

SOUTHERN RAILWAY
HAND BOOK
On
3 PHASE LOCOS COURSE
(WAP5/WAP7/WAG9&9H)



ZONAL ELECTRIC TRACTION TRAINING CENTRE.

AVADI, CHENNAI -109

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ADVANTAGES OF 3-PHASE LOCOMOTIVES

The merits of 3-phase locomotives over conventional locomotives are summarized below.

The size of traction motor for the same output power is much less in case of a 3-phase induction motor compared to DC motor. Therefore, with the permissible axle load and available space in a bogie, realization of a much higher-powered loco motive is possible.

Maintenance cost of a 3-phase locomotive is less due to absence of brush-gear/ commutator in the traction motors and switchgears in the power circuit.

Induction motors are very robust. Consequently reliability of a 3-phase locomotive is higher.

The rated power of a D.C.-motored locomotive reduces beyond the field weakening range. In case of 3-phase loco motives, full power is available up to the maximum speed.

Overload capabilities in 3-phase locomotives are more Liberal.

Regeneration of power is available in 3-phase locomotives. Regenerative braking effort is available from the full speed till dead stop. Consequently, the overall efficiency of operation is higher.

Due to superior drop characteristics of speed Vs. torque and the fact that the motor speed is limited by the synchronous speed, a much improved adhesion is available in 3-phase locomotive and thus higher tractive efforts can be realized within permissible axle load limits.

3-phase locomotive operates at near unity power factor throughout the speed range except at very low speeds.

Due to lesser weight of the traction motors, the un-sprung masses in 3-phase locomotive are low. This reduces track forces and consequently minimizes wear on rails and disturbance to track geometry.

GENERAL FEATURES OF 3-PHASE AC LOCO

Advanced Technological Features: -

In addition to the provision of latest 3-phase traction drive system; the 3-phase locomotives have certain improved technical features as compared to the conventional locomotives so being used on IR. Some major features are listed below.

Digital electronics based real time traction control System: -

To obtain precise control over tractive effort and speed in the normal mode and constant speed control mode of operation respectively.

Electrical weight transfer control system: -To automatically reduce the tractive effort in the leading bogie and increase the same in the trailing bogie to take care of weight transfer effect.

Anti spin protection: -When the ratio of applied and required tractive effort goes below 0.5, anti spin protection initiated which reduce the TE and apply loco brakes to stop spinning.

On-board fault diagnostics system: -To eliminate/ elaborate trouble-shooting by engine crew and also to help maintenance staff to trace faults. The fault diagnostics system provides for automatic isolation of faulty equipment/ subsystems.

Simulation mode of operation: - To facilitate a complete functional testing of the locomotive without raising pantograph.

An exclusive harmonic filter circuit: -To reduce harmonics in the loco current

Static auxiliary converter: - To supply auxiliary 3-phase motors. The auxiliary converter, depending on then traction load, operates at an optimum frequency to minimize power consumed by auxiliaries

Electronic speedometer: - Paper less speed recording system. An over speed alarm system is built in.

Electronic energy meter: - For information of energy generated and energy consumed

Fire detection and alarm system: - For the machine room.

Low traction bar arrangement between bogie and body to reduce Weight transfer:-
Unidirectional mounting of traction motors to further reduce weight Transfer effect.

Ergonomically designed and spacious driving cabs: - To provide comfort and relief to crew.

Use of dust filters: - Pressurized machine room to prevent entry of dust into sensitive equipment in the machine room.

Electronic brake system: -For precise and fast control of braking effort, blending between electrical brake and pneumatic brake on the locomotive.

Triplet pneumatic brake panel: - To minimize piping and provide single- place location of all pneumatic equipment.

Use of tread brake units: - To reduce maintenance

Spring loaded parking brake system -Instead of handbrakes, spring loaded parking brakes are provided on this loco, these brakes can be operated from loco and remain applied without pressure by spring.

Over-charge feature in the brake system for quick release of brakes - For faster release of train brakes after recreation, BP is charged to 5.4 kg/ cm² for short time with restricted dropping rate to 5.0 kg/cm².

Electronic controlled vigilance system -To keep the loco pilot alert Vigilance system is provided, As per this system, loco pilot has to do predetermined task once within 60 seconds, otherwise VCD will apply emergency braking.

Wheel Flange lubrication system: -To reduce energy consumption and wheel wear.

Under-slung compressors: - To eliminate oil fumes and oil spillage inside the machine room, which is potential cause for fire hazards.

TECHNICAL DATA			
Technical Data	WAP-5	WAP-7	WAG-9
Type of Service	Passenger	Passenger	Freight
Axle Arrangement	Bo-Bo	Co-Co	Co-Co
Gear Ratio	1:3.65(67:35:17)	1:3.6(72:20)	1:5.133(77:15)
Gauge	1676 mm	1676 mm	1676 mm
Length over Buffer	18162 mm	20562 mm	20562 mm
Overall Width	3142 mm	3100 mm	3152 mm
Maximum Height with Pantograph Locked	4255 mm	4255 mm	4255 mm
Wheel Diameter New Worn	1092 mm 1016 mm	1092 mm 1016 mm	1092 mm 1016 mm
Total Weight	78 T	123 T	123 T
OHE Voltage Nominal Minimum Maximum	25 KV 17.5 KV 30 KV	25 KV 17.5 KV 30 KV	25 KV 17.5 KV 30 KV
OHE Frequency Nominal Minimum Maximum	50 Hz 45 Hz 55 Hz	50 Hz 45 Hz 55 Hz	50 Hz 45 Hz 55 Hz
Power Supply to Auxiliary Frequency No. of Auxiliary Converter	415 V \pm 10% 0 to 59 Hz Aux. Conv. 1,2,3	415 V \pm 10% 0 to 59 Hz Aux. Conv. 1,2,3	415 V \pm 10% 0 to 59 Hz Aux. Conv. 1,2,3.
Battery Voltage	110 V	110 V	110 V
Power Supply to Traction Motors	2180 V	2180 V	2180 V
No. Of Power Converters	2	2	2

Type of Traction Motor	Three phase Induction Motors	Three phase Induction Motors	Three phase Induction Motor
No. of Traction Motors	4 6FXA7059	6 6FRA6068	6 6FRA6068
Power of Traction Motor	1563HP	1156 HP	1156 HP
Tractive Effort	258 KN	322.6 KN	458 KN
Braking	Regenerative, Pneumatic, Parking, Anti Spin	Regenerative Pneumatic, Parking, Anti Spin	Regenerative, Pneumatic, Parking, Anti Spin
Braking Effort	160 KN	182 KN	260 KN
Parking Brakes:	Wheel No. 1,4,5 & 8	Wheel No. 2,6,7 & 11	Wheel No. 2,6,7 & 11
Horse Power	5440 HP	6120 HP	6120 HP
Maximum Speed	160 Kmph	130 Kmph	100 Kmph
Main Reservoir	3 nos	2 nos.	2 nos
Hotel Load	Available	Not available	Not available
Loco brakes	On Disc 5 kg/cm ²	On Wheel 3.5 kg/cm ²	On Wheel 3.5 kg/cm ²

ABBREVIATIONS

ALG	Drive Control Unit - Drive Inverter and Line converter Control
ASC	Loco pilot Converter Control
ASR	Drive Converter
BL	Key switch
BLCP	Spring-loaded switch for Main compressors
BLDJ	Spring-loaded switch for Main circuit breaker
BLHO	Spring-loaded switch for Hotel load (not active on WAG-9)
BLPR	Switch Headlights
BPCS	Illuminated push-button, green for Constant speed control
BPFA	Illuminated push-button, yellow for acknowledgement all fault Messages
BPFL	Illuminated push-button, yellow Emergency flashlight
BPPB	Illuminated push-button, red for parking brake
BPVG	Push-button, green for Vigilance
BPVR	Push-button, illuminated yellow for resetting vigilance
BUR	Auxiliary Converter
BZ-V-O-F	Buzzer for vigilance, over speed and fire
CEL	Central Electronics
CSC	Constant Speed Control
DDS	Diagnostic Data Set
FLG	Vehicle Control Unit
GTO	Gate Turn Off
HB	Cubicle Auxiliary Circuits
HBB	Processor
HRA	Switch Cab blower/heating
LSAF	Indication lamp, red for Train parting
LSCE	Indication lamp, amber for over temperature CEL
LSDJ	Indication lamp, red for Main Circuit Breaker
LSFI	indication lamp, red for Fault message, priority 1
LSHO	Indication lamp, yellow Hotel load (Not active on WAG-9)
LSP	Indication lamp, yellow for Wheel slipping
LSVW	Indication lamp, yellow for Vigilance Warning
MCB	Main Circuit Breaker
MCE	MICAS-S2 Control Electronics
MEMOTEL	Speed Recorder and Indicator
MR	Machine Room
MUB	Over voltage Protection Unit
NSR	Line Converter
Pan	Pantograph
PCLH	Socket Hand Lamp
PP	Pneumatic Panel
SB	Cubicle Control Circuits
SLG	Converter Control Unit

SR	Traction Converter
SS	Subsystem
STB	Low Voltage Cubicle Control
TE/BE	Tractive/braking effort
UBA	Voltmeter Battery Voltage
VCB	Vacuum Circuit Breaker - Main Circuit Breaker
ZBAN	Switch- Banking operation
ZBV	Train Bus Administrator
ZLC	Switch for Loco pilot's cab lighting
ZLDA	Switch for Assistant Loco pilot's desk Illumination
ZLDD	Switch for Loco pilot's desk illumination
ZLFR	Switch for Marker lights, red
ZLFW	Switch for Marker lights, white
ZLH	Switch for Socket hand lamp
ZLI	Switch for Instrument lighting
ZPRD	Switch for Headlights, intensity
ZPT	Spring-loaded switch for Pantograph
ZTEL	Switch for Max. Traction limitation
ZK	DC link

INTRODUCTION TO ELECTRONIC DEVICES:

Semi Conductor diodes:

A PN junction is made by joining a P-type and a N-type semi conductor. P region contains holes (+) and negatively charged (-) acceptor impurity ions. N region contains electrons (-) and positively charged donor (+) ions.



The PN junction allows flow of current depending on the bias i.e., application of voltage. In forward bias the +ve of the supply is connected to P and -ve is the supply connected to N side. This facilitates flow of current due to repulsion of holes from P side to junction and electron from N side to junction where electrons cross the junction. During the reverse bias, the +ve of the battery is applied to N side and - of the battery is connected to the P side. In such a situation the holes are attracted to battery terminals so also the electrons from N side. Due to these phenomena the interval of potential barrier increases and no flow of current takes place.

Thyristor

Thyristor, in general, is a **solid-state** semiconductor device having 3 or more junctions. It is having Anode (A), cathode (K) and Gate (G). It starts working only when required Gate supply is given between Gate and cathode.

The thyristor family include SCR, GTO, TRIAC, DIAC etc. The thyristor is a four-layer semiconductor device, with each layer consisting of alternately N type or P type material, for example P-N-P-N. The main terminals, labeled anode and cathode, are across the full four layers, and the control terminal, called the gate, is attached to p-type material near to the cathode.

They act as a switch, conducting when their gate receives a current pulse, and continue to conduct for as long as they are forward biased (that is, as long as the voltage across the device has not reversed). Such device can be fabricated to have voltage ratings of several hundred volts and current ratings from a few ampere to thousands amperes.

Gate Turn off (GTO) Methods

The simplest and most widely used method of commutation makes use of the alternating, reversing nature of a.c. voltages to effect the current transfer. We know that in a.c. circuits the current always passes through zero every half cycle. As the current passes through natural zero, a reverse voltage will simultaneously appear across the device. This immediately turns-off the device.

Once Thyristor are operating in the ON State, carrying forward current, they can only be turned OFF by reducing the current flowing through them to zero for sufficient time to allow the

removal of charged carriers. In case of d.c. circuits, for switching off the Thyristor, the forward current should be forced to be zero by means of some external circuits. The process is called forced commutation and the external circuits required for it are known as commutation circuits. The components (inductance and capacitance) which constitute the commutating circuits are called as commutating components. A reverse voltage is developed across the device by means of a commutating circuit that immediately brings the forward current in the device to zero, thus turning off the device.

Thyristors have three states:

1. Reverse blocking mode -- Voltage is applied in the direction that would be blocked by a diode
2. Forward blocking mode -- Voltage is applied in the direction that would cause a diode to conduct, but the thyristor has not yet been triggered into conduction
3. Forward conducting mode -- The thyristor has been triggered into conduction and will remain conducting until the forward current drops below a threshold value known as the "holding current"

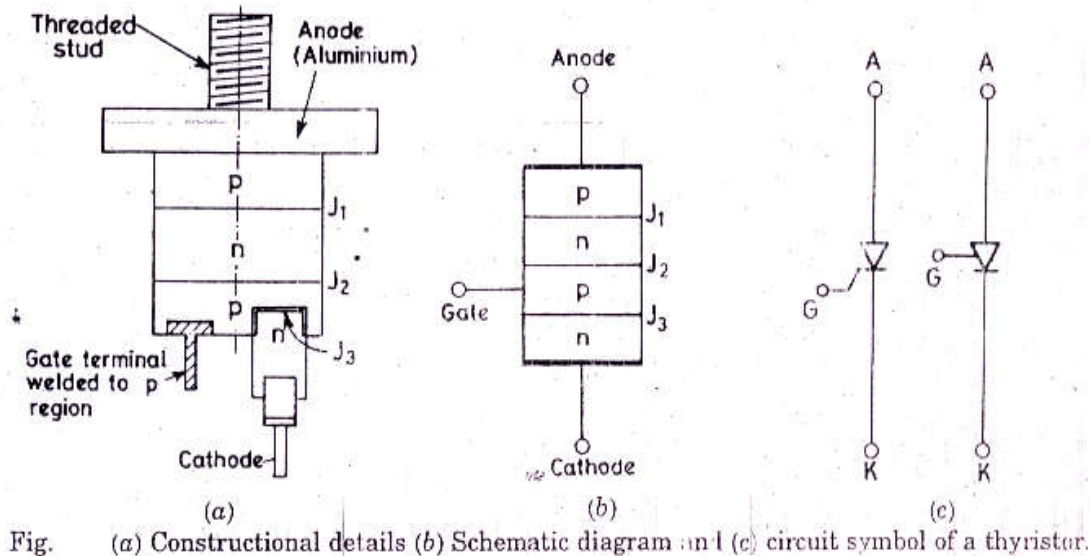


Fig. (a) Constructional details (b) Schematic diagram and (c) circuit symbol of a thyristor.

Applications

Thyristors are mainly used where high currents and voltages are involved, and are often used to control alternating currents, where the change of polarity of the current causes the device to automatically switch off, referred to as Zero Cross operation. The device can be said to operate *synchronously* as, once the device is open, it conducts current in phase with the voltage applied over its cathode to anode junction with no further gate modulation being required to replicate; the device is biased *fully on*.

IGBT

The **insulated gate bipolar transistor** or **IGBT** is a three-terminal power semiconductor device, noted for high efficiency and fast switching. Since it is designed to rapidly turn on and off, amplifiers that use it often synthesize complex waveforms with pulse width modulation and low-pass filters.

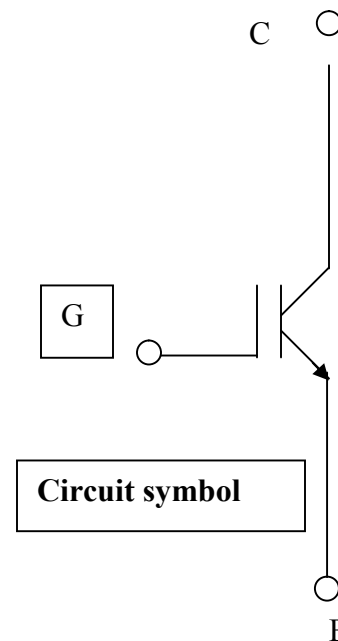
The IGBT combines the simple gate-drive characteristics of the MOSFETs with the high-current and low-saturation-voltage capability of bipolar transistors by combining an isolated gate FET for the control input, and a bipolar power transistor as a switch, in a single device. The IGBT is used in medium- to high-power applications such as switched-mode power supply, traction motor control and induction heating. Large IGBT modules typically consist of many devices in parallel and can have very high current handling capabilities in the order of hundreds of amps with blocking voltages of 6,000 V.

The main advantage of IGBT technology is a significant reduction in power loss due to the switching loss is considerably lower and proportional to the switched current. This leads to significantly reduced total power losses and the subsequent increase in converter efficiency, It is also having short circuit turn-off protection, simplification and optimisation of the control circuits.

B) Insulated-gate bipolar transistor



A power IGBT (3300 V/1200 A)



C – Cathode G – Gate E – Emitter

Transducers :

A transducer is a device which converts energy from one form to another form; it may be electrical, Mechanical, chemical, optical or thermal. It requires DC power supply to function. The transducer that gives electrical energy as out put is known as electrical transducer.

(C) Optical Fiber cable

Optical fibers are made of glass which in turn is made from sand an inexpensive raw material available in unlimited amounts. The fiber optic cable consists of core (glass), cladding (glass), Jacket (plastic).

The light propagates through centre core (glass). The core is of 8 to 10 microns in diameter. The core is surrounded by glass cladding with a lower index of refraction than core, to keep all the light in the core. This further protected by thin plastic jacket.

The optical transmission system has three components the light source, the transmission medium and the detector. Conventionally a pulse of light indicates a bit and the absence of light indicates a zero bit. The detector generates an electrical pulse when light falls on it. By attaching a light source to one end of an optical fiber and a detector to the other, we have an unidirectional data transmission system that accepts an electrical signal, converts and transmits it by light pulses, and then reconverts the output to a electrical signal at the receiving end.

When light ray passes from one medium to another, the ray is refracted (bent) at boundary. In above fig we see a light ray incident on the boundary at angle μ_1 , emerging at an angle μ_2 . The amount of retraction depends on the properties of two media used. For angles of incidence above a certain critical valve, the light is retracted back into the silica none of it escapes into the air. Thus a light ray incident at or above a critical angle is trapped inside the fiber as shown in Fig (2)

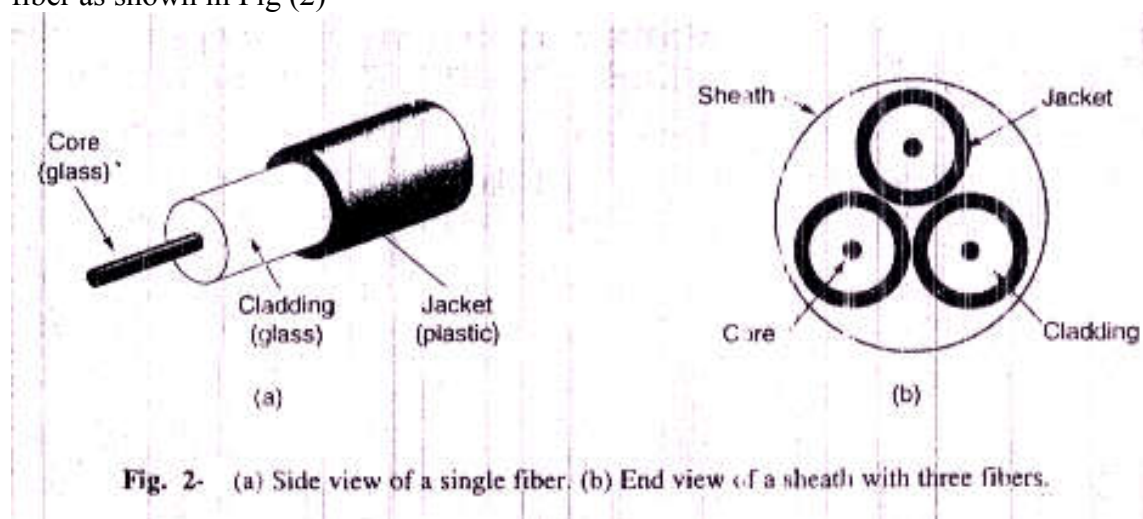
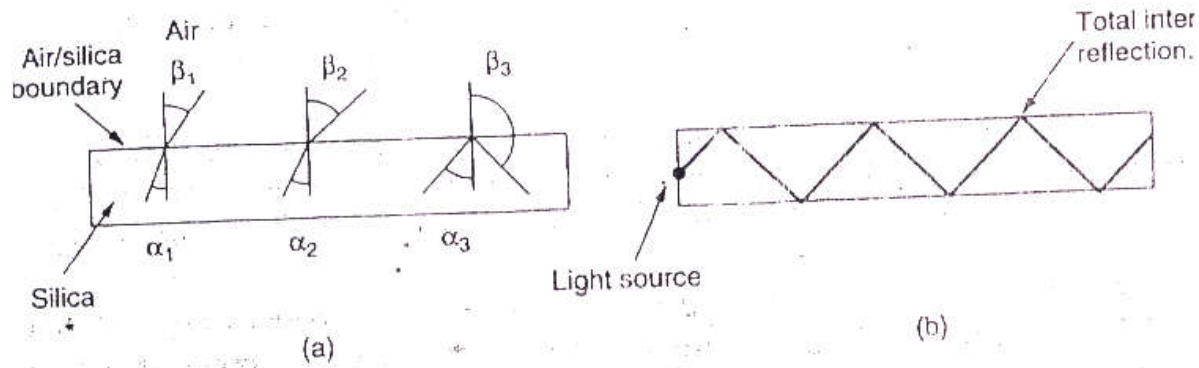


Fig. 2- (a) Side view of a single fiber. (b) End view of a sheath with three fibers.

Advantages:

1. It can be operated in much higher band widths, light weight and thin.
2. Due to low attenuation, repeaters are needed only about every 30 Km on long lines (cost saving.)
3. They are not affected by power surges, electromagnetic interference, or power failures, no affect of corrosive chemicals.



(D)Micro Controllers

A **microcontroller** (also MCU or μC) is a functional computer system-on-a-chip. It contains a processor core, memory, and programmable input/output peripherals.

Microcontrollers include an integrated CPU, memory (a small amount of RAM, program memory, or both) and peripherals capable of input and output.

It emphasizes high integration, in contrast to a microprocessor which only contains a CPU (the kind used in a PC). In addition to the usual arithmetic and logic elements of a general purpose microprocessor, the microcontroller integrates additional elements such as read-write memory for data storage, read-only memory for program storage, Flash memory for permanent data storage, peripherals, and input/output interfaces. At clock speeds of as little as 32 KHz, microcontrollers often operate at very low speed compared to microprocessors, but this is adequate for typical applications. They consume relatively little power (mill watts), and will generally have the ability to retain functionality while waiting for an event such as a button press or interrupt. Power consumption while sleeping (CPU and peripherals off) may be just nanowatts, making them ideal for low power and long lasting battery applications.

Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, remote controls, office machines, appliances, power tools, and toys. By reducing the size, cost, and power consumption compared to a design using a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to electronically control many more processes.

TECHNICAL PARTICULARS FOR WAG9 LOCOMOTIVE
--

A. SALIENT DATA ON LOCOMOTIVE

1.1 Guaranteed performance at 22.5 kV and half worn wheel:

(i)	Starting tractive effort	460 kN
(ii)	Continous rated tractive effort in The speed range of 0-50 km/h	325 kN
(iii)	Continuous rated speed	50 km/h
(iv)	Continuous rated power at wheel Rim in the speed range of 80-160 km/h	4500 kW
(v)	Maximum regenerative braking effort	260 kN (10-62 km/h)
(vi)	Maximum service speed	100 km/h

1.2 Arrangement:

(i)	Axle arrangement	Co-Co
(ii)	Traction motor mounting	Axle hung, nose suspended
(iii)	Brake system	Air, regenerative and parking brake for loco Air brake for train.
(iv)	Control circuit voltage	100 V dc (nominal)

1.3 Important dimensions:

(i)	Total weight	123.0 ± 1% tones
(ii)	Axle load	20.5 ± 2% tones
(iii)	Unsprung mass per axle	3.99 tonnes
(iv)	Wheel Dia	- new 1092 mm - half worn 1054 mm - full worn 1016 mm
(v)	Gear ration	5.133 (77:15)
(vi)	Length of loco over buffers	20562 mm
(vii)	Length of loco over headstock	19280 mm
(viii)	Bogie centre distance	12000 mm
(ix)	Loco wheel base	15700 mm
(x)	Bogie wheel base	1850 + 1850 mm
(xi)	Overall width of the body	3152 mm
(xii)	Length of cab	2434 mm
(xiii)	Panto locked down height	4255 mm
(xiv)	Height of C.G. from rail level	1349 mm

1.4 Other salient features:

3-phase drive with GTO thyristors and MICAS-S2 Microprocessor based control system. Provision for multiple unit operation of two locomotives. Provision for ballasting to increase the loco weight to 135 tonnes in future. Provision for fitment of LOCOTROL equipment in future. Design permits interfacing and allows space. The design permits interfacing and provision of “inching control” in future.

B. SALIENT DATA ON MAJOR SUBSYSTEMS/EQUIPEMENT/COMPONENTS
--

EQUIPMENT, TYPE, MAKE AND MAIN RATING/DATA

1.1 Traction motor:

Make	:ABB, Switzerland	6 nos/loco
Type	:6 FRA 6068	3-pahse Induction Motor Axle hung nose suspended type.

	<u>Cont.</u>	<u>Max.</u>	
Voltage phase to phase	2180	2180	V
Current per pahse	270	393	A
Frequency	65	132	Hz
Output at shaft	850	850	kW
Torque at shaft	6330	9200	Nm.
Speed	1283	2584	rpm
Cos Φ	0.88		

All the above values are given for half worn wheels

Design speed	2842	rpm
Over speed test speed For 2 minutes	3250	rpm
Stator winding	Class 2000, Veridur (R) system	
Insulation system		

1.2 Transformer:

Make	:ABB, Switzerland	1 no/loco
Type	:LOT 6500	
Rating	:at 25 kV line voltage	

Primary winding	:25 kV, 6531 kVA, 261.25 A	
Traction winding	:4x1269V, 4x1449 kVA, 4x1142 A	
Aux. Converter winding	:1000V, 334 kVA, 334 A	
Filter winding	:1154 V, 400 kVA, 347 A	
No load current	:0.5A at 22.5 kV	
Series resonant circuit reactor	:2x984 A RMS, 2X0.551 mH, Assembled in linear upto 2x1391 A peak transformer	
Cooling system	:Forced oil cooling using standard mineral oil	Oil type shell Diala DX

Impedances

Traction winding

(Guaranteed value for traction winding inductivity $L = 2.1 \text{ mH} \pm 15\%$ only, others for information purpose)
 $R = 34 \text{ m}\Omega$

Aux. Converter winding

$L = 0.5 \text{ mH}$

$R = 23.7 \text{ m}\Omega$

Temp. Rises

Primary	11 K
Traction	17 K
Aux. Converter	12 K
Hotel load	13 K
Filter	3 K

Temperatures

Cu.max.	100 °C
Oil max.	84 °C
Oil mean	82 °C

1.3 Power converter:

Make :ABB, Switzerland 2 nos/loco
 Type :UW 2423-2810

(i) 4 Quadrant power converter

Suitable for

Transformer secondary 2 x 1269 V at 25 kV line voltage

Voltage

Frequency 50 Hz \pm 3%

DC link voltage 2800 V nominal

Cooling system

Forced oil cooling

Oil type shell

Using standard

Diala DX

Mineral oil.

(With 8 GTO Thyristors 4.5 kV/3 kA, Thoshiba Type SG 3000GXH24 or equivalent type and gate units and 8 Poer Diode Type D921S45T Eupec Make or equivalent)

(ii) Motor Inverter

Suitable for

Motor voltage 2180 V

(phase to phase)

Motor frequency	0... 132 Hz	
DC link voltage	2800 V (nominal)	
Colling system	Forced oil cooling	Oil type shell
	Using standard	Diala D
	Mineral oil.	

(With 6 GTO Thyristors 4.5 kV/3 kA, Toshiba Type SG 3000GXH24 or equivalent type and gate units and 6 Power Diode Type D921S45T Eupec Makeor equivalent)

(iii) DC Link Capacitor

Make	:Condis
Type	:CDM15230A0815
Rating	:Capacity: 815 μ F
	:Voltage : 2940 Vnom.
Bank	:11.41 mF
Capacity	

(iv) Instant Voltage Limitation

Make	:Microelecttrica Scientifica, Italy
Type	:MUB
Voltage	:2800 V
Current	:500 A
Containing	- GTO thyristor and gate units
	- power diode
	- power resistor (Microelettrica)

(With 1 GTO thyristor 4.5 kV/3kA Toshiba type SG 3000GXH24 or equivalent type and gate unit and power diode type D921S45T Eupec make or equivalent type)

(v) Series Resonant Circuit Capacitor

Make	:ERO
Type	:ERO-GFP 3.8
Rating	:560 μ F, 2940 V
Bank	:4.6 mF (The bank has 8 nos of these
capacity	capacitors and one adjustable capacitor unit
	consists of 3 capacitors
	(280 μ F+140 μ F+140 μ F)

1.4 Auxiliary converter set

Type	BUR 10A	3 nos. per loco
	100/L VPS	

ABB, Switzerland All 3 units are identical and can be operated either in constant voltage/frequency or VVVF mode.

Input power 90 kW each
Cooling Forced air

Output (each)

(i),(ii) Variable frequency 0-50 Hz, 3 phase, 415 V, 100 kVA for
- 1 Traction motor blower
- 1 Oil cooler blower
- 1 Scavage blower for traction motor and oil cooler blowers.

(ii) Constant frequency 50 Hz, 3 phase, 415 V, 100 kVA for:
- 2 Trnasformer oil pumps
- 2 Converter oil pumps
- 2 Compressors
- 1 Battery charger

Semi-conductor data: Controlled Rectifier
Thyristors 447 A
Diode 600 A
Inverter
GTO 600 A
Diode 480 A

Input voltage:
Rated voltage 1000 V at 25 kV

DC Link:
Rated voltage 580 V
Rated current 155 A
Max. Current 190 A

Output voltage:

(i) 3-phase output #1 & #2:
(variable frequency)
Voltage 0-415 V, 3-phase, rectangular
Wave form
Frequency 0-50 Hz
Performance 100 kVA
Cos ϕ 0.85

(ii) 3-phase output #3:
(fixed frequency)

Voltage	415V, 3-phase, rectangular wave form
Frequency	50 Hz
Performance	100 kVA
Cos ϕ	0.85

1.5 Auxiliary Machines:

(a) On 415 V, 3 phase, 0-50 Hz variable frequency supply system:

(i) Traction Motor Blower: (2 nos/loco)

Blower

Make	:FLAKT ABB
Type	:HCBO-605-115
Rating	:4.05m ³ /s, 2950 Pa

Motor

Make	:LANDERT
Type	:200L55-RFX112A-01
Rating	:3phase, 415V, 50Hz, 2930rpm,25 kW
Insulation	:Class F

(ii) Oil Cooler Blower: (2 nos/loco)

Blower

Make/Type	:BEHR
Rating	:8.8 m ³ /s, 1781 Pa

Motor

Make	:LANDERT
Type	:200L55-R112A
Rating	:3 phase, 415V, 50Hz,2930rpm,25 kW
Insulation	:Class F

(iii) Scavage blower for TM & Oil cooler Blower: (2 nos/loco)

Blower

Make	:HOWDEN SAFANCO
Type	:MB 55
Rating	:0.664 m ³ /s, 450 Pa

Motor

Make	:LANDERT
Type	:100L28-R2C
Rating	: 3 phase,415V,50Hz,2850rpm,3.0kW
Insulation	:Class H

(b) On 415 V, 3 phase, 50 Hz constant frequency supply system:

- (i) Trnasformer oil pump: (2 nos/loco)

Pump

Make :Plumettaz, Switzerland
 Type :TA08-2174/15
 Rating :1000 lpm, 1720 Pa

Motor

Make :LANDERT
 Type :112M-2B
 Rating :3 phase, 415 V, 50 Hz, 4.7 kW, 2850 rpm
 Insulation :Class F

- (ii) Converter oil pump: (2 nos/loco)

Pump

Make :Plumettaz, Switzerland
 Type :TC10-2186/29
 Rating :960 LPM, 3300 Pa

Motor

Make :LANDERT
 Type :112M-2B
 Rating :3 phase, 415 V, 50 Hz, 11 kW, 2860 rpm
 Insulation : Class F

- (iii) Main compressor: (2 nos/loco)

Compressor

Make :D&M
 Type :2A320D C13-T32
 Rating :1554 It/min, 10 Kg/cm² □ Air dryer (1 no/loco)
 Provided for compressors

Motor

Make :LANDERT
 Type :200L55-RPAH8B
 Rating :415 V, 3 phase, 50 Hz, 15 kW, 730 rpm
 Insulation :Class H

- (c)
- On 415 V, 1 phase, 50 Hz system:

- (i) Machine room blower: (2 nos/loco)

Blower

Make :FLAKT ABB
 Type :HCBO-415 60
 Rating :1 m³/s, 1390 Pa

Motor

Make :LANDERT
 Type :132M-RFXHE2C
 Rating :1 phase, 415 V, 50 Hz, 2830 rpm, 2.6 kW
 Insulation :Class F

- (ii) Scavange blower for MR blower: (2 nos/loco)

Blower

Make :HOWDEN SAFANCO
 Type :BB 11
 Rating :0.1 m³/s, 550 Pa

Motor

Make :LANDERT
 Type :90L24-RE2C
 Rating :1 phase, 415 V, 50 Hz, 0.75 kW, 2910 rpm
 Insulation : Class F

- (d)
- On 110 V DC supply system:

Auxiliary compressor: (1 no/loco)

Compressor

Make :D&M, Bristol
 Type :FF 3145
 Capacity :141.6 lt/min, 7.03 kg/cm²

Motor

Make :D&M
 Type :
 Rating :110 V DC, 0.75 kW, 1450 rpm

1.6 Pantograph:

Make :Secheron
 Type :ESiD 103-2500
 Rated Current :500 A
 Material of strips :Steel
 Speed range :200 km/h
 Including - 1 operating mechanism
 - roof insulators 25 k V for pantograph

1.7 Earthing Switches:Roof Line earthing switch (hand operated)

Make :Secheron, Switzerland

Type :BTE 25.04
 Rating :25 kV, 400 A

DC Link Earthing switch (hand operated)

Make :ABB, Switzerland
 Type :BTE 07-03.04/2
 Rating :3 kV/400A, 2 poles

1.8 Main Circuit Breaker:

Make :Secheron, Switzerland
 Type :BVAC 25.10/110V (Vacuum Circuit Breaker)
 Ratings :25 kV, 50 Hz, 1000 A

1.9 Battery and Battery Charger:

Battery

Make :SAFT NIFE
 Type :Nickel-Cadmium (SAF-39 SBL 199)
 No. of cells :78 (26 blocks of 3 cells each)
 Ratings :110 V, 199 AH

Battery Charger

Trnasformer

Make :Trafomec, Switzerland
 Type :Input 415 V, 3-phase, 50 Hz
 Output 76 V, 3-phase, 50 Hz
 15 k VA, Delta-star arrangement

Rectifier

Make :ABB, Switzerland
 Type :BL 172.5
 Rating :Input 76V, 3 phase, 50 Hz
 Output 110 V, 40 A, Diode 90 A

1.10 Contactors:

Converter Charging contactor

Make :Secheron, Switzerland
 Type :SSA-HSM
 Rating :300 V, 50 A

Converter contactor

Make :Secheron, Switzerland
Type :BPS 15.1500.C/2
Rating :1500V, 2 x 1400A

Harmonic filter On/Off contactor

Make :Secheron, Switzerland
Type :SSA-BPS 30.065
Rating :3000V, 600A

Harmonic filter adaption contactor

Make :Secheron, Switzerland
Type :SSA-BPS 30.065
Rating :3000V, 600A

Harmonic filter discharge contactor

Make :Secheron, Switzerland
Type :SSA-HSM
Rating :3000V, 50A

Compressor contactor

Make :Telemecanique
Type :TEL-LP1 D80 11 FW
Rating :750V, 3 phase, 50 Hz, 80/125A

Auxiliary Converter Contactor

Make :Telemecanique
Type :TEL-LC1 F150 Lx4FF090
Rating :1000V, 50 Hz, 150A, 3 pole

1.11 Miniature Circuit Breakers (MCBs) & Fuses:

TYPE	MAKE	RATING	APPLICATION
CMC-QX1-AH 8569 16A	CMC	1 POLE-690VAC- 16A	CIRCUIT BREAKER CAB HEATER
CMC-QX1-AH 8569 20A	CMC	1 POLE-690VAC- 20A	CIRCUIT BREAKER MR BLOWER
CMC-QX1-AH 9569 6A	CMC	1 POLE-690VAC- 6A	CIRCUIT BREAKER CAB VENTILATION
			CIRCUIT BREAKER CREW FAN
			CIRCUIT BREAKER SCAVENGER BLOWER MR
CMC-QX3-63A	CMC	3 POLES- 690VAC-63A	CIRCUIT BREAKER MAIN COMPRESSOR
			CIRCUIT BREAKER OIL COOLING UNIT
			CIRCUIT BREAKER TM BLOWER
CMC-QX3-AH 6569 32A	CMC	3 POLES- 690VAC-32A	CIRCUIT BREAKER CONVERTER OIL PUMP
CMC-QX3-AH 8569 16A	CMC	3 POLES- 690VAC-16A	CIRCUIT BREAKER OIL PUMP TRANSFORMER
CMC-QX3-AH 8569 20A	CMC	3 POLES- 660VAC-20A	CIRCUIT BREAKER BATTERY CHARGER INPUT
CMC-QX3-AH 9569 6A	CMC	3 POLES- 690VAC-6A	CIRCUIT BREAKER SCAVENGE BLOWER TM/OCU

(b) Fuses

TYPE	MAKE	RATING	APPLICATION
FEF-12URD70 D11A0280	FERRAZ	1500V, 280 A	AUXILIARY CONVERTER INPUT
FER-CC1051 CPRC	FERRAZ	1000V, 40 A	AUXILIARIES 415V/110V

(c) DC Circuit Breakers

TYPE	MAKE	RATING	APPLICATION
CMC-QX1-DH 8538 16A	CMC	1 POLE- 250VDC-16A	CIRCUIT BREAKER LIGHTING MACHINE ROOM
			CIRCUIT BREAKER AUXILIARY COMPRESSOR
CMC-QX1-DH 8538 20A	CMC	1 POLE- 250VDC-20A	CIRCUIT BREAKER POWER SUPPLY GATE UNITS
CMC-QX1-DH 9538 10A	CMC	1 POLE- 250VDC-10A	CIRCUIT BREAKER DRIVER'S CAB

CMC-QX1-DH 9538 6A	CMC	1POLE- 250VDC-6A	CIRCUIT BREAKER 24V/48V POWER SUPPLY
			CIRCUIT BREAKER ELECTRONICS AUXILIARY CONVERTER
			CIRCUIT BREAKER ELECTRONICS TRACTION CONVERTER
			CIRCUIT BREAKER LIGHTNING FRONT
			CIRCUIT BREAKER MEMOTEL SPEEDOMETER
			CIRCUIT BREAKER PNEUMATIC PANEL
			CIRCUIT BREAKER COMMISSIONING 1
			CIRCUIT BREAKER PANTO/VCB CONTROL
			CIRCUIT BREAKER VIGILANCE CONTROL
			CIRCUIT BREAKER CENTRAL ELECTRONICS
			CIRCUIT BREAKER MONITORING
			CIRCUIT BREAKER COMMISSIONING 2
CIRCUIT BREAKER MARKER LIGHTS			
TRE-NF 100-SS	MITSUBISI	3 POLES-75A- 110VDC	CIRCUIT BREAKER BATTERY
			CIRCUIT BREAKER CONTROL CIRCUITS LOCOMOTIVE
			CIRCUIT BREAKER BATTER CHARGER OUTPUT

1.12 Relays & 110 V dc circuit Contactors:

(a) Relays

TYPE	MAKE	RATING	APPLICATION
ABB-BVW 2800/110V	B+Z	150 MA – 43 OHM	EARTH FAULT RELAY AUXILIARY CONVERTER
			EARTH FAULT RELAY 415V/110V
			EARTH FAULT RELAY CONTROL CKT
			EARTH FAULT RELAY HARMONIC FILTER
MES-VSA/5R	MESUCO	17.5KV.200V/140V- 47.63HZ	MINIMUM VOLTAGE RELAY

SSA-DI/POS.12	SECHERON	330A-2.5A/3.3A 50HZ	MAXIMUM CURRENT RELAY
TEL-CA3 DN 22FW	TELEMECA	10A-600VDC-110 VDC	RELAY TEMPERATURE CONTROL ELECTRONICS
TEL-CA3DN 22FW	TELEMECA	10A-600VDC-110VDC	RELAY CONTROL ELECTRONICS OFF
			SAFETY RELAY CONTROL ELECTRONICS ON
TEL-LP1 D12008FW	TELEMECA	1 SEC.DELAY.12A/25A- 750V-4POLES	TIME RELAY VCB
PV C000 A01	ABB	4 KV	POWER CONVERTER EARTH FAULT DETECTION

(b) 110 V dc Circuit Contactors

TYPE	MAKE	RATING	APPLICATION
SBM- S163C1DT/110V	SCHALTBA	110VDC-1345 OHM-NO	CONTACTOR AUXILIARY COMPRESSOR
			AUXILIARY CONTACTOR TO CONTACTOR AUXILIARIES
			CONTACTOR GATE UNIT POWER SUPPLY
			AUXILIARY CONTACTOR FLANGE LUBRICATION
SBM- S164C1DT/110V	SCHALTBA	110VDC-NO	CONTACTOR CONTROL CIRCUIT ON
			CONTACTOR CONTROL ELECTRONICS

1.13 Harmonic Filter:Filter capacitor

Make :SIEMENS
 Type :SIE-B25838-W7666J0004
 Rating :66.6 μ F, 2500V, 80A
 Bank :0.8 mF, 2800V, 80A
 Capacity

Filter resistor

Make :SECHERON
 Type :BW40 12/-2.20
 Rating :2800V, 0.2 ohm/40 Kw
 0.2 ohm/60 kW

Filter discharge resistor

Make :ESTEC
 Type :ESTE DT 45992
 Rating :1400V, 50A, 784WS

1.14 Current Transformer/Current sensor:

Primary current transformer #1:

Make	:pfiffner, Switzerland
Type	:EPF-G-IEBL1
Rating	:500/5A, 90 VA

Primary current transformer #2 & #3:

Make	:LEM, Switzerland
Type	:LEM LT 1000-SI/SP59
Rating	:5000:1, 1000A, 40Ω

Current sensor for auxiliary converter winding:

Make	:LEM, Switzerland
Type	:LEM LT 1000-SI/SP59
Rating	:5000:1, 1000A, 40Ω

Current sensor for traction winding:

Make	:LEM, Switzerland
Type	:LEM LT 2000-S/SP20
Rating	:5000:1, 1000A, 25Ω

Current sensor for filter winding:

Make	: LEM, Switzerland
Type	: LEM LT 1000-SI/SP59
Rating	: 5000:1, 1000A, 40Ω

Current sensor for inverter phase current:

Make	: LEM, Switzerland
Type	: LEM LT 2000-S/SP20
Rating	: 5000:1, 2000A, 25Ω

Current transformer for control circuits:

Make	: LEM, Switzerland
Type	: LEM LT 300-SI/SP4
Rating	: 300A/150mA,

Current transformer for battery charger:

Make	: LEM, Switzerland
Type	: LEM LT 300-S/SP4
Rating	: 300A/150mA

1.15 Potential Transformer:(i) Primary Voltage Transformer:

Make : MWB MITTELSPANNUNGS
TECHNIK BmbH
Type : VGF 36
Rating : 25 Kv/200V
30 VA/150VA, Usw 170 kV

(ii) DC Link Voltage Sensor:

Make : ABB, Switzerland
Type : PV C000 A01
Rating : 4000V

1.16 Lightning Arrestor:

Make : ABB, Switzerland
Type : MWA 33 (Gapless type)
Rating : 33 kV

1.17 Control Electronics & Fault Diagnostics set:

(Microprocessor based)

Make : ABB, Switzerland
Type : MICAS S-2

Containing

- 4 Quadrant power control
- Motor inverter control
- Locomotive control
- Diagnostics
- Power supply
- Light emitters & test points
- Cubicle
- Ventilation
- Fiber optic cable

1.18 Master Controller Set:

Make : Secheron, Switzerland
Type : BSK 88-1-2/4.

