THOROUGHTEC™
simulation

Thoroughbred Technologies (Pty) Ltd

PRODUCT SPECIFICATION

FOR THE

GE DIESEL ELECTRIC U20C LOCO SIMULATOR

DOCUMENT: 54-00316-U20C-SPE
Revision 2

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2009/03/25	0	50-00066-TSD-ICD	3 DOF Cab Interface Document
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2009/07/03	0	54-00320-U20-SPE	Virtual Gauges I/O Sheet
2010/04/13	-	GE ENG BOOK	Technical Operating Data
2010/04/13	-	28-LAV-1	Westinghouse Technical Specification on 28-LAV-1
2010/04/13	-	Brake System Spec.doc	Client Supplied user requirements Specification

TABLE OF CONTENTS

LIST OF ABBREVIATONS

3-DOF	-	3 Degrees Of Freedom
6-DOF	-	6 Degrees Of Freedom
ADT	-	Articulated Dump Truck
CAT5	-	Category 5 network cabling
CCV	-	Computer-Controlled Vehicle (also referred to as a “Token”)
CFE	-	Client Furnished Equipment
CFI	-	Client Furnished Information
Client	-	The company or organization purchasing the simulator from the Contractor
Contractor	-	Thoroughbred Technologies (Pty) Ltd
COTS	-	Commercial Off The Shelf
*Cyber*MINE™	-	ThoroughTec’s mining simulator software suite from which the equipment specific simulator software is derived
D/A	-	Digital To Analog
I/O	-	Input / Output
IBM	-	International Business Machines
ISO	-	International Standard Organization
KPH	-	Kilometers Per Hour
LAN	-	Local Area Network
LCD	-	Liquid Crystal Display
LDV	-	Light Delivery Vehicle
LED	-	Light Emitting Diode
PC	-	Personal Computer
PCB	-	Printed Circuit Board
PSI	-	Pounds per Square Inch
U20C	-	Model U20C General Electric Locomotive
RPM	-	Revolutions Per Minute
RS232	-	A serial protocol standard
SME	-	Subject Matter Expert (a Client representative)
UPS	-	Uninterruptable Power Supply
USB	-	Universal Serial Bus
UTP	-	Unshielded Twisted Pair
XGA	-	Extended Graphics Array

1 SCOPE

1.1 SYSTEM OVERVIEW

The Client has a requirement for a simulator system for the training, re-training and evaluation of operators of the Diesel Electric G-E U20C Locomotive operating in a generic 3D simulated environment.

The system consists of a set of three projected display screens and a 3 Degrees of Freedom (3 DOF) low profile motion platform where on the simulated LOCO will operate within a 3D virtual generic world. The Simulator will be housed in a *Cyber*TRAIN™ generic container.

1.2 DOCUMENT OVERVIEW

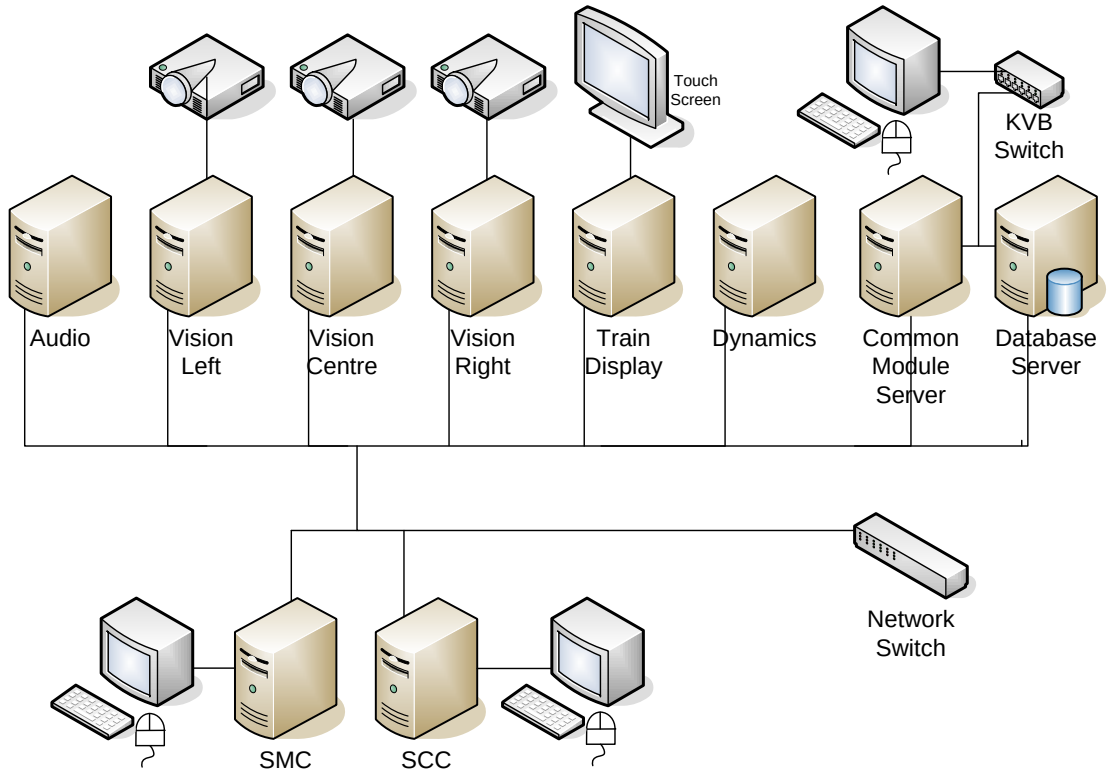
This document defines the physical and functional specifications for the hardware of the *Cyber*TRAIN™ Class 33 Diesel Electric G-E U20C Locomotive simulator.

The purpose of this specification is to identify all hardware requirements based on the U20C G-E Locomotive. It will be documented such that all Hardware will be identified and listed in an Input/Output (I/O) table and an interface control document detailing the operation of the Trio Boards will also be included as separate documents. This will be used to accurately integrate the software and hardware of the simulated LOCO.

2 SYSTEM CHARACTERISTICS

2.1 SYSTEM DEFINITION

2.1.1 System Overview



2.1.2 Computer Equipment

Computer	CPU	Graphics	Memory	Disk	OS	Other	Description
SMC	Std	Dual	Std	std	XP	Keyboard, Mouse and Printer	Simulator Manager Console (off line)
SCC	Std	Dual	Std	std	XP	Keyboard, Mouse and Printer	Simulator Control Console
Train Display	High	Dual	High	std	XP		Train Displays
Audio	High	Dual	High	std	XP	Surround Sound	Audio processor
Vision Left	High	Graphics	High	std	XP		Forward vision
Vision Centre	High	Graphics	High	std	XP		Forward vision
Vision Right	High	Graphics	High	std	XP		Forward vision
Database Server	High	Dual	High	Large Raid	XP		Database server
Common Module Server	High	Dual	High	Large Raid	XP		Common modules and data file storage
Dynamics	High	Dual	High	std	XP		Motion base, trio board interface

2.1.3 Core Components

The following segments of the *Cyber*Train™ simulator have been identified:

The Container Segment, consisting of the following:

- 1 x 6m ISO container
- 1 x Internal lighting sub-system
- 1 x Air conditioning sub-system
- 1 x Power distribution sub-system

The Instructor Desk Segment, consisting of the following:

- 1 x Instructor desk

The Motion Platform Segment, consisting of the following platform:

- 1 x 3 degree of freedom Motion Platform

The Computing Segment, consisting of the following:

- 10 x IBM-compatible PC with specified internal peripherals and operating system
- 1 x IBM-compatible keyboard
- 1 x mouse pointing device
- 1 x joystick device
- 1 x A4 printer

The Visual System Segment, consisting of the following:

- 3 x XGA projectors (minimum 1024 x 768 resolution)
- 3 x projector mounting assemblies
- 3 x projection screens
- 1 x Instructor monitor (minimum 1280 x 1024 resolution)

The Audio System Segment, consisting of the following:

- 1 x 5.1 (minimum) surround sound speaker system

2.1.4 Cab-Specific Components

The Operator Compartment Segment, consisting of the following:

- 1 x Class 33 Diesel Electric G-E U20C Locomotive
  - 1 x Left Console
  - 1 x Centre Console
  - 1 x Right Console
  - 1x Rear Console
  - The Cab Instruments and Controls Segment, consisting of the following:
- I/O printed circuit boards (PCBs) and associated cabling / wiring

2.2 CORE SYSTEM CHARACTERISTICS

2.2.1 Physical Characteristics

In general, the physical characteristics of this *Cyber*Train™ simulator will be similar to those of the real equipment, to facilitate psychological acceptance of the unit as a realistic training aid.

All instruments and controls that are not physically located within the operator's compartment areas or relating to maintenance functions only, will be specifically excluded from the simulator.

Only those instruments and controls that are pertinent to the operator's tasks will be replicated and made functional by the simulation software.

2.2.2 Container Segment

The Container segment will consist of the following components:

- The 6m ISO container
- The air-conditioning sub-system
- The power distribution sub-system (with integral UPS)
- The internal lighting sub-system

The 6m ISO High Cube container will be modified to provide the single door access and an audience viewing port. The interior of the container will be insulated and carpeted throughout to provide a degree of thermal insulation from the external environment.

The Power Distribution Unit will distribute 220V, 50Hz power to the various sub-systems throughout the container. The supplied external power cable must be wired by the end-user to provide this input power configuration. The external power cable must be connected to a 300mA earth-leakage breaker.

A UPS will supply power to all the PC's, the instructor's monitor and the Ethernet switch. The UPS will provide enough power for a graceful shutdown of the system in the event of power loss.

The integrated air-conditioning sub-system will be a remotely operated split unit capable of both heating and cooling. It will be rated at 22000 BTU.

The internal lighting sub-system will provide for variable control of the lighting levels within the container during both operation and maintenance activities. Independent lighting control will be provided for the instructor's area, the cab area and the rear-maintenance area of the container.

2.2.3 Instructor Desk Segment

The Instructor Desk Segment will consist simply of the Instructor desk, to house the Instructor's display monitors, keyboard, mouse and joystick, and provides control interfaces to the audio segment, display projectors and dimmable lighting system.

2.2.4 The 3-DOF Motion Platform Segment

The motion platform system will have three degrees of freedom (3-DOF) and will be capable of providing roll, pitch, and yaw motion/attitude feedback to the operator during the driving simulation.

Movement of the platform will be provided by 3 AC Motors.

The operator's cab will be mounted onto the motion platform.

