

SYSTEM OPERATIONS MANUAL
FOR
LOCOTROL[®] REMOTE CONTROL LOCOMOTIVE
(RCL)

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Global Signaling

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FOR
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(RCL)

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This device complies with Part 15 of the FCC Rules and with RSS-210 of Industry Canada. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation

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Revision History

This document supersedes all previously issued versions, providing new or revised information. The most recent publication can be determined by comparing the last three characters at the end of the part number and the date issued.

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1. INTRODUCTION

1.1 Document Overview

The following outlines the content of Remote Control Locomotive (RCL) Operations Manual:

- **Introduction** – Describes the purpose and physical description (Chapter 1).
- **Controls and Indicators** – Lists and describes the controls and indicators (Chapter 2).
- **Operation** – Provides guidelines for operation as well as information on the various modes used (Chapter 3).
- **System Faults** – Lists the system faults and actions (Appendix A)

This manual refers to the operator as the user of the RCL system; however, the term *operator* and *you* are used *interchangeably* when outlining procedures or instructions.

1.2 Purpose of Equipment

The Remote Control Locomotive (RCL) system provides railroad yard crews the ability to control one locomotive at a time through an Operator Control Unit (OCU) for switching and general yard operations. The locomotive under control can be used in Multiple Unit (MU) locomotive consists. The system provides control of the locomotive by command signals transmitted over a radio link from the OCU. Operationally, several trains equipped with the RCL system can operate on the same radio frequency and within radio range of one another. Additionally, the RCL system allows two OCUs to operate the train in a *pitch and catch* method where only one OCU is in control of the train. The RCL system consists of the portable OCU and a Locomotive Control Unit (LCU) located on the locomotive and other support components. The support components are such items as an operator vest for the OCU, an electronic fence for hump yard operations, and various safety and operational attachments to the locomotive.

1.3 Physical Description of Equipment

The RCL system consists of On-board locomotive equipment and Off-board Operator equipment. The Off-board equipment functions as the commanding unit and the On-board equipment functions as the locomotive controlling unit (Figure 1.3-1).

The locomotive equipment is mechanically designed to withstand, the shock and vibration encountered in locomotive operation. The system is sealed against dust, locomotive gasses and oily fumes; however, it is not weatherproofed and must be sheltered from the elements. The Operator Control Unit (OCU) is designed to meet NEMA 4 standards and to withstand the rigors encountered in the railroad environment, however, the OCU is not waterproof and must be sheltered from the elements.

The major components of the RCL system are briefly described in the following table.

Table 1.3-1 Remote Control Locomotive Components

Component	Description
Operator Control Unit (OCU)	Contains the switches and controls necessary to control the RCL locomotive as well as the alarms and fault reporting messages (see Figure 1.3-2).
Operator Vest	Contains the <i>D</i> ring clips for attaching and securing the OCU during RCL operation (see Figure 1.3-3).
Setup Control Unit (SCU)	Contains the equipment on the RCL to allow for operator set-up, system status display, and provides RCL system interfaces to on and off train equipment (see Figure 1.3-4).
Voice Radio	Contains a standard 35-watt Spectra locomotive radio. This radio provides the capability for the SCU to send alerts and status over the railroad voice radio network (customer provided).
Headlight Control Module	Contains the electronics used for controlling the Long and short hood headlights. These control both Bright and Dim operation (see Figure 1.3-5).
Locomotive Control Unit (LCU)	Contains the electronics, which perform the functions necessary to control the overall system operations. In addition, it provides electrical isolation between the system's module circuitry and the locomotive's train line signals (see Figure 1.3-6).
Brake Control Unit (BCU)	Contains the electronic and pneumatic devices to control the locomotive Automatic, Emergency, and Independent brakes (see Figure 1.3-7).
AEI Tag Reader	Contains the necessary tag reader electronics for detecting track bed mounted AAR/ISO AEI tags. These tags will be placed at the defined boundaries of operation such as yard containment or pullback, as well as at high traffic areas, such as grade crossings within the boundaries (see Figure 1.3-8).
Radio Module	Contains the low power radios. This radio provides the closed loop radio based communications between the OCU and the LCU (see Figure 1.3-9).
Axle Generator	Contains the electronics to detect locomotive wheel rotation rate and convert it to speed and direction signals (see Figure 1.3-10).
Traction Motor Current Module	Contains the electronics necessary to interface to the Locomotive traction motor shunt (see Figure 1.3-11).

Component	Description
Air Sensor Module (ASM)	Contains the electronic and pneumatic devices used to detect Brake Pipe airflow, Truck Brake Cylinder cut in, and Horn activation (see Figure 1.3-12).
GPS	Contains necessary equipment for Global Positioning Satellite (GPS) location determination to supplement AEI Tag Reader System.
Emergency Stop Buttons	Two exterior and one interior mounted red mushroom emergency stop buttons for RCL. (see Figure 1.3-13)

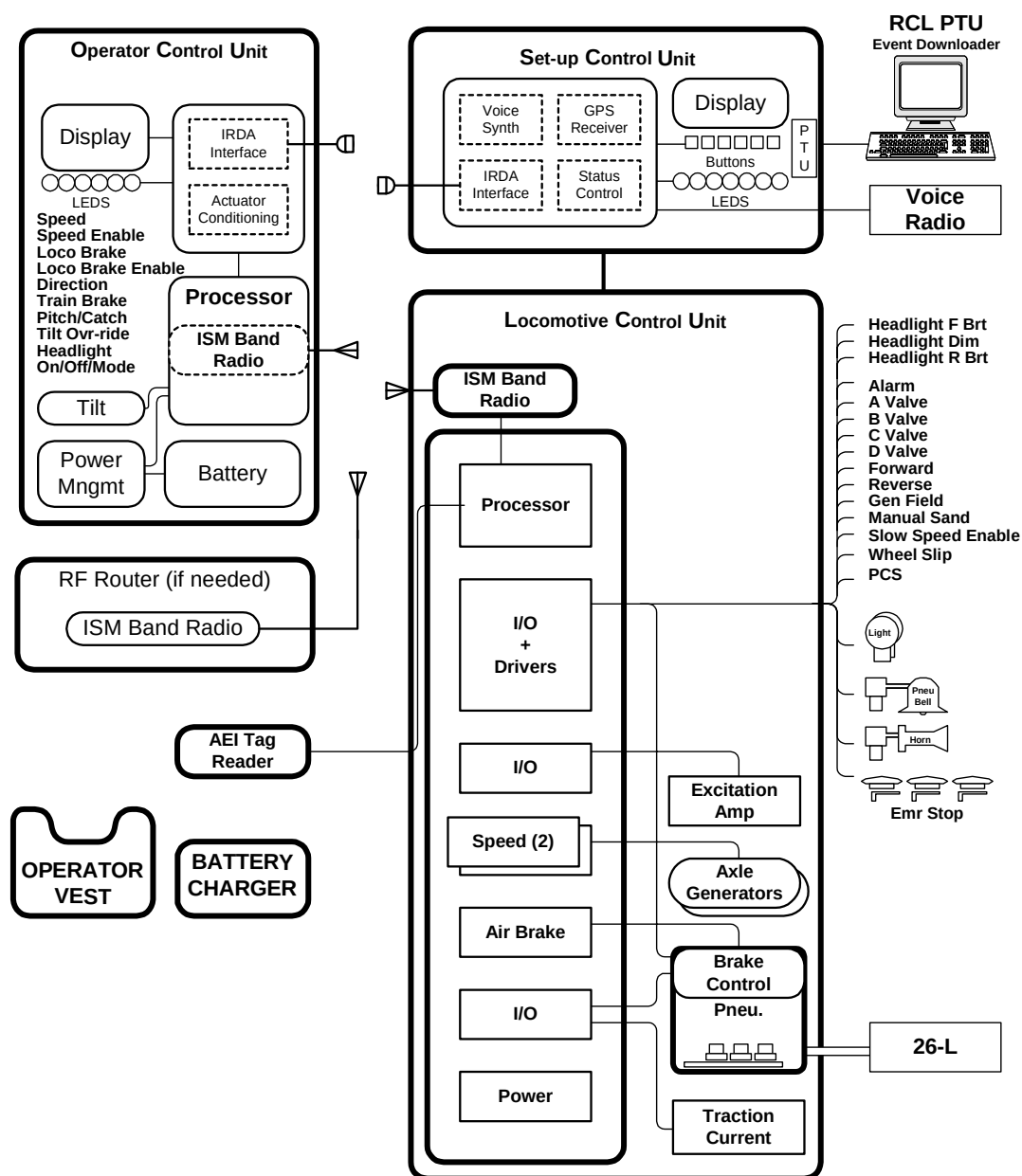


Figure 1.3-1 RCL Top Level Block Diagram



Figure 1.3-2 Operator Control Unit (OCU)



Figure 1.3-3 Operator Vest



Figure 1.3-4 Setup Control Unit (SCU)



Figure 1.3-5 Headlight Control Module



Figure 1.3-6 Locomotive Control Unit (LCU)

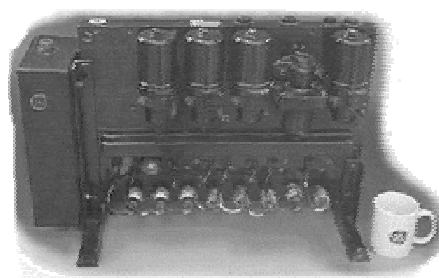


Figure 1.3-7 Brake Control Unit (BCU)

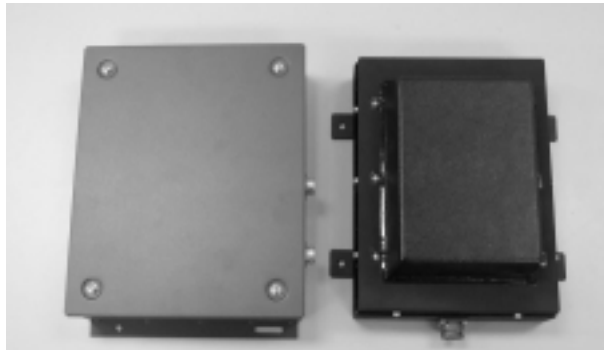


Figure 1.3-8 AEI Tag Reader

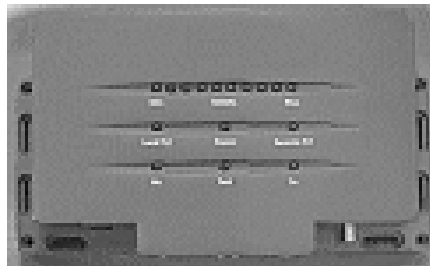


Figure 1.3-9 Radio Module/Router

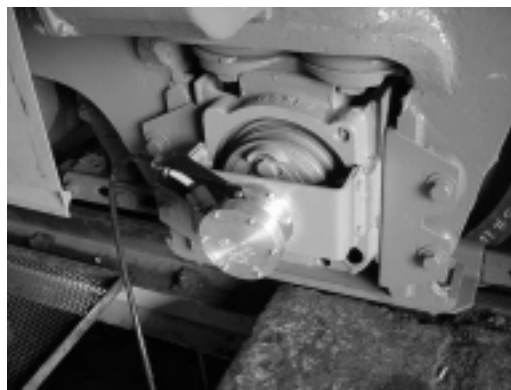


Figure 1.3-10 Axle Generator



Figure 1.3-11 Traction Current Module

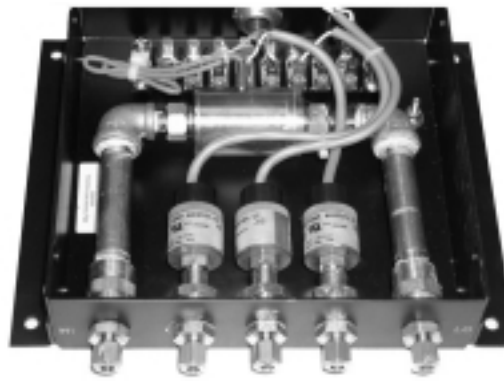


Figure 1.3-12 Air Sensor Module



Figure 1.3-13 Emergency Stop Button

1.4 Operational Overview

In conventional railroad yard switching operations without an RCL system, all car and locomotive movements require an operator on board the locomotive as well as personnel on the ground to direct movements and set switches.

The RCL system provides the yard crews with the ability to control the locomotive from a portable/handheld unit, thereby eliminating the need for an operator on board the locomotive. The yard crew can then set switches and directly control the locomotive/train movements from the ground. Additionally, the RCL system allows one operator to transfer control to another operator in a pitch and catch method when control of the train is needed from another position in the yard.

The yard crew uses the portable OCU to command locomotive movement. The OCU also provides the operator the ability to control the direction, speed, and braking of the locomotive/train. Additionally, the OCU provides the capability to control the headlights, manual sand, bell, and horn. The OCU provides fault and alarm status data from the locomotive.

The LCU on board the locomotive receives the commands from the OCU and activates the appropriate control functions. Control relays or solenoid valves control each function on the locomotive. Sensor circuits monitor the status of the controlled functions to ensure that the control function has been properly activated. If the status does not match the commanded function, a miscompare alarm is generated and appropriate action is taken to ensure the locomotive is in a safe and appropriate state.

If communications are lost between the OCU and LCU for greater than 5 seconds the LCU will go to the Park state where the locomotive is idled and a full service automatic and independent brake application is made. The system remains linked and if communications are restored the Park State can be recovered and normal operations resumed. If communications is lost for longer than the comm. loss unlink time as set in the Configuration File, the LCU will go to the Safe State where the emergency brakes are applied, the locomotive is set to idle, and the system is unlinked.