Including:

- Reverser
- Tractive/Braking effort handle
- Angle transmitter
- Mechanical interlocking of TE/BE handle with reverser
- Auxiliary contacts

1.19 Measuring Instruments:(i) Speedometer set:

Make : Secheron, Switzerland
 Type : Memotel
 Range : 120 km/h

Including:

- Speed recorder and indicator for cab2
- Speed indicator for cab1
- Speed sensor (opetoelectronic type)

(ii) Cab Instruments:

- Catenary voltmeter
- TE/BE meter
- Battery voltmeter
- Pressure gauges (2 duplex, 1 single)
- Air Flow meter

1.20 Ground Return System:Earthing Choke

Make : ABB
 Type : ABB-CHOKE
 Ratings : 1000V, 50Hz

Earthing Brush

Make : Schunk
 Type : 06.21.0052.00,system 'Polyax'
 Ratings : 500V/600A

1.21 Cables:

APPLICATION	TYPE	MAKE	SIZE
Power Circuit	4GKW-AX & 9GKW-AX	HUBER + SUHNER AG	1 x 150 mm□ 1 x 120 mm□ 1 x 95 mm□ 1 x 70 mm□ 1 x 10 mm□
	GKW45/26 KV	COSSONAY	1 x 185 mm□ (HT cable)
Auxiliary Circuit	4GKW-AX	HUBER + SUHNER AG	1 x 70 mm□ 1 x 50 mm□ 1 x 10 mm□ 1 x 6 mm□ 1 x 2.5 mm□
Control Circuit	Radox GKW Twisted	HUBER + SUHNER AG	2 x 1 mm□ 2 x 2 x 1 mm□ 20 x 1 mm□

	Radox GKW/ EMV	HUBER + SUHNER AG	2 x 1 mm□ 3 x 1 mm□ 2 x 2 x 1 mm□ 5 x 1 mm□ 7 x 1 mm□ 3 x 4 x 1 mm□
	Radox GKW RW/ EMV	HUBER + SUHNER AG	2 x 0.5 mm□ 3 x 0.5 mm□ 2 x 2 X 0.5 mm□ 5 x 0.5 mm□ 7 x 0.5 mm□ 4 x 2 x 0.5 mm□ 9 x 0.5 mm□ 15 x 0.5 mm□ 10 x 2 0.5 mm□ 22 x 0.5 mm□ 25 x 0.5 mm□ 15 x 2 x 0.5 mm□
	Radox GKW “Super Screen”	HUBER + SUHNER AG	2 x 1 mm□ 2 x 2 x 1 mm□
Control Circuit	Radox GKW/RW Twisted	HUBER + SUHNER AG	2 x 0.5 mm□ 2 x 2 x 0.5 mm□ 9 x 0.5 mm□ 15 x 0.5 mm□ 25 x 0.5 mm□
	Radox 3 GKW	HUBER + SUHNER AG	1 x 0.5 mm□ 1 x 0.75 mm□ 1 x 1 mm□
	Radox GKW-A (Co-axial)	HUBER + SUHNER AG	2 x 6 mm□

In addition to the above, Fiber optic cables have been used in the control circuit (MVB Bus, GTO gate firing circuit).

1.22 Power Factor

(20 km/h & above in full power)

: Close to unity

MECHANICAL FEATURES OF 3-PHASE AC LOCO.

Co-Co bogie.: The three axle, three motor Co-Co bogie assembly, is one of the major parts of the locomotive. Two bogie assemblies support the entire weight of the locomotive and provide a means for transmission of the tractive effort to the rails.

The bogies are designed to withstand the stresses and vibrations resulting from the normal rolling stock applications. An important function of the bogie is to absorb the isolate shock caused by variations in the track. The suspension systems minimize the transmission of these shocks to the locomotive under frame.

The traction motors are suspended in the bogie frame and on the individual axles. The motors transmit their torque to the driving axles through a gear mounted on the driving axles. The force from the driving axles is transmitted to the contact point between the wheel tread and the rail. Traction force is in turn transmitted through the axles journal boxes and guide rods to the bogie frame. The push-pull link rod, connected between the bogie transom and car underframe, transmits the tractive forces to the car body. Slowing or stopping the locomotive is achieved by use of electrically regenerative braking or pneumatically operated drum brakes. The brake cylinders and rigging are positioned to enable the brake shoes to clamp against the wheel tread surface. As with the tractive effort, braking effort is transmitted to the bogie frame by the axle journal boxes and guide rods from the bogie frame to the locomotive by the traction rods. Isolation and absorption of shock loads and vibration is performed by the primary and secondary suspension. Movement between the car body and bogie is smoothly controlled by the primary and secondary suspension. Although the spring permits free movement in any direction, lateral buffers and dampers limit the amount and rate of lateral movement. Vertical dampers limit the amount and rate of the vertical bounce of the locomotive car body. Yaw (longitudinal) dampers control the car body pitch rate.

The primary suspension, located between the axles and the bogie frame is provided by twin coil springs on the axle journal box fore and aft of the axle line. Vertically hydraulic dampers on the end axles are used to dampen the rebound rate of the springs. The flexicoil arrangement permits lateral movement of the axle. Longitudinal control of the axle and the transmission of tractive and braking effort of the bogie frame is provided by guide rods connected between the axle journal boxes and bogie frame. Spheribloc rubber bushes in the guide rods allow the axle lateral movement without undue restrictions.

Bogie Frame: The bogie frame consists of two longitudinal sections, which form the side members and three lateral transoms, which form the cross members. The cross members are welded to the side members forming rectangular frame. The side and cross members are fabricated from 350L-15 high strength low-alloy steel. The link rod pivot assembly is welded to the center of the end cross member. All structural welds on the bogie are ultrasonically tested during the manufacture for penetration.

The axle guide rod support rod brackets are of cast steel and are welded to the bottom flange of the side members. The axle spring guide and primary suspension spring pads are welded to the bottom flange of the side members as are the mounting brackets for the sanding

equipment and wheel flange lubrication. Secondary suspension spring guide, longitudinal (yaw) damper brackets and vertical bump stops are all welded to the webs of the side and cross members. Lateral damper and bump stop brackets are welded to the top flange of the side members. Brackets for mounting the traction motors and transmission are welded to the cross members. Anchorage point for the brake rigging are located on the inside web of the cross member.

To ensure full protection against corrosion all box sections are sealed against the entry of moisture and the frame is coated with a two-pack polyurethane paint over an epoxy primer.

Primary suspension: Isolation and absorption of shock loads and vibration between the bogie frame and wheelsets is performed by the primary suspension. The primary suspension, located between the axles and the bogie frame, comprises coil springs on the axle box and vertical hydraulic dampers.

The middle axle has a safety link between the axle box and underframe. The link lifts the axle with the bogie frame when bogie is raised by lifting equipment.

The vertical dampers are mounted on the end axles between the axle box front cover and lugs on the bogie frame and are used to dampen the rebound rate of the springs. End axles have a single coil spring situated on the axle box fore and aft of the axle center line. Each end axle (wheelset) has four coil springs. The middle axle has an inner and an outer coil spring situated on the axle box fore and aft of the axle center line. Each middle axle (wheelset) has eight coil springs.

The springs are situated in the seats of each axle box and each end of the wheelset. An insulating base and compensating plates are installed between each spring and the axle box to establish the correct wheel load rate.

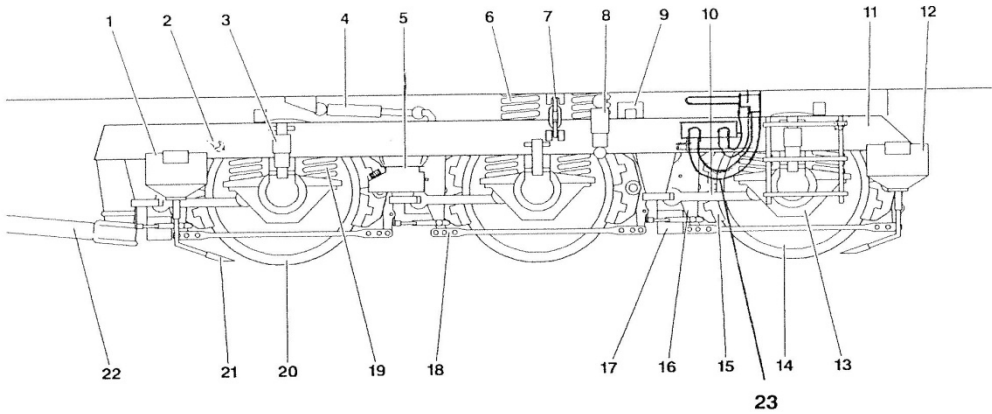
Longitudinal control of the axle, and the transmission of tractive and braking effort of the bogie frame is provided by guide rods connected between the axle boxes and bogie frame. The “Felxicoil” arrangement of the primary suspension permits lateral movement of the axle. Spheribloc rubber bushes in the guide rods allow the axle lateral movement without undue restriction.

Secondary suspension: The primary and secondary suspension absorbs and isolates shock loads, due to shock deformities and other variations. The secondary suspension consists of coil springs and vertical, lateral and yaw dampers, located between the bogie frame and the locomotive underframe on each side of the bogie. The springs support the weight of the locomotive car body and allow free movement between the car body and the bogie. This “ flexifloat” arrangement of the secondary suspension allows the locomotive car body to move both laterally and vertically within certain limits relative to bogies.

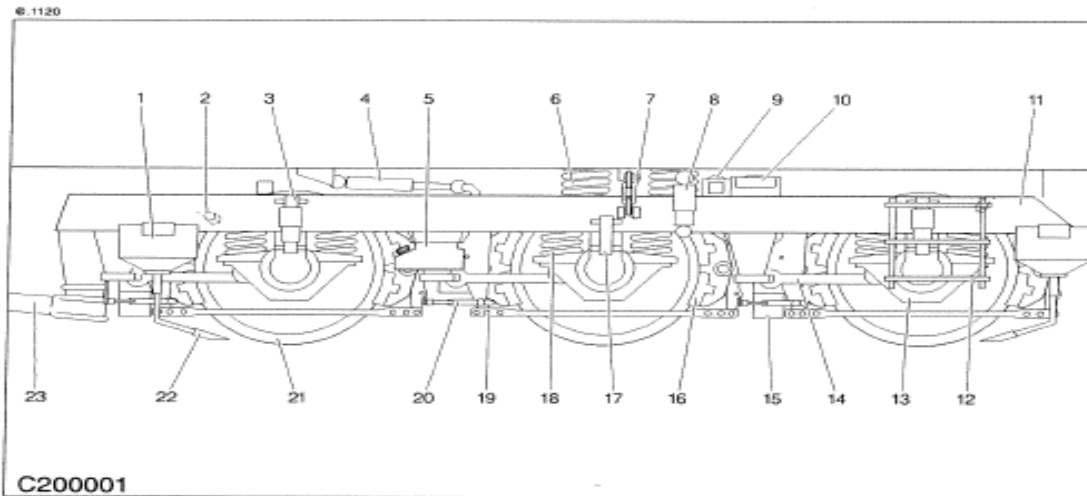
Although the springs allow movement in any direction, lateral buffers and dampers limit the amount and rate of the vertical rebound of the locomotive car body. Longitudinal (Yaw) dampers are provided to dampen the rate of pitch of the car body. Traction rods connected between the bogie and locomotive underframe, control the fore and aft movement between the bogies and the locomotive.

Insulating base and compensating plates (shims) are installed between each spring and the bogie frame. Shims may be added to establish the correct wheel load levels.

Bogie layout



- 1. Sanding box
- 2. Wheel flange lubrication nozzle
- 3. Primary suspension damper
- 4. Secondary suspension yaw damper
- 5. Wheel flange lubrication reservoir
- 6. Secondary suspension spring
- 7. Safety chain
- 8. Secondary suspension vertical damper
- 9. Horizontal damper
- 10. Wheel set guide
- 11. Bogie frame
- 12. Sanding box
- 13. Wheel set
- 14. Wheel
- 15. Brake blocks
- 16. Brake lever
- 17. Brake cylinder
- 18. Brake rod
- 19. Primary suspension spring
- 20. Wheel flange
- 21. Sanding pipe
- 22. Traction link
- 23. Anti compounding valve



C200001

- | | | | |
|----|--|----|----------------------------|
| 1 | Sand box | 12 | Step |
| 2 | Wheel flange lubrication nozzle | 13 | Axle journal box |
| 3 | Primary suspension vertical damper | 14 | Guide rod |
| 4 | Yaw damper | 15 | Brake cylinder |
| 5 | Wheel flange lubrication reservoir | 16 | Brake pad |
| 6 | Secondary suspension spring | 17 | Middle axle link |
| 7 | Safety chain | 18 | Primary suspension springs |
| 8 | Secondary suspension vertical damper | 19 | Brake rigging |
| 9 | Secondary suspension horizontal damper | 20 | Brake slack adjuster |
| 10 | Bump stop | 21 | Wheel |
| 11 | Bogie frame | 22 | Sanding nozzle |
| | | 23 | Traction rod |

Traction link : The traction link transmits traction and braking forces from the bogie to the locomotive superstructure (underframe). Although the traction link maintains the relative longitudinal position of the bogie to the locomotive underframe, it permits lateral movement between the two structures. The link rod is situated between two pivot points. One on the locomotive underframe, the other on the end transom of the bogie, permitting lateral movement but restraining longitudinal movement. Under normal conditions the rod is inclined at a 1:10 slope towards the center of the locomotive underframe.

A pivot head situated at each end of the link rod, has a ring of pliable material between the pivot post and head. The rings are secured to the pivot head by an outer retaining ring and a retaining plate bolted to the post.

The rod is symmetrical end to end and the pivot heads are identical and interchangeable between the bogie and underframe. The link rod is secured to the locomotive underframe by safety cables

Technical Data

Link Rod

- Weight ,assembled	46.7 Kg.
- Overall length	1,299 – 1,301 mm.
- Tube diameter	133 mm.
- Installed inclination	1 in 10.
- Spigot diameter	80 mm.

BRAKE ACTUATORS

Each wheel on the bogie is fitted with a tread brake operated by a pneumatic actuator and a brake rigging. Application of the brakes is by either driver's brake controller via the Davies & Metcalfe E70 brake frame, or directly through the driver's air brake valve.

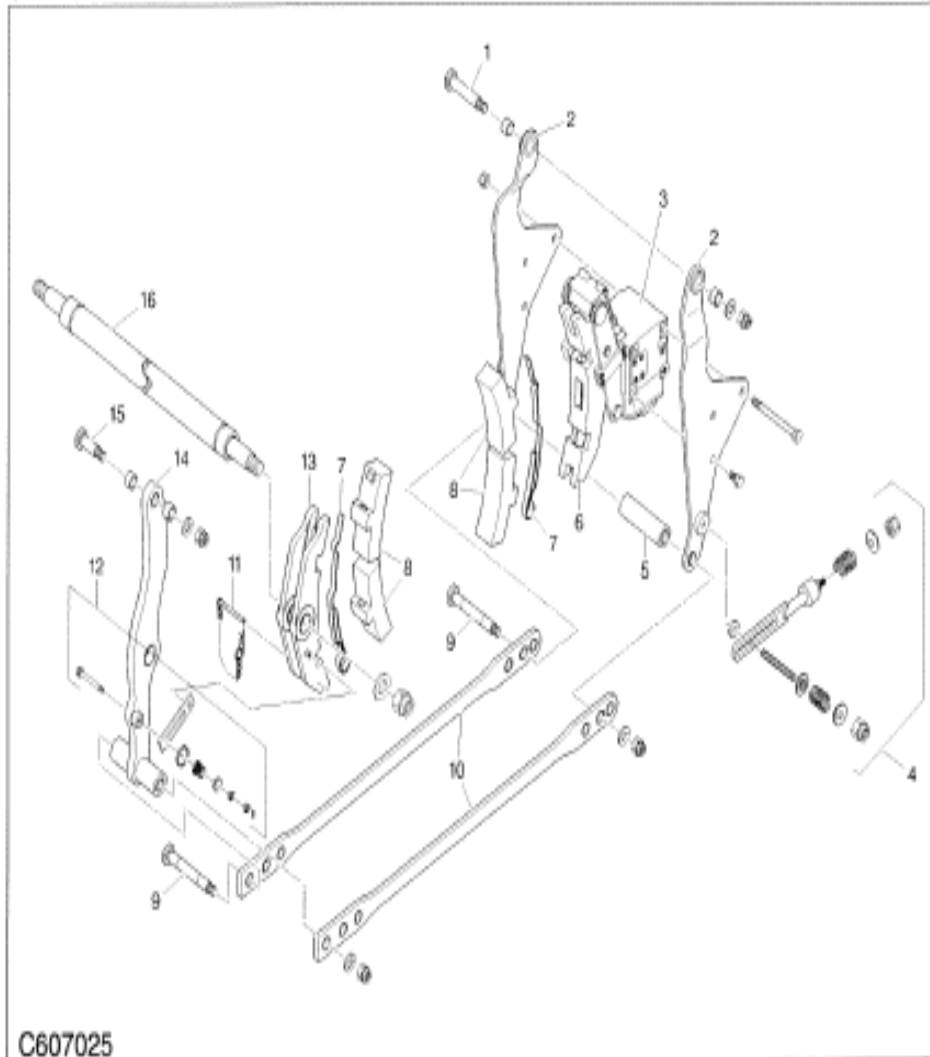
Service brake actuators are fitted on left hand axles 1, 2 and 3 and the 2 right hand axle.

Combination service and spring parking brake actuators are fitted to right hand axles 1 and 3.

Axle 1 is located at the cab end of the bogie. Air pressure from the locomotive pneumatic system is required to release parking brakes. In the event of the pneumatic locomotive system fails, the loss of the pressure causes the spring parking brake to apply. Service brakes actuators only apply the brakes when pressure is supplied from the brake pipe.

The brake rigging consists of levers and rods that distribute the force of the brake blocks on each half of the wheel tread. Slave and actuator brake levers are hung from pivot points on the bogie frame. Slave levers are located at the cab end of the wheel. The brake actuator is fixed within the actuator levers at the opposite side of the wheel. The slave and actuator levers are connected by a pair of rods, one on the inside and another on the outside of the wheel

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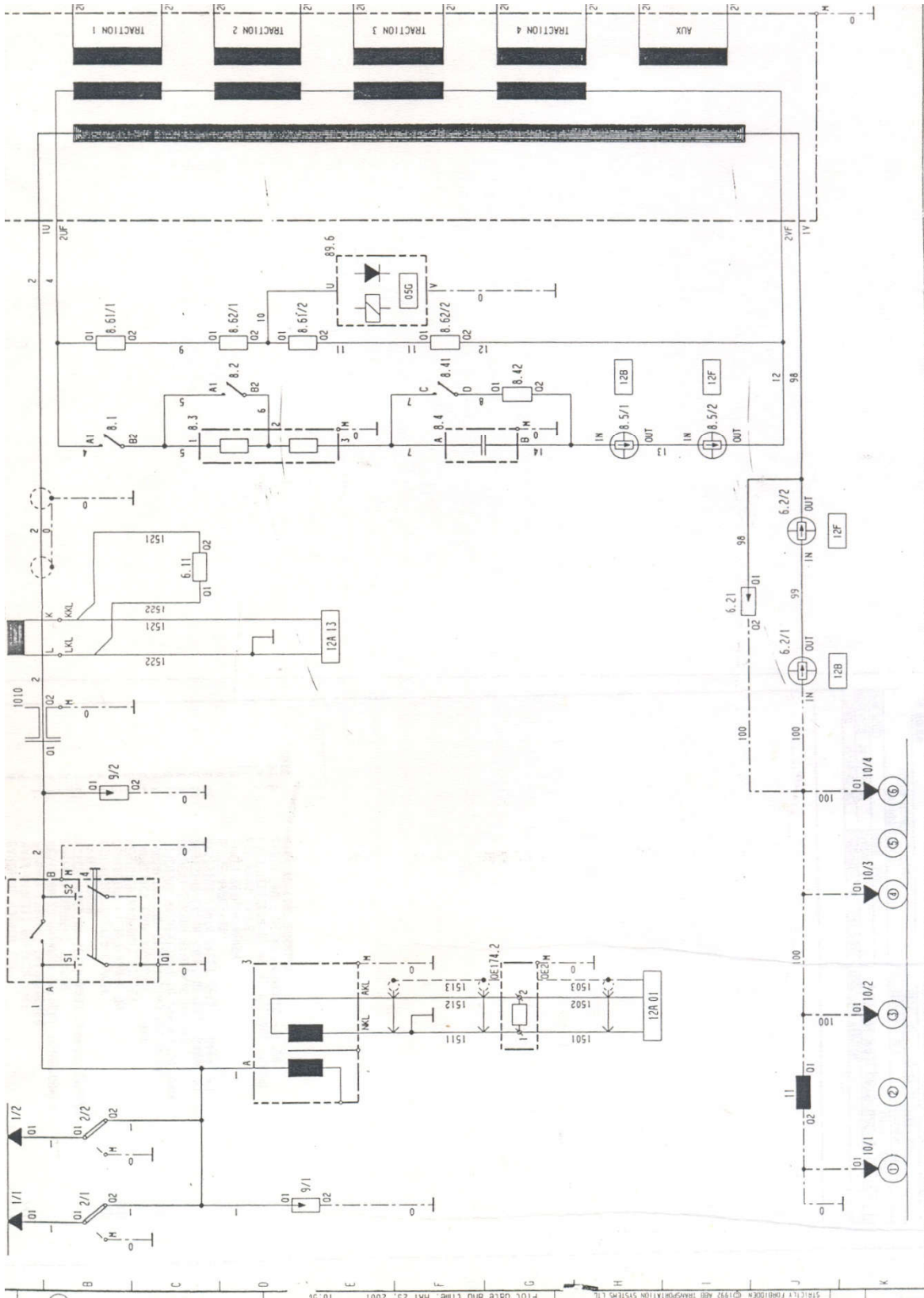
1	Pivot bolt, hex. head	10	Brake rod
2	Actuator brake lever	11	Locking pin
3	Brake actuator	12	Adjusting equipment (Shoe support arm)
4	Adjusting equipment (Slack adjuster)	13	Slave brake shoe
5	Spacer tube	14	Slave brake lever
6	Actuator brake shoe	15	Pivot bolt, hex. head
7	Brake block key	16	Track rod
8	Brake blocks		
9	Pivot bolt, hex. head		

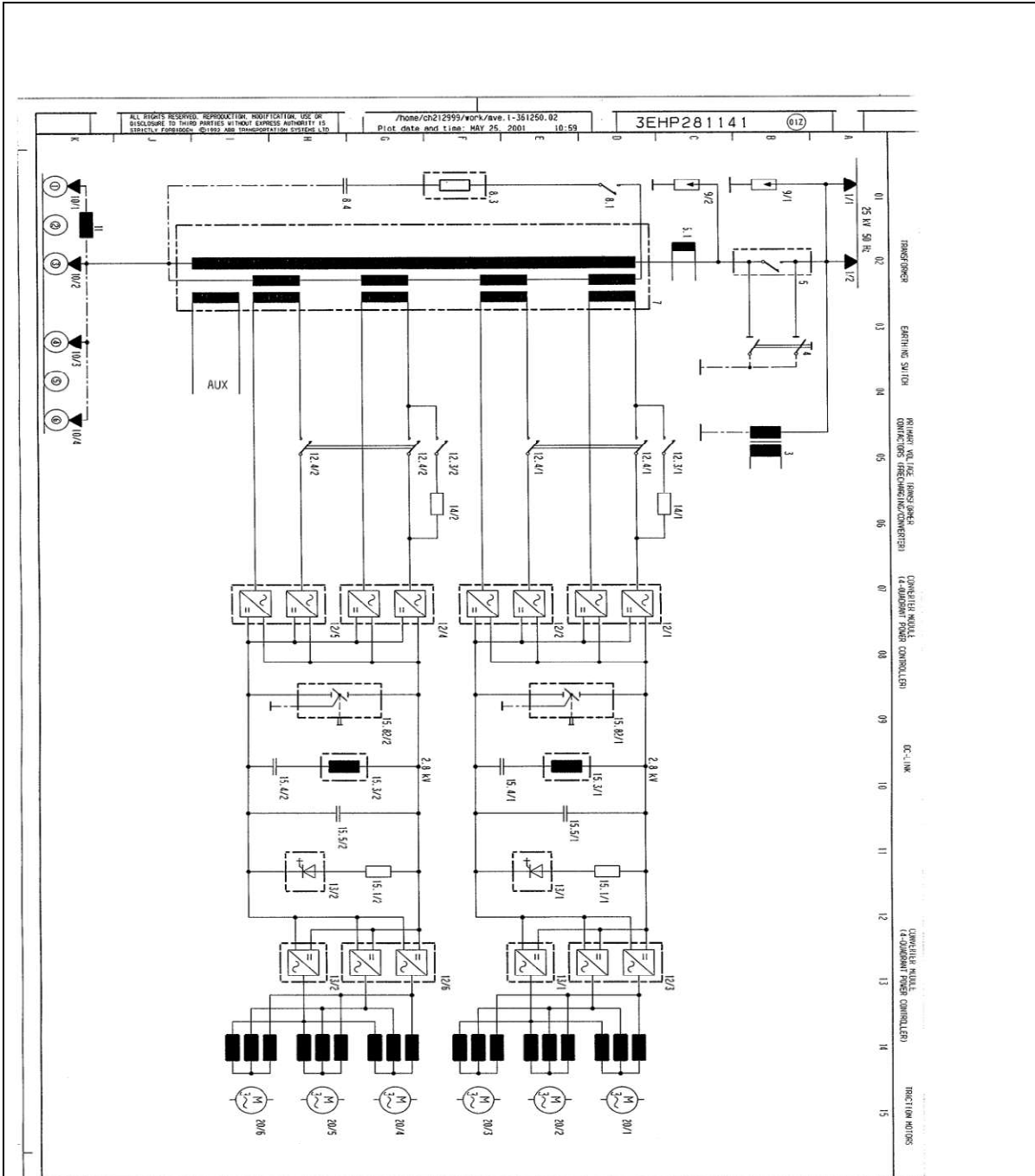
Brake actuators

Each wheel has two brake shoes, one at the slave lever and the other at the actuator lever. The actuator shoe is integral to, and moved directly by the brake actuator cylinder. The slave shoe is operated by the brake rods. Two brake blocks are situated within each shoe and clamp against the wheel tread by the action of the brake actuators and rigging. Brake block wear is compensated for by slack adjusting equipment. All the brake actuators are equipped with internal automatic slack adjusters. A slack adjusting arm is fitted to the actuator lever to maintain clearance between the brake block and wheel tread. A shoe support arm adjusts the operating angle of the slave shoe. Track rods situated between the slave levers on each side of the bogie maintain the alignment of the brake blocks with the wheel tread.

All pivot points on the brake rigging are fitted with bushes and hardened steel bolts to minimize friction and wear. The actuator shoe moves away from the actuator when air pressure is applied to the actuator cylinder. The cylinder continues to expand moving the actuator blocks into contact with the wheel tread; the actuator levers move in the opposite direction away from the wheel. The brake rods pull the slave lever, shoes and blocks, towards the wheel tread. The two levers remain in a parallelogram during brake application. The stroke of the actuator cylinder determines the friction between the brake blocks and wheel tread. The brakes return to their static position when the air pressure is released from the cylinder.

Technical Data Shoe Force (Maximum): 40000N Shoe Force (Emergency brake Max):50000N Brake actuators : Service Brake actuator weight :55 Kg Parking Brake actuator weight :64 Kg	Piston Area : 248.8 cm ² Operating pressure (Min) :0.3bar Operating pressure (Max) :6 bar Service brake stroke (Max)18mm Max automatic stroke :12mm Max adjustment per stroke:6mm
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- 1 Pantograph 3 Primary voltage transformer 4 Earthing switch to VCB 5 Main circuit breaker (VCB) 7 Main transformer 8.1 Filter contactor 8.3 Resistor harmonic filter 8.4 Capacitor bank harmonic filter 9 Surge arrestor 10 Earth return brush 11 Earthing choke 12 Valve set 2*ZV 12.3 Pre-charging contactor of converters 12.4 Contactor converter 13 Valve set ZV + MV 14 Pre-charging resistors of converters 15.1 Resistor of over voltage protection unit 15.3 Series resonant circuit choke 15.4 Capacitor bank of series resonant

circuit 15.5 Capacitor bank of DC-link 15.82 Earthing switch of DC-Link 20 Traction motors

POWER CIRCUIT OF WAP-5/WAG9 LOCOMOTIVES

General description of power circuit:

The main electrical circuit of the locomotive consists of the following main equipment.

- i) Main transformer
- ii) Traction converter (which itself consists of four quadrant input converter / line converter. DC link and the motor inverter).
- iii) 3 phase Asynchronous motor

Beside these a number of other equipments are needed for operation of the system. On the high voltage primary side of the main transformer, the main equipments are pantographs (1) for current collection, vacuum circuit Breaker (5) with earthing switch (4), primary voltage transformer (30) and surge arresters (9/1, 9/2). All these equipments are mounted on the roof of the locomotive.

The main transformer is under slung which consists of a primary winding a filter winding, four secondary traction windings, one auxiliary winding and one-hotell load windings. A line harmonic filter is connected across the filter winding to limit the harmonics. The four traction windings feed the four-quadrant converter. Three auxiliary converter each rated 100 KVA are directly connected to the 1000 V auxiliary winding of the main transformer. In addition to these windings, the transformer tank also houses chokes (inductive coils) for the auxiliary converters.

The traction circuit is split in to two separate circuits after the main transformers. This enables isolation of any circuit, should a fault occur. In such a case, the control electronics open the converter contactor (12.4) and blocks any firing pulse to the converter and its associated inverter. The loco can then be operated at half power.

Each group of two traction windings feed two four- quadrant converters connected in parallel. The four – quadrant converter feed in intermediate circuit of a series resonant circuit and DC link capacitors, which supply power to the motor inverter. Each inverter feeds two traction motors. With the exception of series resonant choke, all converter equipments are housed in two identical cubicles (One for each bogie) and mounted in the machine room. The traction motors are connected in parallel and are fully suspended.

The main transformer and converter are oil forced air forced (OFAF) cooled through a combined heat exchanger. The top radiator is for converter and bottom radiator is for transformer. While traction motor are forced air-cooled. The converter unit has the task of conversion power between transformer and the traction motor in such a way that tractive and braking effort can be generated at any speed. Due to GTO technology the locomotives work on the unity power factors.

Transformer Mechanical

The main transformer is installed in an enclosed, oil-tight aluminum tank together with the 3 auxiliary converter chokes and two series resonant chokes for the traction converters. This aluminum tank is divided in two chambers. The larger chamber contains the main transformer, the smaller chamber contains accommodates the series resonant chokes and auxiliary converter chokes. The tank is filled with transformer oil to increase the insulation strength, so that arising heat loss can be dissipated through circulating oil.

The magnetic circuit of the Main transformer is of two legged design. The primary and secondary windings are in the form of disc windings and are distributed symmetrically between the two legs. They are interwound for the purpose of good coupling with serial and parallel connections.

Oil Cooling

The cooling oil flows through pipes and barriers in such a way that it first cools the main transformer. The main transformer is subject to a symmetrical flow of oil from a chamber surrounding the middle of the transformer. The oil then flows from the large tank compartment at the top down into the smaller compartment where it flows around the chokes from bottom to top. All Oil connections on the tank have stopcocks.

Sump and cover have a conducting connection to one another by means of an outer ground cable, which is attached at the top left on the front side (above the temperature indicator).

Transformer Oil: The transformer unit is filled with ca 2000 kg of mineral oil. The oil serves as a cooling and insulating agent.

Breather/Filter

The purpose of the breather/Filter is to dry the air that goes to and from the transformer oil expansion tank as a result of temperature fluctuations during operation.

The breather/filter with 3 liters of silica gel crystals (SiO_2). Silica gel is very porous and can absorb up to one third of its own weight of water. At the manufacturing stage it is colorless. By treating the crystals with cobaltous chloride. The color changes to blue when dry and pink when water is absorbed.

When the breather/filter is installed, the color of the crystal indicates whether they need drying out or not.

Recirculation/cleaning valve.

The recirculation/Cleaning valve is situated between the relay and the transformer oil expansion tank. It provides a means of stopping the oil flow from the transformer conservator to the main transformer. The valve is of glandless construction, with none of the moving parts of the bonnet assembly coming into contact with the pipe fluid.

The bonnet assembly contains a compressor which supports the diaphragm at all stages of travel. The valve works by –pinching- off the flow of fluid. As the hand wheel is turned clockwise, the diaphragm presses against the body. So stopping the flow of fluid. The diaphragm should not be over closed. Only a –nipping- onto the wear is required.

Prismatic level guage

The prismatic level guage is mounted on the side of the transformer expansion tank (breather/filter). It is basically a glass tube for measuring the level of the transformer oil in the transformer expansion tank. It is held in position by a metal plate and twelve fixing screws. Oil enters the guage through a hole in the bottom, whilst expelling air through a hole in the top (back into the transformer conservator).

Current Bushings

The electrical connections on the unit are brought out of the tank through ceramic wall bushings. The roof bushing, which provides the primary connections of the main transformer, is described separately.

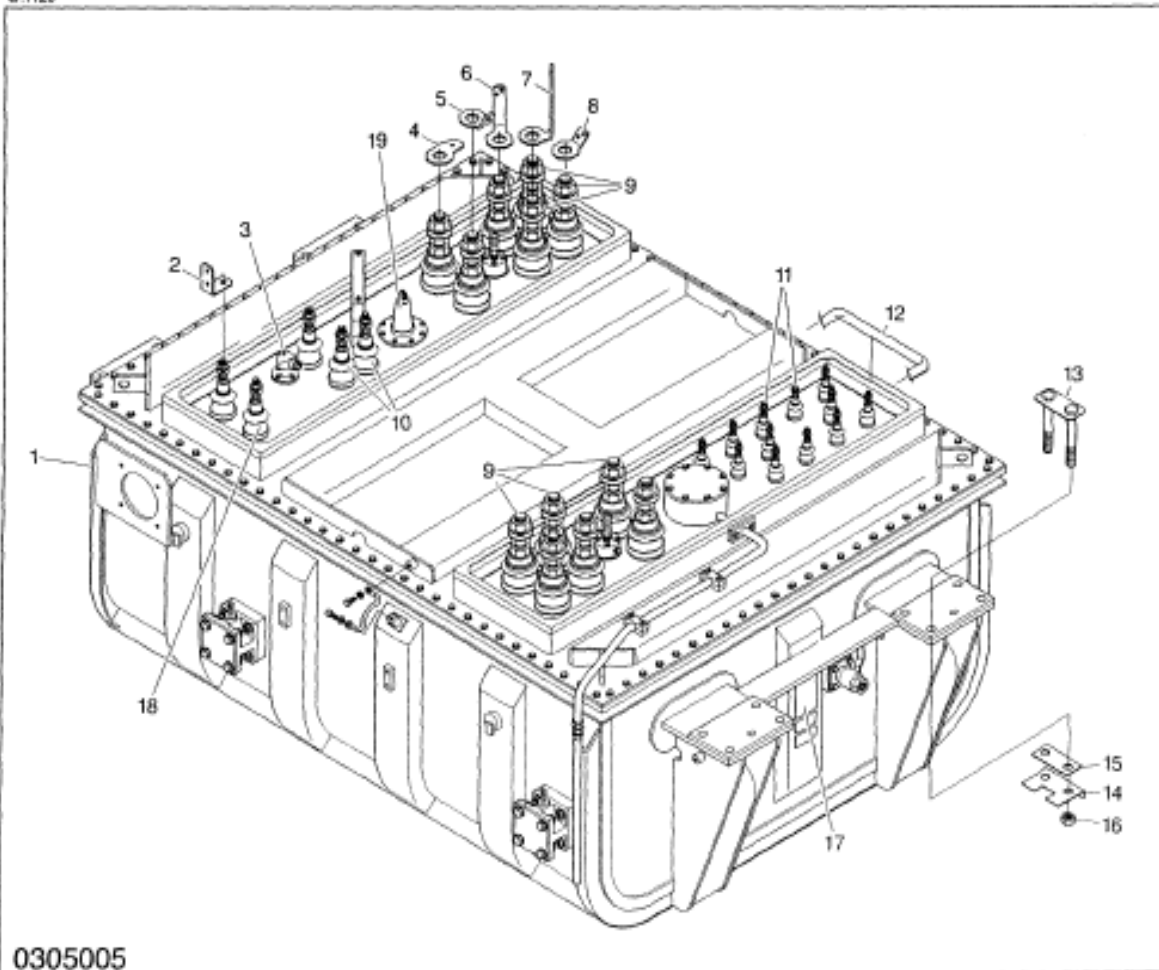
Tank;

The tank insulates the internal high-voltage-carrying components. It all allows the dissipation of heat loss from windings and magnet cores via the oil surrounding them. All penetrations in the wall of the tank as well as the connections between sump and cover of the oil tight design. On the right hand narrow side of the tank, all connections of the main transformer are accessible via ceramic bushings, with those of the chokes being accessible on the left hand narrow side.

The safety valve or pressure relief valve consists of a spring loaded pressure plate above an outlet opening. It opens at a pressure of 0.8 bar and releases excess oil into a surrounding chamber with drain pipe. Its response time to the arrival of a wave of pressure is 2 msec. The pressure wave required for opening can be adjusted prior to installation by means of the spring preload

The gas pressure thermometer provides a local indication of the oil temperature. The sensor measures the oil temperature at the point of the highest valve. There is a change in the pressure of the gas filling; this pressure is transmitted via the capillary tube to the pressure-gauge measuring spring in the indication instrument. Effect of the ambient temperature is compensated by a bimetallic element. The maximum allowable oil temperature is 150⁰ C

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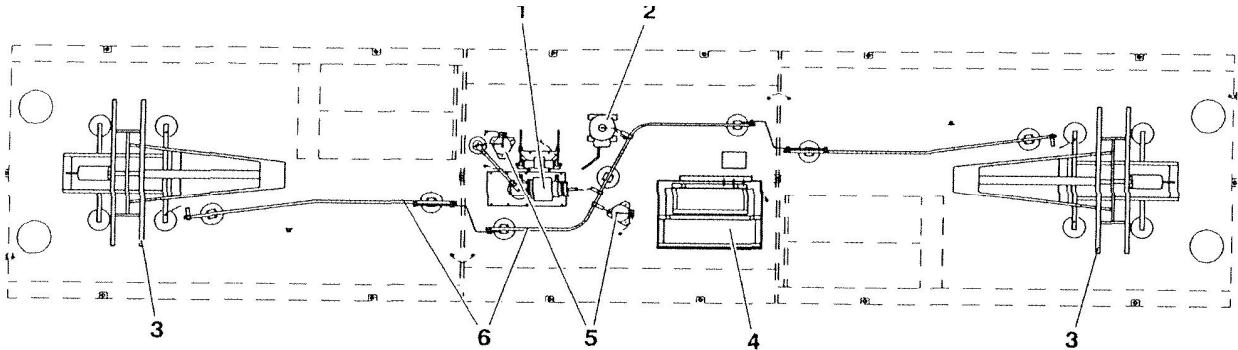


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1	Transformer general arrangement	11	Smoothing reactor bushing
2	Connection angle	12	Profiled joint
3	Thermometer	13	Fixing plate
4	Connection angle	14	Locking tab
5	Connection angle	15	Jacking plate
6	Connection angle, short	16	Hex. nut
7	Connection angle, long	17	Rating plate
8	Connecting plate	18	BUR bushing
9	Traction-Converter bushing	19	High voltage bushing
10	Filter bushings		

ROOF EQUIPMENTS

1.Main circuit breaker,2.Potential transformer, 3.Pantograph, 4. Resistor harmonic filter,5.Surge arrester,6.Roof line



The high tension current is fed to the locomotive from OHE with the help of AM-92 pantograph mounted on the roof of the locomotive.

Each locomotive is equipped with the pantograph PT1 and PT2 which can be raised and lowered by the driver by ZPT switch mounted on the driver desk. The selection of the pantograph is achieved by pantograph selection switch pos. no 129.1 mounted on the pneumatic panel inside the machine room. The pantograph is connected to the main circuit breaker by roof bars mounted on the foot Insulators. Each pantograph has one hand operated earthing roof bar, which disconnects pantograph from the roof bar and connects to the earthing point. Earthing point HPT1 is meant for grounding of PT1 and HPT2 is for PT2. These earthing roof bars mounted on the roof can be operated after isolation of OHE.

The locomotive is provided with two roof mounted surge arrester meant for protection of the electric equipment from surges of the OHE. Potential transformer of ratio 125:1 is also mounted on the roof to sense the OHE voltage. The OHE voltmeter provided in the cab takes its signal from this PT. The OHE voltage sensed by this potential transformer is also utilized in the MICAS-S2 control electronics for loco operation. The resistance unit for the harmonic filter is also provided on roof. The Harmonic Filter reduces the harmonics generated due to switching of power circuit going into traction supply system. The Circuit Breaker (VCB) mounted on the roof switches ON / OFF the OHE supply to the Main Transformer.

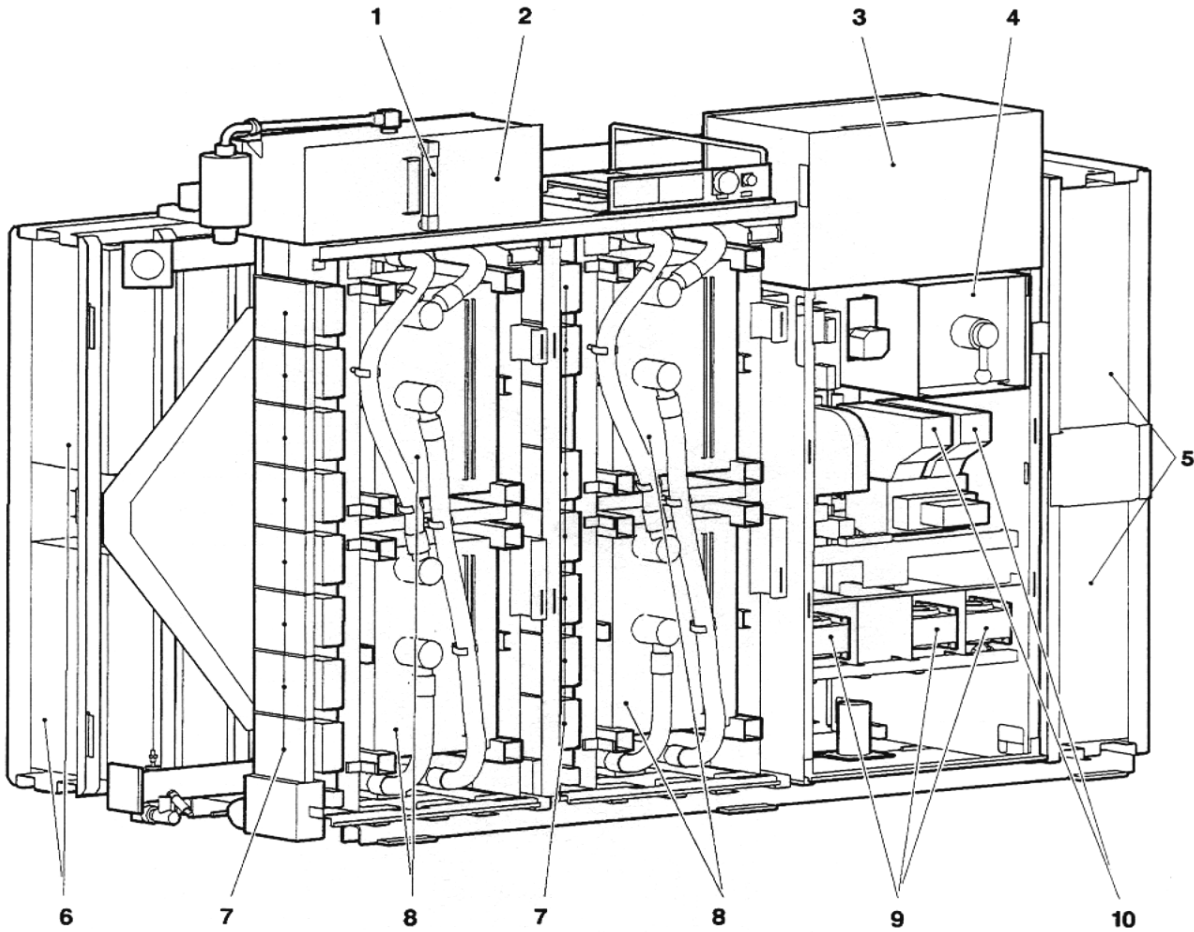
LINE CONVERTER (NSR) SIDE CIRCUIT DESCRIPTION:

Primary side:

The loco is prepared for service in the following manner:

With the control electronics temperature within limits and earthing switch of DC link, VCB open, pantograph is raised and VCB is closed. The main transformer is now energized. The return current flows through three current return brushes {10/*} to the rails. Current sensors (6.2) measure the current on the primary side. An earthing choke (11) is provided to limit dangerous rise of voltage, in case loco is charged with current return brushes not connected. The choke

limits the voltage to approximately 30 volts. If brushes 10/1,2,3 are not connected current flows through the choke and brush 10/4 to the rails. If none of the brushes are connected then current is forced to find its way through axle box bearing to the rails.



- Oil sight glass
- Expansion tank
- Bus station on converter unit
- Earthing switch
- Capacitor bank series resonant circuit
- Capacitors DC-Link
- Gate Units
- Valve set
- Current sensors
- Converter contactors

The Four-Quadrant Converter As Input Circuit (Line Converter, NSR)

The four quadrant converter (12/1) also called pulsed converter or line converter, can be controlled to conduct current either from the catenary to D.C link circuit (rectifier function during traction) or the other way from DC link to the catenary (inverter function during braking). It can also conduct either capacitive or inductive currents. In term of the loco application this means that converter can work in both traction and braking mode with leading or lagging or unity power factor as demanded by the system. This is achieved in the following manner:

Before actual operation of quadrant converter the D.C. link is charged through a Pre Charging Resister (14/1), by closing the contactor 12.3. The resister is required to minimize oscillation in the D.C. link (RLC net work instead of RC Network) and limit the initial inrush current of the circuit. The current flows through the diodes of quadrant converter and charge the DC link to peak transformer secondary voltage. The DC link voltage feed back goes to control electronic and when it is charged, control electronics closes the main power contactor (12.4) and open the charging contactor (12.3).

