New York Air Brake
CCB Brake System

GMC/EMD CONTRACT
CCB BRAKE EQUIPMENT
MAINTENANCE MANUAL

IP-165-C

For the
GT 46 MAC LOCOMOTIVE

Operated by

INDIAN RAILWAYS

AUGUST 2011

Supersedes March 2000
### LIST OF EFFECTIVE PAGES

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<td>ABCB</td>
<td>Air Brake Circuit Breaker</td>
</tr>
<tr>
<td>AD</td>
<td>Analog to Digital</td>
</tr>
<tr>
<td>AE1</td>
<td>Automatic Emergency Switch NO. 1, N.C.</td>
</tr>
<tr>
<td>AE2</td>
<td>Automatic Emergency Switch NO. 2, N.O.</td>
</tr>
<tr>
<td>AP</td>
<td>Automatic Variable Handle Potentiometer</td>
</tr>
<tr>
<td>AR</td>
<td>Automatic Release Switch, N.O.</td>
</tr>
<tr>
<td>AW4-ER</td>
<td>Analog Converter Equalizing Reservoir</td>
</tr>
<tr>
<td>AW4-16</td>
<td>Analog Converter 16 Pipe (control Pipe)</td>
</tr>
<tr>
<td>BAN</td>
<td>Battery Negative</td>
</tr>
<tr>
<td>BAP</td>
<td>Battery Positive</td>
</tr>
<tr>
<td>BC</td>
<td>Brake Cylinder</td>
</tr>
<tr>
<td>BCCO</td>
<td>Brake Cylinder Cut-Out Pressure Switch</td>
</tr>
<tr>
<td>BCEP</td>
<td>Brake Cylinder Equalizing Pipe</td>
</tr>
<tr>
<td>BCEV</td>
<td>Brake Cylinder Equalizing Valve</td>
</tr>
<tr>
<td>BCT</td>
<td>Brake Cylinder Transducer</td>
</tr>
<tr>
<td>BEA</td>
<td>Binary Input Output</td>
</tr>
<tr>
<td>BO1</td>
<td>Bail Off Switch, Automatic</td>
</tr>
<tr>
<td>BO2</td>
<td>Bail Off Switch, Independent</td>
</tr>
<tr>
<td>BP</td>
<td>Brake Pipe</td>
</tr>
<tr>
<td>BPA</td>
<td>Brake Pipe Flow Indicator Port 2</td>
</tr>
<tr>
<td>BPCO</td>
<td>Brake Pipe Cut-Off Valve</td>
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<td>BPDE</td>
<td>Brake Pipe Dead Engine</td>
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<tr>
<td>BPG</td>
<td>Brake Pipe Gauge Port</td>
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<tr>
<td>BPPS</td>
<td>Brake Pipe Pressure Switch</td>
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<td>BPT</td>
<td>Brake Pipe Transducer</td>
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<tr>
<td>C1</td>
<td>Choke</td>
</tr>
<tr>
<td>C2</td>
<td>Choke</td>
</tr>
<tr>
<td>CCB</td>
<td>Computer Controlled Brake</td>
</tr>
<tr>
<td>°C</td>
<td>Degree Centigrade</td>
</tr>
<tr>
<td>COC</td>
<td>Cut Off Cock</td>
</tr>
<tr>
<td>COMM</td>
<td>Communications</td>
</tr>
<tr>
<td>Cont</td>
<td>Controller</td>
</tr>
<tr>
<td>COR</td>
<td>Cut-Out Relay</td>
</tr>
<tr>
<td>CP</td>
<td>Central Processor</td>
</tr>
<tr>
<td>CRU</td>
<td>Computer Relay Unit</td>
</tr>
<tr>
<td>CU IN</td>
<td>Cubic Inch</td>
</tr>
<tr>
<td>DB1</td>
<td>Magnet Valve Driver Board PCB</td>
</tr>
<tr>
<td>DB2</td>
<td>Relay Driver PCB</td>
</tr>
<tr>
<td>dc</td>
<td>Direct Current</td>
</tr>
<tr>
<td>DCV</td>
<td>Double Check Valve</td>
</tr>
<tr>
<td>DI</td>
<td>Diagnostic PCB</td>
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<tr>
<td>ELV</td>
<td>Emergency Limiting Valve</td>
</tr>
<tr>
<td>EMER</td>
<td>Emergency</td>
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<tr>
<td>EPA1</td>
<td>Automatic Application Analog</td>
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<td>ER</td>
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<td>ERG</td>
<td>Equalizing Reservoir Gauge Port</td>
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<td>Equalizing Reservoir Transducer</td>
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<tr>
<td>EX</td>
<td>Exhaust</td>
</tr>
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<td>EXH</td>
<td>Exhaust Magnet Valve</td>
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<tr>
<td>ES</td>
<td>Emergency Sand</td>
</tr>
<tr>
<td>Fig</td>
<td>Figure</td>
</tr>
<tr>
<td>FLT</td>
<td>Flow Transducer</td>
</tr>
<tr>
<td>FOJ1</td>
<td>Automatic Fiber Optic External Connector</td>
</tr>
<tr>
<td>FOJ2</td>
<td>Independent Fiber Optic External Connector</td>
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<tr>
<td>FOR</td>
<td>Fiber Optic Receiver</td>
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<tr>
<td>FS</td>
<td>Full Service</td>
</tr>
<tr>
<td>ft-lbs</td>
<td>Foot Pounds</td>
</tr>
<tr>
<td>FVG</td>
<td>Flow Indicator Port 1</td>
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<tr>
<td>HO</td>
<td>Handle Off</td>
</tr>
<tr>
<td>IBS</td>
<td>Independent Brake Switch</td>
</tr>
<tr>
<td>ID</td>
<td>Inside Diameter</td>
</tr>
<tr>
<td>IM</td>
<td>Independent Maximum Applied Switch, N.O.</td>
</tr>
<tr>
<td>I/O</td>
<td>Input/Output</td>
</tr>
<tr>
<td>IP</td>
<td>Independent Variable Handle Potentiometer</td>
</tr>
<tr>
<td>IPS</td>
<td>Iron Pipe Size</td>
</tr>
<tr>
<td>IR</td>
<td>Independent Release Switch, N.O.</td>
</tr>
<tr>
<td>J1-J11</td>
<td>PCB Internal Connectors</td>
</tr>
<tr>
<td>K1ES</td>
<td>Sanding Relay</td>
</tr>
<tr>
<td>K2IBS</td>
<td>Extended Dynamic Range Cut-Out Relay</td>
</tr>
<tr>
<td>K3BCPS</td>
<td>Dynamic Brake Cut-Out Relay (Spare)</td>
</tr>
<tr>
<td>K4RLIS</td>
<td>Rail Lubrication Relay (Spare)</td>
</tr>
<tr>
<td>K5COR</td>
<td>PCR Cut-Out Relay</td>
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<tr>
<td>K6SPOT</td>
<td>Spotted Relay</td>
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<tr>
<td>K7BOBU</td>
<td>Bail Off Back Up Relay</td>
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<tr>
<td>K12VA</td>
<td>Brake Failure Alarm Relay</td>
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<tr>
<td>KE</td>
<td>Distributor Valve</td>
</tr>
<tr>
<td>kN</td>
<td>Kilo Newtons</td>
</tr>
<tr>
<td>L</td>
<td>Liter</td>
</tr>
<tr>
<td>lbs</td>
<td>Pounds</td>
</tr>
<tr>
<td>mm</td>
<td>Millimeter</td>
</tr>
<tr>
<td>MIN</td>
<td>Minimum</td>
</tr>
<tr>
<td>MR</td>
<td>Main Reservoir</td>
</tr>
<tr>
<td>MRDE</td>
<td>Main Reservoir Dead Engine</td>
</tr>
<tr>
<td>MREP</td>
<td>Main Reservoir Equalizing Pipe</td>
</tr>
<tr>
<td>MRET</td>
<td>Main Reservoir Equalizing Pipe Cut-Off Transducer</td>
</tr>
<tr>
<td>MVBP</td>
<td>By-Pass Magnet Valve</td>
</tr>
<tr>
<td>MVER</td>
<td>Emergency Magnet Valve</td>
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<td>MVEREX</td>
<td>Equalizing Reservoir Default Magnet Valve</td>
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<td>MV53</td>
<td>Brake Pipe Cut-Off Pilot Magnet Valve</td>
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<tr>
<td>MV16T</td>
<td>16 Pipe Default Magnet Valve</td>
</tr>
<tr>
<td>MV20E</td>
<td>Independent Application Exhaust Magnet Valve</td>
</tr>
<tr>
<td>MV20S</td>
<td>Independent Application Supply Magnet Valve</td>
</tr>
<tr>
<td>MV20M</td>
<td>Independent Application Maintaining Magnet Valve</td>
</tr>
<tr>
<td>20T</td>
<td>Direct Application Pipe Transducer</td>
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LIST OF ABBREVIATIONS (Cont.)

N ................... Newtons
Nm .................. Newton Meters
OD .................. Outside Diameter
PARA ............... Paragraph
PCB ............... Printed Circuit Board
PCU ............... Pneumatic Control Unit
P/D ............... Pipe Diagram
Pg .................. Page
P/L ................ Parts List
psig ............... Pounds Per Square Inch, Gauge
PVBIT .......... Pneumatic Break-In-Two Valve
PVBC .......... Pneumatic Valve Brake Cylinder
PVBP .......... By-Pass Pneumatic Valve
PVEM ............ Emergency Pilot Air Valve
PVERI ........ Equalizing Reservoir Pneumatic Interlock
PVLT .......... Lead-Trail Pneumatic Valve
Qty ............... Quantity
R1 .................. Resistor
R2 .................. Resistor
REL ............... Release
RES ............... Reservoir
SC1 ............... Signal Conditioning PCB
SC2 ............... Signal Conditioning PCB
SS9A ............ Digital I/O PCB
SS9B ............ Digital I/O PCB
SUP ............... Supply Magnet Valve
SVJ ............... Computer Power Supply
SV2 ............... Computer Power Supply
TJB ............... Transducer Jumper Board
TPBC .......... BC Test Port Fitting
TPBP .......... Brake Pipe Test Port Fitting
TPER .......... Equalizing Reservoir Test Port Fitting
TPMR .......... Main Reservoir Test Port Fitting
TP16 .......... 16 Port Test Fitting
TP20 .......... 20 Port Test Fitting
V ............... Volts
VA ............... Air Brake Alarm
VCU ........... Voltage Conditioning Unit
Vdc ............ Volts Direct Current
VOL ............. Volume
W/D .............. Wire Diagram
16 RES ........ 16 RESERVOIR
16E ............ EXHAUST MAGNET VALVE
16S ............ SUPPLY MAGNET VALVE
16T ............ 16 PORT TRANSDUCER
20CP .......... 20 PIPE CONTROL PORTION
20F .......... 20 PIPE TRAINLINE FILTER
20R .......... 20 PIPE RELAY VALVE
20T .......... 20 PIPE TRANSDUCER
Introduction

The Purpose of this Manual is to provide necessary information pertaining to the CCB Brake System for performing an on and off locomotive equipment check out and analysis of the brake system. Sufficient information of the introductory overview nature is also included to inform the maintenance personnel of the nature and function of each of the components in the CCB Brake System.

1. The information contained within this manual summarizes the features of the CCB brake equipment and its application to the GMC/EMD/India vehicle.

2. Ensure that you are thoroughly familiar with the instructions for a component and are familiar with all precautionary notes prior to attempting a sequence, operation, or maintenance. Failure to follow procedures and precautionary notes in this publication, could cause loss of or serious injury to personnel and/or malfunction or equipment damage.
CHAPTER 1

SYSTEM DESCRIPTION AND OPERATION

1.1 AIR BRAKE EQUIPMENT

The Computer Controlled Brake (CCB) equipment, arranged for dual cab, multiple-unit operation, is used on this locomotive. The principal parts are as follows:

1.1.1 AIR BRAKE EQUIPMENT LOCATION

See Figure 1-1 for location of equipment in the Brake Bay Rack.
See Figure 1-2 for the Brake Valve Controller (BVC) handle positions.
See Figure 1-3 for the Pneumatic Control Unit (PCU) Valve locations.
See Figure 1-4 for the Computer Relay Unit (CRU) Component locations.

1.1.2 BRAKE VALVE CONTROLLER (Figure 1-2)

1.1.2.1 OPERATING - AUTOMATIC HANDLE

The Brake Valve Controller Automatic handle operates through five detented positions: Release (REL), Running (RUN), Minimum (MIN), Full Service (FS) and Emergency (EMER). There is also a non-detented Service Zone that utilizes the area between the MIN and FS detented notch positions. An indicating plate is provided denoting the five detented operating positions.

When charging a train or releasing an Automatic brake application, the automatic Brake Valve Controller handle must be placed in RUN (for normal charging) or RELEASE position (for accelerated charging).

When a Service brake application is made, the Automatic Brake Valve Controller handle is moved away from the Driver against the second detent position of the quadrant. This is a minimum reduction position which will provide a 0.3 - 0.4 kg/cm² reduction. If it is necessary to increase the reduction, the handle is moved progressively away from the Driver, bearing in mind that the further the handle is moved into the service zone, the greater the reduction will be. The brake valve will self-lap at any point where movement of handle is stopped in the service zone and automatically maintain equalizing reservoir and brake pipe pressure up to full service against permissible brake pipe leakage.

Full service brake application is obtained by moving the Brake Valve Controller handle to the FULL SERVICE position against the fourth detented position of the quadrant. Brake Cylinder pressure at Full Service is 1.82 kg/cm². In this position over-speed control and vigilance penalty applications are suppressed.

Placing the handle in EMERGENCY, the fifth detent position, reduces equalizing pressure to zero. Brake pipe reduces rapidly to zero kg/cm². Equalizing Reservoir reduces to zero at a slower rate. BC pressure is maintained at the Full Service setting of 1.82 kg/cm².

Release of an Automatic locomotive brake on locomotive while retaining the train brake cylinder pressure can be accomplished by lifting bail-off (quick release) ring upward on the Direct Brake handle. Locomotive brakes will remain released unless the Automatic handle is in Emergency. In this case brakes will re-apply when the bail-off (quick release) ring is released. Bail-off (quick release) does not affect a Direct Brake application. The locomotive brake cylinder pressure will be reduced to the value corresponding to the position of the Direct Brake handle.
1.1.2.2 OPERATING - DIRECT BRAKE

When applying the locomotive Direct brake, move the Direct BVC handle away from the Driver (Full Direct application is the extreme forward position), and when releasing, move the handle towards the Driver. The brake valve will self-lap at any point in the application zone where handle movement has been stopped. Brake cylinder pressure is maintained against allowable leakage in any service position.

The Direct Brake Valve Controller handle should always be in RELEASE position (closest to Driver) when the locomotive is a trailing unit in a multiple-unit consist or is being towed DEAD.

1.1.2.3 AIR BRAKE SET-UP

The function of setting up the Locomotive for LEAD, TRAIL, TEST and HLPR is accomplished through the Lead-Trail Selector switch located in the lower right corner of the brake valve controller.

A. For Set-Up as Lead or Single Unit

If the unit is in MU with other locomotives, ensure all units are in TRAIL before attempting to set up locomotive in LEAD.

1. Move Lead/Trail selector switch to “TEST”.
2. Move Automatic BVC handle to “RUN” position and charge equalizing reservoir to 5.2 kg/cm².
3. Move Lead/Trail selector switch to “LEAD ” position and charge brake pipe.
4. Move Direct brake handle to Release position to move the locomotive.

B. For Set-Up as Trail Unit

1. Fully apply Direct Brake and place Automatic BVC handle in Full Service (FS).
2. After Brake Pipe exhaust ceases, select “TRAIL” position on the Lead/Trail selector switch. Move the Direct BVC handle to “RELEASE”.
3. Automatic and Direct Brakes are now cut-out.

NOTE: DO NOT turn off breaker for Computer Controlled Brake (CCB).

C. For Set-Up as Helper Unit

1. Fully apply Direct Brake and place Automatic BVC handle in Full Service (FS).
2. After Brake Pipe exhaust ceases, select “HLPR” position on the Lead/Trail selector switch. Move the Direct BVC handle to “RELEASE”.
3. Automatic Brakes are are now cut-out, Direct Brakes are active.
1.1.3 LOSS OF POWER MODE

When loss of power occurs to the CCB system, such as an "Open" AB circuit breaker, the MVER default magnet valve de-energizes to directly reduce equalizing reservoir (ER) to zero kg/cm² at service rate through a #60 drill choke. This causes brake pipe (BP) to reduce at a service rate to 0.7 kg/cm². Brake cylinder pressure is developed by a pneumatic back-up system to a maximum pressure of 3.8 kg/cm². Trailing units will receive pressure via the brake cylinder equalizing pipe (BCEP) to 3.8 kg/cm².

If power cannot be restored to the brake system, the unit must be used as a 'Trail' or 'Dead' locomotive. If operated as a 'Trail' locomotive, all MU pipes must be connected and the unit set to 'Trail' position. Brake cylinder pressure will be developed from the lead unit via the BCEP.

If the unit is operated as a 'Dead' unit the dead engine cut off cock (COC) located at the lower left corner of the pneumatic control unit (PCU) must be 'opened'. Both BCEP and main reservoir equalizing pipe (MREP) cut-off end cocks must be opened. The brake pipe angle cock and the brake pipe hose must be opened and connected to the train. Bogey brake cylinder cocks must be opened and Air Brake Circuit Breaker (ABCBl) must be opened.

Brake cylinder pressure will be developed similar to the train brakes through the operation of the KE distributor valve and pneumatic interlocks on the PCU.

1.1.4 POWER UP PENALTY

Whenever the Air Brake circuit breaker is first closed in a 'LEAD' mode, the CCB system applies a PENALTY service brake. BC and BCEP are pressurized to 3.8 kg/cm². The Brake Valve Controller handle should be placed into FULL Service detent position to reset the system. The Brake Valve Controller Auto handle must remain in FULL Service detent position for 10 seconds to reset the system. Move the Brake Valve Controller handle to RUN position and PCS will reset when BP charges to 4.0 kg/cm² to fully recharge the brake system.

Brake cylinder pressure must reduce to zero kg/cm² before the computer regains control of the brake cylinders. This function assures that a Penalty brake application will occur should the power be lost for any reason.

1.2 SYSTEM OVERVIEW

Refer to Figure 1-5

The Computer Controlled Brake (CCB) Equipment is a complete microprocessor Air Brake Control System for main line locomotives and switchers. The equipment is fully compatible with locomotives having single pipe MU brake control. All logic is computer controlled. Emergency applications are also initiated pneumatically in parallel with computer initiated emergency applications.

The operator commands the computer through the CCB brake valve controller. The brake valve controller is mainly electronic and signals the computer as to the position for Automatic and Direct braking. Lead/Trail and Brake Pipe Cut-Out modes are set up through the Four-Position selector switch. The Brake Pipe Pressure setting is factory set by the computer software. The only pneumatic valve contained in the brake valve is the mechanically actuated emergency vent valve. The vent valve is open in emergency position.
The Computer interprets the signals of the brake controller and controls the Pneumatic Control Unit for the actual development of pressure. All control pressures are developed in this manner: brake pipe, brake cylinder equalizing pipe and brake cylinder. The Computer also controls the locomotive power knock down cut-off relay (PCS). The voltage conditioning circuitry isolates the locomotive battery supply from the CCB system as well as providing 24 V filtered DC to operate the CCB equipment.

The KE Valve provides #16 control volume pressure to the BC relay control that operates to provide ‘Service’ automatic brake whenever “Loss of Power” of the consist occurs. Computer Controlled Brake (CCB) equipment is compatible with conventional brake systems in basic function and operation. Handle positions, locomotive set-up, pressure development and pressure drop flow rates remain the same. The changes from conventional AAR/UIC systems occur in how the air pressure is controlled and the type of equipment used to control the brakes. Also, a major enhancement is the ability to diagnose problems.

1.2.1 SYSTEM OPERATING PRESSURES

A. AUTOMATIC BRAKE PRESSURES – WDG4/WDP4 & Alco Locomotive

Main Reservoir = 8 - 10 kg/cm².
Release - BP = 5.7 kg/cm² +/- 0.1 kg/cm² Max for WDG4/WDP4 Loco and 5.5 kg/cm² +/- 0.1 kg/cm² Max for Alco Loco
Running - ER and BP = 5.2 kg/cm² +/- 0.1 kg/cm² for WDG4/WDP4 Loco and 5.0 kg/cm² for Alco Loco, BC = 0
Minimum Service - ER/ BP reduce to 4.7 kg/cm² +/- 0.1 kg/cm², BC = 0.3-0.4kg/cm² +/- 0.1 kg/cm².
Full Service - ER/BP reduce to 3.4 kg/cm² +/- 0.1 kg/cm², BC = 1.82kg/cm² +/- 0.1 kg/cm².
Emergency - ER reduces to 0 kg/cm², BC = 1.82kg/cm² +/- 0.1 kg/cm².
BP reduces to less than 1 kg/cm².
BCEP = 1.82 kg/cm² +/- 0.1 kg/cm².

1.2.2 AUTOMATIC BRAKE SYSTEM FEATURES

As with conventional brake systems the CCB system controls the locomotive and train brakes through control of train-line brake pipe pressure. Control of brake pipe pressure permits the development of brake cylinder pressure on both locomotive and train.

Control of brake pipe pressure is accomplished by control of a smaller volume called Equalizing Reservoir (ER). ER pressure is reduced to apply brakes, and increased to release brakes. Brake cylinder pressure develops at a controlled rate.

The CCB system utilizes 2 distinct control circuits to apply and release an automatic brake. I.e.: Brake pipe control circuit increases or decreases the brake pipe pressure according to the pressure commanded by ER control. Brake cylinder control circuit controls the increase or decrease of brake cylinder pressure commanded by #16 Control.

1.2.3 DIRECT BRAKE

A. FOR WDG4 & WDP4 Locomotive

Direct Brake = Maximum brake position BC = 5.2 kg/cm² +/- 0.1 kg/cm².
BCEP = 5.2 kg/cm² +/- 0.1 kg/cm².
Release Position BC = 0 kg/cm².
B. FOR ALCO Locomotive

Direct Brake = Maximum brake position BC = 3.5 kg/cm² +/- 0.1 kg/cm².
BCEP = 3.5 kg/cm² +/- 0.1 kg/cm².
Release Position BC = 0 kg/cm²

1.2.4 DIRECT BRAKE SYSTEM FEATURES

The Direct brake, when operated with a forward motion, develops brake cylinder pressure on the locomotives only. Pressure is developed much faster than with an Automatic application. Simultaneous to development of BC application in the Lead Locomotive, air also flows to the Brake Cylinder Equalizing Pipe at the same charging rate as the Brake Cylinder pressure.

When the Bail-off (quick release) ring on the Direct handle is lifted, both BC and BCEP pressures are vented at the Lead Unit releasing the Automatic brakes on the LEAD and BCEP from all TRAILING units. If a Direct brake was also applied, these brakes would remain applied.

1.2.5 LEAD UNIT AUTOMATIC BRAKE OPERATION - BRAKE RELEASE

Once the brake system is powered-up, equalizing reservoir default magnet valve (MVER) energizes and remains energized until power is removed for any reason.

1.3 BRAKE PIPE CONTROL SUB-SYSTEM

1.3.1 EQUALIZING RESERVOIR ELECTRICAL CONTROL - RUNNING

Refer to Figure 1-6

MVER is energized when commanded by the CPZ via EPA1 and DB1 PCB's. 24 VDC is supplied by the VCU through the DB1 output Direct circuit. When the Automatic Brake Valve Controller handle is in Run position, a frequency is generated by the internal electronic circuitry of the Brake valve controller and transmitted to the FOR PCB via a fiber optic cable. This frequency is decoded by the FOR board and sent to the CPZ (Central Processor) board where the handle position is identified. The computer reads this input and calculates the Equalizing Reservoir pressure for that handle position. The CPZ commands the EPA1 board to the level of output ER pressure required.

The EPA1 board outputs a PWM signal to the ER Analog Converter that opens the normally closed supply magnet valve connecting main reservoir supply air to the equalizing reservoir circuit at a controlled rate determined by the computer. The ER transducer (ERT) feeds back a voltage proportional to the ER pressure. When ER pressure reaches the commanded pressure, the EPA1 de-energizes the supply magnet valve and maintains the pressure level constant through control of the Analog Converter's magnet valves and feedback from the ER Transducer (ERT).

The Equalizing Reservoir pressure pilots the BP relay which connects main reservoir supply air to the brake pipe circuit. When Brake Pipe Pressure reaches the pressure dictated by the Equalizing Reservoir, the BP relay moves to "LAP" position.

In RUN position, 15 VDC is supplied by the SS9 PCB output circuit, through the brake valve controllers' contacts 'AR', back through the SS9 data output to the CPZ PCB. This circuit assures the handle position is calibrated to the proper frequency.
1.3.2 EQUALIZING RESERVOIR AND BRAKE PIPE PNEUMATIC CONTROL - RUNNING

Refer to Figure 1-7

Main Reservoir air flows through the open Analog Converter (AW4-ER) Supply Magnet Valve to the Equalizing Reservoir Transducer (ERT) and to the closed Analog converter (AW4-ER) Exhaust Magnet Valve. Air then passes through the open Equalizing Reservoir Magnet Valve (MVER), in Lead position, to charge Equalizing Reservoir (ER). ER pressure pilots the high capacity Brake Pipe Relay Valve (KR-5EO).

Equalizing reservoir (ER) pressure will be increased and maintained at 5.2 kg/cm² (WGD4/WDP4 Loco) and 5 kg/cm² (Alco Loco) ER pressure is maintained automatically by use of the ER Transducer’s commands to AW4-ER’s Supply and Exhaust magnet valves to either ‘open’ or ‘close’ when leakage is detected by the ER Transducer.

When ER pressure rises slightly above brake pipe pressure, the brake pipe relay valve (KR5-EO) detects the pressure difference and its internal supply valve opens. This allows MR air to pass through KR5-EO, to magnet valve MV53 cutoff pilot valve and to the brake pipe cut-off valve (BPCO). If brake pipe air pressure is below 1.5 kg/cm², it is contained at the BPCO valve. Air flow continues through the de-energized MV53 pilot valve, thus developing pressure at the BPCO pilot port (A4). When this pressure exceeds 1.8 kg/cm², the BPCO valve shuttles to ‘open’ position allowing pressure to flow to the train-line brake pipe through the brake pipe filter.

1.3.3 BRAKE PIPE CHARGING CUT-OFF

Refer to Figure 1-8

MR air flows to the train-line brake pipe via the brake pipe cut-off valve (BPCO). For the purpose of brake pipe leakage testing of locomotive or train or during Emergency Applications, the flow of air from the brake pipe relay (KR5-EO) must be stopped. This is accomplished by closing the high capacity BPCO. This valve automatically closes when the brake pipe pressure on the valve’s pilot port is less than 1.8 kg/cm².

Normally when brake pipe pressure increases at the output of the brake pipe relay (KR5-EO), air flows through deenergized MV53 magnet valve to the pilot port of the BPCO valve. The BPCO valve is forced to its ‘open’ position when pressure is above 1.8 kg/cm², thus permitting brake pipe pressure to develop in the train-line brake pipe.

When the Lead/Trail selector switch is placed to either ‘Hlpr, Test or ‘Trail’ positions, the CPZ PCB commands MV53 magnet valve to energize via EPA1 and DB1 PCB’s. 24 VDC is applied to the MV53 coil. When energized, MV53 vents the pilot port of the BPCO valve allowing an internal spring to move the valve to the closed position. Brake pipe pressure flow to the trainline brake pipe ceases.

When the Lead/Trail selector switch is placed to the ‘Lead’ position, voltage is removed from the MV53 magnet valve by the combination of CPZ, EPA1, and DB1 PCB’s. The pilot port of BPCO is pressurized by brake pipe exiting at the MV53 magnet valve supply port. MV53 is also energized and brake pipe cut-off occurs via CPZ, EPA1 and DB1 whenever an emergency application is detected by the CPZ PCB for the following conditions:

A. Brake valve controller handle in ‘Emergency’ position.

B. Brake valve controller handle not in ‘Emergency’ but brake pipe is less than 3 kg/cm².
In parallel with the CPZ, EPA1 and DB1, MV53 is simultaneously energized by a path through the AE-2 brake valve controller contacts. In ‘Emergency’, 24 VDC is delivered to MV53 through the AE-2 closed contacts.

1.3.4 **FLOW DETECTION**

Refer to Fig. 1-9

This circuit includes two flow indicators, one for each control stand piped across an orifice. The 8 mm orifice is in series with a 5.5 mm orifice restricts the main reservoir flow to the Brake Pipe relay and thus to the trainline brake pipe in RUNNING position.

Whenever an excessive flow of air occurs across the 8 mm/5.5 mm orifice, a pressure drop is developed which is sensed by the Air flow indicator, causing the hands to rotate clockwise giving the Driver an indication that the train may be experiencing loss of pressure due to a train separation. The flow is created when the Brake Pipe relay opens in an attempt to maintain the brake pipe leakage.

An indicator light on the Air Flow Indicator illuminates whenever the flow exceeds the preset flow indication.

1.3.5 **FAST RECHARGE AND ASSIMILATION - RELEASE**

Placing the BVC handle in the Release (REL) position closes the ‘AR’ microswitch. A 15 VDC signal generated by the SS9A PCB returns to the SS9A PCB as input from the AR switch to tell the computer that the handle is in the Release position.

Placing the BVC handle in the release (REL) position provides two functions.

A. **FAST RECHARGE**

Refer to Figure 1-10

MR air flow to the train line brake pipe increases because the size of the Brake Pipe main reservoir charging orifice increases from approximately 5.5 mm to 8 mm. This allows faster charging of the train. The faster charging rate will only be maintained while the handle is held in the release position against the tension of the brake valve controller’s return spring.

MR air flows from the second main reservoir through a ball valve, locomotive final filter, and PCU MR filter, to an 8 mm orifice. The restricted air flow then continues on to the by-pass pneumatic valve (PVBP). The CPZ outputs a command with a data message to the EPA1 PCB. This information is converted by the EPA1 PCB into a 24 VDC command voltage to energize the brake pipe magnet valve (MVBP). MVBP connects MR air pressure to the pilot port ‘A4’ of the PVBP causing it to open, thus allowing MR air to bypass the 5.5 mm charging restriction orifice to deliver pressure directly to brake pipe at a much faster rate. This permits the train brake distributing valves to release brake cylinder pressure sooner.

B. **OVERCHARGE AND ASSIMILATION**

Refer to Figure 1-11

This feature is provided to allow the manual initiation of an automatic overcharge cycle.
(assimilation) to the maximum overcharge level of 0.5 kg/cm². This feature is initiated whenever the Automatic brake valve controller handle is placed in the spring-loaded Release (REL) position.

Once an overcharge cycle is initiated, the brake pipe will charge to the normal brake release pressure of 5.2 kg/cm² (plus any previous unassimilated overcharge) at the normal service rate. Brake pipe pressure will continue to increase at a constant rate of 0.05 kg/cm² per second to the maximum level of 5.7 kg/cm² (For WDG4 & WDP4 Loco) and 5.5 kg/cm² (For Alco Loco) and will remain at that level for a time period of 60 seconds. After the 60 second time period expires, the brake pipe pressure will slowly bleed off or “assimilate” at the UIC specified rate of 0.002 kg/cm² per second down to the normal release pressure of 5.2 kg/cm² (WDG4/WDP4) and 5.0 kg/cm² (ALCO). To reinitiate an overcharge cycle, it is required that the Automatic BVC handle be moved to a service position and then back to Release.

If the Automatic BVC handle is moved into a service position at any time before an overcharge cycle is complete, normal brake pipe control will be resumed with the exception that all subsequent pressure requests will be adjusted upward by the amount of overcharge in effect at the time the handle is first moved out of the ‘RUN’ position. This adjustment will remain in effect until the Automatic BVC handle is placed in the ‘RUN’ position and the existing overcharge is allowed time to assimilate or the handle is placed in the ‘Release’ position and a new overcharge cycle is initiated. The overcharge cycle will automatically complete with the BVC handle in the ‘RUN’ position.

1.3.6 BRAKE CYLINDER PRESSURE CONTROL SUBSYSTEM - RELEASE OR RUNNING

Refer to Figure 1-12

The brake pipe pressure is monitored by the brake pipe transducer, BPT, which outputs a voltage proportional to brake pipe pressure to the CPZ board via the EPA1 and ADZ boards.

Refer to Figure 1-13

The computer calculates the #16 control pressure based on the level of brake pipe pressure. When brake pipe pressure increases, the CPZ calculates the appropriate pressure to be released from the #16 control volume. This command is sent to the EPA2 PCB to release pressure in the #16 control volume. The rate of change for #16 control volume is controlled by an algorithm residing in the computer program which ramps the command to the EPA2 board up or down at a predetermined rate until the target pressure is reached.

The Analog Converter (AW4-16) Supply Magnet Valve closes and the AW4-16 Exhaust Magnet Valve opens exhausting the #16 Control Volume from the open Control Pipe Magnet Valve (MV16T). This exhausting of air allows the BC Relay Valve piston to move and vent the brake cylinder air to atmosphere.

1.3.7 BRAKE CYLINDER EQUALIZING PIPE PRESSURE CONTROL - RELEASE OR RUNNING

A. AUTOMATIC RELEASE

Refer to Figure 1-15

The Brake Cylinder Equalizing Pipe is used to supply air to and from all trailing units of the locomotive consist to control application and release of both Automatic and Direct brakes. The only exception to this operation is locomotive consist separation. This
function will be discussed under ‘Break-in-Two’ protection.

In Release or Running positions the Automatic Brake Valve transmits a frequency of 10.8 - 11.2 and 9.95-10.3 respectively to the FOR PCB. The fiber optic frequency is converted to a data message that is received by the CPZ PCB. This information is used to calculate the pressure level in the BCEP valve’s EXH magnet to energize. This valve will remain energized until the BCEP pressure level commanded is attained.

Pressure in the 20 Reservoir which serves as a control pressure for the BCEV relay valve vents at a rate similar to brake cylinder release rate. This rate is controlled by the variable orifice of the EXH magnet valve.

You can see from Figure 29 that the #20 reservoir control pressure flows to exhaust through pneumatic piston valve PVLT1 and Brake cylinder equalizing pipe pressure flows through PVLT2 before exiting the BCEV relay exhaust. These piloted pneumatic cut-off valves are opened when the locomotive Lead/Trail switch is in Lead position. Both valves are simultaneously operated by air pressure from the magnet valve MVLT which is energized by the Lead/Trail switch via the SS9A, EPA2, CPZ, DB1 PCB’s.

