP, WHEEL SLIDE, and WHEEL OVERSPEED, do not require immediate crew action. These four conditions are as follows.

WARNING

A LOCKED POWERED OR UNPOWERED WHEEL ON A MOVING LOCOMOTIVE IS VERY DANGEROUS. IF A LOCKED WHEEL IS INDICATED, PROCEED AS DIRECTED.

1. LOCKED WHEEL. After a 10 second delay, the indicator will light continuously until fault is reset, or after the system is checked, the locked wheel detection is disabled for one or more axles through the computer display. Wheel slip light is trainlined.

   PROCEED AS FOLLOWS IF A LOCKED WHEEL IS INDICATED:

   a. STOP TRAIN.

   b. DETERMINE WHICH OF THE UNITS HAS THE "LOCKED WHEEL" INDICATION.

   c. SLOWLY ROLL THE UNIT WITH INDICATION PAST OBSERVER WATCHING FOR SLIDING WHEELS WHILE LISTENING FOR UNUSUAL NOISES FROM TRACTION MOTORS AND GEARCASES.

   d. IF ANY WHEEL SLIDES OR ANY TRACTION MOTOR OR GEARCASE MAKES AN UNUSUAL NOISE, THEN CONTACT TRAIN DISPATCHER FOR FURTHER INSTRUCTIONS.

WARNING

DO NOT UNDER ANY CIRCUMSTANCES TOW A UNIT HAVING SLIDING/LOCKED WHEELS OR MOVE SUCH A UNIT IN A LOCOMOTIVE CONSIST.

   1) IF ALL THE WHEELS ROLL FREELY AND THE TRACTION MOTORS AND GEARCASES SOUND AND LOOK OK, ATTEMPT TO RESUME OPERATION. IF FAULT INDICATION RECURS, THEN CONSULT THE TRAIN DISPATCHER BEFORE PROCEEDING.

2. WHEEL SLIP. While starting a train ***when rail conditions are exceptionally poor***, an ***occasional*** flash of the indicator light indicates normal functioning of the system's wheelslip control, which may be accompanied by automatic sanding. Throttle reduction is not required unless severe lurching threatens to break train.

NOTE

When rail conditions are poor and the locomotive is operating in power above 1.5 MPH, ***occasional, irregular flashing*** of the wheel slip light may indicate a wheel creep system failure. Operation may continue, but the condition should be reported to authorized maintenance personnel.

3. WHEEL SLIDE. While operating in dynamic brake, intermittent flashing of the indicator light indicates normal functioning of the system's wheelslide control function, which may be accompanied by automatic sanding.

4. WHEEL OVERSPEED. The indicator light will flash on and off to indicate wheel (and traction motor) overspeed, which can be caused by excessive track speed or by simultaneous slipping of all wheels. In either case, the system automatically corrects by adjusting main generator output.

LOCOMOTIVE SPEED LIMIT

The maximum speed the locomotive can be operated is determined by the gear ratio. This ratio is expressed as a double number such as 83:16. The 83 indicates the number of teeth on the axle gear and the 16 represents the number of teeth on the traction motor pinion gear.

Since the two gears are meshed together, for this ratio the motor rotor turns approximately 5.2 times for a single revolution of the driving wheels. The locomotive speed limit is therefore determined by the maximum permissible rotating speed of the motor rotor. Exceeding this maximum could cause serious damage to the traction equipment.

The overspeed protection system is provided by the ICE and EPIC systems. If an overspeed condition exists for more than ten seconds a penalty brake application will occur with a removal of traction power and a reduction of brake pipe pressure to zero psi at a service rate.

MIXED GEAR RATIO OPERATION

CAUTION

If the units of the consist are of different gear ratios, then do **NOT** operate at speeds in excess of that recommended for the unit having the lowest maximum permissible speed. Similarly, full throttle operation should never be slower than the minimum continuous speed (or maximum tractive effort) for units having established short time ratings.

DOUBLE HEADING

Prior to double heading behind another locomotive, make a full service brake pipe reduction with the automatic brake valve, and set the brake system in the LEAD/CUT-OUT mode.