1.5 OCU Commanded Functions

The OCU detects the operator inputs and transmits these commands to the LCU. The LCU then activates the appropriate control signals to carry out the commanded control function. Table 1.5-1 lists the normal command functions transmitted to the LCU.

Table 1.5-1 OCU Command Functions

Electrical Functions	Pneumatic Functions
Direction	Automatic Brake Applications and Releases
Set Speed	Independent Brake Applications and Releases
Bell	Emergency Brake Applications and Releases
Horn	
Sand	
Headlight	

1.6 LCU Control and Status Functions

When the LCU receives commands from the OCU, it activates the appropriate locomotive control lines needed to perform the commanded control function. Locomotive status lines are monitored to ensure that the proper functions have been activated and to provide feedback for function control loops. Table 1.6-1 and Table 1.6-2 lists the normal LCU controlled and monitored functions.

Table 1.6-1 LCU Controlled Functions

Electrical Functions	Pneumatic Functions
Direction: (FO, RE)	Equalizing Reservoir (DEC, FST, SLO)
Throttles: (AV, BV, CV, DV)	Independent Brake: (IBA, IBR)
Generator Field: (GF)	Bail (ABL)
Manual Sand	Emergency: (EBA)
Slow Speed Enable	Backup Emergency: (BUEMV)
GF Excitation Control (Analog Control)	Emergency Reset: (EBR)
Head Light Control	Horn
Strobe Lights (if equipped)	Bell
Vigilance Disable (if equipped)	

Table 1.6-2 LCU Monitored Functions

Electrical Functions	Pneumatic Functions
Emergency Stop Buttons	ER Pressure, BC Pressure, MR Pressure
Rear Headlight Switch Position	BP Pressure
Wheel Slip	Front and Rear Truck BC Pressure > 25 psi
PC Switch	Bell
Traction Motor Current	Horn
Axle Generator #1 Speed	Feed (Brake)Valve (FV)
Axle Generator #1 Direction	Penalty Pipe
Axle Generator #1 Speed	Switch Pipe
Axle Generator #1 Direction	BP Flow
Locomotive Alarm	
Manual Sand	
Governor Shutdown	
Hot Engine	
Ground Fault	

2. CONTROLS AND INDICATORS

This Chapter provides the operator with a comprehensive background for operation of all controls and an understanding of the monitoring indications. Each control and indicator located anywhere on the system is listed and described in one of the tables provided.

Refer to Figure 2.1-1 and 2.1-2, OCU layout, when reading Table 2.1-1 and Table 2.1-2; Figure 2.2-1, SCU Assembly, when reading Table 2.2-1 and 2.2-2; and Figure 2.3-1 and 2.3-2, LCU Assembly, when reading Table 2.3-2.

No attempt is made to describe any circuitry in detail. Only functional descriptions are provided. For detailed circuit descriptions, see the *Service Manual*.

2.1 Operator Control Unit (OCU)

The OCU contains controls, a display, a speaker and an Infra-Red Port (see Figure 2.1-1). Table 2.1-1 lists and describes the Operator controls. Table 2.1-2 lists and describes the OCU outputs. Commanded functions are indicated on the OCU display by a flashing LEDs and the actual locomotive status is indicated by a solid LEDs. When the actual locomotive status matches the commanded value the status LED is solid.

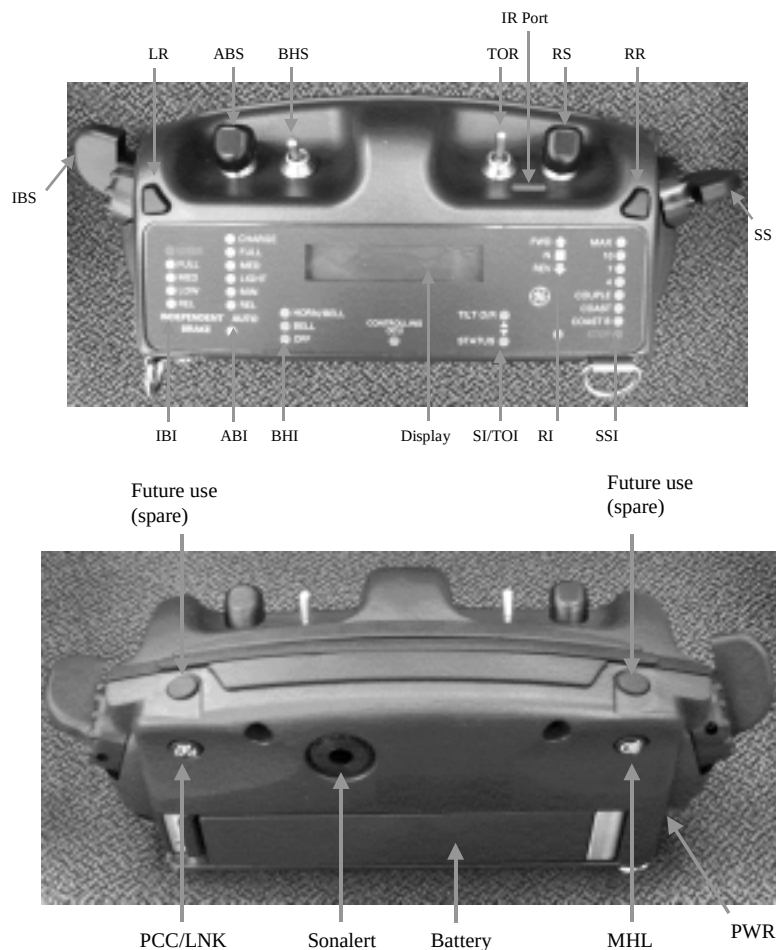
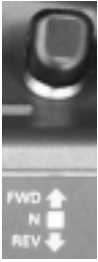
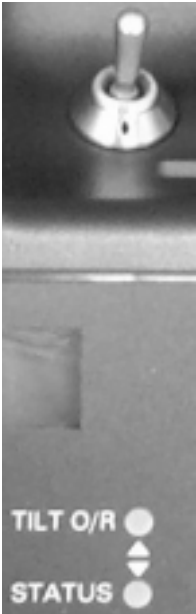


Figure 2.1-1 Operator Control Unit – Actuators

Table 2.1-1 Operator Inputs

Function	Description
Speed Selector (SS) (Flat Yard OCU) 	The Speed Selector provides eight positions that result in the OCU transmitting speed and stop commands. Movement of the Speed Selector also provides a signal to reset the vigilance timer.
Speed Selector (SS) (Hump Yard OCU) 	The Speed Selector provides eight positions that result in the OCU transmitting speed and stop commands. Movement of the Speed Selector also provides a signal to reset the vigilance timer.
Left Reset (LR) Right Reset (RR)  	These switches need to be pressed first to allow the following OCU actions within 3 seconds: • SS out of stop • ABS from full to charge Also these buttons: • Command Manual sanding if pressed for more than 5 seconds: • Resets OCU vigilance. • Approves linking of secondary OCU • Commands sleep mode option • LR: i) unfreezes locomotive status screen ii) lowers OCU LED brightness • RR: i) freezes locomotive status screen ii) increases OCU LED brightness

Function	Description
Reverser Selector (RS) 	The RS is a three-position toggle switch: (a) FWD Position: Activates Locomotive Forward trainline (TL8) (b) N Position: Neutral, no direction commanded (c) Rev Position: Activates Locomotive Reverse trainline (TL9)
Independent Brake Selector (IBS) 	The IBS provides five positions that result in the OCU transmitting the following independent brake commands: (a) emergency (b) full (c) medium (d) low (e) released Actuation of the IBS also provides a signal to reset the vigilance timer.
Automatic Brake Selector (ABS) 	The ABS is a three-position toggle switch. The Center position is a no change position. The ABS toggle position away from operator's body is a momentary position that results in the OCU transmitting a command to the next sequential brake application in the following sequence: (a) Release (b) Minimum (7 psi reduction) (c) Light (15 psi reduction) (d) Medium (20 psi reduction) (e) Full (26 psi reduction) (f) Charge The ABS toggle position toward operator's body for at least 2 seconds results in the OCU transmitting a direct release command. ABS also resets OCU vigilance.

Function	Description
Bell and Horn Selector (BHS) 	The BHS is a three-position toggle switch. The BHS toggle position toward the operator is bell and horn off. The BHS switch center position results in locomotive bell on with horn off. The BHS toggle position away from the operator is a momentary position and results in a bell and horn on. BHS also resets the vigilance timer.
Manual Headlight (MHL) 	The MHL is a push button that results in the OCU transmitting a headlight command to control the brightness level (Off, Dim, or Bright) of the Locomotive consist's front and rear headlights. MHL resets the vigilance timer.
Tilt Over-ride / Tilt Test Over-ride / Status (TOR) 	The TOR is a three-position toggle switch. TOR toggle in the center position shall be in the neutral position. TOR toggle position toward the operator is a momentary position and adjusts the OCU display for status. Toggling the switch Multiple times steps the Status display through the following status displays: • Loco Status • OCU Status • Link Status TOR toggle position away from operator is a momentary position for tilt timer extend and tilt test. The Tilt Override feature will be activated for up to 60 seconds when the switch is toggled to this position. Changing any OCU control will cancel the tilt override timer. TOR also resets the vigilance timer.
Pitch Catch Control / Link (PCC/LNK) 	The PCC/LNK is a momentary switch that: • Starts OCU linking via infrared port to SCU • Pitch and catch operation to move locomotive control to a secondary OCU • Resets OCU vigilance.

Function	Description
Power (PWR) 	The PWR is a push button switch that performs a soft power on/off of the OCU and must be held for 5 seconds to power off the OCU.

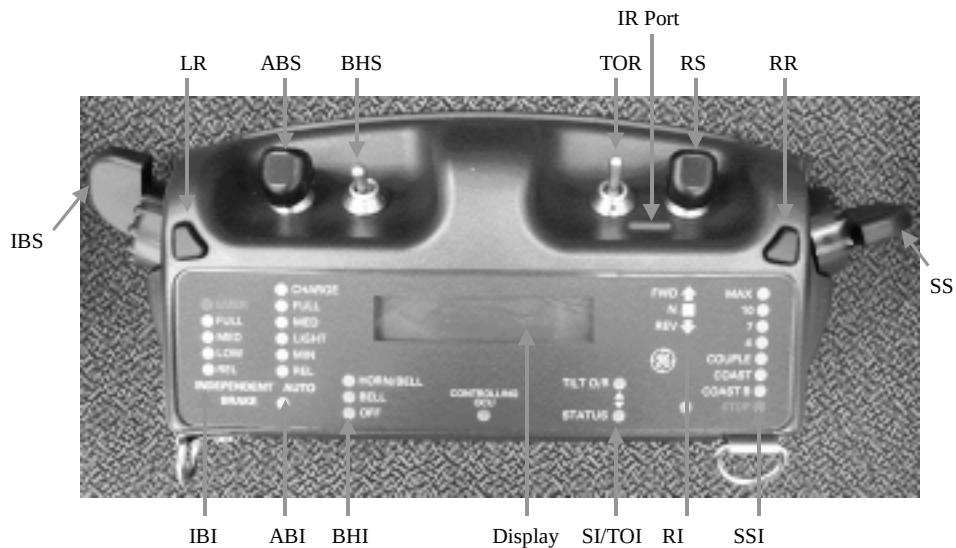


Figure 2.1-2 Operator Control Unit - Indicators

Table 2.1-2 OCU Outputs/Indicators

Function	Description
Display	The display is used to report system events and status and fault and alarm data. Toggling the TOR actuator to the Status position selects the following system status: 1. Loco Status 2. OCU Status 3. Link Status
Independent Brake Indicator (IBI)	The IBI is the status indicator for the Independent Brake Selector (IBS). It indicates the actual independent brake level (illuminated indicator) and the commanded independent brake level (flashing indicator) for the LCU. The following braking levels are indicated: (a) EMER (b) FULL (c) MED (d) LOW (e) REL
Automatic Brake Indicator (ABI)	The ABI is the status indicator for the Automatic Brake Selector (ABS). It indicates the actual automatic brake level (illuminated indicator) and the commanded automatic brake level (flashing indicator) for the LCU. The following braking levels are indicated: (a) CHARGE

Function	Description
	(b) FULL (c) MED (d) LIGHT (e) MIN (f) REL
Bell and Horn Indicator (BHI)	The BHI is the status indicator for the Bell and Horn Selector (BHS). It indicates the commanded Bell and Horn settings for the LCU. The following settings are indicated: (a) HORN-BELL (b) BELL (c) OFF
Controlling OCU (CO)	The CO is the status indicator for the Controlling OCU. When this LED is illuminated, this OCU is in control of the RCL locomotive (primary).
Status Indicator (SI)	The SI is the status indicator for the Display status. When this indicator is illuminated, the OCU Display is displaying status information.
Reverser Indicator (RI)	The RI is the status indicator for the Reverser Selector (RS). It indicates the actuator position and the commanded direction for the LCU. The following settings are indicated: (a) FWD (b) N (c) REV
Speed Selector Indicator (SSI)	The SSI is the status indicator for the Speed Selector (SS). It indicates the actual LCU speed (illuminated indicator) and the commanded locomotive Speed level (flashing indicator) for the LCU. The following braking levels are: (a) MAX (b) 10 (c) 7 (d) 4 (e) COUPLE (f) COAST (g) COAST (B) (h) STOP

Function	Description
Tilt Over-ride / Tilt Test Indicator (TOI)	The TOI is the status indicator for the Tilt Over-ride/Tilt Test Switch (TOR). The indicator is illuminated when TOR is pressed and flashes to indicate that the tilt by-pass or tilt test functions are enabled.
Ambient Light Detector (ALD)	The OCU provides a photo detector to determine ambient lighting conditions and, if selected, automatically adjust the OCU display illumination for day/night operation.
Audible Output	The audible device is a dual tone output used for normal annunciations (low level, chirping tone) and emergency warnings (high level, continuous tone).
Infra-Red Port	The IR port is an Infra-red interface transceiver used for OCU to SCU linking. The IR port is also used for upgrading the OCU software.