The following safety features will be fitted to limit potential injury to persons in close proximity to the platform when operating:

- The motion platform will be automatically disabled when a person or object breaks the infrared beam(s) sensors situated around the motion platform defining the limits of the platform's extents of motion.

- The motion platform may be manually disabled by pressing the Motion Platform Emergency Stop Switch.

The following I/O will be required:

Control Name	Control Type
3-DOF Motion Platform	3-DOF Motion Platform
Optical Safety Sensor 1	Digital Input
Optical Safety Sensor 2	Digital Input

2.2.5 Computing Segment

Ten state-of-the-art PCs will be used to provide all Instructor and Simulation functions. Each will have the following *minimum* specifications and internal peripherals:

- 2.2 / 3.16 GHz Core2 CPU
- 2/4GB RAM
- 80 / 500 GB hard disk drive
- 3D graphics accelerator card with 256MB RAM
- 100 Mb/s UTP LAN card
- Microsoft Windows™ XP Professional or later operating system

The Left, Right, Centre and Auxiliary PCs will include the following additional internal peripherals:

- DVD-ROM drive

The Dynamics PC will include the following additional internal peripherals:

- Sound Blaster Live! or Audigy PCI audio card
- DVD-ROM drive

The Instructor's PC will include the following additional internal and external peripherals:

- DVD-RW drive
- Monitor
- Keyboard
- Mouse pointing device
- Joystick device
- Sound Blaster Live! or Audigy PCI audio card
- A4 black and white laser printer

The following computing segment components will be housed inside the industrial 19" and 10" rack:

- The Ethernet switch
- The Instructor's A4 printer
- The ten rack-mounted PCs
- UPS

2.2.6 Visual Segment

Three high-resolution video projectors (1024 x 768 pixels) will each front-project onto a dedicated screen. Each screen will be mounted within the container at approximately 90 degrees to its adjacent screen.

This configuration will provide the operator with front, left and right views constituting a 180º-plus field of view onto the 3D world.

The instructor will operate the system using separate desk-mounted LCD monitors (1280 x 1024 pixels minimum resolution).

2.2.7 Audio Segment

Audio feedback will be provided by five satellite speakers (mounted in an arrangement around the operator in the cab) and a sub-woofer. Two sets of stereo outputs from the sound card will pass through an amplifier and drive the speaker system. The instructor will have the facility to adjust the volume levels using the infrared remote control or the volume control knob supplied with the audio segment.

The instructor will be provided with an additional set of two speakers, mounted above his desk, used for exercise replay only.

2.3 CAB-SPECIFIC CHARACTERISTICS

2.3.1 Operator Compartment Segment

One replicated Class 33 Diesel Electric G-E U20C Locomotive cab will be provided. The cab will be mounted upon the motion platform assembly.

The replicated cab will consist of the following simulated instruments and controls mounted around the operator's seat on the motion platform:

- The left console assembly,
- The right console assembly,
- The centre console assembly,
- The rear console assembly,

All operator control panels will be built to be similar in look and colour to that of the actual equipment. The operator's seat will be mounted at a similar position relative to the controls as per the actual equipment.

2.3.2 Cab Instruments and Controls Segment

A set of proprietary I/O PCBs –Trio Boards form the heart of this Segment and will provide the interface to all relevant instruments and controls forming part of the simulation. The Table that follows is an outline of the Controls and the Control Logic used to simulate the original part.

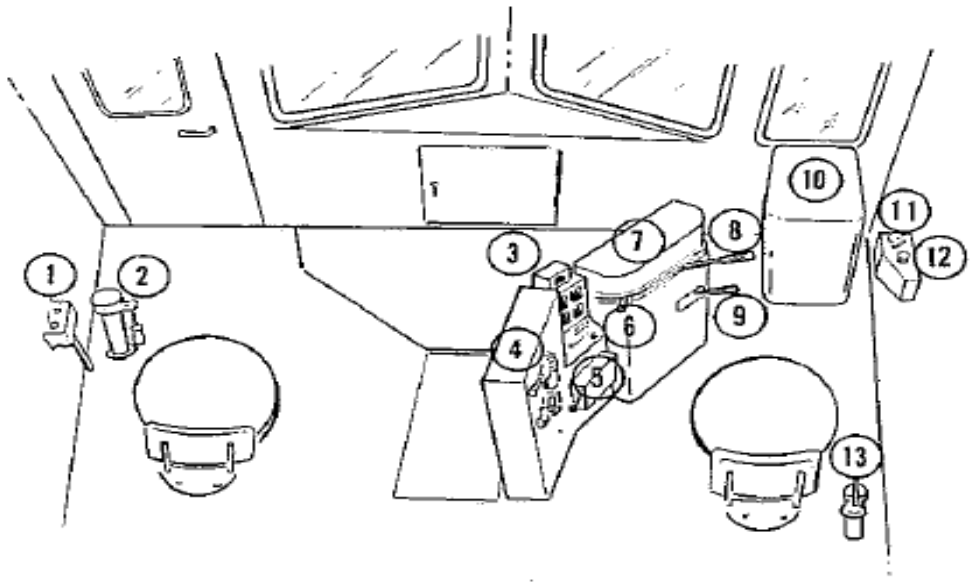
Note: The Trio Boards capabilities and Interface Control Document will be included as a separate document.

Any instrumentation labelled as “Optional” in the table below is fitted in the actual LOCO only if ordered specifically by the customer, and ThoroughTec’s design must allow for this instrumentation to be replaced or omitted as required by specific client requirements.

The following Class 33 Diesel Electric G-E U20C Locomotive specific instruments and controls will be interfaced to the I/O Trio PCBs for simulation purposes.

NOTE: The I/O List will be provided as a separate document.

Figure 1. Overall Layout of Operating Controls (as per actual LOCO)



1	Boiler Control Panel	8	Throttle Handles
2	Handbrake	9	Reverse Handle
3	Driver's Gage Panel	10	Cab Heater
4	Brake Valve Handles	11	HS4 Controlair Valve
5	Hump Controller	12	Quick Release Push Valve
6	Selector Handle	13	Emergency Vacuum Brake Valve
7	Master Controller		

Fig. 1. Operating cab controls

Control Name	Control Type
Centre Console (Master Controller)	

Figure 2. Master Controller

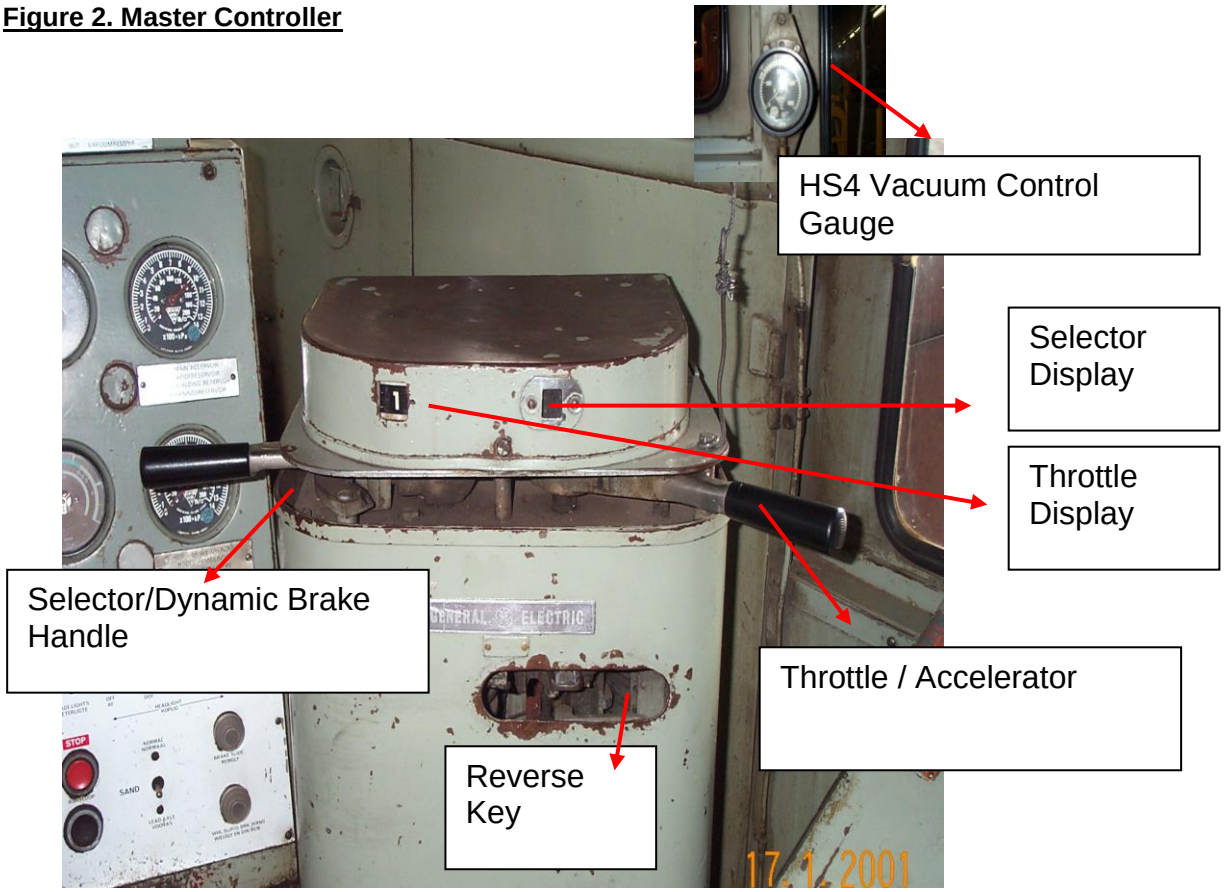
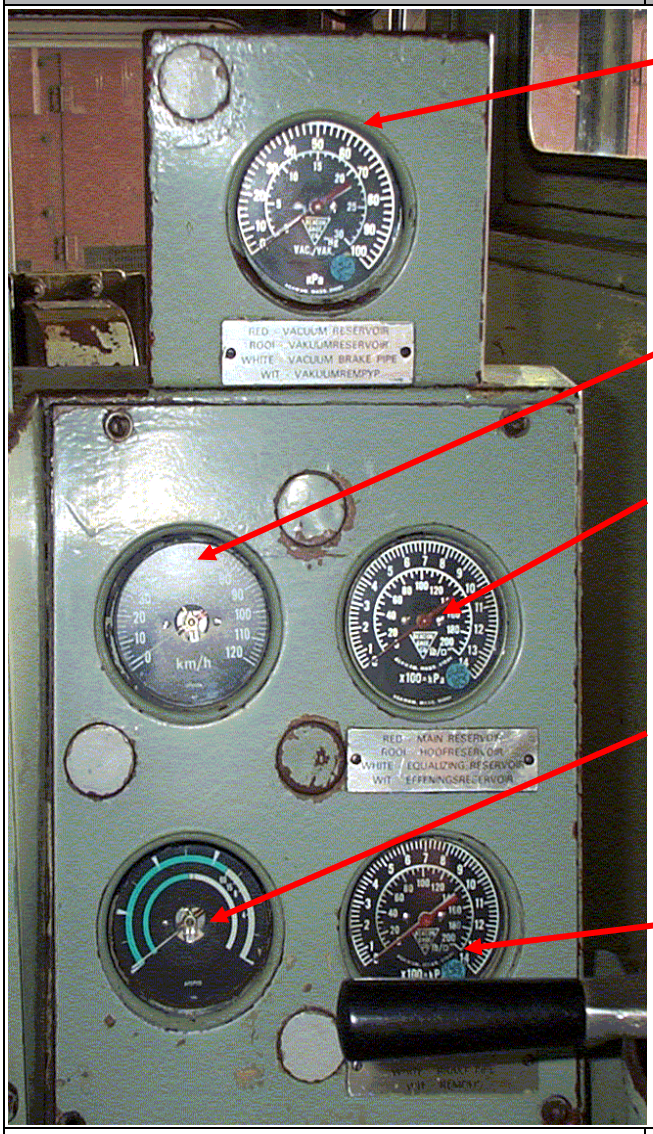