After opening the charging contactor, first four-quadrant converter GTO's are triggered and then the motor inverter GTO. (Approx. time difference of 300 millisecond between the trigger of converter and motor inverters during which time DC link is charged to approx. 2800 V DC).

Intermediate Circuit:

The intermediate circuit connects the line side converter to the drive side converter and consists of a series resonant circuit and DC link capacitor.

Series Resonant Filter:

Power in single-phase supply system (DC voltage side of line converter) pulsates as twice system frequency. Therefore, the D.C. link circuit will have pulsating current component at 100 Hz besides the D.C. current. A series resonant filter (15.3, 15.4) is provided, tuned to 100 Hz to smoothen out this double frequency component.

DC Link Capacitors:

It consists of capacitor bank (15.5) and acts as buffer between line and drive converters compensating power difference between the two. The buffering action takes place in such a way that DC link voltage remains constant for all operating conditions.

Instantaneous Voltage Limiter MUB:

The DC link is equipped with an over voltage protection circuit (MUB) consisting of a GTO and resistor (15.1). If voltage on DC link exceeds a pre-set value, the GTO is fired by control electronic, causing current to flow through the resister, thus lowering the voltage of the DC link. This circuit is also used to discharge the DC link capacitor when loco put out of service. This is done automatically by control electronic ever time VCB is switched OFF. A manual earth

switch (15.82) is also provided to discharge the DC Link capacitor, DC Link voltage is measured by voltage transducer (15.6) and feed back sent to control electronics.

Earth Fault Monitoring:

Earth fault relay is provided to detect earth fault in the circuit. No corrective action is taken if fault occurs on either positive or negative side. Only a fault message is displayed on the display unit in front of driver. When fault occurs simultaneously on positive and negative side (which results in short circuit), the sub system is isolated through software.

D.C Link Voltage Indication:

LED indicators (15.7) are provided on each converter cubicle, which blink at a frequency proportional to D.C link voltage.

DRIVE CONVERTER (ASR) SIDE CIRCUIT DESCRIPTION:

The drive inverter is composed of four quadrant modules, connected with the three phases of the motors and on the DC side connected to DC link. Thus an alternating voltage is generated from the DC voltage consisting of square pulses.

The torque and speed of the motors are controlled by varying both fundamental wave frequency and the amplitude of the alternating voltage which is achieved by controlling the switching times and switching instances of various GTOs.

The three-phase supply induces a rotating field in the motor, if the frequency of the supply is higher than frequency corresponding to motor speed, torque is produced on the rotor of the motor during traction. This difference in stator and rotor frequency is controlled to give required tractive effort. Large the difference greater is the developed rotation torque. During braking the frequency of three phase supply is reduced below frequency corresponding to motor speed resulting in braking torque.

Up to a certain frequency (approx. 60Hz) the torque is constant. The voltage and frequency are varied such that their ratio V/f i.e. flux is always constant. This is called constant torque region of operation. Approximately at this point maximum motor voltage is reached and now its held constant. This is called constant power region of operation. After this is the weak field region where torque falls as square of speed while motor voltage is kept at maximum.

Technical Data Of Traction Converter

Coolant oil		SHELL DIALA DX
Input voltage	(RMS)	2 x 1,269 Volt
Input current	(RMS)	2 x 1,142 Amp
Input frequency		50Hz
DC-Link circuit nominal voltage(Ud)		2,800 Volt
Output voltage (line-line voltage, RMS)		2,180 Volt
Output current (per phase, RMS)		740 Amp
Output power		2,105 kW
Out put frequency		65-132 Hz

Traction Motor: General;

The ABB Traction motor type 6FRA 6068 is a 6-poles squirrel – cage rotor asynchronous motor which was specially developed for operation with a three –phase converter.

The traction motor is forced air cooled and intended for transverse installation in a 3-motor bogie. The power transmission is effected via a spur-wheel gear.

The traction motor type 6FRA6068 belongs to a construction series of 6- poles asynchronous traction motors of the construction size 60 which are specially designed for use in standard-gauge rail locomotives and similar traction vehicles (speed trains ,power cars).

Structure and Function:

The active part of the stator is laminated. The stator stack is held on both sides by wrap-around rings which are firmly welded together by traction rails. To protect the stator winding from thermal overload ,temperature probes are installed in the stator stack.

The openings for air inlet and outlet are integrated in the end plates. The plug-in cartridge for the rotary speed transmitter is on the non drive end (NDE) endplate.

The stator winding is insulated with the ABB class ‘C’ insulation system ‘Verifur’. In the case of this Case of this insulating system the stator is impregnated under vacuum conditions with a solvent free silicon resin of the class ‘C’.

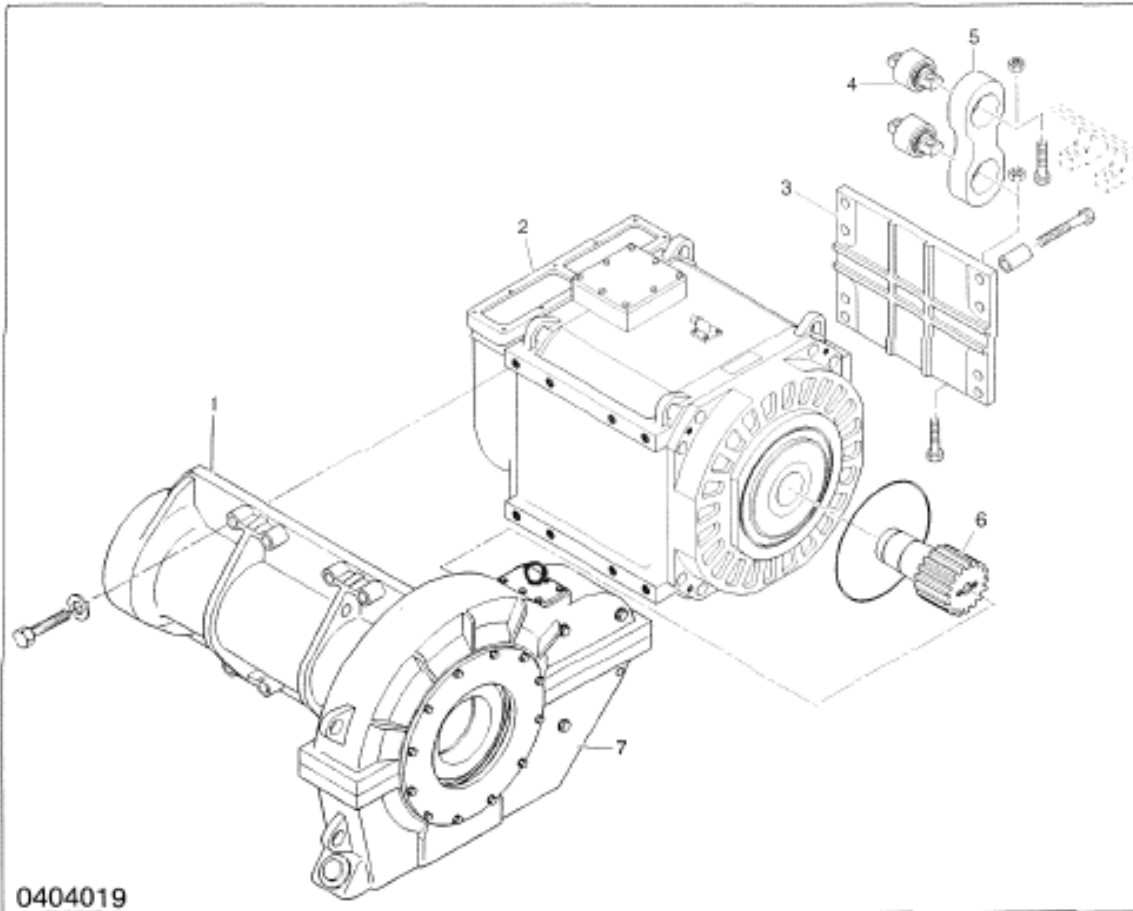
Although the rotor plate is laminated directly on to the shaft, a faulty shaft can be exchanged for a new shaft without any other parts, for instance the squirrel cage rotor having to be renewed.

The non drive end(NDE) roller bearing is at the same time a guide bearing. The non drive end (nDE) bearing and the drive end (DE) bearing are lubricated with grease and provided with radial non contacting seals which protect the bearings from the loss of grease and from the penetration of dirt.

There are total 6 traction motors provided in WAG-9 / WAP-7 loco. TM 1-2-3 are mounted in bogie-1 and are fed from traction converter -1 where as TM 4-5-6 are mounted in bogie -2 and are fed from traction converter -2. In case of WAP-5 there are 4 traction motors in which, Traction converter-1 feeds to TM-1-2 where as traction converter-2 feeds to TM3-4.

Unlike conventional WAG-5/7 individual TM cannot be isolated in this loco only a group isolation is possible. For isolation of TM group one rotating switch No. 154 is provided in SB-1, its normal position is “ Normal”

This group contains information on the traction motor and the gear case.



1	Suspension tube	5	Torque arm
2	Air inlet/outlet	6	Pinion
3	Mounting plate	7	Gear case
4	Spheriblocs		

”

In WAP-7 & WAG-9, the traction motor is forced—air cooled and intended for transverse installation in a 3—motor bogie. The power transmission is effected via a spur—wheel gear. In WAP-5 the TM is fully suspended and connected with gear by hurth coupling by which power is transmitted.

Traction motor is suspended on axle, by axle cap at one end and on link at another end.

To check the oil in gear case one spyglass is provided on gear case.

To monitor the temperature & speed, sensors are provided in the stator assembly.

In WAP5 the traction motor type 6FxA7059 is a 6-pole squirrel cage asynchronous motor, which is specially developed for operation with a three-phase converter. Each traction motor

equipped with one temperature sensor & two speed sensors. The traction motor is forced air-cooled. The power transmission is effected via spur wheel gear.

The ZF HURTH crown gear coupling provides for the transmission of rotational forces between the traction motor and gearbox. One drive coupling half is pressed onto the traction motor output shaft and the gearbox input shaft.

This dual cardanic-acting coupling transfers the torque from the motor to the transmission and can compensate for radial, axial and angular shaft shifting. The inner-toothed coupling sleeves are mounted rigidly on the motor and transmission shaft.

The coupling is equipped with separate, closed lubricant chambers in each coupling half. When removing or installing the motor or transmission, the lubricant chambers remain closed, eliminating the possibility of the tothing become dirty. The sealing elements are each arranged on the side facing the motor or transmission. With this, and the possibility to integrate the labyrinth seals from the motor and transmission with the coupling sleeves, a maximum of tooth center spacing is achieved.

This means a relatively small coupling star diffraction angle for radial shifts and:

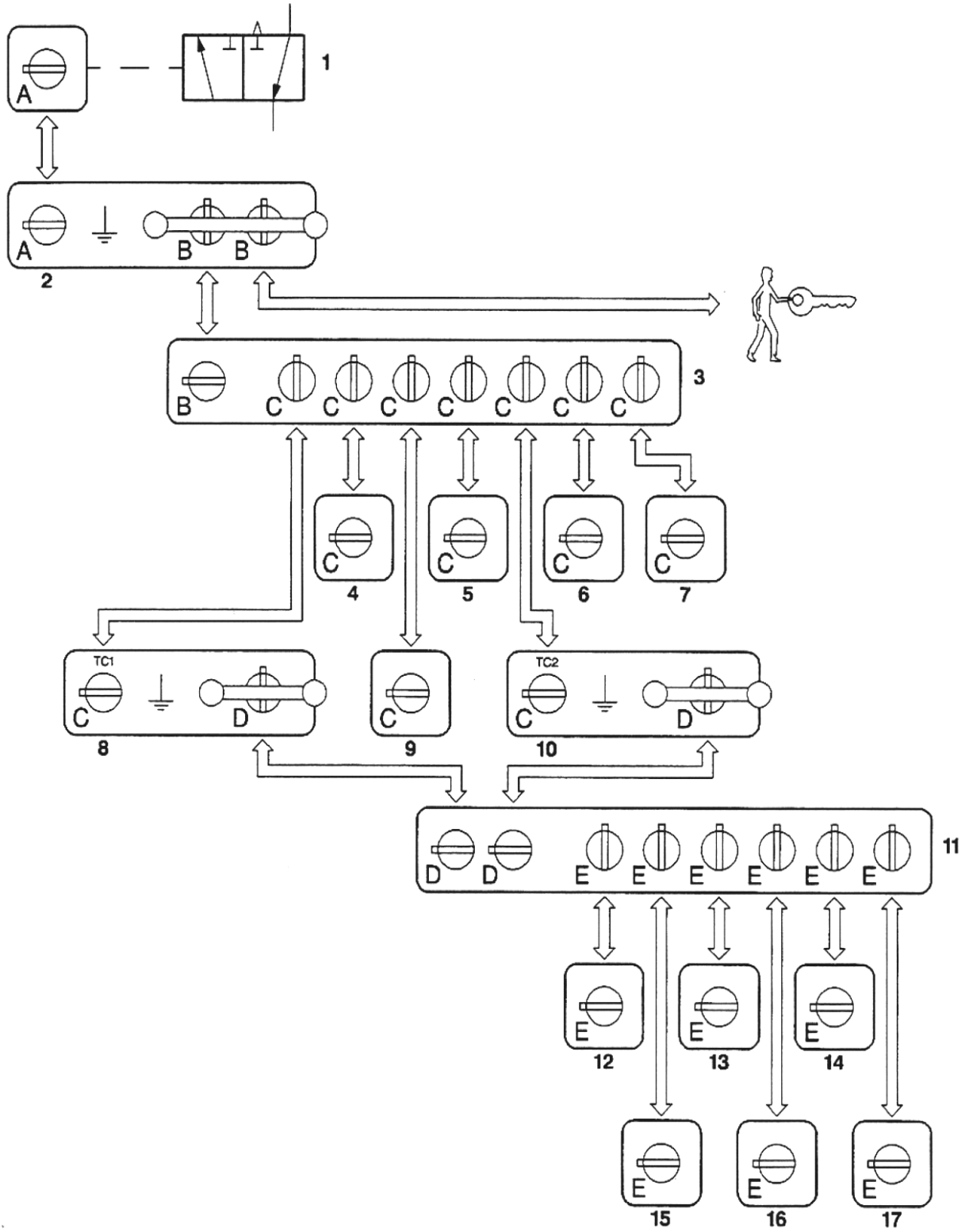
- Low required crowning of the tothing
- Low specific loading at the tooth face
- Increased operating safety and longer service life

Another advantage lies in the very low weight of the movable coupling stars. In conjunction with the spherically shaped tooth-tip centering, imbalances are also avoided in the unloaded state (vehicle rolling) depending on backlash. This is particularly important at high driving speeds, i.e. at high engine speeds. Maintenance is limited to a visual check for oil leaks or damage and an oil change during major transmission and vehicle inspections. It is also possible to attach a magnet wheel for a speed sensor on the coupling sleeve.

The gear coupling consists of a star coupling (pinion) within a geared sleeve. The star has curved teeth to allow for minor misalignment and movement between the motor and gearbox.

GROUNDING OF THE LOCOMOTIVE:

For safety of the operating personnel during maintenance work a hand operated earthing switch (HOM) is provided near the VCB in the central corridor. This switch can be operated from the machine room itself to connect the VCB input and output to ground. The locomotive is equipped with a Key Multiplier unit, which ensure proper operating sequence. For this purpose there are a number of coloured keys, which are utilized to unlock main converter, Auxiliary converter, HB cubical, FB cubical, earthing switch and pneumatic panel. The sequence of earthing is as under:



Key A (light blue) and B (yellow)

By locking the pantograph valve at by moving IG38 from horizontal to vertical, key A (Blue) becomes free.

Key A unlocks the earthing switch on the main circuit breaker (handle to be rotated 180 degrees). If this is moved into earthing position, the locomotive is earthed and both B (yellow) keys become free.

Key B is used to unlock the key multiplier No. 1 for key C (green). Key multiplier No. 1 is located in the machine room behind the cab.

The seven C keys (green) are used for:

- Opening the auxiliary circuit block 1
- Opening the auxiliary circuit block 2
- Opening the auxiliary converter 1
- Opening the auxiliary converter 2
- Opening the filter block
- Unlocking the earthing switch on traction converter 1
- Unlocking the earthing switch on traction converter 2

By actuating the earthing switch on the traction converter, one D key (black) becomes free in each case. With both D keys together, the key multiplied No. 2 for key E (white) is unlocked. Key multiplier No. 2 is located in the machine room behind the cab.

With the 6 E keys, the following doors can be opened:

- 1004.6 Traction converter 1, door lock 1 - 3
- Traction converter 2, door lock 1 – 3

AUXILIARY POWER CIRCUIT OF -WAP5/WAG9 LOCOMOTIVES:

Each locomotive is equipped with three auxiliary converters (BUR1, BUR2, BUR3) each rated 100 KVA, which are directly connected to the 1000 V auxiliary winding of main transformer. The load distribution among the auxiliary converters is almost uniform and required redundancy is achieved by switching load from one auxiliary converter to another with the aid of converters. The three phase auxiliary circuit is fed through three-phase voltage generated by the three auxiliary converters called BUR-1, 2,3.

The entire three auxiliary converters are designed for connection to the auxiliary service winding of the main transformer. BUR-1 supplies the variable frequency i.e. 24, 37 and 50 HZ depending on the temperature of converter/TFP oil. BUR-2 supplies at 47 HZ and BUR-3 supply at 50 HZ. Under normal circumstances, BUR1 takes the load of both oil cooler blower motors, BUR2 the load of both TM cooling blower motors & all oil pumps and BUR3 the load of TM Scavenger Blowers, both Compressors & Battery Charger. Whenever any one BUR goes isolated due to any reason then another two BURs take over the load of all auxiliary motors.

THREE PHASE AUXILIARY CIRCUIT DESCRIPTION:

The output voltage (1000VAC) of TFP auxiliary winding fed to the Burs.

Further the ckt is divided into following parts.

Half Controlled Rectifier Bridge (GG Module) (50.11)

Intermediate Circuit Choke (51.3) & Capacitors (51.1)

Three Single Phase Inverters, Connected As Three Phase Inverter (51.12)

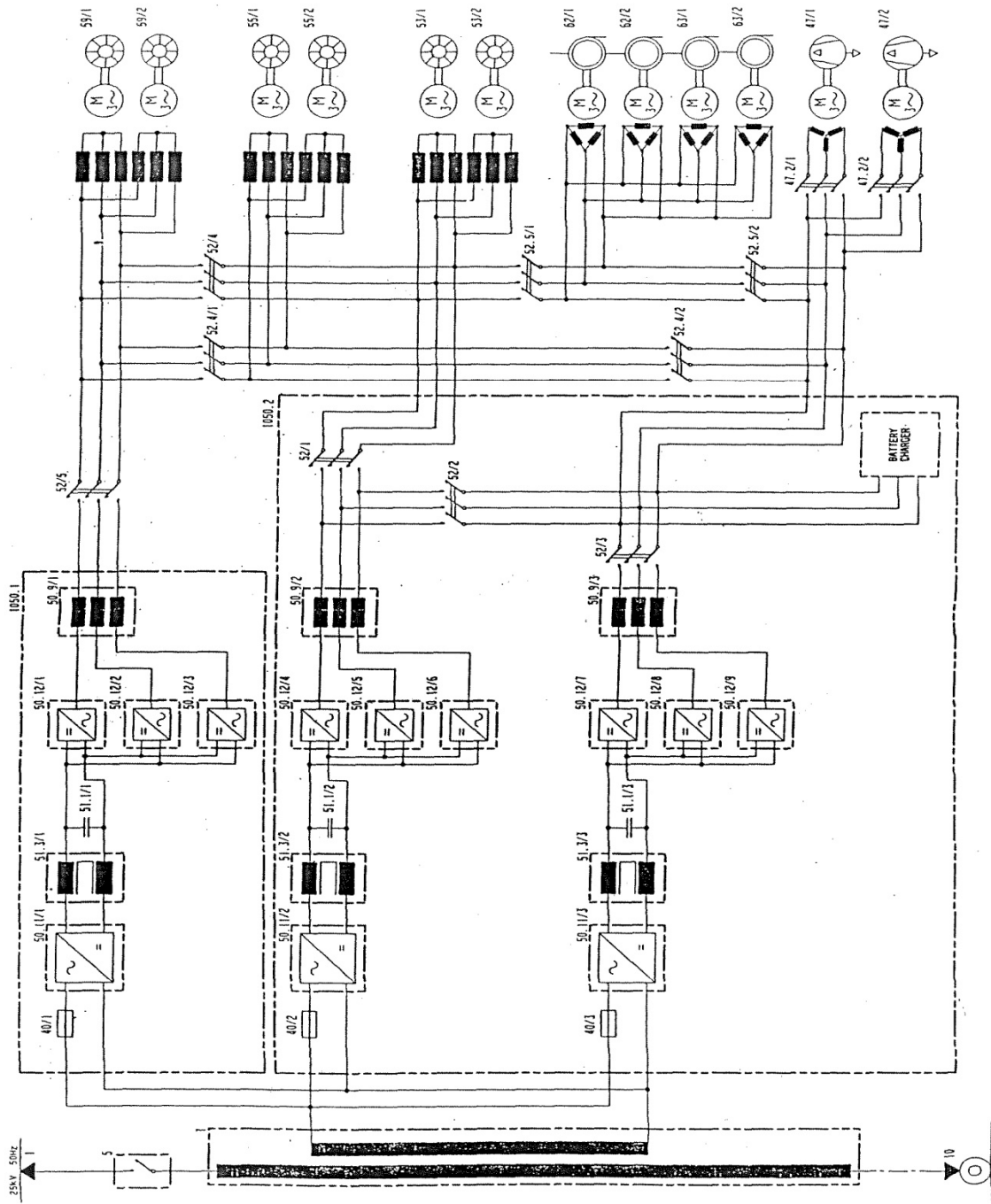
Control Electronics (426)

Three Phase Output Choke (50.9)

Half Controlled Rectifier bridge (GG Module) (50.11)

The rectifier bridge is of half- controlled design. The rectifier converts AC input voltage varying between 760 V to 1100V (depending upon the catenary voltage) to a stabilized DC voltage of 850 V (D.C. link voltage). This is achieved by appropriate setting of the thyristor.

On the input of the rectifier, a RC filter consisting of resistor and capacitor is connected to filter out harmonics



The Intermediate Circuit (D.C. Link Voltage Circuit) (51.3 & 51.1)

The intermediate circuit connects the rectifier with the inverter. It consists of choke (51.3) to filter-out harmonics and smoothen DC output of rectifier. The voltage across the intermediate circuit capacitor (filter output voltage) called the intermediate circuit voltage U_Z , is the main controlled value for the converter. The intermediate circuit reactor smoothes the pulsating energy flow from the input rectifier and supplies a D.C. (Intermediate circuit) current I_Z with superimposed ripple. The choke is equipped with two coils in order to keep voltage spikes away from the inverter and the connected load. The Intermediate circuit capacitor absorbs the alternating components of the circuit, with little fluctuation in terminal voltage. In addition, D.C. link capacitors represent the low impedance voltage source.

Three Phase output Inverter (51.12) (WRE module):

The output inverter consists of three identical single-phase modules which convert the DC link voltage to three-phase AC voltage of 415V. Each single-phase module consists of 2 Gatos with antiparallel diodes. Each GTO is switched ON for half cycle of output frequency, and connect the DC link voltage to output terminals. To obtain three-phase output at the output terminal, the three-inverter modules are operated with a phase shift of 120 degrees. Alternating switching positive and negative poles of DC link circuit to output terminal generates square wave AC output voltage. The amplitude of AC output voltage is constant and corresponds to DC link voltage.

The two-channel gate-drive units are mounted at modules. The logical protection integrated into the drive-unit monitors the phase current. Both gate channels are interlocked in order to avoid simultaneous firing of the GTO's.

Control Electronics (426):

The auxiliary converter is provided with its own microprocessor based control unit, which communicates with locomotive control system through fiber optics MICAS Vehicle bus (MVB). The control of converter is structured in following stage:

Intermediate circuit regulation (Current and Voltage):

The DC link voltage is the main controlled parameter. When battery charger is connected to the converter then voltage reference is derived from battery control, to adjust the battery charging voltage. Otherwise DC link voltage is varied depending on the requirement.

Output inverter frequency and voltage regulation:

The function of inverter control consists in maintaining the output voltage and frequency on the prescribed set point and in limiting the deviation to acceptable limits. The Temperature Sensors provided in the Traction Motor Windings and Oil Circuits determine the fan speed, which in turn determine inverter frequency and voltage.

Protection and control logic

Fuse: - The fuse protects the circuit from serious consequential damage, which could result in the event of failure of power components in the rectifier bridge or defects of the regulation, overall the actual value monitoring. The rating of fuse is 1200V, 280 Amp.

Surge Arresters: - The surge arresters protect the semiconductors of the rectifier bridge from over voltage spikes.

R.C. Filter:- This filter is intended to limit the rate of rise of voltage spikes in order to avoid spurious thyristor firing.

Input Voltage Measuring Transformer: - The measuring transformer is used to provide the electronic control unit with information about voltage amplitude and voltage phase required for accurate generation of the thyristor firing pulses.

Voltage Transducers: - The voltage transducer service to measure the D.C. link voltage.

SINGLE PHASE (415V / 110V) AUXILIARY CIRCUIT DESCRIPTION:

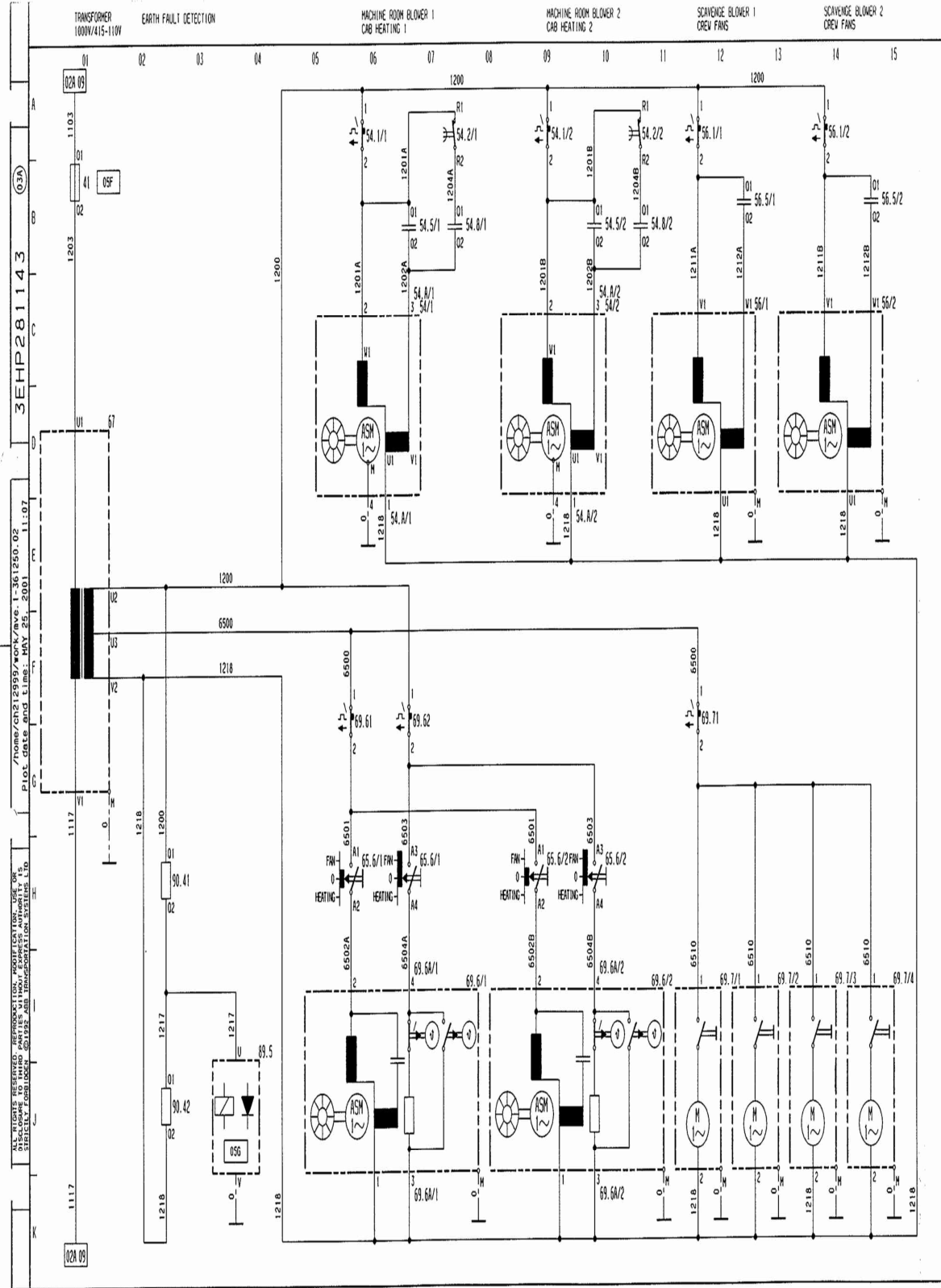
The auxiliary winding of transformer supplies 1000 volt to the input of auxiliary transformer fitted in HB1 panel through a fuse. This auxiliary transformer has three windings (two of 415V and one of 110V) at output. The machine room blowers and corresponding scavenger blowers, cabs heaters are fed through the 415-volt single phase AC supply, while the crew fans and heater blower works on 110V AC supply. The machine room blowers and their scavengers are capacitor start capacitor run single-phase induction motor. Thus, the circuit provides for cooling of machine room even when CEL (control electronics) is OFF. The function of machine room blower is to cool down the machine room and scavenger blower collect and through the dust and water, which received from out side.

PROTECTIVE DEVICES:

Fuse: A fuse of rating 1000 volt – 040 A is provided in the input circuit of auxiliary transformer circuit to protect the circuit for over current and short circuit during operation.

Earth Fault Detection Relay: A solid-state earth fault detection relay is provided in the output circuit of transformer to detect the earth fault in the circuit.

MCB's: Each auxiliary machine i.e. M.R. Blower, M.R scavenger blower; cab heater and crew fans are protected by MCB's.



Auxiliary	Location	Function	MCB
Load on Auxiliary Converter no.- 1			
Oil Cooling Blower-1 (OCB-1)	Machine Room-1	To cool transformer and SR-1 oil in cooling unit-1 by taking air from roof	59.1/1 In HB-1
Oil Cooling Blower-2 (OCB-2)	Machine Room-2	To cool transformer and SR-2 oil in cooling unit-1 by taking air from roof	59.1/2 In HB-2
Load on Auxiliary Converter no.- 2			
Tr. Motor Blower-1	Machine Room-2	To cool bogie –1 TM group by forced air.	53.1/1 In HB-1
Tr. Motor Blower-2	Machine Room-1	To cool bogie –2 TM group by forced air.	53.1/2 In HB-2
Transformer oil pump-1	Under Truck Below Machine room-1	To circulate oil from TFP to Cooling Unit-1 & back	62.1/1 In HB-1
Transformer oil pump-2	Under Truck Corridor-2	To circulate oil from TFP to Cooling Unit-2 & back	62.1/2 In HB-2
Tr. Converter Oil Pump-1	Machine Room-1 Near SR-1	To circulate oil from SR-1 to Cooling Unit-1 & back	63.1/1 In HB-1
Tr. Converter Oil Pump-2	Machine Room-2 Near SR-2	To circulate oil from SR-1 to Cooling Unit-2 & back	63.1/2 In HB-2
Load on Auxiliary Converter no.- 3			
Main Compressor-1	Under Truck below Machine room-1	To create MR pressure to 10.0 kg/cm ²	47.1/1 In HB-1
Main Compressor-2	Under Truck below Machine room-2	To create MR pressure to 10.0 kg/cm ²	47.1/2 In HB-2
Scavenging Blower-1	Machine Room-1 Near TMB-2	To clean dust from air filters of TMB-2 & OCB-1	55.1/1 In HB-1
Scavenging Blower-2	Machine Room-2 Near TMB-1	To clean dust from air filters of TMB-1 & OCB-2	55.1/2 In HB-2
Battery Charger	Within Auxiliary Converter Cubicle	To charge battery	110 In SB-2

Machine Room Blower-1	Machine Room-1	To cool machine room by ducting and limit the temperature of control electronics parts below 70°C	54.1/1 In HB-1
Machine Room Blower-2	Machine Room-2	-do-	54.1/2 In HB-2
Scavenging Blower for	Machine Room-1	To clean dust from air filters of Machine Room Blower-1	56.1/1 In HB-1

Machine room Blower-1			
Scavenging Blower for Machine room Blower-2	Machine Room-2	To clean dust from air filters of Machine Room Blower-2	56.1/2 In HB-2
Heater Element	In Both cab. Inside Desk	To deliver heat for keeping the cab warm	69.62 In HB-1
Single phase 110 Volts			
Crew Fan: 4 nos.	2nos. in Both cabs	Crew ventilation	69.71 In HB-1
Cab Ventilation Blower- 2 nos.	One in Both cab Inside Desk	To expel heat of heater element into the cab.	69.61 In HB-1

Load Sharing

Generally all the 3 Auxiliary converters are loaded equally, but in case of failure of any converter another converter shares its load. In such condition, frequency of aux. Motor drops from 50 Hz to 37Hz.

Load sharing after isolation of any aux. converter.

Aux.Conv-1 isolate	Load on Aux.Conv-2	Oil cooling blower 1-2,Tr. Motor blower 1-2 Scavenging blower 1-2
	Load on Aux. Conv.-3	MCP 1-2, Transformer pump 1-2 Converter pump 1-2, Battery Charger
Aux.Conv-2 Isolate	Load on Aux.Conv-1	Oil cooling blower 1-2,Tr. Motor blower 1-2 Scavenging blower 1-2
	Load on Aux. Conv.-3	MCP 1-2, Transformer pump 1-2 Converter pump 1-2, Battery Charger
Aux.Conv-3 Isolate	Load on Aux.Conv-1	Oil cooling blower 1-2,Tr. Motor blower 1-2 Scavenging blower 1-2
	Load on Aux. Conv.-2	MCP 1-2, Transformer pump 1-2 Converter pump 1-2, Battery Charger

Contactor	52/1	52/2	52/3	52/4	52/5	52.4/1	52.4/2	52.5/1	52.5/2
Position	closed	open	closed	open	closed	open	closed	closed	open

Contactors positions in normal

In case of BUR1 fails

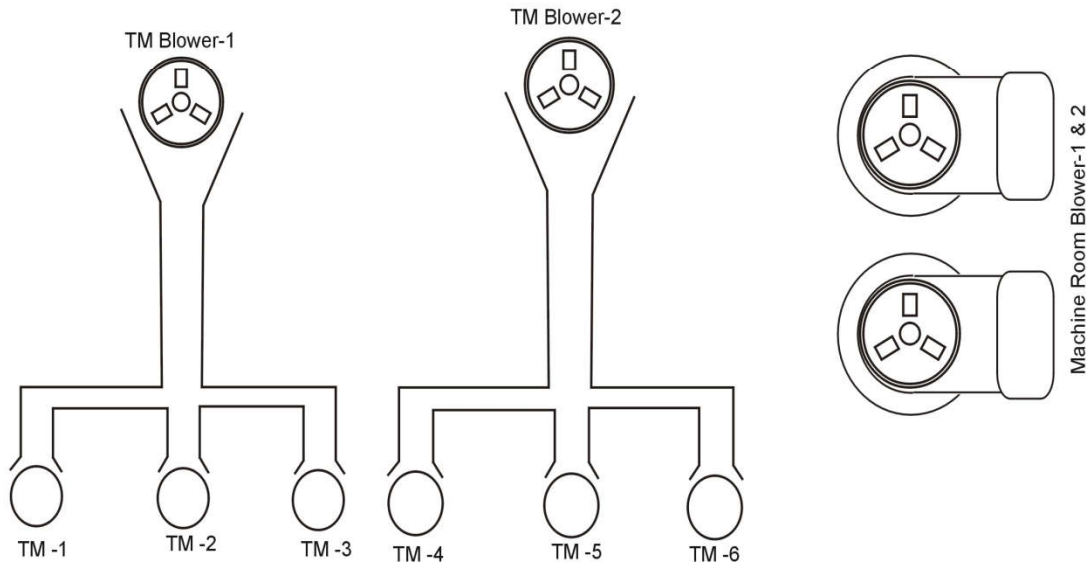
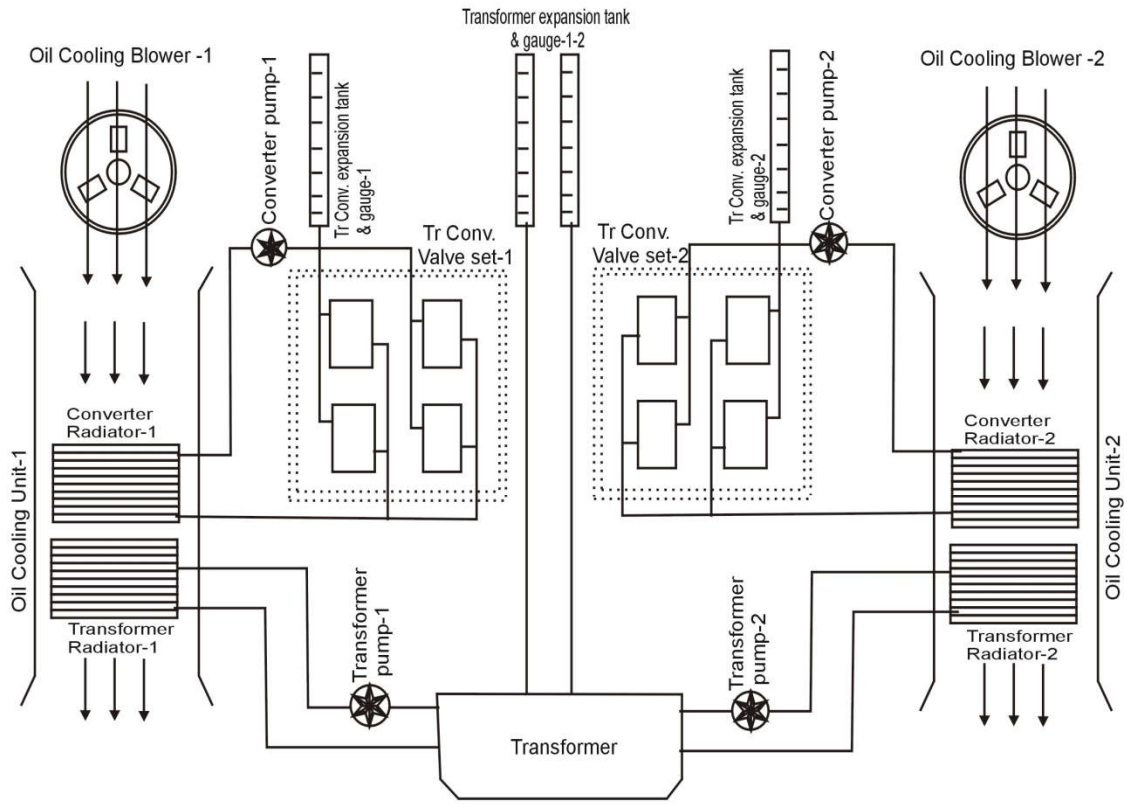
Contactor	52/1	52/2	52/3	52/4	52/5	52.4/1	52.4/2	52.5/1	52.5/2
Position	closed	open	closed	closed	open	closed	open	open	closed

In case of BUR2 fails

Contactor	52/1	52/2	52/3	52/4	52/5	52.4/1	52.4/2	52.5/1	52.5/2
Position	open	open	closed	closed	closed	closed	open	open	closed

In case of BUR3 fails

Contactor	52/1	52/2	52/3	52/4	52/5	52.4/1	52.4/2	52.5/1	52.5/2
Position	open	closed	open	closed	closed	closed	open	open	closed



BATTERY CHARGER CONTROL CIRCUIT

Battery charger is fed normally through Auxiliary Converter No-3 (BUR-3). If converter no 3 are isolated due to any malfunction, then charger is connected to Auxiliary Converter-2 (BUR2). Central Electronics (CEL) through I/O and Processor cards controls this.

This 3 Φ , 415V AC supply is fed to the battery charger (107) through charger MCB (100) which consists of a three phase 415 to 110V step down transformer (107.1) and a Diode Rectifier (107) to convert AC supply to DC.

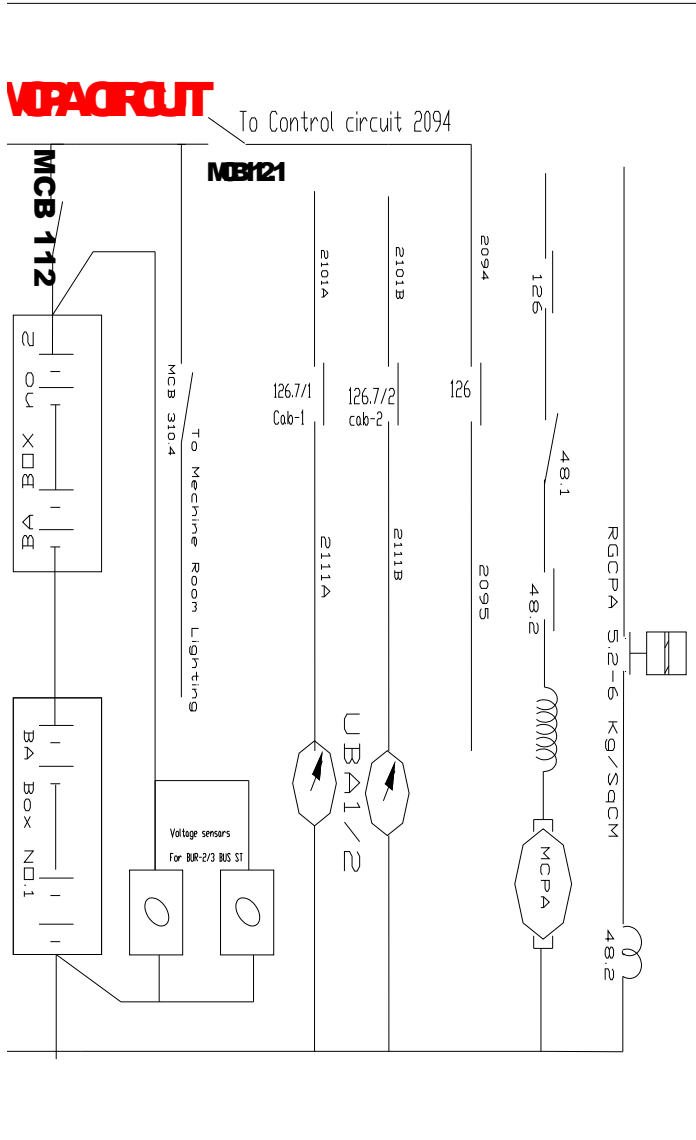
Independent of the charge / discharge state, battery is charged with a constant voltage of 1.38V / cell as soon as battery charger is switched on.

The output of charger transformer is fed to diode rectifier (107), which converts it to DC. The output current of charger is continuously monitored through current sensors. If the charger is getting supply from converter 3 then current sensor connected in rectifier module and when charger is getting supply from converter 2 then current sensors 107.2 and 107.3 send the feedback to respective auxiliary converter control.

A capacitor is connected across the output of charger to smoothen the output and prevent over voltage due to sudden change in current.

The output of the charger is fed to the battery (111/112) through MCB (110) which is connected at the output of the charger to prevent excessive charging. Battery supply is measured and the feedback is sent to auxiliary converter control 426/2 & 3. The battery output is fed to the control circuit through battery circuit breaker (112). Battery supply is fed to various control circuit through their respective MCBs.

An Earth Fault Relay is provided to detect earth fault in the Control Circuit. Two resistances are connected across the 110V DC output and the Relay is connected at the mid point of the resistance with its other terminal grounded. Any traction control system has three levels of control



CONTROL ELECTRONICS

1. Train control level - Between vehicles of trains
2. Vehicle control level - Within the vehicle - Coordination between various sub systems like Aux. Traction, brakes
3. Drive control - Traction control - Auxiliary power circuit - Brake interface

General

A sequential control checks the operating status and determines the order in which operations are carried out. It includes nodes (states) which are connected by transitions. The state of a system or sub-system can thus be simple and logically controlled. The sequential control can only be in one defined state at any one time.