2.2 Setup Control Unit (SCU)

The SCU is part of the RCL On board equipment and provides the human interfaces required on the locomotive. It contains a keypad, circuit breaker, status LEDs, Synthesizer, PTU interface port, Infra-Red Port and other electronic devices to allow for operator set-up, system status display, (see Figure 2.2-1). Table 2.2-1 lists and describes the Operator input switches and actuators. Table 2.2-2 lists and describes the SCU outputs and Indicators.



Figure 2.2-1 Setup Control Unit (SCU)

Table 2.2-1 SCU Inputs

Function	Description
Relay Circuit Breaker	The Relay Circuit Breaker provides power to the LCU locomotive control relays
Keypad	The Keypad is a sixteen (16) button keypad for control of the status display and entry of information. The keypad is disabled when the LCU is linked to the OCU.
GPS Input	The GPS input provides a connection for the GPS antenna.

Table 2.2-2 SCU Outputs

Function	Description
Display	The display is a 2 line, 16 character display. It is used to report system status and diagnostic data.
Infra-Red Port	The IR port is used for OCU to LCU linking, and data transfer.
Status LEDs	Status LEDs are provided for the following items (a) SCU power (green) (b) Trainline relay Power (green) (c) Event Recorder Continuous Self-Test (green) (d) OCU #1 linked (green) (e) OCU #2 linked (green) (f) Primary OCU Comm Loss (red) (g) System Failure (red) (h) Spare
PTU Port	The PTU port provides the serial channel interface to a Laptop computer and is used for downloading Event Recorder data.
Voice Radio	The radio connection provides an interface to the voice radio.

3. INTRODUCTION

This chapter provides recommended guidelines for operating the RCL system and includes additional information to assist the operator in understanding the various modes of operation.

The procedures are written to assist the railroad in establishing safe operating procedures for the RCL System; however, they are not intended to replace standard locomotive operating procedures or approved railroad practices. Standard railroad operating procedures should take precedence.

A periodic checkout of the RCL system is recommended. This checkout should include a complete test of all system functions as well as checks of the radios. For detailed circuit descriptions, see the *Service Manual*.

3.1 Operator Interface Overview

The Operator Control Unit (OCU) is the primary operator interface. The OCU operation begins at RCL system linking and progresses through the required tests until the operator has complete control of the RCL locomotive.

3.2 Initial Conditions

The following conditions are required prior to RCL start-up and operation:

1. The RCL System is installed and operating properly.
2. The operator is completely familiar with locomotive operating procedures and established railroad practices and is duly authorized by the railroad to operate an RCL equipped train.
3. All RCL power switches and circuit breakers in the RCL locomotive are in the **OFF** position.

Note – If the locomotive is in Manual Mode all the RCL switches and circuit breakers will be on.

4. The operator puts fresh batteries in the OCU and verifies battery charge.
5. The operator puts on the operator vest and adjusts for comfort.

3.3 Preparing RCL Equipment for Service

Preparation of the RCL equipment is done in steps as indicated in the following sections.

Note – Locomotive Independent brakes (cabstand) should not be released until after the RCL system is setup.

3.3.1 Locomotive Set Up for RCL Operation

Set the following switches on the RCL locomotive to the positions indicated.

Table 3.3.1-1 Locomotive Setup

Switch	Position
Control and Fuel Pump Switch	ON
Dynamic Brake Circuit Breaker (if equipped)	OFF
Reverser	NEUTRAL (Handle Removed)
Unit Isolation Switch	RUN
Automatic Brake Valve	RELEASE
Brake Valve Cut-out	FREIGHT or IN
MU2A	LEAD
Independent Brake Handle	RELEASE
Engine Run Switch	ON
Generator Field Switch	OFF
Cab Stand Headlight Switch	OFF
Remote Headlight Select Switch	Set for Normal MU Operation

Note – All units which form the part of the RCL consist must be coupled to the RCL equipped unit in the conventional trailing unit mode.

Set the RCL System switches to the position indicated:

1. RCL Manual/RemoteValve –Remote position

Note –When RCL Manual/Remote valve is placed in the Remote position, the locomotive will go to emergency.

2. RCL main Circuit Breaker -**ON**
3. SCU Relay Circuit Breaker -**ON**

After system initialization the RCL SCU unit turns on the following LED status indicators: LCU/SCU Power (green), Train line Relay Power (green), and Event Recorder Continuous Self-Test (green). The SCU displays “Low MR” until the Main Reservoir pressure is greater than 80 psi. The SCU then displays the “Setup Emergency” message.

After system initialization the RCL LCU unit enters the Setup State where it will wait for link commands from the OCU. While in the Setup State the LCU will be in the Safe mode in which the emergency brakes are applied, the Independent Brakes are set to full, and the Throttle is set to Idle.

If the LCU is not linked to an OCU within 90 seconds then the LCU enters the Standby Mode. In this mode, the LCU remains powered up but relinquishes control of the locomotive air brakes and allows the locomotive to be operated conventionally. When the LCU enters the Manual mode (after 90 seconds) the emergency valves are closed which allows manual recovery of the train brake pipe using the automatic brake handle. When the brake pipe is recovered and the brake pipe pressure rises above 65 psi, then the LCU releases the Independent brakes and turns control over to the locomotive operator. When the LCU receives a link command from an OCU it will then re-enter the Setup State.

3.3.2 Operator Control Unit Setup

Set the following switches on the OCU to the positions indicated:

Table 3.3.2-1 OCU Switch Setup

Switch	Position
Speed Selector (SS)	STOP
Reverser Selector (RS)	N
Independent Brake Selector (IBS)	EMERGENCY
Bell / Horn Selector (BHS)	OFF
Power (PWR)	ON

3.3.3 RCL Equipment Shutdown Procedure

The following procedure should be followed to shutdown the RCL system:

1. With the train stopped; set the Speed Selector to **STOP**, the Reverser to the Neutral (**N**) position, The Bell and Horn Selector (BHS) to **OFF**, and the independent brake to **FULL** or Emergency.
2. Unlink the system by setting the PWR switch on the Primary OCU to the **OFF** position (press and hold pwr for 5 seconds). Follow the directions on the OCU display to power down OCU. The OCU transmits the Unlink command to the LCU and after receiving an acknowledge command from the LCU that it is the Safe mode, and then powers off.
3. When the RCL system on the locomotive receives the unlink command from the Primary OCU, it enters the *Setup* State and initiates an Emergency Brake Application, sets a Full Independent Brake Application, sets the Throttle to idle and enters the Safe mode. The LCU then transmits an acknowledge command to the OCU indicating that it is in the Safe mode.
4. After 90 seconds the LCU enters the Manual Mode, closes the emergency valves, and allows the locomotive operator to operate the locomotive conventionally.

The locomotive can now be operated conventionally without having to power off the LCU, cutout any pneumatic valves, or re-configure any switch settings. Alternatively, the LCU can be powered off and cutout as follows:

1. Place the RCL Main Circuit Breaker to **OFF**.
2. Move the RCL Manual/Remote Valve to the Manual position.
3. Configure the locomotive for conventional lead operation.

3.4 System Linking and Testing

When the train has been made up properly and the RCL system has been prepared per the previous instructions, system linking and safety checks can be performed. On initial power up, the OCU performs a display and audible alarm test. All display indicators light in sequence, each line of the display is exercised, and the audible alarm sounds. When all

indicators and the audible alarm have been verified, the display shows **GETS GS LOCOTROL RCL**, and the OCU is now ready for linking to the Setup Control Unit (SCU). If the locomotive is not set up properly for RCL operation (i.e., Air brake cutout cock not cut in, Locomotive trucks cutout, automatic brake handle not in release, etc.) or an alarm condition exists on the locomotive, the SCU display will indicate which device that is improperly setup or the RCL fault that is active. If properly set up, the SCU will indicate **Setup Emergency** when the LCU is in the Setup State or **Manual Mode** when it is in the Manual mode and is ready for linking with the OCU.

3.4.1 Linking RCL Operation

To begin the RCL linking process, follow the guidelines outlined below:

1. Hold the OCU so that its Infrared Port is pointed at the SCU Infrared port and press and release the PCC/Link button on the OCU. (see Figure 3.4.1-1) The OCU will give a **Linking LCU** and **Radio Testing** message.
2. Verify that the OCU and the SCU are linked together by observing that the OCU displays **Linked to Locomotive, Loco ID: XXXX** and that the Green **OCU # 1 Linked** status LED is lit. The first OCU that links to the SCU is defined as the Primary OCU and the Controlling OCU LED illuminates on the OCU to indicate that it is the controlling OCU for the RCL system.
3. Once linked, the SCU will display **Primary Tilt Test Not Complete**. Press and hold the tilt override switch forward. Rotate the OCU greater than 45 degrees from horizontal until the SCU message disappears. The locomotive voice Radio will send a voice message that the tilt test is completed and the locomotive number. The RCL system remains in the Setup State (or transitions to the Setup State if it was in the Manual mode) with the emergency brakes applied, the Independent Brakes set to Full, and the Throttle in Idle. Release independent brakes on cabstand.
4. Leave the locomotive and proceed to the area of intended operation.



Figure 3.4.1-1 Linking

A secondary OCU can be linked to the LCU for use during *Pitch and Catch* operations. Linking the secondary OCU is accomplished in the same manner as the Primary OCU except the Primary OCU must acknowledge and authorize the secondary OCU linking.

The process for linking the secondary OCU is outlined below:

1. Hold the second OCU so that its Infrared Port is pointed at the SCU Infrared port and press and release the PCC/Link button on the OCU. The Primary OCU operator will get a **Secondary OCU Link** message on their display and within 5 seconds the operator must press the LR or RR button on the OCU to authorize the second OCU to Link.
2. Verify that the second OCU and the SCU are linked by observing the Locomotive road number on the second OCU display and that the **Green OCU # 2 Linked** status LED is lit. The **Controlling OCU** LED on the secondary OCU remains off.
3. If the Setup Emergency has been recovered by the Primary OCU, the locomotive will be put into Park State. Once the secondary OCU is linked a secondary OCU Tilt test must be performed using the same method as the primary Tilt test. If the Setup Emergency has not been recovered prior to linking a secondary OCU, the RCL system will remain in the Setup State.

3.4.2 Emergency Valve Test

The Emergency Valve Test verifies the proper operation of the RCL locomotive emergency. The test runs automatically when the automatic brakes are released for the first time after linking.

The operator moves the Independent Brake Selector (IBS) from the **EMERGENCY** position to the **RELEASE** position. The SCU will display **EMV Test in Progress**. The

OCU will display **Consist Recovering** and if the test passes, BP will recover and the OCU will display **Consist Ready**.

Upon successful completion of the Link operation, recovery of the Set Up Emergency, and verifying the emergency valves, the Locomotive Control Unit (LCU) transitions into the *Ready* State. The *Ry* State allows an OCU operator to control the locomotive's speed and brakes. The SCU display Remote Mode on the display.

3.4.3 System Status Functions

The RCL system status is displayed on the OCU display. Select the status functions using the TOR actuator. By toggling the TOR actuator toward the Status position, the OCU display toggles through the each status function. As the operator selects each status function, the OCU scrolls through the information related to the selected item. The selected status functions and information provided is as follows:

Table 3.4.3-1 Status Functions

Status Function	Information Provided
Status Menu	Status List
Pitch to Proyard (If a Hump Yard OCU is being used)	1. Pitch to Proyard... Press PCC to Pitch
Loco Status	1. Brake Pipe: XX psi BP Flow: YY scfm 2. Main Res: XX psi Brake Cyl: YY psi 3. Loco speed: XX mph Loco Throt: Z 4. Headlight Command: Dim (Bright) (Off)
OCU Status	1. LED Intensity: AUTO (XX %) Adjust with LE/RE 2. Ver: 8000451-6XX SW Date: MM/DD/YY 3. Battery Life XX hrs YY mins 4.
Link Status	1. Radio Link Status Unlinked (Linked to Loco XXXX) 2. IR Linked Status Unlinked (Linked)

Note: The Loco Status Screen can be frozen with the **RR** button and unfrozen with the **LR** button while the loco status is being displayed.

3.4.4 System Operating States

The following sections identify and describe the main operating States of the RCL system and the criteria used to transition between states.

3.4.4.1 Initialization (Power Up) State

Upon power up the LCU performs a power up self-test and checks the status of the locomotive, brake, and yard containment.

If the self-test passes, the LCU system transitions to the Setup State. Failure of the self-test holds the system in the Initialization State and an alarm message is displayed on the SCU display.

3.4.4.2 Setup State

In the Setup State, the LCU commands the air brake system to emergency, the independent brakes to maximum, and the locomotive to Idles with direction Neutral. The SCU display shows Setup Emergency. The LCU also checks for system faults, improper system setup, and invalid configuration parameters.

If the LCU system checks pass then the LCU can be linked to the OCU. Failure of the system checks holds the system in the Setup State, displays an alarm message on the SCU display, and prevents the LCU from Linking with the OCU.