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 automatic brake on this unit may be released by pushing the independent handle to the right.

OPERATION IN HELPER SERVICE

There is no basic 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. Refer to railroad operating rules and instructions.

DYNAMIC BRAKING

Dynamic braking provides a valuable assist in retard-

ing train speed in many phases of locomotive operation. With a gear ratio of 83:16 maximum dynamic braking strength is realized in a range between 0.5 to 20 MPH. At train speeds higher than the optimum, dynamic braking effectiveness gradually declines as speed increases. **Dynamic brake is operational with an inverter (truck) cut out on the other truck.**

To operate with dynamic brakes, proceed as follows:

1. The reverser handle must be positioned in the direction of locomotive movement.

   NOTE: The 10 second delay in the next item and in the following warning applies only if operating in consist with DC traction motor locomotives.

2. Return throttle to idle and wait for 10 seconds before proceeding.

3. Move the handle to the *SET UP* position. This establishes the dynamic brake control circuits.

4. After an initial application of minimum braking to bunch slack, normal service braking begins.

   WARNING
   The 10 seconds delay must be completed before the braking handle is moved to *SET UP* position. A short delay occurs automatically when the throttle is placed in idle.
   It is possible for a sudden surge or braking effort to occur on older model trailing units if the dynamic braking handle is open when the automatic delay times out.

5. Dynamic brakes assume the majority of the braking effort with supplemental air braking proportionally increased at speeds above and below the optimum dynamic braking range. Maximum dynamic braking current is automatically limited by a current limiting regulator.

6. With automatic regulation of dynamic braking strength, the brake warning light should rarely give an indication of excessive braking current.

   NOTE: The 10 second delay mentioned in the next item is only necessary if operating in consist with older (DC traction motor) model locomotives. SD80MAC locomotives do not require this delay.

7. After coming to a stop, a 10 second delay must be observed prior to moving throttle handle to a power position to allow the control contactors to reset for power mode.

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 engineman can then operate with braking effort up to the limit of the unit having the lowest brake current rating, without overloading the dynamic brake system of a trailing unit. The locomotive consist must always be operated so as not to exceed the braking current of the unit having the lowest maximum brake current rating.

NOTE

The brake warning light will come on whenever the unit is generating excessive dynamic braking current, regardless of tractive effort meter reading. When the warning light goes on, it should not remain on longer than a few seconds.

If brake warning indications are repeated, the locomotive should be taken out of dynamic braking by placing the dynamic brake (DYN BRAKE) cutout switch on the engine control panel in *CUT OUT* position. The locomotive will then operate normally under power and during braking but with reduced braking effort. If dynamic brake is not cut out and excessive braking effort continues for an extended period of time, then an automatic dynamic brake lockout will occur.

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 rating.

DYNAMIC BRAKE WHEEL SLIP (SLIDE) CONTROL

The wheel slip control system operates in dynamic brake as well as in power operation. If an inverter (TCC1 or TCC2) computer detects one of the following two conditions, then that computer will reduce braking effort on that truck and cause automatic sanding applied to the rails -

- one wheelset rotating slower than the other (on the same truck)
- all the wheels on the same truck are rotating more slowly than the radar speed

Reducing braking effort will generally correct for the slipping (sliding) wheels and when the slip (slide) is over, braking effort will be restored to the former level. Automatic sanding continues for 3 to 5 seconds after the wheel slip is corrected.

ISOLATING A UNIT

When it is necessary to isolate a locomotive unit, observe the following:

1. When operating in power in a multiple unit consist, 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 throttle/dynamic brake handle in the lead unit to *SETUP/IDLE*. The isolation switch can then be moved to *START/STOP/ISOLATE* position to eliminate the braking on that unit. If the braking is resumed, other units will function normally.

ISOLATING AN INVERTER

Most inverter fault conditions will cause a fault message to be displayed. Inverter problems fall into three general classifications based on severity of the fault and engineman response -

minor faults - the computer can correct for the fault by lowering excitation and resets the fault automatically.

intermediate faults -

- engineman must reset the fault by moving the throttle to *IDLE* and set up for normal operation.
- engineman must reset the fault condition through the display. Refer to FAULT RESET in Section 5 - TROUBLESHOOTING.

major faults - the computer will lock out the inverter and the engineman must request an inverter (traction) cutout as follows.