When the pressure in the #20 reservoir reduces lower than the brake cylinder equalizing pressure, the BCEV is forced to move to its exhaust position. Brake cylinder equalizing pressure can now vent through the BCEV exhaust port to atmosphere at the same rate as the #20 control reservoir. With the brake valve handle in Running or Release position, the BCEP pressure reduces to zero.

**B. BAILOFF (QUICK RELEASE)**

When the brakes are bailed off as previously described, the BCEP is exhausted in the same manner as described under automatic release of BCEP. However, the rate of release is faster.

**1.3.8 LEAD UNIT AUTOMATIC BRAKE OPERATION-BRAKE APPLICATION**

**1.3.8.1 BRAKE PIPE CONTROL SUBSYSTEM**

**A. SERVICE APPLICATION**

Refer to Figure 1-16, 1-17, 1-18

There are several positions of the Brake Valve Controller Automatic handle that control locomotive and train brake applications. When the automatic Brake Valve Controller handle is moved from Running to any of the service detent positions from Minimum Service to Full Service. Equalizing Reservoir and Brake Pipe will be reduced by an amount proportional to handle movement. In each position of the Automatic Brake Valve, a different frequency is generated by the electronic circuitry identifying the level of Equalizing Reservoir pressure commanded. This frequency is transmitted through a fiber optic cable isolated from electrical interference to the Fiber Optic Board (FOR) in the computer rack. As explained in "RUNNING" the computer reads the FOR, calculates the ER pressure and commands the EPA1 board to energize the Exhaust Magnet Valve of the ER Analog Converter. The supply magnet valve remains closed. The flow rate of Equalizing Reservoir to exhaust is controlled by the computer by changing the command pressure to the EPA1 relative to elapsed time. Since the Analog Converter magnet valves are soft seat type, the valves need not be fully open or fully closed. As the pressure approaches the commanded level of pressure, the EPA1 compares pressure demand with the output voltage of the Equalizing Reservoir.
Transducer (ERT) located on the Analog Converter. The EPA1 slowly closes the Supply Magnet Valve until the desired pressure is reached. This action avoids undesired valve chatter and pressure fluctuations normally inherent to digitally controlled systems.

Refer to Figure 1-19

ER reduces through the energized magnet valve (MVER) and the open exhaust magnet valve of the analog converter (AW4-ER) at a controlled rate. With ER reducing, ER air is removed from the control port of the BP Relay Valve (KR-5EO). The piston in the relay valve moves and BP reduces through the exhaust port of the Relay Valve (KR-5EO) at a controlled rate by the relay exhaust choke 60D from the brake pipe volume of the locomotive and train consist. This action is totally pneumatic. When brake pipe pressure is equal or slightly less than equalizing Reservoir pressure acting on the Relay diaphragm, the valve slowly moves to a "LAP" position closing the exhaust port. Since the Relay is a maintaining type valve, brake pipe pressure will be maintained to the level of Equalizing Reservoir for acceptable train brake leakage conditions.

B. EMERGENCY APPLICATION

Refer to Figure 1-20

An Emergency Application means to apply brakes at the maximum rate. When the Brake Controller Valve AUTOMATIC handle is placed into Emergency position several actions take place to insure an Emergency Application occurs. As with Service braking a frequency is generated that is read by the computer via the Fiber Optics board. The analog converter operates the same as described under Service Application - Lead unit; ER reduces at a faster rate and reduces to 0 kg/cm² instead of 3.4 kg/cm². This causes the KR-5EO brake pipe relay to open brake pipe to exhaust assuring no rise in brake pipe can occur even if the cut-off valve leaks. In addition, the brake controller AE1 switch opens sending an emergency input signal to the computer via the SS9A or SS9B circuit board. In Emergency position the brake valve mechanically opens a vent valve that exhausts brake pipe, Directly venting BP throughout the entire length of the train.

Refer to Figure 1-21 & 1-22

In addition, the brake controller AE1 switch opens sending an emergency input signal to the computer via the SS9A or SS9B circuit board. Both of the above signals tell the computer to energize the Emergency Magnet Valve (MVEM) via the EPA1 board and Driver Board (DB1). The opening of the Emergency Magnet Valve (MVEM) vents the pilot port of the high capacity pneumatic valve (PVEM) thus additionally venting the BP through the PVEM exhaust port..

C. TRAIN SEPARATION EMERGENCY APPLICATION

Refer to Figure 1-23

To insure an Emergency rate of brake pipe reduction, brake pipe charging must be suspended. With the handle in Emergency position, or from a train or locomotive separation, or Driver's Emergency valve, the brake pipe cut-off Magnet Valve (MV53) energizes. A second switch AE2 also provides 24 VDC, via wires, to energize MV53 in Emergency position. With a brake valve emergency the Analog Converter (AW4-ER) exhaust magnet valve, Brake Pipe Cut-Off Magnet Valve (MV53) and Emergency Magnet Valve (MVEM) are commanded to energize. The opening of the analog converter exhaust magnet valve allows ER air from the BP relay valve (KR-5EO) and ER reservoir to flow through the open ER
magnet valve (MVER) and to open analog converter (AW4-ER) exhaust magnet valve to vent
to atmosphere. With BPCO Magnet Valve (MV53) open, the BPCO valve pilot port vents,
forcing the valve to lose communication between Brake Pipe Relay (KR-5EO) and trainline
brake pipe.

A Brake Valve emergency application provides immediate power or dynamic brake knock
down by de-energization of the cut-off Relay (COR) through the computer program logic. If a
train separation occurs, BP level and flow are monitored. If BP level drops 2.5 kg/cm² below
release pressure, emergency logic is initiated. If during this time BP Flow exceeds 1200
L/min or BP drop rate exceeds 10PSI/Sec, the brake pipe flow indicators will alert the
operator. An emergency application is also initiated if an emergency rate of brake pipe
reduction is achieved.

With a Break-in -Two in affect Power Knockdown is delayed for 20 seconds or whenever the
Brake Valve Controller is moved to emergency position.

1.3.8.2 BRAKE CYLINDER CONTROL SUBSYSTEM

A. SERVICE APPLICATION

Refer to Figure 1-24

The Brake Pipe Transducer (BPT) detects the reduction of brake pipe, which is read by the
central processor (CPZ) via the Analog/Digital circuit Board (ADZ). The computer calculates
the required brake cylinder pressure and commands the #16 Analog Converter via the EPA2
board to the desired rate and pressure level.

Refer to Figure 1-25, 1-26, 1-27 & 1-28

The EPA2 board responds by controlling the Analog Converter's magnet valves to develop
#16 pipe volume pressure from MR supply. In this closed loop system, #16 pipe pressure is
monitored by the Analog Converter's Transducer (16T). When #16 pressure equals the
demand pressure, the EPA2 board slowly closes the Supply Magnet Valve. Again #16 control
pressure will be maintained by the Analog Converter by comparing the 16T Transducer
feedback to the EPA2 output. Main Reservoir air flows through the open supply magnet valve
of Analog Converter (AW4-16) and through open magnet valve (MV16) to the #16 Reservoir
and the pilot port of the high capacity BC Relay Valve.

The #16 Reservoir air acting on the BC Relay Valve piston allows Main Reservoir air to pass
through the BC Relay Valve and supply air to the Brake Cylinders. Brake cylinder pressure
increases until it matches the #16 pipe control pressure. Similar in operation to the KR-5EO
relay valve, the BC Relay Valve moves to LAP position closing off the supply of MR pressure
to the brake cylinders. The application is complete and brake cylinder pressure will be
maintained at the level commanded until the Brake Valve Controller handle is again moved.

At this point the Driver can make a further reduction by moving the Automatic Brake Valve
controller handle towards Full Service position where a 1.6 - 1.8 kg/cm² brake pipe reduction
is attained and maximum service brake cylinder pressure of 1.82 kg/cm² is achieved.

The Service position provides for nullification or reset of penalty applications created by
Alerter systems, power-up penalties, or diagnostic penalties.
B. EMERGENCY APPLICATION

Refer to Figure 1-29

As in a Service brake application the Brake Pipe Transducer (BPT) detects the reduction of brake pipe pressure which is read by the central processor (CPZ) via the Analog/Digital circuit Board (ADZ). The computer calculates the required brake cylinder pressure and commands the #16 Analog Converter supply valve via the EPA2 board to the desired rate and pressure level.

The EPA2 board responds by controlling the Analog Converter's magnet valves to develop #16 pipe volume pressure from MR supply. In this closed loop system #16 pipe pressure is monitored by the Analog Converter's Transducer (16T). When #16 pressure equals the demand pressure, the EPA2 board slowly closes the Supply Magnet Valve.

Again #16 control pressure will be maintained by the Analog Converter by comparing the 16T Transducer feedback to the EPA2 output. So far as this system is concerned, the #16 control circuit works the same as in SERVICE application except that the rate of pressure increase is slightly faster. The maximum pressure of 1.82 kg/cm² is identical.

Main Reservoir air flows through the open supply magnet valve of Analog Converter (AW4-16) through open magnet valve (MV16) to the #16 Reservoir and the pilot port of the high capacity BC Relay Valve. The #16 Reservoir air acting on the Relay Valve piston allows Main Reservoir air to pass through the Relay Valve and supply air to the Brake Cylinders. Brake cylinder pressure increases until it matches the #16 pipe control pressure. Similar in operation to the KR-5EO relay, the BC Relay moves to LAP position closing off the supply of MR pressure to the brake cylinders. The application is complete and brake cylinder pressure will be maintained at the level commanded until the Brake Valve Controller handle is again moved. Again the brake cylinder pressure rise is slightly faster than a Service application, but the pressure level is the same as for Full Service.

C. BAILOFF (QUICK RELEASE) - AUTOMATIC APPLICATION

Refer to Figure 1-30

When an Automatic brake is applied, depressing the Bail-ring on Direct brake handle in any position will release BC.

Depressing the Bail-ring on Direct handle closes a microswitch, sending a signal input to CPZ via the SS9 PCB's. An isolated output is fed by computer (CPZ) PCB via the EPA2 PCB to the AW4-16 analog converter.

On the LEAD UNIT the central processor (CPZ) commands the EPA2 PCB to release the #16 pipe pressure through the Analog Converter Exhaust magnet valve which in turn drives the BC relay to release (Refer to Automatic Brake Release for operation). BC will remain exhausted if the brake was applied as a SERVICE application. If an EMERGENCY brake had been made, the brake would reapply to maximum as soon as the bail off (quick release) ring was released.

NOTE: If the bail off (quick release) continues for longer than 180 seconds, the brake cylinder pressure is restored and a fault will be displayed. This prevents tampering with the bail off (quick release) button.
1.3.8.3 BRAKE CYLINDER EQUALIZING PIPE CONTROL SUBSYSTEM

A. APPLICATION-SERVICE OR EMERGENCY

Refer to Figure 1-31

The Brake Cylinder Equalizing Pipe is used to supply air to and from all trailing units of the locomotive consist to control application and release of both Automatic and Independent (Direct) brakes. The only exception to this operation is locomotive consist separation. This function will be discussed under ‘Break-in-Two’ protection.

In Service positions the Automatic Brake Valve transmits a frequency to the FOR PCB. The fiber optic frequency is converted to a data message that is received by the CPZ PCB. This information is used to calculate the pressure level in the BCEP. The BCEV’s supply valve will energize and remain energized until the BCEP pressure level commanded is attained.

Pressure in the 20 Reservoir which serves as a control pressure for the BCEV relay valve increases at a rate similar to brake cylinder application rate. This rate is controlled by the computer controlled variable orifice of the EXH magnet valve.

The #20 reservoir control pressure flows through normally open pneumatic piston valve (PVLT1) to pilot the BCEV relay valve.

When the pressure in the #20 reservoir increases slightly above brake cylinder equalizing pressure, the BCEV is forced to move to its apply position. Main Reservoir air from BCEV is now ported through the BCEV relay valve and the open supply valve (PVLT2) to the BCEP of the Lead locomotive. Air flows through BCEP and on to the Trailing Units where it will be used to develop brake cylinder pressure on those locomotives.

When BCEP pressure equals #20 the BCEV relay moves to LAP position, terminating flow of air to the BCEP pipe. Since the BCEV relay valve is a self-lapping pressure maintaining type of pneumatic valve, BCEP will be maintained at a constant pressure should leakage develop to either increase or decrease BCEP pressure.

B. BAILOFF (QUICK RELEASE) - SERVICE AND EMERGENCY

Refer to Figure 1-32

When an Automatic brake is applied, depressing the Bail-off ring on Direct brake handle in any position will release BCEP which was developed as a result of BP reduction.

Depressing the Bail-off ring on Direct handle closes a microswitch, sending a signal input to CPZ via the SS9 PCB’s. An isolated output is fed by computer (CPZ) PCB via the EPA2 PCB to the AW4-16 analog converter.

On the LEAD UNIT the central processor (CPZ) commands the EPA2 PCB to release the BCEP pipe pressure through the #20 Analog Converter Exhaust (part of the BCEV) magnet valve which in turn drives the BC relay to release (Refer to Automatic Brake Release for operation). BCEP will remain exhausted if the brake was applied as a SERVICE application. If an EMERGENCY brake had been made, the brake would reapply to maximum as soon as the bail off (quick release) ring was released.
NOTE: If the bail off (quick release) continues for longer than 180 seconds, the BCEP pressure is restored and a fault will be displayed. This prevents tampering with the bail off (quick release) button.

1.3.9 TRAIL UNIT AUTOMATIC BRAKE OPERATION - BRAKE RELEASE

1.3.9.1 BRAKE PIPE CONTROL SUBSYSTEM

A. ER Control

Refer to Figure 1-33

In Trail operation the Brake Valve controllers are set up with the Automatic handles in Full Service position and the Direct handles in Release. The Lead/Trail switch of each controller is set to TRAIL. The handle positions of the controllers have no affect on system operation except in Emergency. However, it is a good idea to position the handles as described should a failure occur.

In Trail, once the brake system is powered-up, equalizing reservoir default magnet valve (MVER) energizes as in Lead unit operation. However, the CPU is programmed to command the AW4-ER to energize the AW4-ER analog converter Exhaust magnet valve and reduce the ER pressure to zero kg/cm². Equalizing reservoir pressure remains at zero kg/cm² in all Trail operation. MVER remains powered to enable the CPU to determine the output of the ERT transducer.

The Trail Unit has no control over brake pipe, but does monitor brake pipe through the BPT transducer. The purpose for BPT on a Trail Unit will be discussed under Locomotive separation.

B. BRAKE PIPE CUT-OFF

Refer to Figure 1-34

When the Lead/Trail selector switch is placed in Trail position, the CPZ PCB commands MV53 magnet valve to energize via EPA1 and DB1 PCB’s. 24 VDC is applied to the MV53 coil. When energized, MV53 vents the pilot port of the BPCO valve allowing an internal spring to move the valve to the closed position. Brake pipe pressure flow to the trainline brake pipe ceases. Brake Pipe pressure cannot flow either way through the valve.

C. BRAKE CYLINDER AND BRAKE CYLINDER EQUALIZING PIPE CONTROL SUBSYSTEM

Refer to Figure 1-35

Brake Pipe pressure increases on the Trail Unit when charged by the Lead Unit. Although the brake pipe pressure is monitored by the Trail Units’ CPU, brake cylinder pressure is not reduced because of this action, but rather by the fact that brake cylinder equalizing pipe is being vented by the Lead Unit’s Brake Cylinder Equalizing Valve.

The venting of BCEP at the Trail Unit is sensed by the 20T transducer located on the Brake Cylinder Equalizing Valve on the Trail Unit. The output voltage from this transducer is fed back to the CPU via the ADZ PCB. The computer calculates the pressure required in the Brake Cylinders based on the BCEP pressure. At this point the CPU commands the AW4-16 to reduce the #16 Control volume at the same rate as BCEP. The BC pressure vents via the
BC Relay valve which moves to release position when #16 pressure is lowered at the BC Relay pilot port.

D. BAILOFF (QUICK RELEASE)

When the brakes are bailed off at the Lead Unit, the BCEP is exhausted and in turn causes the Trail unit’s brakes to release as described above but at a faster rate.

1.3.10 TRAIL UNIT AUTOMATIC BRAKE OPERATION-BRAKE APPLICATION

1.3.10.1 BRAKE CYLINDER CONTROL SUBSYSTEM

A. ANY AUTOMATIC APPLICATION

Refer to Figure 1-36

As previously mentioned Automatic application at the Lead Unit reduces brake pipe to apply the train brakes. With the Brake Cylinder Equalizing Pipe type of control system on the GT 26 MAC locomotives the trail units normally do not respond to reduction of brake pipe to apply brakes. The Trailing Unit instead receives BCEP pressure during an Automatic application.

The increase of BCEP at the Trail Unit is sensed by the 20T transducer located on the Brake Cylinder Equalizing Valve. The output voltage from this transducer is fed back to the CPU via the ADZ PCB. The computer calculates the pressure required in the Brake Cylinders based on the BCEP pressure. At this point the CPU commands the AW4-16 to increase the #16 Control volume via the Supply Valve at the same rate as BCEP. The BC pressure rises via the BC Relay valve which moves to apply position when #16 pressure increases at the BC Relay pilot port. BC pressure increases to the level of BCEP and is maintained against leakage.

The maximum brake cylinder pressure that can be obtained on the Trail Unit for Automatic application is the same as the Lead Unit i.e 1.82 kg/cm² is calculated by the computer and is based on 1x the BCEP pressure.

B. TRAIN SEPARATION-EMERGENCY APPLICATION

The Trail Unit does nothing different in this circumstance. The brakes are applied as described above.

1.3.11 DIRECT APPLICATION AND RELEASE - LEAD MODE

A. SERVICE POSITION

As its name implies, Independent (Direct) Braking applies and releases locomotive brakes Direct of the Automatic Brake. The CCB system uses an Analog Converter to accomplish this. This Analog Converter is (AW4-20) located on the BCEV and controls pressure to and from the brake cylinder equalizing pipe.

Similar to the operation of the Automatic Brake, the Direct Brake Handle on the CCB Brake valve outputs a frequency to the computer proportional to handle position. The Direct Brake is a closed Loop system. The EPA3 responds by controlling the analog converter’s magnet valves for developing BCEP pressure from MR supply. Moving the handle between Release
position to Maximum brake produces a variable pressure output from 0 to 5.2 kg/cm² (in WDG4 & WDP4 Locomotive) and 0 to 3.5 kg/cm² (in Alco Locomotive) The system is pressure maintaining at all pressure levels. The BCEP pressure will be maintained by the analog converter by comparing the 20T transducer feedback to the EPA3 output.

The Brake Cylinder Equalizing Pipe is used to supply air to and from all trailing units of the locomotive consist to control application and release of both Automatic and Direct (Direct) brakes. The only exception to this operation is locomotive consist separation. This function will be discussed under ‘Break-in-Two’ protection.

In Service positions the Direct Brake Valve transmits a frequency to the FOR PCB. The fiber optic frequency is converted to a data message, which is received by the CPZ PCB. This information is used to calculate the pressure level in the BCEP. The BCEV’s supply valve will energize and remain energized until the BCEP pressure level commanded is attained.

Pressure in the 20 Reservoir which serves as a control pressure for the BCEV relay valve increases at a rate similar to brake cylinder application rate. This rate is controlled by the computer controlled variable orifice of the SUP magnet valve.

The #20 reservoir flows through normally open pneumatic piston valve PVLT1 to pilot the BCEV relay valve.

When the pressure in the #20 reservoir increases slightly above brake cylinder equalizing pressure, the BCEV is forced to move to its apply position. Main Reservoir is now ported through the BCEV relay valve and the open supply valve to the BCEP of the Lead locomotive. Air flows through BCEP and on to the Trailing Units where it will be used to develop brake cylinder pressure on those locomotives.

When BC pressure equals BCEP the BCEV relay moves to LAP position, terminating flow of air to the brake cylinders. Since the BCEV relay valve is a self-lapping pressure maintaining type of pneumatic valve, BCEP will be maintained at a constant pressure should leakage develop to either increase or decrease BCEP pressure.

Brake Cylinder pressure is developed as described under Automatic Brake Application via the AW4-16 and BC Relay circuits except that the BC pressure is greater and the build-up rate is faster.

- Maximum BC=5.2 kg/cm² in WDG4 & WDP4 Locomotive & 3.5 kg/cm² in Alco Locomotive
- Build-up Rate 0 to 4.94 = 4-6 seconds
- BCEP 5.2 kg/cm² (in WDG4 & WDP4 Locomotive & 3.5 kg/cm² (in Alco Locomotive)

B. RELEASE POSITION

Refer to Figure 1-38

As the Direct handle is moved to “Release”, the computer reads the updated fiber-optic frequency information and sends new “set point” data to the EPA3 board which works with the 20T transducer to reach the new command pressure. The supply MV remains closed while the exhaust MV opens to vent BCEP pre-control pressure to atmosphere. In turn, the BCEP relay reduces BCEP pressure to match the pre-control pressure.
C. INDEPENDENT (DIRECT) BRAKING - TRAIL UNIT

Refer to Figure 1-39

The Direct brake on the Trail Unit works the same as the Automatic Brake except for the pressures and rates. Refer to Section on Trail-Automatic. The Brake Controller Direct handles are inactive on the trail Unit and cannot be used to apply a brake.

D. INDEPENDENT (DIRECT) BRAKING - HELPER (BANKING) SERVICE

When a locomotive is to be used to push a train, the Lead/Trail switch should be positioned to HLPR and Auto Brake handle in FS. This allows operation of the Direct brake while keeping the Automatic brake cut-out.

E. LOCOMOTIVE CONSIST SEPARATION-LEAD UNIT

Refer to Figure 1-40

When the consist is accidentally separated, all the end hoses immediately begin exhausting pressure. Within a few seconds Main Reservoir Equalizing Pipe reduces to nearly zero. When the pressure reduces to less than 3.2 kg/cm² the CPU detects the drop in pressure via the MRET transducer voltage feedback through the ADZ board. The CPU commands the BCEV valve via the EPA2 board to revert to Trail mode. The BCEP pipe is now isolated from the brake system preventing any pressure from venting out the open BCEP end hose.

With the brake pipe hose severed brake pipe reduces to zero at a rapid rate. Brake cylinder pressure begins to increase as if an emergency application is in effect. Since the second main reservoir is captivated by a one way check valve to the 1st main reservoir, second main reservoir is preserved for use in the brake cylinders. Pressure develops from the operation of the computer brake system and not from the backup system in this case.

F. LOCOMOTIVE CONSIST SEPARATION-TRAIL UNIT

Refer to Figure 1-41

Since the development of brake cylinder pressure on a Trail Unit normally is derived from the Lead Unit BCEP pressure, but, BC pressure must now be controlled by the AW4-16/BC circuit. The Trail Unit also detects the loss of MREP through its own MRET transducer. On the Trail Unit detection of low MREP causes AW4-16/BC circuit to operate the same as a Lead Unit. Brakes are applied by the computer controlled system to an emergency level.

In both cases above MREP must be restored to above 8.4 kg/cm² to restore normal brake operation.

G. LOSS OF POWER BRAKE APPLICATION-LEAD UNIT

Refer to Figure 1-42

With no voltage to CRU no components can be energized to apply brakes. The normally energized MVER, MV16T and MVLT deenergize. Equalizing reservoir begins reducing through MVER to atmosphere through a calibrated orifice at a rate equal to a normal service brake rate. Pressure is internally ported to the pneumatically actuated PVERI valve. ER pressure at the pilot port of this valve temporarily moves the valve to its applied position. In
this position the valves internal porting connects the MREP at the PVBIT pilot port to exhaust causing the valve to move to its open position. In this position, pre-control volume from the KE distributor backup valve is connected to the BC relay valve via the double throw check valve and deenergized MV16T magnet valve.

As Equalizing Reservoir pressure decreases at the brake pipe relay, the relay in turn begins to vent brake pipe pressure at a service rate starting an automatic brake application. With the brake pipe reducing at the KE valve, pre-control pressure develops and flows to the BC relay through the PVBIT valve just activated, double check valve and MV16T.

Pre-control pressure continues to increase at a service rate until approximately 3.8 kg/cm² is attained. The KE valve will not maintain pressure against leakage.

To keep the backup circuit activated pre-control pressure is directed to the PVERI valves pilot port through a double check valve. ER pressure on the opposite side of the same check valve bleeds to zero.

BCEP normally developed by the closed BCEV now comes from the PVBC valve. This valve was initially opened by the same equalizing pressure that triggered PVERI. With ER at the pilot port of PVBC, the valve opens allowing BC pressure to flow through into the BCEP pipe. This pressure will increase to 3.8 kg/cm² and pressurize the trail units.

H. POWER LOSS BRAKE APPLICATION-TRAIL UNIT

Refer to Figure 1-43

On the trail unit MV16T deenergizes. MVER and MVLT are already deenergized. With MV16T deenergized, a path is created from the BCEP to the BC relay pilot port via the double check valve. When brake application is made by the Lead Unit the BC relay will be pressurized by the BCEP pipe pressure and Brake Cylinder pressure will develop on the Trial Unit. BC pressure will be limited to the maximum pressure in the BCEP pipe.
## INPUT/OUTPUT ELECTRICAL AND COMMUNICATION INTERFACE

<table>
<thead>
<tr>
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<th>PRINTED CIRCUIT BOARD</th>
<th>CCB TO EM2000 OR LOCOMOTIVE WIRING</th>
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## INPUT/OUTPUT ELECTRICAL AND COMMUNICATION INTERFACE

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FIGURE 1-8 BRAKE PIPE CHARGING CUT-OFF - LEAD OPERATION
FIGURE 1-9 FLOW DETECTION

NOTES:

1. IN RUN OR SERVICE POSITION, AIR IS OPEN. MVBPI IS DE-ENERGIZED.
2. ALL AIR PRESSURE DEVELOPED IN TRAINLINE BRAKE PIPE MUST FIRST FLOW THROUGH THE 4 mm ORIFICE IN THE ORIFICE BLOCK.
3. FLOW INDICATORS ARE TAPPED ON BOTH SIDES OF THE 8 mm ORIFICE.
4. WHEN DEMAND FOR MR OCCURS, SUCH AS TRAIN SEPARATION, ORIFICE AND ORIFICE.
5. IF PRESSURE IS DROPING FASTER AT THIS POINT THAN UPSTREAM, GIVING THE ENGINEER A VISUAL INDICATION OF EXCESSIVE AIR FLOW.
FIGURE 1-10 FAST RECHARGE

1. BVC HANDLE IS MOVED TO RELEASE, AIR CLOSES.
2. SS9 SENSES AIR SWITCH & INPUTS INFORMATION TO CPZ.
3. CPZ OUTPUTS SIGNALS TO BPV, WHICH IN TURN SIGNALS DB1 TO ENERGIZE MVBP.
4. MVBP OPENS TO SUPPLY MR TO BPV. PILOT PORT PRESSURIZES 4 mm ORIFICE AND FLOW THROUGH.
5. THE PRESSURE & ORIFICE SWAPS THE PRESSURE & ORIFICE.
6. WITH MORE CAPACITY, THE BP RELAY CAN CHARGE TIL BRAKE PIPE FASTER.
7. PBVBP SWITCH OPENS, THIS SIGNAL IS SENT TO THE CPZ VIA SS9 AND IS USED FOR DIAGNOSTICS.

NOTES:
FIGURE 1-11 OVERCHARGE AND ASSIMILATION
FIGURE 1-12 BRAKE PIPE TRANSUDER CIRCUIT

NOTES:
1. BPT INPUTS VOLTAGE TO THE CPZ PCB PROPORTIONAL TO THE BRAKE PIPE PRESSURE.
2. CONVERSIONS:
   3 kPa/mbar
   0.01428 MPa/kPa
   1 kPa/0.1428 MPa

CPZ
DATA
ADZ
EPA-1

5 VDC
COMMON
5-4.5 SIGNAL
TEST FITTING
FILTER
BLK RED WHI
B3 a0 c6

BRK PIPE
FIGURE 1-13 #16 PIPE CONTROL CIRCUIT - BRAKE RELEASE
FIGURE 1-14 AUTOMATIC RELEASE BRAKE CYLINDER PRESSURE CONTROL
FIGURE 1-15 BRAKE CYLINDER EQUALIZING PIPE CONTROL
RELEASE OR RUN - LEAD UNIT - LEAD IN / LEAD OUT
FIGURE 1-16 ER CONTROL CIRCUIT - MINIMUM SERVICE POSITION - LEAD-IN

NOTES

1. BY MOVING TO MINIMUM SERVICE POSITION, PRESSURE VIA COP TO CPU VIA ERT ENGINES IN ACCELERATION MODE password for CPU REGULATES THE ERT ALGORITHM BASED ON THE COMMAND LEVER LEVEL BY THE CPU VIA CPZ. 
2. ERT FEEDS BACK PRESSURE VIA CPA TO CPU VIA ERT ALGORITHM BASED ON THE COMMAND LEVER LEVEL BY THE CPU VIA CPZ. 
3. CPA ENGINES IN ACCELERATION MODE password for CPU REGULATES THE ERT ALGORITHM BASED ON THE COMMAND LEVER LEVEL BY THE CPU VIA CPZ. 
4. CPA ENGINES IN ACCELERATION MODE password for CPU REGULATES THE ERT ALGORITHM BASED ON THE COMMAND LEVER LEVEL BY THE CPU VIA CPZ. 
5. CPA ENGINES IN ACCELERATION MODE password for CPU REGULATES THE ERT ALGORITHM BASED ON THE COMMAND LEVER LEVEL BY THE CPU VIA CPZ. 
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7. CPA ENGINES IN ACCELERATION MODE password for CPU REGULATES THE ERT ALGORITHM BASED ON THE COMMAND LEVER LEVEL BY THE CPU VIA CPZ.
FIGURE 1-17 ER CONTROL CIRCUIT - FULL SERVICE POSITION - LEAD-IN
FIGURE 1-18 ER CONTROL CIRCUIT - SERVICE POSITION/LAP - LEAD-IN
FIGURE 1-19 ER/BP PNEUMATIC CONTROL CIRCUIT - LEAD-IN

AW4-ER SUP. M.V. - DE-ENERGIZED
AW4-ER EXH. M.V. - ENERGIZED
MV53 - DE-ENERGIZED
MVER - ENERGIZED
FIGURE 1-20 ER CONTROL CIRCUIT - EMERGENCY POSITION - LEAD-IN
FIGURE 1-21 EMERGENCY CIRCUIT - ANY EMERGENCY
FIGURE 1-22  PNEUMATIC EMERGENCY CONTROL CIRCUIT - EQUALIZING RESERVOIR AND BRAKE PIPE
FIGURE 1-23 BRAKE PIPE CUTOFF - BRAKE VALVE IN EMERGENCY - LEAD-IN

NOTES:
1. BRAKE PIPE RATE OF REDUCTION SENDED BY BPT & INPUTS SIGNAL TO CPZ VIA DATA BUS.
2. MV53 IS ENERGIZED BY THE COMPUTER VIA EPA1 AND DB1.
3. MV53 PILOTS CUTOFF VALVE CLOSED.
4. MV53 PILOTS CUTOFF VALVE OPENING FROM KT5 RELAY.
5. BRACE PIPE AT ZERO WAG.
6. BPCO SWITCH USED FOR DIAGNOSTICS ONLY.
FIGURE 1-24 #16 PIPE CONTROL CIRCUIT - MINIMUM SERVICE POSITION

NOTES:
1. THIS POSITION INCREASES #16 PIPE VOLUME PRESSURE TO 1.1 kgc/m².
2. BRAKE PIPE REDUCTION VOLUME IS SENSED BY BPT VIA EPA2 AND AZ.
3. CPU CALCULATES PRESSURE AND COMMANDS THE EPA2 TO ENERGIZE.
4. BRAKE PIPE FEEDS BACK VOLTAGE PROPORATIONAL TO #16 VOLUME.
5. BRAKE PIPE VOLUME REMAINS OFF.
6. 16T TRANSPUCER FEEDS BACK A VOLTAGE PROPORATIONAL TO #16 VOLUME.
7. WHEN PRESSURE REACHES 1.1 kgc/m², SUP MV SLOWLY CLOSES.
FIGURE 1-25 #16 PIPE CONTROL CIRCUIT - FULL SERVICE POSITION
FIGURE 1-26 #16 PIPE CONTROL CIRCUIT - EMERGENCY POSITION

NOTES
1. THIS POSITION INCREASES #16 VOLUME TO 4.37 kN/cm².
2. BRAKE PIPE REDUCTION IS SENSED BY BPT.
3. BRAKE PIPE VOLUME READS VIA CPU VIA EP42 AND ADZ.
4. CPU CALCULATES PRESSURE AND COMMANDS THE EP42 TO ENERGIZE.
5. BRAKE PIPE VOLUME READS VIA CPU VIA ADZ.
6. 167 TRIGGER FEEDS BACK A VOLUME PROPORTIONAL TO #16 VOLUME.
7. WHEN PRESSURE REACHES COMMAND 4.37 kN/cm², SUP MV SLOWLY CLOSES.

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FIGURE 1-27 #16 PIPE CONTROL CIRCUIT - LAP POSITION
FIGURE 1-28 AUTOMATIC APPLICATION AND LAP - BRAKE CYLINDER CONTROL

AW4-16 SUP. MV - ENERGIZED
AW4-16 EXH. MV - DE-ENERGIZED
MV16T - ENERGIZED
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FIGURE 1-31 BCEP - AUTOMATIC APPLICATION - SERVICE OR EMERGENCY - LEAD UNIT
FIGURE 1-32 BCEP - BAILOFF (QUICK RELEASE) - SERVICE OR EMERGENCY - LEAD UNIT

NOTES:
1. THIS POSITION CONTROLS THE FLOW OF AIR FROM THE BCEP TO ATMOSPHERE WHEN THE DIRECT BRAKE HANDLE IS IN BAILOFF.
2. THE PRESSURE IS VARIED BETWEEN 0 & 3.6 kg/cm².
3. THE TRANSDUCER (20T) FEEDS BACK PRESSURE FROM BCEP.
4. IN THIS MODE, BCEP WILL BE VENTED VIA THE 20R RELAY.
5. BAILOFF RELEASE OF BRAKES WILL BE FASTER THAN A NORMAL AUTOMATIC RELEASE.
FIGURE 1-33 AUTOMATIC BRAKE - BRAKE RELEASE - TRAIL UNIT

AW4-ER SUP. M.V. - DE-ENERGIZED
AW4-ER EXH. M.V. - ENERGIZED
MV53 - ENERGIZED
MVER - ENERGIZED
FIGURE 1-34 BRAKE PIPE CHARGING CUT OFF - TRAIL OPERATION
FIGURE 1-35 AUTOMATIC BRAKE RELEASE - TRAIL POSITION
FIGURE 1-36 AUTOMATIC APPLICATION - TRAIL POSITION

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<td>MVLT</td>
<td>DE-ENERGIZED</td>
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AW4-16 SUP. MV - ENERGIZED
AW4-16 EXH. MV - DE-ENERGIZED
MV16T - ENERGIZED
BC RELAY - SUPPLY OPEN
FIGURE 1-37 DIRECT BRAKE - BCEP APPLICATION - LEAD UNIT
FIGURE 1-38 DIRECT BRAKE - BCEP RELEASE - LEAD UNIT

AW4-20 SUP. M.V. - DE-ENERGIZED
AW4-20 EXH. M.V. - ENERGIZED
MVLT - ENERGIZED

AW4-16 SUP. MV - DE-ENERGIZED
AW4-16 EXH. MV - ENERGIZED
MV16T - ENERGIZED

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FIGURE 1-39 DIRECT BRAKE - TRAIL POSITION
FIGURE 1-40 LOCOMOTIVE CONSIST SEPARATION - LEAD UNIT
FIGURE 1-41 LOCOMOTIVE CONSIST SEPARATION - TRAIL UNIT
FIGURE 1-42 LOSS OF POWER BRAKE APPLICATION - LEAD UNIT
FIGURE 1-43 LOSS OF POWER BRAKE APPLICATION - TRAIL UNIT
### 2.1 COMPONENT DESCRIPTION

The following provides information regarding the construction, function and/or other important features of the major components that make up the CCB/INDIAN RAILWAYS Brake System.