3.4.4.3 Manual Mode

If the LCU remains in the Setup State for 90 seconds without linking to an OCU, then the LCU transitions to the Manual Mode. When the LCU transitions to the Standby Mode, the SCU display shows **Manual Mode**. The locomotive is still in emergency with the LCU maintaining a Maximum (Full) independent brake application. The brake pipe may now be recovered manually using the automatic brake handle on the cabstand. When the brake pipe pressure rises above 65 psi, the LCU releases the independent brakes and the locomotive is now suspended from RCL operation and can be operated conventionally.

The LCU remains in the Manual Mode until a Link command is received from an OCU via the Infra – Red port. When a Link command is received, the LCU re-enters the Setup State, applies the emergency brakes, sets the independent brakes to maximum (Full). The LCU then processes the linking commands from the Setup State as outlined above.

3.4.4.4 Ready State

Upon successful completion of the Linking sequence with the OCU, recovery of the Setup emergency, and verification of the emergency valves, the LCU transitions to the Ready State. The Ready State is the system operational State and allows the operator to control the following:

- Locomotive Speed
- Independent Brakes
- Automatic Brakes
- Bell

- Headlights
- Horn
- Sand

The system monitors the yard containment to ensure that the system is operating safely within the proper boundaries.

The system also monitors all critical parameters and subsystems to ensure no fault conditions are present. If fault conditions are detected, the system transitions to either the *Park State* or the *Safe State*, depending on the severity of the fault.

The System returns to the Setup State if it receives an Unlink command from the controlling OCU or if it unlinks automatically due to an extended loss of OCU communications.

3.4.4.5 Park State

When a minor fault is detected, the system enters the Park State. Minor faults result from situations where the locomotive should be stopped until the fault is resolved, but does not warrant an emergency brake application.

Minor faults result in the following:

- Full Service Automatic Brake Application
- Full Independent Brake application
- Direction Neutral
- Throttle Idle

The system will remain in the *Park State* until:

- The Fault is Cleared
- The locomotive has stopped
- Primary operator acknowledges the fault by moving the Speed Selector to the STOP position and the IBS to the FULL position as prompted by the OCU.

3.4.4.6 Safe State

The system enters the *Safe State* when a *Major Fault* is detected. Major Faults result from a situation where the locomotive needs to be stopped using an emergency brake application.

For Major Faults, the system commands the locomotive to a *Safe State* which consists of:

- Emergency Brake Application
- Full Independent Brake Application
- Direction Neutral
- Throttle Idle

The system will hold the locomotive in the Safe State until:

- The Fault has been cleared
- A 60 second Emergency Brake timer has elapsed. (The OCU display shows a 60 seconds count down timer when the IBS is placed in the Emergency position to indicate the time remaining).
- The operator acknowledges the fault by moving the SS actuator to the STOP position and the IBS actuator to the EMERGENCY position as prompted by the OCU.
- The Operator moves the IBS actuator from the EMERGENCY position to the RELEASE position.

3.5 Control Functions

3.5.1 Air Brake Functions

The LCU provides all air brake control of the locomotive and train brake functions including Multiple Unit (MU) capability and emergency brake control. The brake system is operated with the Brake Valve always cut in to ensure operation is allowed only when automatic braking capability is available.

3.5.1.1 Automatic Brake

Automatic brake applications can be initiated by the operator using the OCU ABS switch as follows:

1. Push the ABS switch away from operator and then release to increase brake application one level
2. REL is 0 psi reduction
 - MIN is 7psi reduction
 - LIGHT is 15 psi reduction
 - MED is 20 psi reduction
 - FULL is full service reduction
3. The solid LED on the indicator shows switch position and the flashing LED shows current brake level on the locomotive.
4. Operator releases brake application by pulling back on the ABS for 2 seconds.

Note: Automatic brakes are bailed for an automatic brake applications except full and emergency.

3.5.1.2 Charge

Charge will recharge locomotive brake pipe and release automatic brakes. To initiate charge:

1. Press LR or RR on the OCU and move ABS immediately from FULL to CHARGE position.
2. From REL pull back for 5 seconds on TBA to wrap it back to CHARGE.

To release from charge pull back of ABS momentarily.

Note: i) Locomotive is not allowed to move while in charge.

ii) If MR is less than 110 psi the RCL system will “dry charge” the locomotive by setting throttle to Notch 4 (Direction is Neutral).

3.5.1.3 Independent Brakes

The locomotive independent brake functions are controlled manually by the operator via the Operator control Unit (OCU) or automatically (during speed control operation) by the LCU.

The operator initiates independent brake applications by rotating the independent brake control on the left side of the OCU. The operator can select the following independent brake setting as shown in Table 3.5.1.3-1 by moving the independent brake controller to the appropriate position.

Table 3.5.1.3-1 IBS Brake Cylinder Pressure

IBS Setting	Brake Cylinder Pressure
REL	0 psi
LOW	25 psi
MED	45 psi
FULL	> 65 psi

Note: The locomotive brake cylinder pressure is determined by the J type relay valve installed on the locomotive and the actual brake cylinder pressure may vary from those noted above in Table 3.5.1.3-1. See Table 3.5.1.3-2 below.

Table 3.5.1.3-2 Various J Type Relay Valve Brake Cylinder Pressures

J Type Valve	Brake Cylinder Pressure
J8.6	38 psi
J1	45 psi
J1.6	72 psi

The LCU will automatically apply independent brakes as needed to control the train speed.

An automatic Bail feature is provided in the RCL system to release the locomotive brakes after any automatic brake application. When the LCU commands an automatic brake application less than Full Service, the BAIL function will be activated for 20 seconds. The locomotive brakes are not bailed during Full Service Applications. During emergency brake applications and locomotive penalty applications the locomotive brakes will not be bailed.

3.5.1.4 Emergency Brakes

An emergency brake application can be initiated by the operator in any of 3 methods:

- a) Rotate the IBS actuator to the **EMER** position on either the Primary or Secondary OCU. This causes an emergency brake command to be sent to the LCU on the locomotive which puts the train in to emergency.
- b) Cause a brake pipe emergency at the locomotive cabstand by moving the automatic brake handle to emergency or opening the conductor's emergency valve.
- c) Press one of the **RCL Emergency STOP** switches located in the locomotive cab or on the left or right side of the locomotive.

When an emergency brake application is in effect, the locomotive is placed in the Safe State where the emergency brakes are applied, Independent brakes are set to full, Bail is deactivated, and the throttle is idled.

When an Emergency Application is commanded the OCU will display **Emerg.Countdown:XX**. This is a 60 second count down timer, which indicates when the Emergency application can be reset.

An operator initiated emergency brake application is released by disengaging the locomotive emergency stop switches or brake valves (if previously activated), setting the OCU speed selector to the **STOP** position, the independent brake selector to the **EMER** position, waiting for the emergency timer to expire (1 minute), then rotating the IBS actuator to the **REL** position. The OCU will prompt the operator throughout this recovery process.

3.5.2 Air Brake Function Interlocks

To ensure the RCL system operates in a *Safe* State, interlocks are provided in the air brake control system to protect against improper operation.

1. **Brake Valve CUT IN** – The locomotive Brake Valve must always remain in the Cut IN position (except Emergency). Detection of the Brake Valve out will put the train in the *Safe* State.
2. **Automatic Brake Handle in Release** – The locomotive brake handle must always be placed in the **RELEASE** position. Movement of the Automatic Brake handle out of the **RELEASE** position will result in the locomotive being commanded to the *Park* State. The OCU will display **BV Handle not in Release**.
3. **Low Main Reservoir** – If the Main Reservoir pressure drops below 105 psi for greater than 5 Seconds, a Low Main Reservoir Warning alarm will be generated. If the Main Reservoir pressure drops below 90 psi for greater than 5 Seconds, a Low Main Reservoir Fault will be declared and the locomotive will be commanded to the *Safe* State. While the RCL system is in the Charge mode, the Low Main Reservoir feature is disabled.
4. **Brake Pipe not Charged** – If the train brake pipe is not properly charged, the locomotive will be prohibited from releasing the independent brakes. The brake pipe is considered charged if the rate of change of airflow into the brake pipe is less than 5 cfm per second.

5. **Low Brake Pipe** – If the brake pipe pressure drops below 45 psi, the locomotive will be commanded to a *Safe State*. If the direction is neutral and the brake cylinder pressure is greater than 25 psi this interlock will be disabled.
6. **Brake Pipe Rise** – The LCU system continually monitors the brake pipe pressure during all automatic brake applications. If brake pipe pressure increases significantly (2 psi sustained for 2 seconds) when not expected, an emergency brake application is applied and the system commanded to the *Safe State*.
7. **Train Separation Detection** – A train separation causes a charged brake pipe to fall at an emergency rate. If the brake valve cuts out with an un-commanded drop in brake pipe pressure, the LCU will declare a train separation and command the locomotive to the *Safe State*.
8. **Brake Cylinder Pressure Monitoring** – The brake cylinder pressure is monitored at each truck to ensure that each truck has been properly cut in and that the cylinder pressure rises to at least 25 psi when the commanded independent brake control pressure is greater than or equal to 25 psi. If the monitored brake cylinder pressure does not rise greater than 25 psi the locomotive will be commanded to the *Park State*.

3.5.3 Electrical Functions

The LCU provides all electrical control of the locomotive including MU capability. Control relays provide the required signals for proper locomotive operation and safety equipment operation. In addition monitoring circuits are provided to ensure safe and effective operations.

3.5.3.1 Direction Control

The LCU controls the locomotive direction as defined by the operator using the Reverser Selector on the OCU. The Speed Selector (SS) must be in the **STOP** position with actual speed at 0 m.p.h. in order to select a direction with the Reverser.

Once a direction is selected and the speed selector is set for speed control operation, movement of the Reverser Selector back to the neutral (N) position returns the locomotive throttle back to the idle and sets the direction to neutral. No brake application is applied. The locomotive remains in this state until:

1. The operator moves the OCU Reverser Selector (RS) to the previously commanded direction. The locomotive then resumes speed control operation at the OCU commanded speed setting.
2. The operator moves the SS actuator to the **STOP** position. The LCU commands the locomotive to stop.

3.5.3.2 Throttle Control

The RCL system does not provide the operator direct throttle step control; rather, the operator uses the OCU to select the desired operating speed. The LCU also provides MU capability for controlling the tractive effort on all locomotives within the consist.

3.5.3.3 Speed Control

The RCL system provides a speed control system for controlling traction and moving the locomotive and train. Provisions are made within the speed control algorithms for operation at Hump yards and Flat yards.

3.5.3.3.1 Throttle vs Excitation Speed Mode

Before linking the OCU, the SCU inside the locomotive can be set to excitation or throttle mode. On the SCU press MENU, scroll down to the Speed Control option. Press enter and use arrow key to pick *Excitation* or *Throttle* and press ENTER again.

Throttle mode must be used if another locomotive is MU'd that does not have slow speed control. Excitation uses the excitation Trainline and will provide a smoother speed control.

To enter the Speed mode and move the train, the operator uses the OCU to perform the following steps:

1. Set the SS actuator to the **STOP** position.
2. Select the desired movement direction using the Reverser Selector.

Press the LR or RR button and, within 3 seconds, move the speed selector to the desired speed control position. Speed settings are configurable and may vary from yard to yard. The typical speed settings for Flat Yards (Table 3.5.3.3.1-1) and Hump Yards (Table 3.5.3.3.1-2) are defined as:

Table 3.5.3.3.1-1 Speed Selector (SS) (Flat Yard)

SS Setting	Commanded Speed
STOP	0 m.p.h.
COAST (B)	COAST w/Brake
COAST	COAST
COUPLE	1 m.p.h. (typical)
4	4 (typical)
7	7 m.p.h. (typical)
10	10 m.p.h. (typical)
MAX	10-20 m.p.h.

Table 3.5.3.3-2 Speed Selector (SS) (Hump Yard)

SS Setting	Commanded Speed
STOP	STOP
COAST	COAST
HUMP 1	1.0 m.p.h. (typical)
HUMP 2	1.2 m.p.h. (typical)
HUMP 3	1.5 m.p.h. (typical)
4	4.0 m.p.h. (typical)
8	8.0 m.p.h. (typical)
MAX	13 m.p.h. (typical)

The LCU receives commands from the OCU and releases the locomotive brakes, sets the commanded direction, and enters the Speed Control mode. The LCU rings the Bell for 3 seconds and then the LCU increases the throttle and generator excitation until the train starts moving. The throttle and excitation are then continually adjusted, as required, to maintain the commanded speed.

The operator may increase or decrease the set speed using the SS on the OCU. The LCU will then increase / decrease throttle and excitation as required to adjust the speed for the new command speed.

If the speed increases above the point where decreasing the throttle and excitation cannot reduce the speed, then the LCU will automatically apply independent brakes.

While in Speed Control mode if the commanded brake application exceeds the predefined limit or the speed limit is exceeded with excessive independent or automatic brake application, the LCU will declare a **Drag Brake Warning** and alert the operator via the OCU alarm display.

To exit Speed Control mode, the operator moves the Speed Selector (SS) to the **STOP** position on the OCU. Upon receipt of the **STOP** command the LCU speed control will set the command speed to zero m.p.h. set the throttle to idle, and set the locomotive brake to full.

3.5.3.4 Headlight Control

The LCU automatically controls the locomotive headlights based on the OCU commanded brightness level and the direction of movement of the locomotive. The default setting for the headlights upon linking is DIM.