Fig 2. Master Controller

Throttle/Accelerator control handle	9- Position Potentiometer Lever - (neutral and 1 to 8 running positions, calibrated Via software)
Selector/Dynamic Brake Handle	5-Position Potentiometer Lever – (Interlocks lifting handle between positions 2,1, Neutral,B, b – (small b x 13 is the application zone for dynamic braking)
Reverse Handle	3-Position Latch Lever (Forward,neutral and reverse)
HS4 Vacuum Control Gauge	Gauge
Throttle Display	7 Segment - Star Burst Display (Neutral and 1 to 8)
Selector Display	7 Segment – Star Burst Display (2,1,N,B,b)
Left Console (Drivers Gauge Panel)	

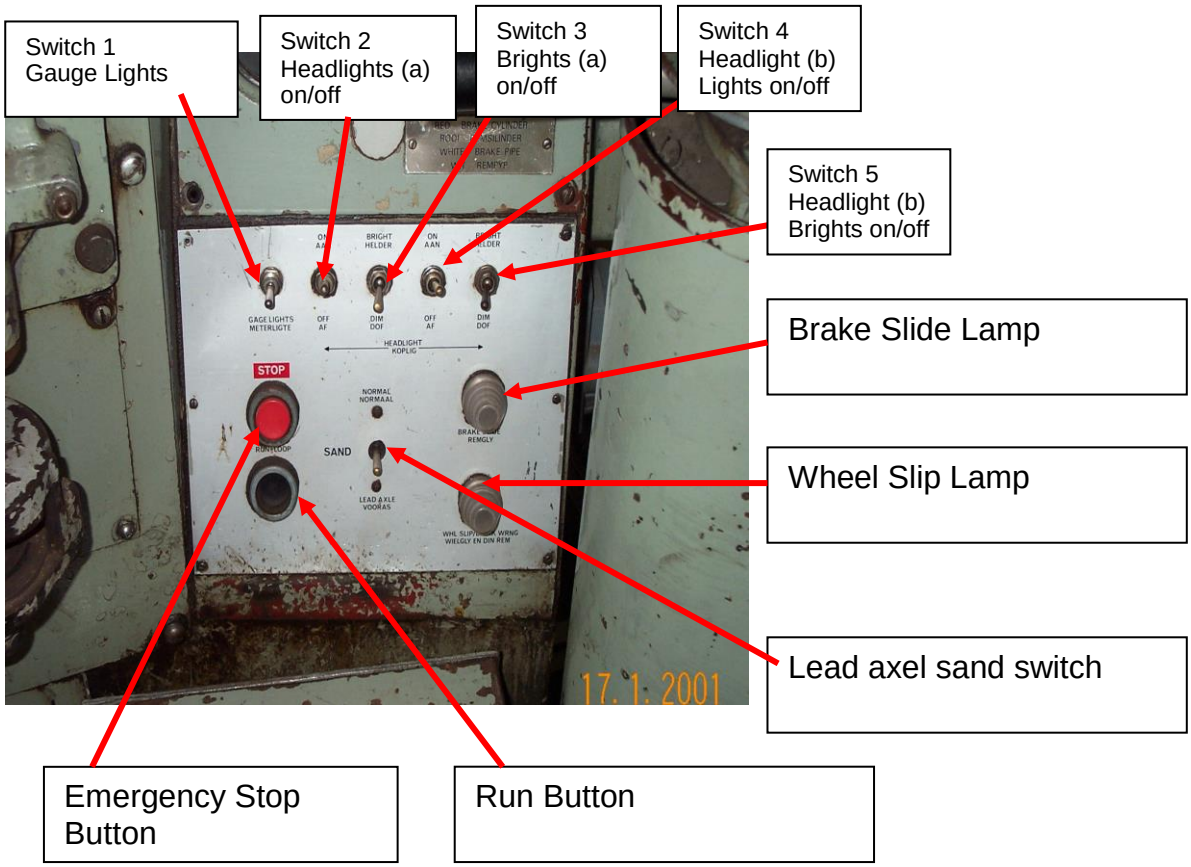
NOTE: The drivers gauge panel will be-replaced with an LCD screen displaying the gauges.
This will be simulated via Art/Software.

Figure 3. Drivers Gauge Panel

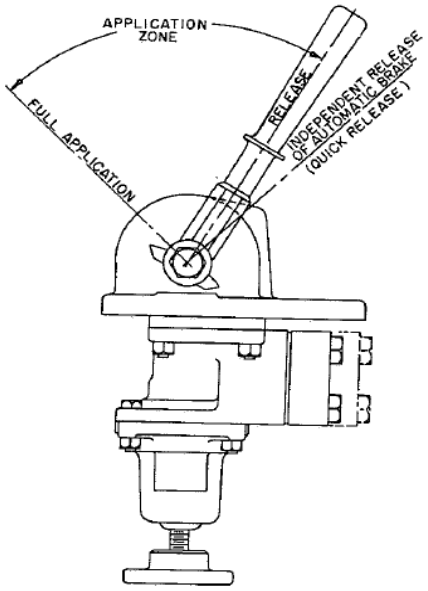
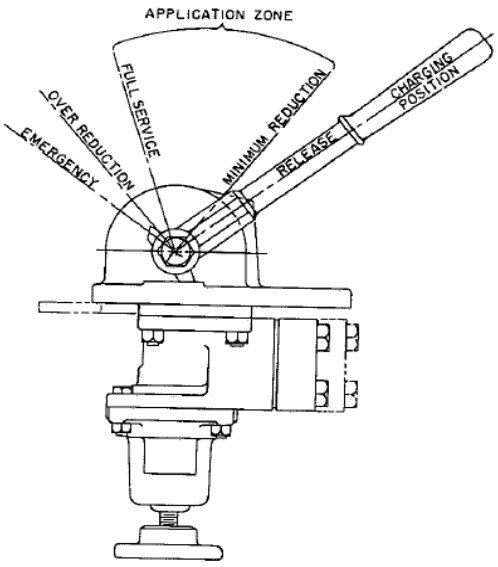
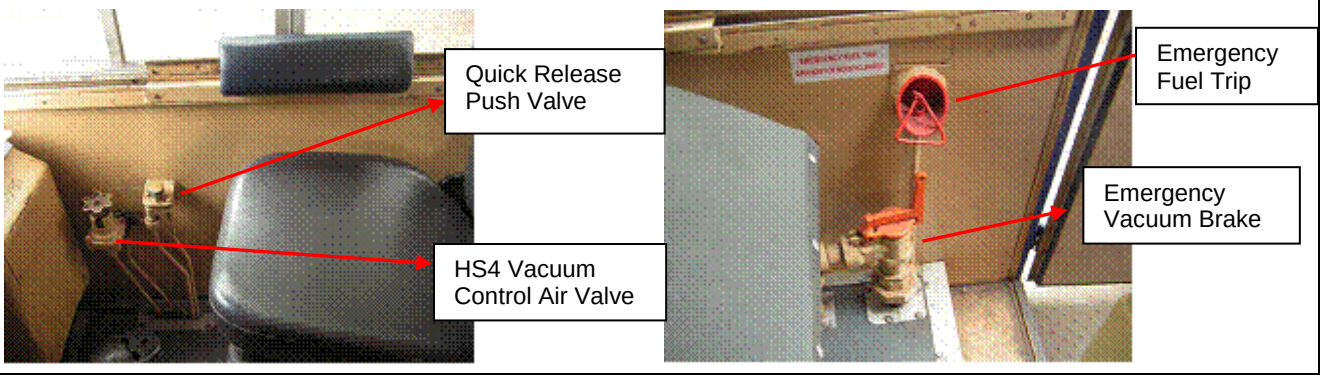
Control Name	Control Type
	
Load meter Gauge	LCD – Art / Software Simulated
Speedometer Gauge	LCD – Art / Software Simulated
Main /Equalizing Air reservoir gauge	LCD – Art / Software Simulated
Brake Pipe / Cylinder gauge	LCD – Art / Software Simulated
Vacuum Gauge	LCD – Art / Software Simulated
HS4 Vacuum Control Gauge	Gauge (Backlit)
Vigilance Lamp	Lamp - white
Left Console (Drivers Control Panel)	