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<th>COMPONENT</th>
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CHAPTER 3

PREPARATION FOR MAINTENANCE

3.1 General Information

This chapter covers the safety and assembly precautions that must be taken at all times when performing the work procedures described in Chapter 4 of this Manual.

3.2 Safety Precautions

To prevent physical injury or death, all personnel directly or indirectly involved with the maintenance, repair, overhaul and/or inspection of the equipment described in this Manual must conform to the following:

3.2.1 Observe all Indian Railways rules and regulations. Whenever there is a conflict between the instructions given below and in this manual, INDIAN Railway rules and regulations will govern.

3.2.2 When performing any test work on devices or equipment while they are on the vehicle (on locomotive test, etc.) special precautions must be taken to ensure that vehicle movement will not occur which could result in injury to personnel and/or damage to equipment. Make sure the hand brake is applied and that the wheels are chocked to prevent vehicle from moving.

3.2.3 Dangerous voltages are present throughout the locomotive. Always exercise extreme care when working in close proximity to electrically-energized apparatus or when making current measurements. To prevent receiving electrical shock when performing electrical tests, hands must be clear of electrical components, contacts and housing, and there must be no bodily contact with the work area. Failure to heed this warning could result in severe injury or death.

Shut off locomotive power and open air brake circuit breaker (ABCB) whenever continuity is to be checked or when handling equipment connections. When shutting off power by means of knife or switch:

(a) Attach an approved WARNING tag to the open breaker.

3.2.4 De-pressurize air system before loosening connections or components. Before removing any component from its mountings, the train must be safely parked. To prevent personal injury, all main reservoir, brake supply reservoir, and brake cylinder on the affected locomotive must be vented.

"Bottled" up air under pressure (even though air supply is cut off) may cause gaskets and/or particles of dirt to become airborne and an increase in sound level when any component part is removed from the equipment arrangement. Personal eye and ear protection must be worn and care taken to avoid possible injury when performing any work on these component parts.

3.2.5 The use of an air jet, which must be less than 2 kg/cm², to blow parts clean or to blow them dry after being cleaned with a solvent will cause particles of dirt and/or droplets of the cleaning solvent to be airborne. These particles and droplets may cause skin and/or eye irritation. Personal eye protection must be worn to protect the eyes from possible injury. When using an air jet do not direct it toward another person. Improper use of air jet could result in bodily injury.
3.2.6 If degreasing fluids are used for cleaning purposes, the current local safety regulations plus the safety precautionary statements of the manufacturer of the cleaning agent must be adhered to. Otherwise, physical harm could result from the inhalation of toxic fumes. Make sure the area is well ventilated when working with materials which produce harmful fumes.

3.2.7 Personal eye protection must be worn when doing any work to protect eyes from possible injury.

3.2.8 When performing maintenance procedures on system components, assemblies may be under a spring load. Exercise caution during disassembly so that no parts "Fly Out" and cause bodily injury.

3.2.9 Where fasteners removed from the locomotive equipment are not satisfactory for reuse, care must be taken to select replacements that match the originals. Mismatched or incorrect fasteners can result in equipment damage or malfunction, or possible personal injury.

3.2.10 Follow all WARNING, CAUTIONS, and NOTES found throughout this Manual. If you must use a work procedure or tool which is not recommended, you must first satisfy yourself that neither your safety, your fellow workers safety, nor that of the equipment will be jeopardized by the method selected.

3.2.11 Appropriate tool selection is required when performing all maintenance operations to avoid personal injury.

3.2.12 Person(s) having the appropriate job skill level, as governed by Indian Railways, are required to be present when performing maintenance and/or operational tasks with the brake system and system components.

3.3 Component Assembly Precautions

To prevent accidental damage to or the malfunction of the system components or entire brake system, the following must be adhered to:

3.3.1 Open air brake circuit breaker when any welding is done near CCB Brake Equipment.

3.3.1.1 Make sure the CRU/PCU is properly grounded (one ground strap on CRU and one ground strap on PCU, grounding studs provided on NYAB units).

3.3.1.2 CRU cover must be installed during welding.

3.3.1.3 Protect all cabling from weld splatter.

3.3.1.4 If pipes are not installed, protect ports so welding splatter cannot enter the PCU ports.

CAUTION: Place welding ground near the piece to be welded so that current will not flow through the Electronic Brake unit.
3.3.1.5 If welding on a pipe connected to the PCU:
- Place the welding ground on the pipe away from the PCU.
- If welding on PCU piping within 6 ft. of the PCU, insert a shim to blank off the port.
- After welding, remove the shim and blow air back thru the piping to clear out any weld splatter or pipe scale.

3.3.2 To ensure the correct functioning of each component, use only the manufacturers genuine spare parts as replacements.

3.3.3 Although the component parts of identical valves are interchangeable, it is generally preferable to refit serviceable used parts in the valve from which they have been dismantled. When possible, the component parts of each valve should be grouped together after dismantling, cleaning, etc.

3.3.4 The solvent used for cleaning the metal parts MUST be an aliphatic organic solution, such as mineral spirits or naphtha, that will dissolve oil or grease and that will permit all parts to be cleaned without abrasion.

3.3.5 Many of the component parts have a fine surface finish and must be handled carefully to avoid accidental damage. A clean well-lit work bench is essential. A linoleum topped wooden work bench provides an ideal working surface. If a metal topped work bench is used, some form of protection must be provided in order to avoid brushing any metal parts, which might accidentally strike the bench top.

3.3.6 The work area should be clean. The locomotive equipment must be clean and located in the assigned maintenance area.

3.3.7 Whenever a valve or system component is removed from a vehicle for any reason, and it is reinstalled or replaced with a new or repaired and tested component, a stationary vehicle air brake test and an equipment test must be performed to ensure that the component functions properly within the system.

3.3.8 Before a valve or system component is installed on a vehicle, the valve or component must have successfully passed an approved code of tests for that valve component when such is required.

3.3.9 Appropriate tool selection is required when performing maintenance operations to avoid unwarranted equipment damage.

3.3.10 When air pressure measurements are to be made for the purpose of pressure level verification and/or adjustment, a digital test gauge having an accuracy of ± 0.03 kg/cm² is required.
CHAPTER 4
SCHEDULED INSPECTION

4.1 General Information

This chapter provides recommendations regarding scheduled maintenance to be performed on the CCB Brake System.

4.2 Inspections

The CCB brake system must be inspected at the intervals prescribed in this section.

The preventative maintenance schedule as established by Indian Railways consists of an inspection performed at 92 day intervals.

WARNING

BEFORE ATTEMPTING TO SERVICE, INSPECT, TROUBLE-SHOOT, REMOVE OR REPAIR ANY COMPONENTS OF THE BRAKE SYSTEM, THE SAFETY PRECAUTIONS OUTLINED IN CHAPTER 3 MUST BE ADHERED TO.

4.3 92 Day Inspection

Identification and location of components is shown on figures 4-1 and 4-2.

4.3.1 Air Pressure Test

Reference Chapter 5, Section 5.2.3.
4.4 EQUIPMENT REPLACEMENT, REPAIR AND OVERHAUL

4.4.1 Equipment Replacement

In the event that a component of the Indian Railways Brake System requires removal and/or replacement, the procedures given in Chapter 6, Equipment Replacement should be followed.

The suggested guidelines for component overhaul of the Indian Railways Brake System are listed in the schedule below.

4.4.1.1 Annual

Clean all air filters or replace if damaged

4.4.1.2 5 Years (Per FRA waiver H-95-3)

Brake Controller - Overhaul (Pneumatic vent valve only!)
Pneumatic Control Unit - Overhaul
CHAPTER 5
ON-LOCOMOTIVE EQUIPMENT CHECKOUT AND ANALYSIS

5.1 GENERAL INFORMATION:

This chapter provides recommendations regarding equipment checkout and analysis to be performed on the Knorr CCB Brake System for Indian Railways. Whenever there is a suspected brake problem or degraded brake performance, it is necessary for that locomotive to have an equipment checkout and analysis performed to locate and correct the problem. The following instructions should also be used when normal equipment inspections are performed.

Figure 5-1 shows an average Test Gage Panel that should be attached to the Pneumatic Control Unit’s (PCU) test ports during testing.
## Abbreviation Legend

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<th>Abbreviation</th>
<th>Word or Phrase</th>
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<td>AIR BRAKE CIRCUIT BREAKER</td>
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<td>BP</td>
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<td>BPA</td>
<td>BRAKE PIPE FLOW INDICATOR PORT 2</td>
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<td>BPCO</td>
<td>BRAKE PIPE CUT-OFF VALVE (CLOSES BP 20 PSI DECR.)</td>
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<td>BRAKE PIPE DEAD ENGINE</td>
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<td>BRAKE PIPE GAUGE PORT</td>
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<td>BRAKE PIPE - PRESSURE SWITCH</td>
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### Abbreviation

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### 5.3 Engineering Test Instructions

The following Test is issued and approved by The Electro-Motive Division of General Motors Corporation.
NOTE:

The Multiple Unit Test can be done either with using the Test Cart Method or using the Two Locomotive Method. It does not have to be done both ways.
PURPOSE:

This test instruction is to provide a test code for the microprocessor controlled brake system as applied to the GT46MAC locomotive.

SCOPE:

This procedure is issued to provide a test code for the Knorr CCB brake system which has the following features:

I. EM2000 serial interface

NOTES:

I. Since the brake equipment is electronically controlled, battery power is required. It may be desirable to conduct all testing with the locomotive running. Follow shop rules regarding running locomotives.

II. A minimum main reservoir pressure of 120 psi is required for the test procedure.

III. Loss of main power to the CCB brake system will cause the alarm bell to sound.

IV. The CCB system is equipped with a pneumatic back up that operates in parallel to the microprocessor control and is always in operation. Upon system power up, there are certain conditions that must be satisfied before the microprocessor system gains control of the brake system. Until that time, the locomotive brakes are under control of the pneumatic back up system.

V. If the CCB system set up is for LEAD-IN on power up, the computer will not take control of the brake system until the automatic brake handle is moved to the FULL SERVICE position for a minimum of 10 seconds and returned to the RUNNING position and brake cylinder pressure is zero psi. If the Automatic brake valve handle had previously been placed in Emergency position, then the handle must remain in the emergency position for 60 seconds.

VI. If the CCB system is set up is for TRAIL or LEAD-OUT on power up, the computer will not take control of the brake system until brake cylinder pressure is zero psi.

EQUIPMENT:

The system includes the following main components:

I. Brake Valve Controller - There are two brake valve controllers in the cab. The brake valve controller includes one automatic and one independent brake control handle. The brake valve controllers are the operator interface to the brake system.

II. Brake Bay Equipment Rack which Includes:
A. Computer Relay Unit (CRU) - The computer relay unit contains the brake control computer used for control of the brake system. It also contains the input interface circuit boards and output relays for interface with the locomotive control system.

B. Pneumatic Control Unit (PCU) - The pneumatic control unit includes the equipment required to operate the pneumatic system. The pneumatic control unit is the interface to the locomotive air system.

C. Voltage Conditioning Unit (VCU) - The voltage conditioning unit is the main power supply for the CCB system. The VCU reduces the 73.5 volts DC to a filtered 24 volts DC to the CRU.

D. Dead In Tow (KE) Valve - The KE valve provides pneumatic back up functions to allow basic air brake functions in the event of failure of the microprocessor control. When the locomotive is in back up mode using the KE valve, operation of the locomotive is possible only in the trail mode.

III. EM2000 System Interface - The EM 2000 interface is provided for all air brake I/O’s except the PCR. Blending will be provided on future Passenger locomotives.

PRECAUTIONS:

Due to the characteristics of the brake equipment, the following precautions must be observed:

I. All cables and input wires to the CRU, CPU and VCU must be connected at all times while the equipment is on.

II. All cables and input wires to the CRU, CPU and VCU must be disconnected during all meggaring, hi-potting and welding.

III. Since the brakes will periodically be released during the test, the wheels must be blocked.

SERIAL NUMBERS:

Record the following serial numbers:

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<th>Serial Number</th>
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<td>Brake Bay Equipment Rack</td>
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<td>Computer Relay Unit</td>
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<tr>
<td>Voltage Control Unit</td>
<td>775145</td>
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</table>

Stamp each paragraph upon completion

I. TEST PREPARATION:
A. Check that all piping and wiring is complete and all unused wires are tied back.

B. Apply a brake cylinder pressure test gauge at the BC pressure tap fitting on the Pneumatic Control Unit. Use this gauge for BC timing, and during CCB and EM2000 loss of power tests as noted.

C. Apply an equalizing reservoir pressure test gauge at the ER pressure tap on the Pneumatic Control Unit. Use this gauge for ER timing, and during CCB and EM2000 loss of power tests as noted.

D. Apply a brake pipe pressure test gauge at the BP pressure tap fitting on the Pneumatic Control Unit. Use this gauge for BP as noted during CCB and EM2000 loss of power tests.

E. Apply a Brake Cylinder Equalizing pipe test point at the 20 pipe test point.

F. Close the Dead Engine cut out cock.

G. Block the locomotive wheels and apply the parking brake.

H. Close MR filter drain valves.

I. Close manual MR drain valves.

J. If the engine will not be running during testing, connect the unit to a clean and dry air supply that is a minimum of 8.3 kg/cm² and is capable of meeting the air demands of the air system.

K. Close all unused end connection cut out cocks.

L. Close the emergency brake valves.

M. Open the #2 main reservoir cut out cock, auxiliary main reservoir cut out cock and brake cylinder cut out cocks. Cut in all auxiliaries, bell, sanders, etc.

N. Check the air compressor control settings using a test gauge at the main reservoir test fitting provided on the equipment rack.

Since the EM2000 system is required for brake system functions, the EM2000 system must be qualified prior to qualification of the locomotive brake system.

II. SYSTEM POWER UP AND SET UP:

A. Pass/Goods switch must be set to GOODS position.
B. Move the automatic handle to the FULL SERVICE position and leave there for 40 seconds to reset system.

C. Place the independent handle in the RELEASE position.

D. Close the battery knife switch, EM2000 control circuit breaker, local control circuit breaker, control circuit breaker, control and fuel pump switch, and the computer control breaker.

E. If the engine will be running during the test, close all circuit breakers and switches so required.

F. Set the brake system to LEAD-IN via the Lead-Trail switch on the console.

G. Note that after the EM2000 system is running and has been initialized, close the air brake circuit breaker. The current air brake pressures and brake system status will be displayed on the cab pressure gauges.

H. Place the automatic handle to the RUNNING position and allow system to fully charge for three minutes. Note that the equalizing reservoir is 5.2 ± 0.07 kg/cm² (73.5 ± 1 psi) and that brake pipe is within 0.07 kg/cm² (1 psi) of equalizing gauge display. Note that brake cylinder pressure reduces to zero.

NOTE: If brake pipe fails to charge, place the automatic handle into the FULL SERVICE position for a minimum of 10 seconds. Return the automatic handle to the RUNNING position and note brake pipe charges to within 0.07 kg/cm² of equalizing reservoir gauge display.

I. Check all gauges for accuracy to within 0.07 kg/cm².

III. MAIN RESERVOIR AND RELATED PIPING LEAKAGE TEST:

A. If the locomotive is running during main reservoir leakage test, the manual override on the air compressor magnet valve must be used to keep the air compressor unloaded during the main reservoir leakage test. Condition both automatic MR drain valves not to function during the main reservoir leakage test.

B. Check main reservoir and related piping for leaks. Leakage must not exceed 0.07 kg/cm²/min in a three minute test after main reservoir has been reduced to 40 psi below maximum pressure. When soaping for leakage, make certain that the line being soaped has air in it and all connections are mechanically tight. Repair all leaks before proceeding.
IV. BRAKE PIPE AND EQUALIZING RESERVOIR LEAKAGE
Controller #1

A. With the brake system fully charged (ER at 5.2 kg/cm² ± 0.07 kg/cm² (73.5 ± 1 psi), BP within 0.07 kg/cm² of ER), move the automatic handle of Controller #1 into the MINIMUM SERVICE position until ER gauge display has reduced to 4.7 ± 0.07 kg/cm² (67 ± 1 psi).

1. Note that BP gauge display reduces to within 0.07 kg/cm² (1 psi) of ER gauge.

B. Set the brake system to LEAD-OUT.

C. Move the automatic handle to the SERVICE position to reduce ER Test gauge pressure to 3.5 ± 0.07 kg/cm² (50 ± 1 psi).

D. Observe the BP and ER gauge displays for one minute and note the following:

1. BP does not reduce with ER.
2. BP does not reduce by more than 0.07 kg/cm² (1 psi).
3. BP pressure must not increase.
4. ER pressure remains at 3.5 ± 0.07 kg/cm² (50 ± 1 psi).

E. Place the automatic handle to the RUNNING position and note ER gauge pressure increases to 5.2 ± 0.07 kg/cm² (73.5 ± 1 psi).

F. Observe the BP gauge display for one minute and note that BP pressure must not increase.

G. Set the brake system to LEAD-IN and note BP charges to within .07 kg/cm² of ER.

V. AUTOMATIC BRAKE OPERATION - GOODS MODE
Controller #1

A. Place the Pass / Goods switch to Goods position.

B. Allow the brake system to recharge for a minimum of one minute and note the following:

1. ER Test gauge display is 5.2 ± .07 kg/cm² (73.5 ± 1psi).
2. BP Test gauge display is within 0.07 kg/cm\(^2\) (1 psi) of ER. 

3. BC Test gauge display is zero.

4. BCEP (20 Pipe test point) Test gauge display is zero

5. PC indicator is not lit.

C. Momentarily place the automatic handle to the MINIMUM SERVICE position, to reduce ER to 4.7 ± 0.07 kg/cm\(^2\) (67 ± 1 psi) and note the following:

1. BP reduces to within 0.07 kg/cm\(^2\) (1 psi) of ER.

2. BC applies to 1.1 ± 0.14 kg/cm\(^2\) (16 ± 2 psi).

3. BCEP applies to 0.9 ± 0.14 kg/cm\(^2\) (13 ± 2 psi)

D. Continue moving the automatic handle into SERVICE positions to reduce ER in 0.5 kg/cm\(^2\) (7.1 psi) increments until ER has decreased to 3.5 ± 0.07 kg/cm\(^2\) (50 ± 1 psi) and note the following:

1. Each step results in the reduction of ER and BP displays.

2. BP is within 0.07 kg/cm\(^2\) (1 psi) of ER gauge display.

3. With each decreasing step of ER and BP, a corresponding increase of BC pressure occurs to a maximum of 4.4 ± 0.14 kg/cm\(^2\) (62 ± 2 psi).

E. Move the automatic handle to the RUNNING position and note the following:

1. BC gauge display reduces from the maximum value to 0.4 kg/cm\(^2\) (6 psi) in 45 to 60 seconds and continues to zero when brakes are released.

2. ER display increases to 5.2 ± 0.07 kg/cm\(^2\) (73.5 ± 1 psi).

3. BP gauge display is within 0.07 kg/cm\(^2\) (1 psi) of ER.

F. Allow one minute for the system to fully recharge.

G. Move the automatic handle to the RELEASE position and note the following: (Assimilation test)
1. ER gauge display increases to 5.7 ± 0.07 kg/cm² (81 ± 1 psi) in 12 to 14 seconds. ____________

2. BP gauge display is within 0.07 kg/cm² (1 psi) of ER. ____________

3. BC & BCEP gauge remains at zero. ____________

H. Note that ER reduces to 5.2 ± 0.07 kg/cm² (73.5 ± 1 psi) in less than 5.5 minutes. ____________

1. BP gauge display is within 0.07 kg/cm² (1 psi) of ER. ____________

I. Move the automatic handle directly to the FULL SERVICE position. Note the following:

1. ER test gauge reduces to 3.6 kg/cm² (50 psi) in 6-10 seconds and continues to reduce to 3.5 ± 0.07 kg/cm² (50 ± 1 psi). ____________

2. BC test gauge increases from zero to 4.15 kg/cm² (59 psi) in 18 to 22 seconds. ____________

3. BC test gauge continues to charge to 4.4 ± 0.14 kg/cm² (62 ± 2 psi). ____________

J. Move the automatic handle to the RUNNING position and note the following:

1. ER charges to 5.2 ± 0.07 kg/cm² (73.5 ± 1 psi). ____________

2. BP charges within 0.07 kg/cm² (1 psi) of ER. ____________

3. BC pressure reduces to zero. ____________

K. Place the automatic handle directly to the FULL SERVICE position to reduce ER to 3.5 ± 0.07 kg/cm² (50 ± 1 psi). Note the following:

1. BCEP test gauge increases from zero to 3.4 kg/cm² (48 psi) in 18 to 22 seconds. ____________

2. Continues to charge to 3.6 ± 0.14 kg/cm² (51 ± 2 psi). ____________

L. Place the automatic handle in the RUNNING position and allow one minute for the system to fully charge. ____________

M. Place the automatic handle in the EMERGENCY position and note the following:
1. BP pressure rapidly reduces to zero.

2. PCS Open is indicated.

3. ER pressure reduces to zero.

4. BC gauge increases from zero to 4.15 kg/cm² (59 psi) in 18 to 20 seconds.

5. BC continues to charge to 4.4 ± 0.1 kg/cm² (62 ± 2 psi).

6. Automatic emergency timed sanding is provided for 60 ± 5.0 seconds.

7. After 60 seconds, the emergency can be reset.

N. Place the automatic handle to the RUNNING position, allow one minute for the system to fully charge and note the following:

1. ER gauge display is 5.2 ± 0.07 kg/cm² (73.5 ± 1 psi).

2. BP gauge display is within 0.07 kg/cm² (1 psi) of ER.

3. BC and BCEP gauge display reduces to zero.

4. PCS open is not indicated.

O. Open the Driver’s emergency brake valve and note the following:

1. BP pressure rapidly reduces to zero.

2. PCS is indicated after approximately 20 seconds.

3. BC gauge increases from zero to 4.15 kg/cm² (59 psi) in 18 to 20 seconds.

4. BC continues to charge to 4.4 ± 0.14 kg/cm² (62 ± 2 psi).

5. Automatic emergency timed sanding is provided for 60 ± 5.0 seconds.

6. Allow 60 seconds before the emergency can be reset.

7. Close the emergency brake valve.

P. Open the Driver Assistant’s emergency brake valve and note the following:
1. BP pressure rapidly reduces to zero. 

2. PCS is indicated after approximately 20 seconds. 

3. BC gauge increases from zero to 4.1 kg/cm² (59 psi) in 18 to 20 seconds. 

4. BC continues to charge to 4.4 ± 0.14 kg/cm² (62 ± 2 psi). 

5. Automatic emergency timed sanding is provided for 60 ± 5.0 seconds. 

6. Allow 60 seconds before the emergency can be reset. 

7. Close the emergency brake valve. 

Q. Place the automatic handle to the RUNNING position, and note the following: 

1. ER gauge display is 5.2 ± 0.07 kg/cm² (73.5 ± 1 psi). 

2. BP gauge display is within 0.07 kg/cm² of ER. 

3. BC pressure is zero. 

4. PCS Open is not indicated. 

5. Set Controller #1 to Trail, then Controller #2 to Lead-Out. Move Automatic handle to Running position to charge ER. 


VI. BRAKE PIPE AND EQUALIZING RESERVOIR LEAKAGE: Controller #2 

A. With the brake system fully charged (ER at 5.2 kg/cm² ± 0.07 kg/cm² (73.5 ± 1 psi), BP within 0.07 kg/cm² of ER), move the automatic handle of Controller #1 into the MINIMUM SERVICE position until ER gauge display has reduced to 4.7 ± 0.07 kg/cm² (67 ± 1 psi). 

1. Note that BP gauge display reduces to within 0.07 kg/cm² (1 psi) of ER gauge. 

B. Set the brake system to LEAD-OUT.
C. Move the automatic handle to the SERVICE position to reduce ER Test gauge pressure to $3.5 \pm 0.07$ kg/cm$^2$ (50 ± 1 psi).

D. Observe the BP and ER gauge displays for one minute and note the following:
   1. BP does not reduce with ER.
   2. BP does not reduce by more than 0.07 kg/cm$^2$ (1 psi).
   3. BP pressure must not increase.
   4. ER pressure remains at $3.5 \pm 0.07$ kg/cm$^2$ (50 ± 1 psi).

E. Place the automatic handle to the RUNNING position and note ER gauge pressure increases to $5.2 \pm 0.07$ kg/cm$^2$ (73.5 ± 1 psi).

F. Observe the BP gauge display for one minute and note that BP pressure must not increase.

G. Set the brake system to LEAD-IN and note BP charges to within 0.07 kg/cm$^2$ of ER.

VII. AUTOMATIC BRAKE OPERATION - GOODS MODE:

Controller #2

A. Allow the brake system to recharge for a minimum of one minute and note the following:
   1. ER Test gauge display is $5.2 \pm 0.07$ kg/cm$^2$ (73.5 ± 1 psi).
   2. BP Test gauge display is within 0.07 kg/cm$^2$ (1 psi) of ER.
   3. BC Test gauge display is zero.
   4. BCEP (20 Pipe test point) Test gauge display is zero
   5. PC indicator is not lit.

B. Momentarily place the automatic handle to the MINIMUM SERVICE position, to reduce ER to $4.7 \pm 0.07$ kg/cm$^2$ (67 ± 1 psi) and note the following:
   1. BP reduces to within 0.07 kg/cm$^2$ (1 psi) of ER.
   2. BC applies to $1.1 \pm 0.14$ kg/cm$^2$ (16 ± 2 psi).
3. BCEP applies to $0.9 \pm 0.14$ kg/cm$^2$ $(13 \pm 2$ psi).

C. Continue moving the automatic handle into SERVICE positions to reduce ER in $0.5$ kg/cm$^2$ $(7.1$ psi) increments until ER has decreased to $3.5 \pm 0.07$ kg/cm$^2$ $(50 \pm 1$ psi) and note the following:

1. Each step results in the reduction of ER and BP displays.
2. BP is within $0.07$ kg/cm$^2$ $(1$ psi) of ER gauge display.
3. With each decreasing step of ER and BP, a corresponding increase of BC pressure occurs to a maximum of $4.4 \pm 0.14$ kg/cm$^2$ $(62 \pm 2$ psi).

D. Move the automatic handle to the RUNNING position and note the following:

1. ER display increases to $5.2 \pm 0.07$ kg/cm$^2$ $(73.5 \pm 1$ psi).
2. BP gauge display is within $0.07$ kg/cm$^2$ $(1$ psi) of ER.
3. BC gauge display reduces from the maximum value to $0.4$ kg/cm$^2$ $(6$ psi) in 45 to 60 seconds and continues to zero when brakes are released.

E. Allow one minute for the system to fully recharge.

F. Move the automatic handle to the RELEASE position and note the following: (Assimilation test)

1. ER gauge display increases to $5.7 \pm 0.07$ kg/cm$^2$ $(81 \pm 1$ psi).
2. BP gauge display is within $0.07$ kg/cm$^2$ $(1$ psi) of ER.
3. BC & BCEP gauge remains at zero.

G. Note that ER reduces to $5.2 \pm 0.07$ kg/cm$^2$ $(73.5 \pm 1$ psi).
1. BP gauge display is within $0.07$ kg/cm$^2$ $(1$ psi) of ER.

H. Move the automatic handle directly to the FULL SERVICE position. Note the following:

1. ER test gauge reduces to $3.6$ kg/cm$^2$ $(50$ psi) in 6-10 seconds and continues to reduce to $3.5 \pm 0.07$ kg/cm$^2$ $(50 \pm 1$ psi).
2. BC test gauge increases from zero to 4.15 kg/cm² (59 psi) in 18 to 22 seconds.

3. BC test gauge continues to charge to 4.4 ± 0.14 kg/cm² (62 ± 2 psi).

I. Move the automatic handle to the RUNNING position and note the following:

1. ER charges to 5.2 ± 0.07 kg/cm² (73.5 ± 1 psi).

2. BP charges within 0.07 kg/cm² (1 psi) of ER.

3. BC pressure reduces to zero.

J. Place the automatic handle directly to the FULL SERVICE position to reduce ER to 3.5 ± 0.07 kg/cm² (50 ± 1 psi). Note the following:

1. BCEP test gauge increases from zero to 3.4 kg/cm² (48 psi) in 18 to 22 seconds.

2. Continues to charge to 3.6 ± 0.14 kg/cm² (51 ± 2 psi).

K. Place the automatic handle in the RUNNING position and allow one minute for the system to fully charge.

L. Move Reverser handle to forward position.

M. Place the automatic handle in the EMERGENCY position and note the following:

1. BP pressure rapidly reduces to zero.

2. PCS Open is indicated.

3. ER pressure reduces to zero.

4. BC gauge increases from zero to 4.15 kg/cm² (59 psi) in 18 to 20 seconds.

5. BC continues to charge to 4.4 ± 0.1 kg/cm² (62 ± 2 psi).

6. Automatic emergency timed sanding is provided for 60 ± 5.0 seconds.

7. After 60 seconds, the emergency can be reset.
N. Place the automatic handle to the RUNNING position, allow one minute for the system to fully charge and note the following:

1. ER gauge display is $5.2 \pm 0.07$ kg/cm$^2$ (73.5 ± 1 psi).  

2. BP gauge display is within 0.07 kg/cm$^2$ (1 psi) of ER.  

3. BC and BCEP gauge display reduces to zero.  

4. PCS open is not indicated.  

O. Open the Driver’s emergency brake valve and note the following:

1. BP pressure rapidly reduces to zero.  

2. PCS is indicated after approximately 20 seconds.  

3. BC gauge increases from zero to 4.15 kg/cm$^2$ (59 psi) in 18 to 20 seconds.  

4. BC continues to charge to $4.4 \pm 0.14$ kg/cm$^2$ (62 ± 2 psi).  

5. Automatic emergency timed sanding is provided for 60 ± 5.0 seconds.  

6. Close the emergency brake valve.  

7. Move the automatic handle to emergency to reset.  

P. Place the automatic handle to the RUNNING position, and note the following:

1. ER gauge display is $5.2 \pm 0.07$ kg/cm$^2$ (73.5 ± 1 psi).  

2. BP gauge display is within 0.07 kg/cm$^2$ of ER.  

3. BC pressure is zero.  

4. PCS Open is not indicated.  

VIII. AUTOMATIC BRAKE OPERATION - PASSENGER MODE  
Controller #2

A. Place the Pass/Goods switch to PASSENGER position  

B. Allow the brake system to recharge for a minimum of one minute and note the following:
1. ER Test gauge display is 5.2 ± 0.07 kg/cm² (73.5 ± 1 psi).

2. BP Test gauge display is within 0.07 kg/cm² of ER.

3. BC Test gauge display is zero.

4. BCEP (20 Pipe test point) Test gauge display is zero.

5. PC indicator is not lit.

C. Momentarily place the automatic handle to the MINIMUM SERVICE position, to reduce ER to 4.7 ± 0.07 kg/cm² (67 ± 1 psi) and note the following:

1. BP reduces to within 0.07 kg/cm² (1 psi) of ER.

2. BC applies to 1.1 ± 0.14 kg/cm² (16 ± 2 psi).

3. BCEP applies to 0.9 ± 0.14 kg/cm² (13 ± 2 psi).

D. Continue moving the automatic handle into SERVICE positions to reduce ER in 0.5 kg/cm² (7 psi) increments until ER has decreased to 3.5 kg/cm² (51 ± 1 psi) and note the following:

1. Each step results in the reduction of ER and BP displays.

2. BP is within 0.07 kg/cm² (1 psi) of ER gauge display.

3. With each decreasing step of ER and BP, a corresponding increase of BC pressure occurs to a maximum of 4.4 ± 0.14 kg/cm² (62 ± 2 psi).

E. Move the automatic handle to the RUNNING position and note the following:

1. ER display increases to 5.2 ± 0.07 kg/cm² (73.5 ± 1 psi).

2. BP gauge display is within 0.07 kg/cm² of ER.

3. BC gauge display reduces from the maximum value to 0.4 kg/cm² (6 psi) in 15 to 20 seconds and continues to zero when brakes are released.

F. Allow one minute for the system to fully recharge.
G. Move the automatic handle to the FULL SERVICE position and note the following:

1. ER test gauge reduces to 3.6 kg/cm² (51 psi) in 6-10 seconds and continues to reduce to 3.5 ± 0.14 kg/cm² (50 ± 1 psi).