The operator momentarily presses and releases the Manual Headlight (MHL) switch on the OCU to change the locomotive headlights to **OFF**, **DIM**, or **BRIGHT**. Each time the operator presses the MHL button the intensity will step to the next level of intensity and then wrap around back to **OFF**. The locomotive front and rear headlights will be controlled in intensity as shown in Table 3.5.3.4-1:

Table 3.5.3.4-1 Headlight Control

Light Intensity Command	Direction	Front Light Of Consist	Rear Light Of Consist
Off	N/A	Off	Off
Dim	F, R, N	Dim	Dim
Bright	F	Bright	Dim
	N	Dim	Dim
	R	Dim	Bright

Note – Bright Headlight control is only enabled when a direction is selected.

3.5.3.5 Horn / Bell Control

The RCL system provides control of the locomotive bell and horn. The Bell and Horn can manually be controlled by using the OCU. In addition, the LCU automatically activates the Bell when commanded by AEI Tags.

When the locomotive enters Speed mode the LCU automatically activates the locomotive Bell for 3 seconds before the locomotive is moved.

The locomotive bell can be activated by moving the Bell and Horn Switch (BHS) to the **BELL** position on the OCU. The BELL status indicator illuminates as long as the bell is active on the locomotive. To de-activate the bell, the operator returns the BHS to the **OFF** position.

With the BHS in the **BELL** position, the operator activates the locomotive horn by moving the BHS to the **HORN/ BELL** position on the OCU. The LCU keeps both the locomotive bell and horn activated as long as the BHS is in the **HORN/ BELL** position. The BELL/HORN status indicator illuminates as long as the bell and horn are active on the locomotive. Releasing the BHS returns it to the **BELL** position and the LCU will continue to keep the locomotive bell activated. The bell and horn can be activated by either the Primary or Secondary OCU.

3.5.3.6 Sand Control

The OCU provides the operator with the capability to activate the manual sanders on the locomotives. If the LR or RR actuator is pressed and held for 5 seconds or more, the OCU will send a sand command to the LCU. When the LCU receives the sand command it activates the locomotive sanders in the direction of travel (or the last selected direction) for 30 seconds. Each additional press and hold of the LR or RR actuator for 5 seconds resets the LCU sand timer to 30 seconds.

The OCU display will momentarily indicate manual sanding is active.

The OCU will also display **Sustained Wheel Slip** when the wheel slip trainline is active 5 at least 5 seconds, as an indication that the operator may want to apply the manual sanders.

3.5.3.7 Electrical Function Interlocks

To ensure the RCL system operates safely, interlocks are provided to prevent improper and invalid operation. A complete fault list is provided in Appendix A.

1. The LCU will command the locomotive to the *Park* State if the PC train line is activated.
2. The LCU will command the locomotive to the *Park* State if the locomotive speed exceeds the set speed by 13 m.p.h. for 5 seconds.
3. The LCU will command the locomotive to the *Park* State if the locomotive speed does not increase above 0 m.p.h. within 15 seconds of commanding speed.
4. For Speed operation one and only one direction must be sensed at the LCU. If the proper direction is not detected the LCU puts the locomotive in the *Park* State.
5. Emergency brake applications force the locomotive immediately to Idle.

6. During Speed Control operation, only valid throttle steps are allowed. Invalid throttle steps detected by the LCU puts the locomotive in the *Park State*.
7. Loss of communications between the LCU and the SCU causes the LCU to put the locomotive in the *Park State*.

3.6 Special Operating Features

The RCL system provides special features to aid and enhance operational effectiveness.

3.6.1 Pitch and Catch

The OCU allows the primary operator to transfer (*Pitch*) control of the locomotive to one other previously linked operator (*Catch*). The RCL locomotive must be stopped with at least 25 psi brake cylinder pressure and not in Emergency for control to be pitched.

To transfer control of the LCU from one operator to another using the Pitch and Catch function, both operators must be linked to the same LCU. The 2 operators then use their respective OCUs to perform the following steps:

1. The primary operator (A) stops the locomotive and sets the independent brakes with a brake cylinder pressure greater than 25 psi.
2. The primary operator (A) requests a *Pitch* operation by pressing the **PCC/LNK** button on their OCU. (if the Primary operator does not receive catch confirmation from the secondary operator within 10 seconds, the audible alarm sounds and a **PITCH FAILED** message is displayed. The primary OCU (A) remains in control of the LCU.)
3. The Secondary operator (B) receives an audible signal and a *Catch* request on the OCU display. The secondary operator (B) then presses the **PCC/LNK** button on the OCU to accept the catch. (if the secondary operator does not receive catch confirmation from the primary operator within 10 seconds, the audible alarm sounds and a **PITCH FAILED** message is displayed. The primary OCU (A) remains in control of the LCU.)
4. The primary operator (A) receives an audible signal and a **Catcher Ready** on the OCU display. The Primary operator (A) again presses the **PCC** actuator on the OCU to confirm the pitch.
5. The LCU then reassigns the primary operator as **B** and the secondary operator as **A**. The primary operator will have its **Controlling OCU** LED on.
6. The Automatic Brake settings and Headlight control settings are automatically transferred to the new Primary OCU when the pitch and catch is successfully completed.

3.6.2 Sleep Mode

The Primary or Secondary OCU can go into Sleep mode. Sleep mode leaves the RCL system linked and puts the locomotive into *Safe State* (only for primary OCU going into Sleep mode) for up to 90 minutes. After 90 minutes, the system will automatically unlink and go into Standby mode after 90 additional seconds.

To put the system into Sleep mode, power down the primary and/or secondary OCU and follow the directions on the OCU for entering Sleep mode. The OCU will confirm Sleep mode before shutting down and the OCU #1 (#2) linked LED will flash on the SCU.

To go back to RCL mode, power on the OCU using the **PWR** button within 90 minutes from going into Sleep mode. The OCU will display the locomotive number it is linked to and resume RCL operations as long as it was in communication range.

If a third OCU links up to the RCL system while the other OCU's are asleep, the new OCU will be the primary and the other OCU's will automatically be unlinked.

3.6.3 Yard Containment

The RCL system provides methods to detect specified yard boundaries, stop locomotive movement automatically when boundary limits are exceeded, and restrict locomotive speed on specific yard tracks and pullback tracks. Two independent methods are used (Figure 3.3.3-1) for yard containment: Automatic Equipment Identification (AEI) tag readers and Global Positioning System (GPS).

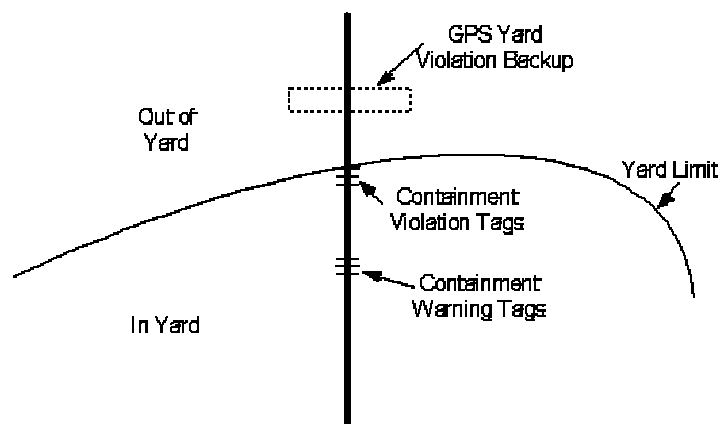


Figure 3.6.3-1 Yard Containment

3.6.4 AEI Tag Reader

The AEI tags are used to enforce yard containment, set temporary speed restrictions for various segments of tracks, activate pullback control of the locomotive for hump yard operations, provide warning of movement out of an operational area, and sound the horn and/or bell automatically.

3.6.4.1 Yard Containment

Yard containment tags are used to limit the RCL controlled locomotive from leaving the yard.

There are two types of yard containment tags. The first type is the *Containment Warning Tags*, which provide a warning to the OCU operator that the yard limit is about to be exceeded. It does not restrict the speed or stop the locomotive. These are mounted on the inside of the second type, which are the *Containment Violation Tags*. These are the actual

yard containment tags, which will cause the LCU to bring the locomotive to a stop (Park State) and applying a Full service independent and automatic brake application.

3.6.4.2 Speed Restrictions

Speed Restriction tags can be used to restrict the speed of the locomotive through sections of track. This allows the yard personnel to set speed restrictions. The LCU will restrict the OCU commanded speed when these tags are read (if they are more restrictive). When Speed restrictions are in force, the operator will be notified by a **Speed Restriction** message on the OCU display.

3.6.4.3 Pullback Control

Pullback control limits the speed of the locomotive as it moves back on the pullback track (Figure 3.6.4.3-1).

The following outlines the Pullback control operation:

1. Set the speed on the OCU for the locomotive to travel down the pullback track.
2. As the RCL locomotive enters the pullback area, it crosses the *Start Pullback Tag*. You will receive confirmation on the OCU display, **Pullback On: GPS OK**.
3. The AEI tags will then limit the speed of the locomotive as it moves back on the track.
4. The operator can further limit the speed of the locomotive if needed.
5. When the end of the Pullback track is reached, the locomotive crosses the *End of Pullback Tag* and the locomotive stops. The operator will now receive an **End of Pullback Track** message on the OCU display.
6. Change the locomotive direction and command speed.
7. The RCL system then disables Pullback Control and notifies the operator by removing the **Pullback On: GPS OK** message from the OCU display.
8. The OCU operator controls the locomotive back down the Pullback track in the opposite direction. As the locomotive moves towards the hump yard under operator control, the AEI tags do not limit speed.
9. When pullback control is disabled and the locomotive is moving out of the pullback track, if a Tag has not been crossed, then anytime the direction of travel changes back to the direction when it was enabled, the pullback control re-enables itself. After the locomotive crosses a tag, then the Pullback function remains disabled until the locomotive crosses another tag while traveling into the Pull Back track direction.

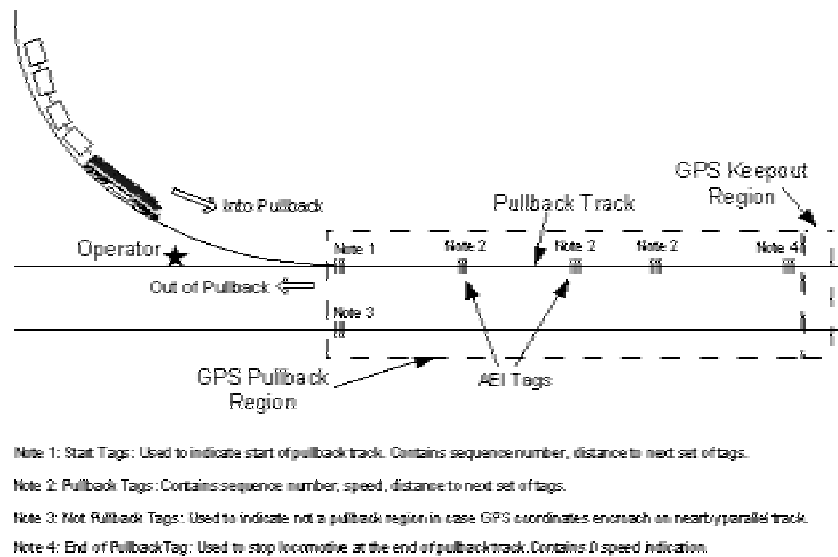


Figure 3.6.4.3-1 Pullback Control

3.6.4.4 Bell and Horn

Bell and Horn tags can be used to automatically sound that the horn or bell. These tags are placed at crossings in the yard, or in places where they are normally sounded.

3.6.5 GPS

The Global Positioning System (GPS) containment system provides a backup to the AEI tag system. Whenever the GPS system determines that the locomotive has entered a particular region (either yard limit area or pullback protection area), and no tags are seen within a set distance, it sends the appropriate message to the OCU and/or stops the train.

There are two types of GPS containment which are for keep-out areas within a yard and leaving a yard. When the GPS detects that the locomotive is out of the yard, the LCU will command the locomotive to come to a stop and wait for the operator to acknowledge the violation. The operator may have to board the locomotive (or optionally use the OCU) to acknowledge the fault and continue operation in the same direction. Movement, however, in the opposite direction of travel will be allowed and the GPS system waits until the locomotive re-enters the yard limits before re-arming the GPS again. This allows the operator to stop only once for a given containment violation.

The second type of GPS containment is for entering the pullback protection area. If the GPS indicates that the locomotive is in a pullback protection area and a pullback control tag has not been seen, a GPS pullback fault is declared and the locomotive is stopped. Movement in the opposite direction of travel is allowed after acknowledging the fault in the *Park State*.

If GPS becomes invalid, the locomotive will only be allowed to move a certain distance until a GPS Invalid *Park State* fault will occur.

3.6.6 Vigilance

The OCU is equipped with a Vigilance system. Whenever any speed selector on the primary OCU is out of STOP, a 60 second timer is started. If any OCU control has not been changed, or the vigilance reset function has not been activated for 60 seconds, the OCU sends a **PARK** command to the LCU, idles the locomotive and applies brakes. If a control vigilance reset has not been activated for 50 seconds, the OCU emits an audible alarm notifying. The operator that the locomotive will be commanded to the *Park* State in 10 seconds. When the vigilance audible alarm is heard, the operator must reset the vigilance timer. If the OCU Speed selector is commanding STOP, then Vigilance is disabled.

Test the vigilance system by placing the Speed Selector (SS) on the OCU in the **Coast** position. The train brakes should be set to prevent movement. The operator then lets the vigilance timer time out and verifies that the locomotive transitions to the *Park* State.

3.6.7 Fault Reporting

Fault reporting is provided to keep the system in a *safe* state, warn the operator of system abnormalities, and log events. Fault data is displayed on the OCU and the SCU.