Control Name	Control Type

Figure 4. Drivers Control Panel



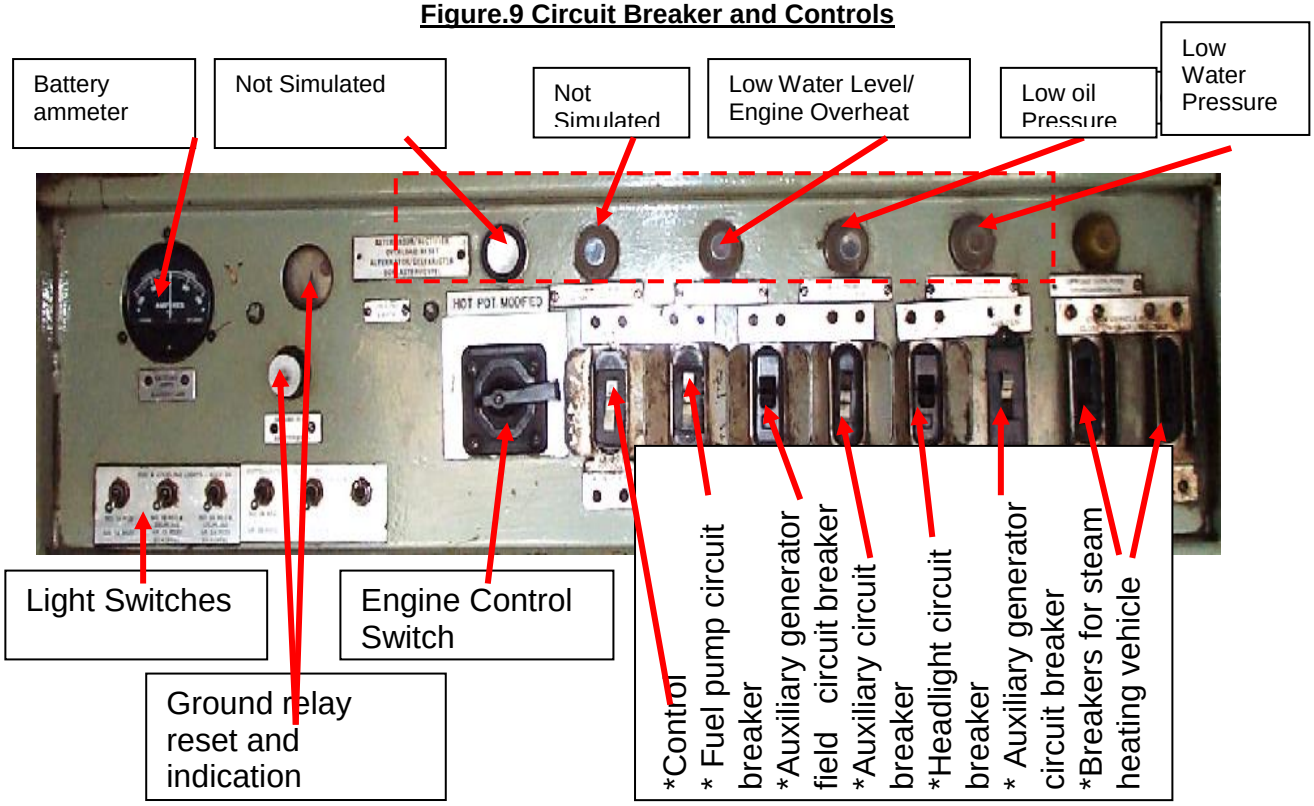
Run Button	2- Position Latched Push Button Switch(Linked to Emergency Engine Stop Switch)
Emergency Engine Stop Button	2- Position Latched Push Button Switch(Linked to Run Button)
Switch 1 Gauge Lights	2-Position Toggle Switch
Switch 2 Headlight (a)	2-Position Toggle Switch
Switch 3 Brights(a)	2-Position Toggle Switch
Switch 4 Headlight (b)	2-Position Toggle Switch
Switch 5 Brights (b)	2-Position Toggle Switch
Brake Slip Lamp	LAMP (Amber)
Wheel Slide Lamp	LAMP (White)
Warning Bell	Software Simulated
Warning Buzzer	Software Simulated
Lead axel sand switch	2-Position Toggle Switch
Hump Controller	Potentiometer – Linearly Controlled (Calibrated via software)
Left Console (Brake Valve Handles)	

Control Name	Control Type
Figure 5. Independent Brake Valve  Fig. 3 (E-13074) **Figure 6. Automatic Brake Valve** 	
Independent Brake Valve Handle	Potentiometer (4 position with application zone-software calibrated)
Automatic Brake Valve Handle	Potentiometer (5 Position with application zone-software calibrated)
Brake selector switch	3 Position Latched (Spring loaded –pushing switch in to turn)
Air Brake regulating valve	Potentiometer – Linearly controlled(calibrated via software)
MU-2B Trail/Lead switch	2 Position Latched (Spring Loaded – pushing switch in to turn)
Right Console (Valves)	
Figure 7. Valves 	
HS4 Vacuum Control Air Valve	Potentiometer – linearly controlled (software calibrated)
Sander Pedal Switch	2-Position Momentary switch (pedal –down =on up=off)
Quick Release Push Valve	2-Position Momentary switch

Control Name	Control Type
Emergency Vacuum Brake Valve	2-Position Latched Lever (up=on down=off)
Horn Switch	2-Position Momentary switch
Emergency Fuel Trip	2-Position pull switch
Vigilance Pedal	2-Position Momentary switch (pedal –down =on up=off)
Rear Console(Circuit Breaker, Controls and Gauges)	

Figure.8 Overview : Circuit Breaker, Controls and Gauges

Figure.9 Circuit Breaker and Controls



Battery Ammeter Gauge	Gauge (Backlit)
High Engine temp/Low water temp Warning Lamp	Lamp (Colour Red)
Low Oil Pressure Warning Lamp	Lamp (Colour Green)
Low Water Pressure Warning Lamp	Lamp (Colour Yellow)
Crank Case Over Pressure Warning Lamp	Not Simulated
Light Switch 1	2-Position Latched toggle switch
Light Switch 2	2-Position Latched toggle switch
Light Switch 3	2-Position Latched toggle switch
Light Switch 4	2-Position Latched toggle switch
Light Switch 5	2-Position Latched toggle switch
Ground Relay Reset Switch	2-Position Momentary Push button switch
Ground Relay Reset Indicator	Gauge (backlit)
Engine Control Switch	5-Position (2-Positions Spring Loaded –Pump, Start)

Control Name	Control Type
	(3-Position Latched – Idle,Run,Stop)
Circuit Breaker Switch -Control	2-Position Circuit Breaker switch
Circuit Breaker Switch –Auxiliary Generator	2-Position Circuit Breaker switch
Circuit Breaker Switch - Headlight	2-Position Circuit Breaker switch
Circuit Breaker Switch - Auxiliary	2-Position Circuit Breaker switch
Circuit Breaker Switch –Auxiliary Generator Field	2-Position Circuit Breaker switch
Circuit Breaker Switch – Fuel Pump	2-Position Circuit Breaker switch
Circuit Breaker Steam Heating	2-Position Circuit Breaker switch (not simulated)
Circuit Breaker GENERIC	2-Position Circuit Breaker switch
Battery Leaver Switch	2-Position Latched Switch (Manual Lever to close/open circuit)
Rear Console(Gauges)	

Figure.10 Gauges

Turbocharger Gauge	Gauge (Backlit)
Fuel Gauge	Gauge (Backlit)
Lube Oil Pressure Gauge	Gauge (Backlit)
Water Temperature Gauge	Gauge (Backlit)

Note: Switches and controls other than those that are listed in the above table will not exist in the simulator.

2.4 Simulated Loco Cab Layout

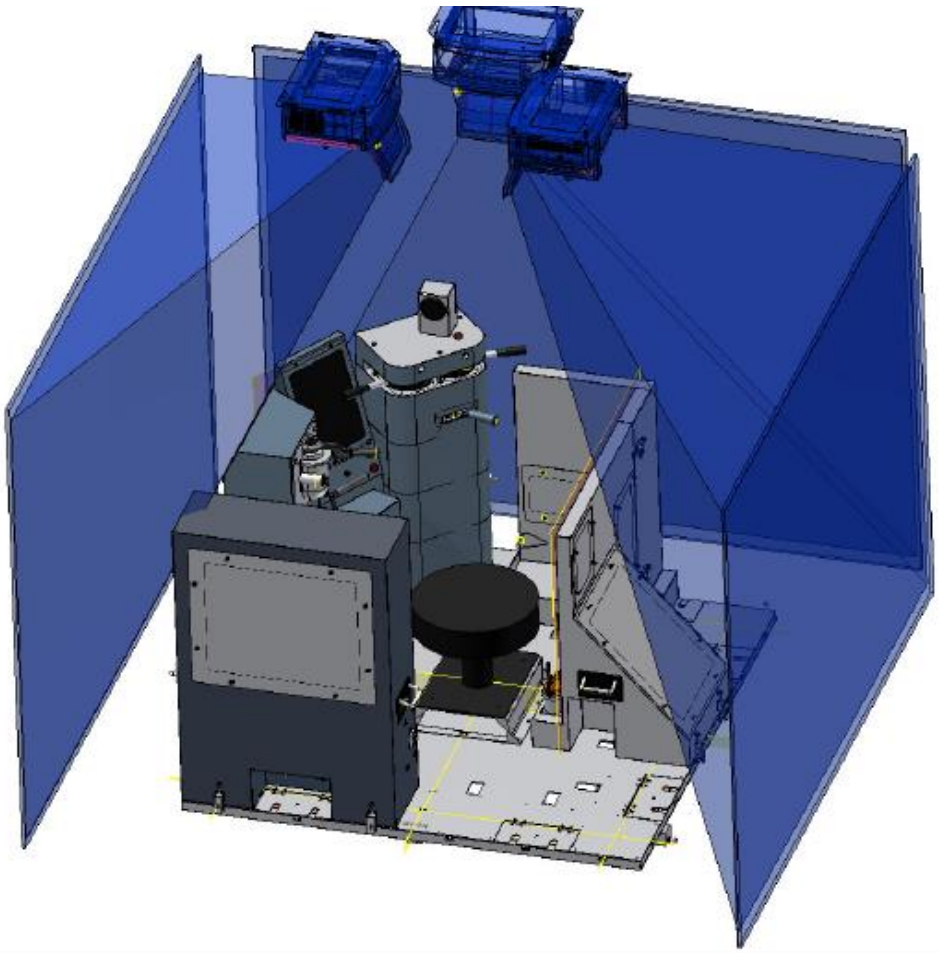
The simulated cab hardware will be broken down into four separate consoles they will be labelled as follows:

- Centre Console (Master controller)
- Left console (Driver controls and gauges including Brake valves)
- Right Console (Pressure release Valves)
- Rear Console (Circuit Breakers and Gauges)

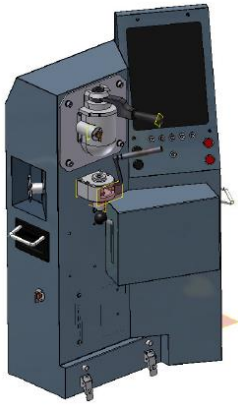
The figure below depicts the actual layout of the LOCO cab hardware incorporating all four consoles seated upon the motion platforms base.