Either one of the 2 inverters can be cut out by first selecting the **TRACTION CUTOUT** screen on the EM2000 main menu. This screen will display the status; either **ENABLED** or **DISABLED** for each inverter. Each inverter can be "toggled", or changed from one state to another, by using the ICE keypad and following the instructions on the screen. Toggling an inverter will cause an on-line inverter to go to the cut-out state, and, a cut-out inverter to go to an on-line state.

NOTE

Cutting out an inverter takes a few seconds for the computer to accomplish. A message on the screen will indicate when the cutout operation has been performed.

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

Set up EPIC brake equipment for **TRAIL** position in multiple consist or single unit, place handles and operate integrated display keys in the following sequence:

1. Independent fully applied.
2. Automatic handle to Full Service.

PRESS:

1. **Air Brake Setup**
2. Lead Trail for Trail (Cuts out Ind. & Auto. Brake)
3. **Accept New**
4. Automatic handle to handle off.
5. Independent handle to release.
6. Note Brake cylinder pressure holds.

Pressing the Exit key returns to the function menu.

7. With the throttle/dynamic brake handle in *IDLE*, set the reverser handle in neutral position, then remove it to lock the controls.
8. Set all switches in the off position. Make certain that the control and fuel pump switch, generator field switch, and engine run switch are in off position.
9. At the engine control panel, set remote headlight control switch in proper position for trailing unit operation. Place other switches on as needed.
10. At the circuit breaker panel and circuit breaker compartment, all circuit breakers in the black area

are to remain in the on(up) position.

11. After completing the operations outlined in the preceding steps, move to the cab of the new lead unit.

ON END BEING CUT IN

1. At the left side CB/switch panel make certain the generator field switch is OFF (down).
2. Insert reverser handle and leave in neutral position.

Set up EPIC brake equipment for **LEAD** position in multiple consist or single unit, place handles and operate integrated display keys in the following sequence:

1. Independent handle to Full Application.
2. Automatic handle to release.

PRESS:

1. **Air Brake Setup**
2. **Lead Trail** for Lead (Cuts in independent)
3. **Accept New** (Equalizing Res. increases)
4. **Air brake Setup**
5. Cut in cut out for Cut in (Cuts in Auto)
6. **Accept New**

If Equalizing Res. must be adjusted:

7. **Air Brake Setup**
8. **EQ Res Setup**

Use preset key for 80, 90, 100, or 110

9. **Enter**
10. **Accept New**

11. At the circuit breaker panel and circuit breaker compartment, make certain that all circuit breakers in the black area are in ON (up) position.
12. At the engine control panel, set the remote headlight control switch in proper position and set other switches on as needed.
13. Set the engine run, control and fuel pump, and generator field switch in ON (up) position and other switches ON (up) as needed.

STOPPING ENGINES

EMDEC equipped engines <u>cannot</u> be shut down using safety functions of a governor or injector control lever (layshaft), as both of these mechanical devices have been eliminated. Normal engine stops can still be made using an Emergency Fuel Cut-Off (EFCO) switch or the M.U. Engine stop switch on the overhead console.

> **NOTE**
> Normal engine stops using EFCO or MU engine stop switches will cause an **EMERGENCY FUEL CUTOFF ACTIVATED** or an **MU ENGINE STOP REQUEST** message on the ICE screen.

In addition to the normal engine stop functions that have been retained, there are several new functions provided with the EMDEC equipment:

1. At the #2 Circuit Breaker Panel place the **FUEL INJECTION** switch in the **STOP** (down) position.
2. At the #1 Circuit Breaker Panel, place the **ENGINE CONTROL** circuit breaker in the **OFF** (down) position.

NOTE

Both the **FUEL INJECTION** switch and **ENGINE CONTROL** circuit breaker will cut off fuel injection to cause an immediate engine shut down. In addition, it is possible to switch off the **FUEL PUMP** circuit breaker to stop the engine by fuel starvation, however, this method is not recommended. It should only be used as an emergency stop if there is a problem stopping the engine in a normal manner.