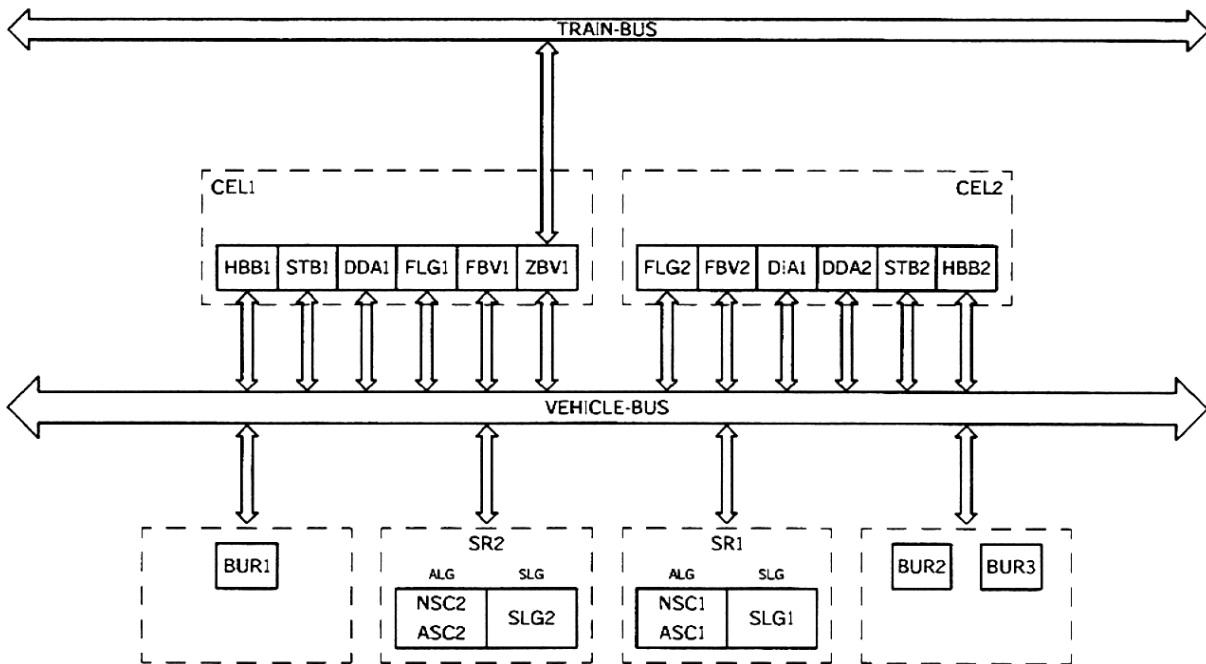
The master sequential control defines the current state of the locomotive with the aid of a node number. The node number is the central reference for all the system processors and is therefore decisive for maintaining the proper locomotive operating procedures. The MSC also performs various protection functions, e.g. the main circuit-breaker can only be closed after the MSC has reached the corresponding node or state.

A sub-sequential control defines the current state of a processor with the aid of a node number. It is generally controlled by the MSC.

The most important functions are duplicated to enable the locomotive to remain in operation in spite of the failure of a sub-system

Bus Concept

The remote arrangement of computers for the control electronics means that not much wiring is required for the control signals. Information is recorded as closely as possible to their sources and the actuating members are piloted by the nearest computer.



Main diagram control electronics

SR	Converter	STB	Low Voltage Cubicle Control
ALG	Drive Control Unit	FLG	Vehicle Control Unit
SLG	Converter Control Unit	FBV	Vehicle Bus Administrator
ASC	Drive Converter Control	ZBV	Train Bus Administrator
NSC	Line Converter Control	DIA	Diagnostic Control
BUR	Auxiliary Converter Control	DDA	Display Data Control
HBB	Auxiliary Cubicle Control		

The vehicle bus directs the information flow to the different computers by fiber-optic cable. The networking of signals takes place solely in the computers which means that the control electronics system always has a complete picture of the status of the locomotive at all times. This is a major benefit, especially when dealing with faults in the system.

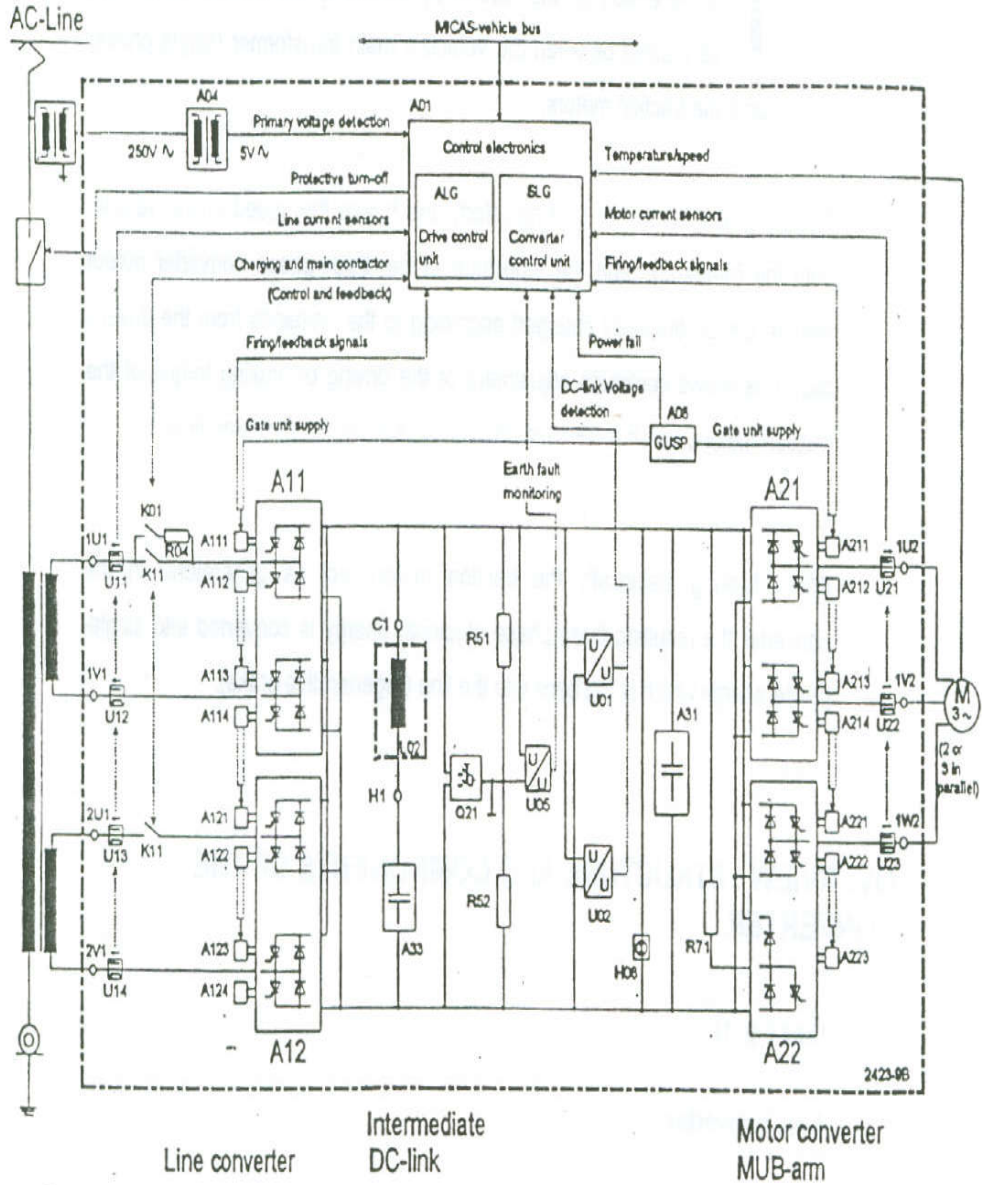
Bus Stations

A control electronics level with at least one computer and a connection to the vehicle bus is defined as a bus station.

Third Party Control Electronics

The following third party systems are operated by their own control electronics and independent from the above mentioned bus concept:

Main circuit diagram



ICARD DETAILS FOR CONVERTER CONTROL UNIT (2 per loco)

S.no	Card no.	Description of the card	Slot	No. of cards
1	AFB635B08	Fiber Optics Transmitter/Receiver LWL	Slot	2
2	UAB630A36	Signal Conditioning SAP1	A	1
3	UAB630A91	Signal Conditioning SAP2	B	1
4	UAB630A93	Signal Conditioning SAP3	C	1
5	ARB705B01	Signal Input Board SFP	D	1
6	XVA987C22	Drive Converter Peripheral Device AS-Peri	H	1
7	PPA988B02	3NEA-Controller (AS-/NS-CTR)	IJ-MN	2
8	XVA986B22	Line Converter Peripheral Device NS-Peri	L	1
9	UFB701A01	Bus Coupler 1 channel BTG1	R	1
10	UAB514B33	Analog Input/Output AEA	ST	2
11	PPB622B01	Single board processor EKRII VB	U	1
12	URB177D15	Binary input/output BEAG	W	1
13	KUA915B01	Power supply unit	XYZ	1
Total cards per CCU				16 (13 Types)

ICARD DETAILS FOR VEHICLE CONTROL UNIT (2 per loco)

S.no	Card no.	Description of the card	SLOT	No. of cards
1	KUB921A01	Power supply	(AB) (CD)	2
2	ARB705B01	Signal Routing Board (SFP)	E	1
3	UAB514B33	Analog I/O	F	1
4	PPB622B01*	Single Board computer (EKR II) FLG, STB, HBB	GNS	3
5	PPB908A01	Diagnostic Display (EKR II) (DDA)	HI	1
6	URB512D15	Binary I/O Relay Board (BEAR)	JLOQ	4
7	UFB660A01	Bus coupler	W	2
8	XBC029A01	Temp. measurement	K	1
9	PPB626B01	Bus administrator (FBV)	T	1
10	PPB624A1	Diagnostic computer (EKR II) (One in CEL-2 only)	U	1
11	PPA425B01	Train bus coupler (ZBV) (One in CEL-1 only)	YZ	1
12	LAA424C01	Train bus coupler (ZB- Int) (One in CEL-1 only)	X	1
Total cards per VCU				19 (12 types)

***FLG card in Slot C of VCU2 is redundant.**

ICARD DETAILS FOR BUR (3 per loco)

S.no	Card no.	Description of the card	SLOT	No. of cards
1	UFB701A01	Bus coupler 1 channel BTG1	B	1
2	PPB471A02	BUR computer BUR-LR	CD	1
3	RDB472A01	GG, WRE controller	F	1
4	UAB476A01	Aux interface (Peripheral Board 2 WRE)	G	1
5	KVB993A01	Aux interface power supply		1
6	KUC153A02	Power supply Aux. bus station	I	1
Total cards per BUR				6 (6 types)

IV.CARD DETAILS FOR PNEUMATIC (1per loco)

S.no	Card no.	Description of the card	Slot	No. of cards
1	AB578-W189	Power supply card	E	1
2	AB578-W395	Control card	D	1
3	AB578-W391	LPO card	C	1
4	AB578-W393	Blended Card	A	1
Total cards for Pneumatics				4 (4 types)

PPB622 A01

PPB622	Type number
A	Change index
01	Version

BRIEF FUNCTIONAL DETAILS FOR CONVERTER CONTROL UNIT

S.no	Card no.	Description of the card/SLOT No.	
1	AFB635B08	Fiber Optics Transmitter/Receiver LWL/1-4	2 Transmitter and Receiver cards for the fiber optic cable connection between the bus station and the gate units of the line converter (slot 1-2 and the motor converter (Slot 3-4) to transmit both the control and feed back signals for the GTO, Power Thyristers
2	<i>UAB630A36</i>	Signal Conditioning SAP1/A	TFP Primary Current, Earth fault monitoring signals (U05), BUR current detection
3	<i>UAB630A91</i>	Signal Conditioning SAP2/B	NSR AC Transducers (U11-U14), Power failure signal GUSP.
4	<i>UAB630A93</i>	Signal Conditioning SAP3/C	ASR AC current transducers (U21-U23), DC link voltage transducers (U0I-02)
5	<i>ARB705B01</i>	Signal Input Board SFP/D	Motor temperature pressure and Temperature of TFP and converter oil cooling system.
6	<i>XVA987C22</i>	Drive Converter Peripheral Device AS-Peri/H	ASR Peripheral card, Motor speed signals MUB controls
7	<i>PPA988B02</i>	3NEA-Controller (AS-/NS-CTR)/IJ & MN	IJ: ASR Controller, Service connector MN: NSR Controller, Service Connector
8	<i>XVA986B22</i>	Line Converter Peripheral Device NS-Peri/L	Calculation of the TFP magnetizing current
9	<i>UFB701A01</i>	Bus Coupler 1 channel BTG1/R	Bus coupling unit: Coupling from remote bus (optical) and local bus (electrical)
10	<i>UAB514B33</i>	Analog Input/Output AEA/S	Analog inputs and outputs
11	<i>PPB622B01</i>	Single board processor EKRII VB/U	Single card processor for: Slip-slide protection (main function) Contactor control programs Powering up and powering down of the converter, Switch-on and switch-off of GUSP 2 service connectors (sub-D)
12	<i>URB177D15</i>	Binary input/output BEAG/W	Binary input-output card
13	<i>KUA915B01</i>	Power supply unit/X	Power supply unit Battery supply for the power supply unit

BASIC FUNCTION OF ELECTRONIC CARDS**POWER SUPPLY MODULE – KUB921 (KU1BA)**

INPUT VOLTAGE : 77.0 -137.5 V

OUTPUT VOLTAGE : +5V / 4A,+/- 15 V / 1.5A,+/-24 V / 2A

Power draw DCU/CCU,Nominal: 207W (ZLT1 + ZLT2),Max:247W (ZLT1 + ZLT2)

POWER SUPPLY MODULE –KUA915(KU1CA)

INPUT VOLTAGE : 77.0 -137.5 V ,

OUTPUT VOLTAGE : +5V / 7A,+/- 15 V / 2A,+/-24 V / 7.3A

Power draw DCU/CCU-Nominal: 130W,Maximum:200w

Single Board Computer PPB622-EKR II VA(PP1AA)

Computation of inputting and outputting signals and process them accordingly.

Power supply monitoring .Self test hardware (in the IMASC ASIC)

Diagnostic Computer PPB624-EKR II DR(PP2AA)

To control the diagnostic displays in the driver's cab

Generation of report and reset signals.

Bus Administrator PPB626-EKR II BV(PP3AA)

Administration of data traffic performed on the MVB using redundancy

Monitoring logical addressed device status words.

Computer Display Module PPB908(PP2BA)

Diagnostic display board

BUS COUPLER SINGLE CHANNEL MODULE – UFB701-BTG (CM1AA)

Converts signals between the redundant electrical local bus and non redundant remote bus.

Regenerates (equalizes) the signals received by the local or remote bus.

BUS COUPLER 5 CHANNEL MODULE – UFB660-BTGR(CM2AA)

The Bus couplers serve as electrical isolator .

Level converter between the local bus and the remote bus

BINARY INPUT / OUTPUT MODULE – URB177-BEAG(UB1AA)

Transformation of Binary I/O signal into processor and vice versa.

Electrical isolation & Overvoltage transient protective devices.

BINARY INPUT / OUTPUT RELAY MODULE – URB512-BEA(UB1BA)

Digital data exchanged between AMS-Bus and a process.

Electrical isolation & Overvoltage transient protective devices.

ANALOG INPUT / OUTPUT MODULE – UAB514-AEA(UA1AA)

Samples analog values and makes them available in the digital form on the AMS-Bus. The input can be configured (Current, voltage etc.) by the user.

Temperature Measurement and Current Measurement.

Signal input Board –ARB705-SFP(UR1CA)
Motor Temperature and EMC Protector

Signal Conditioning Board –UAB630-SAP(UK1CA/BA/DA)
Main transformer primary current, Train supply Current, E/f monitoring signal
Filter Current, BUR Current detection, Oil Pressure transformer, NSR current transducer
Power failure signal, GUSP, Primary Voltage, ASR current transducer & DC Link Voltage

Fibre optic S Transmitter/receiver Module – AFB635-LWL(UF1AA)
FO connection b/w Bus station & Gate Unit. Converts electrical firing pulses stemming from the AS & NS Controller into corresponding to light pulses for potential-free and interference free transfer to the Gate Units and vice versa.

H4 AS / NS Peri Controller Board –PPA988-CTR(PC1AA)
Generate firing Pulses for the drive and line converter operated with GTO Thyristor.
Function as D/A and A/D converter. Filtering for interference.

Drive Converter AS Peripheral Board –XVA987-AS Peri (GM1AA)
Motor speed detection, MUB Control, Protective shutdown and Simulation of DC link Current

Line Converter NS Peripheral Board –XVA986-NS Per(GL1AA)
Calculation of Transformer magnetization current, Exchange of Traction current between two bogies, Detection of 100-Hz component of the line current and Line circuit current calculation

Gateway consists of three Module

FSK Train Bus Server –PPA425(CT1AA)
Control(on/off) of the bypass. Organize data traffic.
Executes train inauguration initiated by Loco driver.

FSK Train Bus Interface –LAA424(CT2AA)
Matching and filter unit between the Train bus server and line unit on the FSK transmission line
Signal monitoring. Voltage limiters and standard insulation against vehicle surges

FSK Train Bus Line Unit – XVB708(BC1BA)
Interfacing between the communication coupler and the transmission line. Filtering of high frequency signals to separate the two sides of the transmission.

Basic Functions of Gateway

Remote control and coordination of traction units. This concerns setup, drive and braking.
Remote control of auxiliary functions such as door actuation, lighting, heating systems.
Check back messages for conditions such as pantograph position, door status, contactor switching positions. Fault and failure messages.

CAB ACTIVATION CIRCUIT

Cab activation Key is inserted in the Cab Activating Switch (125), in either of the cabs from which driving is to be done. This switch has three positions – OFF, Driving (D) & COOLING (C). Normally both the cab activating switches are in OFF position and either of them can be put to DRIVING or COOLING position by rotating the key in the cab Activating Switch (125). When cab1 (cab2) is selected then contact of 125/1 (125/2) between potential 2111A & 2500 A (2111B & 2500B) in driving mode and message goes to Control Electronics (411).

As soon as key is inserted and position (cooling or driving) is selected then Contactors of cab1 (cab2) power supply 126.7/1 (126.7/2) closes through following circuit.

Contact of 125/1 between potential 2067 & 2503A closes, once driving or cooling position is selected and normally closed contacts of cab2 contactor 126.7/2 between potential 2503A and 2504A remain closed. Supply goes to cab1 contactor 126.7/1, which closes the contactor. When cab switch 125 is turned off contactor 126.7/1 opens. Once cab1 contactor 126.7/1 closes, its N/C contact between potential 2503B & 2504B opens to ensure that cab2 contactor does not closed as long as cab1 contactor is closed

Also with the selection of 125, control circuit contactor 126 closes through the following circuit.

Normally closed contact of control electronics off relay 126.5 between potential 2505 and 2508 remains closed and supply goes to coil of 126.2067-2053A-2505-2508. Contractor 126 opens when relay 126.5 picks up or cab switch 125 is turned to OFF from COOLING or DRIVING MODE.

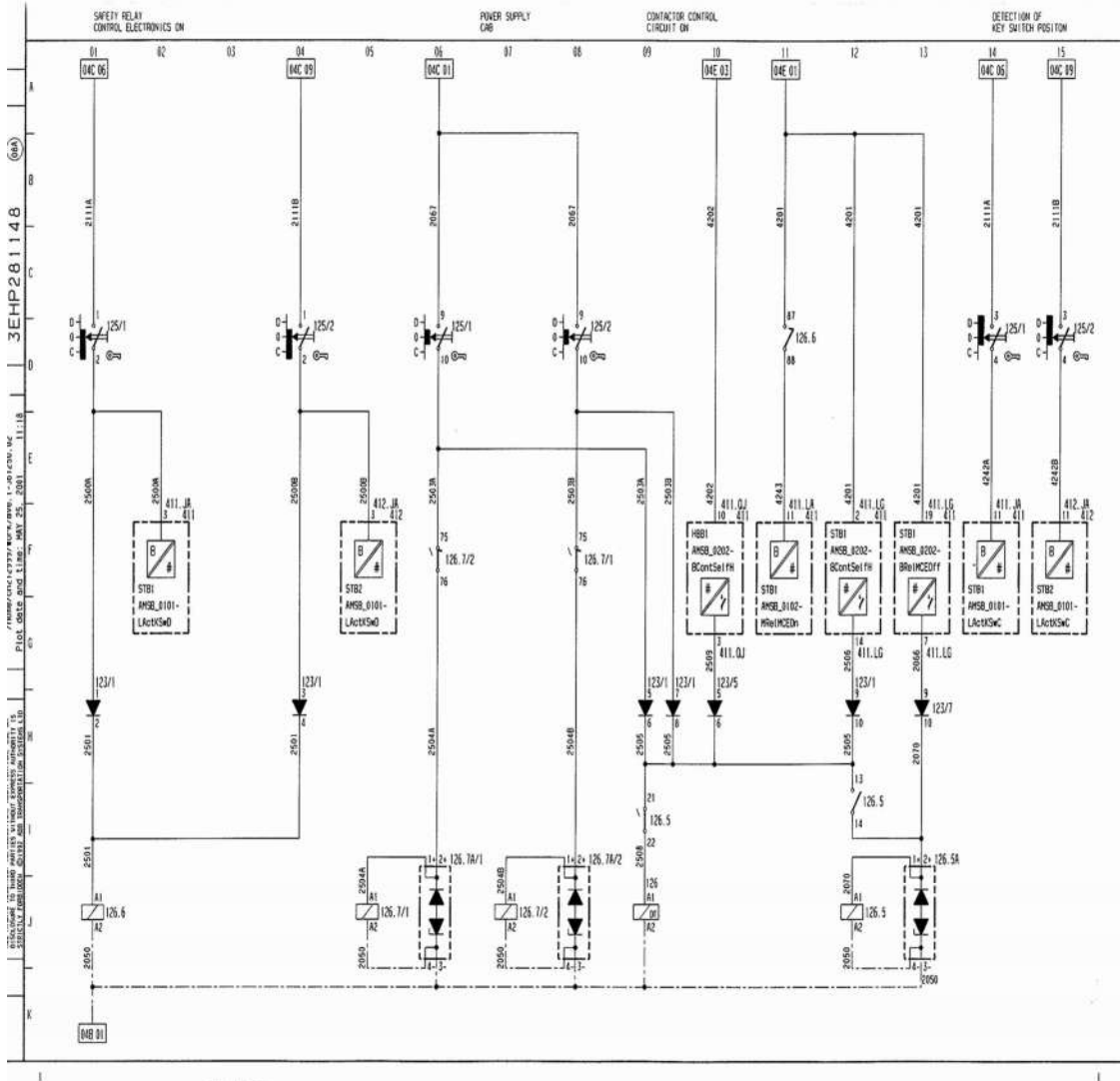
Relay Control Electronics off (126.5) is normally de-energized. Turning key switch from D (driving) to off position will not automatically shut down the supply of control electronics (contactor 126). The coil of 126 remains supplied by control electronics through HBB1 I/O card (411 QJ) until coil of 126.5 is energized by control electronics (4201-2066). This ensures that the control electronics (411) remains the master for switching the control circuit off.

When relay 126.5 is energized the contactor 126 opens and trips supply to Pantograph, vacuum Circuit Breaker and other Control Circuit.

Safety relay control electronics on (126.6) closes only in DRIVING MODE of cab switch and message goes to the control electronics through potential 2500A/B.

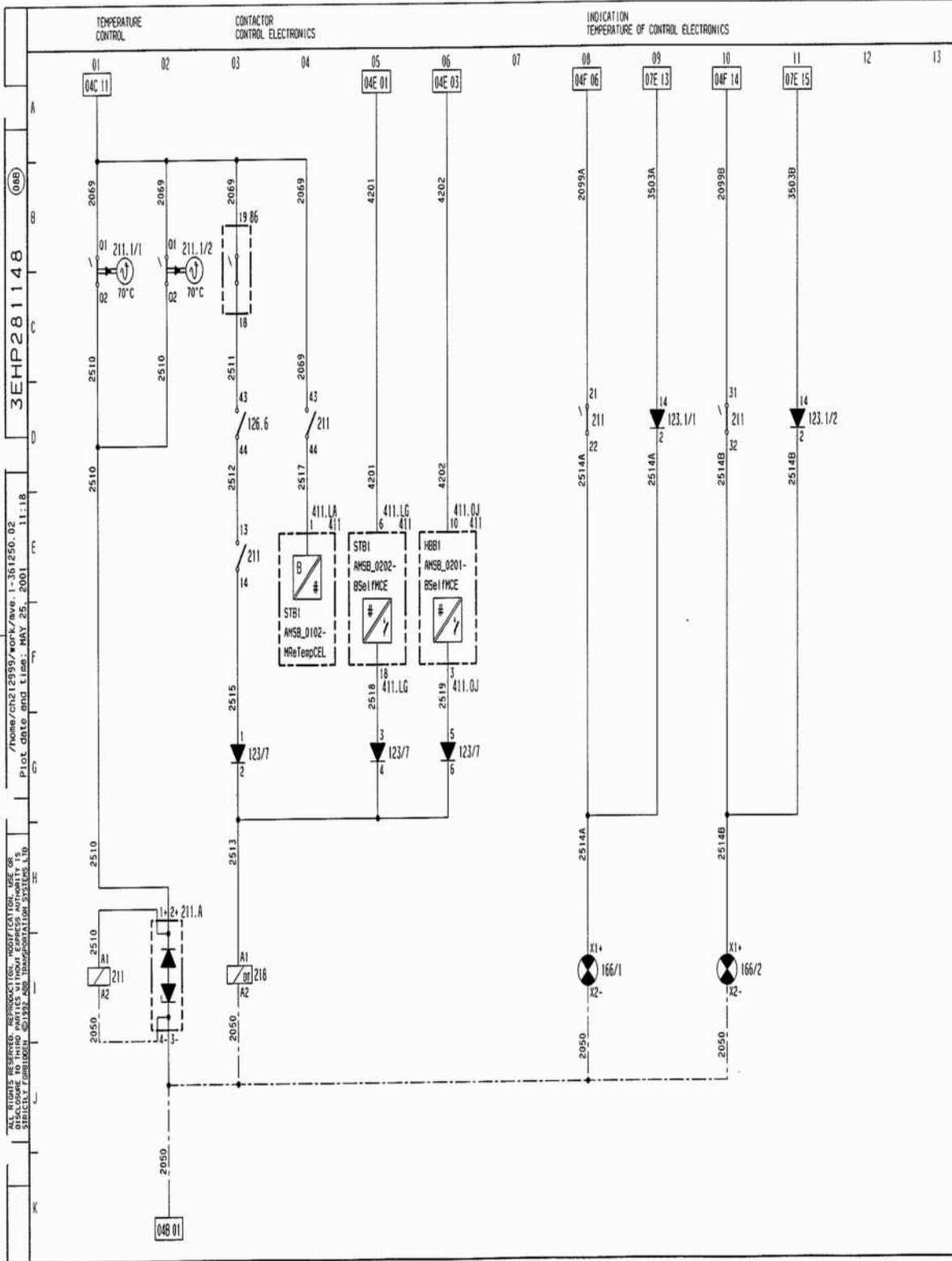
Relay temperature control electronics (211) is normally kept energised through normally closed contacts of thermostat (211.1/1). When temperature of Control Electronics increase beyond 70 degree C, thermostat contact between potential 2069 & 2510 opens and de-energises relay 211. The status of rely 211 is monitored by control electronics through potential 2517.

Lamp LSCE (166/1) on the driver desk glows through NC contacts of 211 when relay 211 is de-energised due to high temperature of control electronics. Driver should stop the loco before putting the loco in cooling mode, after which Cab Activating Switch (125) should be brought to “C”, Pantograph should be raised and VCB should be closed for cooling the machine room.



Contactor control electronics (218) is closed only in DRIVING position of key through following circuit.

Contacts of minimum voltage relay (86) between potential 2069 & 2511 are closed when catenary voltage is more than 17.5 KV (Open when catenary voltage falls below 17.5 KV). When contacts of safety relay 126.6 between potential 2511 & 2512 are closed after picking up 126.6 contacts of relay 211 between potential 2512 & 2515 closes and gives supply to coil of contactor 218. As soon as contactor 218 is closed control electronics gets supply. Now contactor 218 remains energised through control electronics 411.



BL KEY	211	126	126.7/1 or 126.7/2	218	126.6
D Mode	ON	ON	ON	ON	ON
C.Mode	ON	ON	ON	OFF	OFF
Self HoldMode	ON	ON	OFF	ON	OFF

PANTOGRAPH CONTROL CIRCUIT

Selection of Pantograph: -

To select which pantograph is to be raised panto selection switch (129.1) is provided on the pneumatic panel in the machine room with three positions.

Position 1:	Panto above cab 1 is raised
Position Auto:	Panto above the unoccupied cab is raised.
Position 2:	panto above cab 2 is raised.

Activation of Auxiliary Contacts of Pantograph: -

In each cab a panto-raising switch ZPT (129) is provided. This is a spring-loaded switch with two positions “panto raising” and “Panto Lowering”.

After cab activation when switch ZPT (129) is turned to panto raising position “129” is connected between potential 2121 A & 2300 and auxiliary contactor of pantograph (130.1) is closed through (2111A-2333A-2319-2300-2309B-2301). Once it is closed it is held by its contact between 2064 and 2302. In driving mode control electronics continuously monitors the air pressure through Pressure Switch 130.4/1 and 130.4/2 ($5.2 \text{ kg/cm}^2 / 2.5 \text{ kg/cm}^2$). If the air pressure in the panto circuit falls below 2.5 kg/cm^2 then the auxiliary contactor 130.1 is opened by control electronics.

RAISING AND LOWERING OF PANTOGRAPH IN COOLING MODE:

Raising Of pantograph: -

After activation of auxiliary contactor of pantograph (130.1) its auxiliary contact between 2111A & 2103A closes. Normally Closed (NC) contact of 126.6 between potential 2103A & 2104A or 2103B & 2104B remain closed during cooling mode and contacts of 126.7/1 or 126.7/2 between potential 2101 A & 2111A and 2101B & 2111B respectively are already closed.

The position of contacts of Panto Selection Switch 129.1 is as follows.

- Between potential 2107B & 2106B: Closed in position Auto & 1. Open in 2
- Between potential 2107A & 2107B: Closed in position 1 & 2. Open in Auto
- Between potential 2107A & 2106A: Closed in potential Auto & 2. Open in 1

(A) When switch is in Auto position then:

- If Cab1 is activated then Panto-2 is raised.** (2111A-2103A-2104A-2105A-2107A-2106A)
- If Cab is activated then panto-1 is raised.** (2111B-2103B-2104B-2105B-2107B-2106B)

(B) When switch is in position 1, Panto-1 is always raised.

- From cab1---** (2111A-2103A-2104A-2105A-2107A-2107B-2106B)
- From cab2---** (2111B-2103B-2104B-2105B-2107B-2106B)

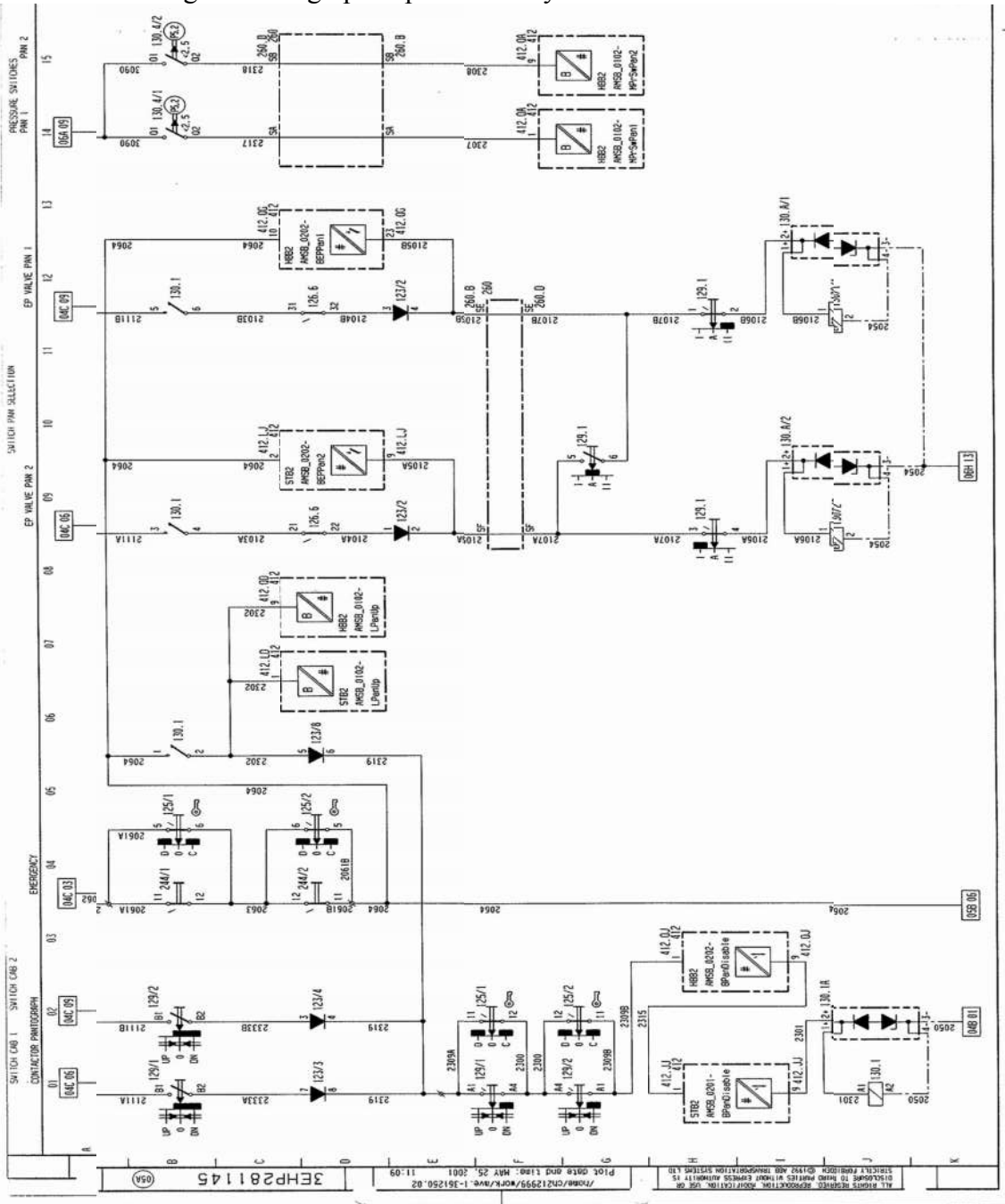
(C) When switch is in position 2, Panto-2 is always raised.

- From cab1---** (2111A-2103A-2104A-2105A-2107A-2106A)

**ii) From cab2--- (2111B-2103B-2104B-2105B-2107B-2107A-2106A)
Lowering Of Pantograph In Cooling Mode:**

From the diving cab when panto switch ZPT (129) is brought to panto lower position its auxiliary contact between potential 2319 & 2300 opens and cuts off the supply to coil of auxiliary contactor of pantograph 130.1 and it opens. Therefore, the supply to pantograph EP valve 130/1 and 130/2 is cut off and corresponding pantograph is lowered.

NOTE: Lowering Of Pantograph is possible only from the activated cab



RAISING AND LOWERING OF PANTOGRAPH IN DRIVING MODE: -

In this mode panto raising and lowering is controlled by central electronics (CEL) (411 & 412)

Raising Of Pantograph: -

Contact of Safety relay Control Electronics ON (126.6) between potential 2103A and 21047A or 2103B and 2104B is open during driving mode. The status of contactor 130.1 is monitored by central electronics through status of potential 2302. The central electronics contact between potential 2064 & 2105 A and 2064 and 1058B closes and supply reaches potential 2105 & 2105B respectively. From here circuit is similar to cooling mode described above at (2.3.3.1).

Lowering Of Pantograph: -

By switching panto switch ZPT (129) to panto lower position its auxiliary contact between potential 2319 & 2300 opens which results in disruption of supply to coil of auxiliary contactor of pantograph 130.1 and hence its open. The state of auxiliary contactor 130.1 is monitored by the central electronics. The central electronics contact between potential 2064 & 2105A, 2064 & 2105B respectively are opened after opening of auxiliary contactor of pantograph 130.1, thereby the supply to EP valve 130/1 and 130/2 is cut off and corresponding pantograph is lowered.

Emergency Lowering Of Pantograph:

Emergency shut down of loco (opening of VCB, Application of emergency brakes lowering of pantograph) is possible only from the occupied cab by pressing Emergency Push Button (244).

By pressing emergency Push Button 244/1 (from cab1), its contact between potential 2061A & 2063 opens, which interrupts supply to coil of contactor 130.1 and it, open. This causes de-energisation of panto valve 130 through opening of contact of 130.1 between potential 2111A,B & 2103 A, B. With cab2 unoccupied the cab switches 125/2 contacts between potential 2063 & 2064 remains closed bypassing Emergency Push Button 244/2.

MAIN CIRCUIT BREAKER (VCB) CONTROL CIRCUIT

Closing of VCB:

With cab activated (Cab Activation Switch in position C / D) and pantograph raised contactor 130.1 is closed, the circuit breaker can be closed by the following operation:

Putting switch for circuit breaker BLDJ (134/1 & 2) to ON position so that its auxiliary relay (136.4) picks up (2111A---2334A---2327---2313B---2310---2313A---2311). Once this relay has picked up, it is held in pick up condition by self-contact between potential 2314 & 2312

i) In cooling Mode:

Safety Relay Control Electronics ON (126.6) remains de-energised in cooling mode

After closing of auxiliary relay 136.4 its contacts between potential 2314 & 2312 closes, which in turn closes time relay (136.3) as NC contact of 126.6 between potential 2312 & 2326 remains close, normally closed (NC) contact of Over current Relay (78) is closed and contacts of Minimum Voltage Relay (86) are also closed. (2064-2320-2314-2312-2326)

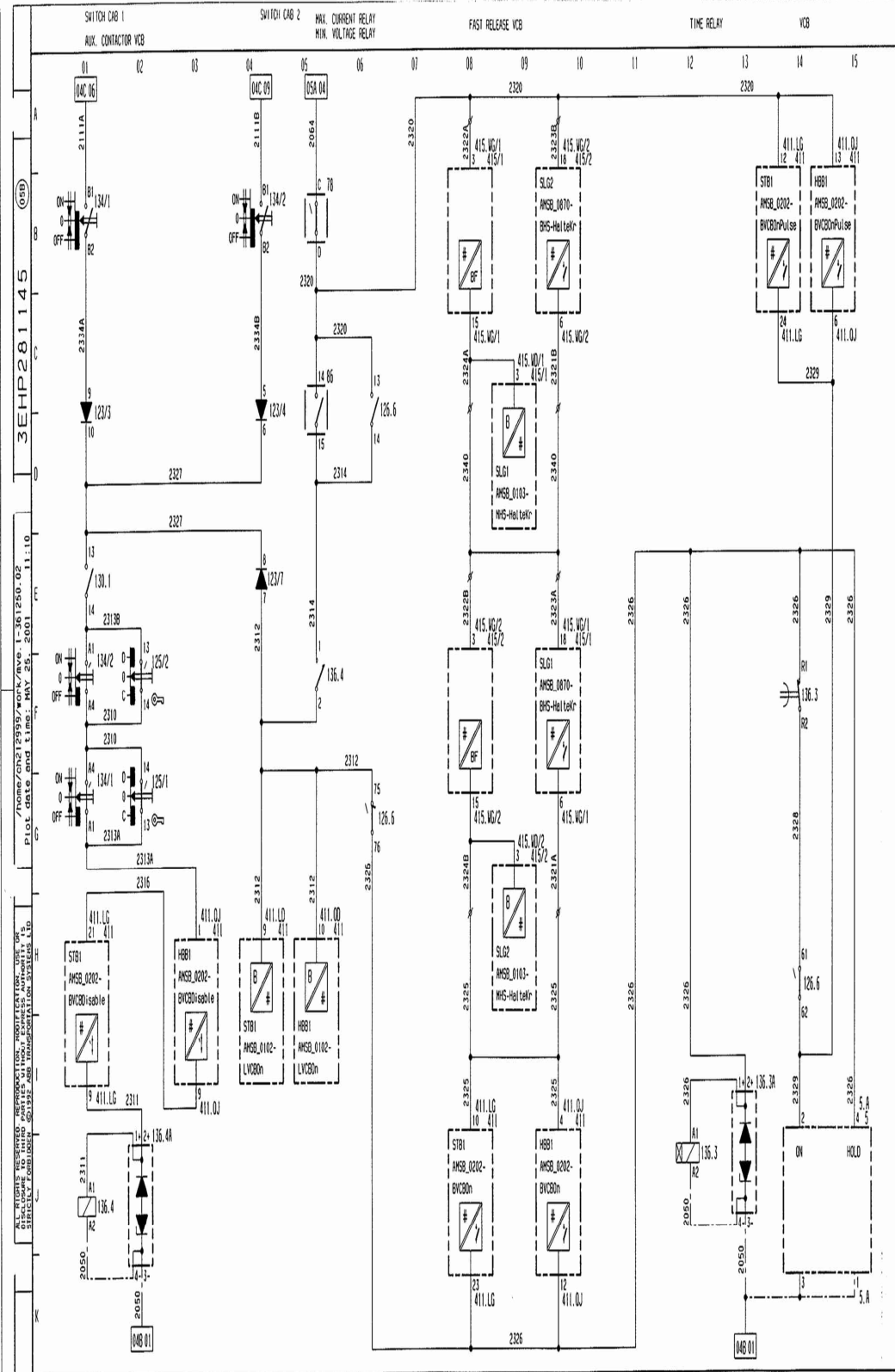
With time relay 136.3 closed supply goes to the closing coil circuit breaker (VCB) for 1 second and closes the circuit breaker before NC contact of (136.3) opens (set for delayed opening of one second). Once the breaker (VCB) is closed it is held closed through its holding coil and contact of time relay 136.3 opens, disconnecting supply to closing coil of circuit breaker.

ii) In Driving Mode

In this mode, closing and opening of circuit breaker is through control electronics and Safety Relay Control Electronics ON (126.6) remains energised.

Relay 126.6 is closed and so its NC contact between potential 2312 and 2326 opens. The control electronics gets feed back on the status of auxiliary relay 136.4 by monitoring status of potential 2312. Time Relay of VCB gets feed through control electronics of converter 1 & 2 (2064—2320—2322A—2324A—2322B—2324B—2325). In case converter 1 is isolated then supply is through (2320—2323B—2321B—2322B—2324B—2325). In case converter 2 is isolated supply is through (2320—2322A—2324A—2323A—2321A—2325).

With time relay 136.3 closed through control electronics, supply goes to the closing coil of circuit breaker for one second before NC contact of 136.3 opens (set for delayed opening of one second), which closes the circuit breaker. Once the breaker is closed it is held closed through its holding coil and contact of time relay 136.3 opens, disconnecting supply to closing coil of circuit breaker. In driving mode Minimum Voltage Relay is bypassed by contacts of 126.6 as Control Electronics monitors the catenary voltage.



OPENING OF VCB:

1) Normal Opening:

By putting the switch BLDJ in OFF condition on driver desk from the occupied cab the supply to potential 2310 is cut off and 136.4 de-energised which interrupts supply to VCB coil and it opens (2314—2312—2326) and indication lamp LSDJ glows (Red) through Normally closed (NC) contacts of VCB.

Status of VCB is monitored by Control Electronics by normally open (NO) contacts of VCB connected between potential 2062 and 2330A or 2330B, which closes when VCB is closed and control electronics gets the message.

2) Emergency Opening:

By pressing Emergency Push Button (244) on driver desk from the occupied cab:

A) VCB Opens:

The supply to potential 2064 is cut off which interrupts supply to VCB coil and it opens (2064—2320—2326) and indication lamp LSDJ glows (RED) through Normally closed (NC) contacts of VCB.

B) Pantograph lowered

Emergency Push Button 244 contact between potential 2061A & 2063 opens which interrupts supply to coil of Auxiliary Contactor of Pantograph (130.1) and it opens. This causes deenergisation of panto valve 130 through opening of contact of auxiliary contactor of Pantograph (130.1) between potential 2111A, B & 2103 A, B.

C) Emergency brakes applied automatically

Status of VCB is monitored by Control Electronics by normally open (NO) contacts of VCB connected between potential 2062 and 2330A or 2330B, which closes when VCB is closed and control electronics gets the message.

HOTEL LOAD CONTROL CIRCUIT

Hotel load contactor closes by switching ON hotel load switch (BLHO) (169.1). Supply to control electronics is through potential 2803A (2095—2101A—2111A---2803A), which sends the message to control electronics connected between potential 2801A & 2805 to close contact and supply goes to contactor coil. (2095---2096---2801A---2805). Contactor can be opened by switching OFF switch 169.1, Supply to control electronics is then through potential 2804A (2095---2101A---2111A---2804A) which in turn sends the message to open the contactor 32. (2095---2096---2801A---2805).

The status of contactor is monitored by control electronics through normally open auxiliary contact of contactor connected between potential 2805 & 2806. An indication lamp (169.3) in activated cab lights up when Hotel Load Contactor 32 is closed .