Figure.11 Simulated LOCO Cab Layout

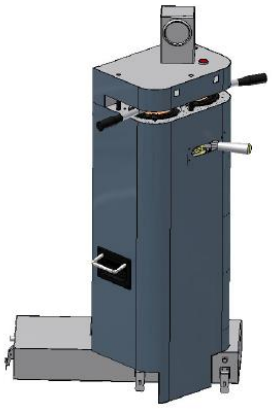
FORWARD VIEW



Left Console

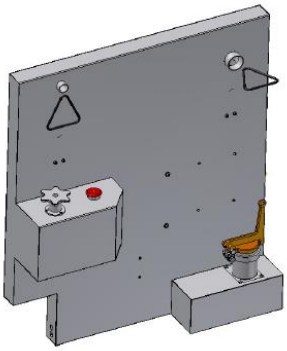


Centre Console



Rear Console

Right Console



3 Functional Cab Characteristics

3.1.1 Vehicle Controls and Logic

The following table describes the functionality of each of the instruments and controls implemented in the simulated cab. The software as a bare minimum must meet the conditions outlined here under.

Where Dynamic simulation models clash with functional description, dynamic modelling must take preference.

Control Logic
Centre Console (Master Controller)
Throttle/Accelerator control handle The throttle is used to control engine speed and locomotive power. It has a neutral position and eight notches. This is displayed on a 7 Segment Starburst display as the Throttle leaver is moved into the relevant Notch position. ➢ Engine speed normally, but not necessarily always, increases with every notch, the power developed by the engine does proportionately increase progressively when notching up. (No revs in notch 1, but traction is available, in all other notches engine revs increase) ➢ Notching up or down through the gears needs to be done in accordance with the load meter. The Throttle will be simulated to a Dynamic Modelling Level
Selector/Dynamic Brake Handle The selector handle determines the mode of motoring operation or the amount of dynamic braking. It has positions 2,1, Neutral, big "B", and a series of small "b's". This is displayed on a 7 segment starburst display as The Selector / Dynamic handle is moved into the relevant Notch position. ➢ Positions 1 and 2 are motoring positions. Position 2 is used for normal open line working and Position 1 is used for shunting. ➢ In Position 2 the rate of power build up is the same as Position 1 up to 23km/h. However, the driver must be in Position 2 for transitions to be made automatically at 23km/h, 29km/h and 72km/h. So, normal open line working is to pull away in Position 2 and leave the locomotive to make transitions automatically. If the driver pulls away in Position 1, the torque will drop off at 23km/h because the locomotive will not be able to make transition. Note: "transition" is changing of traction motors from series to parallel connection, thus at transition speeds the amps (load meter) must build up. ➢ Position big "B" for dynamic braking can be selected after moving the throttle to neutral with the reverse key in either forward or reverse and then moving the selector handle through the neutral position to the "B" position. There must be a **pause of 6 seconds** in neutral before moving to the "B" position. If there is no pause the software will not recognise the B position ➢ When the selector handle is placed in the neutral position, the engine speed will automatically increase to X revs. ➢ The reverser mechanism will switch to braking (sound will be heard) when switched to B position the contactor sound needs to be heard as well. The Selector Handle will be simulated to a Dynamic Modelling Level for this LOCO To Switch to Dynamic Braking is as follows. Dynamic braking may be introduced at any speed provided that the permissible speed for a particular train is not exceeded. ➢ Push Throttle into Neutral position. Place the selector in neutral and wait **six** seconds for contactor to switch over (sound will be heard) **-** engine revolutions will build up relevant to throttle **notch 5** position. If the engine revolutions do not build up, dynamic braking may not be used. ➢ Place the selector in the big **"B"** position after **six seconds. The following will happen:** ➢ The wheel slip buzzer and light is now coupled to the braking grids to indicate if there are

Control Logic
overheated grids. ➢ The load meter registers a low reading. ➢ Slowly advance the selector in the **small "b"** and observe the load meter until the train slack is fully taken up. (Approximately 200 amps) (See pg.89-93 of GE ENGINEERING Book for full Dynamic Braking Description.) <u>The Dynamic Braking will be simulated to a Dynamic Modelling Level for this LOCO</u>
Reverser Handle The Reverser Handle is used to select Forward, Off or Reverse. Selecting Reverse will allow the LOCO to Travel in Reverse Direction Selecting Forward will allow the LOCO to Travel In Forward Direction Selecting Off will not allow the LOCO to travel in either direction <u>The Reverser Handle will be simulated to a Dynamic Modelling Level for this LOCO</u>
HS4 Vacuum Control Gauge Displays the Vacuum Pressure controlled by the HS-4 Control air valve From 0kPa to 300kPa. It is a single needle gauge but displays two separate readings on the decals <u>The HS4 Vacuum Control Gauge will be simulated to a Dynamic Modelling Level for this LOCO.</u>
Vigilance Safety Control Lamp Provided the engine is running the lamp will illuminate if the Vigilance Pedal is not depressed after 70 seconds or during the vigilance control test.
Throttle Display When the Throttle Lever is moved into Notch N,1,2,3,4,5,6,7,8 it will display the relevant notch number on the 7 Segment Star Burst Display.
Selector/ Dynamic Braking Display When the Selector / Dynamic Braking lever Is moved into Notch 2,1,N,B,b it will disblay the relevant notch number on the 7 Segment Star Burst Display. Position small b is an application zone and therefore the display will stay displaying b during this application zone.
Left Console (Drivers Gauge Panel)
Load meter Gauge The load meter indicates the ampere the alternator sends out to the traction motors when the throttle is open. It also indicates the ampere that the traction generator sends out to the resistor grids during dynamic braking. The load meter is marked from 0 to 1000 ampere in 100-ampere units. The traction force area (outer zone) is divided in a normal zone (green 0-650 ampere) and an overload zone (yellow 650-1000 ampere). The yellow zone is subdivided in 60, 15, 8 and 4 minute zones. It indicates the maximum time that the Train Driver may work the locomotive in these zones. If the time has expired, the Train Driver must notch down the locomotive until the load meter registers approximately 500 amperes. **NOTE** *Above-mentioned procedure is not applicable during dynamic braking.* ➢ The load meter must be observed when picking up a load and also en route. If all the locomotive wheels slip, the load meter will register a low reading and the Wheel slip warning Lamp and buzzer will sound.

Control Logic
➢ The inner scale is divided in a green, yellow and a red zone. This scale is used during dynamic braking. The Loadmeter gauge is marked from 0 – 1000 amperes **NOTE** *The locomotive may not be operated in the red zone during dynamic braking*. The Load Meter Gauge will be simulated to a Dynamic Modelling Level
Speedometer Gauge The speedometer will display LOCOs speed in km/h Provided the Engine is running (see ECS for functionality) Speedo will display the following: ➢ 0 proportionately increasing as throttle is applied through the notches to max speed in notch 8 ➢ Speedometer is marked from 0-120km/h The Speedometer will be simulated to a Dynamic Modelling Level
Main /Equalizing Air reservoir gauge This Gauge will be simulated on an LCD screen and will display the following: ➢ The white needle of this duplex gauge indicates the pressure in the equalising reservoir from 0-200 lb/0” ➢ The red needle indicates the pressure in the main air reservoirs from 0 – 1400kPA The Main / Equalizing Air reservoir Gauge will be simulated to a Dynamic Modelling Level for this LOCO.
Brake Pipe / Cylinder gauge This Gauge will be simulated on an LCD screen and will display the following: ➢ The white needle of the duplex gauge indicates the pressure in the brake pipe from 0-200lb/0” ➢ The red needle indicates the pressure in the brake cylinder from 0-1400kPA The Brake Pipe /Cylinder Gauge will be simulated to a Dynamic Modelling Level for this LOCO.
Vacuum Gauge This Gauge will be simulated on an LCD screen and will display the following: ➢ The White needle of the duplex gauge indicates the vacuum train pipe pressure from 0-100kPA ➢ The Red needle indicates the pressure in the vacuum reservoir from 0 – 100kPA ➢ By adjusting the HS-4 Control Air valve you can increase or decrease pressure on this gauge. The Vacuum Gauge will be simulated to a Dynamic Modelling Level for this LOCO.
Hump Controller Controls the pulling power of the LOCO ➢ If in off” position = (maximum power) when it is pulled all the way up. ➢ Pushing the lever downward out of the “off” position Proportionately decreases the pulling power of the locomotive without changing engine speed ➢ The hump controller lever can be moved regardless of the position of the other operating handles. It will not affect dynamic braking in any position. ➢ The hump controller will only be active if the selector is in position 2 The Hump Controller will be simulated to a Dynamic Modelling Level for this LOCO.
Left Console (Drivers Control Panel)
Run Button *Note: This button works in tandem with the Run Button*

Control Logic
The Run Button allows the Engine to be started via the Engine control switch. ➢ If depressed engine can be started (see ECS for Engine start procedures) ➢ To Reset the Start button the Emergency Stop Button must be depressed causing engine to cease running. The normal position is with the Run Button (black button) depressed.
Emergency Engine Stop Button *Note: This button works in tandem with the Run Button* When Pressed: ➢ Engine will cease running. ➢ Engine will not be able to be started. When resetting this device, the black run button must be firmly pressed in to let the red stop button protrude. If the button pair is not properly reset the engine will not start nor will the engine revolutions build up.
Switch 1 Gauge Lights Provided the following are met: ➢ Circuit Breaker – Auxiliary field generator and Auxiliary Generator are closed ➢ Gauge lights toggle switch is in the on position Then all gauge backlights will illuminate. If either Circuit breaker or toggle switch is in the off position then the gauge backlights will be off.
Switch 2 Headlight (a) Provided the engine is running and the Headlight Circuit breaker is in the on position Turning this switch on will illuminate the headlight on (a) side of LOCO
Switch 3 Brights(a) Provided the engine is running and the Headlight Circuit breaker is in the on position turning this switch on will turn the headlight on to Bright on (a) side of LOCO
Switch 4 Headlight (b) Provided the engine is running and the Headlight Circuit breaker is in the on position Turning this switch on will illuminate the headlight on (b) side of LOCO
Switch 5 Brights (b) Provided the engine is running and the Headlight Circuit breaker is in the on position turning this switch on will turn the headlight on to Bright on (b) side of LOCO
Wheel Slip Lamp Provided the engine is running. If the following occur this Warning Lamp will illuminate: ➢ If the Loco experiences any form of traction loss on the wheels. ➢ If the Wheel Slip Lamp is Illuminated the Warning Buzzer will also sound. ➢ Must be capable to simulate working in dynamic braking mode, where it indicates overheated grids *Note See OEM Document for full functionality.*
Brake Slide Lamp Provided the engine is running. If the following occur this Warning Lamp will illuminate: ➢ If the Locos Selector Handle is in the Dynamic Breaking positions and the Loco is experiencing excessive dynamic breaking conditions. ➢ If the Locos wheels are slipping due to excessive breaking force being applied above 29km/h.