FREEZING WEATHER PRECAUTIONS

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

Whenever the engine is shut down, and freezing temperatures are possible, the cooling system, as well as the flush toilet and the water cooler, should be drained or otherwise protected from freezing.

DRAINING THE COOLING SYSTEM

When necessary to drain the cooling system, open the engine water drain valve located at the pit between the engine and accessory rack. This valve will drain the engine, water tank, and water cooled air compressor and associated piping.

CAUTION

When draining a hot engine, always allow the engine to cool before refilling with coolant.

DRAIN FLUSH TOILET

Not necessary-toilets have antifreeze.

DRAIN WATER COOLER

TOWING LOCOMOTIVE IN TRAIN

The computer air brake system requires battery power to operate, therefore if the locomotive is shipping without the engine running, the air brake circuit breaker must be opened as part of the setup procedure to protect the locomotive batteries. With the air brake circuit breaker open, all brake system operation will be under control of the pneumatic backup system.

NOTE

The computer brake system is connected on the battery side of the knife switch, therefore the air brake circuit breaker must be opened to isolate the brake system from the locomotive batteries.

When a locomotive equipped with electronic air brakes is to be towed in a train, control and air brake equipment should be set as follows:

3. Move automatic brake handle to handle off position.
4. Move independent handle to release position.
5. If the locomotive is to be shipped **with the engine running,** then set the air brake system for LEAD/CUT-OUT and make certain the AIR BRAKE circuit breaker is closed.
6. If the locomotive is being shipped **without the engine running,** then open the AIR BRAKE circuit breaker and silence the alarm by operating the CONTROLS function key on the #1 ICE screen which provides a menu with an BRK ALM SILENCE function key. Operating this function key silences the alarm. If the locomotive is being shipped with the engine running, then the AIR BRAKE circuit breaker should remain closed.
7. Close the brakeman's emergency brake valve.
   a. Isolate all safety control devices if possible.
   b. Open all brake cylinder cut out cocks.
   c. Open all end connection cut out cocks.
8. Manually override the compressor control magnet valve if the locomotive is to be shipped running.
   a. Open the dead engine cut out cock.
   b. Due to air compressor clutch the engine must be shut down before draining main reservoir. Open main reservoir drain valves to drain main reservoir pressure to approximately 20 psi.
   c. Close main reservoir drain valves.

CAUTION

If there is danger of freezing, the engine cooling system should be drained. Refer to "FREEZING WEATHER PRECAUTIONS," page 4-49.

9. IF ENGINE IS TO REMAIN IDLING, switches should be positioned as follows:
   a. Isolation switch in *START/STOP/ISOLATE*.
   b. Battery switch and ground relay cutout switch closed.
   c. Generator field circuit breaker OFF (down).
   d. All breakers in black area of circuit breaker panels in ON (up) position.
   e. Control and fuel pump switch ON (up).
   f. Fuel pump circuit breaker ON (up).
   g. Throttle/dynamic brake handle in *IDLE*.

Remove reverser handle from controller to lock controls.

TOWING SD80MAC DEAD IN CONSIST

If a locomotive is to be towed DEAD IN CONSIST, control equipment should be positioned as follows:

1. If locomotive is to be towed with all MU hoses connected to the consist, then normal set up of the brake system for TRAIL operation is required.

2. If the locomotive is to ship without main reservoir equalizing, independent application and release, and actuating MU hoses connected to the consist, then set up the locomotive as described in Towing Locomotive Dead In Train.