EARTH FAULT MONITORING

Earth Fault Relay (89.2) for Auxiliary Power Circuit: -

When an earth fault occurs in the auxiliary power circuit, Earth Fault Relay (89.2) picks up and its contacts between potential 2801B & 2858 close and the message goes to central electronics. CEL sends priority 2 messages on DDS “Earth Fault In Auxiliary Ckt Normal Operation Can Continue”

Earth Fault Relay (89.5) For 415/110-Volt Circuit

When an earth fault occurs in the 415/110 Volt circuit, earth fault relay (89.5) picks up and its contacts between potential 2801A & 2859 close and the message goes to central electronics. CEL sends priority 2 messages on DDS “ Earth Fault In Auxiliary Ckt Normal Operation Can Continue”

Earth Fault Relay (38.1) For Hotel Load Circuit

When an earth fault occurs in the hotel load circuit, earth fault relay (38.1) picks up and its contacts between potential 2801A & 2860 close and the message goes to central electronics. CEL sends priority 2 messages on DDS “Earth Fault In Auxiliary Ckt Normal Operation Can Continue”

Earth Fault Relay (89.7) For Control Circuit

When an earth fault occurs in the control circuit, earth fault relay (89.7) picks up and its contacts between potential 2801A & 2870 close and the message goes to central electronics. CEL sends priority 2 messages on DDS “Earth Fault In Auxiliary Ckt Normal Operation Can Continue”

Earth Fault Relay (89.6) for filter Circuit

When an earth fault occurs in the auxiliary circuit, earth fault relay (89.6) picks up and its contacts between potential 2801A & 2869 close and the message goes to central electronics. CEL sends priority 2 messages on DDS “Earth Fault In Auxiliary Ckt Normal Operation Can Continue”

Monitoring Of Battery Charger MCB:

Battery charger was fed by auxiliary converter (BUR3/2). With auxiliary converter switched ON and MCB 100 closed supply goes to battery charger.

When the MCB trips then its auxiliary contacts opens between potential 5092 & 2822 (BUR2), 5093 & 2823 (BUR 3) respectively and the message goes to auxiliary converter electronics 426/2 & 426/3.

Monitoring Of Auxiliary Machines MCB:

59.1/1, 59.1/2, 62.1/1, 63.1/1 and 63.1/2 are the MCBs of oil cooling unit 1 & 2, oil pump transformer 1 & 2 and oil pump converter 1 & 2 respectively. When any MCB trips then its auxiliary contacts open and message goes to central electronics. CEL sends priority 2 messages on DDS “ MCB in Auxiliary Cubicle tripped power will be reduced”

HARMONIC FILTER CONTROL CIRCUIT OPERATION

Filter ON/OFF: -

To switch ON/ OFF filter circuit Contactor (8.1) is used whose coil is energised through Converter Control Electronics (415 WG/1).

With Key switch in Driving (D) position, Control Electronics contactor 218 closes and extends supply to potential 5101B, A through MCB 127.1 and to coil of contactor 8.1 through converter Control Electronics 415 and NC contact of Contactor Discharging Resistance (8.41).

Control electronics controls the closing of filter ON/OFF contactor in the following manner: -

- i) With VCB closed and Reversor position selected, the filter ON / OFF Contactor (8.1) will close when TE/BE throttle is moved from Zero Position to any other position.
- ii) After wards whenever Throttle is brought to Zero with VCB closed the filter contactor will remain close. However, if this situation persists for more then 5 minute then Filter Contactor (8.1) opens Discharger Contactor (8.41) closes for 120 M seconds. Filter ON/OFF (8.1) will remain close when TE/BE throttle is moved again.

With contactor energised, its auxiliary contacts 8.1 connected between potential 2801A and 2861A, B closes and this message is taken by converter control electronics connected at potential 2861A, B.

Filter Adaptation:

Contactor 8.2 is used for Filter adaptation, which is closed when both the bogies are in operation and open when one bogie is isolated.

Contactor coil is energised through converter control electronics (415)

With Key Switch in Driving (D) position, Control Electronics Contactor 218 closes and supply comes to potential 5101B, A through MCB 127.1

Supply comes to coil of contactor 8.2 through Converter Control Electronics 415 (5101A, B-2866) Control Electronics will allow supply to the contactor coil only when one Traction Converter is isolated.

With contactor energised, its auxiliary contact 8.2 connected between potential 2801A and 2862A, B closes and this message is taken by control electronics connected at potential 2861A & B.

Resistor discharging: -

Contactor 8.41 is used for resistor discharging, which is closed to discharge harmonic filter capacitor (8.41) through Discharge resistor (8.42) and is controlled by control electronics.

Supply comes to coil of contactor 8.41 through control electronics 415 and normally closed contact (NC) of filter ON/OFF contactor 8.1 to ensure that contactor 8.41 is closed only when contactor 8.1 is open. With contactor energised, its auxiliary contact 8.41 connected between potential 2801A and 2863A,B closes and this message is taken by control Electronics connected at potential 2863A,B.

MASTER CONTROLLER (ANGLE TRANSMITTER) OPERATION

Master controller (150) consists of 3 position Rotary switch (Reverser) for selection of travel direction – “FORWARD”, “NEUTRAL”, “REVERSE” and throttle for TE / BE.

Throttle for TE / BE, except in zero position, interlocks the reverser through an electromagnet controlled by Control electronics.

Each reversor has four contacts:

Two close during forward (2111A-2524A-, 2111A-2525A) and two close during reverse (2111A-2526A-, 2111A-2527A) and feedback goes to central electronics (411)

The demanded corresponding value for TE / BE is generated by means of an angle transmitter (150.1) and the output is fed to control Electronics (411), (ADDRESS 08C09).

The TE / BE throttle has following auxiliary contacts:

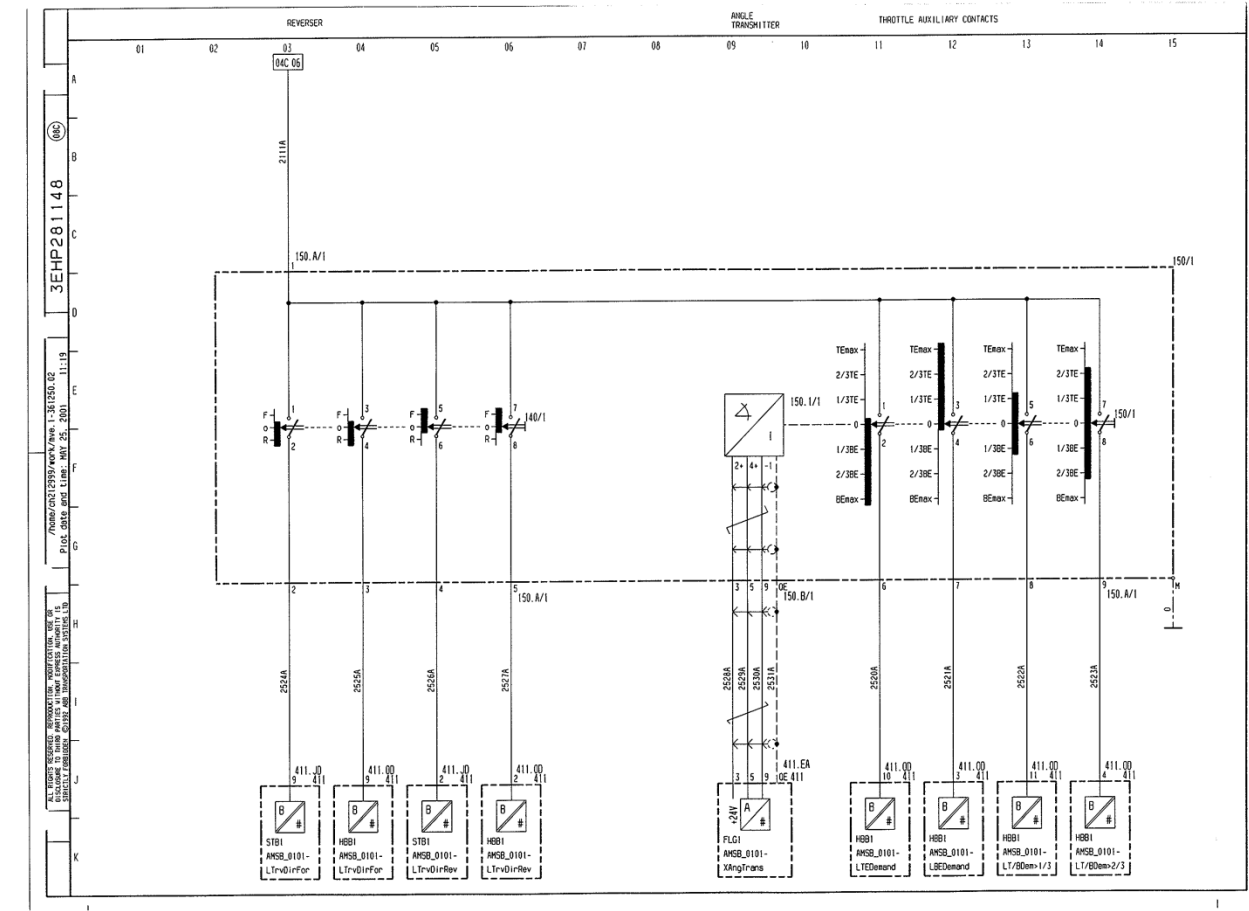
- 1) Between potential 2111A and 2520 A which is closed during “Traction” position of throttle handle.
- 2) Between potential 2111A and 2521A which is closed during “BRAKING” position of throttle handle.
- 3) Between potential 2111A & 2522A which is closed during “TRACTION” position of throttle between angle 13.5 and 40.5 degree i.e. 1/3 TE to TE Max and in BRAKING position from 1/3 BE to BE Max.
- 4) Between potential 2111A&2523A which is closed during “TRACTION” position of throttle between angle 27&40.5 degree i.e. 2/3 TE to TE Max and in “BRAKING” position from 2/3 BE to BE Max. The last two contacts are provided so that in case of failure of angle transmitter of loco can be driven and broken in three steps (1/3,2/3, and Max TE/BE) through these contacts. A switch (152) is provided in the machine room to change over from transmitter to manual stepped control. The feedback is sent to control Electronics (411).

To limit Maximum tractive effort during starting, a switch ZTL (151.1) is provided on driver’s desk. When this switch is closed feed goes to central electronics, which limits the tractive effort.

For constant speed control, a push button switch (BPCS) (151.4) provided on driver's desk. When this switch is pressed, lamp lit up to indicate constant speed operation and feed goes to central electronics, which accordingly adjusts TE/BE to maintain constant speed with in available TE / BE range (2111A-2541A).

To indicate wheel slip, an indication lamp (LSP) 92/1 is provided on the driver's desk, which gets supply through control Electronics. Control electronics monitors all the axles speed and detects wheel slip.

Two TE/BE meters (79.1 & 79.2) are provided on each desk, one for each bogie. Control electronics calculated tractive/Braking effort from traction motor parameters and accordingly feed the meters.



SPEEDOMETER CONTROL CIRCUIT CIRCUIT

MEMOTEL speedometer consists of a pulse generator (PG) 94.1 having two optical sensors mounted on the axle box of the Loco and driven by driving fork. One speedometer with recording and indicating (Memotel Master) 94.2 in cab2 and one speedometer with only indicator (Memotel slave) 94.3 in cab1 are provided. Alarm relay is provided which operates to

indicate a general MEMOTEL error on closing of this relay its contact between potential 4206 & 4207 (terminal 25& 9) close and the feed goes to control electronics.

1) Loco speed indication:

110-volt supply through potential 4206 & 2050 is fed to the speedometer at terminal 35 & 34. The output of the pulse generator, which gives a frequency signal proportional to speed, is fed at terminals 4,8 & 3 from first optical sensor and at terminal 7,5 from second sensor. The master speedometer in cab2 sends signal to speedometer in cab1 through screened cables from terminals 50, 17 using Rs 422/485 serial data link. 110V DC supply is fed to cab1 speedometer through potential 4206.

2) Loco Over Speed Protection:

1) Warning: - An output relay is provided with speed dependent contact. When speed reaches 105% of the Max. Permissible speed contact of output relay between potential 4206 & 4208 close and feed goes to buzzer.(745 Hz)

2) Emergency brake application: - When speed reaches 110% of the Maximum permissible speed, contact of Memotel Master between potential 3097 & 4220 open and the supply to EP valve for Emergency brakes is cut off which results in application of Emergency brakes. The message goes to the control electronics through potential 4244.

3) Wheel flange lubrication: - Two transistor output are configured to give distance dependant control signals which are used for operating wheel flange lubrication EP valves (300.3/1 & 300.3/2).

FIRE DETECTION CONTROL SYSTEM

The Fire Detection unit (212) detects any fire in the Machine room by checking the Machine room air at various locations for smoke. In case of fire the contact between terminals 18 & 19 and between 4 & 5 of the unit close. This results in sounding of Buzzer (2097B – 4238 - 4232A,B). Message also goes to control electronics through potential 4227.

Incase of false Message on fire detection unit, pressing the reset button on the unit can reset it. Incase of any fault in the fire detection unit the contact between terminals 10 & 11 open and the message goes to control electronics potential 4229.

VIGILANCE CONTROL SYSTEM

Vigilance control system consists Main control unit (237), warning buzzer (238.1) one in each cab, spring loaded pushbutton (BPVG) 236, Foot switch (235), spring loaded Reset Push Button (237.5) and pressure switch vigilance control (269.5)

1) Vigilance System Operation: -

Vigilance system is ON only when loco is in driving mode and speed is above 1.5 kmph. In driving mode supply comes through potential 2516A or 2516B to terminals K or J of Main control unit to switch on the system. Main supply to the system comes through potential 4236 to terminal A.

Vigilance system is off when loco brakes are fully applied. Pressure switch (269.5) monitors the brakes cylinder pressure and when BC pressure is more than 1.5 bars the contacts between potential 3090 and 3049 open and supply at terminals U is disconnected which results in switching OFF of vigilance system. When pressure is less than 1.0 bars contacts close and reactive the vigilance control system.

The system operates on the principal that normal operation performed by Driver (such a master controller operation or application of brakes through Auto brake handle) is accepted by the system as an indication of driver's fitness. This information to the vigilance control unit comes through control electronics connected at terminal V and through contacts of brake controller.

When driver is not doing any of the above operation with in 60 seconds, he has to press pedal switch / push button (BPVG) and release it. This has to be repeated after every 60 seconds, otherwise the Buzzer 238.1 will sound (supply comes to terminal G) and lamp (LSLW) (242.1) lit up and emergency brakes will be apply after 8 seconds, if driver fails to press pedal switch / push button (BPVG) even after coming of buzzer, application of emergency brakes takes place in the following way: -

Normally EP valve for emergency braking (243) is energized through supply from terminal E of control unit. (3000-3108B-3108A-3097-4240-4241). When vigilance system operates the emergency brakes then supply at terminal E is cut off which results in deenergisation of EP valve for emergency braking (243) and emergency brakes are applied on the locomotive. Once Emergency Brakes are applied they cannot released for **Two Next Minutes**.

2) Vigilance system Isolation: -

To isolate vigilance system, switch (237.1) in SB1 put to Zero. When this switch is put to Zero supply to vigilance control unit is cutoff through potential 4236. Supply to emergency Brake valve (243) is maintained through potential 3000 by closing of contacts of switch 237.1 (in its Zero position) between potential 4200 & 3000.

It can also be isolated with Isolating cock (237.3) I the pneumatic Panel Central electronics checks the compressor working and shut the timer off. Then both the towers will be dried.

5. Sanders:

Sanding is electro – pneumatically operated through four ER valves (192/1, 2, 3, 4), two for each direction. The operation of sanding can be manual through spring loaded sanding switches in the cabs 9192.1 or automatic by control electronics when wheel is slopping. In both

cases message goes from central electronics to brake electronics (260), which gives supply to the EP valves. Valves energized when moving in reverse direction from cab1.

6. Wheel flange lubricator:

Wheel flange lubrication takes place at pre set distance. After every fixed distance contacts of speedometer I/O card closes which close flange lubricator contactor (300.3 / 1&2) and it's contacts between potential 3101 & 3062A, B close and supply goes to flange lubrication EP valve (300 / 1 & 2) that causes release of compressed air from main reservoir for spraying of oil.

7. Pressure Switch For Flow Indicator (269.41):

Pressure switch for flow Indicator (269.41) monitors the pressure in the main reservoir pipe. In case of train parting, the flow from main reservoir to brake pipe is too high, which causes drop in main reservoir pressure, which is detected by the pressure switch and the message goes to central electronics (412) through brake electronics (260). The setting of the pressure switch is 6.9 / 8.4 kg/cm².

8. Pressure Switch For Emergency Brake (269.1):

Pressure switch for emergency brake (269.1) monitors the pressure in the air brake pipe. In case of application of emergency brake, pressure in air brake pipe falls to Zero as it is vented to atmosphere which is detected by pressure switch and the message goes to central electronics (412) through the brake electronics (260). This information is mainly used for the central emergency brake in multiple operations. The setting of pressure switch is 4.2 / 3.0 kg/cm².

9. Pressure Switch For Brake Cylinder (2.69 / 1 & 2):

Pressure switch of brake cylinder (2.69 / 1 & 2) monitor the pressure in the brake cylinder. During application of brakes, pressure in the brake cylinder increases, which is detected by this pressure switch and the message, go to central electronics through brake electronics (260). The setting of pressure switch in 0.2 / 0.65 kg/cm².

10. Pressure Switch For Direct Brake (269.2)

Pressure switch for direct brake (269.2) monitors the pressure in direct brake pipe. Direct brake pipe is connected to other locos in multiple. In case of any parting of Locos, main reservoir equalizing pipe pressure falls which results in cutting of air to direct pipe, which is vented to atmosphere. This is sensed by pressure switch and feedback sent to central electronics through brake electronics (260). The setting of pressure switch is 0.2 / 0.65 kg/cm².

PNEUMATIC CIRCUIT OF WAG9.

Two compressors are provided on the loco to build up air pressure. In this system 2 main reservoirs and one Auxiliary reservoir are provided. When BLCP is in auto position compressors starts working and build up pressure in the reservoirs (cut in/cut out is 8-10 kg/cm²). During cut in cut out time the compressors are connected to the atmosphere by the unloaded valve, CDC and an auto drain opens and closes automatically valve which is connected to MR 1.

Compressed air from the compressors is allowed to pass through a separate after cooler and store in MR1, MR2,. Safety valve is set at 11.5 kg/cm² and is provided between each compressor and main reservoirs, to avoid air pressure entering from MR to CP. separate NRV's are provided in the pipeline after the after cooler. A safety valve set at 10.5 kg/cm² is provided between MR1 & MR2. Two NRV's are provided one in between MR1 and MR2 and another between MR1&AR.

Use of MR1:

Air from MR1 is taken after Air dryers through a duplex valve set at 5 kg/cm² to the MR equalizing pipe and then air is supplied to sanders, wipers, F1 selector , also to the feed pipe (FP) through a feed valve (6 kg/ cm²) with cutout cock(136).

From MR1 air supply is taken after Air dryers through to charging BP pressure Via E70, AMV, Venture Valve. It also to the panto servomotor through IG38, Panto electro valves and throttle valve. Compressed air is also supplied to RDJ for the operation of DJ through DJ COC. A pressure switches are provided on panto pipeline to trip DJ and lower panto when the air pressure drops below 4.51 kg/cm² panto pipe line. Air is supplied to SR1, SR2, WFL and FB for the operations pneumatic contactors after limiting to 6 kg/cm². NRV is provided after the line filer of MR-1 to avoid the pressure escaping from RS to the Main reservoir whenever on usage. This RS pressure is for initial energisation.

An Auxiliary compressor CPA is provided with drain cock and safety valve, to build up pressure in RS (5 lts) for initial charging in RS, for raising the panto and for closing DJ. It is provided with a gauge.

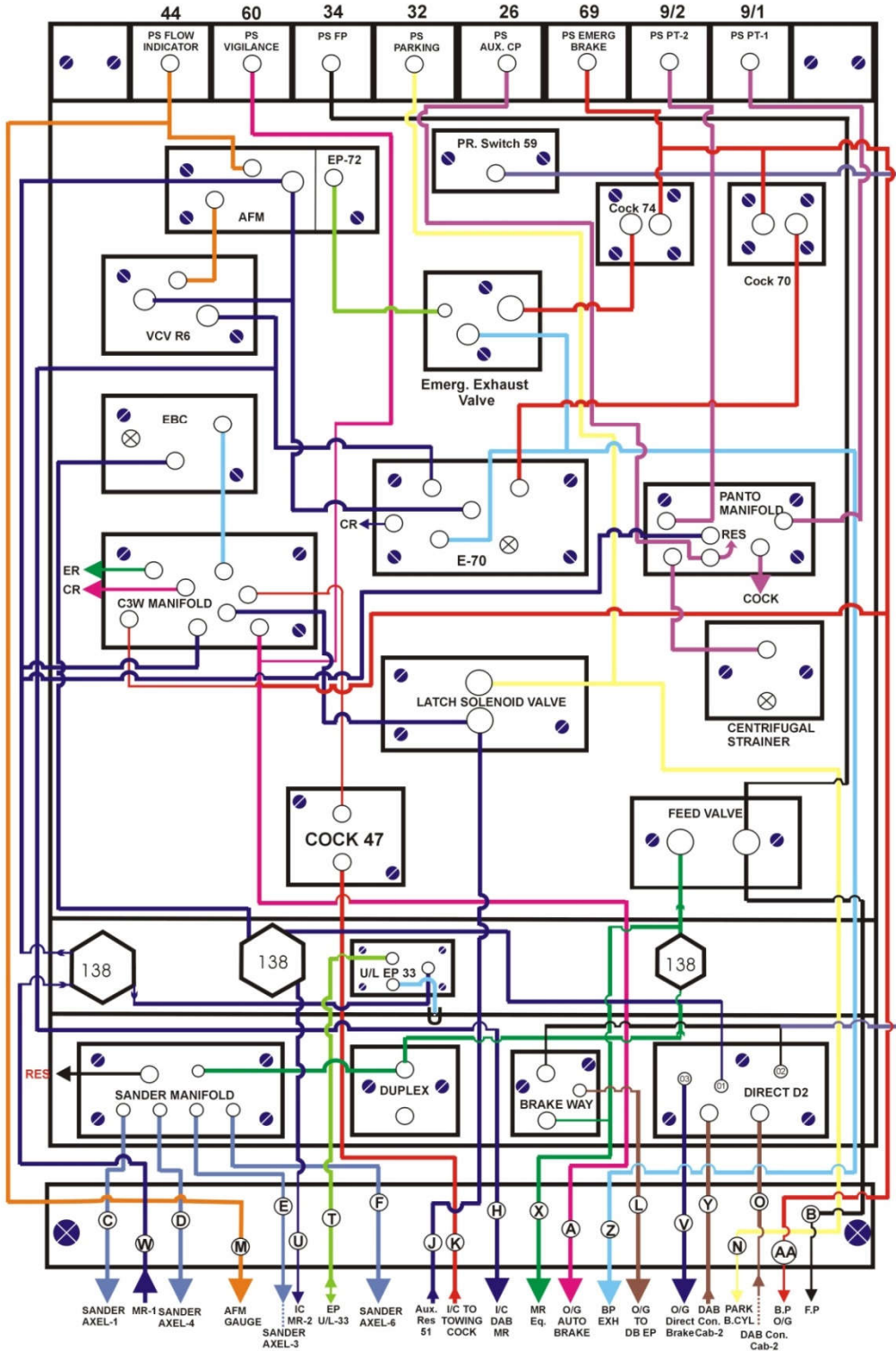
USE OF AUXILIARY RESERVOIR.

From MR1 air supply is taken to Auxiliary reservoir with NRV. From the control reservoir air pressure is supplied to C3WDV, C2RV for conjunction brake application and parking brake cylinders through solenoid 30 after limiting to 6 kg/cm². The AR also charged with BP pressure through 47 COC during dead loco operation. Normally 47 COC should be in closed condition.

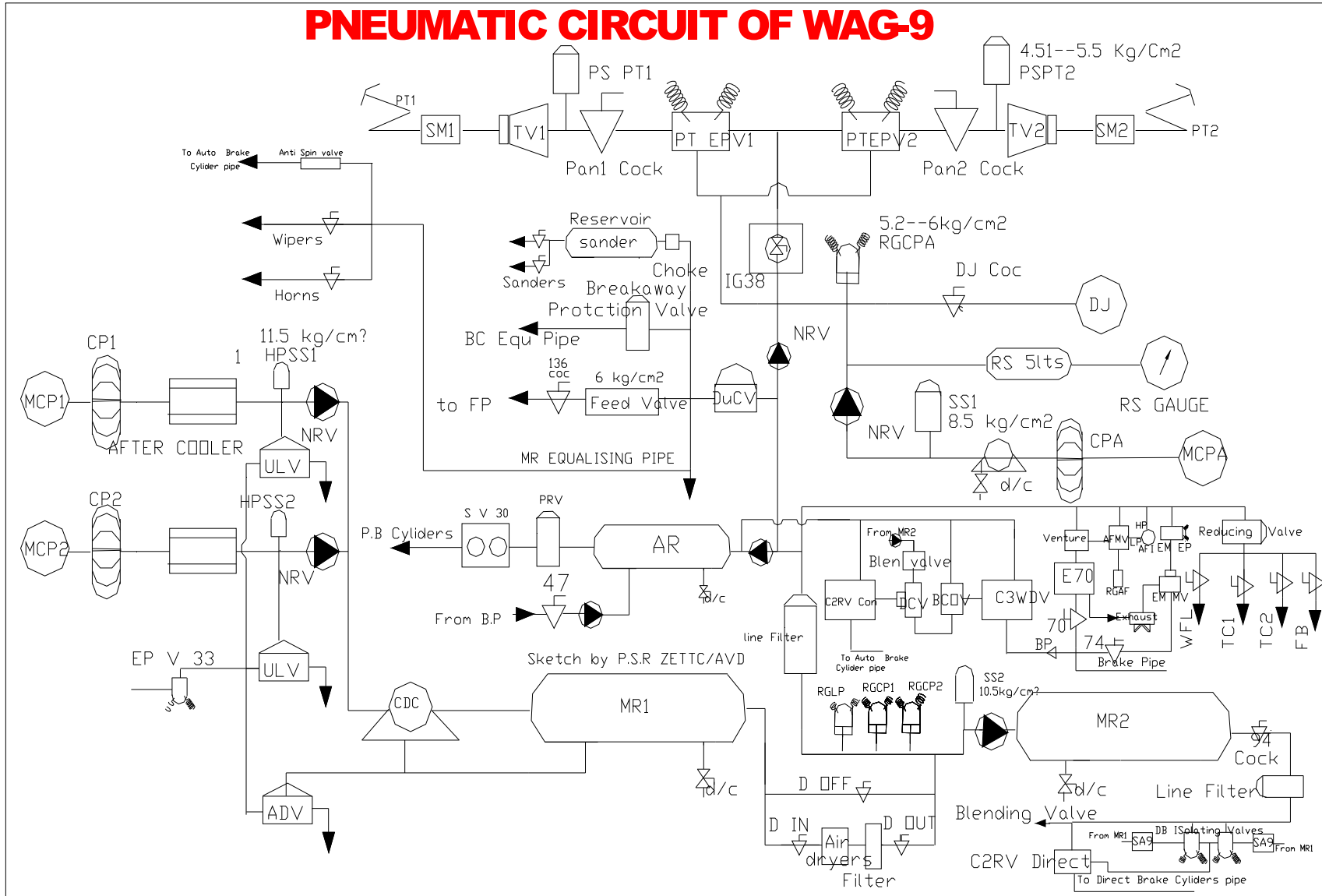
USAGE OF MR2

From MR2 air pressure is supplied to air brake system with 94 COC for air brake operation Via C2RV direct brake and to blending valve.

INTERNAL CONNECTION FOR PNEUMATIC PANEL OF WAG9



PNEUMATIC CIRCUIT OF WAG-9



Brake System:

There are 5 types of brakes available on this loco.

1. Automatic Train Brake (Pn)
2. Direct Brake (Pn)
3. Parking Brake (Spring Loaded)
4. Anti Spin Brake.(Pn)
1. Regeneration Brakes.(Elect)

Note: All the brake system functions are monitored by brake electronics and if there is any wrong configuration, the brake electronics do protective action along with P-1 message on screen. One circuit breaker is also provided in SB-2 for this brake electronics. In case of failure of brake electronics, crew should check this MCB.

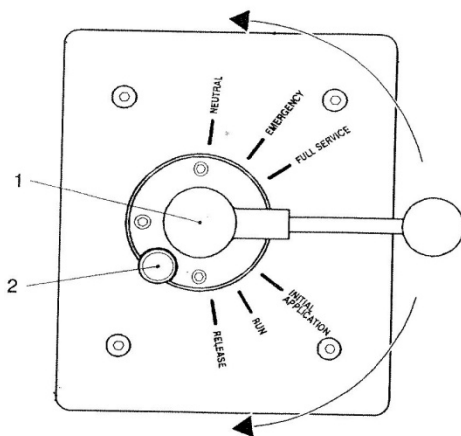
Automatic Train Brake (A-9)

In both the cabs one Loco pilots automatic train brake (A9) is provided. The function of the A9 is to generate a variable voltage code in accordance with the position of the controller handle and to perform a number of ancillary electrical functions by control card of E70. One air connection is a pressure of emergency exhaust valve and vents on emergency application by A9 in addition to the electronically controlled emergency brake. This pressure charged through BP and holds by ½” check valve inside A9.

This brake valve is used for charging and discharging the B.P. Pressure to apply/release train brake and also loco brakes in conjunction working.

This valve has following 6 positions.

This A-9 is remaining active in active cab only. Once the BL key is rotate from D to OFF, this handle will not functions, but its emergency position will act.



Handle position	Pressure
(kg/cm ²) Release	5.4 ± 0.05
Running	5 ± 0.05
Initial Application Variable	4.60 ± 0.05
Full Service	3.35 ± 0.10
Emergency	0
Neutral	0

BP Charging : E-70 control unit is a valve which is responsible for charging and discharging pressure of Brake pipe. There are six Nos. of EP valve mounted on E-70 control unit i.e. EP valves. NO- 15, 16, 17,18,19 & 36.

According to position of A9 i.e. Release, run, initial application, full service, emergency and neutral. Voltage signal is given to control card of brake electronics. Accordingly EP NO16 is energized (LED No.3 glowing). MR pressure is received from MR which is reduced by regulator on E-70 (set at 5.6 kg/cm²) and charges control reservoir of E-70 (at the same time pressure transducer on E70 valve monitor the CR pressure and gives feed back equivalent electrical signal to control card of brake electronics).

A9- RUN POSITION

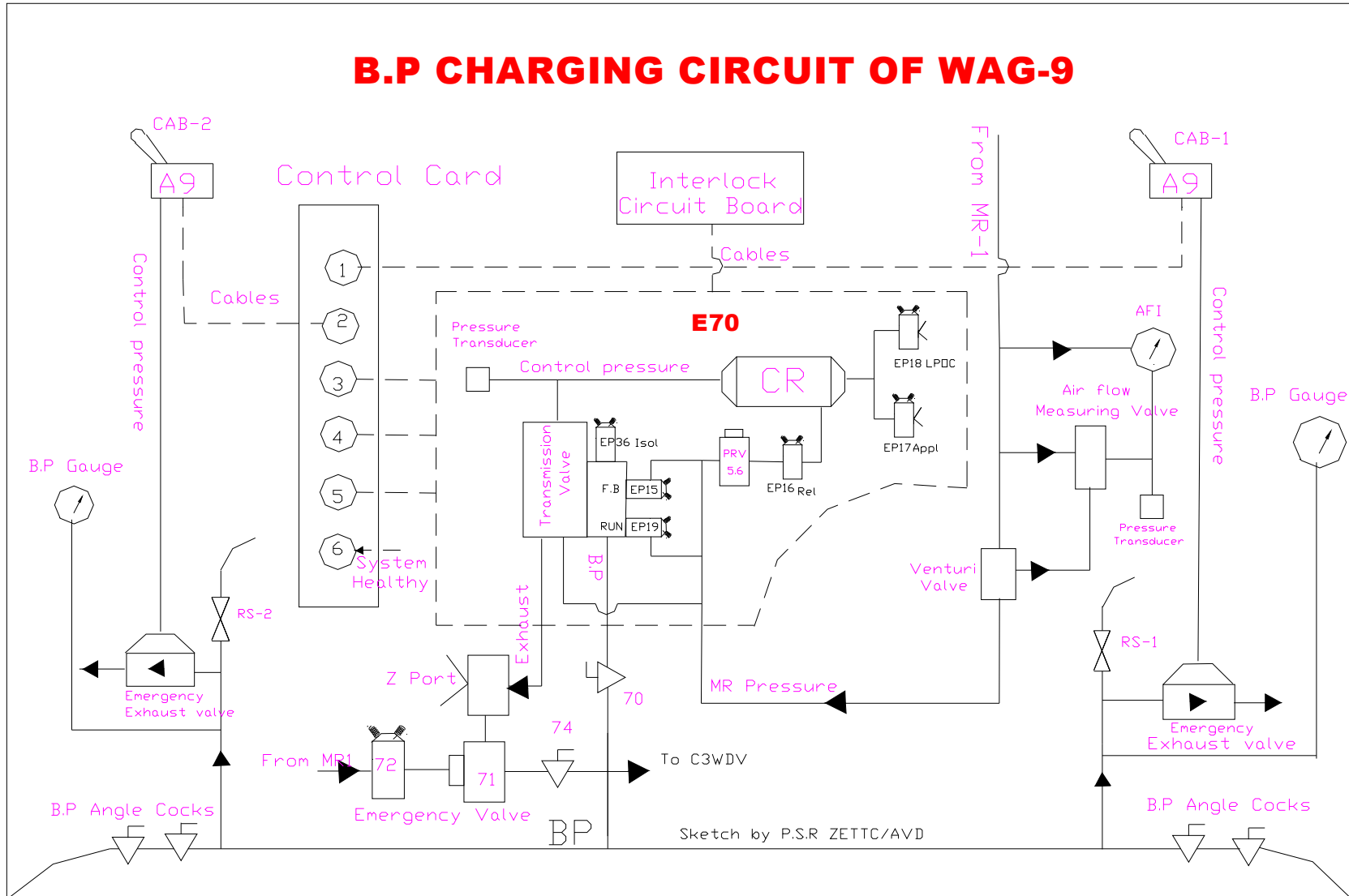
When A9 is on RUN position, means to charge BP at 5.0 kg/cm, control electronic will de energized EP 16 as soon as CR is at 5.0 kg/cm, With reference to CR, MR will charge BP pipe through transmission valve and via combined restricting, isolating and check valve. This BP is charged, when the loco electronics is 'ON' EP No.19 is energized which opens the path of combined restricting, isolating and check valve.

A9- RELEASE POSITION

When Loco Pilot keeps A9 handle to release position LPO is generated and as long as handle is pressed, EP No.15 is energized, which open the path of combined restricting, isolating and check valve for charging BP pipe to higher valve, parallel at the same time EP No.16 is energized and which allows CR pressure to increase at 5.6 kg/cm at set value of pressure regulator valve and finally BP overcharges to 5.6 kg/cm pressure. Now the LPO card come in picture which keep EP No.18 energized (Normally energized hence no venting of CR). Till 40 seconds EP 18 energized (can be seen on control card LED-5 glowing) and LPO card LED 1 & 2 glowing). After stabilizing time of 40 sec to 60 sec is over, bleed down period is started i.e. venting of CR from EP No.18 in controlled manner within 180 +/- 20 sec by energizing and de-energizing of EP No.18, can be seen from, LED 5 flickering on control card and venting for exhaust of EP 18, note that at this time LPO card shows LED 1 & 3 glowing. After complete LPO is over then BP come down to 5.0 kg/cm. LED 5 of control card glowing permanently and all LED's on LPO card is extinguished. If LPO cycle is interrupted before to complete LPO cycle by dropping BP by A9 and again back to "RUN" position then again full LPO cycle is repeated.

B.P. DESTRUCTION: A9 - APPLICATION

When A9 is put on application I.e. dropping of BP, EP No.17 of E-70 is de-energized (can be seen on control card LED- 4 not glowing) and pressure vent from EP No.17, which reduces CR pressure to a desired level as demanded by Loco Pilot through A9 and give feed back by pressure transducer to control card. As per CR pressure, excess pressure of BP pipe is vented through exhaust port of E70. There is small choke provided on E-70 valve near EP NO. 19 which is meant to leak continuously, this is because to keep system sensitive, CR is dropping continuously by choke and which is again filled by energizing by EP-16 till the CR is maintained at desired 5.0 kg/cm², where required level is completed, again EP-16 de energized. If we observe on control card we can see LED NO 3 is always glowing and OFF regularly.



EP-36 is provided on the top of E-70 control valve, which is normally de-energised when any one of the cab is selected and when central electronic is 'ON' and both the cabs are in 'OFF' position, this EP-36 valve is energised, which closed the path of E-70 BP charging system and brake pipe. This is used when loco is in multiple operation as well as in banking operation. This valve is also energised when 'ZBAN' switch is 'ON' which is provided on 'A' panel.

A9- EMERGENCY OPERATION.

Emergency exhaust is a valve which vents/ drops BP pressure heavily by opening BP pipe when A9 is operated at emergency position. When control pressure on top of valve seat is vented through ½" check valve of A9, the balancing air pressure on valve stem is vented and causes stem, to lift and BP to vent to atmosphere at faster rate.

A9-NEUTRAL:

When the handle of the brake controller is in the 'Neutral' position the cam operated switches within the controller cut off the power supply to all the E.P. valves (except 'Isolate' E.P. valve which is already de-energised) as for the 'Emergency' position.

EMERGENCY EXHAUST VALVE

The Emergency brake exhaust valve drops BP pressure when vigilance not acknowledged, Max. speed being exceeded (through momental), actuation of emergency stop button and failure of Brake electronics.

Note: 1. The handle of A-9 can be removed and inserted in neutral position and can be locked by locking device.

2. If the electronic brake control system fails, a priority-1 message display on the screen and an emergency brake is triggered.

Air Flow valve and venturi valve.

Function: The purpose of the flow meter and venturi is to indicate the rate of flow of air to the brake pipe via E-70. The function of this valves are the same as Air flow measuring valve and R6 relay valve in conventional system.

The principle upon which the flow meter works is that, when air flows through a small choke, the pressure at that point at venturi is reduced,

When there is no flow, the pressure remains constant at the maximum value .The flow meter consists of the venturi itself, and a flow meter valve is necessary to amplify the differential across the venturi so that it can be readily indicated on the gauge connected to the flow meter

Direct brakes: Direct Air brake valve (SA9) provided in each cab having two positons (release and operational range). This valve having pressure adjustment and normally setted at 3.5 kg/cm². The Direct brake D2 relay valve and direct brake isolate EP valves EP-31 and EP-32 are provided in the bootom of Pnuematic panel. From cab-1 EP NO.31 (top) is energized control pressure from Cab-2 SA9 is isolated and from cab-2 and EP NO.32(bottom) in de energised condition allowing pressure of Cab-1 SA9 and vice -versa for Cab-2 SA9 operation. When SA9

in Working Cab is applied, control pressure from SA9 3.5 kg/cm^2 is admitted to D2 relay valve and MR-2 pressure (3.5 kg/cm^2) will be admitted to Brake cylinders via (58) D2 valve. When brakes are released from SA9 then control pressure is exhausted from SA9 valve and the brake cylinders pressure exhaust from (58) D2(DIRECT) exhaust port.

Proportional loco brakes: Whenever BP pressure drops below its pre- determined value (i.e. 5 kg/cm^2), distributor valve gets activated and allows AR pressure limited to (2.5 kg/cm^2) to activate relay valve (57), further this relay valve allows AR pressure to rush in brake cylinder (2.5 kg/cm^2). When BP restores, DV gets balanced and releases the loco brakes accordingly. When PVEF is pressed VEF will energise and CR pressure admits in BP chamber of C₃WDV and nullifies the conjunction brakes.

Brakes through Blending Valve: During failure of (RB) regenerative brakes due to internal fault or VCB tripping, to compensate regenerative braking, blending valve sends the MR pressure in the brake cylinder in proportion according to throttle position. This pressure activates the relay valve (57), further this relay valve allows MR pressure into BC (See figure of loco brake system).

Parking Brakes: In 3-phase loco, instead of hand brakes parking brakes are provided on Wheel No.2-6-7-11 (WAG-9/WAP-7. Its function is just opposite to that of conventional brakes and the brakes are applied through the same brake block of conventional loco brakes. The Parking Brakes can be applied by means of actuating application EP coil and release through activating releasing This can be released individually when there is no pressure in PBU and TBU through releasing handle provided in PBU. When ever releasing plunger EP coil of Solenoid 30 provided in Pneumatic panel through BPPB/manual of is activated the pressure from AR reduced to 6 kg/cm^2 will be admitted to PBU via anti compounding valve and get applied below 3.8 kg/cm^2 in parking activator when pressure exhausted through application plunger.

Locking Of Parking Brakes:

Parking brakes can be locked in applied or in release condition for this purpose locking arrangement is provided on release and application plunger of solenoid valve 30. If plunger is pressed and then rotate, it will be remain in that condition until you unlock it by again rotating it and taking out the plunger out side. For locking the parking brake, follow the instructions of the division if any otherwise don't lock the parking brakes.

Anti-compounding valve: Whenever the application of parking brake and service brake (by DBC & DBV) some time causes damaged to TBU unit. To avoid this, anti compounding valve (Double check valve) is provided such that one incoming is parking brake pressure and other incoming is service brake pressure & the common outgoing of this valve is connected to parking port of TBU unit. Hence if parking brakes are applied (pressure vented) & service brakes are also applied, at that time the service brake pressure connects incoming to out going of ACV and enters in parking sensing port of TBU which cancels parking brake force & allows only service brake force, likewise when parking brakes are released, the pressure flows from incoming of ACV to outgoing & finally to parking brake cylinder as normal run position.

Anti Spin Brakes:

The principle of the anti-spin brake is to provide the traction equipment, with means to obtain a rapid light brake application to the driving wheels. The friction thus generated between the brake shoes and the tyres immediately absorbs the torque, which is in excess of the value that can be absorbed by the normal adhesion between the tyre and railhead. The net result is to prevent any increase of existing wheel slip.

The main advantages are that the slip is prevented or controlled, so avoiding the possibility of damaging the traction equipment, and at the same time it normally enables the traction power to be maintained so improving and simplifying the control of the locomotive when operating under conditions which may cause wheel slip.

The anti-spin brake can give an improved adhesion condition between the rail and tyre, due to the cleaning effect of the brake shoe when used with 'On tread' braking.

A further important advantage of the anti-slip brake is that its use often enables a reduction in the use of sanding.

This device is provided on each bogie behind MCP.

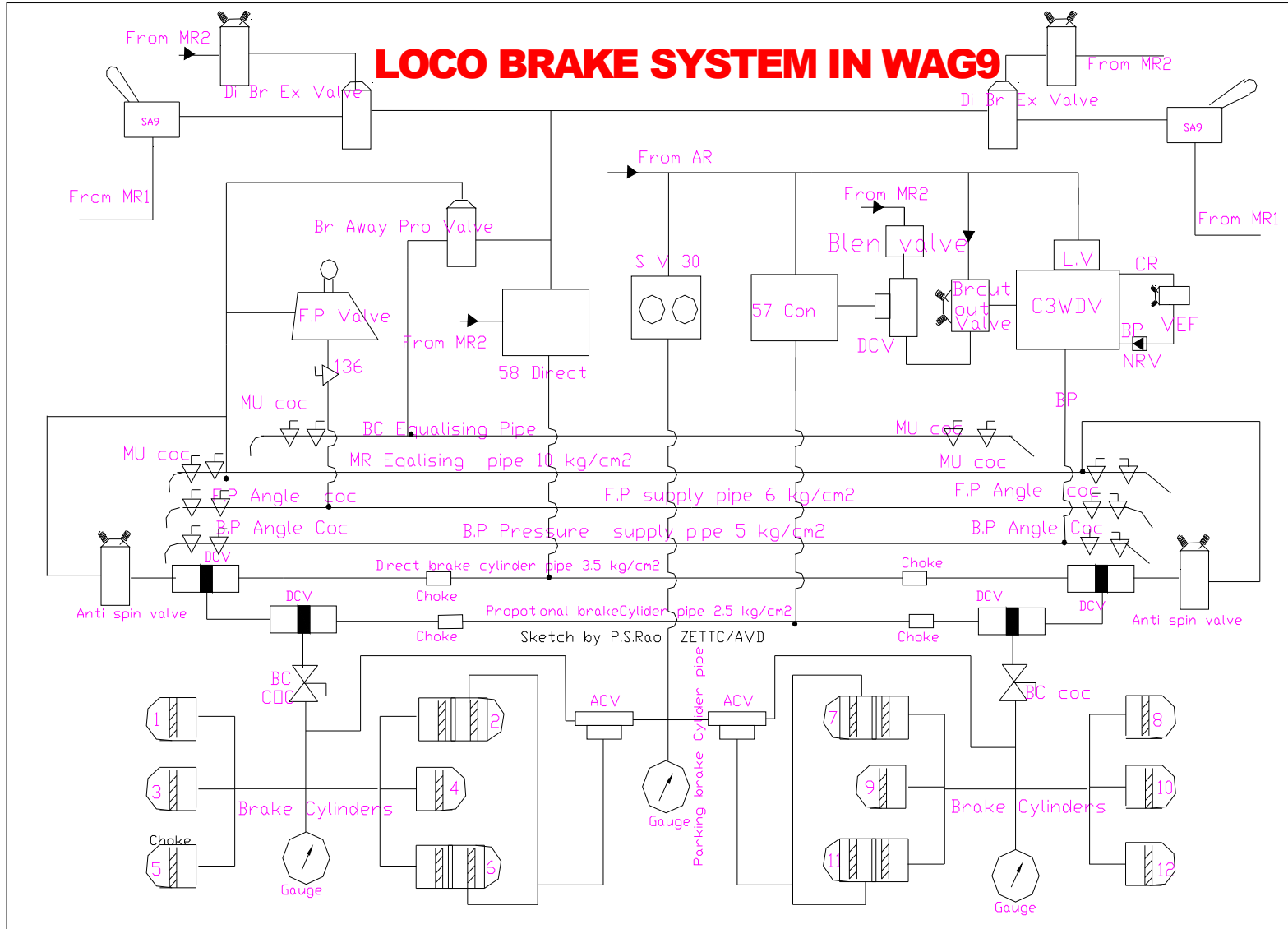
The automatic anti - spin protection is initiated as soon as the ratio between effective tractive/braking effort and requested tractive/braking effort is less than 0.5

As required, one or more of the following actions is/are initiated:

- Sanders start
- LSP glows
- TE/BE difference is reduced by control electronics.
- If necessary required braking force is given to wheel by applying loco brakes by control electronics- you can see that BC needle ups and down. (Which is limited to 0.6 kg/cm^2 to 1.0 kg/cm^2)

Note :

- If anti spin brakes are not applied at the time of wheel slipping, then wheels will get off loaded and to avoid further spinning, CE will reduce tractive effort. This will affect the hauling of load
- When train is in motion with speed more than 10 KMPH, Start/Run interlock get activated if BC pressure rushes above 0.6 kg/cm^2 and TE becomes 0. On run during anti spin brakes, 0.6 kg/cm^2 to 1.0 kg/cm^2 pressure rushes in brake cylinder. So as per above, due to this 0.7 kg/cm^2 pressure TE get reduced to 0 affecting haulage of load.