H. Move the automatic handle directly to RUNNING position and allow brake pipe to recharge.

I. Place the automatic handle to FULL SERVICE and note:

1. BC test gauge increases from zero to 4.15 kg/cm² (59 psi) in 4 to 6 seconds.

2. BC test gauge continues to charge to 4.4 ± 0.14 kg/cm² (62 ± 2 psi).

J. Move the automatic handle to the RUNNING position and note the following:

1. ER charges to 5.2 ± 0.07 kg/cm² (73.5 ± 1 psi).

2. BP charges within 0.1 kg/cm² of ER.

3. BC pressure reduces to zero.

K. Place the automatic handle directly to the FULL SERVICE position and note the following.

1. BCEP test gauge increases from zero to 3.4 kg/cm² (48 psi) in 4 to 6 seconds.

2. Continues to charge to 3.6 ± 0.14 kg/cm² (51 ± 2 psi).

L. Place the automatic handle in the RUNNING position and allow one minute for the system to fully charge.

M. Place the Reverser handle in Forward position.

N. Place the automatic handle in the EMERGENCY position and note the following:

1. BP pressure rapidly reduces to zero.

2. PCS Open is indicated.

3. ER pressure reduces to zero.
4. BC gauge increases from zero to 4.1 kg/cm\(^2\) (59 psi) in 3 to 5 seconds.

5. BC continues to charge to 4.4 ± 0.14 kg/cm\(^2\) (62 ± 2 psi).

6. Automatic emergency timed sanding is provided for 60 ± 5 seconds.

7. After 60 seconds, the emergency can be reset.

O. Place the automatic handle to the RUNNING position, allow one minute for the system to fully charge and note the following:

1. ER gauge display is 5.2 ± 0.07 kg/cm\(^2\) (73.5 ± 1 psi).

2. BP gauge display is within 0.07 kg/cm\(^2\) (1 psi) of ER.

3. BC and BCEP gauge display reduces to zero.

4. PCS open is not indicated.

P. Place the automatic handle in the EMERGENCY position and note the following:

1. BP pressure rapidly reduces to zero.

2. PCS Open is indicated.

3. ER pressure reduces to zero.

4. BCEP gauge increases from zero to 3.4 kg/cm\(^2\) (48 psi) in 3 to 5 seconds.

5. BCEP continues to charge to 3.5 ± 0.14 kg/cm\(^2\) (51 ± 2 psi).

6. Automatic emergency timed sanding is provided for 60 ± 5 seconds.

Q. Place the automatic handle to the RUNNING position, allow one minute for the system to fully charge and note the following:

1. ER gauge display is 5.2 ± 0.07 kg/cm\(^2\) (73.5 ± 1 psi).

2. BP gauge display is within 0.07 kg/cm\(^2\) (1 psi) of ER.
3. BC and BCEP gauge display reduces to zero. 

4. PCS open is not indicated. 

R. Place the automatic handle to the EMERGENCY position for 60 seconds to reset, then to RUNNING position, allow one minute for the system to fully recharge and note the following:

1. ER gauge display is $5.2 \pm 0.07 \text{ kg/cm}^2 (73.5 \pm 1 \text{ psi}).$ 

2. BP gauge display is within $0.07 \text{ kg/cm}^2 (1 \text{ psi})$ of ER. 

3. BC pressure is zero. 

4. PCS Open is not indicated. 

IX. TRAIL OPERATION:

A. Set the Pass/Goods switch to GOODS position. 

B. Place the automatic handle to the MINIMUM SERVICE position and note the following: 

1. ER reduces to $4.7 \pm 0.07 \text{ kg/cm}^2 (67 \pm 1 \text{ psi}).$ 

2. BP reduces to within $0.07 \text{ kg/cm}^2 (1 \text{ psi})$ of ER. 

3. BC applies to $1.1 \pm 0.14 \text{ kg/cm}^2 (16 \pm 2 \text{ psi}).$ 

C. Set the air brake system for TRAIL using the brake controller Lead/Trail switch and note the following: 

1. ER decreases to zero psi. 

2. BP pressure remains unchanged. 

3. BC remains unchanged. 

D. Momentarily lift bail off ring on the independent brake valve handle and note that BC pressure remains unchanged. 

E. Release the bail off ring on the independent handle and move the independent handle to the MAX position and note that BC pressure remains unchanged. 

F. Move the automatic and independent handles to their RUNNING & RELEASE positions respectively.
G. Set the system for LEAD-OUT until ER charges to $5.2 \pm 0.07$ kg/cm$^2$ (73.5 ± 1 psi), then switch to LEAD-IN Allow 1 minute for system to recharge.

X. HELPER MODE OPERATION:

A. Move the automatic brake handle to MINIMUM SERVICE, reduce ER to $4.7 \pm 0.07$ kg/cm$^2$ (67 ± 1 psi) and increase BC to $1.1 \pm 0.14$ kg/cm$^2$ (16 ± 2 psi).

B. Set the air brake system for LEAD-OUT mode with the brake controller Lead/Trail switch.

C. Move the automatic brake handle in steps toward FULL SERVICE position and note that BP does not reduce with ER pressure and BC pressure remains unchanged.

D. Momentarily lift the bail off ring on the independent brake handle and note that BC pressure reduces to zero.

E. Release the bail off ring on the independent brake handle.

F. Move the automatic brake handle to RUNNING position and note the ER pressure increases to $5.2 \pm 0.07$ kg/cm$^2$ (73.5 ± 1 psi).

G. Move the independent brake handle to the MAX position and note BC increases to $4.4 \pm 0.14$ kg/cm$^2$ (62 ± 2 psi).

H. Move the independent brake handle to RELEASE position and note that BC pressure reduces to zero.

I. Set the air brake system for LEAD-IN mode and note that BP is within $0.07$ kg/cm$^2$ (1 psi) of ER.

XI. INDEPENDENT BRAKE OPERATION:

A. Independent Brake Control - Brake Cylinder

1. Move the independent handle in steps toward the MAX and back to Release position, pausing at each step and noting that BC gauge display increases and decreases in steps.

2. Place the independent handle in the MAX position and note that BC test gauge increases to 4.85 kg/cm$^2$ (69 psi) in 4 to 6 seconds and continues to $5.2 \pm 0.14$ kg/cm$^2$ (74 ± 2 psi).
3. Place the independent handle directly to the RELEASE position and note that the BC test gauge reduces to 0.4 kg/cm\(^2\) (6 psi) in 8 to 12 seconds and continues to zero.

B. Independent Brake Control - Brake Cylinder Equalizing Pipe

1. Move the independent handle in steps toward the MAX and back to Release position, pausing at each step and noting that BCEP gauge display increases and decreases in steps.

2. BCEP gauge increases from zero to 3.4 kg/cm\(^2\) (48 psi) in 4 to 6 seconds.

3. BCEP continues to charge to 3.5 ± 0.14 kg/cm\(^2\) (50 ± 2 psi).

4. Place the independent handle directly to the RELEASE position and note that the BCEP test gauge reduces to 0.4 kg/cm\(^2\) (6 psi) in 8 to 12 seconds and continues to zero.

C. Quick Release of Automatic Brake ("Bail Off") - Brake Cylinder

1. Move the automatic handle into the MINIMUM SERVICE position and note that Brake Cylinder applies.

2. Momentarily lift the bail-off ring on the independent handle and note that the BC gauge display rapidly reduces to zero and does not reapply.

3. Move the automatic handle into FULL SERVICE position and note that BC reapplys.

4. Lift the bail-off lift ring handle for four seconds, then release and note that BC gauge reduces to zero.

5. Move the independent handle to the MAX position until BC has increased to 5.2 ± 0.14 kg/cm\(^2\) (74 ± 2 psi).

6. Lift the bail-off lift ring handle for four seconds, then release and note that BC gauge remains at 5.2 ± 0.14 kg/cm\(^2\) (74 ± 2 psi) as originally set.

7. Move the independent handle to the RELEASE position.

8. Move the automatic handle to the RELEASE position for one minute.
9. Move the automatic handle to Emergency position.

10. Lift the Bail-off ring until BC reduces to zero.

11. Release the Bail-off ring and note that BC re-applies.

D. Brake Cylinder Gauge

1. Move the independent handle to the MAX position and note that BC gauge display is 5.2 ± 0.14 kg/cm² (74 ± 2 psi).

2. Close the #1 truck cut out cock and note that the BC gauge display reads zero.

3. Place the independent handle in RELEASE position, wait 5 seconds, then back to MAX position and note that BC gauge display remains at zero.

4. Open the #1 truck cut out cock and note that BC gauge display is 5.2 kg/cm² (74 ± 2 psi).

XII. SAFETY CONTROL:

A. Alerter Penalty

Note: Reverser must be selected

1. With the Independent handle in the RELEASE position and the Automatic in the RUNNING position allow system to fully charge for 2 minutes.

2. Allow Alerter to time out.

3. When the Alerter times out note that the following occurs:
   a) ER gauge display immediately starts to reduce from 5.2 ± 0.07 kg/cm² (73.5 ± 1 psi) and reduces to zero.
   b) PCS open is indicated immediately.
   c) BP gauge display reduces to within 0.07 kg/cm² of ER.
   d) BC gauge increases to 4.4 ± 0.14 kg/cm² (62 ± 2 psi).
4. Reset Alerter.

5. Move the Automatic handle to the FULL SERVICE position for 10 sec to reset the PENALTY application and note that PCS open indication is removed.

6. Move the Automatic handle to the running position and note that ER and BP recharge and BC reduces to zero.

7. Move the Independent handle to the MAX position.

8. Activate Alerter and note that the Alerter alarm and penalty does not occur.

9. Place the Independent handle to the RELEASE position and the Automatic to the RUNNING position.

B. EM2000 Communication Loss

1. Verify the Independent handle is in RELEASE position and the Automatic handle is in RUNNING position.

2. Open the EM2000 circuit breaker and note the following:
   a) Exhaust of BP occurs in approximately 5 to 13 seconds after loss of EM2000.
   b) ER reduces to zero psi.
   c) Brake cylinders and BCEP apply.
   d) Wait one (1) minute.

3. Close EM2000 circuit breaker, wait 30 seconds and note:
   a) ER test gauge is zero.
   b) BP test gauge is 0.6 to 1.0 kg/cm² (9 to 15 psi).
   c) BC test gauge is 4.4 ± 0.14 kg/cm² (62 ± 2 psi). and BCEP test gauge is 3.6 ± 0.14 kg/cm² (51 ± 2 psi).
   d) PCS open is indicated.

4. Move Automatic handle to the FULL SERVICE position for 10 seconds to reset.
5. Move Automatic handle to RUNNING and note:
   a) ER gauge display increases to $5.2 \pm 0.07 \text{ kg/cm}^2$ $(73.5 \pm 1 \text{ psi})$.
   b) BP gauge display increases to $\pm 0.07 \text{ kg/cm}^2$ $(\pm 1 \text{ psi})$ of ER.
   c) BC gauge reduces to zero.
   d) PCS is not lit.

C. POWER LOSS PENALTY (LEAD)

1. Move the Independent handle to the RELEASE position and the Automatic to the RUNNING position.

2. Open the air brake circuit breaker and note:
   a) Exhausting of BP occurs immediately.
   b) ER reduces to zero.
   c) BC test gauge and BCEP test gauge are $3.8 \pm 0.14 \text{ kg/cm}^2$ $(54 \pm 2 \text{ psi})$.

3. Move the Automatic handle to the FULL SERVICE position.

4. Close the AIR BRAKE CIRCUIT BREAKER to the CCB System and note:
   a) ER test gauge display is zero.
   b) BP test gauge display is $0.6$ to $1.0 \text{ kg/cm}^2$ $(9$ to $15 \text{ psi})$.
   c) BC test gauge and BCEP test gauge are $3.8 \pm 0.1 \text{ kg/cm}^2$ $(54 \pm 2 \text{ psi})$.
   d) PCS open indication is lit.

5. Move the Automatic handle to the FULL SERVICE position for 10 seconds to reset and note that PCS is not lit.

6. Move the Automatic handle to RUNNING and note:
a) ER gauge display increases to 5.2 ± 0.07 kg/cm² (73.5 ± 1 psi).

b) BP gauge display increases to ± 0.07 kg/cm² of ER.

c) BC gauge reduces to zero.

D. POWER LOSS PENALTY (TRAIL)

1. Set the brake system Lead Trail switch to TRAIL position and note that ER reduces to zero and BP does not change.

2. Open the air brake circuit breaker and note that brake cylinder pressure does not increase, the AIR BRAKE and PCS open indications are on the EM2000 display.

3. Close the air brake circuit breaker and note that the AIR BRAKE FAIL and PCS Open indications in the cab clear.

4. Set the Lead-Trail switch to the LEAD-OUT position and note that ER increases to 5.2 ± 0.07 kg/cm² (73.5 ± 1 psi).

5. Set the Lead-Trail switch to LEAD-IN and move automatic handle to RUNNING and note that BP increases to within 0.07 kg/cm² of ER.

XIII. ELECTRO PNEUMATIC 20 PORTION BACKUP:

A. DISCONNECT MV16T Magnet Valve Plug.

B. AUTOMATIC BRAKE OPERATION

1. Momentarily move Automatic handle to MIN SERVICE position and note BC applies.

2. Move automatic handle to FULL SERVICE position to reduce ER to 3.5 kg/cm² (50 ± 1 psi) and note that BC gauge display increases to 3.6 ± 0.14 kg/cm² (51 ± 2 psi).

3. Move Automatic handle to RUNNING position, note that BC pressure reduces to zero. Allow one (1) minute for system to charge.

C. INDEPENDENT BRAKE OPERATION

1. Move the Independent handle in steps toward the "MAX" position, pausing at each step and note that BC gauge
display increases in steps.

2. Move the Independent handle into the "MAX" position and note that BC gauge display is $3.6 \pm 0.14$ kg/cm² ($51 \pm 2$ psi).

3. Move the Independent handle in steps toward the RELEASE position, pausing at each step. Note that BC gauge display decreases in steps.

4. Move the Independent handle in the "RELEASE" position and note that BC gauge display is zero.

D. BAILOFF OF AUTOMATIC APPLICATION

1. Momentarily move the Automatic handle to the MIN position and note BC applies.

2. Lift bail-off ring on the Independent handle and note that BC gauge display reduces to zero.

3. Wait one minute and note that BC gauge remains at zero.

4. Move Automatic handle to full service and note BC increases to $3.6 \pm 0.14$ kg/cm² ($51 \pm 2$ psi).

5. Move the Automatic handle to the RUNNING position and allow the system to charge for one (1) minute.

E. EMERGENCY

1. Move the Automatic handle directly to the EMERGENCY position and note that BC gauge increases to $3.6 \pm 0.14$ kg/cm² ($51 \pm 2$ psi).

2. Connect MV16T Magnet Valve Plug.

3. After 60 seconds, place the Automatic handle to the RUNNING position and allow the system to charge for one (1) minute.

XIV. BRAKE PIPE MAINTAINING:

A. Install a 3/16" test orifice at the "F" end brake pipe end connection hose.

B. Move the automatic brake handle into the SERVICE position.
C. Slowly open the brake pipe angle cock with the test orifice and note the following:

1. That BP does not decrease by more than 0.2 to 0.3 kg/cm$^2$ (3 to 4 psi).

2. That BC does not increase by more than 0.5 to 0.6 kg/cm$^2$ (7 to 9 psi).

D. Close the brake pipe angle cock.

E. Move the automatic brake handle to RUNNING position.

F. Remove the 3/16" test orifice from the brake pipe end connection hose.

G. Allow three minutes for system charging.

XV. BREAK IN TWO PROTECTION:

CAUTION: Care must be exercised when opening and closing end connection cut out cocks so as to avoid injury by whipping of end connection hoses.

A. Open the end connection cut out cocks at either the “F” or “R” end of the locomotive in the following sequence: brake cylinder equalizing pipe, main reservoir equalizing pipe and brake pipe, and note the following:

a) An emergency brake application occurs with a PCS indication.

b) BC increases to $4.4 \pm 0.14$ kg/cm$^2$ (62 $\pm$ 2 psi)

c) BCEP remains at zero psi

d) Brakes remain applied for 5 minutes.

e) Move Automatic handle to emergency for 60 seconds to reset then move handle to RUNNING.

XVI. MULTIPLE UNIT TEST - TEST CART METHOD

CAUTION: Care should be exercised when opening and closing end connection cutout cocks so as to avoid injury by whipping of end connection hoses.

A. SETUP
1. Connect the brake pipe (BP), main reservoir equalizing pipe (MREP), brake cylinder equalizing pipe (BCEP) trainline hoses to one end of the locomotive.

2. Close all cut out cocks on the test cart and open the locomotive end connection cut out cocks at the hose connections to test cart.

---

B. LEAD UNIT OPERATION

1. Move the independent brake handle of the locomotive to the MAX position and note the following:
   a) The AIR gauge on the test cart registers 50 ± 2.0 psi.
   b) 50 ± 2.0 psi is present at the remaining three BCEP end connection hoses.

2. Move the independent brake handle of the locomotive to the RELEASE position and note that the AIR gauge on the test cart returns to zero pressure and the three remaining BCEP end connections have zero pressure.

3. Move the automatic brake valve handle to FULL SERVICE position and note the AIR gauge on the test cart registers 50 ± 2.0 psi.
4. Lift the bail off ring of the independent brake handle of the locomotive and note the following while the ring is lifted:
   a) The pressure at the AIR gauge reduces rapidly to zero.
   b) The three remaining end hoses have zero pressure.
5. Release the bail off lift ring and note that the AlR gauge on the air brake test cart remains at zero.

C. Trail Unit Operation
1. Set the brake system to TRAIL with the engineer’s Lead-Trail switch.
2. Open the AIR MU Cut out cock on the air brake test cart.
3. Open the AIR supply cut out cock on the test cart and note that locomotive brake cylinder pressure increases to 45 ± 1 psi when the air supplied by the test cart pressure regulator is 65 ± 2 psi.
4. Open the Driver’s emergency valve and note the pressure at the test cart BC gauge display reduces to 45 psi.
5. Close the AIR supply cut out cock and note that locomotive brake cylinder pressure is zero.
6. Set the brake system to LEAD-IN with the engineer’s Lead-Trail switch.

XVII. MULTIPLE UNIT TEST - TWO LOCOMOTIVE METHOD

CAUTION: Care must be exercised when opening and closing end connection cut out cocks so as to avoid injury by whipping of end hoses.

NOTE: Section XVII can be done by using a second unit (designated as Unit #2) which has been qualified by this test procedure and set up for LEAD operation.

A. Lead Unit Operation
1. Select Lead-In.
   a) Set ER to 5.2 kg/cm² (73.5 psi)
b) BP is within 0.07 kg/cm² (1 psi).

2. Move the independent brake handle to FULL position and note:
   a) BC increases to 5.2 kg/cm² (74 ± 2 psi).
   b) The pressure at all the BCEP end connections is 3.6 ± 0.1 kg/cm² (51 ± 2 psi).

3. Move the independent handle to RELEASE position and note:
   a) The pressure at all the BCEP end connections is zero psi.

B. Trail Operation
   1. Set up Unit 1 for TRAIL
   2. Connect the same function MU hoses on units #1 and #2 together.
      a) Verify that unit #2 is set up for LEAD IN operation
      b) Verify that ER on unit is set for 5.2 kg/cm² (73.5 psi).
   3. Open the end connection cut out cocks having the MU hoses connected.
   4. Move the automatic and independent brake handles on unit #2 to the RUNNING and RELEASE positions and note that:
      a) BP on both units is approximately 5.2 kg/cm² (73.5 psi).
      b) The brakes are released on unit #1. If the brakes are not released on unit #1, make a full service reduction and release on unit #2 and note that the brakes on unit #1 are released.
   5. Allow one (1) minute for recharging.
   6. Move automatic brake handle on unit #2 to the FULL position and note:
a) BC on unit #1 increases to $4.4 \pm 0.14 \text{ kg/cm}^2$ $(62 \pm 2 \text{ psi})$. ____________

7. Bail off brakes from unit #2 and note:
   a) BC on both units reduces to zero psi. ____________

8. Move the automatic handle to RUNNING position and recharge the system for one (1) minute

9. Move the independent handle to FULL position and note:
   a) BC increases to $5.2 \pm 0.14 \text{ kg/cm}^2$ $(74 \pm 2 \text{ psi})$. ____________

10. Move the automatic handle to FS position and note:
    a) BC on both units reduces to $4.4 \pm 0.14 \text{ kg/cm}^2$ $(62 \pm 2 \text{ psi})$. ____________

XVIII. SYSTEM SELF TEST:

A. The brake system is equipped with a self test routine that can be accessed through the EM2000 maintenance screen. The following test procedure provides instructions for running the system self test routine. The self test routine should be run as part of the normal air brake test procedure.

B. Before initiating a Self-Test verify the following:

1. Locomotive speed is zero. ____________

2. The hand brake is applied or the locomotive wheels are chocked. ____________

3. The locomotive is set up as an isolated unit in Lead-In mode. ____________

4. If the unit has multiple controllers, a single controller is selected. ____________

5. The automatic and independent brake valve handles on the selected controller are in RUNNING and RELEASE. ____________

6. The brake valve handles on the inactive controller are in FULL SERVICE and MAXIMUM. ____________

7. The main reservoir pressure is at least $7.2 \text{ kg/cm}^2$ $(102 \text{ psi})$. ____________
8. The brake pipe is fully charged and brake cylinder pressure is exhausted.

Note: In the event that brake pipe cannot charge, a self test can still be run as long as the 60 second timer has expired.

C. Running the Self Test

1. From the EM2000 Self-Test menu, select “Air Brake Test.”

2. From the Air Brake Test menu select “Continue.”

3. Wait for the successful completion of the test as noted in the message area.

4. From the Air Brake test menu select END TEST.

5. If necessary reset the Emergency brake application.

XIX. SINGLE CAR TEST:

Note: All previous testing has been conducted at 5.2 ± 0.07 kg/cm² (73.5 ± 1 psi) brake pipe pressure and the single car test is conducted at 70 psi brake pipe. Therefore the locomotive may have an initial charge from a 73 psi brake pipe which must be dissipated before brakes can be fully released by the single car test. An overcharge can be dissipated by successive applications and releases of the brake as controlled by the single car test device. The overcharge is dissipated when brake cylinder pressure is zero with brake pipe fully charged from the single car test device at 70 psi.

A. Condition the locomotive for dead shipping per the instructions of Section XXVII of this ETI (keep the air brake circuit breaker closed)

B. Single Car Test Unit per AI 2484

C. Open the air brake circuit breaker.

D. Single car test the unit per AI 2484.
XX. BRAKE PIPE RESTRICTION TEST:
   A. Test unit for brake pipe restriction per ETI 456. For this locomotive, the high pressure setting is 49 psi and the low pressure condemning pressure is 5 psi. Also note that the locomotive must be single car tested per AI 2484 rather than AI 1892 as referenced in the preparation section of ETI 456.

XXI. REMOVAL OF TEST GAUGES:
   A. Remove the ER, BC and BP pressure test gauges from the pneumatic control unit.

XXII. WARNING DEVICES:
   A. Verify that the bell can be operated from the push buttons on engineer’s console.
   B. With the reverser in the forward position depress the horn push button on the engineer’s console and note that the forward horn only sounds.
   C. With the reverser in the reverse position note that only the rearward facing horn sounds when the horn push button on the engineer’s console is depressed.
   D. With the reverse centered, note that when the horn push button on the engineer’s console is pressed, both the forward and rearward facing horns sound.

XXIII. SANDING SYSTEM:
   A. Check that the sand delivery nozzles are aligned properly and 6.4 cm (2.5 in) above the rail.
   B. Note that when operated, the sanders apply and release in 2 to 3 seconds from the time the sanding switch is closed or opened.

XXIV. WINDSHIELD WIPERS:
   A. Verify that all windshield wipers and washers operate properly.

XXV. SHIPPING DEAD:
   A. Move the automatic handle to the FULL SERVICE position.
B. Set up the air brake system for TRAIL mode with the engineer’s console Lead-Trail switch.

C. Move the independent handle to the RELEASE position.

D. If the unit is being shipped without the engine running, open the Air Brake circuit breaker. If the unit is being shipped with the engine running the air brake circuit breaker should remain closed.

E. If the unit is being shipped with the engine running, open the Automatic Drain Valve circuit breaker, Air Dryer circuit breaker, and Fuel Gauge Circuit Breaker.

F. Open the Dead Engine cut out cock.

G. Open all MREP and BCEP end connection cut out cocks.

H. If the unit is being shipped with the engine running, manually override the compressor control magnet valve.

I. Open the #2 main reservoir drain valve and reduce main reservoir pressure to 1.1 kg/cm² (15 psi) or less.

J. Close all manual MR and MR filter drain valves

K. Verify that the emergency brake valves are closed.

L. Isolate all safety control devices.

M. Release the hand brake if applied.

N. Verify that the truck BC cut out cocks are open.
CHAPTER 6
EQUIPMENT REPLACEMENT

6.1 General Information

The CCB brake system has been designed for ease of maintenance. Some of the system components are manifold mounted on the pneumatic control unit (PCU). Replacement procedures for this equipment can be easily accomplished.

This Section provides the removal and installation procedures for the major components of the brake system. The General Procedures, Paragraph 6.2.1, however, shall apply for any work which is accomplished on the brake system.

6.2 Replacement Procedures

6.2.1 General Procedures

WARNING: BEFORE STARTING WORK PROCEDURES DESCRIBED IN THIS CHAPTER, MAKE SURE THAT ALL SAFETY PRECAUTIONS OUTLINED IN CHAPTER 3, PREPARATION FOR MAINTENANCE, HAVE BEEN COMPLETED.

A. Important

When a component device is removed from the brake bay rack assembly or manifold, all mounting gaskets and O-rings, seals, etc. must be replaced. Refer to New York Air Brake Illustrated Parts Catalogs for Indian Railways for replacement part name and number.

B. Reference

After installation of replacement equipment, reference must be made to Chapter 5 for Single Car Test Procedures.

NOTE: When removing all components from the brake control unit, the exterior surface of the brake control unit is to be cleaned before removing any portion or device by wiping with a soft, clean, lint-free cloth. Likewise, when installing the components, their respective mounting surfaces of the manifold and valve are to be cleaned of all contaminants prior to the placement of the components.
6.2.2 Brake Valve Controller

The Brake Valve Controller utilizes piping that connects directly to the vent valve on the back of the controller. This piping connects to Brake Pipe. The complete procedures for removal and installation are detailed in the Locomotive Builders Information.

NOTE: The Brake Valve Controller utilizes fiber optic cables to transmit brake commands to the computer relay unit. In the event that replacement of this unit is needed, care should be taken when disconnecting and re-connecting the optical cables to the brake valve controller.

WARNING: OBSERVE ALL SAFETY PRECAUTIONS OUTLINED IN CHAPTER 3, PREPARATION FOR MAINTENANCE. CCB BRAKE SYSTEM TO BE DE-PRESSURIZED BEFORE ANY ATTEMPT IS MADE TO SERVICE THIS UNIT.

A. Brake Valve Controller, (Fig 6-1, Pg. 6-3)

1. Removal
   a) Refer to Locomotive Builder information and remove brake valve controller from console of locomotive.
   b) Unscrew bolts (3) and remove vent valve (2) from back of brake valve controller (1).

2. Installation
   a) Attach vent valve (2) to the brake valve controller (1) by using bolts (3).
1. Brake Valve Controller
2. Vent Valve
3. Bolt

FIGURE 6-1  BRAKE VALVE CONTROLLER COMPONENT REPLACEMENT
6.2.3 Computer Relay Unit

The Computer Relay Unit (CRU) utilizes an enclosure to seal the computer and all electronics from outdoor elements. Normally, maintenance of the unit will be accomplished by replacement of any malfunctioning component and leaving the chassis permanently attached to the locomotive. However, in the event that it is desired to replace the entire unit, the procedures for accomplishing this are detailed in the Locomotive Builders Information.

NOTE: Before removing any components from the CRU, make sure all power to the CRU has been turned off.

WARNING: OBSERVE ALL SAFETY PRECAUTIONS OUTLINED IN CHAPTER 3, PREPARATION FOR MAINTENANCE. CCB BRAKE SYSTEM TO BE DE-PRESSURIZED BEFORE ANY ATTEMPT IS MADE TO SERVICE THIS UNIT.

Refer to Figure 6-2 & 6-3, Pgs. 6-5 & 6-6

A. Removal

1) Unscrew bolts (1), do not turn all the way out. Turn retaining clips (2) 180 degrees. Cover (3) may then be removed.

2) Any one of the relays may be removed by unscrewing the miniature screws that are built into the relay and pulling the relay from the socket by hand.

3) All cable connectors used on the front of the interface unit and the computer are released and attached the same way. Refer to figure 6-3, pg. 6-6. The SV & SVJ boards are the only exception, they are held in place by a screw which is part of the cable connector.

4) All computer cards are removed by loosening the screws located at the top and the bottom of the card face, (see figure 6-2) and then pulling the board out of the slots of the computer cage.

B. Installation

1) To install computer boards, slide board into slot of computer cage, the last 1/4 inch of travel will be harder to insert due to the board sliding into the back plane connector. Boards do not require much force to seat into back plane connector, therefore do not force. Pull board back out and make sure it is in its slot. Tighten slotted head screws on the face of board.

2) Install cable connectors to the front of the SV & SVJ boards. Tighten screw of connector to socket, located on the front of the boards. Attach all cable connectors to the front of the computer boards (see figure 6-3).

3) Insert relays into sockets and tighten miniature screws so relay can not vibrate loose.

4) Install cover (3) onto enclosure, rotate retaining clips (2) back to their original positions and tighten bolts (1) to seal cover.
FIGURE 6-3    CABLE CONNECTOR REMOVAL AND INSTALLATION
6.2.4 Pneumatic Control Unit Replacement

The Pneumatic Control Unit (PCU) utilizes a manifold for attachment of some components of the brake system. Normally, maintenance of the unit will be accomplished by replacement of any malfunctioning component and leaving the manifold permanently attached to the car. However, in the event that it is desired to replace the entire unit, the procedures for accomplishing this are detailed in the Locomotive Builders Information. The removal and installation procedures for the replacement of each individual component mounted on the Pneumatic Control Unit are given in NYAB Maintenance Specification NYR-404 (located in chapter 9).

NOTE: When removing all components from the PCU, the exterior surface of the PCU is to be cleaned before removing any portion or device by wiping with a soft, clean, lint-free cloth. Likewise, when installing the components, their respective mounting surfaces of the manifold and valves are to be cleaned of all contaminants prior to the placement of the components.

WARNING: OBSERVE ALL SAFETY PRECAUTIONS OUTLINED IN CHAPTER 3, PREPARATION FOR MAINTENANCE. CCB BRAKE SYSTEM TO BE DE-PRESSURIZED BEFORE ANY ATTEMPT IS MADE TO SERVICE THIS UNIT.
8.1 GENERAL INFORMATION

This Section provides a list of diagnostic (fault) codes displayed by the DIZ Board.

NOTE: Some of the fault codes listed on the following pages are not active or in use.
### NYAB/KNORR CCB - FAULT CODES

#### GENERAL AIR BRAKE CODES

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<tr>
<th>Description</th>
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<td>Messaging Crash</td>
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<tr>
<td>No Locomotive Communication</td>
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<td>Buss Access Error</td>
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<td>Air Brake Watchdog Timeout</td>
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#### BRAKE VALVE CONTROLLER NUMBER 1 CODES

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<td>C1 Automatic Handle Frequency Low</td>
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<tr>
<td>PVBP Stuck Closed</td>
<td>6D</td>
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<tr>
<td>MVEM Stuck Off</td>
<td>6E</td>
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<tr>
<td><strong>INDEPENDENT/BCEP CODES</strong></td>
<td></td>
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<tr>
<td>Defective 20 Transducer</td>
<td>70</td>
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<tr>
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<td>71</td>
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<td>No 20 Exhaust</td>
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GENERAL INFORMATION

Before starting the troubleshooting procedure, perform a thorough visual inspection of the equipment to determine if the symptom is being caused by some obvious defect, such as loose fasteners, damaged components, etc. Otherwise, the troubleshooting procedure must follow a logical sequence which is designed to isolate the trouble to a single component.

NOTE: In all cases, the rules set forth by INDIAN RAILWAYS are to be followed and in those cases where such rules conflict with these recommendations, the Operating Property's instructions are overriding.

When evaluating the condition of a braking arrangement, safety must remain the most important consideration. In the event it becomes necessary to move a locomotive with an obvious equipment malfunction, the integral alternate control arrangement may be utilized or temporary repairs may be arranged to provide for braking of the locomotive. A locomotive with temporary repairs must be operated at restricted speed and must be "shopped" for corrective action at the first terminal point to prevent continued operation under any unsafe condition.

Inability to readily identify the source of any problem associated with the proper functioning of the equipment arrangement indicates the necessity for repairs which the operator should not perform. Never attempt to remove and detail parts from the equipment arrangement; if repairs to valves or other details are necessary, such repairs must be done at a bench by competent personnel in the shop.

WARNING: WHENEVER ANY DEVICE, PORTION, VALVE OR COMPONENT PART IS REMOVED FROM THE AIR BRAKE EQUIPMENT ARRANGEMENT FOR ANY REASON, AND IT IS REPLACED WITH A NEW OR REPAIRED AND TESTED DEVICE, PORTION, VALVE OR COMPONENT PART, A STANDING OPERATIONAL TEST OF THE TOTAL BRAKE ARRANGEMENT OF THE VEHICLE IS REQUIRED BEFORE PERMITTING THE VEHICLE TO MOVE.

Before operating any locomotive with a suspected malfunction, verify the condition of the equipment arrangement by checking the appropriate operation.

8.3 WPTU (WINDOWS PORTABLE TEST UNIT) PROGRAM FOR CCB 1.5

Description

A standard RS-232 serial communication interface allows maintenance personnel to directly connect to the CCB system using almost any commercially available laptop computer running NYAB’s WPTU software package.

The WPTU software package allows continuous run-time monitoring of all CCB system pressure transducers including MREP (main reservoir equalizing pipe), ER (equalizing reservoir), BP (brake pipe), BC (brake cylinder), and BCEP (brake cylinder equalizing pipe). The returned pressure values can be displayed in units of psi, bar, or kg/cm squared. The WPTU program also provides continuous run-time monitoring and control of all system magnet valves and relays as well as the adjustment of various CCB system parameters via special password protected calibration options.
Some of the other available options of the WPTU program are:

A. Initiation of a comprehensive CCB system self-test.
B. Display of the current CCB system’s internal fault record.
C. A guided help utility that allows the user to analyze diagnostic data to pinpoint the probable cause of and appropriate repair procedure for any existing failure.

8.4 WPTU OPERATING INSTRUCTIONS

A. Connect the portable laptop computer’s 9 pin serial port to the Locomotive’s DI board 25 pin test port using a standard RS-232 (9 to 25 pin) cable.


C. Type ‘ALT-L’ then ‘L’ or click on ‘Logon’ then click ‘Logon’ from the pull down menu.

D. After logging on to the CCB system, the system ID Number and software version number should appear in the upper right corner. The systems pressures will also appear at the bottom of the screen.

NOTE: The Flow Transducer is not accessible with this system.

E. Type ‘ALT-M’ or click on ‘Mode’ menu. Select operating mode ‘Monitor’ or ‘Test’ and choose your preferred pressure units. Normally, ‘Monitor’ mode and ‘kg/cm squared’ pressure units will be selected by default (as indicated by a check mark).

F. Monitor mode allows continuous run-time monitoring of all system magnet valves, relays, and pressure transducers.

G. The ‘Screen’ menu permits the tester to observe the operating modes of various components while operating the Brake Valve Controller (BVC) Handles or the Lead/Trail switch.

   For example: Select ‘Screen’ by typing ‘ALT-S’ or by clicking on ‘Screen’. Choose ‘EPA 1’ and note that MVER, MVBP, and MV53 are displayed. Move the Lead/Trail switch to ‘Trail’ and note that MV53 turns ‘ON’.

   Different functions under the ‘Screen’ menu can be selected to view information about various boards and valves. As BVC functions are changed, conditions of valves or controller frequencies will be displayed accordingly.