WARNING

When towing a dead locomotive -

- The dead unit must be connected for MU operation.
- The battery switch must be **closed** ***and both CONTROL and COMPUTER CONTROL circuit breakers must be ON (UP) to power the traction motor temperature sensors.*** An overheated motor will cause the temperature sensors to provide a message on the display screen in the affected unit and a trainlined alarm signal to all units in consist.
- ***TCC1 COMPUTER and TCC2 COMPUTER circuit breakers must also be ON (up) to detect an unpowered locked wheel and alert the operator of this potentially dangerous condition.***

3. Battery switch closed.
4. All circuit breakers OFF (down) ***except*** COMPUTER CONTROL, CONTROL, TCC1 COMPUTER, and TCC2 COMPUTER which must be ON (up). Refer to previous WARNING.
5. All control switches OFF.
6. Starting fuse removed.
7. Throttle/dynamic brake handle in *IDLE* position. Remove reverser from controller to lock the controls.
8. MU jumper cables must be installed on dead unit.

NOTE

If there is danger of freezing, the engine cooling system should be drained. Refer to Freezing Weather Precautions in this section.

LEAVING LOCOMOTIVE UNATTENDED

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. Isolate the unit.
3. Set engine run and generator field switches in the off (down) position.
4. Set throttle/dynamic brake handle in *IDLE* position. Remove reverser handle from controller to lock controls.
5. Set air brakes.
6. Set parking brake.

Section 5. TROUBLESHOOTING

This section provides some basic troubleshooting information pertaining to an SD80MAC locomotive. Many troubleshooting procedures can be performed through the ICE display. Major subsystems such as the EM2000 locomotive control computer, electronic air brake, and distributed power, are correlated through the ICE Cab Consolidation Computer and displayed on the ICE screens. Locomotive fault and operating conditions detected by the EM2000 computer are displayed automatically on ICE and can be addressed using the EM2000. The EM2000 can be accessed by pressing the **LOCO DATA** key on the #2 ICE (SUM) screen. Some typical fault and operating conditions and their recommended responses are listed below.

The main areas of concern have been prioritized in the following order.

1. NO ELECTRICAL POWER
2. NO ICE SCREENS
3. ENGINE WONT START
4. ENGINE WONT LOAD
5. ENGINE WONT PRODUCE FULL POWER
6. ENGINE SHUT DOWN

MISCELLANEOUS FAULT CONDITIONS

NO ELECTRICAL POWER

Problem	*Solution*
Battery switch open	Close battery switch
Open circuit breakers	Close circuit breakers
No battery power	Check battery cables and connnections

NO ICE SCREENS

Problem	*Solution*
CAB/DISPLAY COMPUTER circuit breaker open	Close circuit breaker

NOTE: No other engineman related procedures can be performed in this system.

ENGINE WONT START

Problem	*Solution*
Starting fuse blown	Replace fuse
Engine purge circuit breaker is open	Close circuit breaker
Main reservoir air pressure less than 80 psi.	• Change to all electric start through the EM2000 computer. Refer to "ENGINE WONT START," page 5-13. **OR** • Connect locomotive main reservoir to other unit main reservoir
Low Battery Voltage	Bypass purge cycle from engine start routine with the EM2000 computer
Low Battery Voltage	Try air start only

UNIT WONT LOAD

Problem	*Solution*
REVERSER HANDLE IS CENTERED message	Position reverser handle.
NO LOADING message	Check if both TCCs (inverters) are cut out - try cutting in a TCC
Generator Field switch is down	Position Generator Field switch UP.
GROUND RELAY LOCKED OUT message	15 seconds after a ground occurs the EM2000 will automatically reset the ground relay. The EM2000 will then reset GR 2 more times within a 5 minute period and then lock it out. Once GR is locked out it can only be reset with the EM2000 through the ICE display.
NO LOAD - PCS OPEN message, penalty or emergency brake application and loss of power, no motoring or dynamic brake, diesel engine limited to TH1 speed.	Move throttle to IDLE. Move automatic brake handle to Emergency (**EMER**) and wait 45 seconds, then to release (**REL**) position.

UNIT WONT FULL LOAD

Problem	*Solution*
REDUCED LOAD-TH6 LIMIT message: Clogged air filters, Hot Engine	Try to reset
FAILED TRACTION MOTOR BLOWER message	Try to reset.
TRACTION MOTOR BLOWER #n CIRCUIT BREAKER IS NOT CLOSED message	Close breaker
REDUCED DYNAMIC BRAKE - GRID OVERCURRENT message	Reduce dynamic brake handle position immediately. Reset the fault through ICE. If fault occurs again, then cut out dynamic brake with the **DYN BRAKE** switch on the Engine Control Panel.