OCU faults and critical LCU and locomotive faults are reported through the OCU display and audible alarm. The highest priority fault condition that is active in the LCU is displayed on the OCU until the fault is cleared. In addition, when the LCU has a restriction in effect that prevents it from honoring a command request from the OCU, it sends information back to the OCU so the OCU can provide an alert and display the reason the request is not being honored.

Detailed fault information is displayed on the SCU display in the locomotive for the Operator or Maintenance personnel. A complete listing of faults and the system reaction is provided in Appendix A.

3.6.8 Operator Down

The OCU provides the capability to detect an *operator down* situation. The OCU is equipped with a tilt sensor, which detects when the OCU is tilted beyond 45 degrees from the horizontal plane and if so, sounds an audible warning alarm for 5 seconds and the display indicates **OCU Tilted > 45 deg. Place OCU Upright**. If the OCU is not brought back within 40 degrees during those 5 seconds, the OCU displays **Primary Operator Down, Place Ind Brk in Emergency**, sounds a continuous high-level audible warning, and transmits a warning to the LCU. When the LCU receives this Operator Down command, it puts the train in the *Safe* state. If the OCU is not righted after 10 seconds uses the RCL system transmits a 9-1-1 tone followed by a **Locomotive xxxx, Operator Down** voice message over the locomotive voice radio. If the OCU tilt is corrected within the 10 seconds, the voice message is not transmitted. If a Secondary OCU is linked, the operator down function is active on both OCUs and functions the same. When an operator down is detected, both OCUs will display the alarm message with initiating OCU identified.

Recognizing that there are times when the operator may need to tilt the OCU during normal operations, a tilt by-pass feature is included which allows the operator to intentionally delay the operator down tilt sensing if the train is stopped. When the TOR actuator is pressed and released with the OCU in a non-tilted orientation, the OCU starts a 60 second tilt by-pass

timer and preempts the normal tilt/operator down process. The Tilt O/R indicator flashes and the display indicates **Tilt Override Active, Timer Set to 60 Sec.** If the OCU is in the tilted state when the tilt by-pass timer reaches 50 seconds, the OCU will output the audible operator alert that the tilt by-pass timer is about to expire and display **Tilt O/R Expiring, Press Tilt O/R Again.** If the operator press the TOR actuator any time during the 60-second tilt by-pass time, the OCU restarts the timer. Pressing any other button or actuator on the OCU cancels the Tilt Override timer. The timer extension at is only 15 seconds while the SS is out of STOP, with no extension allowed at MAX speed.

If the OCU is tilted and the 60-second tilt by-pass timer expires, the OCU will display **Operator Down, Put OCU Upright**, exit the tilt by-pass state, then display **OCU Tilted > 45 Deg, Place OCU Upright.** If the OCU is not righted, then the OCU transmits an **Operator Down** warning to the LCU and continuously sounds the high level audible warning. If not corrected within 10 seconds, then the SCU transmits the *operator down message*. If the OCU is not tilted and the 60-second tilt by-pass timer expires, the OCU will exit the tilt by-pass state and resume normal tilt sensing.

For Test purposes, if the TOR is pressed and continuously held while the OCU is tilted, it enters the Tilt Test Override mode. A ten second timer is started and normal tilt sensing is enabled except that the OCU transmits a Tilt Test Override message to the LCU at the 3-second timeout. If the tilt test override timer reaches 10 seconds, the OCU transmits a normal **Operator Down** message to the LCU.

3.6.9 Communication Loss

The RCL system continually performs communications checks. These checks are performed by both the OCU and the LCU. If a check is unsuccessful, the following functions occur:

1. Loss of communications from the controlling OCU to the LCU for more than 5 seconds forces the LCU to go to the *Park* State (10 seconds if the loco is stopped). Likewise, if the communications from the OCU to the LCU is lost for 35 seconds, the OCU commands the LCU to go to the *Safe* State. The operator will be alerted to the communication loss by an audible alarm and a **Primary Comm Loss** message on the OCU display. In addition, the LCU indicates the communication loss by sending a communication loss message to SCU where the SCU illuminates the **Primary OCU radio Comm** LED on the LED status indicators and displays the **Communication Loss with Primary OCU** message on the display.
2. Loss of communications from the controlling OCU to the LCU for 5 minutes forces the LCU to go to the *Setup* State and the OCU will automatically be unlinked.
3. Loss of communications from the secondary OCU to the LCU for more than 10 seconds causes the LCU to send a secondary OCU Communication loss message to SCU and forces the LCU to go to *Park* State. After 5 minutes of sustained Comm Loss, the OCU will be unlinked.

3.6.10 Battery Monitor

The OCU is powered by 1 rechargeable battery. The operator will be provided the estimated number of minutes of charge remaining on the batteries on the OCU status

display. The operator receives notification via the OCU display when the battery charge calls to 60 minutes, 45 minutes, 30 minutes, 15 minutes, 10 minutes and 5 minutes.

3.7 Event Recorder

The RCL system contains a Event Recorder System. These include the recording of event data, transferring of data to the display unit, the previewing of data and the printing of data. Event Recorder is covered under the service manual.

Appendix A – System Faults

Event Code	Event Name	Cause	LCU Action	SCU Operator Notification	OCU Notification	OCU Audible	Recovery
1	LCU power-up or WDT	• LCU Power Up OR • Reset	• Go To Init State	N/A	N/A	N/A	N/A
2	Emergency command received from Primary OCU	• Pri. OCU Emergency Command	• Safe State • Send Msg to SCU	“Primary Operator Emergency”	“Primary Oper Emer” (Based on status from LCU)	3 Chimes	• Safe State Recovery
3	Emergency command received from Secondary OCU	• Sec. OCU Emergency Command	• Safe State • Send Msg to SCU	“Secondary Operator Emergency”	“Secondary Oper Emer” (Based on status from LCU)	3 Chimes	• Safe State Recovery • Secondary OCU IBS not in Emergency
4	Emergency command received from Stop Switch	• Stop Switch Pressed	• Safe State • Send Msg to SCU	“Stop Switch Emergency”	“Stop Switch Emer” (Based on status from LCU)	3 Chimes	• Stop Switch Released • Safe State Recovery
5	Low brake pipe pressure	• BP drops below 45psi (edge triggered) AND • Not (Dir Centered AND BC > 25psi)	• Safe State • Send Event to OCU • Send Msg to SCU	“Low BP Emergency”	“Low Brake Pipe Press”	3 Chimes	• BP Pressure > 60 psi • Safe State Recovery

Event Code	Event Name	Cause	LCU Action	SCU Operator Notification	OCU Notification	OCU Audible	Recovery
6	Brake pipe rise emergency	• BP Rise of 2 psi for 2 seconds AND • Not Released AND - Dir Centered AND • BC>25psi	• Safe State • Send Event to OCU • Send Msg to SCU	“Brake Pipe Rise Emergency”	“Brake Pipe Rise Emer”	3 Chimes	• Safe State Recovery
7	Pitch and Catch Completed	• Secondary OCU becomes Primary OCU	• Make Secondary OCU the Primary OCU	None	”Pitching... Pitch Successful”	2 Chime	N/A
8	Train separation	Low BP Event # 5 AND BV Out detected within 5 seconds	• Safe State • Send Event to OCU • Send Msg to SCU	“Brake Pipe Emergency”	“Brake Pipe Emer”	3 Chimes	• Safe State Recovery • BP > 60 psi
9	OCU-LCU Incompatible	• OCU fails to link due to SW Incompatibility	• Do Not Allow Link • Send Link Fail to OCU • Send Msg to SCU	“OCU/LCU SW Incompatible”	“OCU/LCU SW Incompat” (Based on Link Fail)	3 Chimes	• Restart Linking Process

Event Code	Event Name	Cause	LCU Action	SCU Operator Notification	OCU Notification	OCU Audible	Recovery
10	EQR loop-back error	• When release is commanded, if EQR status does not rise > 4.0 psi within 2 seconds. - OR • When brake application is commanded at > 45 psi, EQR is not within +/- 4.0 psi of Target EQR for more than 2 seconds or closing on the Target value at a rate of <1 psi/sec for more than 2 seconds.	• Safe State • Send Event to OCU • Send Msg to SCU	“EQR Loopback Error”	“RCL System Fault 10”	3 Chimes	• Commanded EQR is within 1.5 psi of EQR status for 30 seconds • Safe State Recovery
11	MAC Duplication Sensed	LCU receives link command w/ same MAC address	• Send Link Fail Reply to OCU • Send Msg to SCU	“OCU Link Fail”	N/A	2 Chimes	N/A

Event Code	Event Name	Cause	LCU Action	SCU Operator Notification	OCU Notification	OCU Audible	Recovery
12	Transition to Standby	• 90 seconds after entering Setup State	• Send Msg to SCU • Close Emerg mag valves • Upon detection of BP > 65 psi for 2 seconds, release Independent brakes	“Standby Mode”	N/A	N/A	• Receipt of OCU Link request • Upon detection of any Fault, reverts to Init. State
13	Momentary Primary OCU Comm Loss (>5 Sec.)	• LCU does not receive LCU Command message from Primary OCU for 5 seconds if moving (>0.2mph), up to 10 seconds if not moving (<= 0.2mph).	• Park State • Send Event to OCU • Send Msg to SCU • Stop Bell and Horn • Flash SCU LED: ‘Primary OCU Comm Loss’	“Primary OCU Momentary Comm Loss”	“Primary OCU CommLoss”	2 Chimes	• Comm Restored • Park State Recovery
14	Not Used						

Event Code	Event Name	Cause	LCU Action	SCU Operator Notification	OCU Notification	OCU Audible	Recovery
15	Linked with Primary OCU <ID#>	• Primary OCU Link Successful	• Ready State • Send Msg to SCU • Turn on SCU LED: 'OCU #1 Linked'	N/A	"Linked to Loco" "Loco ID: xxxx"	2 Chime	• Power Up Emergency Recovery
16	Linked with Secondary OCU <ID#>	• Secondary OCU Link Successful	• Send Msg to SCU • Turn on SCU LED: 'OCU #2 Linked'	N/A	"Linked to Loco" "Loco ID: xxxx"	2 Chime	• Power Up Emergency Recovery
17	Unlinked With Secondary OCU	• Power Down of Secondary OCU	• Send Event to OCU • Send Msg to SCU • Turn off SCU LED: 'OCU #2 Linked'	N/A	"Secondary OCU Unlink"	2 Chime	N/A

Event Code	Event Name	Cause	LCU Action	SCU Operator Notification	OCU Notification	OCU Audible	Recovery
18	Unlinked (Primary and Secondary)	• Power Down of Primary OCU	• Setup State • Send Msg to SCU • Turn off SCU LEDs: 'OCU #1 Linked' and 'OCU #2 Linked'	N/A	N/A	2 Chime	• Link • Transition to Ready State
19	PCS Open	• PCS detected Open	• Send Msg to SCU • Force Locomotive to Idle	"PCS Open"	N/A	2 Chimes	• PCS Closed
20	Extended Primary OCU communication loss (>5 min.)	• LCU does not receive message from Primary OCU for > 5 minutes	• Send Unlink Command to Pri. and Sec. OCU • Send Msg to SCU • Unlink • Go to Set Up State • Turn on SCU LED 'Primary OCU Comm Loss'	N/A	"Commanded Unlink"	3 Chimes	• Link • Emergency Recovery

Event Code	Event Name	Cause	LCU Action	SCU Operator Notification	OCU Notification	OCU Audible	Recovery
21	Over Speed	• Actual Speed > configured max speed (<=20 mph) for > 5 seconds.	• Park State • Send Event to OCU • Send Msg to SCU	“Loco Overspeed Fault”	“Loco Overspeed”	2 Chimes	• Park State Recovery
22	SCU/LCU Comm Loss	• LCU does not receive message from SCU for 5 seconds	• Park State • Send Event to OCU • Send Msg to SCU	“Lost LCU...Retrying”	“RCL System Fault 22”	2 Chimes	• Comm Restored • Park State Recovery
23	Brake handle movement	• While MR is > 110 psi (configurable), if switch pipe has 0 pressure for > 60 seconds.	• Park State • Send Event to OCU • Send Msg to SCU	“BV Handle Not In Release”	“RCL System Fault 23”	2 Chimes	• Auto Brake Handle in Release • Park State Recovery
24	Primary OCU Commanded Vigilance Timeout	• Vigilance Fault From Primary OCU	• Park State • Send Event to OCU • Send Msg to SCU	“Vigilance Fault”	“Vigilance Fault”	2 Chimes	• Park State Recovery

Event Code	Event Name	Cause	LCU Action	SCU Operator Notification	OCU Notification	OCU Audible	Recovery
25	Yard Containment Violation - AEI tag	• Detection of Yard Containment Violation AEI tags with increasing sequence numbers	• Park State • Send Event to OCU • Send Msg to SCU	"Yard Containment Violation"	"Yard Containment"	2 Chimes	• Optionally, operator perform SCU action onboard loco • Park State Recovery
26	Yard Containment Warning – AEI tag	• Detection of Yard Containment Warning AEI tags with increasing sequence numbers	• Send as Status to OCU • Send Msg to SCU	"Yard Limit Warning Press 1 to Override"	"Yard Limit Warning"	2 Chime	• Occurrence of Event #25 or #74 Yard Containment Violation OR • Detection of Yard Containment Warning tags with decreasing sequence numbers OR • Occurrence of Event #103