Control Logic

- If the Brake Slip Lamp is illuminated the Warning Buzzer will sound.

Warning Bell

Provided the Engine is running.

The Warning Bell will sound if the following occur:

- During Start Up (see Engine Control Switch for Functionality)
- If the batteries are discharging due to an Auxiliary Field Generator Circuit Breaker trip.
- If Low Oil Pressure Warning Lamp is illuminated
- If Crank Case Over Pressure Warning Lamp is illuminated.
- If Ground Reset Relay is Tripped (red dot position)
- If the High Engine Temp Warning Lamp is Illuminated

Warning Buzzer

Provided the Engine is running.

The Warning Buzzer will sound if the following occur:

- If the Wheel Slip Lamp is illuminated.
- If the Brake Slide Lamp is illuminated.

Left Console (Brake Valve Handles)

Independent Brake Valve Handle

Running position

The handle is normally in this position and it releases the locomotive brakes after an independent brake application.

Application zone

This zone extends from the “running position” to the “full application” position. The amount of brake application is determined by the distance that the handle is moved towards the “full application” position.

Full application position

This position provides the brake power available for locomotive braking. When in this Position the brake cylinder pressure builds up to 310 kPa.

Quick release position

By depressing the handle in the “running” position, an automatic (Proportional) brake application on the locomotive will be suppressed, reduced or released without affecting the automatic vacuum or air brake application on the train.

For further operation of the braking model see [3.1.2]

See Specification: 28-LAV-1 Westinghouse Specification[for further technical functionality.

The Independent Brake will be simulated to a Dynamic Modelling Level for this LOCO and linked to all relevant gauges and controls.

Automatic Brake Valve Handle

Running position

Control Logic
The handle is placed in this position for the following: • To charge the brake system. • when the brakes are charged and ready for use. • when the brakes are not being operated. • to release the locomotive and train brakes after an application. <u>Minimum position</u> Smallest application allowed. (Vacuum 17 kpa. Air Brake + 20kPa). <u>Service position</u> This position provides an automatic service application of locomotive and train brakes. <u>Suppression / Over reduction</u> This position is between the full service and handle out positions and is used for resetting the safety vigilance system after a trip. When brakes are applied in this position all air is drained from the brake pipe with no extra braking effort and no pressure for emergency remains. <u>Handle out position</u> The handle can be removed in this position only <u>Emergency position</u> This position provides the quickest and severest locomotive and train brake application. When an emergency brake application is registered with the automatic brake handle. The engine revolutions will drop to idle as soon as the brake pipe pressure drops below **205 kPa (Must fully vent to 0 kPa when in this position)** For further operation of the braking model see [3.1.2] See Specification: 28-LAV-1 Westinghouse Specification for further technical functionality. <u>The Automatic Brake will be simulated to a Dynamic Modelling Level for this LOCO and linked to all relevant gauges and controls.</u>
Air Brake regulating valve This is used to set brake pipe pressure / equalizing pressure. (Coupled directly to equalising reservoir pressure and the Brake pipe pressure will follow. ➢ By turning the valve clockwise you will be able to adjust the pressure from min at 0KPA – max 580KPA ➢ See Specification: 28-LAV-1 Westinghouse Specification for further technical functionality. <u>The Air brake regulating valve will be simulated to a Dynamic Modelling Level for this LOCO and linked to all relevant gauges and controls.</u>
Brake Valve Cut out Selector switch Sets the brake valves in or out of operation or prevents or allows the control of brake pipe pressure and equalising pressure for the brake system. ➢ The brake valve cut out control knob which sets the brake in or out of operation must be set to **"norm"** for the control of vacuum trains and light locomotives. ➢ For trailing or dead locomotives it must be set to **"off".** Direct release **(dir) (direct interlocking function)** sets the brake valve for the operation of air brake trains and must not be used when working vacuum brake trains. ➢ See Specification: 28-LAV-1 Westinghouse Specification for further technical functionality.

Control Logic

MU-2B Trail/Lead switch

The purpose of the MU-2B is to allow locomotives to be worked in single/multiple operation.

- Setting the MU-2B to lead enables brake equipment of one locomotive to be controlled by the brake equipment of another locomotive.
- During single/multiple operations the MU-2B on the leading locomotive must be set to "**lead**" (horizontal) and on the trailing locomotives it must be set to "**trail**" (vertical).

See Specification: 28-LAV-1 Westinghouse Specification for further technical functionality.

Right Console (Valves)

HS4 Vacuum Control Air Valve

Controls the Air Pressure to the Vacuum Brake

Pressure is read on the HS-4 Control Air Gauge and Vacuum Gauge Train brake pipe pressure(white needle)

- Opening the valve increase pressure proportionately from 0kPa to max of 400kPa
- When fully closed air to vacuum brakes is shut and vacuum gauge brake pipe pressure reads 0kPa as well as the HS-4 gauge. Vacuum brakes will be non functional
- Adjusting this valve also adjusts the Vacuum gauge pressure i.e. Setting the HS-4 gauge to 172kPa = 64kPa on the Vacuum gauge

Note: for simulation purposes the HS-4 Control Air valve will be sole control of these two gauge adjustments.

- See Specification: 28-LAV-1 Westinghouse Specification for further technical functionality.

<u>The HS-4 Control Air Valve will be simulated to a Dynamic Modelling Level for this LOCO and linked to all relevant gauges and controls.</u>

Sander Pedal Switch

Provided the engine is running

And dependant on the position of the lead axle sand switch(see lead axle sand switch for functionality)

Pressing the foot pedal will do the following:

- Sand will be applied onto the tracks allowing for better breaking and traction
- Releasing the pedal will stop the application of sand onto the tracks.
- A sanding sound will be heard

Vigilance Pedal

The vigilance pedal must be pressed within a 78 second period from last application to insure driver has not fallen asleep etc**.**

If the pedal is not depressed the following will happen:

- If the safety pedal is not periodically released and again depressed the audible warning device will sound at (± 70 seconds) after the last depress.
- If the safety pedal is **released** at any time during locomotive operation a warning whistle will sound after approximately **four seconds** and will continue to blow for another approximate **4 seconds** after which (**78 seconds**) the train and locomotive brakes will automatically be applied to a full service application intensity.
- Simultaneous with the brake application the Vigilance safety control warning light will come on.
- If the locomotive is in motoring, power will be automatically cut off and engine speed reduced to idle.
- If the locomotive is in dynamic braking, the dynamic brake will automatically cut out and engine speed will reduce to idle.

To **reset** this penalty brake application:

- depress the safety pedal and place the automatic brake handle in **"suppression"** position.

Control Logic
This action will stop the air blow in the brake stand. Leave the handle in this position until the safety control light extinguish (after approximately **6 seconds**) and place the automatic brake handle in the **"running"** position. ➢ To regain motoring throttle control, first "**close**" the throttle and then notch up normally as required. ➢ To regain dynamic brake control move the selector handle to **"neutral"** and then back to **"braking"** as required.
Quick Release Push Valve When pushed down it will increase the exhausting rate of the vacuum brake, creating vacuum quicker. See Specification: 28-LAV-1 Westinghouse Specification for further technical functionality. The quick release push button will be simulated to a Dynamic Modelling Level for this LOCO and linked to all relevant gauges and controls.
Emergency Vacuum and Air Brake Valve When Lifted up an emergency braking application is applied to the loco. The application is the same as a full service brake application but because brake pipe pressure is released, the locomotive will return to idle. after the brake pipe pressure has dropped (below **205 kPa**). It will switch in again at **295 kPa**. If the throttle is still notched up. See Specification: 28-LAV-1 Westinghouse Specification for further technical functionality. The Emergency Vacuum and Air Brake Valve will be simulated to a Dynamic Modelling Level for this LOCO and linked to all relevant gauges and controls.
Horn Switch Provided the Engine is running: ➢ Pressing this switch will cause the horn to activate. An audible LOCO Horn sound will be heard. ➢ Releasing the switch will cause the sound to cease.
Rear Console(Circuit Breaker, Controls and Gauges)
Battery Ammeter Gauge Provided the Engine is running the Auxiliary Generator Field and Auxiliary Generator circuit breakers are closed, then the following will display on the gauge. ➢ Under normal running conditions the ammeter will read >0 ➢ If the Breakers above are open and engine is running the Gauge will read <0 ➢ If engine is not running and all breakers are off Gauge will read 0 The ammeter gauge is marked from -100 amps to +100 amps with 0 amps in the centre
High Engine temp Warning Lamp Provided the Engine is Running the following will trigger the Warning Lamp to illuminate: ➢ If water temp rises to 93C and above the Lamp will illuminate ➢ When this lamp is active the warning bell will sound

Control Logic
The Lamp will extinguish if the following conditions are met: ➢ Water temp falls below 90C ➢ If the ECS switch is turned to Stop position causing Engine to cease running
Low Oil Pressure Warning Lamp Provided the Engine is Running the following will trigger the Warning Lamp to illuminate: ➢ If Lube oil pressure falls below 90kPa when ECR is in IDLE position ➢ If Lube oil pressure falls below 360kPa when ECR is in Run and Throttle is in Notch 8 ➢ When this lamp is active the warning bell will ring The Lamp will extinguish if the following conditions are met: ➢ If Pressure increases above 90kPa with ECR in IDLE ➢ If Pressure increases above 360kPa with ECR in RUN and Throttle in Notch 8 ➢ If the ECS switch is turned to Stop position causing Engine to cease running
Low Water Pressure Warning Lamp This Lamp will illuminate if a low water pressure fault is injected
Light Switch 1 Present but not functionally simulated.
Light Switch 2 Present but not functionally simulated.
Light Switch 3 Present but not functionally simulated.
Light Switch 4 Present but not functionally simulated.
Light Switch 5 Present but not functionally simulated.
Ground Relay*(simulated with a gauge)* **and Ground Reset Relay Switch** For simulation purposes the switch and relay will function as follows: ➢ on start up of LOCO the Ground relay will be set to open ➢ The needle on gauge will indicate to the red dot meaning relay is open ➢ operator will reset the Relay by pressing Ground Relay Reset switch manually, ➢ When Reset the Indicator needle will point to the Green Dot meaning relay is closed If Engine is running and ground fault is activated the relay will indicate to the red dot and the warning bell will sound and Engine Revs will return to IDLE. Pressing the Ground Reset Relay switch will deactivate the bell and return indicator needle to the green dot the engine revs as per normal.
Engine Control Switch (ECS) This switch is used to start and shutdown the diesel engine under normal conditions. The ECS has 5 positions – stop, run, idle, pump, start Provided the following conditions are met: ➢ Ground Relay has been reset ➢ Emergency Stop and Run Switches are in the Run position ➢ Battery Switch is closed ➢ The following circuit breakers are closed, auxiliary generator, Auxiliary generator field, Fuel pump. (see related circuit breaker for operation)