H. Test Mode allows the user to directly operate the electro-pneumatic valves from the laptop keyboard. Select ‘Test’ located under the ‘Mode’ menu.

CAUTION: BRAKE CYLINDER PRESSURE COULD BE REDUCED TO LOW VALUES WHILE IN ‘TEST’ MODE. MAKE SURE THAT THE LOCOMOTIVE HAND BRAKE IS APPLIED AND THAT THE WHEELS ARE BLOCKED.

Any function selected while in ‘Test’ mode will determine proper operation of a component or subsystem. For EXAMPLE:

Select ‘ER’ located under the ‘Control Pressure’ menu. A control pressure window appears. Type in a pressure value in psi and hit ‘ENTER’. The pressure should change to within +/- 1 psi of the selected value. In this case, the pressure would be that of Equalizing Reservoir. If the pressure does not change, a problem exists with the AW4-ER or MVER valve.

When ‘Start Selftest’ is selected, an explanation of setup conditions is displayed. After all conditions are satisfied, select ‘Continue’ to initiate a CCB System selftest.

NOTE: In order to initiate a selftest via the laptop computer, the locomotive’s EM2000 computer needs to be shut off or disconnected.

To review the fault list or to retrieve specific information about a fault:

Select ‘Event Download’ under the ‘Diagnostic’ menu. A filename window will appear and you must type in a filename (limited to eight characters) that you wish to save the information under and hit ‘ENTER’.

A screen where all of the faults, code numbers, pass or fail criteria, and date appear on each line. The date and time displayed will reflect the last time that the system was powered up. It is considered ‘real time’ from this time forward. Every time the system is powered up, the date changes.

To clear the system diagnostic codes:

Select ‘Clear System Diagnostic Codes under ‘Diagnostic’ menu. Type in the ‘password’. All codes will be cleared after the next system power cycle.

To show the WPTU version level:

Click on ‘Version’ menu.

The ‘Help’ menu contains all diagnostic information. To access this information:

Select ‘Diagnostic Codes’ under ‘Help’ menu. Select the desired code for a description of the fault and for a trouble shooting procedure for that fault.

To exit the WPTU program:

Type ‘ALT-L’ then ‘F’ to Logoff. Then choose ‘ALT-E’ and ‘E’ to exit the program.

8.5 DIAGNOSTIC ANALYSIS

The following pages provide the description, system effect, reset procedure, and troubleshooting procedure for each diagnostic code. In certain troubleshooting procedures, the shop personnel will be required to check “resistance” and “voltage” at various connectors. Refer to section 8.6 for connector contact location and reference voltages.
Diagnostic Code 02(Messaging Crash):

Description
When the CCB system starts a message transmission it sends out a message identification character or MID. The system then verifies that the next character it receives is the MID character that it just transmitted. If the next character received is not it’s MID, the system logs a diagnostic code 02 indicating a “messaging crash”. There is a small probability every time the EM2000 or CCB system goes through a power cycle that a single messaging crash might occur if both systems try to access the bus at the same time. After the initial crash however, the two systems should automatically correct themselves. A high level of noise may also result in a messaging crash.

System Effect
No direct system effect but a high frequency of occurrence will result in sporadic locomotive communications and if extremely intense may cause the locomotive to flag a loss of communication and display the crew message “COMMUNICATIONS LINK FAILURE - ELECTRONIC AIR BRAKE SYSTEM”.

Reset Procedure
This diagnostic code will clear on its own as soon as a quarter of a second elapses with no detected messaging crashes.

Trouble Shooting Procedure
Verify that the RS-485 communication cable coming into the front of the CPZ board on the CRU from the EM2000 locomotive computer is tightly connected at the CPZ board, has good continuity, and has a low level of ambient noise.

Diagnostic Code 03(No Locomotive Communications):

Description
This diagnostic code indicates that the CCB system has not received a complete message from the EM2000 in the last 5 seconds. This diagnostic code will normally occur anytime the EM2000 is shutdown and the CCB system is left running. This diagnostic code will also often occur in conjunction with another communications fault.

System Effect
If in lead mode the CCB system will initiate a fault penalty application dropping out COR, and driving brake pipe to exhaust at a service application rate. The system will also default its speed signal to zero and cancel any bail off request due to dynamic braking. If the fault is due to a broken communications cable the locomotive may also flag a loss of communication and display the crew message “COMMUNICATIONS LINK FAILURE - ELECTRONIC AIR BRAKE SYSTEM”.

Reset Procedure
This diagnostic code will clear on its own as soon as a complete message is received from the EM2000. After the diagnostic code is cleared, the penalty application can be reset by moving the automatic brake valve handle to Full Service for ten seconds then to the Run or Release position.

Trouble Shooting Procedure
Verify that the EM2000 locomotive computer is powered on and operational.

Verify that all other communications faults have been cleared.
Verify that the RS-485 communication cable coming into the front of the CPZ board on the CRU from the EM2000 locomotive computer is tightly connected at the CPZ board, has good continuity, and has a low level of ambient noise.

**Diagnostic Code 04 (Checksum Error):**

**Description**
When the CCB system finishes receiving a message it calculates a checksum for the message and compares the calculated value to the checksum sent as the last byte in the message. If the calculated value does not match the value sent in the message a diagnostic code 04 is logged indicating a checksum error. A high level of noise will often result in checksum errors.

**System Effect**
No direct system effect but a high frequency of occurrence will result in sporadic locomotive communications causing a delay before the CCB system is able to process and respond to EM2000 messages.

**Reset Procedure**
This diagnostic code will clear on its own as soon as an EM2000 message is received in with a valid checksum.

**Trouble Shooting Procedure**
Verify that the RS-485 communication cable coming into the front of the CPZ board on the CRU from the EM2000 locomotive computer is tightly connected at the CPZ board, has good continuity, and has a low level of ambient noise.

**Diagnostic Code 05 (Buss Access Error):**

**Description**
Before attempting a new message transmission the CCB system verifies that the RS-485 communication line is idle. It is normal for the communication line to occasionally be busy due to EM2000 message traffic. If however the line does not return to an idle state within a period of 1 second after the CCB system is ready to transmit, a diagnostic code 05 will be logged indicating a buss access error. A high level of noise on the communication line may prevent the system from recognizing that the line is idle.

**System Effect**
No direct system effect but a high frequency of occurrence will result in sporadic locomotive communications and if extremely intense may cause the locomotive to flag a loss of communication and display the crew message "COMMUNICATIONS LINK FAILURE - ELECTRONIC AIR BRAKE SYSTEM".

**Reset Procedure**
This diagnostic code will clear on its own as soon as the communication line returns to an idle state.

**Trouble Shooting Procedure**
Verify that the CTCGAL on the CPZ board is properly inserted and is at a date code revision of 970829 or higher.

Verify that the RS-485 communication cable coming into the front of the CPZ board on the CRU from the EM2000 locomotive computer is tightly connected at the CPZ board, has good continuity, and has a low level of ambient noise.
Diagnostic Code 06 (Message Overrun Error):

Description
The Serial Communications Chip on the CPZ’s RS-485 daughter board can only buffer three characters at a time. Unless the CPZ CPU reads the SCC before a fourth character is received, the SCC will flag a message overrun error and a diagnostic code 06 will be logged. This diagnostic code normally indicates an error in the structuring of the software’s 10 ms interrupt routine. This type of error should never occur in production released software.

System Effect
No direct system effect but a high frequency of occurrence will result in sporadic locomotive communications causing a delay before the CCB system is able to process and respond to EM2000 messages.

Reset Procedure
This diagnostic code will clear on its own as soon as a quarter of a second elapses with no detected message overrun errors.

Trouble Shooting Procedure
Contact New York Air Brake Engineering.
If multiple occurrences are observed, swap out the CPZ board.

Diagnostic Code 07 (Message Loopback Error):

Description
When the CCB system starts a message transmission it sends out a message identification character or MID. The system then tries to confirm that the MID was actually sent by checking its own receive buffer. If nothing is received within the next 1 second a diagnostic code 07 is logged indicating a message loopback error. This type of error is normally due to a missing or damaged RS-485 daughter board.

System Effect
No direct system effect but a high frequency of occurrence will result in sporadic locomotive communications and if extremely intense may cause the locomotive to flag a loss of communication and display the crew message “COMMUNICATIONS LINK FAILURE - ELECTRONIC AIR BRAKE SYSTEM”.

Reset Procedure
This diagnostic code will clear on its own as soon as the CCB system receives its own MID after a transmission.

Trouble Shooting Procedure
Verify that the CPZ board has a RS-485 daughter board installed and that the daughter board is well seated.
Verify that the CTCGAL on the CPZ board is properly inserted and is at a datecode revision of 970829 or higher.
If the problem still occurs, swap out the CPZ board.
Diagnostic Code 08 (Message Framing Error):

Description
The Serial Communications Chip on the CPZ’s RS-485 daughter board checks every received non-zero character for a stop bit. If the SCC does not detect a stop bit for a given character, it will flag a message framing error and a diagnostic code 08 will be logged. A high level of noise on the transmission line can often cause framing errors.

System Effect
No direct system effect but a high frequency of occurrence will result in sporadic locomotive communications causing a delay before the CCB system is able to process and respond to EM2000 messages.

Reset Procedure
This diagnostic code will clear on its own as soon as a quarter of a second elapses with no detected message framing errors.

Trouble Shooting Procedure
Verify that the RS-485 communication cable coming into the front of the CPZ board on the CRU from the EM2000 locomotive computer is tightly connected at the CPZ board, has good continuity, and has a low level of ambient noise.

Diagnostic Code 09 (Communication Break Received):

Description
The Serial Communications Chip on the CPZ RS-485 daughter board will flag a communication break received whenever it receives an all zero character with no stop bit. A diagnostic code 09 will then be logged by the CPZ. A high level of noise may result in the false detection of a communication break.

System Effect
No direct system effect but a high frequency of occurrence will result in sporadic locomotive communications causing a delay before the CCB system is able to process and respond to EM2000 messages.

Reset Procedure
This diagnostic code will clear on its own as soon as a quarter of a second elapses with no detected communication breaks.

Trouble Shooting Procedure
Verify that the RS-485 communication cable coming into the front of the CPZ board on the CRU from the EM2000 locomotive computer is tightly connected at the CPZ board, has good continuity, and has a low level of ambient noise.
Diagnostic Code 10 (Air Brake Self-test):

Description
A CCB system self-test can be initiated via one of two methods:
1.) Selecting “Air Brake Test” under the EM2000’s “Self-tests” menu.
2.) Shutting down or disconnecting the EM2000 locomotive computer then selecting “Start Self-test” under the WPU “Diagnostic” menu.

If the system has multiple controllers, a separate self-test should be run for each controller. Before running a self-test verify the following:
1.) Locomotive speed is zero
2.) The hand brake is applied or the locomotive wheels are chocked
3.) The locomotive is setup as an isolated unit in lead cut-in mode
4.) If the unit has multiple controllers, a single controller is selected
5.) The brake valve handles on the selected controller are in Run\Release
6.) The brake valve handles on the inactive controller (if any) are in Full Service
7.) Main reservoir pressure is at least 7 bar (102 psi)
8.) If possible, brake pipe has fully charged and all brake cylinder pressure has been exhausted

Note: In the event that brake pipe is unable to be charged, a self-test can still be run.

System Effect
The system will check all system inputs against a known state and will then rapidly modulate the various pressure control circuits to verify proper operation. During the self-test, a self-test in progress code will be displayed on the CCB system DI board (shown as a “IP”). If the self-test fails or is canceled the system will go into an emergency. With the exception of communications faults and a few position specific controller faults, all existing faults will be cleared at the end of a successful self-test.

Reset Procedure
If the system is in emergency, move the Automatic brake valve controller handle to Emergency for 60 seconds then to Run/Release.

Trouble Shooting Procedure
If the self-test request by the WPTU program is not recognized, verify that the EM2000 is shutdown or disconnected from the CCB system.

If the self-test request by the EM2000 is not recognized, use the WPTU program to verify that on the LCC to MABS screen the LCC STATUS 2 signal reads 0000 0001. This combination represents a self-test request by the EM2000.

If the self-test can not be initiated as indicated by either an “IMPROPER AIR BRAKE TEST CONDITION” message on the EM2000 screen or a check setup code on the CCB system DI board display (shown as a “CS”) verify the following:
1.) Locomotive speed is zero - Use the WPTU program to verify that on the LCC to MABS screen the first digit from the left of the VEHICLE SPEED signal is 7 or less and the third and fourth digits are both 0 (we don’t care about the second digit). This combination represents a speed of less than 0.87 miles per hour at which the CCB will recognize as “zero speed.” Note: If no EM2000 communications are present the speed signal defaults to a zero value.
2.) Main reservoir pressure is at least 7 bar (102 psi) - Use the WPTU program to check the value displayed on the MREP transducer.

Unless the above entry conditions are met, the CCB system will not allow the initiation of a self-test. If the locomotive speed attains a non-zero value or the main reservoir pressure drops below 7 bar during self-test operation the self-test will be logged as a failure and the system will go into an emergency.
Diagnostic Code 11(Air Brake Watchdog Time-out):

Description
The CCB system software did not hit the watchdog timer in the last 1.6 seconds. This diagnostic code normally indicates an error in the software that caused it to get hung up in a particular section of the code. This type of error should never occur in production released software.

System Effect
The system will automatically reset itself as if a power cycle occurred and will log a diagnostic code 11.

Reset Procedure
None. The diagnostic code only shows up in the event log as a failure.

Trouble Shooting Procedure
Contact New York Air Brake Engineering.
If multiple occurrences are observed, swap out the CPZ board.

Diagnostic Code 20(No C1 Controller):

Description
On power up and at the start of a self-test the CCB system checks to see if the automatic and independent handles on controller 1 are generating frequency inputs greater than 100 Hz. If both the independent and automatic frequencies are below 100 Hz the entire C1 controller assembly will be flagged as missing and diagnostic code 20 will be logged.

System Effect
The CCB system will automatically default controller 1’s Lead/Trail switch to Trail mode and AE1 switch to CLOSED. If another controller is present, the CCB system will display the following crew message on the EM2000 “AIR BRAKE CONTROLLER NUMBER 1 FAILURE - SWITCH TO AIR BRAKE CONTROLLER NUMBER 2” and will allow the system to be run from the other controller, otherwise the CCB system will display the following crew message on the EM2000 “AIR BRAKE FAILURE - USE LOCOMOTIVE IN TRAIL ONLY” and will default to Trail mode.

Reset Procedure
This diagnostic code can only be cleared by running a system self-test.

Trouble Shooting Procedure
Verify that the two fiber optic cables coming into the FOR board on the CRU from controller 1 are properly connected at both the FOR board and the controller.

Diagnostic Code 21(C1 Automatic Handle Frequency Low):

Description
This diagnostic code means that the frequency signal from the automatic handle on controller 1 has reduced below the valid recognition limit of 808 Hz. This condition is normally due to a disconnected or damaged fiber optic cable. This diagnostic code can also be mistakenly logged as a result of a system self-test run with controller 1’s automatic handle not in the correct position.
System Effect
The CCB system will display the following crew message on the EM2000 “AIR BRAKE CONTROLLER NUMBER 1 FAILURE - SWITCH TO CONTROLLER NUMBER 2” and will initiate a fault penalty application dropping out COR and driving brake pipe to exhaust at a service application rate. The message will continue to be displayed and the penalty will remain in effect until controller number 2 is selected or the fault is cleared. Until the fault is cleared any attempt to switch back to controller 1 from controller 2 will result in the re-initialization of the penalty brake application.

Reset Procedure
This diagnostic code can only be cleared by running a system self-test.

Trouble Shooting Procedure
Verify that the two fiber optic cables coming into the FOR board on the CRU from controller 1 are properly connected at both the FOR board and the controller.

Move the automatic brake handle on controller 1 to the EMERGENCY position. Use the WPTU program to verify that under the “Controller 1” screen the AUTOMATIC signal is between 808 and 1592 Hz.

21-1(The observed signal is not within that range)
Swap the two fiber optic cables from controller 1 at the FOR board. Use the WPTU program to verify that under the “Controller 1” screen the INDEPENDENT signal is now between 808 and 1592 Hz. The FOR board has a defective channel. Replace the FOR board.

If a signal between 808 and 1592 Hz does not appear on the INDEPENDENT line, swap the other end of the fiber optic cables at the back of the Brake Controller.

If a signal between 808 and 1592 Hz now appears on the INDEPENDENT line of the PTU, the FO transmitter has a defective channel. Change out the brake controller.

If a signal between 808 and 1592 Hz does not appear, change out the fiber optic cable. Make sure the labels on the cables match the labels on the FOR board and the Brake Controller.

Diagnostic Code 22(C1 Automatic Handle Frequency High):

Description
This diagnostic code means that the frequency signal from the automatic handle on controller 1 has risen above the valid operating limit of 11392 Hz. This condition is normally due to a defective controller. This diagnostic code can also be mistakenly logged as a result of a system self-test run with controller 1’s automatic handle not in the correct position.

System Effect
The CCB system will display the following crew message on the EM2000 “AIR BRAKE CONTROLLER NUMBER 1 FAILURE - SWITCH TO CONTROLLER NUMBER 2” and will initiate a fault penalty application dropping out COR, and driving brake pipe to exhaust at a service application rate. The message will continue to be displayed and the penalty will remain in effect until controller number 2 is selected or the fault is cleared. Until the fault is cleared any attempt to switch back to controller 1 from controller 2 will result in the re-initialization of the penalty brake application.

Reset Procedure
This diagnostic code can only be cleared by running a system self-test.
Trouble Shooting Procedure
Verify that the two fiber optic cables coming into the FOR board on the CRU from controller 1 are properly connected at both the FOR board and the controller.

Move the automatic brake handle on controller 1 to the RUNNING position. Use the WPTU program to verify that on the “Controller 1” screen the AUTOMATIC signal is between 9745 and 10525 Hz.

21-1(The observed signal is higher than 10525)
Swap the two fiber optic cables from controller 1 at the FOR board. Use the WPTU program to verify that on the “Controller 1” screen the INDEPENDENT signal is between 9745 and 10525 Hz.

If a signal between 9745 and 10525 Hz now appears on the INDEPENDENT line, the FOR board has a defective channel. Change out the FOR board.

21-2(The observed signal is higher than 10525 range)
If a signal between 9745 and 10525 Hz does not appear on the INDEPENDENT line, swap the other end of the fiber optic cables at the back of the Brake Controller.

If a signal between 9745 and 10525 Hz now appears on the INDEPENDENT line of the PTU, change out the brake controller.

Diagnostic Code 23(C1 Automatic Release Switch Stuck Open):

Description
The AR switch inside the automatic handle on controller 1 verifies that the controller’s automatic handle is in the RELEASE position. This switch should close when the automatic handle is moved to the spring-loaded RELEASE position. There is a delay counter associated with this fault to allow for switch debouncing and contact settling time. This counter is incremented whenever the handle frequency is at or above 11000 Hz and the AR switch does not read closed. If the delay counter reaches 2 seconds and the AR switch still does not read closed, diagnostic code 23 will be logged indicating that the switch is stuck in the open position.

System Effect
The CCB system will display the following crew message on the EM2000 “AIR BRAKE CONTROLLER NUMBER 1 FAILURE - SWITCH TO CONTROLLER NUMBER 2”. The message will continue to be displayed until controller number 2 is selected or the fault is cleared. The automatic overcharge feature will not be available from controller 1.

Reset Procedure
This diagnostic code will clear automatically when controller 1 is selected as the active controller and the AR switch reads closed. Moving the automatic handle to the RELEASE position will close the AR switch.

Trouble Shooting Procedure
Make sure the BVJ1-1 and SS9A connectors are properly seated.

Move the automatic brake handle on controller 1 to the RELEASE position. Use the WPTU program to verify that on the “Controller 1” screen the AUTOMATIC signal is above 10568 Hz.
Use the WPTU program to verify that under the “Controller 1” screen the AR SWITCH input reads CLOSED.

If OPEN is displayed, open the Air Brake Circuit Breaker. Remove the BVJ1-1 from the controller and check the resistance across pins F and G. If the multi-meter reads OL or infinite resistance, change out the controller. If the resistance is less than 5 ohms, install the BVJ1-1 connector.

Remove the SS9A connector and check the resistance across the cable connector pins G and F. If the resistance reads OL or infinite resistance, repair or replace the cable or cable connectors. If the resistance is less than 5 ohms, change out the SS9A board.

**Diagnostic Code 24(C1 Automatic Release Switch Stuck Closed):**

**Description**
The AR switch inside the automatic handle on controller 1 verifies that the controller’s automatic handle is in the RELEASE position. This switch should be open whenever the automatic handle is not in the spring-loaded RELEASE position. There is a delay counter associated with this fault to allow for switch debouncing and contact settling time. This counter is incremented whenever the handle frequency falls below 10508 Hz and the AR switch does not read open. If the delay counter reaches 2 seconds and the AR switch still does not read open, diagnostic code 24 will be logged indicating that the switch is stuck in the closed position.

**System Effect**
The CCB system will display the following crew message on the EM2000 “AIR BRAKE CONTROLLER NUMBER 1 FAILURE - SWITCH TO CONTROLLER NUMBER 2”. The message will continue to be displayed until controller number 2 is selected or the fault is cleared.

**Reset Procedure**
This diagnostic code will clear automatically when controller 1 is selected as the active controller and the AR switch reads open. The AR switch should read open if the automatic handle is not in the RELEASE position.

**Trouble Shooting Procedure**

Make sure the BVJ1-1 and SS9A connectors are properly seated.

Move the automatic brake handle on controller 1 to the RUNNING position. Use the WPTU program to verify that under the “Controller 1” screen the AR SWITCH input reads OPEN. If CLOSED is displayed, open the Air Brake Circuit Breaker. Remove the BVJ1-1 from the controller and check the resistance across pins G and F. If the multi-meter is less than 5 ohms, change out the controller. If the resistance reads OL or infinite resistance, the controller is okay, install the BVJ1-1 connector.

Remove the SS9A connector and check the resistance across the cable connector pins G and F. If the resistance is less than 5 ohms, change out the SS9A board. If the resistance reads OL or infinite resistance, repair or replace the cable or cable connectors.
Diagnostic Code 25(C1 Automatic Emergency Switch Stuck Open):

Description
The AE1 switch inside the automatic handle on controller 1 verifies that the controller’s automatic handle is in the EMERGENCY position. This switch should be closed whenever the automatic handle is not in the EMERGENCY position. There is a delay counter associated with this fault to allow for switch debouncing and contact settling time. This counter is incremented whenever the handle frequency rises above 1692 Hz and the AE1 switch does not read closed. If the delay counter reaches 2 seconds and the AE1 switch still does not read closed, diagnostic code 25 will be logged indicating that the switch is stuck in the open position.

System Effect
The CCB system may initially go into an undesired emergency brake application dropping out COR, and driving brake pipe to zero at an emergency application rate. The CCB system then will display the following crew message on the EM2000 “AIR BRAKE CONTROLLER NUMBER 1 FAILURE - SWITCH TO CONTROLLER NUMBER 2”. The message will continue to be displayed until controller number 2 is selected or the fault is cleared. Once the initial emergency brake application is reset, the system can be run as normal.

Reset Procedure
This diagnostic code will clear automatically when controller 1 is selected as the active controller and the AE1 switch reads closed. The AE1 switch should read closed if the automatic handle is not in the EMERGENCY position.

Trouble Shooting Procedure
Make sure the BVJ1-1 and SS9A connectors are properly seated.

Move the automatic brake handle on controller 1 to the RUNNING position. Use the WPTU program to verify that on the “Controller 1” screen the AUTOMATIC signal is above 808 Hz.

Use the WPTU program to verify that under the “Controller 1” screen the AE1 SWITCH input reads CLOSED.
If OPEN is displayed, open the Air Brake Circuit Breaker. Remove the BVJ1-1 from the controller and check the resistance across pins E and F. If the multi-meter reads OL or infinite resistance, change out the controller. If the resistance is less than 5 ohms, the controller is okay, install the BVJ1-1 connector.

Remove the SS9A connector and check the resistance across the cable connector pins E and F. If the resistance is less than 5 ohms change the SS9A board. If the resistance reads OL or infinite resistance repair or replace the cable or connector.

Diagnostic Code 26(C1 Automatic Emergency Switch Stuck Closed):

Description
The AE1 switch inside the automatic handle on controller 1 verifies that the controller’s automatic handle is in the EMERGENCY position. This switch should be open whenever the automatic handle is in the EMERGENCY position. There is a delay counter associated with this fault to allow for switch de-bouncing and contact settling time. This counter is incremented whenever the handle frequency is at or below 1200 Hz and the AE1 switch reads closed. If the delay counter reaches 2 seconds and the AE1 switch still does not read open, diagnostic code 26 will be logged indicating that the switch is stuck in the closed position.
**System Effect**
The CCB system will display the following crew message on the EM2000 “AIR BRAKE CONTROLLER NUMBER 1 FAILURE - SWITCH TO CONTROLLER NUMBER 2”. The message will continue to be displayed until controller number 2 is selected or the fault is cleared.

**Reset Procedure**
This diagnostic code will clear automatically when controller 1 is selected as the active controller and the AE1 switch reads open. The AE1 switch should read open if the automatic handle is placed in the EMERGENCY position.

**Trouble Shooting Procedure**
Make sure the BVJ1-1 and SS9A connectors are properly seated.

Move the automatic brake handle on controller 1 to the EMERGENCY position.

Use the WPTU program to verify that under the “Controller 1” screen the AE1 SWITCH input reads OPEN.
If CLOSED is displayed, open the Air Brake Circuit Breaker. Remove the BVJ1-1 from the controller and check the resistance across pins E and F. If the resistance is less than 5 ohms, change out the controller. If the multi-meter reads OL or infinite resistance, the controller is okay, install the BVJ1-1 connector.

Remove the SS9A connector and check the resistance across the cable connector pins E and F. If the resistance is less than 5 ohms, repair or replace the cable or cable connector. If the resistance reads OL or infinite resistance, change out the SS9A board.

**Diagnostic Code 27(C1 Independent Handle Frequency Low):**

**Description**
This diagnostic code means that the frequency signal from the independent handle on controller 1 has reduced below the valid operating limit of 2729 Hz. This condition is normally due to a disconnected or damaged fiber optic cable. This diagnostic code can also be mistakenly logged as a result of a system self-test run with controller 1’s independent handle not in the correct position.

**System Effect**
The CCB system will display the following crew message on the EM2000 “AIR BRAKE FAILURE - GRADUATED INDEPENDENT BRAKING IS NOT AVAILABLE” and unless the independent handle is in the Release position, full independent brakes will be applied. The message will continue to be displayed until controller number 2 is selected or the fault is cleared.

**Reset Procedure**
This diagnostic code can only be cleared by running a system self-test with controller number 1 as the active controller.

**Trouble Shooting Procedure**
Verify that the two fiber optic cables coming into the FOR board on the CRU from controller 1 are properly connected at both the FOR board and the controller.

Move the Independent brake handle on controller 1 to the Maximum position. Use the WPTU program to verify that under the “Controller 1” screen the INDEPENDENT signal is above 2729 Hz.
If the signal is below 2729 Hz. swap the two fiber optic cables from controller 1 at the FOR board. Use the WPTU program to verify that under the “Controller 1” screen the AUTOMATIC signal is now above 2729 Hz. The FOR board has a defective channel. Replace the FOR board.

If a signal above 2729 Hz does not appear on the AUTOMATIC line, swap the other end of the fiber optic cables at the back of the Brake Controller.

If a signal above 2729 Hz. appears on the AUTOMATIC line of the PTU, the FO transmitter has a defective channel. Change out the brake controller.

If a signal above 2729 Hz. does not appear, change out the fiber optic cable. Make sure the labels on the cables match the labels on the FOR board and the Brake Controller.

**Diagnostic Code 28(C1 Independent Handle Frequency High):**

**Description**
This diagnostic code means that the frequency signal from the independent handle on controller 1 has risen above the valid operating limit of 11489 Hz. This condition is normally due to a defective controller. This diagnostic code can also be mistakenly logged as a result of a system self-test run with controller 1’s independent handle not in the correct position.

**System Effect**
The CCB system will display the following crew message on the EM2000 “AIR BRAKE FAILURE - GRADUATED INDEPENDENT BRAKING IS NOT AVAILABLE” and unless the independent handle is in the Release position, full independent brakes will be applied. The message will continue to be displayed until controller number 2 is selected or the fault is cleared.

**Reset Procedure**
This diagnostic code can only be cleared by running a system self-test with controller number 2 as the active controller.

**Trouble Shooting Procedure**
Verify that the two fiber optic cables coming into the FOR board on the CRU from controller 1 are properly connected at both the FOR board and the controller.

Move the Independent brake handle on controller 1 to the Release position. Use the WPTU program to verify that under the “Controller 1” screen the INDEPENDENT signal is not above 11489 Hz.

If the signal is above 11489 Hz. swap the two fiber optic cables from controller 1 at the FOR board. Use the WPTU program to verify that under the “Controller 1” screen the AUTOMATIC signal is not above 11489 Hz. The FOR board has a defective channel. Replace the FOR board.

If a signal not above 11489 Hz does not appear on the AUTOMATIC line, swap the other end of the fiber optic cables at the back of the Brake Controller.

If a signal not above 11489 Hz. appears on the AUTOMATIC line of the PTU, the FO transmitter has a defective channel. Change out the brake controller.

If a signal not above 11489 Hz. does not appear, change out the fiber optic cable. Make sure the labels on the cables match the labels on the FOR board and the Brake Controller.
Diagnostic Code 29(C1 Independent Release Switch Stuck Open)

Description
The IR switch inside the independent handle on controller 1 verifies that the controller’s independent handle is in the RELEASE position. This switch should close when the independent handle is moved to the RELEASE position. There is a delay counter associated with this fault to allow for switch debouncing and contact settling time. This counter is incremented whenever the handle frequency is at or above 11000 Hz and the IR switch reads open. If the delay counter reaches 2 seconds and the IR switch still does not read closed, diagnostic code 29 will be logged indicating that the switch is stuck in the open position.

System Effect
None

Reset Procedure
This diagnostic code will clear automatically when controller 1 is selected as the active controller and the IR switch reads closed. Moving the independent handle to the RELEASE position will close the IR switch.

Trouble Shooting Procedure
Make sure the BVJ1-1 and SS9A connectors are properly seated.

Move the Independent brake handle on controller 1 out of the Release position. Use the WPTU program to verify that on the “Controller 1” screen the INDEPENDENT signal is above 808 Hz.

Use the WPTU program to verify that under the “Controller 1” screen the IR SWITCH input reads CLOSED.
If OPEN is displayed, open the Air Brake Circuit Breaker. Remove the BVJ1-1 from the controller and check the resistance across pins K and F. If the multi-meter reads OL or infinite resistance, change out the controller. If the resistance is less than 5 ohms, the controller is okay, install the BVJ1-1 connector.

Remove the SS9A connector and check the resistance across the cable connector pins K and F. If the resistance is less than 5 ohms, change out the SS9A board. If the resistance reads OL or infinite resistance, repair or replace the cable or cable connectors.

Diagnostic Code 2A(C1 Independent Release Switch Stuck Closed):

Description
The IR switch inside the independent handle on controller 1 verifies that the controller’s independent handle is in the RELEASE position. This switch should be open whenever the independent handle is not in the RELEASE position. There is a delay counter associated with this fault to allow for switch debouncing and contact settling time. This counter is incremented whenever the handle frequency drops below 10589 Hz and the IR switch reads closed. If the delay counter reaches 2 seconds and the IR switch still does not read open, diagnostic code 2A will be logged indicating that the switch is stuck in the closed position.

System Effect
None

Reset Procedure
This diagnostic code will clear automatically when controller 1 is selected as the active controller and the IR switch reads open. The IR switch should read open if the independent handle is not in the RELEASE position.
Trouble Shooting Procedure
Make sure the BVJ1-1 and SS9A connectors are properly seated.

Move the Independent brake handle on controller 1 to the RUNNING position. Use the WPTU program to verify that on the “Controller 1” screen the AUTOMATIC signal is between 9703 and 10568. Use the WPTU program to verify that under the “Controller 1” screen the AR SWITCH input reads OPEN. If CLOSED is displayed, open the Air Brake Circuit Breaker. Remove the BVJ1-1 from the controller and check the resistance across pins K and F. If the multi-meter is less than 5 ohms, change out the controller. If the resistance reads OL or infinite resistance, the controller is okay, install the BVJ1-1 connector.

Remove the SS9A connector and check the resistance across the cable connector pins K and F. If the resistance is less than 5 ohms, change out the SS9A board. If the resistance reads OL or infinite resistance, repair or replace the cable or cable connectors.

Diagnostic Code 2B(C1 Independent Max Switch Stuck Open):

Description
The IM switch inside the independent handle on controller 1 verifies that the controller’s independent handle is in the FULL position. This switch should be closed whenever the independent handle is in the FULL position. There is a delay counter associated with this fault to allow for switch debouncing and contact settling time. This counter is incremented whenever the handle frequency is at or below 3218 Hz and the IM switch reads open. If the delay counter reaches 2 seconds and the IM switch still does not read closed, diagnostic code 2B will be logged indicating that the switch is stuck in the open position.

System Effect
None

Reset Procedure
This diagnostic code will clear automatically when controller 1 is selected as the active controller and the IM switch reads closed. The IM switch should read closed if the independent handle is placed in the FULL position.

Trouble Shooting Procedure
Make sure the BVJ1-1 and SS9A connectors are properly seated.

Move the Independent brake handle on controller 1 into Full or maximum brake position. Use the WPTU program to verify that on the “Controller 1” screen the INDEPENDENT signal is below 3218 Hz.

Use the WPTU program to verify that under the “Controller 1” screen the IM SWITCH input reads CLOSED. If OPEN is displayed, open the Air Brake Circuit Breaker. Remove the BVJ1-1 from the controller and check the resistance across pins J and F. If the multi-meter reads OL or infinite resistance, change out the controller. If the resistance is less than 5 ohms, the controller is okay, install the BVJ1-1 connector.

Remove the SS9A connector and check the resistance across PCB connector pins J and F. If the resistance reads OL or infinite resistance, change out the SS9A board. If the resistance is less than 5 ohms, repair or replace the cable or cable connectors.
Diagnostic Code 2C(C1 Independent Max Switch Stuck Closed):

Description
The IM switch inside the independent handle on controller 1 verifies that the controller’s independent handle is in the FULL position. This switch should be open whenever the independent handle is not in the FULL position. There is a delay counter associated with this fault to allow for switch debouncing and contact settling time. This counter is incremented whenever the handle frequency rises above 3629 Hz and the IM switch reads closed. If the delay counter reaches 2 seconds and the IM switch still does not read open, diagnostic code 2C will be logged indicating that the switch is stuck in the closed position.