Event Code	Event Name	Cause	LCU Action	SCU Operator Notification	OCU Notification	OCU Audible	Recovery
27	Operator Down Primary	• Primary OCU Tilted for >5 Sec w/ No TOR	• Safe State • Send Event to OCU • Send Msg to SCU • Transmit 'Operator Down' Talker msg	"Primary Operator Down"	"Primary Oper Down"	3 Chimes	• Primary OCU Not Tilted • Safe State Recovery
28	Operator Down Secondary	• Secondary OCU Tilted for >5 Sec w/ No TOR	• Safe State • Send Event to OCU • Send Msg to SCU • Transmit 'Operator Down' Talker msg	"Secondary Operator Down"	"Secondary Oper Down"	3 Chimes	• Secondary OCU Not Tilted • Secondary OCU IBS command to Emergency then out of Emergency • Safe State Recovery
29	Radio Test Fail Primary OCU Link	• No Receipt of Radio Test Message after 3 retries (4 seconds total)	• Send Msg to SCU	"Pri.OCU Radio Test Fail"	N/A	N/A	• Re-link Attempt successful
30	Radio Test Fail Secondary OCU Link	• No Receipt of Radio Test Message after 3 retries (4 seconds total)	• Send Msg to SCU	"Sec.OCU Radio Test Fail"	N/A	N/A	• Re-link Attempt successful

Event Code	Event Name	Cause	LCU Action	SCU Operator Notification	OCU Notification	OCU Audible	Recovery
31	Wheel Diameter Entered	• LCU Receives New Wheel Diameter via SCU Keypad Entry		N/A	N/A	N/A	N/A
32	Single Axle Generator Direction Fault (see also #77 Status message)	• While speed > 0.2 mph : One Axle Generator Indicates Forward and Reverse at same time - OR - One Axle Generator Indicates neither Forward or Reverse	• Park State • Send Event to OCU • Send Msg to SCU	“Axle Generator Fault”	“Axle Generator Fault”	2 Chimes	• Park State Recovery
33	Transition to Setup State	• LCU Transitions to Setup State	N/A	N/A	N/A	N/A	N/A
34	Transition to Ready State	• LCU Transitions to Ready State	N/A	N/A	N/A	N/A	N/A
35	Pitch and Catch Failed	• Primary OCU fails to Pitch to Secondary OCU		N/A	”Pitch/Catch Aborted”	3 Chimes	N/A
36	Self Test Fail	• LCU Fails Self Test	• Send Msg to SCU	“Self Test Failed”	N/A	N/A	N/A

Event Code	Event Name	Cause	LCU Action	SCU Operator Notification	OCU Notification	OCU Audible	Recovery
37	LCU Radio Fail	• No LCU Comm with Radio OR • Radio does not reply with requested frequency	• Stay in Init State	“LCU Radio Fail”	N/A	N/A	• Radio Comm Established OR • Correct frequency reply
38	Stop Failure - Safe	• Loco Speed >.5 mph while in STOP, configured Stop Fault – Park (#93) time + 30 seconds	• Safe State • Send Event to OCU • Send Msg to SCU	“Loco Stop Failure”	“Loco Stop Failure”	3 Chimes	• Loco Speed = Not Moving • Safe State Recovery
39	EMV Pneumatic Test Fail	• If, while commanding the EMV valve open, BP pressure does not drop 1 psi from its peak value within 15 seconds of the valve being commanded open.	• Safe State • Send Event to OCU • Send Msg to SCU	“EMV Test Fail”	“EMV Test Fail”	3 Chimes	• Pass Test • Safe State Recovery

Event Code	Event Name	Cause	LCU Action	SCU Operator Notification	OCU Notification	OCU Audible	Recovery
40	Low main reservoir pressure alarm	• If not in Charge, Main Reservoir Pressure < 900psi (configurable) for 5 seconds <u>OR</u> • While in Charge, MR pressure < 50psi for 5 seconds	• Safe State • Send Event to OCU • Send Msg to SCU	“Low MR Fault”	“Low MR Fault”	3 Chimes	• MR >110 psi (default) for 5 seconds • Safe State Recovery
41	Speed control stall / no output from speed sensor	• If, while in Traction/Speed Mode, the input speed is < 0.15 mph for 15 seconds.	• Park State • Send Event to OCU • Send Msg to SCU	“Invalid Or No Speed Input”	“Stall Fault”	2 Chimes	• Valid Speed Input • Park State Recovery
42	Speed mode fault	• SSE Trainline in Wrong State	• Park State • Send Event to OCU • Send Msg to SCU	“Speed Mode Fault”	“RCL System Fault 42”	2 Chimes	• Valid SSE Trainline • Park State Recovery

Event Code	Event Name	Cause	LCU Action	SCU Operator Notification	OCU Notification	OCU Audible	Recovery
43	AEI tag Speed Restriction	OCU commanded Speed > Restriction Speed Limit, while inside AEI tag restricted section (other than pullback)	• Limit locomotive Speed to Restriction Speed • Send as Status to OCU • Send Msg to SCU	N/A	“AEI SpeedRestriction”	2 Chimes	• Speed Command < Restriction Speed Limit OR Restriction Lifted via AEI tag
44	Brake valve in/out miscompare	• Brake Valve Status Does Not Match Expected BV State	• Safe State • Send Event to OCU • Send Msg to SCU	“Auto BV Cutout”	“RCL System Fault 44”	3 Chimes	• Brake Valve Status Matches Expected BV • Safe State Recovery
45	Range Error: DBC/Excitation Volts input	• DBC/Excitation < 0 Volts or > 52 Volts	• Park State • Send Event to OCU • Send Msg to SCU	“Excitation Input Error”	“RCL System Fault 45”	2 Chimes	• DBC/Excitation => 0 Volts and <= 50 Volts • Park State Recovery
46	Cycle Braking	• Second train brake application with brake pipe not fully charged.	• Safe State • Send Event to OCU • Send Msg to SCU	“Cycle Brake “	“Cycle Braking”	3 Chimes	• Safe State Recovery

Event Code	Event Name	Cause	LCU Action	SCU Operator Notification	OCU Notification	OCU Audible	Recovery
47	Range Error: EQR pressure transducer	• Over/Under Range Bit Set	• Park State • Send Event to OCU • Send Msg to SCU	“EQR Transducer Fail”	“RCL System Fault 47”	2 Chimes	• Over/Under Range Bit Cleared • Park State Recovery
48	Range Error: Main reservoir pressure transducer	• Over/Under Range Bit Set	• Park State • Send Event to OCU • Send Msg to SCU	“Main Reservoir Transducer Fail”	“RCL System Fault 48”	2 Chimes	• Over/Under Range Bit Cleared • Park State Recovery
49	Range Error: Brake pipe pressure transducer	• Over/Under Range Bit Set	• Park State • Send Event to OCU • Send Msg to SCU	“Brake Pipe Transducer Fail”	“RCL System Fault 49”	2 Chimes	• Over/Under Range Bit Cleared • Park State Recovery
50	Range Error: Brake cylinder pressure transducer	• Over/Under Range Bit Set	• Park State • Send Event to OCU • Send Msg to SCU	“Brake Cylinder Transducer Fail”	“RCL System Fault 50”	2 Chimes	• Over/Under Range Bit Cleared • Park State Recovery

Event Code	Event Name	Cause	LCU Action	SCU Operator Notification	OCU Notification	OCU Audible	Recovery
51	Failure of power interlock relay PIR	• PIR Feedback High When PIR De-energized - OR • PIR Feedback Low When PIR Energized	• Park State • Send Event to OCU • Send Msg to SCU	“PIR Failure”	“RCL System Fault 51”	2 Chimes	• PIR Feedback High When PIR Energized or Low When PIR De-energized • Park State Recovery
52	Backup emergency valve electrical test fail	• EMV Feedback Wrong	• Safe State • Send Event to OCU • Send Msg to SCU	“Backup Emergency Valve Fail”	“RCL System Fault 52”	3 Chimes	• Backup EMV Status Correct • Safe State Recovery
53	Speed excitation output miscompare	• While SSE in ON, commanded excitation differs from TL monitor feedback by > 2.0 Volts for >3 secs - OR • If no change is detected in TL status for a sustained 3 seconds, when being commanded to change.	• Park State • Send Event to OCU • Send Msg to SCU	“Speed Excitation Error”	“RCL System Fault 53”	2 Chimes	• Commanded excitation differs from excitation feedback by < .3 Volts for >5 secs • Park State Recovery

Event Code	Event Name	Cause	LCU Action	SCU Operator Notification	OCU Notification	OCU Audible	Recovery
54	Direction output miscompare / invalid direction inputs	• Commanded Direction Differs From TL status or Invalid for >5 seconds	• Park State • Send Event to OCU • Send Msg to SCU	“TL Direction Miscompare”	“TL Direction Miscompare”	2 Chimes	• Commanded Direction Same As TL status for >5 sec. • Park State Recovery
55	Traction step output miscompare / invalid step inputs	• Traction Step Miscompare or Invalid for >5 seconds	• Park State • Send Event to OCU • Send Msg to SCU	“TL ABCD Error”	“TL ABCD”	2 Chimes	• Commanded Traction Step equals Traction Step Status for > 5 sec. • Park State Recovery
56	Brake cylinder pressure control error	• Commanded BC Pressure Differs From BC Pressure status by > 5 psi for >30 seconds	• Park State • Send Event to OCU • Send Msg to SCU	“Brake Cylinder Pressure Error”	“RCL System Fault 56”	2 Chimes	• Commanded BC Pressure Differs From BC Pressure status by < 3 psi for >5 sec. • Park State Recovery
57	Throttle mode output miscompare / invalid mode inputs	• Throttle Mode Miscompare OR • Throttle Mode Invalid for >5 seconds (GF)	• Park State • Send Event to OCU • Send Msg to SCU	“TL GF Error”	“TL GF”	2 Chimes	• Commanded Throttle Mode equals Throttle Mode Status for > 5 sec. • Park State Recovery

Event Code	Event Name	Cause	LCU Action	SCU Operator Notification	OCU Notification	OCU Audible	Recovery
58	No Relay TL power	• Relay Power Input Low	• Safe State • Send Event to OCU • Send Msg to SCU	“No Relay Power”	“RCL System Fault 58”	3 Chimes	• Relay Power Input High • Park State Recovery
59	Sustained wheel slip	• Wheel Slip Train Line Active for > 5 seconds	• Send as Status to OCU • Send Msg to SCU	“Sustained Wheel Slip”	“Sustained Wheel Slip”	2 Chimes	• Wheel Slip Trainline Goes Inactive
60	Drag Brake Warning	• Brake applied is too much for requested speed.	• Send as Status to OCU • Send Msg to SCU	“Drag Brake Warning”	“Drag Brake Warning”	2 Chimes	• Occurrence of Event #62 OR • Operator commanded Auto Brake release.
61	Sustained Secondary OCU Comm Loss Fault (>10 sec.)	• LCU does not receive message from Secondary OCU for > 10 seconds	• Park State • Send Msg to SCU	“Secondary OCU Sustained Comm Loss”	“Secondary Comm Loss” (Based on LCU Status)	2 Chime	• Primary Recovery from Park State • OCU comm. restored OR OCU unlink after 5 minutes

Event Code	Event Name	Cause	LCU Action	SCU Operator Notification	OCU Notification	OCU Audible	Recovery
62	Drag Brake	• Brake applied is too much for requested speed and has not been corrected.	• Park State • Send Event to OCU • Send Msg to SCU	“Drag Brake Stop”	“Drag Brake Stop”	2 Chimes	• Park Recovery
63	Speed Increase While in Coast	• Failure to prevent overspeed during Coast or Coast B.	• Park State • Send Event to OCU • Send Msg to SCU	“Coast Mode Overspeed”	“Coast Mode Overspeed”	2 Chimes	• Park Recovery
64	Setup Emergency	• Enter Setup State	• Once Linked go to Safe State • Send Event to OCU • Send Msg to SCU	“Setup Emer”	“Setup Emer”	3 Chimes	• Linked to Primary OCU • Safe State Recovery

Event Code	Event Name	Cause	LCU Action	SCU Operator Notification	OCU Notification	OCU Audible	Recovery
65	BU EMV Pneumatic Test Fail	• If, while commanding the BU EMV valve open, BP pressure does not drop 1 psi from its peak value within 15 seconds of the valve being commanded open.	• Safe State • Send Event to OCU • Send Msg to SCU	"BU EMV Test Fail"	"EMV Test Fail"	3 Chimes	• Pass Test • Safe State Recovery
66	Extended Secondary OCU communication loss (>5 min.)	• LCU does not receive message from Secondary OCU for > 5 minutes	• Unlink Secondary OCU • Send Secondary OCU Link Request ADU to OCU w/ Secondary OCU unlink status • Send Msg to SCU	N/A	"Secondary OCU Unlink" "Pitch/Catch Not Avail"	1 Chime	N/A

Event Code	Event Name	Cause	LCU Action	SCU Operator Notification	OCU Notification	OCU Audible	Recovery
67	Speed Fault	• For Set Speeds <= 1.00 mph, if input speed is >+0.25 mph from Set Speed for > 60 secs. - OR • For Set Speeds > 1.00 mph, if input speed is >+ 20% from Set Speed for > 60 secs	• Park State • Send Event to OCU • Send Msg to SCU	“Speed Fault”	“Speed Fault”	2 Chimes	• Park Recovery
68	Invalid GPS position data	• No GPS detected from SCU.	• Send Msg to SCU	“GPS Invalid”	N/A		
69	Low main reservoir pressure warning	• Main Reservoir Pressure < 105 psi (default) for 5 seconds	• Send as Status to OCU • Send Msg to SCU	”Low MR Warning”	“Low MR Warning”	2 Chimes	• MR >110 psi (default) for 5 seconds
70	Locomotive Brake Cylinder Cutout	• BC Cutout status OR BC Pressure < 25 psi detected >10 seconds after commanding full independent brakes	• Park State • Send Event to OCU • Send Msg to SCU	“Locomotive Brake Cylinders Cutout”	“Loco BC Cutout”	2 Chimes	• Park Recovery