Control Logic
Turning the ECS clockwise to Pump will cause fuel Pressure to rise to 34kPa and an Audible Warning Bell will ring. Once at 34kPA turn switch to START for 5 seconds. Audible cranking sound will be heard and Engine will start, the audible warning bell will continue to ring. Allow switch to return to Pump and hold for 5 seconds until Lube Oil Pressure = >70kPa <90kPa. If lube pressure does not reach 70kPA before releasing the switch to Idle then: Engine will shutdown, Warning Bell will ring and Low Lube Warning Lamp will illuminate. Turning ECS to stop will clear the fault. Release switch to Idle Position, The warning Bell will stop ringing. Turn Switch to Run Position, Close Control Breaker - LOCO Master Controller will be functional and LOCO is ready for operation.
Circuit Breaker Switch –Control The Control Circuit Breaker allows the following to function when Closed: ➢ Reverse handle ➢ Selector Handle ➢ Throttle ➢ Wheel slip lamp and buzzer ➢ Sand Pedal When Open the above will not function as well as: ➢ Dynamic Breaking will not function unless Throttle is in Neutral for longer than >6 seconds before opening the Control Breaker. ➢ Engine RPM will return to idle if engine is running.
Circuit Breaker Switch –Auxiliary Generator Allows all of the circuit breakers to function when closed; if open all other circuit breakers will not function. ➢ Engine Control Switch ➢ Battery Charging If tripped whilst engine is running: Engine will continue to run but Battery System will not charge The Bell will ring and battery amp will show discharge
Circuit Breaker Switch – Headlight Allows the following to function when closed: ➢ All headlights ➢ Red Lights and coupler lights If open the following will not function regardless of independent light switches. ➢ All headlights ➢ Red Lights and coupler lights
Circuit Breaker Switch – Auxiliary Allows the following to function when closed: ➢ Internal compartment lights *Note: This Breaker is non crucial to operation and will only be used when required.*
Circuit Breaker Switch –Auxiliary Generator Field Allows the following to function when closed: ➢ Engine Control Switch ➢ Auxiliary Generator Breaker to function

Control Logic
➢ Battery Charging If tripped whilst engine is running: Engine will continue to run but Battery System will not charge due to Auxiliary Generator Circuit Breaker not working.
Circuit Breaker Switch – Fuel Pump Allows the following to function when closed: ➢ Engine Control Switch ➢ Fuel Pressure Gauge ➢ Warning Lamps ➢ Warning Bell When open the following will happen: ➢ If running the Engine will cease to run ➢ Fuel Pressure will drop to zero over a period of 3 seconds ➢ Warning Lamps and Bell will cease to operate.
Circuit Breaker Steam Heating *Will be present but not functionally simulated.*
Circuit Breaker "GENERIC" *(for training purposes this circuit breaker will simulate the function of three externally located breakers)* This circuit breaker will trip when one of the following faults are triggered: Overspeed Trip: If the LOCO exceeds normal full speed revs the "GENERIC", circuit breaker will trip. The engine will cease running and a warning bell will sound. To reset trip – switch engine off and follow normal start up procedures(see ECS switch for start up procedures) NOTE: See 3.1.3 Warning conditions for further functionality. Low Water Pressure: If the Engine cooling water pressure is excessively low the GENERIC circuit breaker will trip. The engine will cease running, the low water pressure warning lamp will come on and a warning bell will sound. To reset trip- switch engine off turn Generic breaker on and follow start up procedures as per normal. NOTE: See 3.1.3 Warning conditions for further functionality. Low Lube Oil Pressure: If the Lube oil pressure drops to between 68KPA and 90KPA at idle revs or 310KPA to 358KPA at full engine speed then the GENERIC Circuit breaker will trip, the engine will shutdown, the bell will ring AND THE Low lube oil pressure warning lamp will come on. To reset trip- switch engine off turn GENERIC breaker on and follow normal start up procedures. <u>The above faults will be simulated to a Dynamic Modelling Level for this LOCO and linked to all relevant gauges and controls.</u>
Rear Console (Gauges)

Control Logic
Turbocharger Gauge Displays the turbo pressure in kPa Provided the Engine is running For simulation purposes turbocharger pressure will be set as follows: ➢ With ECR at IDLE pressure =0kPA ➢ With ECR at Run, normal pressure will increase proportionately from 0kPa to max pressure of 200kPa as LOCO throttle is increased through the notches to max at notch 8 Turbo gauge reads from 0 – 400 kPA *Note: Pressure will drop in accordance with Load / Gradient and shall be worked out via dynamic modelling allowing the operator to adjust Throttle gearing if pressure decreases below 80kPa*
Fuel Pressure Gauge Displays the fuel under pressure in kPa Provided the Engine is running and Fuel Pressure Circuit Breaker is closed For simulation purposes fuel pressure will be set as follows ➢ With ECR at IDLE pressure =240 kPa ➢ With ECR at Run pressure = 120kPa ➢ With ECR at Stop pressure = 0kPA ➢ Fuel Circuit Breaker open pressure = 0kPa Fuel Pressure Gauge reads from 0-700kPA
Lube Oil Pressure Gauge Displays the oil lube pressure in kPa Provided the Engine is running For simulation purposes lube oil pressure will be set as follows: ➢ With ECR at IDLE, normal pressure =190kPA ➢ With ECR in RUN, normal pressure will proportionately increase from 190kPa to a max Pressure of 500kPa as the LOCO throttle is increased through the notches to max at notch 8 ➢ With ECR in STOP, pressure = 0kPa ➢ At IDLE Low oil lube pressure fault will activate below 90kPa When fault is active the Low Oil Pressure Lamp will illuminate and warning bell will ring. ➢ At RUN and throttle in notch 8 Low oil lube pressure fault will activate below 360kPa When fault is active the Low Oil Pressure Lamp will illuminate and warning bell will ring ➢ Shutting engine down will clear fault Lube Oil Pressure gauge reads from 0-1100kPA
Water Temperature Gauge Displays Water temp in Degrees Celsius Provide the Engine is running For simulation purposes water temp will be set as follows: ➢ Normal operating temp = 80C (will rise to 80C over a period of 10s from Start of Engine) ➢ High water temp fault will activate at 93C and deactivate at 90C when active the warning bell will sound and the Engine Overheat warning Lamp will illuminate. ➢ Shutting engine down will clear the fault

Control Logic
Water Temperature gauge reads from 0 -100 Centigrade
Battery Lever Switch If this switch is open then the LOCO will not be able to be started. When closed the LOCO can be started

3.1.2 Brake Model Functionality

The brake system is based on the Westinghouse 28-LAV-1 System used on Diesel-Electric locomotives in single or multiple unit service which are to move vacuum braked trains or pressure braked trains of either the direct or graduted release type. The locomotive brakes are operated by compressed air, either independently or in conjunction with the car brakes. When the car brakes are of the vacuum type they are piloted by the air system.

All Brake modelling must be simulated in accordance with technical documents labelled “28-LAV-1.pdf” and “Brake System for Simulator.doc” and “GE Eng Book.doc”.

The brake system allows for the following types of applications:

- Operation of locomotive and train brakes simultaneously
- Operation of train brakes only
- Operation of locomotive brakes only

NOTE: See reference Documents for relevant System/Technical Specifications pertaining to the 28-LAV-1 Brake System.

3.1.2.1 Independent Brake

The independent brake provides independent control of the locomotive brake cylinder irrespective of the automatic brake.

- the independent brake valve is self-lapping and pressure maintaining, i.e. a particular position of the handle corresponds with a particular locomotive brake cylinder pressure, which will be maintained against leakage
- The independent brake has 3 positions, Release/Running, Min Application and Full application:

Release/Running

- The handle is normally in this position and it releases the locomotive brakes after an independent brake application.

Min Application

- This zone extends from the “running position” to the “full application” position. The amount of brake application is determined by the distance that the handle is moved towards the “full application” position.

Max Application

- This position provides the maximum brake power available for locomotive braking.

Quick Release

- When making a brake application with the automatic brake valve the locomotive brakes will apply in proportion with the reduction of vacuum and brake pipe pressure.

To release this proportional locomotive brakes, the independent brake handle is pressed down and only the loco brakes will release. The train brakes (Air and/or vacuum) will not be effected. By depressing the handle in the "running" position, an automatic brake application on the locomotive will be suppressed, reduced or released without affecting the automatic vacuum brake application on the train.

- Brake pipe pressure will not vent. Only the loco brake cylinder pressure will release (vent)
- A venting sound will be heard

NOTE: See 3.1.2.3 for pressures pertaining to relevant Brake position.

3.1.2.2 Automatic Brake

The driver's automatic brake controls equalising pressure. The reduction/increase of brake-pipe pressure is converted to a reduction/increase of train pipe vacuum by means of a vacuum control valve. On this system the reduction of vacuum is converted to an increase of locomotive brake cylinder pressure by means of a control valve (proportional valve).

- Automatic brake is **"self-lapping"** and **"pressure-maintaining".** From a fully charged position, movement of the handle to a particular position will result in a corresponding degree of brake pipe pressure reduction. The new pressure will automatically be maintained without leaking off.
- Automatic Brake Handle has Five Positions:

Running
The handle is normally in this position and it charges/re-charges the equipment.

Minimum Application
This position provides a minimum brake application on the train and locomotive. See pressures in brake test.

Application zone (Min-Max - To full service)
This position provides a medium to heavy brake application on the train, and on the locomotive. The degree of application is determined by the distance that the handle is moved towards the **full service** position. On full service the vacuum must be zero and the equalising and brake pipe pressures must be 320 kPa

Full Service/Suppression
If the handle is placed in this position, no further brake application is made. The vacuum isalready on zero and the brake pipe and equalising pressures will leak off resulting in draining all air and an emergency application will not be possible. This position is used to reset a vigilance penalty application.
(See Vigilance functionality for further details.