System Effect
None

Reset Procedure
This diagnostic code will clear automatically when controller 1 is selected as the active controller and the IM switch reads open. The IM switch should read open if the independent handle is not in the FULL position.

Trouble Shooting Procedure
Make sure the BVJ1-1 and SS9A connectors are properly seated.

Move the Independent brake handle on controller 1 to the RELEASE position. Use the WPTU program to verify that on the “Controller 1” screen the RELEASE signal is above 10,689 Hz.

Use the WPTU program to verify that under the “Controller 1” screen the IM SWITCH input reads OPEN. If CLOSED is displayed, open the Air Brake Circuit Breaker. Remove the BVJ1-1 from the controller and check the resistance across pins K and F. If the multi-meter is less than 5 ohms, change out the controller. If the resistance reads OL or infinite resistance, the controller is okay, install the BVJ1-1 connector.

Remove the SS9A connector and check the resistance across the cable connector pins K and F. If the resistance is less than 5 ohms, change out the SS9A board. If the resistance reads OL or infinite resistance, repair or replace the cable or cable connectors.

Diagnostic Code 2D(C1 Bail Off Switch Stuck Closed):

Description
This diagnostic code means that the BO switch inside the independent handle on controller 1 has read closed for 50 consecutive seconds or more. This condition is normally due to a short (closed circuit) in the bail off wiring. This diagnostic code can also be mistakenly logged as a result of the operator continuously depressing the bail off ring for an extended period of time.

System Effect
10 seconds prior to logging the fault the CCB system will override the bail off request, allowing brake cylinder pressure to automatically rise if the system is in emergency. This action will prompt the operator to release and then re-depress the bail off if release of the brake is desired. If the BO switch remains closed the CCB system will then display the following crew message on the EM2000 “AIR BRAKE FAILURE - BAIL OFF IS NOT AVAILABLE” and continue to override the bail off request from controller 1. The message will continue to be displayed and bail off will not be available until controller number 2 is selected or the fault is cleared.
Reset Procedure
This diagnostic code will clear automatically when controller 1 is selected as the active controller and the BO switch reads open. The BO switch should read open if the bail off ring on the independent handle is not depressed.

Trouble Shooting Procedure
Make sure the BVJ1-1 and SS9A connectors are properly seated.

Use the WPTU program to verify that under the “Controller 1” screen the BO SWITCH input reads OPEN. If CLOSED is displayed, open the Air Brake Circuit Breaker. Remove the BVJ1-1 from the controller and check the resistance across pins H and F. If the multi-meter is less than 5 ohms, change out the controller. If the resistance reads OL or infinite resistance, the controller is okay, install the BVJ1-1 connector.

Remove the SS9A connector and check the resistance across the cable connector pins H and F. If the resistance is less than 5 ohms, repair or replace the cable or cable connectors. If the resistance reads OL or infinite resistance, change out the SS9A board.

Diagnostic Code 30(No C2 Controller):

Description
On power up and at the start of a self-test the CCB system checks to see if the automatic and independent handles on controller 1 are generating frequency inputs greater than 100 Hz. If both the independent and automatic frequencies are below 100 Hz the entire C1 controller assembly will be flagged as missing and diagnostic code 20 will be logged.

System Effect
The CCB system will automatically default controller 2’s Lead/Trail switch to Trail mode and AE1 switch to CLOSED. If another controller is present, the CCB system will display the following crew message on the EM2000 “AIR BRAKE CONTROLLER NUMBER 1 FAILURE - SWITCH TO AIR BRAKE CONTROLLER NUMBER 1” and will allow the system to be run from the other controller, otherwise the CCB system will display the following crew message on the EM2000 “AIR BRAKE FAILURE - USE LOCOMOTIVE IN TRAIL ONLY” and will default to Trail mode.

Reset Procedure
This diagnostic code can only be cleared by running a system self-test.

Trouble Shooting Procedure
Verify that the two fiber optic cables coming into the FOR board on the CRU from controller 2 are properly connected at both the FOR board and the controller.

Diagnostic Code 31(C2 Automatic Handle Frequency Low):

Description
This diagnostic code means that the frequency signal from the automatic handle on controller 1 has reduced below the valid recognition limit of 808 Hz. This condition is normally due to a disconnected or damaged fiber optic cable. This diagnostic code can also be mistakenly logged as a result of a system self-test run with controller 1’s automatic handle not in the correct position.
System Effect
The CCB system will display the following crew message on the EM2000 “AIR BRAKE CONTROLLER NUMBER 2 FAILURE - SWITCH TO CONTROLLER NUMBER 1” and will initiate a fault penalty application dropping out COR and driving brake pipe to exhaust at a service application rate. The message will continue to be displayed and the penalty will remain in effect until controller number 1 is selected or the fault is cleared. Until the fault is cleared any attempt to switch back to controller 2 from controller 1 will result in the re-initialization of the penalty brake application.

Reset Procedure
This diagnostic code can only be cleared by running a system self-test.

Trouble Shooting Procedure
Verify that the two fiber optic cables coming into the FOR board on the CRU from controller 1 are properly connected at both the FOR board and the controller.

Move the automatic brake handle on controller 2 to the EMERGENCY position. Use the WPTU program to verify that under the “Controller 2” screen the AUTOMATIC signal is between 808 and 1592 Hz.

The observed signal is not within that range
Swap the two fiber optic cables from controller 2 at the FOR board. Use the WPTU program to verify that under the “Controller 2” screen the INDEPENDENT signal is now between 808 and 1592 Hz. The FOR board has a defective channel. Replace the FOR board.

If a signal between 808 and 1592 Hz does not appear on the INDEPENDENT line, swap the other end of the fiber optic cables at the back of the Brake Controller.

If a signal between 808 and 1592 Hz now appears on the INDEPENDENT line of the PTU, the FO transmitter has a defective channel. Change out the brake controller.

If a signal between 808 and 1592 Hz does not appear, change out the fiber optic cable. Make sure the labels on the cables match the labels on the FOR board and the Brake Controller.

Diagnostic Code 32(C2 Automatic Handle Frequency High):

Description
This diagnostic code means that the frequency signal from the automatic handle on controller 1 has risen above the valid operating limit of 11392 Hz. This condition is normally due to a defective controller. This diagnostic code can also be mistakenly logged as a result of a system self-test run with controller 1’s automatic handle not in the correct position.

System Effect
The CCB system will display the following crew message on the EM2000 “AIR BRAKE CONTROLLER NUMBER 2 FAILURE - SWITCH TO CONTROLLER NUMBER 1” and will initiate a fault penalty application dropping out COR, and driving brake pipe to exhaust at a service application rate. The message will continue to be displayed and the penalty will remain in effect until controller number 1 is selected or the fault is cleared. Until the fault is cleared any attempt to switch back to controller 2 from controller 1 will result in the re-initialization of the penalty brake application.

Reset Procedure
This diagnostic code can only be cleared by running a system self-test.
Trouble Shooting Procedure
Verify that the two fiber optic cables coming into the FOR board on the CRU from controller 2 are properly connected at both the FOR board and the controller.

Move the automatic brake handle on controller 2 to the RUNNING position. Use the WPTU program to verify that on the “Controller 1” screen the AUTOMATIC signal is between 9745 and 10525 Hz.

The observed signal is higher than 10525
Swap the two fiber optic cables from controller 2 at the FOR board. Use the WPTU program to verify that on the “Controller 2” screen the INDEPENDENT signal is between 9745 and 10525 Hz.

If a signal between 9745 and 10525 Hz now appears on the INDEPENDENT line, the FOR board has a defective channel. Change out the FOR board.

The observed signal is higher than 10525 range
If a signal between 9745 and 10525 Hz does not appear on the INDEPENDENT line, swap the other end of the fiber optic cables at the back of the Brake Controller.

If a signal between 9745 and 10525 Hz now appears on the INDEPENDENT line of the PTU, change out the brake controller.

Diagnostic Code 33(C2 Automatic Release Switch Stuck Open):

Description
The AR switch inside the automatic handle on controller 1 verifies that the controller’s automatic handle is in the RELEASE position. This switch should close when the automatic handle is moved to the spring-loaded RELEASE position. There is a delay counter associated with this fault to allow for switch debouncing and contact settling time. This counter is incremented whenever the handle frequency is at or above 11000 Hz and the AR switch does not read closed. If the delay counter reaches 2 seconds and the AR switch still does not read closed, diagnostic code 33 will be logged indicating that the switch is stuck in the open position.

System Effect
The CCB system will display the following crew message on the EM2000 “AIR BRAKE CONTROLLER NUMBER 2 FAILURE - SWITCH TO CONTROLLER NUMBER 1”. The message will continue to be displayed until controller number 1 is selected or the fault is cleared. The automatic overcharge feature will not be available from controller 2.

Reset Procedure
This diagnostic code will clear automatically when controller 2 is selected as the active controller and the AR switch reads closed. Moving the automatic handle to the RELEASE position will close the AR switch.

Trouble Shooting Procedure
Make sure the BVJ1-2 and SS9A connectors are properly seated.

Move the automatic brake handle on controller 2 to the RELEASE position. Use the WPTU program to verify that on the “Controller 2” screen the AUTOMATIC signal is above 10568 Hz.

Use the WPTU program to verify that under the “Controller 2” screen the AR SWITCH input reads CLOSED.
If OPEN is displayed, open the Air Brake Circuit Breaker. Remove the BVJ1-2 from the controller and check the resistance across pins G and F. If the multi-meter reads OL or infinite resistance, change out the controller. If the resistance is less than 5 ohms, install the BVJ1-2 connector.

Remove the SS9A connector and check the resistance across the cable connector pins G and F. If the resistance reads OL or infinite resistance, repair or replace the cable or cable connectors. If the resistance is less than 5 ohms, change out the SS9A board.

**Diagnostic Code 34(C2 Automatic Release Switch Stuck Closed):**

**Description**
The AR switch inside the automatic handle on controller 2 verifies that the controller’s automatic handle is in the RELEASE position. This switch should be open whenever the automatic handle is not in the spring-loaded RELEASE position. There is a delay counter associated with this fault to allow for switch debouncing and contact settling time. This counter is incremented whenever the handle frequency falls below 10508 Hz and the AR switch does not read open. If the delay counter reaches 2 seconds and the AR switch still does not read open, diagnostic code 24 will be logged indicating that the switch is stuck in the closed position.

**System Effect**
The CCB system will display the following crew message on the EM2000 “AIR BRAKE CONTROLLER NUMBER 2 FAILURE - SWITCH TO CONTROLLER NUMBER 1”. The message will continue to be displayed until controller number 1 is selected or the fault is cleared.

**Reset Procedure**
This diagnostic code will clear automatically when controller 2 is selected as the active controller and the AR switch reads open. The AR switch should read open if the automatic handle is not in the RELEASE position.

**Trouble Shooting Procedure**
Make sure the BVJ1-2 and SS9A connectors are properly seated.

Move the automatic brake handle on controller 2 to the RUNNING position. Use the WPTU program to verify that under the “Controller 2” screen the AR SWITCH input reads OPEN. If CLOSED is displayed, open the Air Brake Circuit Breaker. Remove the BVJ1-2 from the controller and check the resistance across pins G and F. If the multi-meter is less than 5 ohms, change out the controller. If the resistance reads OL or infinite resistance, the controller is okay, install the BVJ1-2 connector.

Remove the SS9A connector and check the resistance across the cable connector pins G and F. If the resistance is less than 5 ohms, change out the SS9A board. If the resistance reads OL or infinite resistance, repair or replace the cable or cable connectors.
Diagnostic Code 35(C2 Automatic Emergency Switch Stuck Open):

Description
The AE1 switch inside the automatic handle on controller 1 verifies that the controller’s automatic handle is in the EMERGENCY position. This switch should be closed whenever the automatic handle is not in the EMERGENCY position. There is a delay counter associated with this fault to allow for switch debouncing and contact settling time. This counter is incremented whenever the handle frequency rises above 1692 Hz and the AE1 switch does not read closed. If the delay counter reaches 2 seconds and the AE1 switch still does not read closed, diagnostic code 35 will be logged indicating that the switch is stuck in the open position.

System Effect
The CCB system may initially go into an undesired emergency brake application dropping out COR, and driving brake pipe to zero at an emergency application rate. The CCB system then will display the following crew message on the EM2000 “AIR BRAKE CONTROLLER NUMBER 2 FAILURE - SWITCH TO CONTROLLER NUMBER 1”. The message will continue to be displayed until controller number 1 is selected or the fault is cleared. Once the initial emergency brake application is reset, the system can be run as normal.

Reset Procedure
This diagnostic code will clear automatically when controller 2 is selected as the active controller and the AE1 switch reads closed. The AE1 switch should read closed if the automatic handle is not in the EMERGENCY position.

Trouble Shooting Procedure
Make sure the BVJ1-1 and SS9A connectors are properly seated.

Move the automatic brake handle on controller 2 to the RUNNING position. Use the WPTU program to verify that on the “Controller 2” screen the AUTOMATIC signal is above 808 Hz.

Use the WPTU program to verify that under the “Controller 2” screen the AE1 SWITCH input reads CLOSED.
If OPEN is displayed, open the Air Brake Circuit Breaker. Remove the BVJ1-2 from the controller and check the resistance across pins E and F. If the multi-meter reads OL or infinite resistance, change out the controller. If the resistance is less than 5 ohms, the controller is okay, install the BVJ1-2 connector.

Remove the SS9A connector and check the resistance across the cable connector pins E and F. If the resistance is less than 5 ohms change the SS9A board. If the resistance reads OL or infinite resistance repair or replace the cable or connector

Diagnostic Code 36(C2 Automatic Emergency Switch Stuck Closed):

Description
The AE1 switch inside the automatic handle on controller 2 verifies that the controller’s automatic handle is in the EMERGENCY position. This switch should be open whenever the automatic handle is in the EMERGENCY position. There is a delay counter associated with this fault to allow for switch de-bouncing and contact settling time. This counter is incremented whenever the handle frequency is at or below 1200 Hz and the AE1 switch reads closed. If the delay counter reaches 2 seconds and the AE1 switch still does not read open, diagnostic code 36 will be logged indicating that the switch is stuck in the closed position.
System Effect
The CCB system will display the following crew message on the EM2000 “AIR BRAKE CONTROLLER NUMBER 2 FAILURE - SWITCH TO CONTROLLER NUMBER 2”. The message will continue to be displayed until controller number 1 is selected or the fault is cleared.

Reset Procedure
This diagnostic code will clear automatically when controller 2 is selected as the active controller and the AE1 switch reads open. The AE1 switch should read open if the automatic handle is placed in the EMERGENCY position.

Trouble Shooting Procedure
Make sure the BVJ1-2 and SS9A connectors are properly seated.

Move the automatic brake handle on controller 2 to the EMERGENCY position.

Use the WPTU program to verify that under the “Controller 2” screen the AE1 SWITCH input reads OPEN.
If CLOSED is displayed, open the Air Brake Circuit Breaker. Remove the BVJ1-2 from the controller and check the resistance across pins E and F. If the resistance is less than 5 ohms, change out the controller. If the multi-meter reads OL or infinite resistance, the controller is okay, install the BVJ1-2 connector.

Remove the SS9A connector and check the resistance across the cable connector pins E and F. If the resistance is less than 5 ohms, repair or replace the cable or cable connector. If the resistance reads OL or infinite resistance, change out the SS9A board.

Diagnostic Code 37(C2 Independent Handle Frequency Low):

Description
This diagnostic code means that the frequency signal from the independent handle on controller 1 has reduced below the valid operating limit of 2729 Hz. This condition is normally due to a disconnected or damaged fiber optic cable. This diagnostic code can also be mistakenly logged as a result of a system self-test run with controller 2’s independent handle not in the correct position.

System Effect
The CCB system will display the following crew message on the EM2000 “AIR BRAKE FAILURE - GRADUATED INDEPENDENT BRAKING IS NOT AVAILABLE” and unless the independent handle is in the Release position, full independent brakes will be applied. The message will continue to be displayed until controller number 1 is selected or the fault is cleared.

Reset Procedure
This diagnostic code can only be cleared by running a system self-test with controller number 2 as the active controller.

Trouble Shooting Procedure
Verify that the two fiber optic cables coming into the FOR board on the CRU from controller 2 are properly connected at both the FOR board and the controller.

Move the Independent brake handle on controller 2 to the Maximum position. Use the WPTU program to verify that under the “Controller 2” screen the INDEPENDENT signal is above 2729 Hz.
If the signal is below 2729 Hz. swap the two fiber optic cables from controller 2 at the FOR board. Use the WPTU program to verify that under the “Controller 2” screen the AUTOMATIC signal is now above 2729 Hz. The FOR board has a defective channel. Replace the FOR board.

If a signal above 2729 Hz does not appear on the AUTOMATIC line, swap the other end of the fiber optic cables at the back of the Brake Controller.

If a signal above 2729 Hz. appears on the AUTOMATIC line of the PTU, the FO transmitter has a defective channel. Change out the brake controller.

If a signal above 2729 Hz. does not appear, change out the fiber optic cable. Make sure the labels on the cables match the labels on the FOR board and the Brake Controller.

**Diagnostic Code 38(C2 Independent Handle Frequency High):**

**Description**
This diagnostic code means that the frequency signal from the independent handle on controller 1 has risen above the valid operating limit of 11489 Hz. This condition is normally due to a defective controller. This diagnostic code can also be mistakenly logged as a result of a system self-test run with controller 2’s independent handle not in the correct position.

**System Effect**
The CCB system will display the following crew message on the EM2000 “AIR BRAKE FAILURE - GRADUATED INDEPENDENT BRAKING IS NOT AVAILABLE” and unless the independent handle is in the Release position, full independent brakes will be applied. The message will continue to be displayed until controller number 2 is selected or the fault is cleared.

**Reset Procedure**
This diagnostic code can only be cleared by running a system self-test with controller number 1 as the active controller.

**Trouble Shooting Procedure**
Verify that the two fiber optic cables coming into the FOR board on the CRU from controller 2 are properly connected at both the FOR board and the controller.

Move the Independent brake handle on controller 2 to the Release position. Use the WPTU program to verify that under the “Controller 2” screen the INDEPENDENT signal is not above 11489 Hz.

If the signal is above 11489 Hz. swap the two fiber optic cables from controller 2 at the FOR board. Use the WPTU program to verify that under the “Controller 2” screen the AUTOMATIC signal is not above 11489 Hz. The FOR board has a defective channel. Replace the FOR board.

If a signal not above 11489 Hz does not appear on the AUTOMATIC line, swap the other end of the fiber optic cables at the back of the Brake Controller.

If a signal not above 11489 Hz. appears on the AUTOMATIC line of the PTU, the FO transmitter has a defective channel. Change out the brake controller.

If a signal not above 11489 Hz. does not appear, change out the fiber optic cable. Make sure the labels on the cables match the labels on the FOR board and the Brake Controller.
Diagnostic Code 39(C2 Independent Release Switch Stuck Open)

Description
The IR switch inside the independent handle on controller 2 verifies that the controller’s independent handle is in the RELEASE position. This switch should close when the independent handle is moved to the RELEASE position. There is a delay counter associated with this fault to allow for switch debouncing and contact settling time. This counter is incremented whenever the handle frequency is at or above 11000 Hz and the IR switch reads open. If the delay counter reaches 2 seconds and the IR switch still does not read closed, diagnostic code 39 will be logged indicating that the switch is stuck in the open position.

System Effect
None

Reset Procedure
This diagnostic code will clear automatically when controller 2 is selected as the active controller and the IR switch reads closed. Moving the independent handle to the RELEASE position will close the IR switch.

Trouble Shooting Procedure
Make sure the BVJ1-2 and SS9A connectors are properly seated.

Move the Independent brake handle on controller 2 out of the Release position. Use the WPTU program to verify that on the “Controller 2” screen the INDEPENDENT signal is above 808 Hz.

Use the WPTU program to verify that under the “Controller 2” screen the IR SWITCH input reads CLOSED.
If OPEN is displayed, open the Air Brake Circuit Breaker. Remove the BVJ1-2 from the controller and check the resistance across pins K and F. If the multi-meter reads OL or infinite resistance, change out the controller. If the resistance is less than 5 ohms, the controller is okay, install the BVJ1-2 connector.

Remove the SS9A connector and check the resistance across the cable connector pins K and F. If the resistance is less than 5 ohms, change out the SS9A board. If the resistance reads OL or infinite resistance, repair or replace the cable or cable connectors.

Diagnostic Code 3A(C2 Independent Release Switch Stuck Closed):

Description
The IR switch inside the independent handle on controller 1 verifies that the controller’s independent handle is in the RELEASE position. This switch should be open whenever the independent handle is not in the RELEASE position. There is a delay counter associated with this fault to allow for switch debouncing and contact settling time. This counter is incremented whenever the handle frequency drops below 10589 Hz and the IR switch reads closed. If the delay counter reaches 2 seconds and the IR switch still does not read open, diagnostic code 3A will be logged indicating that the switch is stuck in the closed position.

System Effect
None

Reset Procedure
This diagnostic code will clear automatically when controller 2 is selected as the active controller and the IR switch reads open. The IR switch should read open if the independent handle is not in the RELEASE position.
Trouble Shooting Procedure
Make sure the BVJ1-2 and SS9A connectors are properly seated.

Move the Independent brake handle on controller 2 to the RUNNING position. Use the WPTU program to verify that on the “Controller 2” screen the AUTOMATIC signal is between 9703 and 10568. Use the WPTU program to verify that under the “Controller 1” screen the AR SWITCH input reads OPEN. If CLOSED is displayed, open the Air Brake Circuit Breaker. Remove the BVJ1-2 from the controller and check the resistance across pins K and F. If the multi-meter is less than 5 ohms, change out the controller. If the resistance reads OL or infinite resistance, the controller is okay, install the BVJ1-2 connector.

Remove the SS9A connector and check the resistance across the cable connector pins K and F. If the resistance is less than 5 ohms, change out the SS9A board. If the resistance reads OL or infinite resistance, repair or replace the cable or cable connectors.

Diagnostic Code 3B(C2 Independent Max Switch Stuck Open):

Description
The IM switch inside the independent handle on controller 1 verifies that the controller’s independent handle is in the FULL position. This switch should be closed whenever the independent handle is in the FULL position. There is a delay counter associated with this fault to allow for switch debouncing and contact settling time. This counter is incremented whenever the handle frequency is at or below 3218 Hz and the IM switch reads open. If the delay counter reaches 2 seconds and the IM switch still does not read closed, diagnostic code 3B will be logged indicating that the switch is stuck in the open position.

System Effect
None

Reset Procedure
This diagnostic code will clear automatically when controller 2 is selected as the active controller and the IM switch reads closed. The IM switch should read closed if the independent handle is placed in the FULL position.

Trouble Shooting Procedure
Make sure the BVJ1-2 and SS9A connectors are properly seated.

Move the Independent brake handle on controller 2 into Full or maximum brake position. Use the WPTU program to verify that on the “Controller 2” screen the INDEPENDENT signal is below 3218 Hz.

Use the WPTU program to verify that under the “Controller 2” screen the IM SWITCH input reads CLOSED. If OPEN is displayed, open the Air Brake Circuit Breaker. Remove the BVJ1-2 from the controller and check the resistance across pins J and F. If the multi-meter reads OL or infinite resistance, change out the controller. If the resistance is less than 5 ohms, the controller is okay, install the BVJ1-2 connector.

Remove the SS9A connector and check the resistance across PCB connector pins J and F. If the resistance reads OL or infinite resistance, change out the SS9A board. If the resistance is less than 5 ohms, repair or replace the cable or cable connectors.
Diagnostic Code 3C(C2 Independent Max Switch Stuck Closed):

Description
The IM switch inside the independent handle on controller 2 verifies that the controller’s independent handle is in the FULL position. This switch should be open whenever the independent handle is not in the FULL position. There is a delay counter associated with this fault to allow for switch debouncing and contact settling time. This counter is incremented whenever the handle frequency rises above 3629 Hz and the IM switch reads closed. If the delay counter reaches 2 seconds and the IM switch still does not read open, diagnostic code 3C will be logged indicating that the switch is stuck in the closed position.

System Effect
None

Reset Procedure
This diagnostic code will clear automatically when controller 2 is selected as the active controller and the IM switch reads open. The IM switch should read open if the independent handle is not in the FULL position.

Trouble Shooting Procedure
Make sure the BVJ1-2 and SS9A connectors are properly seated.

Move the Independent brake handle on controller 2 to the RELEASE position. Use the WPTU program to verify that on the “Controller 2” screen the RELEASE signal is above 10,689 Hz.

Use the WPTU program to verify that under the “Controller 2” screen the IM SWITCH input reads OPEN. If CLOSED is displayed, open the Air Brake Circuit Breaker. Remove the BVJ1-2 from the controller and check the resistance across pins K and F. If the multi-meter is less than 5 ohms, change out the controller. If the resistance reads OL or infinite resistance, the controller is okay, install the BVJ1-2 connector.

Remove the SS9A connector and check the resistance across the cable connector pins K and F. If the resistance is less than 5 ohms, change out the SS9A board. If the resistance reads OL or infinite resistance, repair or replace the cable or cable connectors.

Diagnostic Code 3D(C2 Bail Off Switch Stuck Closed):

Description
This diagnostic code means that the BO switch inside the independent handle on controller 2 has read closed for 50 consecutive seconds or more. This condition is normally due to a short (closed circuit) in the bail off wiring. This diagnostic code can also be mistakenly logged as a result of the operator continuously depressing the bail off ring for an extended period of time.

System Effect
10 seconds prior to logging the fault the CCB system will override the bail off request, allowing brake cylinder pressure to automatically rise if the system is in emergency. This action will prompt the operator to release and then re-depress the bail off if release of the brake is desired. If the BO switch remains closed the CCB system will then display the following crew message on the EM2000 “AIR BRAKE FAILURE - BAIL OFF IS NOT AVAILABLE” and continue to override the bail off request from controller 2. The message will continue to be displayed and bail off will not be available until controller number 1 is selected or the fault is cleared.
**Reset Procedure**
This diagnostic code will clear automatically when controller 2 is selected as the active controller and the BO switch reads open. The BO switch should read open if the bail off ring on the independent handle is not depressed.

**Trouble Shooting Procedure**
Make sure the BVJ1 and SS9A connectors are properly seated.

Use the WPTU program to verify that under the “Controller 2” screen the BO SWITCH input reads OPEN. If CLOSED is displayed, open the Air Brake Circuit Breaker. Remove the BVJ1 from the controller and check the resistance across pins H and F. If the multi-meter is less than 5 ohms, change out the controller. If the resistance reads OL or infinite resistance, the controller is okay, install the BVJ1 connector.

Remove the SS9A connector and check the resistance across the cable connector pins H and F. If the resistance is less than 5 ohms, repair or replace the cable or cable connectors. If the resistance reads OL or infinite resistance, change out the SS9A board.

**Diagnostic Code 40(Lead/Trail Switches Open):**

**Description**
This diagnostic code means that the Lead/Trail switches on both controller 1 and controller 2 are set to a Lead position. This condition is normally due to the operator unintentionally selecting a Lead position on both controllers. This diagnostic code can also be due to a disconnect (open circuit) in one of the four LT switch’s wiring. There is a delay timer associated with this fault to allow for switch debouncing and contact settling time. This timer is set to 1.5 seconds whenever any of the LT switches change state.

The CCB system will display the following crew message on the EM2000 “AIR BRAKE FAILURE - CHECK FOR PROPER LEAD/TRAIL SET UP” and will initiate a fault penalty application dropping out COR, and driving brake pipe to exhaust at a service application rate. The message will continue to be displayed and the penalty will remain in effect until the fault is cleared. The last controller to be selected active will continue to be the active controller.

**Reset Procedure**
This diagnostic code will clear automatically as soon as one of the controller’s Lead/Trail switches is set to a Trail position.

**Trouble Shooting Procedure**
Verify that only a single controller is selected in a Lead mode.

Move both controllers’ Lead/Trail switch to Trail positions.

Use the WPTU program to verify that on the “Controller 1” screen both the LT_3_ SWITCH input and the LT_2_ SWITCH input read CLOSED.

Use the WPTU program to verify that on the “Controller 2” screen both the LT_3_ SWITCH input and the LT_2_ SWITCH input read CLOSED.

If both switches do not display as indicated above open the AB circuit breaker, select the controller that is incorrect, remove the BVJ1-1 connector from the controller and check the resistance across pins D and F. If the resistance is OL or infinite resistance replace the controller. If the resistance is less than 5 ohms install the connector.
Remove the connector from the SS9A board and check the resistance across pins D and F of the cable connector. If the resistance reads less than 5 ohms, replace the SS9A board. If the resistance reads open or infinite resistance, repair or replace the cable or cable connector.

**Diagnostic Code 41(Lead/Trail Switches Closed):**

**Description**
This diagnostic code means that the LT2 and LT3 switches on both controller 1 and controller 2 were reading CLOSED during a self-test. This condition is normally due to the operator unintentionally selecting a Trail position on both controllers then running a system self-test. This diagnostic code can also be due to a short (closed circuit) in one of the four LT switch’s wiring. This diagnostic code will only be logged during a system self-test.

**System Effect**
The CCB system will display the following crew message on the EM2000 “AIR BRAKE FAILURE - CHECK FOR PROPER LEAD/TRAIL SET UP”. The message will continue to be displayed until the fault is cleared.

**Reset Procedure**
This diagnostic code can only be cleared by running another system self-test.

**Trouble Shooting Procedure**
Verify that one of the controllers is selected in Lead In prior to running a self-test.

Move controller 1’s Lead/Trail switch to Lead In and controller 2’s Lead/Trail switch to Trail. Use the WPTU program to verify that on the “Controller 1” screen the LT_3_SWITCH input reads CLOSED and the LT_2_SWITCH input reads OPEN.

Move controller 2’s Lead/Trail switch to Lead In and controller 1’s Lead/Trail switch to Trail. Use the WPTU program to verify that on the “Controller 2” screen both the LT_3_SWITCH input reads CLOSED and the LT_2_SWITCH input reads OPEN.

If okay, rerun self-test.

If both switches do not display as indicated above, open the AB circuit breaker. Select the controller that is incorrect, leave the L/T switch in Lead-In, remove the large connector from the controller and check the resistance across pins D and F. If the resistance is less than 5 ohms replace the controller.

If the resistance is reads OL or Infinite resistance, remove the connector from the SS9A board and check the resistance across pins D and F of the cable connector. If the reads less than 5 ohms resistance, replace the SS9A board. If the resistance reads OL or infinite, repair or replace the shorted cable or cable connector.

**Diagnostic Code 42(C1 Lead/Trail Switches Stuck Open):**

**Description**
This diagnostic code means that both the LT2 and the LT3 switches on controller 1 are reading OPEN. This condition is normally due to a disconnection (open circuit) between the SS9A board and the BVJ1-1 connector. There is a delay timer associated with this fault to allow for switch debouncing and contact settling time. This timer is set to 1.5 seconds whenever either of the LT switches change state.
**System Effect**
The CCB system will display the following crew message on the EM2000 “AIR BRAKE FAILURE - CHECK FOR PROPER LEAD/TRAIL SET UP” and will default the LT2 and LT3 signals from controller 1 to the last known values. The message will continue to be displayed until the fault is cleared.

**Reset Procedure**
This diagnostic code will clear automatically as soon as one of the controller’s LT switches reads CLOSED.

**Trouble Shooting Procedure**
Verify that the SS9A, CRJ1, and BVJ1-1 connectors are properly seated.

Move controller 1’s Lead/Trail switch to the Trail position.
Use the WPTU program to verify that on the “Controller 1” screen both the LT_3_SWITCH input and the LT_2_SWITCH input read CLOSED.

If both switches are still open, open the AB circuit breaker and remove the large BVJ1 from the controller and check the resistance across pins D and F of the controller. If the resistance reads OL or infinite resistance replace the controller. If the resistance is less than 5 ohms install the connector to the controller and remove the connector from the SS9A board and check the resistance across pins D and F of the cable connector. If the resistance reads OL or infinite resistance repair or replace the cable and/or the connector. If the resistance is less than 5 ohms replace the SS9A board.

**Diagnostic Code 43(C1 Lead/Trail Switches Failure):**

**Description**
This diagnostic code means that the LT2 switch was reading CLOSED and the LT3 switch was reading OPEN on controller 1 during a self-test. This condition is normally due to the operator unintentionally selecting the Lead-Out position instead of the Lead In position when running a system self-test. This diagnostic code can also be due to an error in the wiring between the SS9A board and the BVJ1-1 connector. This diagnostic code will only be logged during a system self-test.

**System Effect**
The CCB system will display the following crew message on the EM2000 “AIR BRAKE FAILURE - CHECK FOR PROPER LEAD/TRAIL SET UP”. The message will continue to be displayed until the fault is cleared.

**Reset Procedure**
This diagnostic code can only be cleared by running another system self-test.

**Trouble Shooting Procedure**
Verify that controller 1’s Lead/Trail switch is set to Lead In prior to running a self-test.

Verify that the SS9A, CRJ1, and BVJ1-1 connectors are properly seated.

Move controller 1’s Lead/Trail switch to the Trail position.
Use the WPTU program to verify that on the “Controller 1” screen both the LT_3_SWITCH input and the LT_2_SWITCH input read CLOSED.

If both switches do not display as indicated above open the AB circuit breaker. Move the L/T switch to Lead-In, remove the BVJ1-1 connector from the controller and check the resistance across pins C and F. If the resistance is less than 5 ohms replace the controller.
If the resistance is reads OL or Infinite resistance, remove the connector from the SS9A board and check the resistance across pins C and F of the cable connector. If the reads less than 5 ohms resistance, repair or replace the shorted cable or cable connector. If the resistance reads OL or infinite, replace the SS9A board.

Diagnostic Code 44(C1 Lead/Trail Switches Change at Speed):

Description
This diagnostic code means that either the LT2 or the LT3 switch on controller 1 changed state while the locomotive was moving at a speed greater than 1 mph. This condition is normally due to an unintentional movement by the operator of controller 1’s Lead/Trail switch while the locomotive was moving. There is a delay timer associated with this fault to allow for switch debouncing and contact settling time. This timer is set to 1.5 seconds whenever either of the LT switches change state.

System Effect
The CCB system will display the following crew message on the EM2000 “AIR BRAKE FAILURE - CHECK FOR PROPER LEAD/TRAIL SET UP” and will initiate a fault penalty application dropping out COR, and driving brake pipe to exhaust at a service application rate. The message will continue to be displayed and the penalty will remain in effect until the fault is cleared. Additionally, the system will not transition out of Lead-In mode or into Trail mode until the locomotive reaches zero speed. All other mode transitions will be allowed at any speed.

Reset Procedure
This diagnostic code will clear automatically as soon as the locomotive reaches zero speed.