ENGINE SHUT DOWN

Problem	*Solution*
	Check fuel supply
NOTE: Some of the the following messages are provided to the EM2000 locomotive computer from the EMDEC system computer.	
ENGINE SHUTDOWN - ENGINE OIL PRESSURE	Check engine oil level. Toggle **ENGINE CONTROL** circuit breaker and try restarting engine.
NO LOAD - ENGINE PROTECTION SHUTDOWN	Toggle **ENGINE CONTROL** circuit breaker and try restarting engine.
ENGINE SHUTDOWN - ENGINE OIL TEMPERATURE	Toggle **ENGINE CONTROL** circuit breaker and try restarting engine.
ENGINE SHUTDOWN - ENGINE CRANKCASE PRESSURE	Reset crankcase pressure detector. Refer to figure 4-1 on page 4-3.
ENGINE SHUTDOWN - ENGINE COOLANT PRESSURE	Check coolant level. Reset fault through EM2000 .

MISCELLANEOUS FAULT/OPERATING CONDITIONS

Problem	*Solution*
Low ambient temperatures and **ENGINE SPEED INCREASE - TCC #n PREHEAT** message	Normal operation: TCC computer requests EM2000 for diesel engine speed increase - provide greater CA8A companion alternator power to be available for TCC heating.
ENGINE SPEED MINIMAL message	Locomotive could be isolated - move Isolation Switch to **RUN** position.
Ground relay manual reset	The ground relay must be manually reset if ground relay lockout has occurred. The reset can be performed only through the EM2000 on the ICE display.
No Dynamic Brake	Dynamic Brake Switch (**DYN BRAKE**) on Engine Control Panel could be in **CUT OUT**. Position to **CUT IN**.

MISCELLANEOUS FAULT/OPERATING CONDITIONS

Problem	*Solution*
Slow Speed Control fault	Reset COMPUTER CONTROL circuit breaker and run the Slow Speed Self Test.

HVAC NOT HEATING OR COOLING

Problem	*Solution*
If fan blows at all speeds and settings with no heating or air conditioning	HVAC needs to changed out. HVAC has a two hour time out. Turn unit off and turn back on to reset. If HVAC filters are plugged, then unit will heat for a while and then trip the circuit breaker. Operate reset button inside the control panel of the unit itself near the power cables and turn unit back on.

SLIPPED PINION

Problem	*Solution*
Slipped Pinion Suspected	Make a full set on the air system. Go to throttle 1 or 2 Stall Test. Check under Creep Control screen for TMRPMs. If all show 0 (zero) except one, then that pinion is slipping.

The following steps need to be followed to avoid constant wheel slip with a slipped pinion:

a. Disable the TCC with the defective pinion.
b. Disable the Locked Wheel Detection on the locked wheel detection screen.

Problem	Solution

ENGINE WONT START

1. Check starting fuse in starting fuse compartment located above the fuel tank on the brakeman's side just below the underframe.

2. Make certain that ENGINE PURGE circuit breaker is closed. Engine purge is performed as part of the automatic engine start routine every time the Engine Start Switch is operated. A fault in the engine purge circuit could prevent the diesel engine from starting. The engine purge cycle can be bypassed through the **Engine Start Options** ICE screen shown below. Also refer to "FAILURE TO START," page 4-15.

```
        - Engine Start Options -
>Air start:                  < status
 Electric start:               status
 Engine purge bypass:          status

          |          |key stat|  EXIT
|   F1   |   F2   |   F3   |   F4   |
```

Status: ENABLED or DISABLED
Key status: ENABLE or DISABLE

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3. **ENGINE DEAD - LOCOMOTIVE NOT ISOLATED** message.

   Isolate unit and press Engine Start Switch.

4. Engine Start Switch produces no starting attempt and MR LESS THAN 80 PSI.
   a. Change engine start options screen to Electric Start.
      OR
   b. Supply main reservoir air from another locomotive.