Event Code	Event Name	Cause	LCU Action	SCU Operator Notification	OCU Notification	OCU Audible	Recovery
71	AEI System fault	• AEI system error.	• Park State • Send Event to OCU • Send Msg to SCU	“AEI System Fault”	“AEI System Fault”	2 Chimes	• Park State Recovery
72	AEI Comm fault	• RFID Reader msg not received within 10 seconds from last message.	• Park State • Send Event to OCU • Send Msg to SCU	“AEI Comm Fault”	“AEI Comm Fault”	2 Chimes	• Park State Recovery
73	Pullback Control Active	• Detection of AEI pullback control tags with increasing sequence numbers sets status bit to ONE. • Detection of AEI pullback control tags with decreasing numbers sets status bit to ZERO.	• Send as status to OCU • Send Msg to SCU	”Pullback Control ON, Press 1 to Override”	“Pullback ON: GPS OK”	2 Chimes	• Movement in opposite direction - OR• Occurrence of Event #109

Event Code	Event Name	Cause	LCU Action	SCU Operator Notification	OCU Notification	OCU Audible	Recovery
74	GPS Yard Containment Violation	• Detection of Yard Containment Violation from GPS	• Park State • Send Event to OCU • Send Msg to SCU	“GPS Yard Containment Violation”	“GPS Yard Containment”	2 Chimes	• Park State Recovery • Optionally, operator perform SCU action onboard loco
75	Missed AEI tags on Pullback	• Failure to read next set of AEI tags within distance specified on previous tags.	• Park State • Send Event to OCU • Send Msg to SCU	“Missed AEI Pullback Tags”	“Missed AEI Tags”	2 Chimes	• Park State Recovery
76	Axle Generator Speed Miscompare	• When fastest speed < 1.0mph, difference is > .25 for 5 seconds - OR - Fastest speed > 1 mph, difference is > 20% for 5 seconds	• Park State • Send as status to OCU • Send Msg to SCU	“Axle Speed Fault”	“Axle Speed Fault”	2 Chimes	• Park State Recovery
77	Single Axle Generator Direction Error (see also #32 Fault)	• While speed > 0.2 mph, one of two Axle Generators report 00 or 11 for direction	• Send as status to OCU • Send Msg to SCU	“Axle Direction Error”	“Axle Dir Err”	2 Chimes	None; status only

Event Code	Event Name	Cause	LCU Action	SCU Operator Notification	OCU Notification	OCU Audible	Recovery
78	Dual Axle Generator Direction Fault	• While speed > 0.2 mph, both Axle Generators report 00 or 11 for direction OR two Axle Generators have different, but valid, direction states	• Park State • Send Event to OCU • Send Msg to SCU	“Dual Axle Direction Fault”	“Dual Axle Dir Fault”	2 Chimes	• Park State Recovery • Direction bits from both Axle Generators are valid and equal
79	Pullback Area Violation	• Detection of GPS defined Pullback area but no AEI tags detected within time or distance constraint	• Park State • Send Event to OCU • Send Msg to SCU	“GPS Pullback Area -No tags”	“Pullback-No AEI Tags”	2 Chimes	• Park State Recovery
80	EMV Test	• Upon first release of Train Brakes after linking, while EMV pneumatic tests.	• Send Event to OCU • Send Msg to SCU	“EMV Test in Progress”	“Consist Recovering”		• Completion of EMV pneumatic tests OR • Occurrence of Event # 39 or #65

Event Code	Event Name	Cause	LCU Action	SCU Operator Notification	OCU Notification	OCU Audible	Recovery
81	Primary Transition to Sleep	• Upon reception of a Sleep Command from the Primary OCU.	• Safe State • Send Event to OCU • Send Msg to SCU	“Primary Transition to Sleep”	on Secondary OCU, if linked but not in Sleep: “Primary OCU in Sleep”	N/A	• Accept a Sleep Relink Cmd within 90 min. • Relink to another Primary OCU • Transition to Standby Mode • Automatic Unlink after 90 min.
82	Locomotive Penalty Brake	• Upon detection of Penalty input at LCU	• Safe State • Send Event to OCU • Send Msg to SCU	“Airbrake Penalty, Recover at Cabstand”	“RCL System Fault 82”	N/A	• Detection of inactive Penalty input AND • Safe State Recovery
83	Alarm Trainline	• Upon detection of Trainline 2 – General Alarm active for > 5 seconds	• Send Event to OCU • Send Msg to SCU	”TL Alarm”	“TL Alarm”	N/A	• Upon detection of TL2 inactive for > 5 seconds
84	End of Pullback Track	• Upon detection of ‘End of Pullback’ AEI tags	• Park State • Send Event to OCU • Send Msg to SCU	“End of Pullback Reached”	“Stop-End of Pullback”	2 Chimes	• Park State Recovery

Event Code	Event Name	Cause	LCU Action	SCU Operator Notification	OCU Notification	OCU Audible	Recovery
85	Processor Clock Fault	• Upon detection of a 1 minute timer, based on processor clock, > +/- 5 seconds from a 1 minute time interval of GPS time, while GPS data is valid.	• Safe State • Send Event to OCU • Send Msg to SCU	"LCU Processor Failure"	"RCL System Fault 85"	3 Chimes	• Safe State Recovery • Fault inactive
86	Primary OCU Tilt Test not Run	• Upon linking Primary OCU until Operator conducts Tilt Test successfully	• Safe State • Send Event to OCU • Send Msg to SCU • Send Talker msg	"Primary Tilt Test Not Complete"	"Pri Tilt Test Needed"	N/A	• Safe State Recovery • Successful Completion of Tilt Test
87	Secondary OCU Tilt Test not Run	• Upon linking Secondary OCU until Operator conducts Tilt Test successfully	• Park State • Send Event to OCU • Send Msg to SCU • Send Talker msg	"Secondary Tilt Test Not Complete"	"Sec Tilt Test Needed"	N/A	• Park State Recovery • Successful Completion of Tilt Test

Event Code	Event Name	Cause	LCU Action	SCU Operator Notification	OCU Notification	OCU Audible	Recovery
88	Alternate Emergency Active	• Detection of active alternate Emergency in absence of OCU commanded Emergency	• Safe State • Send Event to OCU • Send Msg to SCU	“Alternate Emerg. Active”	“RCL System Fault 88”	3 Chimes	• Safe State Recovery • Alternate Emergency in correct state
89	Alternate Emergency Failed	• Alternate Emergency not active when OCU commanded Emergency received	• Safe State • Send Event to OCU • Send Msg to SCU	“Alternate Emerg. Failed”	“RCL System Fault 89”	3 Chimes	• Safe State Recovery • Alternate Emergency in correct state
90	Corrupt OCU Message Received	• Receipt of OCU msg:	• Safe State • Send Event to OCU • Send Msg to SCU	“Corrupt OCU Message Received”	“RCL System Fault 90”	N/A	• Safe State Recovery
91	Primary OCU Communications Test not Run	• Upon linking Primary OCU until Communications Test runs successfully	• Safe State • Send Event to OCU • Send Msg to SCU	“Primary Comm Test Not Complete”	“RCL System Fault 91”	N/A	• Safe State Recovery • Successful Completion of Communications Test

Event Code	Event Name	Cause	LCU Action	SCU Operator Notification	OCU Notification	OCU Audible	Recovery
92	Secondary OCU Communications Test not Run	• Upon linking Secondary OCU until Communications Test runs successfully	• Park State • Send Event to OCU • Send Msg to SCU	“Secondary Comm Test Not Complete”	“RCL System Fault 92”	N/A	• Park State Recovery • Successful Completion of Communications Test
93	Stop Failure - Park	• > 35 seconds (configurable) after entering STOP from a Speed setting, if speed > 0.5 mph and only if OCU ABS command is Release.	• Park State • Send Event to OCU • Send Msg to SCU	“Loco Stop Failure”	“Loco Stop Failure”	2 Chimes	• Loco Speed = Not Moving • Park State Recovery
94	Coast Mode Brake	• If, more than 15 seconds after entering Coast or Coast B, speed < 0.5 mph.	• Apply Full Independent Brakes	“Coast Mode Brake”	N/A	N/A	• Loco Speed = Not Moving
95	Low Release Pressure	• If, 10 seconds after commanded brake release, still in release AND flow is < 60 cfm, ER is < 70 psi	• Park State • Send Event to OCU • Send Msg to SCU	“Low Brake Release Pressure”	“RCL System Fault 95”	2 Chimes	• Park State Recovery • Release pressure > 70 psi
96	N/A – Not Used						

Event Code	Event Name	Cause	LCU Action	SCU Operator Notification	OCU Notification	OCU Audible	Recovery
97	Invalid AEI tag	• Single tag errors <i>TBD</i>	• Send Event to OCU • Log Event • Send Msg to SCU	"Invalid AEI Tag"	"Invalid AEI Tag"	1 Chime	7 seconds has passed
98	Invalid AEI tag configuration	• Errors in tag placement and groupings.	• Send Event to OCU • Log Event • Send Msg to SCU	"Invalid AEI Layout"	"Invalid AEI Layout"	1 Chime	7 seconds has passed
99	Secondary Transition to Sleep	• Upon reception of a Sleep Command from the Secondary OCU.	• Send Reply to OCU	N/A	on Primary OCU, if linked but not in Sleep: "Secondary OCU in Sleep"	2 Chimes	• 10 second timer; display at Primary OCU only
100	Hot Engine	Hot Engine signal active for > 5 seconds	• Send Event to OCU • Send Msg to SCU • Log Event	"Hot Engine"	"Hot Engine"	2 Chimes	Hot Engine goes inactive
101	Governor Shutdown	Gov. Shutdown signal active for > 5 seconds	• Send Event to OCU • Send Msg to SCU • Log Event	"Governor Shutdown"	"Governor Shutdown"	2 Chimes	Low Oil goes inactive

Event Code	Event Name	Cause	LCU Action	SCU Operator Notification	OCU Notification	OCU Audible	Recovery
102	Ground Relay	Ground Relay signal active for > 5 seconds	• Send Event to OCU • Send Msg to SCU • Log Event	“Ground Relay”	“Ground Relay”	2 Chimes	Ground Relay goes inactive
103	Yard Limit Override	Operator input at SCU while in Yard Limit Warning (Event #26 active)	• Log Event • Disable Events 25 & 74 (Yard Limits) • Send Msg to SCU	“Yard Limit Override Active”	“Yard Limit Override”	N/A	Detection of Yard Containment Warning or Violation AEI tags with decreasing sequence numbers OR Primary OCU unlinked
104	AEI Tag Detected	• RCL formatted AEI tag read (only while linked)	• Log Event only	N/A	N/A	N/A	N/A
105	Invalid GPS at Pullback	• GPS Pullback Region is not detected within 200 feet of reading the first AEI start of pullback tag	• Send as Status to OCU • Send msg to SCU • Log Event	“Pullback ON: GPS Error”	“Pullback ON: GPS Err”	2 Chimes	Detection of GPS Pullback Region OR AEI Pullback is not Active

Event Code	Event Name	Cause	LCU Action	SCU Operator Notification	OCU Notification	OCU Audible	Recovery
106	TL/Axle Generator Direction Fault	• While moving, both Axle Generator directions are opposite the commanded trainline direction unless the OCU is commanding stop	• Park State • Send Event to OCU • Send Msg to SCU • Log Event	“Direction Miscompare”	“Dir Miscompare”	2 Chimes	• Loco Speed = Not Moving • Park State Recovery
107	GPS Invalid - Stop	• Movement > 1000 feet (configurable) in either direction (from point of invalid GPS).	• Park State • Send Event to OCU • Send Msg to SCU • Log Event	“GPS Invalid”	“GPS Invalid”	2 Chimes	• Park State Recovery
108	BC Pressure Cutout Switches Invalid	• BC pressure switch indicates BC > 25 psi when BC transducer < 10 psi.	• Safe State • Send Event to OCU • Send Msg to SCU • Log Event	“BC Cutout Stuck Closed”	“RCL System Fault 108”	3 Chimes	• Safe State Recovery • BC Cutout Switches in correct state

Event Code	Event Name	Cause	LCU Action	SCU Operator Notification	OCU Notification	OCU Audible	Recovery
109	Pullback Control Override	• Operator input from SCU while Event #73 (Pullback Control Active) is active	• Log Event • Disable Pullback Control, Speed Limits and Stop	“Pullback Control Override Active”	N/A	N/A	Detection of Pullback Control tags with decreasing sequence numbers OR Primary OCU unlinked
110	Manual Mode	• MR <= 10 psi for 5 seconds	• Log Event • Unlink, if linked • Send Msg to OCU • Send Msg to SCU • Open BUEMV for 10 seconds	“Manual Mode”	“Unlinking due to cmd from the locomotive”	N/A	MR > 10 psi
111	Invalid Configuration	• Invalid entry of any parameter - Wheel diameter - Road number - J-valve - Speed controller - Brake shoe	• Log Event • Send Msg to SCU	“Invalid Configuration”	N/A	N/A	Valid entry for all parameters: - Wheel diameter - Road number - J-valve - Speed controller - Brake shoe

Event Code	Event Name	Cause	LCU Action	SCU Operator Notification	OCU Notification	OCU Audible	Recovery
112	Unlink Warning	• When unlink timer is < 1 hour, but > 1 hour minus 1 minute	• Log Event • Send Msg to SCU	N/A	“Unlink in 1 hour”		When unlink timer is < 1 hour minus 1 minute