FAILURE OF BRAKE ELECTRONICS:

Whenever brake control electronics get failed a priority-1 message appear on the screen with emergency brake application. One circuit breaker is also provided in SB-1, if this circuit breaker is tripped same symptoms will appear.

Regenerative Braking:

This is an electrical braking system in which brakes are applied on loco without physical application or brake block failure.

1. Brake block does not apply on wheel so wheel and brake block wear is eliminated.
2. Reliable braking.
3. Smooth controlling.
4. Energy generated during braking is fed back to OHE i.e. it works just like a small power station and helps in energy conservation.
5. Braking is available up to 0 KMPH.

When throttle is put to BE side, traction motor work as generator and generates 3-phase, AC supply which is converted into DC supply by Loco pilot converter and fed to line Converter through DC link. In line converter this DC supply is again converted into single phase/AC supply in such a way that it induces supply equal to line voltage in main transformer through converter, which later is fed to OHE through VCB and pantograph.

At the time of Regenerative braking, the TE / BE meter deviates down ward in RB mode.

-If the RB fails during braking operation the independent loco brakes automatically takes over its function in proportion to RB force through blending valve.

Even if the RB and Pn brakes applied together due to fault in the system, excessive braking of loco is avoided because the anti spin slides control system reduces the electrical braking effort. You can use the regenerative braking from full speed to '0' speed.

As train loco can be stopped only by using regenerative braking, there is a possibility of non Application of loco brakes, here one thing should be noted that loco can be stopped but cannot be held by regenerative braking. So, don't forget to apply loco /train brakes at halt/stop. As already explained it feeds back to OHE during regeneration, so, Use RB as more as possible and generate the energy.

Also note the readings at the time of CTO & CHO to calculate energy conservation by you.

An Emergency Braking Operation :

1. Emergency brakes will apply through brake electronics when: Failure of the electronic brake electronics, Response from the Vigilance module, Permitted maximum speed being exceeded
2. Actuation of the emergency brake Cock on the assistant Loco pilot's side
3. Train parting
4. Moving of the Loco pilot's brake handle to position
5. Actuation of the emergency stop push button on the panel A

Note :When the emergency stop button is pressed, the VCB opens and the pantograph is lowered along with BP drop and TE/BE "0".Emergency braking is actuated directly in all cases and is not controlled by the MCE. However, the MCE responds to emergency braking by reducing tractive effort to 0. If an emergency braking operation is triggered in multiple operation, it is transferred to the slave locomotive also.

KNORR's Computer Controlled Brake System

In some WAG-9 locos KNORR type brake system is provided which is different from conventional brake system of WAG-9 locos.

In conventional loco, loco get failed in case of brake electronics failure. But in this loco, block section can be cleared by 10 KMPH in case of failure of brake electronics.

CHANGES IN CAB

1) Pilot lamp panel

One panel of 6 pilot lamps is provided beside panel-C which is as under:

- a) Exclusive Flow: This is a Red colored pilot lamp, glows when MR pressure is less.
- b) PCR open: This is a Red colored pilot lamp, glows when BP pressure is less.
- c) PER action: This is a Green colored pilot lamp, glows when PTDC (Pneumatic Time Dependent Control) is in service.
- d) EAB fail: This is a Yellow colored pilot lamp, glows when brake electronics failed and PTDC in service.
- e) P-16 action: This is a Green colored pilot lamp, glows when DV is isolated.
- f) SIFA cut off: This is a Yellow colored pilot lamp, glows when COC 74 is closed

2) Changes in Auto brakes and Direct Brakes:

In case of conventional system, A-9 / SA-9 handle has to be operated from left to right, but in this system handle has to be operated forward and backward like throttle. Both valves are provided on left side of loco pilot on control stand.

a) SA-9 Direct Brake:

SA-9 has two positions; Applied and Release.

One spring loaded clip called "Bail Ring" is provided below the handle of SA-9. If this clip pressed and released, synchronized brakes get released very fast where as brakes get released gradually if PVEF is pressed.

b) A-9 Auto brake:

A-9 handle can be locked or unlocked in FS (Full service) position by a key provided in each cab and coupled with a chain. Non-driving cab A-9 is kept on FS-locked condition where as driving cab A-9 is kept in RUN condition. While clearing loco as dead both A-9 are to be kept on FS-locked condition. A-9 handle has following 5 positions.

- i)REL-Release: In this position BP pressure is over charged to 5.5 kg/cm² and drop down automatically after some times with restricted flow to 5.0 kg/cm². This position is used for quick releasing of BP.

ii) RUN: This is the normal position of A-9 on which BP is charged to 5.0 kg/cm². At the time of recharging after application, BP is overcharged by 0.2 kg/cm² at this position for short time.

iii) MIN. (Minimum Reduction): BP pressure remains 4.5 kg/cm².

iv) FS (Full Service): BP pressure drops to 3.0 kg/cm². A-9 handle can be locked or unlocked in this position.

v) EMER. (Emergency): BP drops to zero kg/cm² on this position.

c) Mode switch: One rotating switch called mode switch is provided in each cab below SA-9 valve. This is spring-loaded switch and can be operated by pressing downward. This switch has following 4 positions.

i) HLPR: While using loco as banker, this switch should be kept at Help position on this mode in addition to ZBAN at ON.

ii) TRL (TRAIL): In non-driving cab (SU / MU), this switch should be kept on TRL position.

iii) LEAD: In driving cab (SU / MU), this switch should be kept on LEAD position, then BP will be charged 5.0 kg/cm².

iv) TEST: In this position BP leakage test is done. When this switch is kept on TEST position, Loco brakes get applied. This switch should be kept on lead position immediately after testing.

d) Pneumatic Time dependent Control (PTDC):

In this loco SA-9 and A-9 are governed by brake electronics. In case of failure of brake electronics train can be worked by max. 10 KMPH by PTDC. This is provided in each cab near A-9 / SA-9 and has following 2 positions.

i) Release and ii) Apply.

PTDC is having one COC, which should always be in open condition.

PROCEDURE of clearing block section by using PTDC:

- Bring throttle to “0”
- Open the DJ, Lower the panto and switch OFF CE.
- Trip the MCB 127.7 (SB-2) and ensure that MCB 127.15 (SB-2) is in ON condition.
- On Pneumatic panel, Close PB-BUS Cock & PER-COS from horizontal to vertical position.
- Keep A-9 of working cab on RUN.
- If BPF is glowing, then acknowledge the fault.
- Switch ON to CE and raise Panto, close VCB (DJ)
- Keep PTDC on release position and ensure that BP is 5.0 kg/cm² and BC is “0” kg/cm².
- If BC pressure does not come to ‘0’ then release by distributor valve.
- To apply / release auto brakes keep PTDC handle to apply or release as per requirement and clear the block section by 10 KMPH.

CHANGES IN UNDER TRUCK:

BC-1 & BC-2 COCs are not provided in under truck. These COCs are black in color and provided at the bottom of brake manifold in machine room. Normally these COC should be vertical (Open).

2 CHANGES IN PNEUMATIC PANEL IN MACHINE ROOM:

Pneumatic panel is divided into two parts.

- Air Brake Manifold.
- Auxiliary manifold.

1 Air Brake Manifold:

a) Parking Brake Back Up Switch – (PB-BUS):

This is a black colored switch; normally this switch should be in horizontal condition. But in case of PTDC mode or clearing loco as dead, this switch should be kept closed (Vertical) to release the parking brakes.

B) Pneumatic Equalizing Reservoir Cut Off Switch – (PER-COS):

This is a black colored switch; normally this switch should be in horizontal condition. But in case of PTDC mode this switch should be kept vertical.

C) Parking Brake Reservoir Cut Off Switch – (PBR-COS):

This is a black colored switch; normally this switch should be in horizontal condition. Maintenance staff uses this switch.

D) Parking Brake Pneumatic Disable switch- (PB-PDS)

This is a black colored switch; normally this switch should be in horizontal condition. In case of parking brakes malfunctioning maintenance staff uses this switch and kept vertical along with PBR - COS.

E) SIFA-74 (Vigilance exhaust COC):

This is yellow colored COC. Normally this COC should be kept down ward but while clearing loco, as dead this COC should be kept upward.

F) BC- & BC-2 COC:

These are bogie-isolating COC.

G) DV (Distributor valve):

2 Auxiliary Manifold:

Following COCs are provided on this manifold.

- | | |
|-------------------|---|
| a) WFL: | Pressure switch for wheel flange lubrication. |
| b) TC1 & TC2: | Pressure switch for traction converter-1 & 2 |
| c) KABA KEY: | Loco grounding key. |
| d) FC: | Harmonic filter contactor pressure switch. |
| e) PAN1&2: | Pressure switch for Panto1 & panto2. |
| f) VCB: | Pressure switch for VCB. |
| g) VESA1 & VESA2: | Pressure switch for sanders. |

h) 136: Pressure COC for Feed Pipe.

i) 47: Cock for dead loco (normally closed)

j) Panto selector switch: for selection of panto (same as conventional)(COC position of a to f switch should be horizontal. COC position of h & I should be vertical.)

ITEMS TO BE NOTED:

1 Energizing of cab:

Loco should be energized as conventional 3 phase loco, but ensure following:

- i) A-9 handle of driving loco should be at RUN, where as that of non-driving cab should be at FS in locked condition.
- ii) Mode switch is at LEAD in driving cab, and at TRAIL in non-driving cab.
- iii) Energize the loco as per normal position.
- iv) For charging BP move A-9 to FS for 10 seconds and then keep it to RUN position. BP will be charged by 3.0 kg/cm^2
- v) Ensure that parking brakes are released, if not then press BPPB.
- vi) Keep A-9 from RUN to FS. Wait for 10 seconds, then again keep it to RUN and ensure that BP is charged to 5.0 kg/cm^2 and BC is " 0 " kg/cm^2 .
- vii) Every time after recharging BP will overcharge to 5.5 kg/cm^2 at RUN position and then after some time become normal to 5.0 kg/cm^2 .
- viii) For overcharging BP to 5.4 kg/cm^2 , operate A-9 to REL position.(If necessary)
- ix) For releasing synchronized loco brakes use Bail Ring for quick release or use PVEF for normal release.

2. Procedure of Cab Changing:

- i) Keep A-9 handle in FS and lock it and remove the key out side.
- ii) Keep the SA-9 in release and rotate MODE switch to trail position.
- iii) Open the DJ, lower the panto and switch off the CE. Remove the BL key and go in another cab.
- iv) In another cab, Unlock A-9 handle and keep it on RUN condition. Operate Mode switch from TRAIL to LEAD.
- v) To charge BP, release parking brake and ensure charging of BP pressure.
- vi) Take these precautions every time while changing the cab.

3. Parking brake – application & release.

Whenever parking brakes are applied by CE or manually, every time penalty auto brakes will be applied along with parking brakes in which BP will drop to 3 kg/cm^2 and loco brakes up to 2.5 kg/cm^2 with Priority-1 message on screen.

For recharging BP pressure, first release parking brakes and keep A-9 to FS position for 10 seconds. Again keep A-9 on RUN position and ensure that BP is recharged to 5.0 kg/cm^2 . Acknowledge the fault and work further.

For applying parking brake manually, rotate switch PB-Bus from horizontal to vertical and for releasing vertical to horizontal.

4. Vigilance penalty brakes:

In this loco BP pressure is dropped by 3.0 kg/cm² (in gauge 2.0 kg/cm²) on application of vigilance parking brakes. Do the following for resetting vigilance penalty brakes:

- i) Keep throttle at “0”
- ii) Wait for at least 2-3 minutes.
- iii) Keep A-9 to FS, press BPVR for acknowledging fault message.
- iv) Keep A-9 at RUN and ensure that BP is charged to 5.0 kg/cm² and loco brakes are released.
- v) Acknowledge the fault by BPFA and proceed further after ensuring pressure.

5 Action to be taken after Emergency Brake Application:

Emergency penalty brakes applied when, emergency push button is pressed or due to over speeding or due to emergency application by A-9 / ALP Emergency valve, in which BP pressure drops to “0”. For releasing this penalty brake, keep A-9 to Emergency (EMER) for 10 seconds and again keep to RUN position, BP will charge to 5.0kg/cm² then acknowledge the fault message and work further.

6. Service penalty brakes:

Service penalty brakes apply automatically in following condition in which, BP is dropped to 3.0 kg/cm².

- i) If BC-1 & BC-2 are isolated in locos “LEAD” mode.
- ii) If any one COC of PB-PDS, PB-BUS, PB-R-COS is isolated. If all these switches are in isolated condition and BPPB is pressed then also penalty brakes will apply.

To release service penalty brakes, normalize the above switches, keep A-9 to FS for 10 seconds and then again keep to RUN position and ensure BP to charge at 5.0 kg/cm².

7. Clearing loco as DEAD.

- i) Keep the throttle at “0”. Open the DJ, lower the panto, and remove the BL by switching OFF CE.
- ii) Keep the A-9 of both the cab in FS and remove the key after locking it.
- iii) Keep both SA-9 handle at release and keep MODE switch at TRAIL.
- iv) Open COC 47 (Dead loco) and close COC136 (FP) provided on auxiliary manifold.
- v) Keep PAN-1 & 2 (Auxiliary manifold) COC on vertical position.
- vi) Close COC 74 SIFA (Vigilance) provided on pneumatic manifold by keeping upward.
- vii) Switch OFF MCB 112.1 (in SB-2). Drain out the MR & AR.
- viii) Couple the energize loco with dead loco and couple BP/FP pipes and open their angle Cocks.
- ix) BC pressure should be ‘0’ and if not then release the distributor valve.
- x) For application and releasing of brakes in dead locomotive rotate PB-BUS (air brake manifold) from horizontal to vertical. Ensure 5 kg/cm² pressure in parking brake gauge.

NOTE :-

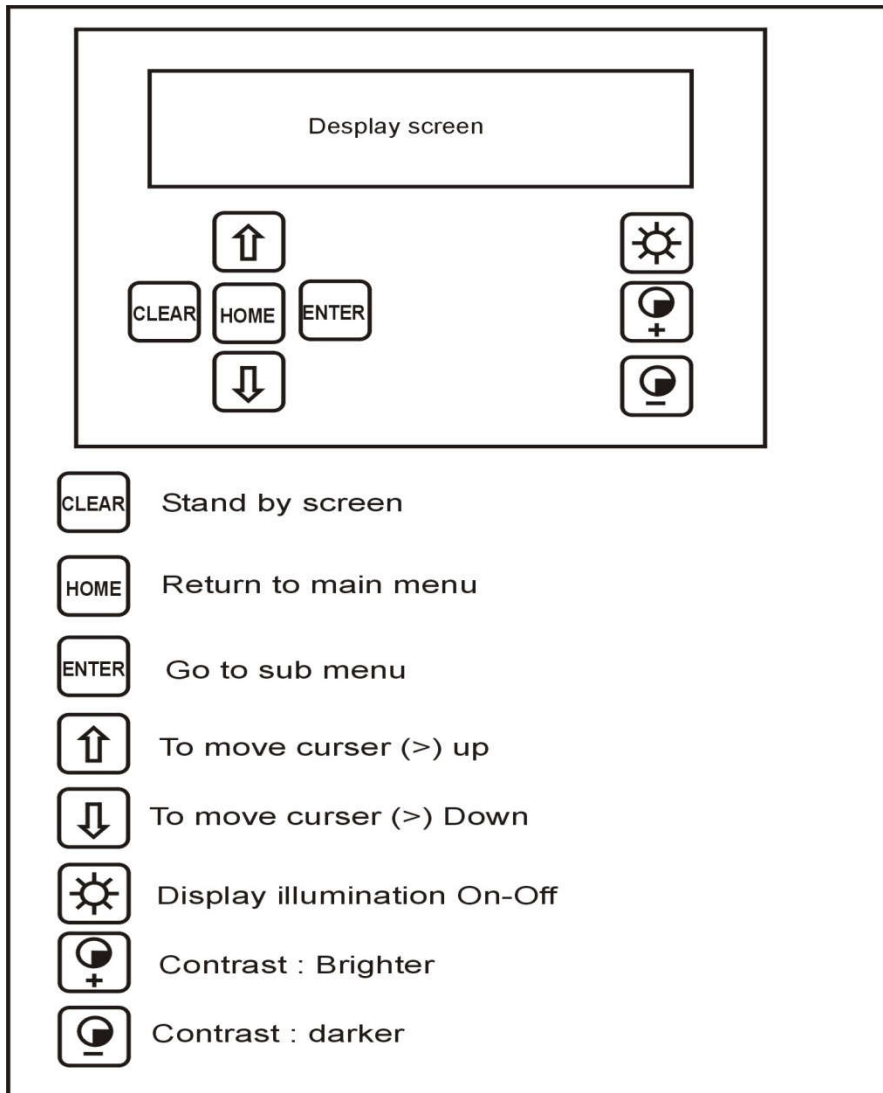
- a. COC number 70 of BP is not provided in this loco.

b. Solenoid valve no. 30 is provided in this locomotive.

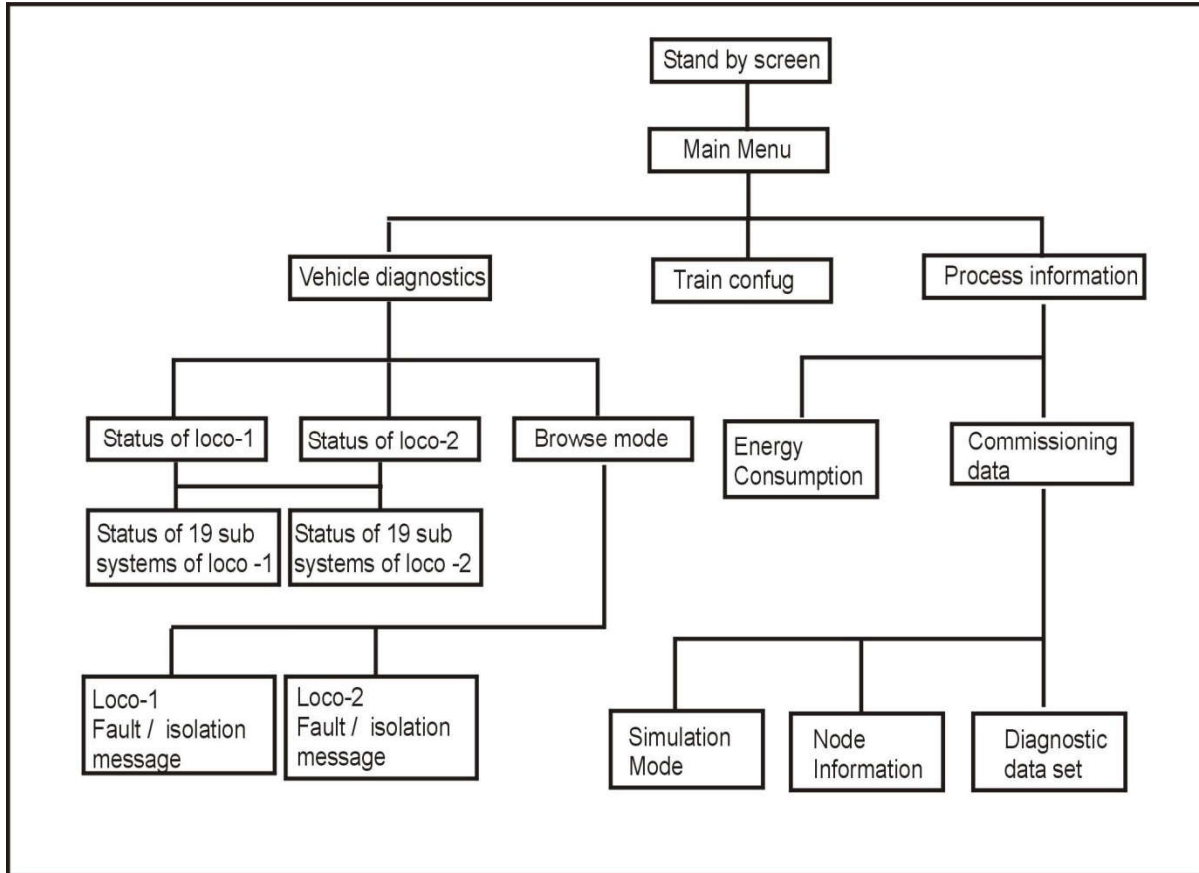
Before clearing loco as dead ensure that parking brakes are released fully and parking brake gauge is showing 5 kg/cm² pressure. Also ensure the same on run.

FAULTS DIAGNOSTIC

Display Screen



Screen Structure



Faults With Priority-1:

Protective action will be executed (Power reduction/ Traction interlock/VCB Off / protective shutdown) . Isolation counter will be activated. Fault message (Priority-1) will display . LSF1 will flicker , BPFA will glow. This over writes the P2 message. The action to be taken must be initiated immediately.The fault has to be acknowledged by BPFA.

Faults With Priority-2:

- The action to be taken is not entirely clear.
- The action to be taken does not have to be initiated immediately.
- The faults can be remedied manually by Loco pilot.
- BPFA will glow.
- Priority-2 message will appear on screen.

Note:

- If a fault message appear on the screen, the yellow illuminated push button “BPFA” lights up. If this is fault of priority-1, the red indication lamp ”LSFI” starts flashing at the same time.
- If a fault message with priority-1 is displayed, a fault message with priority-2 is suppressed on the screen.
- A fault message with priority-2 remains on the screen until it is overwritten by a fault message with priority-1 or by subsequent fault with priority-2.

Isolation Of Sub System:

A constant priority-1 fault or priority-2 fault which occurs twice within one 30 minutes period causes the appropriate subsystem to be isolated.

If sub-system has been isolated it does not issue any more fault message and signals. Only LSFI remains glowing.

Acknowledgement Of Fault Message:**Priority-1**

If a priority-1 fault occurs the fault message must be acknowledged before the loco can travel further, If the train Loco pilot fails to acknowledge, the protection measures introduced remain in force. The fault is not remedied.

- Fault message can be acknowledge by pressing BPFA, if after acknowledgement LSFI extinguish then it indicates now loco is normal, but if LSFI glow continuously it indicates isolation of concerned sub-system.

Priority-2

They are also acknowledged by pressing BPFA. Even if this acknowledgement is not forthcoming, the locomotive is still able to operate. The fault message still remains visible on the screen until it is over written by a fault message with priority-1 or by subsequent fault with priority-2.

Indication and recognition of faults:**Illuminated push button(BPFA):**

Fault indication/fault acknowledgement (Yellow) On occurrence of any fault, the illuminated push button for fault acknowledgement will light up and fault message will appear on the display. The Loco pilot is required to acknowledge the fault through the push button. On acknowledgement, the lamp of acknowledgement push button will go off and the display will be cleared.

Fault status lamp (Red) (LSFI) :

In case of priority-1 fault, the fault status lamp will start blinking additionally. On acknowledgement of fault, the lamp will be off but if there is an isolation of a subsystem persisting, then the lamp will continue to glow.

Automatic display of diagnosis messages

If a fault occurs that needs to be transmitted to the Loco pilot by means of a diagnosis message, such message will be displayed immediately. At the same time, the illuminated push-button for fault acknowledgement will light up.

All diagnostic messages shall be acknowledged by the Loco pilot through the fault acknowledgement push button (BPFA). On acknowledgement, the lamp of acknowledgement push button will go off and the display will be cleared.

In case of priority-1 fault, the fault status lamp (LSFI) will start blinking additionally. On acknowledgement of fault the lamp will be off but if there is an isolation of a subsystem persisting, the lamp will continue to glow.

If the Loco pilot fails to acknowledge priority 1 fault, then the loco is shut down.

If the Loco pilot fails to acknowledge faults of priority-2 then the fault message will remain on the display screen, unless it is overwritten by a fault message of priority-1.

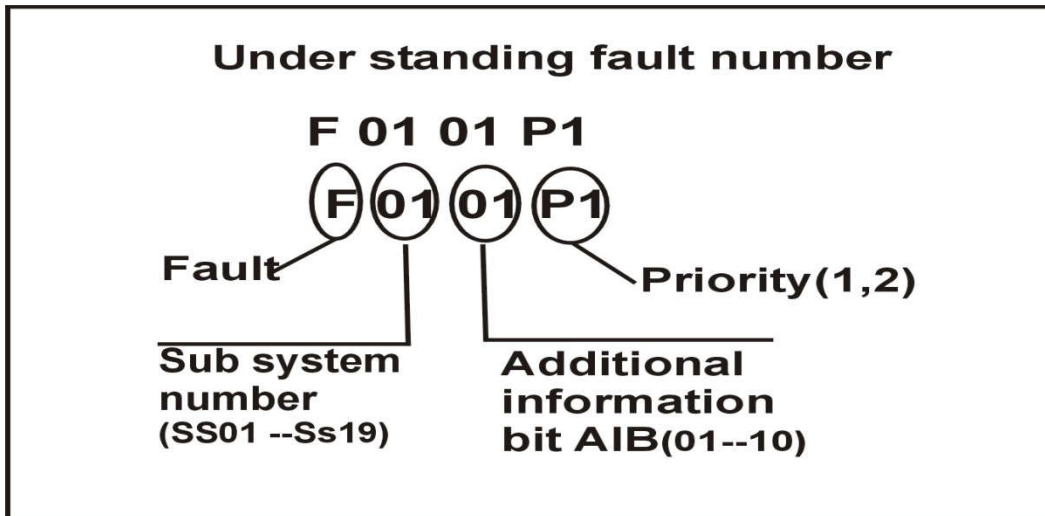
The fault or isolation messages include following information:

- Locomotive number on which the fault or the subsystem isolation respectively occurred
- Name of subsystem being affected (SS01 to SS19)
- Type of fault /subsystem isolation and related consequences
- Instructions to the engine Loco pilot

. STATUS CODE:

STATUS CODE	
FIRST DIGIT 0- No sub system isolated 9- at least one sub system isolated	SECOND DIGIT 0- no fault WITH priority -1 OR 2 1- at least one Priority-2 fault 2- at least one Priority-2 fault
0 0 No fault and no sub system isolated 0 1 No sub system isolated, at least one Priority-1 fault 0 2 No sub system isolated , at least one Priority-2 fault 9 0 At least one sub system isolated , no fault 9 1 At least one sub system isolated , at least one Priority-1 fault 9 2 At least one sub system isolated , at least one Priority-2 fault	

FAULT MESSAGE CODE



DISPLAY OF SUBSYSTEM STATUS

By means of keyboard entry, the Loco pilot can display the status of all subsystems of all locomotives within the train composition. Different display levels furnishing more or less detailed information are provided:

- Survey of all locomotives within the train composition: the status of each individual locomotive is indicated by a two-digit numerical code.
- Survey of all subsystems within one locomotive: the status of individual subsystem is indicated by a two-digit numerical code.

Browse Of Status Messages On Request

All diagnosis messages that appeared at the display since the last activation of the control system may be repeated on request. In this way, the relieving operating personnel is kept informed on the status of the vehicle. If the train composition consists of two locomotives, the Loco pilot can select the locomotive that he wants to process first.

Diagnosis Messages :Diagnostic data set

On the ScrNum 7. “Diagnostic data sets”. An extract of the two latest diagnostic data set (DDS) are shown when selecting this screen. Following DDS information is displayed:

PROX: 000Y – DDS Messagetext (30 characters)

DD-MM-YY HH:MM:SS dd-mm-yy hh:mm:ss +/- zzz

DD-MM-YY :Date when fault occurred

HH-MM-SS :Time when fault occurred

dd-mm-yy :Date when fault, If the fault is persisting ?????? will appear instead.

hh-mm-ss :Time when fault disappeared, If the fault is persisting ?????? Will appear instead

+/- zzz :Position of DDS when data base of diagnostic computer

+0 :Latest DDS when submenu was selected.

-zzz : earlier DDS

+zzz : DDS generated between selection of sub menu and now

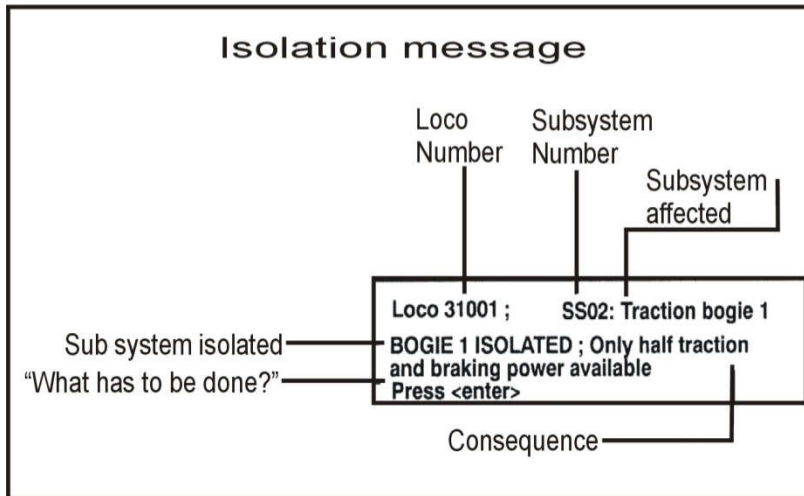
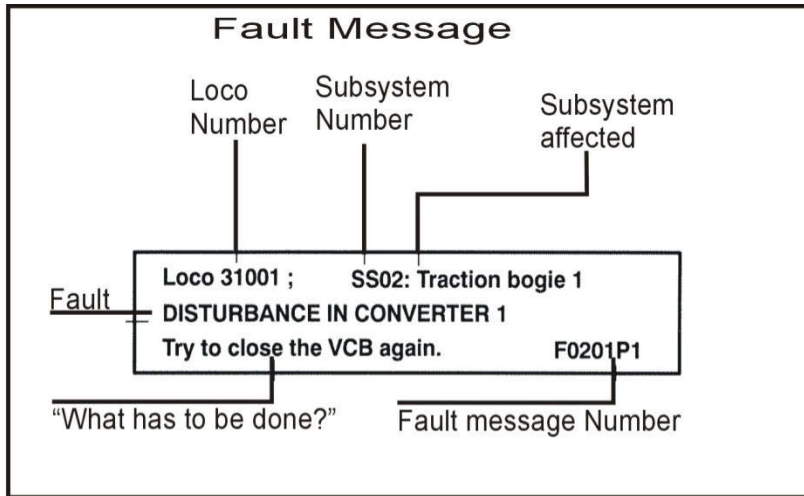
Example:

FLG003-Lifesign of SLG1 missing					
07-09-94	15-33-12	07-09-94	15-33-58		+007
FLG004-Lifesign of SLG2 missing					
07-09-94	15-33-13	??-??-??	??-??-??		+006

By pressing the < ^ > key the scrolling direction is towards the past time and by pressing < ? > key scrolling direction is towards present time. All ways 2 DDS will be scrolled together. There are always 2 DDS displayed at the same time.

There are three types of messages displayed to the Loco pilot on the display unit in the cab: 1. Information messages 2. Fault messages 3. Isolation messages

Fault & Isolation Message Structure



List of Subsystems

SS01	Main power	SS12	Auxiliaries HB2
SS02	Traction Bogie 1	SS13	Cab 1
SS03	Traction Bogie 2	SS14	Cab 2
SS04	Harmonic filter	SS15	Fire detection
SS05	Hotel load	SS16	Speedometer
SS06	Aux Converter 1	SS17	Processor FLG1
SS07	Aux Converter 2	SS18	Processor FLG2
SS08	Aux Converter 3	SS19	Train Bus
SS09	Battery System		
SS10	Brake System		
SS11	Auxiliaries HB1		

List Of Isolation Messages

- SSO1: Main power**
MAIN POWER ISOLATED; VCB inhibited
Loco is dead Ask for relief loco
- SSO2: traction bogie 1**
BOGIE 1 ISOLATED; Only half traction and braking power available
Inform to TLC and make a remark in the log book.
- SSO3: Traction bogie 2**
BOGIE 2 ISOLATED; Only half traction and braking power available
Inform to TLC and make a remark in the log book
- SSO4: Harmonic Filter**
HARMONIC FILTER ISOLATED
Speak to TLC Reduce speed below 40 km/h
Inform to TLC and make a remark in the log book
- SSO6: Aux. Converter 1**
AUXILIARY CONVERTER 1 ISOLATED
Driving still possible Max. Ventilation level will be reduced
Inform to TLC and make a remark in the log book
- SSO7: Aux. Converter**
AUXILIARY CONVERTER 2 ISOLATED
Driving still possible Max. Ventilation level will be reduced
Inform to TLC and make a remark in the log book
- SSO8: Aux. Converter**
AUXILIARY CONVERTER 3 ISOLATED
Driving still possible Max. Ventilation level 'ill be reduced
Inform to TLC and make a remark in the log book
- SS13: Cab 1**
CAB 1 ISOLATED Drive from Cab 2 Change to Cab2
Inform to TLC and make a remark in the log book
- SS14: Cab 2**
CAB 2 ISOLATED Drive from Cab 1 Change to cab-1
Inform to TLC and make a remark in the log book
- S517: FLG 1**
FLG1 ISOLATED
No multiple operations possible, Inform to TLC and make a remark in the log book
- SS18: FLG 2**
FLG2 ISOLATED
No electrical brake power available, Inform to TLC and make a remark in the log book
- SS19: Train bus**
TRAINBUS ISOLATED
Multiple operations not possible, Inform to TLC and make a remark in the log book

List of Information Messages

- Information 001** SELF HOLD MODE ACTIVE for 10 minutes. MCE will switch off
Change cab or repair train or multiple operations within 10 minutes
- Information 002 -** MORE THAN ONE CAB ACTIVE-Deactivate non-driving cab otherwise after
10 minutes. MCE switches off
- Information 003-** Traction MAY NOT BE AVAILABLE ON THIS LOCO OR ON THE SLAVE
LOCO, Bring throttle to 0.Then set again Bring TE/BE throttle to“0”and set it
again
- Information 004-** TRAINBUS CONFIGURATION RUNNING Please wait
- Information 005-** FULL TE/BE RESTORED+
- Information 006-** PANTO RAISING Please wait

PROTECTION SCHEME

Protective measures by control electronics:

Initiation of protective measure in dangerous situation are controlled by Control Electronics. MCE monitors a range of values such as voltage, current, temperature, pressure and other signals.

Catenary voltage out of range

When catenary voltage drops down below 17.0 KV and raise above 30 KV VCB will open automatically.

Temperature protection

When temp of Transformer exceeds beyond 84 degree C, for more than 10 sec, VCB will trip.

Primary Over Current Protection (QLM) -Reason for over current.

1. Disturbance in measurement of primary current. 2. Fault in converter.
3. Short circuit in transformer winding 4. Check machine room for oil flash/smoke/abnormal.
5. Check OCR.78 is in normal.

If any thing is abnormal- fail the loco. If VCB trips during 'C' mode then check oil level of transformer and converter and check relay 78. If any thing is abnormal, fail the loco.

Train Parting:

Airflow measuring valve is provided in loco. Whenever train gets parted, or air flow increases and AFMV gets activated, resulting in glowing of LSAF and sounding of buzzer. Also message of ALARM CHAIN PULLING will appear on screen.

As due to uncoupling / parting, the BP pressure start expelling at very fast rate, resulting in sudden drop in MR pressure which leads to Priority -1 message on screen " Low Pressure Main reservoir"

So, after parting / uncoupling, the Loco pilot will get message of low MR pressure.

So, when ever AFI shoot up with sudden drop in BP pressure, your first duty is to act as in case load parting / accident (like switching ON of flasher light, protection of adjacent track, Securing of load / loco, etc.), After asserting that trailing load is OK, then think about the loco / message.

Fire Alarm:

In loco fire detention unit is provided in SB2. There are two smoke detector to detect the smoke in machine room.

When one detector detects the smoke –

1. Buzzer will sound 2. Priority-2 message will appear on screen.

When both detectors detect the smoke –

1. Priority-1 message will appear on the screen - Inspect Machine room
2. Throttle T/E, B/E becomes '0' 3. Buzzer will sound. (1170 Hzs)

Do the necessary arrangement to extinguish the fire by using suitable fire extinguisher provided in Cab1/2 and Machine Room 1/2 (Total 4 Nos.)

Resetting Of Fire Alarm:

1. Press Reset button on fire detection equipment provided in Machine Room (SB-2)
2. Press BPFA.

Action to be taken by Loco pilot

1. Inspect the Machine room and take necessary action. In case of fire on loco, use big fire extinguisher provided in the rack behind asstt. Loco pilot in cab. To operate this fire extinguisher, open the cut out COC and release the gas by rotating adjusting knob, gas will expel and extinguish the fire at appropriate places in machine room behind it. In addition to this two numbers of portable fire extinguishers are provided on the loco which should be used accordingly as per requirement.
2. To reset the FDU, press the white knob provided on it. To acknowledge the fault press BPFA. Resume normal traction.

Note:- In case of defect in FDU, P-2 fault message will appear on the screen. After inspecting the machine room, reset the white knob on the FDU. Acknowledge the fault and keep watch on machine room.

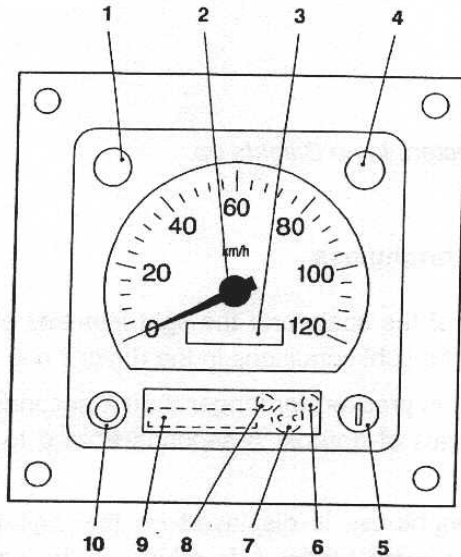
Alarm Chain Pulling:

When airflow increases without initiation of Loco pilot or CE i.e. in case of ACP/Guards brake applied/leakage in train etc. Following indications appear.

1. Air Flow Indicator needle will deviate.
2. LSAF will glow. 3. Buzzer will sound (745 Hzs with 1 sec on and 1sec off)
4. BPFA will illuminate with P-2 message.
5. Auto flasher will start.

ACP Indication:

1. Reset the ACP or arrest the leakage.
2. Buzzer will sound continuously until the leakage/ACP is arrested. To stop sounding, press BPFA. If ACP/leakage is not arrested buzzer will start again.
3. When ACP leakages are reset, all indications will disappear, but for BPFA indication press it once.

MEMOTEL (speed recorder and indicator)

- | | |
|---------------------|--|
| 1-Indication lamp A | Recording function fault |
| 2 | Indicator Speed in km/h |
| 3 | Digital display Date,time, istance covered speed,fault message |
| 4 | Indication lamp B Fault in MEMOTEL,incorrectspeed indication |
| 5 | InterlockInterlock of cover |
| 6 | Push button C Selection of amendment mode, digital display (can be locked) |
| 7 | RS232 interfaceInterface for the Service Computer (can be locked) |
| 8 | Push button B Alters the digital value (can be locked) |
| 9 | Memory Card |
| 10 | Push button A Selection of digital display for lighting control |

Note: Memory Card and interface for Service Computer are not available in Cab 1.

Functions and Settings

Self Test As soon as power supply is available, the internal functions of the digital display are checked.

Note: *If a fault is detected, lamp B lights up.*

Adjustment of Brightness

The brightness of the scale and the light intensity of the digital display can be adapted to suit the light conditions in the driver's cab.

If push button A is pressed for longer than 2 seconds, brightness rises in linear fashion in intervals of approx. 8 seconds from 0 to 100% intensity and starts again from 0%.

The selected brightness is displayed on the digital display as a percentage value and, when push button A is released, the selected brightness value is stored in memory.

Indication Lamps(Indication Lamp A)

1. Lamp A does not light up if:

-All MEMOTEL functions are O.K.

-Lamp B is already lit.

2 Lamp A flashes once every two seconds, if:

90% of the long-term storage capacity of the Memory Card is allocated.

3 Lamp A flashes twice every second if:

MEMOTEL is being configured.

Data are being read out or deleted with the help of a service device

The Memory Card is being configured.

4 Lamp A is lit continuously if:

100% of the capacity of the long-term or fault memory is assigned.

A Memory Card is called for but not installed, or if the card is not accepted.

A different speed display than the Slave MEMOTEL is connected up.

Indication Lamp B (Lamp B does not light up if)

1. MEMOTEL functions perfectly.
 - Service work is being carried out via the serial interface.
2. Lamp B is lit continuously if:
 - A fault is detected in the MEMOTEL (EPROM, RAM)
 - No configuration, or an invalid configuration, is loaded.
 - The speed display (MEMOTEL Master or Slave) is incorrect.

Push Buttons

Push Button A(By pressing push button A)

- 1- 6 Functions can be displayed on the digital display unit (refer to 4.7.2.5)
- 2.-Brightness settings can be performed (refer 4.7.2.2)

Push Button B

With push button B, the value of the selected and flashing digit is changed.

Note: All setting work only by Service Personnel.

Push Button C

1. Activates the amendment mode for the digital display unit.
2. Selects the digit to be amended.

Note: All setting work only by Service Personnel.

Digital Display

This display comprises 8 characters.

Press push button A repeatedly to call up following sequence of displays:

Speed	km/h
Time	HH:MM:SS
Date	DD:MM:YY
Distance covered	km
Encoded fault message Display	DEF XY
Clear	

Note: *Approx. 10 seconds after push button A is released, depending on configuration, time or speed is displayed automatically.*

OPERATING MANUAL

LOCO PREPARATION AND INSPECTION:

Before commissioning Journey, perform an inspection check of the locomotive and through the machine room. In particular, check the following items:

1. In front Of Cab:

1. Ensure that loco is standing on the rail and under the OHE
2. Ensure that both side MRE, BCE BP , FP hoses are connected properly and their angle COCs are as per requirement. Also ensure that hoses are not hanging.
3. Ensure that rail guard, cattle guard, has not any damages
4. Ensure that CBC having no abnormalities and locking pin is available and provided with operating handle.
5. Ensure that UIC connector sockets are covered.
6. Ensure that Flasher light, marker lights, headlights are glowing properly and their glasses are clean.
1. Ensure that both look out glasses are clean and wipers are wiping properly.

2. Below Machine Room No. 1(Cab-1 To Cab-2)

1. Ensure that all sand boxes are filled with dry fine sand and sanders are working properly.
2. Ensure that additional angle COC of MRE & BCE are opened.
3. Ensure that Air dryer unit is in service that (D-in open, D- out open & D-off closed)
4. Ensure that all suspension dampers; helical springs having no abnormalities like, crack etc.
5. Guide rod is fitted properly and its bolts are tightened.
6. All brake rigging; brake block, brake shoe, sleeve rod, assembly hanger arrangement are OK.
7. Wheels are not skidded.
8. Return current bush are connected properly.
9. Parking brakes cylinders are provided with manual releaser hook.
10. Traction link is fitted properly and their all 6+6 bolts are tightened.
11. Oil level in CP is above min mark; also ensure that CP foundation bolts are tightened.
12. Bogie brake -1 COC is in open condition.
13. Battery box cover is locked.
14. Safety chain is intact.
15. BP and FP additional COC are in open condition.

3. Below Machine Room No. 2

1. Ensure that all sand boxes are filled with dry fine sand and sanders are working properly.
2. Ensure that additional angle COC of MRE & BCE are opened.
3. Ensure the all suspension dampers, helical springs having no abnormalities like, crack etc.
4. Guide rod are fitted properly and its bolts are tightened.
5. All brake rigging; brake block, brake shoe, sleeve rod, assembly hanger arrangement are OK.
6. Wheels are no skidded.
7. Return current bush are connected properly.
8. Parking brakes cylinders are provided with manual releaser hook.
9. Traction link is fitted properly and their all 6+6 bolts are tightened.