Trouble Shooting Procedure
Check for proper controller setup
Verify that the SS9A, CRJ1, and BVJ1-1 connectors are properly seated.

Verify locomotive speed is zero - Use the WPTU program to verify that on the LCC to MABS screen the first digit from the left of the VEHICLE SPEED signal is 7 or less and the third and fourth digits are both 0 (we don’t care about the second digit). This combination represents a speed of less than 0.87 miles per hour at which the CCB will recognize as “zero speed.” Note: If no EM2000 communications are present the speed signal defaults to a zero value.

If the speed indication is proper, perform a self-test to determine the actual fault. Follow the appropriate troubleshooting procedure.

Diagnostic Code 45(C2 Lead/Trail Switches Stuck Open):

Description
This diagnostic code means that both the LT2 and the LT3 switches on controller 2 are reading OPEN. This condition is normally due to a disconnection (open circuit) in the wiring between the SS9B board and the BVJ1-2 connector. There is a delay timer associated with this fault to allow for switch debouncing and contact settling time. This timer is set to 1.5 seconds whenever either of the LT switches change state.

System Effect
The CCB system will display the following crew message on the EM2000 “AIR BRAKE FAILURE - CHECK FOR PROPER LEAD/TRAIL SET UP” and will default the LT2 and LT3 signals from controller 1 to the last known value. The message will continue to be displayed until the fault is cleared.
**Reset Procedure**
This diagnostic code will clear automatically as soon as one of the controller’s LT switches reads CLOSED.

**Trouble Shooting Procedure**
Verify that the SS9B, CRJ1, and BVJ1-1 connectors are properly seated.

Move controller 2’s Lead/Trail switch to the Trail position.
Use the WPTU program to verify that on the “Controller 2” screen both the LT_3_SWITCH input and the LT_2_SWITCH input read CLOSED.

If both switches are still open, open the AB circuit breaker and remove the BVJ1-1 connector from the controller and check the resistance across pins D and F of the controller. If the resistance reads OL or infinite resistance replace the controller. If the resistance is less than 5 ohms install the connector to the controller and remove the connector from the SS9B board and check the resistance across pins D and F of the cable connector. If the resistance reads OL or infinite resistance repair or replace the cable and/or the connector. If the resistance is less than 5 ohms replace the SS9B board.

**Diagnostic Code 46(C2 Lead/Trail Switches Failure):**

**Description**
This diagnostic code means that the LT2 switch was reading CLOSED and the LT3 switch was reading OPEN on controller 2 during a self-test. This condition is normally due to the operator unintentionally selecting the Lead-Out position instead of the Lead-In position when running a system self-test. This diagnostic code can also be due to an error in the wiring between the SS9B board and the BVJ1-2 connector. This diagnostic code will only be logged during a system self-test.

**System Effect**
The CCB system will display the following crew message on the EM2000 “AIR BRAKE FAILURE - CHECK FOR PROPER LEAD/TRAIL SET UP”. The message will continue to be displayed until the fault is cleared.

**Reset Procedure**
This diagnostic code can only be cleared by running another system self-test.

**Trouble Shooting Procedure**
Verify that controller 2’s Lead/Trail switch is set to Lead In or Trail prior to running a self-test.

Verify that the SS9B, CRJ3, and BVJ1-2 connectors are properly seated.

Move controller 2’s Lead/Trail switch to the Trail position.
Use the WPTU program to verify that on the “Controller 2” screen both the LT_3_SWITCH input and the LT_2_SWITCH input read CLOSED.

If both switches do not display as indicated above open the AB circuit breaker. Move the L/T switch to Lead-In, remove the BVJ1-2 connector from the controller and check the resistance across pins C and F. If the resistance is less than 5 ohms replace the controller.

If the resistance is reads OL or Infinite resistance, remove the connector from the SS9A board and check the resistance across pins C and F of the cable connector. If the reads less than 5 ohms resistance, repair or replace the shorted cable or cable connector. If the resistance reads OL or infinite, replace the SS9A board.
Diagnostic Code 47(C2 Lead/Trail Switches Change at Speed):

Description
This diagnostic code means that either the LT2 or the LT3 switch on controller 2 changed state while the locomotive was moving at a speed greater than 1 mph. This condition is normally due to an unintentional movement by the operator of controller 2’s Lead/Trail switch while the locomotive was moving. There is a delay timer associated with this fault to allow for switch debouncing and contact settling time. This timer is set to 1.5 seconds whenever either of the LT switches change state.

System Effect
The CCB system will ring the locomotive alarm bell, display the following crew message on the EM2000 “AIR BRAKE FAILURE - CHECK FOR PROPER LEAD/TRAIL SET UP” and initiate a fault penalty application dropping out COR, and driving brake pipe to exhaust at a service application rate. The message will continue to be displayed and the penalty will remain in effect until the fault is cleared. Additionally, the system will not transition out of Lead-In mode or into Trail mode until the locomotive reaches zero speed. All other mode transitions will be allowed at any speed.

Reset Procedure
This diagnostic code will clear automatically as soon as the locomotive reaches zero speed.

Trouble Shooting Procedure
Verify that the SS9B, CRJ3, and BVJ1-2 connectors are properly seated.

Locomotive speed is zero - Use the WPTU program to verify that on the LCC to MABS screen the first digit from the left of the VEHICLE SPEED signal is 7 or less and the third and fourth digits are both 0. This combination represents a speed of less than 0.87 miles per hour which the CCB will recognize as “zero speed.” Note: If no EM2000 communications are present the speed signal defaults to a zero value.

Move Controller 2’s Lead/Trail switch to the Trail position.
Use the WPTU program to verify that on the “Controller 2” screen both the LT_3_SWITCH input and the LT_2_SWITCH input read CLOSED.

If the speed indication is proper, perform a self-test to determine the actual fault. Follow the appropriate troubleshooting procedure.

Diagnostic Code 48(Passenger/Goods Switches Stuck Open):

Description
This diagnostic code means that both the PG1 switch and the PG2 switch are reading OPEN. This condition is normally due to a disconnection (open circuit) in the wiring between the SS9B board and the Passenger/Goods switch. There is a delay timer associated with this fault to allow for switch debouncing and contact settling time. This timer is set to 1.5 seconds whenever either of the PG switches change state.

System Effect
The CCB system will default to the last known Passenger/Goods mode. In the event that this diagnostic code is present at power up, the system will default to Goods mode. While this fault is in effect, the system will immediately fail any self-test request.
Reset Procedure
This diagnostic code will clear automatically as soon as one of the PG switches reads CLOSED.

Trouble Shooting Procedure
Verify that the SS9B connector is properly seated. Select ‘Goods’ position.

Use the WPTU program to verify that on the “SS9B” screen that the PG_1_SWITCH input reads OPEN and the PG_2_SWITCH input reads CLOSED.

If the switches do not indicate the above positions open the AB breaker and remove the connector from the SS9B board. Check the resistance across pins a0 and c4 of the cable connector. If the resistance is less than 5 ohms, change the Pass/Goods switch. If the resistance reads OL or Infinite, check the resistance across pins a0 and c5. If the resistance reads OL or Infinite, change the Pass/Goods. If the resistance reads less than 5 ohms the switch and cable are okay. Replace the SS9B board.

Diagnostic Code 49(Passenger/Goods Switches Stuck Closed):

Description
This diagnostic code means that both the PG1 switch and the PG2 switch are reading CLOSED. This condition is normally due to a short (closed circuit) in the wiring between the SS9B board and the Passenger/Goods switch. There is a delay timer associated with this fault to allow for switch debouncing and contact settling time. This timer is set to 1.5 seconds whenever either of the PG switches change state.

System Effect
The CCB system will default to the last known Passenger/Goods mode. In the event that this diagnostic code is present at power up, the system will default to Goods mode. While this fault is in effect, the system will immediately fail any self-test request.

Reset Procedure
This diagnostic code will clear automatically as soon as one of the PG switches reads OPEN.

Trouble Shooting Procedure
Verify that the SS9B connector is properly seated. Select ‘Goods’ position.

Use the WPTU program to verify that on the “SS9B” screen that the PG_1_SWITCH input reads OPEN and the PG_2_SWITCH input reads CLOSED.

If the switches do not indicate the above positions, open the AB breaker and remove the connector from the SS9B board. Check the resistance across pins a0 and c4 of the cable connector. If the resistance is less than 5 ohms, change the Pass/Goods switch. If the resistance reads OL or Infinite, check the resistance across pins a0 and c5. If the resistance reads OL or Infinite, change the Pass/Goods. If the resistance reads less than 5 ohms the switch and cable are okay. Replace the SS9B board.
Diagnostic Code 4A(Passenger/Goods Switch Change at Speed):

**Description**
This diagnostic code means that either the PG1 or the PG2 switch changed state while the locomotive was moving at a speed greater than 1 mph. This condition is normally due to an unintentional movement by the operator of Passenger/Goods switch while the locomotive was moving. There is a delay timer associated with this fault to allow for switch debouncing and contact settling time. This timer is set to 1.5 seconds whenever either of the PG switches change state.

**System Effect**
The CCB system will remain in the last known Passenger/Goods mode.

**Reset Procedure**
This diagnostic code will clear automatically as soon as the locomotive reaches zero speed.

**Trouble Shooting Procedure**
Verify the locomotive speed is zero - Use the WPTU program to verify that on the “LCC to MABS” screen the first digit from the left of the VEHICLE SPEED signal is 7 or less and the third and fourth digits are both 0. This combination represents a speed of less than 0.87 miles per hour at which the CCB will recognize as “zero speed.” Note: If no EM2000 communications are present the speed signal defaults to a zero value.

Verify that the SS9B connector is properly seated. Select ‘Goods’ position.

Use the WPTU program to verify that on the “SS9B” screen that the PG_1_SWITCH input reads OPEN and the PG_2_SWITCH input reads CLOSED.

If the switches do not indicate the above positions, open the AB breaker and remove the connector from the SS9B board. Check the resistance across pins a0 and c4 of the cable connector. If the resistance is less than 5 ohms, change the Pass/Goods switch. If the resistance reads OL or Infinite, check the resistance across pins a0 and c5. If the resistance reads OL or Infinite, change the Pass/Goods. If the resistance reads less than 5 ohms the switch and cable are okay. Replace the SS9B board.

Diagnostic Code 50(Defective MR Transducer):

**Description**
This diagnostic code means that the signal from the Main Reservoir Equalizing Pipe Transducer (MREP) to the CCB system is outside the valid range. This condition is normally due to a disconnected (open circuit) or shorted (closed circuit) transducer/connector.

**System Effect**
All main reservoir related system features would no longer be available. These features include consist break-in-two detection, PCR knock out due to low Main Reservoir, and the low main reservoir pressure by-pass of the 16, 20, and ER pressure diagnostics. While this fault is in effect, the system will immediately fail any self-test request.

**Reset Procedure**
Returning the transducer signal to within the valid limits can clear the diagnostic code.
Trouble Shooting Procedure
Make sure the EPA-3 board, CRJ7 and the MREP connectors are properly seated.

If the problem still exists, remove the transducer connector and connect a good transducer to the cable. With the WPTU check the output of the MRET transducer. The pressure should be between 0 and 1 psi. If the pressure is correct replace the transducer. If the pressure is incorrect, replace the ADZ2 board and run a self-test. If the fault still exists, replace the EPA-3 board and rerun the self-test. If the self-test still fails the problem exists with cable or connectors
Remove the transducer test fitting and the CRJ7 cable connector from the CRU and check the resistance between Pin B of the transducer connector and pin P of the CRJ7 cable connector
Pin A of the transducer connector and pin R of the CRJ7 cable connector
Pin C of the transducer connector and pin N of the CRJ7 cable connector

If any open circuits exist replace the cable. If not remove the EPA-3 board connector and check the resistance between
Pin N of the CRJ7 connector and pin b3 of the EPA-3 cable connector
Pin P of the CRJ7 connector and pin a0 of the EPA-3 cable connector
Pin R of the CRJ7 connector and pin c6 of the EPA-3 cable connector

If any open circuits exist replace the cable. Rerun Self-test to verify the fault is cleared.

Diagnostic Code 60(Defective ER Transducer):

Description
This diagnostic code means that the signal from the Equalizing Reservoir Transducer (ERT) to the CCB system is outside the valid range. This condition is normally due to a disconnected (open circuit) or shorted (closed circuit) transducer/connector.

System Effect
The CCB system will display the following crew message on the EM2000 “AIR BRAKE FAILURE - USE LOCOMOTIVE IN TRAIL ONLY” and initiate a fault penalty application dropping out COR, and driving brake pipe to exhaust at a service application rate by de-energizing MVER. The message will continue to be displayed until the fault is cleared and the penalty will remain in effect until the fault is cleared or the locomotive is set to Trail. While this fault is in effect, all other equalizing reservoir diagnostics will be skipped to prevent false indications of other failures and the AW4-ER control circuit will be disabled.

Reset Procedure
Returning the transducer signal to within the valid limits can clear the diagnostic code. After the diagnostic code is cleared, the penalty application can be reset by moving the automatic brake valve handle to Full Service for ten seconds then to the Run or Release position.

Trouble Shooting Procedure
Make sure the EPA1, ADZ board and the Equalizing Reservoir Transducer connectors are properly seated.

If the problem still exists, open the AB circuit breaker, remove the transducer connector and connect the Test Adapter to the cable. Close the AB circuit breaker. With a multi-meter check the output of the ERT transducer across pins 1 and 3. The voltage should be between 2 and 12 volts. If the voltage is correct replace the transducer. If the voltage is incorrect reconnect the cable to the transducer. Change the ADZ2 board and run a self-test. If the fault still exists, change the EPA1 board and rerun the self-test. If the self-test still fails the problem exists with cable or connectors.
Remove the transducer connector and the CRJ7 cable connector from the CRU and check the resistance between Pin 3 of the transducer connector and pin A of the CRJ7 cable connector
Pin 2 of the transducer connector and pin B of the CRJ7 cable connector
Pin 1 of the transducer connector and pin S of the CRJ7 cable connector

If any open circuits exist replace the cable. If not remove the EPA-3 board connector and check the resistance between
Pin A of the CRJ7 connector and pin a3 of the EPA1 cable connector
Pin B of the CRJ7 connector and pin c3 of the EPA1 cable connector
Pin S of the CRJ7 connector and pin b1 of the EPA1 cable connector

If any open circuits exist replace the cable. Rerun Self-test to verify the fault is cleared.

**Diagnostic Code 61(ER Supply Magnet Valve Stuck Open):**

**Description**
This diagnostic code means that the ER pressure has risen 8 psi over the highest possible ER pressure command and has remained there for at least 8 seconds. This condition is normally due to the AW4-ER supply magnet valve stuck open. This diagnostic is skipped if the ER command is changing by more than one psi per loop, the main reservoir pressure is less than 78 psi, the ADZ board has failed, the ER transducer has failed, or ER is not under electronic control.

**System Effect**
The CCB system will display the following crew message on the EM2000 “AIR BRAKE FAILURE - USE LOCOMOTIVE IN TRAIL ONLY” and initiate a fault penalty application dropping out COR, and driving brake pipe to exhaust at a service application rate by de-energizing MVER. The message will continue to be displayed until the fault is cleared and the penalty will remain in effect until the fault is cleared or the locomotive is set to Trail. While this fault is in effect, the AW4-ER control circuit will be disabled.

**Reset Procedure**
The diagnostic code can only be cleared by running a system self-test.

**Trouble Shooting Procedure**
Make sure the connectors for the AW4-ER magnet valves and transducer are properly seated. Perform the same check for the EPA1 board.

Using the WPTU program select Test Mode under MODE menu. Select EPA1 under screen, then select Control pressure. Type 70, press enter. ER pressure should increase to 70 psi. If the ER pressure continues to rise above 70 psi, the AW4-ER is defective. Replace and rerun self-test. Note: The other AW4 may be exchanged to verify the AW4 is bad.

If the AW4 does not correct the problem replace the EPA1 board. Rerun Self-test to confirm fault has cleared.

**Diagnostic Code 62(No ER Supply):**

**Description**
This diagnostic code means that the ER pressure has reduced 8 psi below the current ER pressure command and has remained there for at least 8 seconds. This condition is normally due to the AW4-ER supply magnet valve stuck closed. This diagnostic is skipped if the ER command is changing by more than one psi per loop, the main reservoir pressure is less than 78 psi, the ADZ board has failed, the ER transducer has failed, or ER is not under electronic control.
System Effect
The CCB system will display the following crew message on the EM2000 “AIR BRAKE FAILURE - USE LCOMOTIVE IN TRAIL ONLY” and initiate a fault penalty application dropping out COR, and driving brake pipe to exhaust at a service application rate by de-energizing MVER. The message will continue to be displayed until the fault is cleared and the penalty will remain in effect until the fault is cleared or the locomotive is set to Trail. While this fault is in effect, the AW4-ER control circuit will be disabled.

Reset Procedure
The diagnostic code can only be cleared by running a system self-test.

Trouble Shooting Procedure
Make sure the connectors for the AW4-ER magnet valves and transducer are properly seated. Perform the same check for the EPA1 board.

Using the WPTU program select Test Mode under MODE menu. Select EPA1 under screen, then select Control pressure. Type 70, press enter. ER pressure should increase to 70 psi. If the ER pressure does not increase to 70 psi, the AW4-ER may be defective. Remove the connector from the AW4-ER Supply Magnet and with a multi-meter check the voltage across connector pins 1 and 2. If the voltage is approximately 24 vdc, replace the Analog Converter.

If the voltage is not 24 vdc replace the EPA1 board, reconnect the AW4-ER connector and rerun the self-test to clear the fault. If the fault still exists, one of the cables between the AW4-ER and the CRU is open. Remove the cables and check the continuity. Replace the defective cable.

Diagnostic Code 63(No ER Exhaust)

Description
This diagnostic code means that the ER pressure has risen 8 psi above the current ER pressure command and has remained there for at least 8 seconds. This condition is normally due to the AW4-ER exhaust magnet valve stuck closed. This diagnostic is skipped if the ER command is changing by more than one psi per loop, the main reservoir pressure is less than 78 psi, the ADZ board has failed, the ER transducer has failed, or ER is not under electronic control.

System Effect
The CCB system will display the following crew message on the EM2000 “AIR BRAKE FAILURE - USE LCOMOTIVE IN TRAIL ONLY” and initiate a fault penalty application dropping out COR, and driving brake pipe to exhaust at a service application rate by de-energizing MVER. The message will continue to be displayed until the fault is cleared and the penalty will remain in effect until the fault is cleared or the locomotive is set to Trail. While this fault is in effect, the AW4-ER control circuit will be disabled.

Reset Procedure
The diagnostic code can only be cleared by running a system self-test.

Trouble Shooting Procedure
Make sure the connectors for the AW4-ER magnet valves and transducer are properly seated. Perform the same check for the EPA1 board.
Using the WPTU program select Test Mode under MODE menu. Select EPA1 under screen, then select Control Pressure. Type 70, press enter. ER pressure should increase to 70 psi. If the ER pressure does not increase to 70 psi, the AW4-ER may be defective. Remove the connector from the AW4-ER Supply Magnet and with a multi-meter check the voltage across connector pins 1 and 2. If the voltage is approximately 24 vdc, replace the Analog Converter.

If the voltage is not 24 vdc replace the EPA1 board, reconnect the AW4-ER connector and rerun the self-test to clear the fault. If the fault still exists, one of the cables between the AW4-ER and the CRU is open. Remove the cables and check the continuity. Replace the defective cable.

**Diagnostic Code 64(Brake Pipe Cut-Off Valve Stuck Open):**

**Description**
This diagnostic code means that either the ER pressure has been below 5 psi or MVER has been de-energized for at least 8 seconds and the switch inside the brake pipe cut-off valve (BPCO) still reads OPEN. While this condition is normally due to a real mechanical failure of the brake pipe cut-off valve, a disconnection in the switch’s wiring could also cause this diagnostic code to be logged. This diagnostic is skipped if the main reservoir pressure is less than 78 psi, the ADZ board has failed, or the ER transducer has failed. This diagnostic will normally be over-ridden by the MV3 stuck off diagnostic and as a result will only show up when the system is in Lead-In mode.

**System Effect**
The CCB system may be unable to cut-off brake pipe and may continue to drive brake pipe to exhaust in both Lead Out and Trail modes. The CCB system will display the following crew message on the EM2000 “AIR BRAKE CUT-OFF FAILURE - USE LOCOMOTIVE IN LEAD IN MODE ONLY”. The message will continue to be displayed until the fault is cleared.

**Reset Procedure**
This diagnostic code will clear automatically as soon as the BPCO switch reads CLOSED.

**Trouble Shooting Procedure**
Make sure the connectors for the SS9A board and the Brake Pipe Cut-Off Valve are properly seated.

Use the WPTU program to verify the BPCO switch is operating correctly. Under the Screen menu select Brake Pipe. Move the brake valve to emergency position to vent brake pipe to zero and leave the brake valve in Emergency position. The BPCO switch should indicate closed and the fault should clear. If the fault does not clear, open the AB circuit breaker, remove the connector from BPCO and check the resistance across pins 2 and 3. If the circuit reads open, replace the BPCO valve.

If the resistance is less than 5 ohms, attach the BPCO connector, remove the connector from the SS9A board and check the resistance across pins a0 and c4 of the cable connector. If the resistance is still less than 5 ohms then replace the SS9A board. If the circuit is open make a continuity check on the interconnecting cables and repair or replace as required.
Diagnostic Code 65 (Brake Pipe Cut-Off Valve Stuck Closed):

**Description**
This diagnostic code means that the ER pressure has been above 15 psi, MVER has been energized, and MV53 has been de-energized for at least 8 seconds and the switch inside the brake pipe cut-off valve (BPCO) still reads CLOSED. While this condition is normally due to a real mechanical failure of the brake pipe cut-off valve, a short in the switch’s wiring could also cause this diagnostic code to be logged. This diagnostic is skipped if the main reservoir pressure is less than 78 psi, the ADZ board has failed, or the ER transducer has failed.

**System Effect**
The CCB system will be unable to control brake pipe except for emergency applications. The CCB system will display the following crew message on the EM2000 “AIR BRAKE FAILURE - USE LOCOMOTIVE IN TRAIL ONLY” until the fault is cleared.

**Reset Procedure**
This diagnostic code will clear automatically as soon as the BPCO switch reads OPEN.

**Trouble Shooting Procedure**
Move the Brake Valve to Emergency position. Wait 60 seconds. Move Brake Valve handle to Running position.
If the brake pipe does not charge to ER pressure the BPCO pneumatic valve did not open. Either the MV-53 magnet valve is energized or stuck closed or BPCO is stuck closed.
Remove the electrical connector from MV-53. If brake pipe charges, the BPCO is okay. The problem is the MV-53 is energized or stuck open.
Check the voltage at the MV-53 connector pins 1 and 2. If the voltage is zero, replace the DB1 board. If after removing the electrical connector from MV-53 magnet valve above the brake pipe does not charge, replace the BPCO valve.

Diagnostic Code 66 (MV53 Stuck Off):

**Description**
This diagnostic code means that the brake pipe cut-off magnet valve (MV53) has been commanded ON for at least 8 seconds and the switch inside the brake pipe cut-off valve (BPCO) still reads OPEN. This condition is normally due to either the brake pipe cut-off magnet valve (MV53) stuck OFF or the brake pipe cut-off valve stuck OPEN. This diagnostic is skipped if the main reservoir pressure is less than 78 psi, the ADZ board has failed, or the ER transducer has failed.

**System Effect**
The CCB system may be unable to cut-off brake pipe and may continue to drive brake pipe to exhaust in both Lead Out and Trail modes. The CCB system will display the following crew message on the EM2000 “AIR BRAKE CUT-OFF FAILURE - USE LOCOMOTIVE IN LEAD IN MODE ONLY”. The message will continue to be displayed until the fault is cleared.

**Reset Procedure**
This diagnostic code will clear automatically as soon as the BPCO switch reads CLOSED while MV53 is commanded on.
Trouble Shooting Procedure
Make sure the connectors for the SS9A board, the EPA-1 board, the DB-1 board, MV53 magnet valve and the Brake Pipe Cut-Off Valve are properly seated.

Move the brake valve handle to Emergency position. After brake pipe has vented to zero, use the WPTU program to verify the BPCO valve switch is closed. Select MONITOR under MODE. Under the SCREEN menu select Brake Pipe. Verify that the BPCO switch is closed. If the switch is open, the BPCO valve is defective. Change out the valve. If the valve switch is closed, MV53 or the circuit controlling MV53 is defective.

Select TEST under MODE. Under the SCREEN menu select Brake Pipe. Select MV53 to ON. Remove the connector from MV53 and check the voltage across pins 1 and 2. If the voltage is 24 vdc replace the defective MV53. If the voltage is zero, open the AB breaker, remove the EPA-1 board connector, close the AB breaker and check the voltage across pins a9 of the board and TB1-4 terminal board. If the voltage is zero, change out the EPA-1 board.

If the voltage is 24 vdc, open the AB circuit breaker and install the EPA1 board connector. Remove the connector from the DB-1 board and close the AB circuit breaker. Check the voltage across TB1-4 and TB1-5. If the voltage is zero, change out the DB-1 board. If the voltage is 24 vdc, the problem is in the cabling between the DB-1 and MV53 magnet valve.

Open the AB breaker and reinstall the DB-1 board. Close the AB breaker. Check the voltage at TB-1, terminals 4 and 5. If the voltage is 0 vdc, repair or replace the cable or connector between DB-1 and TB-1. If the voltage is 24 vdc open the AB breaker and remove the CRJ-6 connector from the CRU. Check the voltage across pins E and F. If the voltage is 0 vdc, replace the cable between TB-1 and CRJ6. If the voltage is 24 vdc, repair or replace the cable between CRJ6 and the MV53 magnet valve. Retest system.

Diagnostic Code 69(Defective BP Transducer):

Description
This diagnostic code means that the signal from the Brake Pipe Transducer (BPT) to the CCB system is outside the valid range. This condition is normally due to a disconnected (open circuit) or shorted (closed circuit) transducer/connector.

System Effect
The CCB system will display the following crew message on the EM2000 “AIR BRAKE FAILURE - USE LOCOMOTIVE IN TRAIL ONLY” and the brake pipe pressure reading sent to the EM2000 will be invalidated. If the unit is in Lead-In mode, train break-in-two detection capability will be and the system will initiate a fault penalty application dropping out COR, and driving brake pipe to exhaust at a service application rate. If the unit is in Lead-Out mode, the system will drive the automatic brake cylinder demand to zero but will consider an automatic brake to be applied when determining the independent brake cylinder ratio. If the unit is in Trail mode, the system will clear any associated fault penalty initiated in Lead In mode and as in Lead Out mode will consider an automatic brake to be applied when determining the independent brake cylinder ratio.

Reset Procedure
Returning the transducer signal to within the valid limits will clear the diagnostic code. After the diagnostic code is cleared the system can be reset by moving the automatic brake valve handle to Full Service for ten seconds then to the Run or Release position.
Trouble Shooting Procedure
Make sure the ADZ board, EPA1 board and the Brake Pipe Transducer connectors are properly seated.

If the problem still exists, remove the transducer connector and connect a good transducer to the cable. With the WPTU check the output of the BPT transducer. The pressure should be between 0 and 1 psi. If the pressure is correct replace the transducer. If the pressure is incorrect, change the ADZ2 board and run a self-test. If the fault still exists, replace the EPA1 board and rerun the self-test. If the self-test still fails the problem exists with cable or connectors.

Remove the transducer test fitting and the CRJ7 cable connector from the CRU and check the resistance between Pin B of the transducer connector and pin D of the CRJ7 cable connector
Pin A of the transducer connector and pin E of the CRJ7 cable connector
Pin C of the transducer connector and pin C of the CRJ7 cable connector

If any open circuits exist replace the cable. If not remove the EPA-3 board connector and check the resistance between
Pin C of the CRJ7 connector and pin b3 of the EPA1 cable connector
Pin D of the CRJ7 connector and pin a0 of the EPA1 cable connector
Pin E of the CRJ7 connector and pin c6 of the EPA1 cable connector

If any open circuits exist replace the cable. Rerun Self-test to verify the fault is cleared.

Diagnostic Code 6A(Brake Pipe Control Failure):

Description
This diagnostic code means that during a CCB system self-test, the system was unable to bring BP pressure to within 5 psi of the ER pressure. After verifying normal ER control, the system charges ER to 79.75 psi, waits 10 seconds and checks for BP within plus or minus 5 psi of the ER transducer reading. The system then releases ER down to 30 psi, waits another 10 seconds and again checks for BP within plus or minus 5 psi of the ER transducer reading. If either of these two tests fail, diagnostic code 6A will be logged. This diagnostic code will only be logged during a system self-test. This condition may be due to a disconnection in the Equalizing Reservoir Default Magnet Valve (MVER) wiring.

System Effect
The CCB system may be unable to control brake pipe except for emergency applications. The CCB system will display the following crew message on the EM2000 “AIR BRAKE FAILURE - USE LOCOMOTIVE IN TRAIL ONLY” until the fault is cleared.

Reset Procedure
This diagnostic code will only be cleared by running another system self-test.

Trouble Shooting Procedure
Make sure the connectors for the Equalizing Reservoir Default Magnet Valve (MVER), the EPA1 board and DB1 board are properly seated.

Connect a test gage to the TPER test point. Open the WPTU test program and under MODE, select TEST. Under the SCREEN window select EPA-1. Type 0 in the Control Pressure window. The ER pressure should reduce to zero. If already at zero type 70 psi. The ER pressure should increase to 70 psi. If in either of the above cases, the MVER magnet valve did not open, either the magnet valve is defective or is not being energized by the control circuit.
Remove the connector from MVER and measure the voltage across the connector pins 1 and 2. If the voltage is 24 vdc, change out the magnet valve.

Open the AB breaker, remove the EPA-1 board connector, close the AB breaker and check the voltage across pin b8 of the board and TB1-4 terminal board. If the voltage is zero, change out the EPA-1 board.

If the voltage is 24 vdc, open the AB circuit breaker and install the EPA1 board connector. Remove the connector from the DB-1 board and close the AB circuit breaker. Check the voltage across pin b3 of the DB-1 board and pin 4 of TB-1. If the voltage is zero, repair or replace the cable or connector. If the voltage is 24 vdc, install the cable connector.

Open the AB breaker. Remove the circular connector CRJ6. Close the AB breaker and check voltage across pins A and B. If the voltage is zero, replace the DB1 board. If the voltage is 24 vdc, check the continuity between CRJ6 on the CRU and the MVER magnet valve. Repair or replace the cable or connector.

**Diagnostic Code 6B(Brake Pipe Leakage Failure):**

**Description**
This diagnostic code means that during a CCB system self-test, brake pipe was found to have an excessively high leakage rate. After verifying normal ER control and brake pipe charging, the system cuts-off brake pipe, waits 10 seconds, and then reads the BP transducer. If this reading is not within 5 psi of the BP transducer reading prior to cut-off, diagnostic code 6B will be logged. This diagnostic code will only be logged during a system self-test.

**System Effect**
The CCB system may be unable to adequately charge or maintain brake pipe pressure.

**Reset Procedure**
This diagnostic code can only be cleared by running another system self-test.

**Trouble Shooting Procedure**
Check all end cocks for closure. Soap all pipe fittings in the brake pipe system for leakage.

**Diagnostic Code 6C(PVBP Stuck Open):**

**Description**
This diagnostic code means that the high charge brake pipe magnet valve (MVBP) has been commanded OFF for at least 8 seconds and the switch inside the brake pipe pilot valve (PVBP) still reads OPEN. This condition is normally due to an open circuit in the PVBP wiring.

**System Effect**
Train break-in-two detection may become difficult due to the effect of the higher capacity brake pipe charging valves. CCB system commanded brake pipe reductions should be unaffected.

**Reset Procedure**
This diagnostic code will clear automatically as soon as MVBP is commanded OFF and the switch inside the brake pipe pilot valve (PVBP) reads CLOSED. MVBP should be commanded OFF in all handle positions except the spring-loaded release position.
Trouble Shooting Procedure

With the brake valve handle in RUN position, verify the ER pressure is approximately 74 psi. With the WPTU program, select MONITOR under MODE. Under the SCREEN menu select BRAKE PIPE. Verify that the PVBP switch is closed. If the switch is open, the PVBP valve switch is defective. Change out the valve. If the valve switch is closed, MVBP or the circuit controlling MVBP is defective.

Remove the connector from PVBP and check the resistance across the valve connector pins 2 and 3. If the switch is open, replace the PVBP valve and retest. If closed, install the connector. Select TEST under MODE. Under the SCREEN menu select Brake Pipe. Cycle the MVBP magnet valve several times on and off noting that an exhaust occurs at the top of MVBP. With each cycle the PVBP valve switch should indicate ‘ON’ and ‘OFF’. If not, replace the PVBP valve. The exhaust proves MVBP and its control circuit is functional. If there is no exhaust, MVBP and or its control circuit is bad. Remove the MVBP magnet valve connector and check the voltage across pins 1 and 2 of the cable connector. If the voltage is 24 vdc, replace MVBP. If the voltage is zero, install the connector. Remove the CRJ6 connector and check voltage across pins C and D of the cable connector. If the voltage is 24 vdc, replace or repair the cable or connector within the CRU. If the voltage is o vdc, install the connector.

Disconnect the cable connector from the DB1 board. Measure the voltage between pin a3 and TB1-4. If the voltage is 24 vdc, replace the DB1 board. If the voltage is zero, install the cable to the DB1 board and remove the cable from the EPA1 board. Measure the voltage between pin b8 and TB1-4. If the voltage is 24 vdc, replace or repair the cable between the EPA1 board and the DB1 board. If the voltage is zero, replace the EPA1 board.

Diagnostic Code 6D(PVBP Stuck Closed):

Description
This diagnostic code means that the high charge brake pipe magnet valve (MVBP) has been commanded ON for at least 8 seconds and the switch inside the brake pipe pilot valve (PVBP) still reads CLOSED.

System Effect
The high capacity brake pipe charging feature may not be available.

Reset Procedure
This diagnostic code will clear automatically as soon as MVBP is commanded ON and the switch inside the brake pipe pilot valve (PVBP) reads OPEN. MVBP should be commanded ON when the automatic handle is in the spring loaded release position.

Trouble Shooting Procedure
Make sure the connectors for the SS9A board, the EPA-1 board, the DB-1 board, MVBP magnet valve and the Pneumatic Valve Brake Pipe (MVBP) are properly seated.

Move the brake valve handle to Release position and note that the brake pipe has increased to approximately 80 psi in 8-12 sec. If the ER pressure increased properly but brake pipe did not. Use the WPTU program to verify the PVBP valve switch is open. Select MONITOR under MODE. Under the SCREEN menu select Brake Pipe. Verify that the PVBP switch is open. If so, retest. If the switch is closed, the PVBP valve switch is defective. Change out the valve.