Emergency Position.
This position provides the quickest and severest brake application with brake pipe and equalising pressure reduced quickly to zero and vacuum totally destroyed. Locomotive brake cylinder pressure will be higher (410kPa) than that obtained with a full service brake application. This locomotive brake cylinder pressure must be able to release with the automatice brake handle in emmergency, but when the independent handle is placed in the running position again, the brake cylinder pressure must build up to 410 kPa again.

3.1.2.3 Brake Pressures

Normal Running Conditions

- Vacuum train pipe 64 kPa
- Vacuum reservoir 80 -100 kPa
- Main air reservoir 860 – 960 kPa
- Equalising reservoir 500 kPa – 550KPA (Loaded Train)
- Brake pipe 500 - 550 kPa (Loaded Train)
- Brake cylinder 0 kPa

Automatic Brake - Minimum Application Position

- Vacuum train pipe 47 kPa
- Vacuum reservoir 80 -100 kPa
- Main air reservoir 860 – 960 kPa
- Equalising reservoir 450 kPa – 500KPA (Loaded Train)
- Brake pipe 450 - 500 kPa (Loaded Train)
- Brake cylinder Approximately 34 kPa

Automatic Brake - Full Service Position

- Vacuum train pipe 0 kPa
- Vacuum reservoir 80 -100 kPa
- Main air reservoir 860 – 960 kPa
- Equalising reservoir 320 kPa – 370KPA (Loaded Train)
- Brake pipe 320 - 370 kPa (Loaded Train)
- Brake cylinder 340 kPa

Automatic Brake - Emergency Position

- Vacuum train pipe 0 kPa
- Vacuum reservoir 80 -100 kPa
- Main air reservoir 860 – 960 kPa
- Equalising reservoir 0 kPa – 0 KPA (Loaded Train)
- Brake pipe 0 kPa - 0 kPa (Loaded Train)
- Brake cylinder 410 kPa

Independent Brake – Min Application

- Brake Cylinder 34kPA

Independent Brake – Max Application

- Brake Cylinder 340kPA

3.1.2.4 Brake Sounds

Independent brake

Application – No sound
Release – Continuous low blowing sound while releasing. If stopped halfway, the sound stops

Automatic brake

If the train is fully charged the blowing sounds will be loud, if not fully charged the sounds will be softer

Minimum application - Shorter sharp blowing sound.

Service application - Dependant on the length of the train and the size of the application, but a continuous blowing sound until pressures equalise.
Emergency application - A loud blowing sound until pressures are zero

3.1.3 Vehicle Test Procedures

The following are test procedures performed by the operator on start-up of the LOCO.

These test procedures will need to be included within the simulated software.

TEST PROCEDURE

BRAKE TEST

Provided the LOCO is Running:
Make a minimum brake application. After the gauge readings have stabilised it must register as follow :

- Vacuum train pipe - 47 kPa
- Vacuum reservoir - 80 -100 kPa
- Main air reservoir - 860 – 960 kPa
- Equalising reservoir - 450 kPa
- Brake pipe - 450 kPa
- Brake cylinder - Approximately 34 kPa

Make a full service brake application and after the gauge readings have stabilised the readings must be:

- Vacuum train pipe - 0 kPa
- Vacuum reservoir - 80 – 100 kPa
- Main air reservoir - 860 – 960 kPa
- Equalising reservoir - 320 kPa.
- Brake pipe - 320 kPa.
- Brake cylinder - 340 kPa.

- Place the independent brake valve handle in the quick release position. The brake cylinder pressure must reduce to **zero kPa**. Ensure that the brake cylinder pressure does not build up after releasing the handle**. (Test pilot air valve)**

- Place the automatic brake valve handle in the running position to recharge the system. If an air brake train is operated, place the automatic brake handle in the minimum position. Ensure that brake pipe pressure does not increase. Place the automatic brake valve handle back in the running position.

- Place the automatic brake in the full application position again.

- As soon as the blow in the brake stand stops, place the automatic brake handle in the emergency position.

- Operate the throttle to notch 8 and back again to neutral –no power (test engine pressure switch. – Brake pipe pressure drops to below 205 kPa.

  (The engine revolutions will drop to idle as soon as the brake pipe pressure drops below **205 kPa**.

After the gauge readings have stabilised the readings must be:

- Vacuum train pipe - 0 kPa
- Vacuum reservoir - 80 – 100 kPa

TEST PROCEDURE

- Main air reservoir - 860 – 960 kPa
- Equalising reservoir - 0 kPa
- Brake pipe - 0 kPa
- Brake cylinder - 410 kPa

Recharge the system fully by placing the automatic brake handle in the "**running" position**.

VIGILANCE CONTROL TEST

Ensure that the engine control switch is still on run and that the control circuit breaker is closed.

Place the foot on the vigilance control pedal, the reverse key in "neutral" and move the throttle handle to **notch 2.**

- Listen that the engine revolutions build up.
- Lift the foot from the pedal. There will be silence for four seconds and thereafter a whistle will sound
- Depress the pedal. The whistle sound will stop and no changes must take place (no brake application).
- Again lift the foot from the pedal – Four seconds silence. Thereafter a whistle will sound for four seconds and keep on sounding. Thereafter a penalty application will occur. As soon as the brake application begins (observe the equalising needle) try to prevent the application by quickly placing the foot back on the pedal. **(It must not be possible to prevent the application.)** The following will occur:

  - The vigilance control light (white) will illuminate on the safety control box.
  - No reaction on the throttle. (Open the throttle to notch 8 and back to notch 2)
  - A full automatic penalty application occurs**.**

  - A blow sound is heard in the brake stand**.**
  - The engine revolutions reduce to idling speed**.**

- Place the automatic brake handle in the suppression (over reduction) position for approximately **6 seconds**. The blow sound in the brake stand will stop and the white light extinguish. As soon as the light extinguishes place the automatic brake handle in the running position and the throttle in neutral. The system will now recharge.

  Long cycle

  - Lift and replace foot on the pedal and after approximately **70 seconds** with foot on the pedal a warning signal will sound for four seconds where after the whistle will sound.
  - As soon as the whistle sounds, lift foot from the pedal and immediately replace it again.
  - The whistle sound must stop immediately and no brake application must take place.
- Place the independent brake handle in the **full application position** and ensure that the brake cylinder pressure builds up to **310 kPa.**
- Lift the foot from the pedal and for approximately **eight seconds** no whistle must sound nor should any brake application take place.

3.1.4 Vehicle Warning Conditions

LOGICAL SEQUENCE	LOW OIL PRESSURE	LOW WATER PRESSURE
BELL	RING	RING
LIGHT	GREEN	YELLOW
ENGINE REVOLUTIONS	SHUT DOWN	SHUT DOWN
POSITION OF TRIP	UPPER TRIP ON WOODWARD GOVERNOR TRIPS OUT	LOWER TRIP ON WOODWARD GOVERNOR TRIPS OUT
OTHER OBSERVATIONS		

LOGICAL SEQUENCE	HOT ENGINE	LOW WATER LEVEL	OVERSPEED
BELL	RING	RING	RING
LIGHT	RED	RED	NONE
ENGINE REVOLUTIONS	REMAIN UNCHANGED	REMAIN UNCHANGED	SHUT-DOWN
POSITION OF TRIP	NONE	NONE	TRIP ON OVERSPEED. GOVERNOR TRIPS OUT. Driver to reset on rear console with generic trip switch. (All trips in the control / machine compartment must be reset with this switch in the simulated cab)

OTHER OBSERVATIONS	TEMPERATURE 93°C OR HIGHER	TEMPERATURE NORMAL. WATER-LEVEL IN LEXAN GAUGE GLASS IS LOW	
REMARKS	DISAPPEARS AT 90°C	IF WATER IS NOT LOW CHECK GAUGE ON "B" SIDE FOR HOT ENGINE	IF THE THROTTLE IS NOT CLOSED IN TIME THE LOW LUBE OIL PRESSURE TRIP WILL ALSO TRIP

LOGICAL SEQUENCE	**GROUND RELAY**	**BATTERIES NOT CHARGING**
BELL	RING	RING
LIGHT	BLACK NEEDLE ON RED DOT	
ENGINE REVOLUTIONS	RETURN TO IDLE	REMAIN UNCHANGED
POSITION OF TRIP	RESET BUTTON ON SWITCH PANEL TRIPS OUT	Auxiliary generator trip
OTHER OBSERVATIONS	POSSIBLE SEVERE CRACK	DISCHARGING READING ON AMMETER. AUXILIARY GENERATOR FIELD, CIRCUIT BREAKER TRIPPED
4 REMARKS		

The following trips in the control / machine compartment must be reset with the generic trip switch on the rear console in the simulated cab:

- Low oil pressure trip
- Low water pressure trip
- Overspeed trip

5 ADDITIONAL REQUIREMENTS

5.1 Customer Furnished Equipment

No Customer Furnished Equipment (CFE) will be required.

5.2 Customer Furnished Information

The Contractor will require the Client to assign a Subject Matter Expert (SME) to the project for the duration of the development cycle. The role of the SME will be as follows:

- To provide the development team with technical and operational information required for the simulation (*e.g.* operator procedures, physical and functional characteristics, *etc.*).
- To provide expert feedback and advice to the development team on design issues at both formal and informal design review sessions.
- To provide feedback to the Client team on the technical / operational progress of the development project.
- The Contractor views the SME as an integral member of the development team who will contribute greatly to the overall success of the project.

5.3 Acceptance Test Procedures

5.3.1 Factory Acceptance Tests

A Factory Acceptance Test Procedure document (FATP) will be produced. The FATP will describe a set of tests that will demonstrate the functionality described in this specification. Factory acceptance tests will be performed on the simulator and / or simulator sub-systems against this FATP prior to system / sub-system delivery, in accordance with ThoroughTec Business Processes.

5.3.2 Site Acceptance Tests

ThoroughTec's standard Site Acceptance Test Procedure document (SATP) describes the set of tests that verify correct commissioning of the unit at Site. Site acceptance tests will be performed on the simulator and / or simulator sub-systems against this SATP to conclude the commissioning process in accordance with ThoroughTec Business Processes.

5.4 Facilities and Facility Equipment

The Client will be responsible for the preparation of all facilities and facility equipment prior to the delivery of the sub-system. These responsibilities will include:

- The supply of an enclosed sheltered area with floor space of an area large enough to deploy the simulator for its intended use.
- The provision of stable power at a suitable location in the deployment area (power specifications to be supplied by ThoroughTec upon request).