10. Oil level in CP is above min mark; also ensure that CP foundation bolts are tightened.
11. Bogie brake -2 COC is in open condition.
12. Battery box cover is locked.
13. Safety chains are intact.
14. BP and FP additional COC are in open condition..

4 In Cab

1. Cab and look out glasses are clean.
2. All switches are normal, ZBAN-OFF, BLCP-AUTO
3. Emergency exhaust Cocks are normal.
4. Water is filled up in windshield washer unit.
5. Spare hoses, wooden wedges are provided in side locker.
6. Fixed and handy both fire extinguisher are in good condition and filled with gas.
2. Ensure that emergency push button is released.

5. In Machine Room

1. Control and power Circuit breakers in cubicle SB-1 / SB-2 , HB-1 and HB-2 are normal
2. Switches provided in SB-1 are at normal position.
3. Oil level of conv-1/2 and transformer-1/2 are above min mark.
4. All fittings and connections are normal.
5. Outer cover of any power equipment is not opened.

6. Pneumatic Panel

1. Panto selector switch is at “auto” position.
2. COC 70,74,136 are in open condition and COC 47 is in close position.
3. COC of panto 1, panto 2, VCB and sanders are in open condition.
4. Distributor valve is in service.
5. IG 38 Key is inserted and kept ‘ON’.
6. CPA drain Cock is in close condition.
7. Parking brake apply/release plungers are not in locked condition.

How To Energise The Loco:

1. Check the machine room and cubicle HB1/2,SB1/2 and pneumatic panel and ensure that all Circuit breakers, rotating switches and Cock at Pn. Panel are at Normal position and ensure that key 'IG-38' is provided on pneumatic panel. Also ensure that panto selector switch is at normal position.
2. Switch ON compartment light, it ensures closing of main circuitry breaker 112 of battery.
3. Put battery additional circuit breaker No.112.1 to 'ON' position in cubicle SB-2. Also ensure that CHBA circuit breaker no. 110 (SB-2) is at ON position.
4. Go in operating cab.
5. Insert A-9 handles at 'Neutral' position and keep it in 'RUN' position by lifting lock.
6. Insert 'BL' key at 'OFF' position and turn it to 'D' position
 - a. Light of screen (panel-C) and Memotel will get ON.
 - b. MCPA will start (if pressure is less).
 - c. UBA will deviate to 110 volts.
 - d. LSDJ will glow.

All above indications indicates that Control Electronics is get 'ON'.
7. The message "Loco is in configuration, please wait" will appear on the screen and self testing is done for 10 seconds.
8. During testing, all pilot lamps will glow and extinguish, Bogies-1 & 2 meter will deviate both in TE/BE mode and come to -0
9. After testing FLG No. 504, will be displayed on the screen, Now press 'ZPT' in 'UP' mode for raising of pantograph and confirm the touching of panto with contact wire by seeing physically also U-meter will deviate and indicate the value of OHE voltage.
10. No.550 will display on the screen- now press BLDJ for closing VCB and check 'LSDJ' is extinguished.
Now DJ will close, loco will energize and all the auxiliary motors will start automatically.
11. Ensure that BLCP is at AUTO position.
12. No.570 will appear on the screen.
13. After building of MR pressure to 6.4 kg/cm^2 , set Reverser to F/R as per requirement. (FLG 590 will show on the screen.)
Note:- If the reverser is set without confirming the MR pressure i.e above 6.4 kg/cm^2 , then P-1 message will be there on screen- indicating wrong operation.
14. Apply loco brakes
Now release the parking brakes
Ensure BP pressure is 5 kg/cm^2
Ensure AFI is at Zero.
15. Now operate throttle in TE direction.
16. TE /BE meter will deviate in TE side indicating that traction is available. No. "596" will appear on the screen.
17. Check the loco brake power. Release loco brake.
18. Now you can move the train / loco.

Note:

Priority -1 message will appear on the screen if: -

1. If Reverser is put on position F or R when MR pressure is below 6.4 kg/cm²
2. If throttle is operated without releasing parking brakes.
3. If throttle is operated without recharging BP to 5 kg/cm².

Information message will appear on the screen:-

1. If throttle is operated before node information No. 590.

Operation Of BL Key

BL key is operated in the following modes:

- | | |
|---------------------------------------|---------------------------|
| 1. DRIVING MODE: | (Off - D) |
| 2. SELF HOLD MODE. | (D - Off) |
| 3. Switching OFF control electronics: | (D - Off - C - Off) |
| 4. COOLING MODE: | (D - Off - C - Off - C) |

Driving Mode:

This mode is used to drive the loco. To achieve this mode Loco pilot has to:

- 1) Insert BL key in 'OFF' position.
- 2) Turn it clockwise from 'OFF' to 'D'
- 3) By doing so, following indications will confirm the driving mode:
 - a) LSDJ will glow
 - b) UBA will show battery voltage.
 - c) Display screen will activate.
 - d) Memotel screen will activate. Control electronics will get ON.

Self Hold Mode:

- 1) Open DJ , lower the pantograph
- 2) Rotate 'BL-key' from 'D' to 'OFF': Now control electronics will remain 'ON' for 10 minutes and then it will become 'OFF' automatically. This mode is used while changing the cab.

Switching Off - Control Electronics:

Loco pilot has to switch off control electronics in many cases like;

- a) Making the loco dead.
- b) During troubleshooting.
- c) For taking the isolated sub system in service.
- d) Before e resetting circuit breaker or before rotating any switch.

To switch off the control electronics do the following:

- 1) Stop the train
- 2) Open the DJ and lower the pantograph.
- 3) Operate BL-key from 'D' to 'Off' (wait for 2 sec.)
- 4) Operate BL-key from 'Off' to 'C' and wait until display screen, LSDJ, and UBA goes off.
- 5) It indicates that CE got 'OFF' and now rotate it from 'C' to 'OFF'.

Note :

- 1) CE gets automatically 'off' after 10 minutes if BL-key is rotate from 'D' to 'OFF' (as explained in self hold mode.)

2) C.E. will get 'off' automatically after 10 minutes in driving mode also, if panto is remained in lowered position for more than 10 minutes.

3) If the key switch is moved from "D" to "Off" without opening VCB and lowering panto graph, results in automatic shutdown of the loco.

Cooling Mode:

Whenever temperature of control electronics is increases above 70⁰ then lamp LSCE glows on Panel 'A' and throttle will not respond.

1. Try to coast in to station or stop the train at suitable place.
2. Inform TLC/SCOR regarding cooling.
3. Keep the throttle on '0'.
4. Keep SA9- in applied condition and A-9 to emergency.
5. Open VCB and lower the pantograph.
6. Switch off CE as per procedure.
7. Put 'BL' key from 'C' to OFF.
8. Again put 'BL key' from 'Off' to 'C' and ensure that UBA shows battery voltage and LSDJ glows, Screen is Off - no node information. (Note CE is OFF)
9. Now raise the panto, close the VCB- LSDJ will extinguish and loco will energize in cooling mode.
10. Machine room blowers & scavenge blowers will start automatically to cool the machine Room. Ensure working of machine room blowers.
11. When the machine room temperature goes below 70⁰C then LSCE will extinguish.
12. Now Open the VCB, lower the pantograph.
13. Put BL from 'C' to 'Off' and 'off' to 'D' and energize loco & resume traction.

Operation Of Reverser :

Reverser has following 3 positions.

Position 'F'	= Forward
Position 'O'	= Neutral
Position 'R'	= Reverse

Throttle and reverser are interlocked mechanically.

Driving:

1. After creating MR pressure above 6.4 kg/cm² and node information no. 570.
2. Move the reverser into desired position.
3. Release the parking brake if applied
4. Put A9 to 'RUN' position & ensure BP 5 kg/cm²
5. Check AFI is not deviating.
6. Set the TE/BE throttle to desire position.
7. Put SA9 handle to 'Release' position.
8. In order to increase adhesion and to avoid wheel slipping use sanders.
9. Bogies 1 & 2 meters will show in TE side and loco starts moving.

Braking:

1. Set the TE/BE throttle to - '0' or move towards braking side as per requirement..

2. Move A9 from 'RUN' to 'Initial Application'. If more brake force is required move the A9 handle to desire position between 'Initial Application' and ' Full Service' & vice versa gradually.
3. Regenerative Braking is possible up to 0 KMPH.
4. When train stops, apply SA9.
5. Maximum brake force is 260 KN in WAG-9/WAP-7 & 160 KN in WAP-5.

Note :- Train brakes can be applied with Regenerating brakes but Loco brake can not be applied simultaneously with Regenerating brakes.

Operation Of Throttle:

TE/BE Throttle

The TE/BE throttle controls traction and the electric braking effort of the locomotive with an angle transmitter and auxiliary contacts.

The TE/BE throttle has the following three positions:

For Traction

Position 1/3	33% tractive effort
Position 2/3	67% tractive effort
Position TE max	100% tractive effort
Position "0"	no tractive / no braking effort

For Regenerative Braking effort

Position 1/3	33% braking effort
Position 2/3	67% braking effort
Position TE max	100% braking effort

NOTE:

If TE doesn't increase beyond 300 KN in WAG-9/WAP-7 & 150KN in WAP-5 then Loco pilot should check ZTEL switch on 'A' Panel whether it is 'ON' or 'OFF', ZTEL should be kept in 'OFF'.

The % tractive/braking effort is indicated on the two-tractive/braking meters on panel A.

Failure Mode Operation

This mode allows the locomotive to operate even if the angle transmitter of the TE/BE throttle is failed. In this mode, driving and electrical braking are controlled by the auxiliary contacts on the TE/BE throttle.

Driving in failure mode

Driving in failure mode becomes necessary if the difference between auxiliary contacts and the absolute value of the angle transmitter is greater than 25% of the full range because of a defective master controller.

The following steps are initiated with a time delay of 2 sec:

1. Traction is set to 0 by the MCE.
2. A priority 2-fault message is displayed.
3. The Loco pilot must now move the rotary switch "152-Failure Mode Operation" in the machine room (SB1) into position '1'. This deactivates the angle transmitter.
4. The Loco pilot must move the TE/BE throttle into position "0".
5. The Loco pilot must acknowledge the fault message.
6. The Loco pilot can now select a new TE/BE throttle value carefully.

152 -positions.

- Position '0' - Fine control though out the range by angle transmitter.
 Position '1' - fine control in steps though auxiliary contacts.

Loco Brake Testing:

- 1) Apply loco brakes by SA-9.
- 2) Ensure that brake cylinders showing 3.5 kg / cm².
- 3) Release parking brakes and release A-9.
- 4) Operate reverser to forward.
- 5) Move throttle in traction and give 150 KN tractive effort for WAG9/WAP7 and 100 KN in case of WAP5 Locos
- 6) Loco should not move.

How To Change The Cab :**Single Unit**

1. Open 'DJ' by pressing BLDJ at 'OFF'
2. Lower the panto by pressing ZPT at 'DN'
3. Operate BL key from 'D' to 'off' and remove it.
(CE will remain ON for 10")
4. Apply loco brakes by SA-9
5. Set automatic brake controller to position 'Neutral' and then remove handle
6. Release direct brake handle.
7. Go in another cab and energize it in "Normal" way.

Note:

- * If BL key is taken 'OFF' without opening DJ and lowering panto , loco will be shutdown as emergency shutdown will initiate on loco.
- * During normal driving if BL key is kept 'OFF', emergency brakes will get applied as emergency shutdown will initiate on loco.
- * After moving the key switch 'BL' to position 'O', the MCE remains active for 10 minutes. The cab changing should take place during this time.

Multiple unit

1. Move key switch 'BL' on master locomotive into position 'Off' and remove the key.
2. Set automatic brake controller to position 'Neutral'
3. Release direct brake
4. Set the brake pipe Cock 70 to the 'Close'
Position
5. Change the loco and set the brake pipe Cock 70 to the 'Open" position on this previous slave loco.
6. Insert key in Loco pilot's cab of previous slave loco.
7. Move key switch "BL" into position "D"

Note:

The change of Loco pilot's cab has to take place within this 10 minutes period otherwise the MCE has to be restarted.

Banking Mode

When it is required to use loco as a banker i.e use of TE / BE without charging BP, at that time loco should be operate in banking mode.

Procedure:

- 1) Trip the VCB and Set switch “ZBAN” “to position “ON” (Panel A).
- 2) Close COC 70 & 136 provided on pneumatic panel.
- 3) Set up the loco in the normal manner.
- 4) BP pressure will be drop to 0, but when coupled with master loco, its BP will rush into BP pipe of this loco which will be seen in the gauge.

Note: During the Set Up, the train Loco pilot receives a priority-2 message that banking mode is active.

Constant Speed Controller:

This system enables the train to maintain a constant speed automatically and can be activated at any speed above 5 KMPH by pressing illuminated push button ‘BPCS’.

The control electronics and GTO controls the constant speed by giving tractive or braking effort to the TM as per requirement irrespective of position of throttle (ATDC-Angle transmission Loco pilot Controller) i.e. TE/BE .

The actions of CSC are cancelled in following conditions.

1. Moving of throttle.
2. Pressing ‘BPCS’ while CSC is active, lamp will extinguished.
3. Drop in ‘BP’ by 0.25 kg/cm^2 and above.
4. BC pressure more that 0.6 kg/cm^2

CSC is activated only when

1. Speed is more than 5 KMPH
2. Throttle in either TE or BE side.
3. Train Br. and loco Br. are not applied
4. BPCS is pressed once, lamp will lit.

Emergency Stop Push Button

One red colored arrow push button is provided on panel 'A' in such a place that Loco pilot as well as Asst. Loco pilot can operate it. In normal condition it remain projected out. In case of an emergency if Loco pilots/Asst. push this button, button go inside and remain pressed and following actions initiated.

1. VCB get opened.
2. TE/BE comes to '0'
3. Panto lowered
4. BP drops to 0 Kg/cm²- Train/Loco brakes applied.
5. LSF1/BPFA glow with message.

“Emergency shutdown on the loco” on screen and train will stop with emergency brakes.

Resetting:

- 1) Bring TE/BE throttle to '0'.
- 2) Press “emergency stop push button” slightly and rotate it clockwise as per arrow indication on it, the button will comes out from pressed condition.
- 3) Press BPFA and acknowledge the fault and node information will appear.
- 4) Flasher light will lit.
- 5) Energise the loco and work the train as per procedure given.

Automatic Vigilance Control System:

VCD is meant for checking and keeping the Loco pilot alert. It is a safety device. A foot switch of VCD is provided below Loco pilot's desk in each cab, also press button 'BPVG' is provided on Loco pilots' desk on Asst. side.

Loco pilot/Asst. Loco pilot is expected to activate VCD within every 60 seconds interval by one of the following way.

1. Press VCD “Foot switch” OR
2. Press BPVG (Green) OR
3. Operate throttle in TE/BE in different of more than 3% OR
4. Operate 'Sanders'.

If one of the above exercises is done, the Loco pilot is considered alert and the 60 seconds cycle get reset.

If none of the above activities are done once within 60 seconds, then buzzer will sound (546Hz) and 'LSVW' will glow for next 8 seconds.

Within these 8 second acknowledge the VCD by pressing 'vigilance footswitch' or 'BPVG', if not acknowledged, VCD will apply penalty with emergency braking (2.5 – 3.0 kg/cm²). TE/BE will become '0' & BP pressure will drop 2.5 to 3.0 kg/cm².

Note: For VCD, the speed of train should be more than 1.5 KMPH.

Dead Mans Mode:

If VCD 'Foot switch' lies remain pressed for more than 60 second, then the system will go automatically in “Dead Mans” mode, & buzzer will sound, if not released with next 8 second, VCD penalty will be applied with emergency braking. The BP will drop 2.5 to 3.0 kg/cm².

Resetting Of VCD Penalty Brakes:

1. Bring throttle to '0'
2. Wait for 160 seconds in WAG-9/WAP-7 and 120 seconds in WAP-5 without switching ON/OFF of the electronics
3. Press “BP-VR” to reset VCD, LSVW will extinguished and buzzer will stop.

4. Press and release VCD “Foot switch”.
5. Press ‘BPFA’ for acknowledging fault message.
6. MR/BP pressure would come back to normal
7. Resume ‘Normal’ traction.

Isolation Of VCD :

If Loco pilot is acknowledging VCD correctly as per procedure, but till VCD penalty is applying, in that case it is assumed that VCD is malfunctioning. In such cases stop the train, take safety measures. VCD can be bypassed by keeping switch no. 237.1 (SB-1) on ‘0’ position. Remark should be given in log book, TLC is to be informed and proceed carefully.

PASSING NEUTRAL SECTION (SU)

Before approaching neutral section:

1. Ensure that MR pressure is between 8.5 to 10 kg/cm²
2. Bring TE / BE throttle to ‘0’ gradually before 250M board.
3. At DJ open board, open DJ by BLDJ, LSDJ will glow, Aux. sound will stop, but U meter will show OHE supply.
4. At actual neutral section location, OHE meter will comes down to “0” and will shoot up when neutral section over.
5. In PTFE type neutral section, at higher speed, needle will just fluctuate.
6. At DJ close board close VCB (DJ), and resume normal traction.

In case MU operation

- The command from the master locomotive to switch the main circuit breaker “ON”, “OFF” also controls the main circuit breaker on the slave loco.
- The VCB of the slave loco is switched on after a delay of 0.5 seconds following the switch on of the master loco. When switching off, there is no delay.
- While passing neutral section follow the procedure mentioned for SU, but DJ should be closed after passing one mast after DJ close board.

For Isolation of Bogie -154 Rotary switch Bogie cut-out

Position

NORM : Traction converter-1 & 2 (All TM’s) in service

I : Traction converter-1 (TM 1-2-3 WAG-9/WAP-7) (TM1-2 WAP-5) isolated

II : Traction converter-2 (TM 4-5-6 WAG-9/WAP-7) (TM 3-4 WAP-5) isolated

I+II : Traction converter-1 & 2 (TM 1-2-3 & 4-5-6 WAG-9/WAP-7)
(TM1-2 & 3-4 WAP-5) isolated

160 Rotary switch Configuration

Position

- 1 : Normal Normal mode
0 : Shunting (Max Speed 15 KMPH) mode

Multiple Unit Operation

Multiple operation with two locomotives

In multiple operations a maximum of two locomotives can be operated. Both must be directly coupled to one another. They must not be separated by a carriage.

While in motion, the front Loco pilot's cab is usually activated.

When linking up or in unusual situations, it is also possible to control the locomotives from another Loco pilot's cab.

The train bus configuration for multiple operation is only possible from the Loco pilot's cab at the uncoupled end. A configuration from a rear Loco pilot's cab is referred to as single-unit traction. The train bus automatically checks the configuration :

The leading manned locomotive is called the master locomotive and the other one is called the slave locomotive.

The two locomotives are correctly linked together once the mechanical and pneumatic systems and the UIC cable have been connected.

Commands are transmitted down the UIC cable.

Pantograph

In multiple operation, both the most distant pantographs are raised if “pantograph selector switch” in both the locomotives are in position “AUTO”. The train bus connections define the free end of each locomotive.

The command from the master locomotive to raise/lower the pantographs also controls the pantographs on the slave locomotive.

Note : Whenever the simulation key switches on the master and slave locomotives are not in the same position, the pantograph are not active (fault message).

Main circuit breaker

The command from the master locomotive to switch the main circuit breaker “ON/OFF” also control the main circuit breaker on the slave locomotive.

The VCB on the slave locomotives is switched on after a delay of 0.5 seconds following the switch on of the VCB on the master locomotive. When switching off, there is no delay.

Note :

If the VCB on the slave locomotive cannot be closed due to a fault, an appropriate fault message appears on the screen.

Regenerative brake

During multiple operation, there is a limitation on the regenerative brake on the slave locomotive. This limitation reduces forces on the loco buffers (prevention of derailing).

Constant Speed Control (CSC)

During multiple operation, the constant speed control of the slave locomotive is inactive. The train bus transmits the selected tractive/braking effort from the master locomotive to the slave locomotive. The master loco performs speed controlling function, demanding TE/BE on master and slave loco.

Anti-spin protection

The anti-spin protection of the slave locomotive is independent of the master locomotive.

Compressor control

The compressors are able to operate in three different operating modes.

These modes can be selected with the spring-loaded switch “BLCP”, (Panel A).

- Pos. “Off” Compressor switched off.
- Pos. “Auto” Automatic pressure monitoring.
- Pos. “Man” Compressor switched on (manual monitoring).

The selected position of the compressor switch is transmitted to the slave locomotive.

In the “Main” and “Off” positions, all main compressors in both locomotives are controlled directly.

In the position “Auto”, there are the following options :

1. A main reservoir pressure below 8 kg/cm² on the master or slave locomotive activates a particular compressor on both locomotives. Each locomotive switches alternately and independently between its two compressors.
2. A main reservoir pressure below 8.5 kg/cm² on the master or slave locomotive activates all compressors on both locomotives at the same time.
3. At a main reservoir pressure below 6.4 kg/cm², each locomotive independently control its compressors.

Parking brake

The multiple unit cannot drive if one of the parking brakes is applied.

Note :

An activated parking brake on the master or slave locomotive is indicated in the activated Loco pilot’s cab of the master locomotive by the red illuminated push button “BPPB”.

Emergency Brake

An emergency brake on the slave locomotive can only be initiated in the following manner :

1. By actuating the brake handle of the automatic train brake to “Emergency” position.
2. By actuating the emergency brake Cock on the assistant Loco pilot’s side. If the pressure switch 269.1 on the master or slave locomotive registers actuation of the emergency brake, the ensuing command for emergency braking applies to both locomotives.

The master for all other emergency braking commands is the master for all other emergency braking commands is the master locomotive in the double (multiple)Unit.

Other Brake functions

If the pressure switch (269.6) registers a pressure in the brake cylinder of any bogie, and if speed exceeds 10 km/h, tractive effort is set to 0.

Note : If the electrical brake on one of two locomotives fails, the electrical brake on the other locomotive remains functional.

Coupling

1. Both locomotive must be deactivated.
The key switch must be in position “0”
2. Couple both locomotives mechanically, pneumatically and connect the UIC cable.
3. Close the isolating Cock on the brake supply line of the slave locomotive.
4. Move the key switch on the slave locomotive into position “D” and, as soon as the light test starts, turn back to position “0”. The MCE on the slave locomotive is now in self-hold mode.
5. During the self-hold mode of the slave locomotive, move key switch into Pos. “D” on the master locomotive. The control electronics starts to configure the train bus.
6. After the configuration procedure, screen on the display shows the serial numbers of the master and slave locomotives.

Example :

Train configuration Loco 31001

Note : If configuration proves impossible, (or if no locomotive is available) locomotive number 00000 appears.

If more than one Loco pilot’s cab is activated in both locomotive, one is shutdown and a corresponding message appears on the displays in both locomotives.

Uncoupling

Starting position :

Master and slave locomotives are available and both are ready.

1. Shut down both locomotives in accordance with regulations (VCB switched off, pantograph lowered).
2. Remove the UIC cable and disconnect the locomotives pneumatically and mechanically.
3. Both the locomotives are now ready for setting up as a single locomotive.

Note : If for any reason the train bus link is interrupted, or if both locomotives are set up or in motion, the system protection initiates a monitored shut down of the slave locomotive.

Reaction : The pantograph of the slave locomotive is lowered and a corresponding fault message appears on the screen of the master locomotive.

Sanding

Sanding on both locos can be initiated by the Loco pilot by pressing the sanding foot switch on the master loco.

Fire alarm

A fire detection on the slave locomotive initiates an audio signal on the master locomotive.

In addition, the VCB on the slave locomotive is switched off and a priority 1 fault message appears on the displays of both locomotives.

Trailing mode

Trailing mode means that on the master locomotive in a multiple unit no tractive effort is available, if both bogies are electrically isolated. The Loco pilot's cab of the master locomotive still controls the slave locomotive.

The status of the master locomotive is as follows :

1. VCB switched off.
2. Pantograph is lowered.
3. Train bus is working correctly.
4. Pneumatic brake system is working correctly.
5. Brakes are controlled from the master locomotive.
6. The TE/BE meters show the values for the slave locomotive.

Note : All equipments on the master locomotive are supplied by the battery and are functional for a maximum of 5 hours, if battery is fully charged.

Procedure of wheel lifting

The axle of locomotive get locked under the following circumstances:

- Traction Motor Bearing Seizure
- Traction motor suspension bearing seizure.
- Axle box roller bearing seizure.

While it may be possible to free three traction motor in case of traction motor bearing seizure, the other cases require floating / lifting of the affected wheel for movement of the locomotive. Floating / lifting of the affected wheel may become necessary in case of wheel flats & heavy skidding of wheels.

Procedure when Traction Motor Roller Bearing gets seized:

In case of traction motor roller bearing seizure, the pinion of the affected motor should be removed and all the traction motors of the affected bogie should be electrically isolated. The locomotive should be worked as light engine on its power to the nearest Electric Locomotive Shed for attention.

However, where removal of the pinion is not possible due to any reason, the locked axle should be floated following the procedure below for clearing the section.

Procedure for Floating / Lifting the Locked Axle:

In case when axle gets locked due to Axle Roller Bearing Seizure, Traction Motor Suspension Bearing Seizure, Wheel Flat or Heavy skidding of Wheels, the affected axle should be floated / lifted (depending on the axle number) after electrically isolating all the motors of affected bogie. The locomotive should be worked as a light engine on its own power with a maximum restricted speed of 25 km/h under escort by maintenance staff. In such case, a close watch is necessary while passing over curves and turnouts.

Precautions to be taken

Before attempting the lifting of locked axle of the locomotive, the steps given below should strictly be followed to avoid damage to equipment or any mishap.

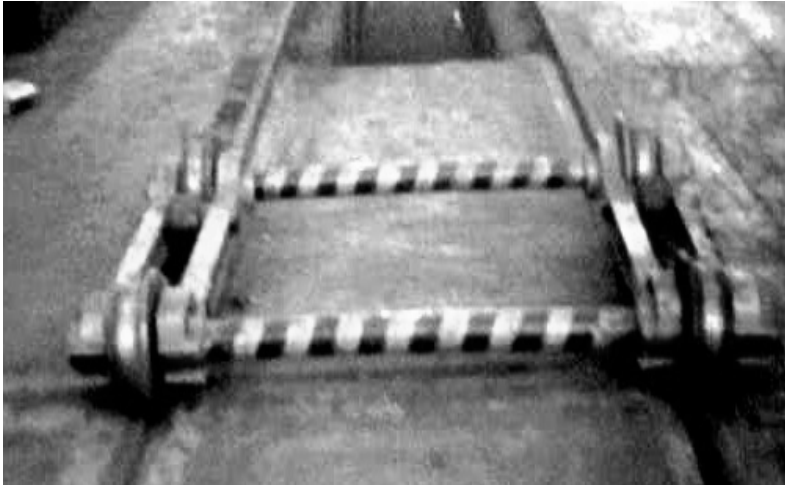
- i. Apply wooden wedges at wheels to prevent rolling of locomotive.
- ii. Release all TBUs (brakes) of the affected bogie, which requires lifting.
- iii. Before application of jacks for lifting, ensure that the ground below the lifting jacks is firm and leveled. Due care must be taken to avoid slipping of the jacks.
- iv. Isolate all the traction motors of the affected bogie.
- v. Remove all primary vertical dampers of the affected bogie to avoid their damage.
- vi. Remove links between axle box and bogie frame from middle axle of the affected bogie.

When One of the End Axles (i.e Axle Nos. 1, 3, 4 or 6) gets Locked

- i. Dismantle the slack adjuster of the locked end axle wheels.
- ii. Clamp the vertical brake hanger levers of locked axle at appropriate place with the bogie frame to prevent fouling of these levers with the wheel set trolley during movement.
- iii. Dismantle the sand box pipes. Remove footsteps, if required.
- iv. Remove the vertical dampers between the bogie frame and axle boxes of locked end axle of the affected bogie.
- v. Lift frame of the affected bogie from the end at the other side of the locked axle (e.g. from the end near axle No. 3 if axle No. 1 is locked) to obtain a clearance of 75 to 80 mm between axle box top and bottom of the bogie frame at both sides by simultaneously applying two jacks of minimum 15t capacity each below the axle guide bracket / bogie end beam.
- vi. Place the Resilient Block Between axle box top and bottom of the bogie frame at both the sides and release the jacks.
- vii. Now lift the locked end axle of the affected bogie simultaneously from both sides by applying two jacks of minimum 15t capacity each under the bogie end beam / axle guide bracket. The bogie frame should be lifted to obtain sufficient clearance between axle box top and bottom of the bogie frame at middle axle.
- viii. Place the resilient block between axle box top and bottom of the bogie frame at both the sides at middle axle location and release the jacks.
- ix. While releasing the jacks, it must be ensured that the springs are properly seated.
- x. Now, lift the locked end axle by 55 to 60 mm by simultaneously applying two jacks of minimum 15t capacity each below the axle housings at both sides.
- xi. Assemble the wheel set trolley below the locked end axle over the track in such a way that the wheels of locked axle rest over the supporting rollers. Refer procedure given below for Assembly of Wheel Set Trolley.
- xii. Sketch 4 shows the locations of the application of jacks for lifting and arrangement of wheel set trolley under the affected end axle.

- xiii. Release the jacks from both sides of the locked end axle ensuring that the defective wheels of the locked axle rest properly on the rollers of the wheels set trolley.
- xiv. Remove the wooden wedges placed at wheels of the locomotive.
- xv. Locomotive with affected wheel set placed on the wheel set trolley cleared dead at a restricted speed not exceeding 25 km/h to clear the block section.

Trolley (towing equipment)



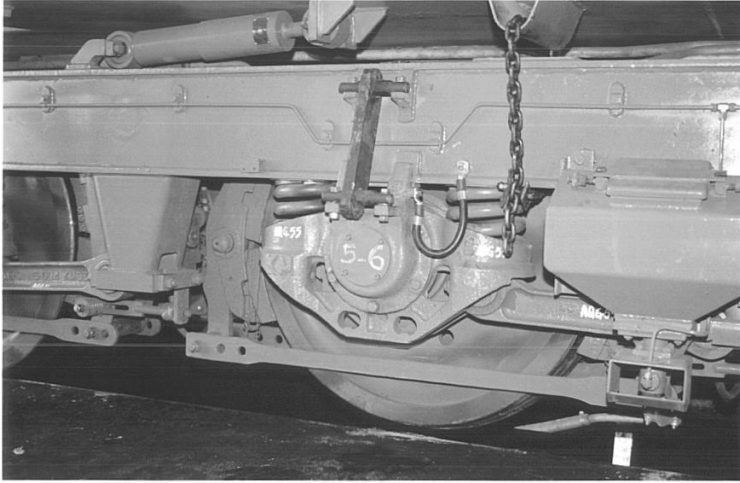
Procedure For Assembly of Wheels Set Trolley:

- i. The locked wheel set has to be lifted up approximately by 55 mm to 60 mm.
- ii. Push both the inner Longitudinal Frames of trolley under the locomotive.
- iii. Place both the steel Tubes in position.
- iv. Lift up the frame along with the steel tubes, push in and fasten the running Wheel Arrangements, Supporting Roller Arrangements .
- v. Push the outer Longitudinal Frames of the trolley under the locomotive; lift the frame, push in Outer Steel Tubes / Sleeves and fasten the frames with keys and nuts.
- vi. To facilitate easy assembly of wheel set trolley, suitable markings must be provided to identify the matching parts.
- vii. Lower the locked wheel set of the locomotive gradually on the supporting rollers.
- viii. After lowering the wheels on trolley, it is essential to ensure that the wheel flanges of the lifted wheel set are sufficiently clear from the rails, to avoid hitting / infringement during movement of the locomotive.

When Middle Axle (i.e. Axle No. 2 or 5) gets Locked:

- i. Lift the bogie frame of the affected bogie from one end by applying two jacks of minimum 15t capacity each simultaneously at both sides (RHS & LHS) below the axle guide bracket / bogie end beam to obtain a clearance of 105 to 110 mm between axle box top and bottom of the bogie frame.

Short links between axle box cover and bogie frame



- ii. Place the resilient Block at the top of the axle box in center position at both the sides (RHS & LHS) of this end axle and release the jacks gradually till the bogie frame rests on the resilient blocks. While releasing the jacks it must be ensured that the springs are properly seated.
- iii. Now lift the bogie frame of the affected bogie from the other end axle from both the sides (RHS & LHS) simultaneously by applying two jacks of minimum 15 t capacity each under the bogie end beam / axle guide bracket to obtain clearance of 105 to 110 mm between axle box top and bottom of the bogie frame at this end.
- iv. Place the Resilient Block at the top of axle box in center position at both the sides (RHS & LHS) of this end axle and release the jacks gradually till the bogie frame rests on the resilient blocks. While releasing the jacks it must be ensured that the springs are properly seated.
- v. Now, lift the locked middle axle simultaneously by applying two jacks of minimum 15t capacity each below the axle box housings at both sides (RHS &LHS).
- vi. Mount short links between axle box cover and bogie frame at both sides (RHS & LHS) using existing pins of middle axle links.
- vii. It can be seen that the wheel flanges of the affected axle are lifted approximately by 40 to 45 mm from rail level.
- viii. Remove wooden wedges placed at wheels of the locomotive.
- ix. The locomotive with effected wheel set lifted can now be moved on its own power at a restricted speed not exceeding 25 km/h to clear blocked section after isolating all the motors of the affected bogie.

DEAD LOCO MOVEMENT

(FOR DETAILS, REFER RAILWAY BOARD LETTER No. **2000 /M (L) /466/803/Pt. dated 28.06.2006**)

Hauling 3-Phase loco fitted with E-70 brake system as a dead loco.

These locomotives are fitted with electro pneumatic E-70 brake system. These locomotives in dead condition can be hauled both by locomotive fitted with IRAB-1/28LAV-1 brake system and locomotive fitted with E-70 brake system.

If these locos are coupled with conventional A.C. locos as a dead, then direct loco brake application is not possible by SA-9 since MRE & BCE can not be coupled but if BP is dropped from live loco, conjunction loco brakes application will take place in dead loco.

A) Hauling dead WAP-5/WAG-9 electric locomotive fitted with E-70 brake pipe control system in a train.

1. Switch off BLDJ and lower the pantograph of the loco to be sent as dead. Isolate the pantograph through panel isolating Cock on pneumatic panel.
2. Switch off CEL as follows:
 - a) Operate BL-key from 'D' to 'Off' (wait for 2 sec.)
 - b) Operate BL-key from 'Off' to 'C' and wait until display screen, LSDJ, and UBA goes off.
 - c) It indicates that CE is get 'OFF' and now rotate BL from 'C' to 'OFF'.
Switch off the 'circuit breaker control circuit locomotive' (112.1) in SB2 panel.
3. Couple the dead loco in the train.
4. Put auto brake controller (A9) in "Neutral" position in both cabs of dead loco.
5. Put the direct brake controller (SA9) in "Release" position in both cabs of dead locomotive.
6. Drain the Main and Aux. reservoirs of dead locomotive completely. After draining out, close the drain Cock of main reservoir and aux. reservoir.
7. If loco brake in the dead locomotive have not got released, which can be verified by observing the BC pressure gauge, then release the same in the following steps.
 - ii) Manual handle of distributor valve at pneumatic panel should be operated manually to release control pressure. BC pressure shall automatically vent through D2 relay valve to release loco brakes.
 - iii) In case residual BC pressure remains in brake cylinder line, the BC pressure should be released through bogie isolating Cock of both bogies. Make bogie-isolating Cocks in 'Normal' position after releasing the BC pressure
8. In the dead locomotive, ensure isolating Cock position in the pneumatic panel as follows. (Towed dead):

Cock	47 (Dead Engine)	74 (Emergency/ Vigilance)	136 (Brake Feed Pipe)	70 (E-70 brake pipe)
Position	Open	Closed	Closed	Closed

9. Connect BP pipe of the dead loco to the BP pipes of load and open BP angle Cock of both of loco and load side. The aux. reservoir on dead locomotive will get charged from BP supply. Check the BP pressure gauge in the cab of dead loco. It should show the same pressure as that of the load in case of load (In case of locos are to be attached on a train having twin pipe i.e. both BP and FP then FP of dead locos should also connected and its angle Cock should be opened.)
10. Release the parking brakes of dead loco by Release push button. Lock the parking brakes in release condition and ensure parking brake are released and PB gauge will show 6 Kg/Cm2. The parking brake units are fitted on the following wheels:

LOCO TYPE	WHEEL POSITION OF PARKING BRAKE UNITS			
	WAP5	1	4	5
WAG9/WAP7	2	6	7	11

11. Apply auto brakes (A9) in the working locomotive and check that loco brakes on both the locomotives are getting applied. Then release the auto brake in the working loco and check that loco brakes are getting released on both the locomotives. Rear locomotive (WAG-9 / WAP-5 dead) takes about 1 minute to release.
12. As a final check, run the coupled loco for about 500 metres and feel for any abnormal rise in temperature of wheels of dead loco and also check if at subsequent stop during journey.
13. Remember that in the dead locomotive, the loco brakes takes about 1 minute to release after auto brake application from the live loco. Hence after every auto brake application and release wait for adequate time (minimum 1 minute) for release of loco brakes in dead locomotive before resuming traction
14. After reaching the destination, before detaching the working loco,
 - a) Unlock the Release plunger of parking brake solenoid valve no. 30.
 - b) Apply parking brakes on dead locomotive by application plunger of parking brake solenoid valve no. 30.

B) Hauling dead WAP5/WAG-9 locomotive fitted with E-70 brake pipe control system when attached next to leading working locomotive:

1. Switch off BLDJ and lower the pantograph of the loco to be sent as dead. Isolate the pantograph through panel isolating Cock on pneumatic panel.
2. Switch off CEL as follows:
 - a) Operate BL-key from 'D' to 'Off' (wait for 2 sec.)
 - b) Operate BL-key from 'Off' to 'C' and wait until display screen, LSDJ, and UBA goes off.
 - c) It indicates that CE is get 'OFF' and now rotate BL from 'C' to 'OFF'.
Switch off the 'circuit breaker control circuit locomotive' (112.1) in SB2 panel.
3. Couple the dead loco in rear of the working loco.
4. Put auto brake controller (A9) in "Neutral" position in both cabs of dead loco.
5. Put the direct brake controller (SA9) in "Release" position in both cabs of dead locomotive
6. Drain the Main and Aux. reservoirs of dead locomotive completely. After draining out, close the drain Cock of main reservoir and aux. reservoir

7. If loco brake in the dead locomotive have not got released, which can be verified by observing the BC pressure gauge, then release the same in the following steps.
- Manual handle of distributor valve at pneumatic panel should be operated manually to release control pressure. BC pressure shall automatically vent through D2 relay valve to release loco brakes.
 - In case residual BC pressure remains in brake cylinder line, the BC pressure should be released through bogie isolating Cock of both bogies. Make bogie-isolating Cocks in 'Normal' position after releasing the BC pressure
8. In the dead locomotive, ensure isolating Cock position in the pneumatic panel as follows. (Towed dead):

Cock	47 (Dead Engine)	74 (Emergency/ Vigilance)	136 (Brake Feed Pipe)	70 (E-70 brake pipe)
Position	Open	Closed	Closed	Closed

9. Connect BP pipe of the dead loco to the BP pipe of working loco and open BP angle Cock of both the locos. The aux. reservoir on dead locomotive will get charged from BP supply of the working locomotive. Check the BP pressure gauge in the cab of dead loco. It should show the same pressure as that of the live locomotive (In case of locos are to be attached on a train having twin pipe i.e. both BP and FP then FP of both the locos should also connected and its angle Cock should be opened.)
10. Release the parking brakes of dead loco by Release push button. Lock the parking brakes in release condition and ensure parking brake are released and PB gauge will show 6 Kg/Cm². The parking brake units are fitted on the following wheels:

LOCO TYPE	WHEEL POSITION OF PARKING BRAKE UNITS			
WAP5	1	4	5	8
WAG9	2	6	7	11

11. Apply auto brakes (A9) in the working locomotive and check that loco brakes on both the locomotives are getting applied. Then release the auto brake in the working loco and check that loco brakes are getting released on both the locomotives. Rear locomotive (WAG-9 / WAP-5 dead) takes about 1 minute to release.
12. As a final check, run the coupled loco for about 500 metres and feel for any abnormal rise in temperature of wheels of dead loco and also check if at subsequent stop during journey.
13. . After reaching the destination, before detaching the working loco,
- Unlock the Release plunger of parking brake solenoid valve no. 30.
 - Apply parking brakes on dead locomotive by application plunger of parking brake solenoid valve no. 30.

C) Hauling dead locomotive fitted with IRAB-1/28LAV-1 brake system by WAP-5/WAG-9 locomotive

1. Set up the IRAB-1/28LAV-1 locomotives for hauling dead in normal condition.
2. Connect BP pipe of the dead loco to the BP pipes of working loco and open BP angle Cock of both of loco and load side. The aux. reservoir on dead locomotive will get charged from BP supply. Check the BP pressure gauge in the cab of dead loco. It should show the same pressure as that of the live locomotive (In case of locos are to be attached on a train having twin pipe i.e. both BP and FP then FP of both the locos should also connected and its angle Cock should be opened.)
3. Check the release of parking brakes/hand brakes of dead loco by moving the parking brake/hand brakes unit by hand and observing the clearance between the brake blocks/pads and the wheels wheel disc.
4. Apply auto brake (A9) in the working locomotive and check that loco brakes on both the locomotives are getting applied. Then release the auto brake in the working loco and check that loco brakes are getting released on both the locomotives.
5. As a final check, run the coupled loco for about 500 metres and feel for any abnormal rise in temperature of wheels of dead loco and also check if at subsequent stop during journey.
6. After reaching destination, before detaching the working loco, apply parking brake/hand brake on dead locomotive.

MICELLANEOUS

Protection of Transformer oil temperature:

1. When the transformer oil temperature exceeds 90degrees tractive effort comes to zero.
2. When the transformer oil temperature exceeds 95degrees tractive effort comes to zero and GTO stops.
3. When the transformer oil temperature exceeds 100degrees VCB opens.

LOCO GROUNDING: Loco should be grounded only while climbing loco roof to attend any trouble on loco body like removing foreign body,securing damaged pantograph etc.

PROCEDURE:

1. Stop the train at convenient place and secure the train.
2. Open VCB and lower pantograph.
3. Rotate IG-38 in anti clockwise direction and extract key.
4. Insert the key in empty socket of HOM box and rotate in clock wise direction.
5. Operate HOM handle by 180 degrees by taking it out from latch.
6. Rotate yellow KABA key in clock wise direction and extract the key and keep in personal custody.

SIMULATION MODE ACTIVATION

To activate the simulation mode, the key switch {Pos. 179} has to be in horizontal position before the battery is switched on.

Vertical position: Simulation mode off, Horizontal position: Simulation mode on

Note: It's not provided to deactivate the simulation mode (key switch back to vertical position) during the MCE (Micas control electronic) is switched on. In this case the manipulation will be ignored. The simulation mode can be used in case of earth loco and as long as the main DC link is short-circuited. Use an external battery charger, if you suppose to work longer than approx. 30 min. in simulation mode.

Turn on the MCE (Key switch {125} in Pos. Drive), The MCE starts with self-tests
After the lamp test, set-up the pan. The MCE internal catenary voltage is simulated.
Close the VCB, Set the reverser to forward or reverse. Now starts the step by step switch-on of gate unit power supplies and afterwards is following the charge up of both main DC - link.

Release of parking brake: The park brake is, but it's possible to release them simulated, because of start/running interlock in case of applied parking brake. That means, after pressing the push button release parking brake, the illuminated indication lamp of parking brake will extinguish and the start/running interlock is released. The park brake is still applied in reality !

Set the TE or BE Demand with the Throttle {Pos. 150}. The TE/BE meter's will show the simulated tractive/braking effort for each bogie, which is limited by the position of TE/BE Throttle, acceleration and speed. Constant speed control, Hotel load, Vigilance, Fire detection, Diagnostic and fault handling, Multiple operation, Failure mode operation
Simulated multiple operation via UIC-Train bus is possible up to driving/braking, if all both locos are in simulation mode. A loco or cab change in multiple operation is simulated possible.