If the ER pressure did not increase in the proper time frame, the PVBP is not being piloted to Open position. This may be caused by MVBP not being energized. Either the magnet valve is defective or the control circuit is defective.
Select TEST under MODE. Under the SCREEN menu select Brake Pipe. Select MVBP to ON. Remove the connector from MVBP and check the voltage across pins 1 and 2. If the voltage is 24 vdc replace the defective MVBP. If the voltage is zero, open the AB breaker, remove the EPA-1 board connector, close the AB breaker and check the voltage across pins c8 of the board and TB1-4 terminal board. If the voltage is zero, change out the EPA-1 board.

If the voltage is 24 vdc, open the AB circuit breaker and reinstall the EPA1 board connector. Remove the connector from the DB-1 board and close the AB circuit breaker. Check the voltage across pin a3 of the DB-1 connector and pin 4 of TB-1. If the voltage is zero, repair or replace the cable. If the voltage is 24 vdc, open the AB breaker and reinstall the DB-1 board. Remove the CRJ-6 connector from the CRU. Check the voltage across pins C and D. If the voltage is 0 vdc, replace the DB1 board. Run the Self-Test. If the system fails repair or replace the cable between the CRJ6 and DB1. Retest system.

Diagnostic Code 6E(MVEM Stuck Off):

Description
This diagnostic code means that during a CCB system self-test, the Emergency Magnet Valve (MVEM) could not be energized. After verifying normal equalizing reservoir and brake pipe control, the system charges brake pipe to 79.75 psi, cuts-off brake pipe control, waits 1 second, energizes MVEM, waits 4 more seconds, then reads the BP transducer. If brake pipe has not dropped below 20 psi diagnostic code 6E will be logged. This diagnostic code will only be logged during a system self-test. This condition is normally due to an open circuit in the MVEM connector wiring.

System Effect
The CCB system may not be able to electronically reduce brake pipe during emergency applications. The CCB system will display the following crew message on the EM2000 “AIR BRAKE FAILURE - USE LOCOMOTIVE IN TRAIL ONLY” until the fault is cleared.

Reset Procedure
This diagnostic code can only be cleared by running another system self-test.

Trouble Shooting Procedure
Make sure the EPA1 board, the DB1 board, and the MVEM connectors are properly seated.

Use the WPTU program to verify the MVEM can be commanded to ON. Select TEST under MODE. Under the SCREEN menu select Brake Pipe. Select MVEM to ON. Remove the connector from MVEM and check the voltage across pins 1 and 2. If the voltage is 24 vdc replace the defective MVEM. If the voltage is zero, open the AB breaker, remove the SS9-A board connector, close the AB breaker and check the voltage across pins c7 of the board and TB1-4 terminal board. If the voltage is zero, change out the EPA-1 board.

If the voltage is 24 vdc, open the AB circuit breaker and reinstall the EPA1 cable connector. Remove the connector from the DB-1 board and close the AB circuit breaker. Check the voltage across pin a2 of the DB-1 cable connector and pin 4 of TB-1. If the voltage is zero, repair or replace the cable or connector. If the voltage is 24 vdc, open the AB breaker and reinstall the DB-1 cable.

Remove the CRJ-6 connector from the CRU. Check the voltage across pins G and H. If the voltage is 0 vdc, replace the DB1 board and install the cable. Run self-test. If self-test still produces a 6E code, check continuity of the cable between DB-1 and CRJ6. If open, repair or replace the cable between DB1 and CRJ6. If continuity is good, check the continuity of the cable between CRJ6 and the MVEM magnet valve. Repair or replace as required. Retest system.
Diagnostic Code 70 (Defective 20 Transducer)

Description
This diagnostic code means that the signal from the 20 Transducer (20T) to the CCB system is outside the valid range. This condition is normally due to a disconnected (open circuit) or shorted (closed circuit) transducer/connector.

System Effect
The CCB system will display the following crew message on the EM2000 “AIR BRAKE FAILURE - USE LOCOMOTIVE IN TRAIL ONLY.” If the unit is in Lead In mode, the brake cylinder equalizing pipe will be cut-off, the AW4-20 control portion will be disabled, and the system will initiate a fault penalty application dropping out COR, and driving brake pipe to exhaust at a service application rate by de-energizing MVER. The de-energization of MVER will activate the back-up brake cylinder equalizing pipe pressurization circuit that will connect the locomotives brake cylinder pressure to the brake cylinder equalizing pipe. The activation of this connection while electronic control (and subsequent higher ratios) of the locomotive brake cylinders is still enabled may result in a moderate over-pressurization of the brake cylinder equalizing pipe, causing any Trailing units to develop brake cylinder pressure at a higher proportion (up to the setting of the limiting valves) than the Lead-In unit. If the unit is in Lead-Out mode, the brake cylinder equalizing pipe will be cut-off (trapping whatever pressure is in there at the time) and the AW4-20 control portion will be disabled. If the unit is in Trail mode, brake cylinder pressure will only be developed as a result of brake pipe reductions. No independent braking or bail off will be available. The message will continue to be displayed until the fault is cleared and the penalty will remain in effect until the fault is cleared or the locomotive is set to Trail.

Reset Procedure
The diagnostic code can be cleared by returning the transducer signal to within the valid limits. After the diagnostic code is cleared the system can be reset by moving the automatic brake valve handle to Full Service for ten seconds then to the Run or Release position.

Trouble Shooting Procedure
Make sure the AD board, the EPA-3 board, and the 20 Pipe Transducer connectors are properly seated.

If the problem still exists, open the AB circuit breaker, remove the transducer connector and connect the Test Adapter to the cable. Close the AB circuit breaker. With a multi-meter check the output of the 20T transducer across pins 1 and 3. The voltage should be between 2 and 12 volts. If the voltage is correct replace the transducer. If the voltage is incorrect reconnect the cable to the transducer. Change the ADZ2 board and run a self-test. If the fault still exists, change the EPA-3 board and rerun the self-test. If the self-test still fails the problem exists with cable or connectors.

Remove the transducer connector and the CRJ7 cable connector from the CRU and check the resistance between Pin 3 of the transducer connector and pin L of the CRJ7 cable connector
Pin 2 of the transducer connector and pin M of the CRJ7 cable connector
Pin 1 of the transducer connector and pin Y of the CRJ7 cable connector
If any open circuits exist replace the cable. If not remove the EPA-3 board connector and check the resistance between
Pin L of the CRJ7 connector and pin a3 of the EPA-3 cable connector
Pin M of the CRJ7 connector and pin c3 of the EPA-3 cable connector
Pin Y of the CRJ7 connector and pin b1 of the EPA-3 cable connector
If any open circuits exist replace the cable. Rerun Self-test to verify the fault is cleared.
Diagnostic Code 71(20 Supply Magnet Valve Stuck Open):

Description
This diagnostic code means that the 20 pressure has risen 8 psi over the highest possible 20 pressure command and has remained there for at least 8 seconds. This condition is normally due to the AW4-20 supply magnet valve stuck open. This diagnostic is skipped if the 20 command is changing by more than 1 psi per loop, the main reservoir pressure is less than 78 psi, the ADZ board has failed, the 20 transducer has failed, or the 20 pipe is not under electronic control.

System Effect
The CCB system will display the following crew message on the EM2000 “AIR BRAKE FAILURE - USE LOCOMOTIVE IN TRAIL ONLY.” If the unit is in Lead-In mode, the brake cylinder equalizing pipe will be cut-off, the AW4-20 control portion will be disabled, and the system will initiate a fault penalty application dropping out COR, and driving brake pipe to exhaust at a service application rate by de-energizing MVER. The de-energization of MVER will activate the back-up brake cylinder equalizing pipe pressurization circuit which will connect the locomotive’s brake cylinder pressure to the brake cylinder equalizing pipe. The activation of this connection while electronic control (and subsequent higher ratios) of the locomotive brake cylinders is still enabled may result in a moderate over-pressurization of the brake cylinder equalizing pipe, causing any Trailing units to develop brake cylinder pressure at a higher proportion (up to the setting of the limiting valves) than the Lead-In unit. If the unit is in Lead-Out mode, the brake cylinder equalizing pipe will be cut-off (trapping whatever pressure is in there at the time) and the AW4-20 control portion will be disabled. The message will continue to be displayed until the fault is cleared and the penalty will remain in effect until the fault is cleared or the locomotive is set to Trail.

Reset Procedure
The diagnostic code can only be cleared by running a system self-test.

Trouble Shooting Procedure
Make sure the connectors for the BCEV magnet valves and transducer are properly seated. Perform the same check for the EPA-3 board.

Using the WPTU program select Test Mode under MODE menu. Select EPA-3 under screen. Then select Control Pressure. Type 50, press enter. BCEP pressure should increase quickly to 50 psi. If the BCEP pressure continues to slowly rise above 50 psi. Accompanied by a blow of air at the base of the BCEV, the BCEV is defective. Replace and rerun self-test.

Diagnostic Code 72(No 20 Supply)

Description
This diagnostic code means that the 20 pressure has reduced 8 psi below the current 20 pressure command and has remained there for at least 8 seconds. This condition is normally due to the AW4-20 supply magnet valve stuck closed. This diagnostic is skipped if the 20 command is changing by more than 1 psi per loop, the main reservoir pressure is less than 78 psi, the ADZ board has failed, the 20 transducer has failed, or 20 is not under electronic control.

System Effect
The CCB system will display the following crew message on the EM2000 “AIR BRAKE FAILURE - USE LOCOMOTIVE IN TRAIL ONLY.” If the unit is in Lead-In mode, the brake cylinder equalizing pipe will be cut-off, the AW4-20 control portion will be disabled, and the system will initiate a fault penalty application dropping out COR, and driving brake pipe to exhaust at a service application rate by de-energizing MVER.
The de-energization of MVER will activate the back-up brake cylinder equalizing pipe pressurization circuit which will connect the locomotives brake cylinder pressure to the brake cylinder equalizing pipe. The activation of this connection while electronic control (and subsequent higher ratios) of the locomotive brake cylinders is still enabled may result in a moderate over-pressurization of the brake cylinder equalizing pipe, causing any Trailing units to develop brake cylinder pressure at a higher proportion (up to the setting of the limiting valves) than the Lead-In unit. If the unit is in Lead-Out mode, the brake cylinder equalizing pipe will be cut-off (trapping whatever pressure is in there at the time) and the AW4-20 control portion will be disabled. The message will continue to be displayed until the fault is cleared and the penalty will remain in effect until the fault is cleared or the locomotive is set to Trail.

**Reset Procedure**

The diagnostic code can only be cleared by running a system self-test.

**Trouble Shooting Procedure**

Make sure all connectors for the BCEV and EPA-3 board are properly seated.

Using the WPTU program select Test Mode under MODE menu. Select EPA-3 under SCREEN, then select Control Pressure. Type 50, press enter. BCEP pressure should increase to 50 psi. If the BCEP pressure does not increase to 50 psi, the BCEP supply valve may be defective. Remove the connector from the Supply Magnet and with a multi-meter check the voltage across cable connector pins 1 and 2. If the voltage is approximately 24 vdc, replace the BCEP valve.

If the voltage is not 24 vdc, open the AB breaker, change out the EPA-3 board, reconnect the BCEP connector, close the AB breaker and rerun the self-test to clear the fault. If the fault still exists, one of the cables between the EPA-3 board and the CRU is open. Remove the CRJ5 connector at the CRU and check the voltage across pins J and K. If the voltage is 24 vdc, repair or replace the cable between the CRU and the BCEP valve. If the voltage is zero, repair or replace the cable between CRJ5 and the EPA-3 board.

Rerun the self-test to clear the fault.

**Diagnostic Code 73(No 20 Exhaust)**

**Description**

This diagnostic code means that the 20 pressure has risen 8 psi above the current 20 pressure command and has remained there for at least 8 seconds. This condition is normally due to the AW4-20 exhaust magnet valve stuck closed. This diagnostic is skipped if the 20 command is changing by more than 1 psi per loop, the main reservoir pressure is less than 78 psi, the ADZ board has failed, the 20 transducer has failed, or 20 is not under electronic control.

**System Effect**

The CCB system will display the following crew message on the EM2000 “AIR BRAKE FAILURE - USE LOCOMOTIVE IN TRAIL ONLY.” If the unit is in Lead In mode, the brake cylinder equalizing pipe will be cut-off, the AW4-20 control portion will be disabled, and the system will initiate a fault penalty application dropping out COR, and driving brake pipe to exhaust at a service application rate by de-energizing MVER. The de-energization of MVER will activate the back-up brake cylinder equalizing pipe pressurization circuit which will connect the locomotives brake cylinder pressure to the brake cylinder equalizing pipe. The activation of this connection while electronic control (and subsequent higher ratios) of the locomotive brake cylinders is still enabled may result in a moderate over-pressurization of the brake cylinder equalizing pipe, causing any Trailing units to develop brake cylinder pressure at a higher proportion (up to the setting of the limiting valves) than the Lead In unit.
If the unit is in Lead-Out mode, the brake cylinder equalizing pipe will be cut-off (trapping whatever pressure is in there at the time) and the AW4-20 control portion will be disabled. The message will continue to be displayed until the fault is cleared and the penalty will remain in effect until the fault is cleared or the locomotive is set to Trail.

**Reset Procedure**
The diagnostic code can only be cleared by running a system self-test.

**Troubleshooting Procedure**
Make sure all connectors for the BCEP and EPA-3 board are properly seated.

Using the WPTU program select Test Mode under MODE menu. Select EPA-3 under SCREEN, then select Control Pressure. Type 50, press enter. BCEP pressure should increase to 50 psi. Type 0, press enter. If the BCEP pressure does not decrease to 0 psi, the BCEP exhaust valve may be defective. Type 50, press enter. Remove the connector from the Exhaust Magnet and with a multi-meter check the voltage across cable connector pins 1 and 2. If the voltage is approximately 24 vdc, replace the BCEP valve.

If the voltage is zero, open the AB breaker, replace the EPA-3 board, reconnect the BCEP connector, close the AB breaker and rerun the self-test to clear the fault. If the fault still exists, one of the cables between the EPA-3 board and the CRU is open. Remove the CRJ5 connector at the CRU and check the voltage across pins L and M. If the voltage is 24 vdc, repair or replace the cable between the CRU and the BCEP valve. If the voltage is zero, repair or replace the cable between CRJ5 and the EPA-3 board.

Rerun the self-test to clear the fault.

**Diagnostic Code 74(MVLT Stuck CLOSED):**

**Description**
This diagnostic code means that during a CCB system self-test, the Brake Cylinder Equalizing Pipe Cut-Off Magnet Valve (MV20) could not be energized. The system exhausts the BCEP via AW4-20, waits 10 seconds, charges BCEP to 55 psi, waits 10 seconds, then checks to see if a 20 No Supply or 20 No Exhaust fault occurred. If both a failure to supply and a failure to exhaust occurred, diagnostic code 74 will be logged. This diagnostic code will only be logged during a system self-test. This condition is normally due to an open circuit in the MV20 connector wiring.

**System Effect**
The CCB system will display the following crew message on the EM2000 "AIR BRAKE FAILURE - USE LOCOMOTIVE IN TRAIL ONLY." If the unit is in Lead In mode, the brake cylinder equalizing pipe will be cut-off, the AW4-20 control portion will be disabled, and the system will initiate a fault penalty application dropping out COR, and driving brake pipe to exhaust at a service application rate by de-energizing MVER. The de-energization of MVER will activate the back-up brake cylinder equalizing pipe pressurization circuit which will connect the locomotives brake cylinder pressure to the brake cylinder equalizing pipe. The activation of this connection while electronic control (and subsequent higher ratios) of the locomotive brake cylinders is still enabled may result in a moderate over-pressurization of the brake cylinder equalizing pipe, causing any Trailing units to develop brake cylinder pressure at a higher proportion (up to the setting of the limiting valves) than the Lead In unit. If the unit is in Lead-Out mode, the brake cylinder equalizing pipe will be cut-off (trapping whatever pressure is in there at the time) and the AW4-20 control portion will be disabled. The message will continue to be displayed until the fault is cleared and the penalty will remain in effect until the fault is cleared or the locomotive is set to Trail.

**Reset Procedure**
The diagnostic code can only be cleared by running another system self-test.
Trouble Shooting Procedure

Make sure the connectors for the EPA-3 board, the DB-1 board and the MVLT magnet valve are properly seated.

Use the WPTU program to verify the MVLT can be commanded to ON. Select TEST under MODE. Under the SCREEN menu select EPA-3. Select MVLT to ON. Remove the connector from MVLT and check the voltage across pins 1 and 2. If the voltage is 24 vdc replace the defective MVLT. If the voltage is zero, open the AB breaker, remove the EPA-3 board connector, close the AB breaker and check the voltage across pins b8 of the board and TB1-4 terminal board. If the voltage is zero, change out the EPA-3 board.

If the voltage is 24 vdc, open the AB circuit breaker and reinstall the EPA-3 cable connector. Remove the connector from the DB-1 board and close the AB circuit breaker. Check the voltage across pin a2 of the DB-1 cable connector and pin 4 of TB-1. If the voltage is zero, repair or replace the cable or connector. If the voltage is 24 vdc, open the AB breaker and reinstall the DB-1 cable.

Remove the CRJ-6 connector from the CRU. Check the voltage across pins L and M. If the voltage is 0 vdc, replace the DB1 board and the install the cable. Run self-test. If self-test still produces a 74 code, check continuity of the cable between DB-1 and CRJ6. If open, repair or replace the cable between DB1 and CRJ6. If continuity is good, check the continuity of the cable between CRJ6 and the MVLT magnet valve. Repair or replace as required. Retest system.

Diagnostic Code 75(MV20 Stuck On):

Description
This diagnostic code means that during a CCB system self-test, the Brake Cylinder Equalizing Pipe Cut-Off Magnet Valve (MV20) could not be de-energized. After verifying normal 20 control and brake cylinder equalizing pipe charging, the system charges BCEP to 55 psi, cuts-off BCEP, waits 5 seconds and then reads the 20 transducer. If this reading is not above 50 psi, diagnostic code 75 will be logged. This diagnostic code will only be logged during a system self-test. This condition is normally due to a short circuit in the MV20 connector wiring or excessive leakage in the brake cylinder equalizing pipe.

System Effect
The CCB system may be unable to cut-off brake cylinder equalizing pipe and may continue to drive brake cylinder equalizing pipe to exhaust in Trail mode. The CCB system will display the following crew message on the EM2000 “AIR BRAKE CUT-OFF FAILURE - USE LOCOMOTIVE IN LEAD IN MODE ONLY.” The message will continue to be displayed until the fault is cleared.

Reset Procedure
The diagnostic code can only be cleared by running another system self-test.

Trouble Shooting Procedure

Make sure the connectors for the EPA-3 board, the DB-1 board and the MVLT magnet valve are properly seated.

Log on to the WPTU program. Select TEST under MODE. Under the SCREEN menu select EPA-3. Select MV20 to OFF. Type 50 under Control_Pressure. BCEP pressure should not increase. If the pressure does increase the MVLT valve may be defective. Remove the connector from MVLT and check the voltage across pins 1 and 2. If the voltage is 0 vdc replace the defective BCEV valve. If the voltage is 24 vdc, open the AB breaker, remove the EPA-3 board connector, close the AB breaker and again check the voltage across pins 1 and 2 of the MVLT connector.
If the voltage is still 24 vdc, change out the DB1 board. Rerun the self-test.

If the voltage is zero change out the EPA-board, reconnect the MVLT cable connector and rerun the self-test to clear the fault.

**Diagnostic Code 80(Defective 16 Transducer):**

**Description**
This diagnostic code means that the signal from the 16 Transducer (16T) to the CCB system is outside the valid range. This condition is normally due to a disconnected (open circuit) or shorted (closed circuit) transducer/connector.

**System Effect**
The CCB system will display the following crew message on the EM2000 "AIR BRAKE FAILURE - BACK-UP BRAKING ACTIVE", disable the aw4-16 control portion, and de-energize MV16T causing the pressure in the brake cylinder equalizing pipe to be fed to the locomotive brake cylinder relay. The use of the BCEP pressure instead of electronic brake cylinder control will result in lower locomotive brake cylinder pressures. The message will continue to be displayed and back-up braking will remain in effect until the fault is cleared and all brake cylinder pressure has exhausted.

**Reset Procedure**
The diagnostic code can be cleared by returning the transducer signal to within the valid limits. After the diagnostic code is cleared the system can be reset by releasing all brake cylinder demand long enough for the existing brake cylinder pressure to exhaust at which point electronic brake cylinder control will return.

**Trouble Shooting Procedure**
Make sure the ADZ board and the 16 Transducer connectors are properly seated.

If the problem still exists, open the AB circuit breaker, remove the transducer connector and connect the Test Adapter to the cable. Close the AB circuit breaker. With a multi-meter check the output of the 16T transducer across pins 1 and 3. The voltage should be between 2 and 12 volts. If the voltage is correct replace the transducer. If the voltage is incorrect reconnect the cable to the transducer. Change the ADZ2 board and run a self-test. If the fault still exists, change the EPA-2 board and rerun the self-test. If the self-test still fails the problem exists with cable or connectors.

Remove the transducer connector and the CRJ7 cable connector from the CRU and check the resistance between Pin 3 of the transducer connector and pin F of the CRJ7 cable connector
Pin 2 of the transducer connector and pin G of the CRJ7 cable connector
Pin 1 of the transducer connector and pin B of the CRJ7 cable connector

If any open circuits exist replace the cable. If not remove the EPA-3 board connector and check the resistance between
Pin F of the CRJ7 connector and pin a3 of the EPA-3 cable connector
Pin G of the CRJ7 connector and pin c3 of the EPA-3 cable connector
Pin B of the CRJ7 connector and pin b1 of the EPA-3 cable connector

If any open circuits exist replace the cable. Rerun Self-test to verify the fault is cleared.
Diagnostic Code 81(16 Supply Magnet Valve Stuck Closed):

Description
This diagnostic code means that the 16 pressure has reduced 8 psi below the current 16 pressure command and has remained there for at least 8 seconds. This condition is normally due to the AW4-16 supply magnet valve stuck closed. This diagnostic is skipped if the 16 command is changing by more than 1 psi per loop, the main reservoir pressure is less than 78 psi, the ADZ board has failed, the 16 transducer has failed, or the 16 portion is not under electronic control.

System Effect
The CCB system will display the following crew message on the EM2000 "AIR BRAKE FAILURE - BACK-UP BRAKING ACTIVE", disable the AW4-16 control portion, and de-energize MV16T causing the pressure in the brake cylinder equalizing pipe to be fed to the locomotive brake cylinder relay. The use of the BCEP pressure instead of electronic brake cylinder control will result in lower locomotive brake cylinder pressures. The message will continue to be displayed and back-up braking will remain in effect until the fault is cleared and all brake cylinder pressure has exhausted.

Reset Procedure
The diagnostic code can only be cleared by running a system self-test.

Trouble Shooting Procedure
Make sure all connectors for the AW4-16 and EPA-2 board are properly seated.

Using the WPTU program select Test Mode under MODE menu. Select EPA-2 under SCREEN, then select Control Pressure. Type 50, press enter. AW4-16 pressure should increase to 50 psi. If the AW4-16 pressure does not increase to 50 psi, the AW4-16 supply valve may be defective. Remove the connector from the Supply Magnet and with a multi-meter check the voltage across cable connector pins 1 and 2. If the voltage is approximately 24 vdc, replace the AW4-16 valve.

If the voltage is not 24 vdc, open the AB breaker, change out the EPA-2 board, reconnect the AW4-16 connector, close the AB breaker and rerun the self-test to clear the fault. If the fault still exists, one of the cables between the EPA-3 board and the CRU is open. Remove the CRJ5 connector at the CRU and check the voltage across pins E and F. If the voltage is 24 vdc, repair or replace the cable between the CRU and the AW4-16 valve. If the voltage is zero, repair or replace the cable between CRJ5 and the EPA-2 board.

Rerun the self-test to clear the fault.

Diagnostic Code 82(16 Exhaust Magnet Valve Stuck Closed):

Description
This diagnostic code means that the 16 pressure has risen 8 psi above the current 16 pressure command and has remained there for at least 8 seconds. This condition is normally due to the AW4-16 exhaust magnet valve stuck closed. This diagnostic is skipped if the 16 command is changing by more than 1 psi per loop, the main reservoir pressure is less than 78 psi, the ADZ board has failed, the 16 transducer has failed, or the 16 portion is not under electronic control.
System Effect
The CCB system will display the following crew message on the EM2000 "AIR BRAKE FAILURE - BACK-UP BRAKING ACTIVE", disable the AW4-16 control portion, and de-energize MV16T causing the pressure in the brake cylinder equalizing pipe to be fed to the locomotive brake cylinder relay. The use of the BCEP pressure instead of electronic brake cylinder control will result in lower locomotive brake cylinder pressures. The message will continue to be displayed and back-up braking will remain in effect until the fault is cleared and all brake cylinder pressure has exhausted.

Reset Procedure
The diagnostic code can only be cleared by running a system self-test.

Trouble Shooting Procedure
Make sure all connectors for the AW4-16 and EPA-2 board are properly seated.

Using the WPTU program select Test Mode under MODE menu. Select EPA-2 under SCREEN, then select Control Pressure. Type 50, press enter. #16 pressure should increase to 50 psi. Type 0, press enter. If the AW4-16 pressure does not decrease to 0 psi, the AW4-16 exhaust valve may be defective. Type 50, press enter. Remove the connector from the Exhaust Magnet and with a multi-meter check the voltage across cable connector pins 1 and 2. If the voltage is approximately 24 vdc, replace the AW4-16 valve.

If the voltage is zero, open the AB breaker, replace the EPA-2 board, reconnect the AW4-16 connector, close the AB breaker and rerun the self-test to clear the fault. If the fault still exists, one of the cables between the EPA-2 board and the CRU is open. Remove the CRJ5 connector at the CRU and check the voltage across pins G and H. If the voltage is 24 vdc, repair or replace the cable between the CRU and the AW4-16 valve. If the voltage is zero, repair or replace the cable between CRJ5 and the EPA-3 board.

Rerun the self-test to clear the fault.

Diagnostic Code 83(No Electronic BC Control):

Description
This diagnostic code means that during a CCB system self-test, the system was unable to bring BC pressure to within 4 psi of the 16 pressure. At the start of the BC/16 portion of the self-test, the system charges 16 to 72 psi, waits 5 seconds, verifies normal 16 control, and checks for BC within plus or minus 4 psi of the 16 transducer reading. The system then releases 16 down to 30 psi, waits another 5 seconds, verifies normal 16 control, and checks for BC within plus or minus 4 psi of the 16 transducer reading. If either of these two tests fail, diagnostic code 83 will be logged. This diagnostic code will only be logged during a system self-test. This condition may be due to a disconnection in the 16 Pipe Default Magnet Valve (MV16T) wiring.

System Effect
The CCB system will display the following crew message on the EM2000 "AIR BRAKE FAILURE - BACK-UP BRAKING ACTIVE", disable the aw4-16 control portion, and de-energize MV16T causing the pressure in the brake cylinder equalizing pipe to be fed to the locomotive brake cylinder relay. The use of the BCEP pressure instead of electronic brake cylinder control will result in lower locomotive brake cylinder pressures. The message will continue to be displayed and back-up braking will remain in effect until the fault is cleared and all brake cylinder pressure has exhausted.

Reset Procedure
The diagnostic code can only be cleared by running another system self-test.
Trouble Shooting Procedure
Make sure the connectors for the EPA-2 board, the DB-1 board and the MV16t magnet valve are properly seated.

Log on to the WPTU program. Select TEST under MODE. Under the SCREEN menu select EPA-2. Select MV16T to ON. Type 50 under Control_Pressure. #16 pressure should increase to 50 psi. If the pressure does not increase the MV16T valve may be defective. Remove the connector from MV16T and check the voltage across pins 1 and 2. If the voltage is 24 vdc replace the defective MV16T valve. If the voltage is zero, open the AB breaker, remove the EPA-2 board connector, close the AB breaker and check the voltage across pins b8 of the board and TB1-4 terminal board. If the voltage is zero, change out the EPA-2 board.

If the voltage is 24 vdc, open the AB circuit breaker and reinstall the EPA-2 board connector.

Remove the CRJ-6 connector from the CRU. Check the voltage across pins F and G. If the voltage is 0 vdc, repair or replace the cable between the EPA-2 board and CRJ6. If the voltage is 24 vdc, repair or replace the cable between CRJ6 and the MV16T magnet valve. Rerun the self-test.

Diagnostic Code 89(Defective BC Transducer):

Description
This diagnostic code means that the signal from the Brake Cylinder Transducer (BCT) to the CCB system is outside the valid range. This condition is normally due to a disconnected (open circuit) or shorted (closed circuit) transducer/connector.

System Effect
The brake cylinder pressure reading sent to the EM2000 will be invalidated and the periodic MVER cycle function will be disabled. The MV16T control function will consider BC pressure to be zero.

Reset Procedure
The diagnostic code can be cleared by returning the transducer signal to within the valid limits.

Trouble Shooting Procedure
Make sure the EPA-3 board, CRJ7 and the BCT connectors are properly seated.

If the problem still exists, remove the transducer connector and connect a good transducer to the cable. With the WPTU check the output of the BCT transducer. The pressure should be between 0 and 1 psi. If the pressure is correct replace the transducer. If the pressure is incorrect, replace the ADZ2 board and run a self-test. If the fault still exists, replace the EPA-2 board and rerun the self-test. If the self-test still fails the problem exists with cable or connectors.

Remove the transducer test fitting and the CRJ7 cable connector from the CRU and check the resistance between
Pin B of the transducer connector and pin J of the CRJ7 cable connector
Pin A of the transducer connector and pin K of the CRJ7 cable connector
Pin C of the transducer connector and pin H of the CRJ7 cable connector

If any open circuits exist replace the cable. If not remove the EPA-2 board connector and check the resistance between
Pin H of the CRJ7 connector and pin b3 of the EPA-3 cable connector
Pin J of the CRJ7 connector and pin a0 of the EPA-3 cable connector
Pin K of the CRJ7 connector and pin c6 of the EPA-3 cable connector
If any open circuits exist replace the cable. Rerun Self-test to verify the fault is cleared.

**Diagnostic Code 8E(KE Distributor Valve Failure):**

**Description**
This diagnostic code means that during a CCB system self-test, the back-up KE distributor valve was not operating correctly. At the start of the KE valve portion of the self-test, the system first verifies that the brake cylinder pressure is close to 30 psi and that the equalizing reservoir is pressurized. Once those entry conditions have been verified the system cuts off electronic control of the brake cylinder equaling pipe and activates the backup brake system by de-energizing MVER and MV16T. The de-energization of MVER will also drive brake pipe to exhaust causing the KE valve to develop brake cylinder pressure. If after 30 seconds in freight mode or 10 seconds in passenger mode, the brake cylinder pressure has not charged to at least 45 psi the system logs a failure of the KE valve. If the pressure did charge to 45 psi the system then cut’s MVER back in - but not MV16T and verifies that after 30 seconds in freight mode or 10 seconds in passenger mode, the KE valve was able to release brake cylinder pressure down to at least 30 psi. This condition is normally due to an incorrect Passenger/Goods setting on either the KE valve or the Passenger/Goods selector switch on the CRU.

**System Effect**
The system may not be able to take electronic control of brake cylinders after a power cycle. The MV16T cycle function to clear accumulated water will be disabled and the system will continue to fail the self-test until the fault is corrected.

**Reset Procedure**
The diagnostic code can only be cleared by running another system self-test.

**Trouble Shooting Procedure**
Check to see if the KE distributor valve Pass/Goods handle, the Auxiliary Reservoir handle and the control reservoir handle are in the correct position.  Rerun self-test.  If the code does not clear check for leaks in all piping connected to the KE valve.  Rerun self-test to clear code. If the code does not clear, replace the KE Distributing Valve. Rerun self-test to clear code.

**Diagnostic Code 8F(Back-Up Brake Cylinder Over-pressurization):**

**Description**
This diagnostic code means that during Trail operation when the system cycles the MV16T magnet valve to exhaust moisture build up in the 16 circuit, brake cylinder pressure does not reduce below 10 psi. This retained BC pressure would be caused by the malfunction of both the KE valve and the PVBIT valve

**System Effect**
The MV16T control function will consider BC pressure to be zero.

**Reset Procedure**
Run self-test

**Trouble Shooting Procedure**
Replace the KE valve and the PVBIT valve.
Diagnostic Code 90 (Defective ADZ Board):

Description
This diagnostic code means that the reference signal from the ADZ board has varied by more than 0.1 volt from the nominal operating voltage of 2.5 volts. This condition is normally due to a dip in the 24 volt power supply to the ADZ board or to vibration damage to the ADZ board connectors.

System Effect
The CCB system will display the following crew message on the EM2000 “AIR BRAKE FAILURE - USE LOCOMOTIVE IN TRAIL AND OPEN AB CIRCUIT BREAKER” Drop out COR, ignore all transducer inputs setting the internal pressure values to zero and the EM2000 pressure validation bits to invalid. Cut-off all electronic pressure control and diagnostics, and provide pneumatic control via the de-energization of MVER, MV16T, and MV20. The pneumatics will respond by driving brake pipe to exhaust at a service application rate and activating the back up brake system. All of the above conditions will remain in effect until the fault is cleared.

Reset Procedure
Restore the ADZ board reference signal to the 2.5 volt range.

Trouble Shooting Procedure
Make sure the connector for the ADZ board is properly seated.

Verify the 24 volt power supply to the ADZ board. Check the yellow indicator light on SV2 board. If not lit, replace the SV2 board. If okay, replace the ADZ2 board and retest. If code 90 still appears, replace the Backplane board.
8.6 CONNECTOR PIN LOCATION AND POLARITY

**TRANSDUCER CONNECTOR**

**TRANSUCER**

1 - 24 VDC POS  
2 - 24 VDC RETURN  
3 - 2-12 VDC SIGNAL  
SH - SHIELD

**MAGNET VALVE AND S.V. BOARD CONNECTOR**

**MAGNET VALVE OR S.V. BOARD**

1 - 24 VDC POS  
2 - 24 VDC RETURN  
SH - SHIELD

**TRANSDUCER CONNECTOR**

BLACK  
RED  
GREEN  
KAVLICO TRANSUCER
9.1 MAINTENANCE SPECIFICATIONS

The following repair codes provide information regarding the maintenance, overhaul and other important features pertaining to the major components that make up the CCB/INDIAN RAILWAYS Brake System.

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<th>P/N</th>
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CHAPTER 10

TEST SPECIFICATIONS

10.1 TEST SPECIFICATIONS

The following test codes provide final test information pertaining to the major components that make up the CCB/INDIAN RAILWAYS Brake System.

<table>
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<tr>
<th>COMPONENT</th>
<th>P/D DES.</th>
<th>P/N</th>
<th>NYT NO.</th>
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