DISABLE OR ENABLE A TRUCK

A failure of the a traction motor blower or an inverter will produce a crew message such as **TRACTION MOTOR BLOWER #1 IS NOT TURNING**. If the CUT OUT function key (*F2*) on the ***CREW MESSAGE*** screen is operated, then the screen will change to the ***TRACTION CUTOFF*** screen to allow the appropriate truck to be *cut out*.

1. The **CUT OUT** indication will be illuminated (*above F3*) on the ***CREW MESSAGE*** screen displaying the fault message.

2. Press the CUT OUT function key (*F3*) to bring up the Traction Status screen.

   Note: The ***TRACTION CUTOFF*** screen can also be accessed directly from the ***MAIN MENU*** screen by selecting the **Traction cut out** option.

3. On the ***TRACTION CUTOFF*** screen the "key stat" function key (*F3*) can be designated as - ENABLE or DISABLE for a faulted inverter or truck blower.

   Changing the page and/or moving the cursor to the desired truck causes the function key to indicate the state of that device.

4. The status of the truck is displayed.

5. If the cursor is at *Truck 1:* and truck 1 is ENABLED, then only **DISABLE** and **EXIT** are available (illuminated) since this truck is already enabled.

6. Press **DISABLE** key (*F3*) to cut out the # truck.

During the cutout process, the truck status will change to TRANSFER while the cut out is in process.

Note: No other keys will be available while this message is displayed.

If the cutout process is successful, Truck 1 status will change to **DISABLED** on the display.

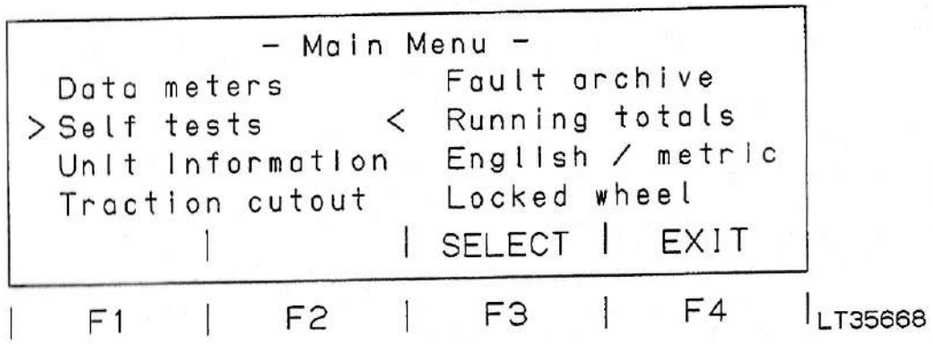

Figure 5-1. Main Menu.

FAULT RESET

A typical EM2000 fault crew message is shown in Figure 5-2 where a grid overcurrent fault is annunciated by the message **REDUCED DYNAMIC BRAKE - GRID OVERCURRENT.**

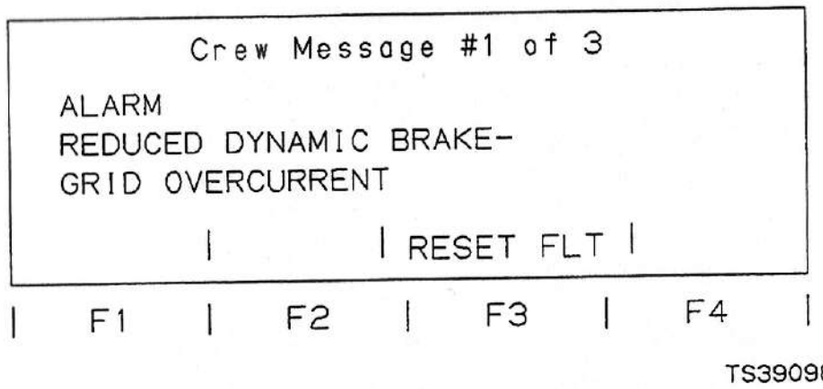

Figure 5-2. Typical Fault Crew Message.

9301 W. 55th Street
La Grange, IL 60525
Telex: 270041 McCook, IL
Cable: ELMO DIV La Grange, IL
Telephone: 708-387-6000