ELECTRIC LOCO FITNESS CERTIFICATE - WAG-9

Dt. Of checking	Loco no.	Type of sch/Un-sch.	
Sl.	Nature of Test		Observation
1.	Battery:- Record the battery voltage with the switch 112.1 in machine room. Function of CPA	VCB in tripped condition ZCPA on	105 volt. (in panel "A") Wkg./N Wkg
2.	Function of Auxiliaries a) Are the main compressor wkg. b) Can the main compressor build up & maintain air pressure in the locomotive c) Is there is any abnormal sound in the Aux. d) If the answer to 2C is Yes indicate the defective Aux.	VCB closed and main compressor and other Aux. started	Yes/No Yes/No Yes/No Yes/No
3.	Pantograph By PT selector switch. a) PT-1 b) PT-2 c) PT-1 d) PT-2	From cab-1 From cab-1 From cab-2 From cab-2	Raising/N raising Raising/N raising Raising/N raising Raising/N raising
4.	Brake test on Loco:- a) Are the bogies isolating cock in normal position b) Are the brake applied normally with independent brake. c) Is the Asst. Dr. emergency brake wkg.	Loco in energized condition	YES/NO YES/NO YES/NO

<p>5.</p>	<p>Conjunction working:- a) Apply A-9 to full service position the brake cylinder pressure should not exceed 2.5Kg/CM² ., apply PVEF the loco brakes should be released. b)Apply A-9to emergency position the bake cylinder pressure should show 2.5Kg/CM² . Apply OVEF the loco brakes should not remain release.</p>	<p>Loco in energized condition</p>	<p>energized</p>	<p>Brake cylinder pressure 2.5Kg/CM² Brake cylinder pressure 2.5Kg/CM²</p>
<p>6.</p>	<p>Parking brake. Is the parking brake working</p>	<p>Loco in energized condition</p>	<p>energized</p>	<p>YES/NO(use of BPPB)</p>
<p>7.</p>	<p>Safety items a) Whistle of either cab. b) head light of either cab.(also from loading cab to rear H.light) c) Maker light/cab light and machine room light d) Cattle guard e) Screw coupling Cab-1 end f) Screw coupling cab-2 end g) Cab-1 end CBC coupler h) Cab-2 end CBC coupler i) Fire extinguisher cab-1 j) Fire extinguisher cab-2 k) Machine rook Dr.1 l) Machine room Dr.2 m) Brake sleeve rod/guide rod. n) TM gear case bolt o) Check the proper wkg and visibility of flasher light p) Check the frequency of flashing' q) Check the Auto flasher light wkg. r) Check the flasher light glass is cleaned in respect s) Check the additional BP and FP isolating cocks. t) Check for wkg. Of sanders * Special remarks if any on the condition of loco</p>	<p>Loco in energized condition</p>	<p>W/N.WK G W/N.WK G OK/N.OK OK/N.OK OK/N.OK OK/N.OK OK/N.OK OK/N.OK OK/N.OK OK/N.OK OK/N.OK OK/N.OK OK/N.OK OK/N.OK OK/N.OK</p>	<p>OK/N.OK OK/N.OK OK/N.OK OK/N.OK</p>
<p>8.</p>	<p>Oil levels a) Check the oil level of CP-1 b) Check the oil level of CP-2 c) Check the oil level of TFP (in two place)</p>	<p>Loco in de-energized condition</p>	<p>A/NA A/NA A/NA</p>	<p></p>

	d) Check the oil level of cooling unit (in 2 place)SR-1 & SR-2 e) Check the oil level of gear case (in 6 place) f) oil level of CPA		A/NA A/NA A/NA		
9.	Working of equipment /circuit a) Check the work of SPM-1 b) Check the work of SPM-2 c) Check the work of wiper in cab-1 d) Check the work of wiper in cab-2 e) Check the work of AFL f) Check the work of regenerative brake	Loco in de-energized condition	W/NW W/NW W/NW W/NW W/NW W/NW		
sl	Nature of Test	Condition	Observation	TRS remarks	TFR remarks
10.	Ensuring availability and positioning of followings a) Spare screw coupling b) Spare BP hose pipe c) 04 nos. of wooden wedges d) All the rotating switches are normal position. In SB-Switch No.152-0, 154-NORM. 160-1, 237.1-1(In sealed position). In SB-2 OCR relay target in OK condition switch No.110-ON	Loco in deenergized condition	A/NA A/NA A/NA OK/N OK		
11.	Under gear inspection ensuring the following a) All TM axle cap bolts are in sealed condition b) All TM cables are secured properly c) All air ducts are properly sealed and no air leakage in existing d) No bogie crack is existing e) All TM nose sperri block with link f) Traction link. g) Wheel set guide.	Loco in energized condition	OK/N OK OK/N OK OK/N OK OK/N OK OK/N.OK OK/N.OK		
12.	Ensure the cleanness of following a) Inside the locomotives and cab are properly cleaned. b) All the doors & shutters are in working order c) All the look out glasses, head light, flasher light, marker light glasses are properly cleaned	Loco in de-energized condition	OK/N OK OK/N OK OK/N OK		
13.	All sub system to be checked by in panel "C"	Loco in de-energized condition	OK/N OK		

The loco is now fit for traffic.	The loco is now fit for traffic
Signature of TFR:	Signature of TRS maintenance supervisor
Name:	Name:
Duty & Time	Duty & Time
Date:	Date

GENERAL CHECK FORMAT FOR-WAP-7& WAG-9

Sl.	Nature of Test	Condition	Observation
1	Battery:- Record the battery voltage with the switch 112.1 in machine room. Function of CPA	VCB in tripped condition ZCPA on	105 volt. (in panel "A") Wkg./ N Wkg
2	Function of Auxiliaries a) Are the main compressor wkg. b) Can the main compressor build up & maintain air pressure in the locomotive c) Is there is any abnormal sound in the Aux. a) If the answer to 2C is Yes indicate the defective Aux.		Yes/No Yes/No Yes/No Yes/No
3	Pantograph By PT selector switch. b) PT-1 c) PT-2 d) PT-1 e) PT-2	From cab-1 From cab-1 From cab-2 From cab-2	
4	Brake test on Loco:- a) Are the bogies isolating cock in normal position b) Are the brake applied normally with independent brake. c) Is the Asst. Dr. emergency brake wkg.	Loco in energized condition	YES/NO YES/NO YES/NO
5	Conjunction working:- a) Apply A-9 to full service position the brake cylinder pressure should not exceed 2.5Kg/CM ² ., apply PVE b) F the loco brakes should be released. b)Apply A-9to emergency position the bake cylinder pressure should show 2.5Kg/CM ² . Apply OVEF the loco brakes should not remain release.	Loco in energized condition Loco in energized condition	Brake cylinder pressure 2.5Kg/CM ² Brake cylinder pressure 2.5Kg/CM ²
6	Parking brake. Is the parking brake working	Loco in energized condition YES/NO(use of BPPB)	
7	Working of equipment :-		

	<ul style="list-style-type: none"> a) Check the working of H.L's and marker lights in cab-1&2 b) check the working of Flasher light-1&2 a) Check the work of SPM-1&2 b) Check the work of wiper in cab-1&2 e) Check the work of AFL-1&2 in simulation mode f) Check the working of TE/BE meters in cab-1&2 g) Check the work of regenerative brake in cab-1&2 h) Check the working of horns in cab-1&2 i) Check the working of cooling mode operation in Cab-1&2 j) Check the MCB's position in HB1&2 and SB1&2 panels k) Ensure no leakages in FP & BP pipes by providing dummies. 		
8	<ul style="list-style-type: none"> Oil levels a) check oil level of CP-1&2 b) check the oil level of TFP-1&2 and SR-1&2 		
9	<ul style="list-style-type: none"> Under gear inspection ensuring the following a) All TM axle cap bolts are in sealed condition b) All TM cables are secured properly c) All air ducts are properly sealed and no air leakage in existing d) No bogie crack is existing e) All TM nose spere block with link f) Condition of Traction link-1&2 g) Wheel set guide. h) Gear case oil levels and oil leakages i) Condition of Cab-1&2 CBC and working of CBC operating handles j) Condition of doors and it's locking system k) Condition of brake pull rods l) Condition of TS coupling-1&2 m) working of all 8 sanders 		
10	Verify the log book remarks and issue job cards accordingly		

Dt. Of checking	Loco no.	Type of sch/Un-sch.	Remarks
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Signature of shift supervisor

Signature of Technician(E)

Signature of Technician(M)

TI FORMAT FOR-WAP-7

Dt. Of checking | Loco no. | Type of sch/Un-sch. | Remarks

Sl.	Nature of Test	Condition	Observation
1	Battery:- Record the battery voltage with the switch 112.1 in machine room. Function of CPA	VCB in tripped condition ZCPA on	105 volt. (in panel "A") Wkg./ N Wkg
2	Roof inspection: 1) Check the roof generally for any foreign materials 2) Check the insulators visually for cracks and any flashovers 3) Check pantograph for any copper deposition, grooving of strips and proper lubrication. 4) Visually check pantograph springs and articulation and also test raising and lowering		
3	Function of Auxiliaries a) Are the main compressor wkg. b) Can the main compressor build up & maintain air pressure in the locomotive c) Is there is any abnormal sound in the Aux. f) If the answer to 2C is Yes indicate the defective Aux.		Yes/No Yes/No Yes/No Yes/No
4	Pantograph By PT selector switch. g) PT-1 h) PT-2 i) PT-1 j) PT-2	From cab-1 From cab-1 From cab-2 From cab-2	
5	Brake test on Loco:- a) Are the bogies isolating cock in normal position b) Are the brake applied normally with independent brake. c) Is the Asst. Dr. emergency brake wkg.	Loco in energized condition	YES/NO YES/NO YES/NO
6	Conjunction working:- a) Apply A-9 to full service position the brake cylinder pressure should not exceed 2.5Kg/CM ² ., apply PVEF the loco brakes should be released. b) Apply A-9 to emergency position the bake cylinder pressure should show 2.5Kg/CM ² . Apply OVEF the loco brakes should not remain release.	Loco in energized condition Loco in energized condition	Brake cylinder pressure 2.5Kg/CM ² Brake cylinder pressure 2.5Kg/CM ²
7	Parking brake. Is the parking brake working	Loco in energized condition YES/NO(use of BPPB)	
8	Working of equipment :- a) Check the working of H.L's and marker lights in cab-1&2		

	<ul style="list-style-type: none"> b)check the working of Flasher light-1&2 a) Check the work of SPM-1&2 b) Check the work of wiper in cab-1&2 e) Check the work of AFL-1&2 in simulation mode f) Check the working of TE/BE meters in cab-1&2 g) Check the work of regenerative brake in cab-1&2 h)Check the working of horns is cab-1&2 i)Check the working of cooling mode operation in Cab-1&2 j)Check the MCB's position in HB1&2 and SB1&2 pannels k) Ensure no leakages in FP & BP pipes by providing dummies. 		
9	<ul style="list-style-type: none"> Oil levels a)check oil level of CP-1&2 b)check the oil level of TFP-1&2 and SR-1&2 		
10	<ul style="list-style-type: none"> Under gear inspection ensuring the following a) All TM axle cap bolts are in sealed condition b) All TM cables are secured properly c) All air ducts are properly sealed and no air leakage in existing d) No bogie crack is existing e) All TM nose sper block with link f) Condition of Traction link-1&2 g) Wheel set guide. h)Gear case oil levels and oil leakages i)Condition of Cab-1&2 CBC and working of CBC operating handles j)Condition of doors and it's locking system k)Condition of brake pull rods l)Condition of TS coupling-1&2 m)working of all 8 sanders 		
11	Verify the log book remarks and issue job cards accordingly		

Signature of shift supervisor

Signature of Technician(E)

Signature of Technician(M)

VARIOUS MAINTENANCE SCHEDULES IN WAG 9 LOCO

IA/IB Schedules

A) LOCO BODY

1. DOORS AND STEPS

- i. Check external door locks for correct operation and for damage.
- ii. Lubricate external door hinges with general purpose oil. Wipe away excess oil from around hinges. Apply a small amount of general-purpose grease to the lock.
- iii. Examine the door seals for damage. Replace as required.

2. DRAFT GEAR AND COUPLERS

- i. Liberally apply general-purpose grease to the face of the centre buffer coupler at the end of the Locomotive.
- ii. Examine the brake hoses at the ends of the locomotive to make sure that they are not chafed or damaged. Check coupling cocks for correct operation.
- iii. Check the intactness of the CBC bottom support plate bolts.

3. BUFFERS

- i. Liberally apply general purpose to the face of the buffers at the ends of the Locomotive. Also smear grease on the buffer head plunger.

4. BODY STRUCTURE

- i. Check the body structure for damage. Repair any damage found.

5. EXTERIOR FINISH

- i. Wash the exterior of the locomotive. Remove all dirt & debris.
- ii. Louver panels:
Check the various to ensure they are cleaned & free from debris.

To remove dirt, wash vents with detergent/ water solution and

Thoroughly cleaned with a stiff, non-metallic brush.

- iii. Check and adjust, if necessary, the rail guard height.
- iv. Check cattle guard fasteners for breakage.

6. WINDOWS

- i. Clean any built up dirt and debris from the channel below the cab-sliding window. Clear the sliding window channel drains hole in the door opening.
- ii. Clean look out glass with detergent/water solution.
- iii. Examine windscreens and side windows for cracks and scratches. Renew if damaged.
- iv. Examine all windscreens and side windows for leaks. Remove wind screen/ window and re-seal, if leaks appear.
- v. Check the condition of the windscreen guard grills. Rectify any faults found. Tighten the windscreen guard grill retaining bolts.
- vi. Check the condition of the sliding window lip seal. Replace, if required.

7. TRANSMISSION

- i. Inspect the gear case box case for leakage. Check and top up if required the gearbox lubricant level.

- ii. Check tightness of gear case bolts.

8. TRACTION LINK

- i. Check the security of the safety cables.
- ii. Check the push /pull rod pivot heads for damage.
- iii. Examine the traction link assembly for signs of damage. Any defective item should be renewed.
- iv. Check the fastener at the traction ends and those retaining the traction rod for security. If a fastener loose, it must be renewed and tightened to the specified torque.
- v. DPT of flange of traction bar. (To be done by C&M Lab)
- vi. Check Aclathen ring against any crack or shifting.
- vii. Apply a film of Thiocol sealant or Groa black oil to the area between
 - The retaining plate and the pivot heads.
 - The push / pull rod and pivot head.

9. BOGIE FRAME.

- i. Check the brake rigging for loose, damaged or worn out parts. Rectify as required.
- ii. Examine the bogie frame for signs of damage.
- iii. Check all the earthing shunts provided on Bogie and body.
- iv. Check air leakage from TBU/PBU.
- v. Check intactness of axle box cover bolts.

10. WHEELSET

- a) Examine all the wheels visually for following defects.
 - i. Cracks: if any, requires replacement.
 - ii. Flats: Length 40mm or more requires re-profiling.
 - iii. Cavities: Isolated cavities of length 15mm or more or multiple cavities of length 10mm or more and less than 50mm apart require re-profile/replacement.
 - iv. Metal builds up Height 1mm. or above and length 50mm or more requires re-profiling. For length less than 50mm., remove the build up with hand tools.
 - v. Scoring and Grooving: Circumferentially around the wheel tread due to action of brake blocks require re-profile/replacement.
- b) Measure and record the wheel diameters and tread profile. Take any corrective action if required. The following limits should not be exceeded for difference in tread diameter.
 - i. Same axle : 2.5 mm
 - ii. Same bogie : 4.0 mm
 - iii. Same locomotive : 20.0 mm

11. SUSPENSION

- i. Examine the primary and secondary springs for signs of damage and cracks.
- ii. Examine different types of dampers for oil leakage and damage to the end fittings. Spheri blocks rubber components.
- iii. Check the condition of spheri blocks of primary and secondary suspension, axle guide link, traction motor and its support arm, gear case torque arm and all other spheri blocks for any sings of cracks*
- iv. Check for any crack on the axle guide link and intactness of axle guide link blot*

12. SANDING EQUIPMENTS

- i. Check and replenish if necessary the sand level in all sand boxes.
- ii. Visually check the condition and alignment of sanding pipes.
- iii. Check sanding gear for correct operation for both direction of travel.

- iv. Check exhaust nozzle for wears or damage. Replace if necessary.
- v. Inspect the sand box lid seals for wear or damage. Replace if required.
- vi. Replace lid seals, if required.

13. PANTOGRAPH

- i. Examine the entire pantograph for visible cracks. Renew any defective items.
- ii. Check that the pan head locking pins are in place and that the spring pins are secure. Check that the head moves freely on its mounting pins attached to the apex frame.
- iii. Check tightness of the shunt connection screws. Check all shunts for frayed strands and renew any shunt in which 25% or more of the strands are frayed.
- iv. Raise and lower the pantograph, visually checking for any misalignment or excessive friction in the bearings.
- v. Clean foot mounting insulators. Apply specified grease and polish with a soft lint free cloth.
- VI. Static balancing tests to be carried out.

14. ROOF EQUIPMENT

- i. Examine the insulator for cracks, burning and damage. Renew defective item.
- ii. Clean the porcelain insulators. Apply specified grease and polish with a soft lint free cloth.
- iii. Examine the roofline conductors for defects/looseness.
- iv. Examine the roof isolation switch for signs of defect.
- v. Clean the roof voltage transformer insulator. Apply specified grease and polish.
- vi. Clean the surge arrester. Examine the damage, cracks etc. Renew if damaged.
- vii. Check the tightness of roof bolts and roof joint support clamp.

15. BRAKE -RIGGING

- i. Check the brake rigging for loose, damaged, or worn parts. Rectify as required.

16. BRAKE BLOCK

- i. Inspect the brake blocks for wear. When the block is below the minimum limit, replace the complete locomotive set.
- ii. Check the brake block key security.

17. BATTERIES AND BATTERY BOX

- i. Visually inspect the battery box for any external hits and damages. If required-repair.
- ii. Check the integrity of the welding of the hanging supports.
- iii. Check electrolyte and top up when necessary to prevent level dropping below.
- iv. Remove any dirt deposits or electrolyte spilling from around batteries and connections and apply petroleum jelly to terminals.
- v. Check tightness of electrical connections and apply white petroleum jelly.
- vi. Check the following:
 - Specific gravity of electrode.
 - Individual cell voltage.

18. BLINDS

- i. Clean the blind material.

19. LIGHTING UNITS

- i. Check lighting units for physical damage, tightness of fixings and connections, particularly look for signs of overheating or burning. Replace bulbs/ tubes, which have failed.
- ii. Clean all internal light unit diffuses, bulbs or tubes and reflectors.

20. DRIVERS DESK

- i. Clean the surfaces of the driver's desk with a soap solution and cloth, taking care not to allow water to enter electrical cubicles.

Buzzer: Clean the dust filter on the buzzer using a soft brush without using the pressure / compressed air.

- ii. Check the switches, lamps and gauges on driver's desk, their tightness and clean.

21. CAB FLOOR

- i. Clean the cab floor with a suitable cleaning agent.

22. OIL LEAKAGE IN MACHINE ROOM / CLEANING OF MACHINE ROOM.

- i. Visually inspect the machine room for any signs oil leakage from traction converter, transformer, D.C. Link, and series resonant circuit capacitors and other electrical equipment and carefully clean the same.
- ii. Clean the complete machine room with the air pressurized supply and vacuum cleaner to remove all the dust particles.
- iii. Clean fire detection pipeline holes.

23. TRACTION CONVERTER

- i. Check the oil level indicator situated on the conservator (Expansion Tank). If the oil is below the minimum mark-top up with the specified oil. Check for any signs of leakage.
- ii. Visually examine Oil pipe joints for leaks, loose or missing screws and correct as necessary.
- iii. Examine the two flange joints for leaks, loose or missing screws. Check gaskets/oil seals, if dismantling is required. Check that the radiator is not blocked.
- iv. Examine all electrical equipment of traction converter for signs of dirt, corrosion, damage etc. Remove all dust/dirt deposits from the connection insulators.
- v. Check the cable connection of Sicem connectors of differential amplifier provided below SR oil pump.

24. AUXILIARY CONVERTER (Do not open the cover)

- i. Visually Inspect cubicle with respect to mechanical and electrical integrity. Check all fixings for security and tightness.
- ii. Auxiliary DC link capacitor bank: Remove dust deposits on the terminal insulators of the capacitors by blowing brushing with a metallic brush or by rubbing with cloth.

25. FIRE DETECTION UNIT (FDU)

- i. Clean FDU and clean pipeline by blowing.

B) Eqpt :- DJ/TFP/SR/Harmonic Filter

1. VCBDJ

a. Insulator

- i. Check for cracks & flash marks.
- ii. Clean any parts that are dirty with soft, clean & dry cloth (Do not use cleaning products based on fluorated or chlorate compounds or sodium metasilicate).

b. Connection for Earthing Isolator.

- i. Check for damage to connection of the earthing isolator.
- ii. Cleaning & greasing, oil if necessary.

c. H.V. Connection.

- i. Check door latches / locks for correct operation and damage.

d. VCB fixing Screw.

- i. Check the torque of fixing screw tightening torque 70Nm.

e. Earthing Connection.

- i. Check the earthing connection tightening torque 70Nm.

f. Pressure Regulator.

- i. Drain the pressure regulator.
- g. Air Tank (Reservoir)**
 - i. Drain the air tank.
 - ii. Check for any air leakage.
- h. Pneumatic Circuit.**
 - i. Check the sealing of connectors, flexible pipe, regulator, air tank etc.

2. MAIN TRANSFORMER

- i. Read off the oil level on the gauge situated on the conservator. Top up the oil as necessary and check for any signs of leakage.
- ii. Inspect the colour of the silica gel. If it is pink, remove the filter from the locomotive.
- iii. Dry the silica gel in oven at 150 degree C and replace.
- iv. Prismatic level gauge-clean the gauge with a dry cloth and check for leaks.
- v. Examine the flanges of the pipe couplings and flexible hose that link the transformer and conservator.
- vi. Check visually the foundation bolts of transformer and Nylock nuts, for proper locking.
- vii. Check the condition of earthing shunts of transformer body.
- viii. DGA of transformer oil (To Be done by C&M Lab)
- ix. Visually inspect & clean the electrical connection to the insulator and condition of insulator for crack.
- x. Visually inspect the condition of oil cooling metallic pipes, check for leakage / damage & check all fixing clamps.

3. HARMONIC FILTER

- i. Examine the roof-mounted resistor for any signs of damage and clean debris away from the resistor.
- ii. Check electrical connections are secure.
- iii. Visually inspect the contact tips for signs of arcing damage. Repair / Replace the Defective parts.

4. TRACTION CONVERTER

- i. Check BDV of traction converter oil.
- ii. Carry out DGA of traction converter oil. (To Be done by C&M Lab)

C) Eqpt: – TRACTION MOTOR

- i. Examine all traction motors for signs of damage caused by ballast. Check air outlets are not obstructed in any way.
- ii. Check traction power cables, speed sensor and temperature sensor cables are not chafed or damaged in any way.
- iii. To check the condition of bearing by seeing if any grease comes out from grease inlet. Check the condition of grease too.
- iv. Check grease nipple on DE & NDE sides.
- v. Check for oil falling on TM from under frame.
- vi. Check for proper tightness of cable with Din Rail for cable connection and tie up with Cotton Tape for additional protection.
- vii. Check the earthing connection with TM body and earthing screw.

D) Eqpt:- AUXILIARY MOTORS**I. Main Compressor**

1. Clean the compressor externally by Compressed air.
2. Check visually for any damages, oil leakage & overheat marks.
3. Clean suction Air filter by compressed air.
4. Clean Airflow path, Inter / after cooler by compressed air.
5. Check condition of and replace if required for SAB WABCO CP.
Change oil for Knorr / Elgi CPs.
6. Check tightness of foundation bolts, Anti vibration rubber pads, all bolts of mounting brackets, Inter, After cooler mounting bolts.
7. Check tightness of Nut bolts of all Guards of CP. Check Fan.
8. Visually check for any cracks on Main foundation brackets of CP.
9. Clean Breather valve Assly, if Elgi CP.
10. Check tyre coupling and it's tightness for Elgi CP. (Torque 32 N-m)

II. CPA + MCPA

1. Clean the CPA externally.
2. Clean Suction Air filter.
3. Check oil level and condition of oil.
4. Clean commutator. Check carbon brush pig tails Holder and spring.
5. Check connection tightness.
6. Check tightness of all nut bolts, foundation bolts.

III. All Aux. Motors

1. Check tightness of foundation bolts of all motors.
2. Check freeness of Rotor of all four scavenge blowers after Checking of foundation bolts.
3. Clean and visually check impellers of TMB, OCB, MRB and check against any crack by DPT.
4. Check tightness of SB and cable connections at Terminal Box
5. Provide RTV on MCP Terminal Box at cable entry point and cover.
6. Provide RTV on OCB Terminal Box at cable entry point and cover.
7. Check the condition of flexible hose between SCMRB and filter.
8. Check the condition of hoses of oil blower filter to SCTM.
9. Current, vibration and air velocity measurements of OCB, TMB to be done.

E) Eqpt :- PNEUMATIC

1. BOGIE FRAME; Check the pneumatic systems for leakage.
2. BRAKE RIGGING; Check the pneumatic system for leaks.
3. AIR DRYER
 - i. Check humidity indicators are showing blue, indicating dry air. White indications means the air dryer is not operating effectively.
 - ii. Replace desiccant if found to be contaminated with either water or oil.
 - iii. Test air dryer for correct operation.
4. AUTO DRAIN VLAVE
 - i. Check the operation of the valve.

5. DRIVERS BRAKE CONTROLLER ; Test for correct operation.
6. DIRECT BRAKE VALVE
 - i. Test for correct operation..
7. BRAKE CYLINDER ACTUATOR
 - i. Test for the correct operation of the unit.
8. PNEUMATIC PANEL
 - i. Visually inspect the brake frame noting any sign of air leakages and rectify for accordingly.
 - ii. Check the operation of the parking brake.
9. BRAKE ISOLATING COCKS
 - i. Check for correct operations.
10. EMERGENCY EXHAUST VALVE
 - i. Test for correct operation.
11. WIPERS
 - i. Check the operation of the windscreens wipers using the manual handles. Rectify any faults found.
12. BRAKE ELECTRONICS
 - i. Check the tightness of the brake electronics control cards holding screws.

F) Eqpt :- SPM

1. SPEEDO METER

- i. Check & adjust wheel dia setting accordingly to wheel dia.
- ii. Check the clock time & adjust, if necessary.
- iii. Ensure proper clamping of PG cable, maintaining adequate sag.
- iv. Attend the bookings, if any.
- v. Change the packing ring whenever PG cover is opened.

INSP							
Check List For Measurement Of Wheels & Tyre Of WAG-9							
Loco No.:							
Type OF Inspection:							
Date:							
Wheel No.	Bogie No.	Flange Thickness: Min.29 mm, Max.32 mm Flange wear: Max.3 mm	Root wear at flange : Max. 6mm	Flat wear: Max 6.5 mm	Tread Dia. 1092 mm 1016 mm	Condition of Tyre 1. Good, 2. Dull sound, 3. Cracked, 4. Skidded, 5. Proud Metal,	Remarks
1							

IC Schedule

A) Eqpt :- LOCO BODY

1. DOORS AND STEPS

- i. Check external door locks for correct operation and for damage.
- ii. Lubricate external door hinges with general-purpose oil. Wipe away excess oil from around hinges. Apply a small amount of general-purpose grease to the lock.
- iii. Examine the door seals for damage. Replace as required.

2. DRAFT GEAR AND COUPLERS

Liberally apply general-purpose grease to the face of the centre buffer coupler at the end of the Locomotive.

Examine the brake hoses at the ends of the locomotive to make sure that they are not chafed or damaged. Check coupling cocks for correct operation.

Check the intactness of the CBC bottom support plate bolts.

Check knuckles against crack by **DPT (To be done by C&M Lab)**

3. BUFFERS

Liberally apply general purpose to the face of the buffers at the ends of the Locomotive. Also smear grease on the buffer head plunger.

4. BODY STRUCTURE

Check the body structure for damage. Repair any damage found.

5. EXTERIOR FINISH

Wash the exterior of the locomotive. Remove all dirt & debris.

Louver panels:

Check the various to ensure they are cleaned & free from debris.

To remove dirt, wash vents with detergent/ water solution and

Thoroughly cleaned with a stiff, non-metallic brush.

Check and adjust, if necessary, the rail guard height.

Check cattle guard fasteners for breakage.

6. WINDOWS

Check any built up dirt and debris from the channel below the cab sliding window. Clear the sliding window channel drains hole in the door opening.

Clean look out glass with detergent/water solution.

Examine windscreens and side windows for cracks and scratches. Renew if damaged.

Examine all wind- screens and side windows for leaks. Remove wind screen/ window and re-seal, if leaks appear.

Check the condition of the windscreen guard grills. Rectify any faults found. Tighten the windscreen guard grill retaining bolts.

Check the condition of sliding window lip seal. Replace, if required.

7. TRANSMISSION

Inspect the gear case box case for leakage. Check and top up if required the gearbox lubricant level.

Check the tightness of gear case bolts.

8. TRACTION LINK

i. Check the security of the safety cables.

ii. Check the push /pull rod pivot heads for damage, condition of Aclathen Ring against any shifting.

- iii. Examine the traction link assembly for signs of damage. Any defective item should be renewed.
- iv. Check the fastener at the traction ends and those retaining the traction rod for security. If a fastener loose, it must be renewed and tightened to the specified torque.
- v. Check traction rod flange against crack by DPT. (To be done by C&M Lab)
- vi. Inspect the safety cables, pins and R-clips for wear and damage.
- vii. Check aclathen ring against any crack or shifting.
- viii. Apply a film of Thiocol sealant or Groa black oil to the area between
 - The retaining plate and the pivot heads.
 - The push / pull rod and the pivot head.

9. **BOGIE FRAME.**

Check the brake rigging for loose, damaged or worn out parts. Rectify as required.

Examine the bogie frame for signs of damage.

Examine all body-mounted equipments (Including earthing straps) for signs of damage and security of fastening. All faults must be rectified.

Inspect the rubber bumps for damage deterioration. Replace, if required.

Check the earthing shunts provided on bogie and body.

Check intactness of axle box cover bolts.

Check the pneumatic system for leakage.

10. **WHEEL SET**

Examine all the wheels visually for following defects.

- i. Cracks: if any, requires replacement.
- ii. Flats : Length 40mm or more requires re-profiling.
- iii. Cavities: Isolated cavities of length 15mm or more or multiple cavities of length 10mm or more and less than 50mm apart require re-profile/replacement.
- iv. Metal builds up Height 1mm. or above and length 50mm or more requires re-profiling. For length less than 50mm., remove the build up with hand tools.
- v. Scoring and Grooving: Circumferentially around the wheel tread due to action of brake blocks require re-profile/replacement.

Measure and record the wheel diameters and tread profile (at PWL.) Take any corrective action if required. The following limits should not be exceeded for difference in tread diameter.

Same axle: 2.5 mm

Same bogie: 4.0 mm

Same locomotive: 20.0 mm

Disconnect the electrical cable from the earth return unit. Remove the earth return unit from the axle.

Examine the bearings and rear sealing position for signs of grease leakage or deterioration.

Check the axle for any cracks with the help of ultrasonic flaw detector.

Check the earth brushes length and replace, if required.

11. **TRACTION MOTOR**

- i. Check the match mark on the support arm to traction motor balls. Tighten the balls to specification, if loose.
- ii. Check the condition of traction motor spheri blocks. Replace if worn, cracked, damaged or showing signs of deterioration to either the rubber or metal.
- iii. Open TM junction box at body side and check the tightness of connections.

12. SUSPENSION

- i. Examine the primary and secondary springs for signs of damage and cracks.
- ii. Examine different types of dampers for oil leakage and damage to the end fittings. Spheriblocks rubber components.
- iii. Check the condition of spheriblocks of primary & secondary suspension axle guide link, traction motor and its support arm, gear case torque arm and all other spheriblocks for signs of any cracks.
- iv. Check for any crack on the axle guide link and intactness of axle guide link bolt.

13. SANDING EQUIPMENTS

- i. Check and replenish if necessary the sand level in all sand boxes.
- ii. Visually check the condition and alignment of sanding pipes.
- iii. Check sanding gear for correct operation for both direction of travel.
- iv. Check exhaust nozzle for wears or damage. Replace if necessary.
- v. Inspect the sand box lead seals for wear or damage. Replace if required.
- vi. Replace lid seals.

14. PANTOGRAPH

- i. Examine the entire pantograph for visible cracks. Renew any defective items.
- ii. Check that the pan head locking pins are in place and that the spring pins are secure. Check that the head moves freely on its mounting pins attached to the apex frame.
- iii. Check tightness of the shunt connection screws. Check all shunts for frayed strands and renew any shunt in which 25% or more of the strands are frayed.
- iv. Raise and lower the pantograph, visually checking for any misalignment or excessive friction in the bearings.
- v. Check and adjust the contact force with the help of 7 kg mass.
- vi. Lubricate all grease points using grease gun.
- vii. Clean foot mounting insulators. Apply specified grease and polish with a soft lint free cloth.
- viii. Static balancing tests to be carried out.

15. ROOF EQUIPMENT

- i. Examine the insulator for cracks, burning and damage. Renew defective item.
- ii. Clean the porcelain insulators. Apply specified grease and polish with a soft lint free cloth.
- iii. Examine the roofline conductors for defects/looseness.
- iv. Examine the roof isolation switch for signs of defect.
- v. Clean the roof voltage transformer insulator. Apply specified grease and polish.
- vi. Clean the surge arrester. Examine the damage, cracks etc. Renew if damaged.
- vii. Check the tightness of roof bolts and roof joint support clamp.
- viii. Potential transformer secondary connection to be checked after opening cap.

16. MACHINE ROOM BLOWER FILTER

Remove the fly screen and louvers and clean them. Rectify any fault found.

17. BRAKE -RIGGING

Check the brake rigging for loose, damaged, or worn out parts. Rectify as required.

18. BRAKE BLOCK

- i. Inspect the brake blocks for wear. When the block is below the minimum limit, replace the complete locomotive set.
- ii. Check the brake block key security.

19. LIGHTING UNITS

- i. Check lighting units for physical damage, tightness of fixings and connections, particularly look for signs of overheating or burning. Replace bulbs/ tubes, which have failed.
- ii. Clean all internal light unit diffusers, bulbs or tubes and reflectors.

20. DRIVERS DESK

- i. Clean the surfaces of the driver's desk with a soap solution and cloth, taking care not to allow water to enter electrical cubicles.
Buzzer: Clean the dust filter on the buzzer using a soft brush without using the pressure / compressed air.
- ii. Ensure that transparent rubber caps provided over the push buttons of driver desk.
- iii. Check the switches, lamps and gauges on driver's desk, their tightness and clean.

21 CAB FLOOR

- i. Clean the cab floor with a suitable cleaning agent.

22. OIL LEAKAGE IN MACHINE ROOM / CLEANING OF MACHINE ROOM.

- i. Visually inspect the machine room for any signs oil leakage from traction converter, transformer, D.C. Link, and series resonant circuit capacitors and other electrical equipment and carefully clean the same.
- ii. Clean the complete machine room with the air pressurized supply and vacuum cleaner to remove all the dust particles.
- iii. Clean fire detection pipeline holes.
- iv. Ensure the intactness / firmness of cable connection of Sicem couplers of differential amplifiers provided below SR oil pump.

23. TRACTION CONVERTER

- i. Check the oil level indicator situated on the conservator (Expansion Tank). If the oil is below the minimum mark-top up with the specified oil. Check for any signs of leakage.
- ii. Visually examine Oil pipe joints for leaks, loose or missing screws and correct as necessary.
- iii. Examine the two flange joints for leaks, loose or missing screws. Check gaskets/oil seals, if dismantling is required. Check that the radiator is not blocked.
- iv. Examine all electrical equipment of traction converter for signs of dirt, corrosion, damage etc. Remove all dust/dirt deposits from the connection insulators.
- v. Check the cable connection of Sicem connectors of differential amplifier provided below SR oil pump.
- vi. Check the differential amplifier connection near SR & cable condition.

24. AUXILIARY CONVERTER

Inspect cubicle with respect to mechanical and electrical integrity. Check all fixings for security and tightness.

Check all wirings are secured and insulations are not damaged, burnt or eroded. Visually inspect all components for physical damage.

Auxiliary phase reference transformer: Clean all dirt and dust deposit from the terminal side of the phase reference transformer. Cleaning is by means of blowing out bushing off with a non-metallic brush or by rubbing with a cloth.

Aux. Surge Arrestor: Remove all dirt and dust deposits on the insulator by blowing or bushing off with a non-metallic brush or by rubbing with a cloth.

Auxiliary rectifier (CG module): Check the security of bolted terminals and mechanical mounting of larger components. Remove dirt from insulating and heat convention surfaces.

Auxiliary Inverter (WRE module): Check the security of bolted terminals and mechanical mounting or larger components. Remove dirt from insulating and heat convention surfaces.

Check the contacts of all modules and ensure proper tightness in case of bolted arrangement as per Action Plan.

24 A. MAIN ASSEMBLY BOX-1 & BOX-2

- i. Clean the dust of enclosure using vacuum cleaner.
- ii. Check the connections for 25, 50 & 70 Sq. mm cables for their tightness.
- iii. Tightness of knife contact connections (female).
- iv. Check the metallic strip provided for spring action in the contact is intact. Replace the contact if required.
- v. 3-phase choke connection.
- vi. Power contactor connection.

24 B. CAPACITOR BANK

Remove the bank from the box & do the following.

- i. Clean the deposited dust from bank.
- ii. Tighten the capacitor-mounting nut (M12).
- iii. Tighten the capacitor termination on bus bar.
- iv. Check no excessive tension of terminals of capacitor or breakage of terminal.
- v. Check there are no cracks on the gasket around capacitor. (Replace every 3 years by new gasket).
- vi. If one capacitor found damage, replace it alongwith its series capacitor.
- vii. Check no cracks on body of voltage equilising register and connections are intact. (Replace in case of crack found)

24 C. WRE & GG BATTERY CHARGER MODULE.

- i. Clean the dust from the module.
- ii. Check cable connections of devices does not touch metallic part of the module (clamp). Tie them if required.
- iii. Tightness of Male contacts.
- iv. Gasket of Module does not have any cracks. (Replace every 03 years.)

24 D. ELECTRONIC RACK

- i. Clean the dust by vacuum cleaner.
- ii. Check the tightness of connections.
- iii. Check the power supply for any hot spot or puncture of Electrolyte capacitor. (Replace if leakage observed.)

24 E. SURGE ARRESTER

Tighten the Surge Arrester.

25. BATTERY CHARGER ; Removed dirt particles from heat transfer faces, electrical connections and Insulations material.

26. INTERNAL DOORS

Lubricate machine room hinges with general-purpose oil. Wipe away excess oil from around hinge.

27. INTERNAL DOOR LATCHES

Check door latches / locks for correct operation and damage.

28. CUBICLE DOOR LOCKS

Check all security locks are effective, clean Kaba locks using specified cleaner.

29. SEAT

Examine all components for wear, looseness, scoring and cracks. Renew any defective components.

Check seat-mounting points for integrity and ensure fixings are fully tightened.

30. BATTERY BOX

- i. Visually inspect the battery box for any external hits and damages. If required- repair.
- ii. Check the integrity of the welding of the hanging supports.
- iii. Lubrication of rolling arrangements of battery box.
- iv. Check front battery box bracket against crack by DPT. (to be done by C&M).

B) Eqpt:- VCB/TFP/Harmonic Filter/SR**1. HARMONIC FILTER**

Examine the roof-mounted resistor for any signs of damage and clean debris away from the resistor.

Check electrical connections are secure.

Visually inspect the contact tips for signs of arcing damage. Repair/Replace the defective parts.

2. VCB**Insulator**

- i. Check for cracks & flash marks.
- ii. Clean any parts that are dirty with soft, clean & dry cloth (Do not use cleaning products based on fluorated or chlorate compounds or sodium metasilicate).

Connection for Earthing Isolator.

Check for damage to connection of the earthing isolator.

Cleaning & greasing, oil if necessary.

H.V. Connection.

Check door latches / locks for correct operation and damage.

VCB fixing Screw.

- i. Check the torque of fixing screw tightening torque 70Nm.

Earthing Connection.

- i. Check the earthing connection tightening torque 70Nm.

Pressure Regulator.

- i. Drain the pressure regulator.

- ii. Check and set value of the regulator.
- iii. Change the complete pressure regulator.
- iv. Change the complete pressure regulator.

Air Tank (Reservoir)

- i. Drain the air tank.
- ii. Check for any air leakage.

Pneumatic Circuit.

- i. Check the sealing of connectors, flexible pipe, regulator, air tank etc.

Shock Absorber.

Check the tightness of shock absorbers. If found loose tighten with proper torque (10Nm).

3. MAIN TRANSFORMER

- xi. Read off the oil level on the gauge situated on the conservator. Top up the oil as necessary and check for any signs of leakage.
- xii. Inspect the colour of the silica gel. If it is pink, remove the filter from the locomotive.
- xiii. Dry the silica gel in oven at 150 degree C and replace.
- xiv. Prismatic level gauge-clean the gauge with a dry cloth and check for leaks.
- xv. Examine the flanges of the pipe couplings and flexible hose that link the transformer and conservator.
- xvi. Perform the sample test on transformer oil. Check specific value of BDV and moisture, acidity & DGA. (To be done by C&M Lab)
- xvii. Check visually condition of foundation bolts of transformer and Nylock nuts for proper locking.
- xviii. Check the condition of earthing shunts of transformer body.
- xix. If BDV value falls below 40KV/ DGA gases more, oil centrifuging to be done.
- xx. Visually inspect & clean the electrical connection to the insulator and condition of insulator for crack.
- xxi. Visually inspect the condition of oil cooling metallic pipes, check for leakage / damage & check all fixing clamps.

4. OIL COOLING UNIT RADIATOR

Remove all dust, dirt and debris from the radiator chamber via the machine room access cover (By using vacuum cleaner).
Clean radiator with water jet.

5. TRACTION CONVERTER

- i. Check BDV of traction converter oil.
- ii. Carry out DGA of traction converter oil. (To Be done by C&M Lab)

C: Eqpt :- TRACTION MOTOR

Examine all traction motors for signs of damage caused by ballast. Check air outlets are not obstructed in any way.

Check traction power cables, speed sensor and temperature sensor cables are not chafed or damaged in any way.

To check the condition of bearing by seeing if any grease comes out from grease inlet. Check the condition of grease too.

Open TM junction box at TM side and check the tightness of connections.

Check TM junction box at TM side for water ingress.

Lubricate the traction motor bearing using a grease gun with specified grease.

Check grease nipple on DE & NDE sides.

Check for oil falling on TM from under frame.

Check for proper tightness of cable with Din Rail for cable connection and tie up with Cotton Tape for additional protection.

Check the earthing connection with TM body and earthing screw.

Check for winding of DE side from air inlet of DE side.

Check tightness of screws of DE & NDE End frame.

Before greasing open NDE Speed enclosures cover & give grease sample to lab for ferrous contact checking.

Check IR value of TM in all the phase after removing cable.

Check the resistances of winding (U, V, W) and record it.

Check proper connections of Sub-D of temperature sensor and speed sensor in under frame.

D) **Eqpt:- AUXILIARY MOTOR**

I. **Main Compressor**

1. Clean the compressor externally by Compressed air.
2. Check visually for any damages, oil leakage, overheat marks.
3. Clean suction Air filter by compressed air.
4. Clean Airflow path, Inter / After cooler by compressed air.
5. Change oil as follows:

Sab Wabco - Shell corena P-100

Knorr / Elgi - SP --150

Check tightness of foundation bolts, Anti vibration rubber pads, all bolts of mounting brackets, Inter, After cooler mounting bolts.

Check tightness of Nut bolts of all Guards of CP. Check Fan.

Visually check for any cracks on Main foundation brackets of CP.

Clean Breather valve Assly, if Elgi CP.

Check tyre coupling and it's tightness for Elgi CP. (Torque 32 N-m)

Clean crankcase Breather.

DPT of CP Main foundation bracket. (To be done by C&M lab)

II. **CPA + MCPA**

Clean the CPA externally.

Clean Suction Air filter.

Check oil level and condition of oil.

Clean commutator. Check carbon brush pig tails Holder and spring.

Check connection tightness.

Check tightness of all nut bolts, foundation bolts.

III. All Aux. Motors

Check tightness of foundation bolts of all motors.

Check freeness of Rotor of all four scavenge blowers after

Checking of foundation bolts.

Clean and visually check impellers of MVMT, OCB, MRB and check against any crack by DPT.

Check tightness of SB and cable connections at Terminal Box

Provide RTV on MCP Terminal Box at cable entry point and cover.

Provide RTV on OCB Terminal Box at cable entry point and cover.

Greasing of all motors with RR-3 (Servo Gem Grease).

Check the condition of flexible hose between SCMRB and filter.

Check the condition of hoses of oil blower filter to SCTM.

Current, vibration and air velocity measurements of OCB, TMB to be done.

E) Eqpt :- PNEUMATIC

1. **BOGIE FRAME**

- i. Check the pneumatic systems for leakage.

2. **AIR DRYER**

- i. Check humidity indicators are showing blue, indicating dry air. White indications means the air dryer is not operating effectively.
- ii. Replace desiccant if found to be contaminated with either water or oil.
- iii. Test air dryer for correct operation.

3. **AUTO DRAIN VALVE** :Check the operation of the valve.

4.**DRIVERS BRAKE CONTROLLER** :Test for correct operation.

5.**DIRECT BRAKE VALVE**:Test for correct operation.

6. **BRAKE CYLINDER ACTUATOR**: Test for the correct operation of the unit.

7. **PNEUMATIC PANEL**

Visually inspect the brake frame noting any sign of air leakages and rectify for accordingly.

Check the operation of the parking brake.

8. **BRAKE ISOLATING COCKS**

Check for correct operations.

9. **EMERGENCY EXHAUST VALVE**.Test for correct operation.

10. **PRESSURE REGULATOR**

Check the pressure regulator operates correctly Test for correct operation.

11. **WIPERS** : Check the operation of the windscreen wipers using the manual handles. Rectify any faults found.

12. **BRAKE ELECTRONICS**

- i. Check the tightness of the brake electronics control cards holding screws.

F) Eqpt :- SPM/BATTERY

1. BATTERIES AND BATTERY BOX

- i. Check electrolyte and top up when necessary to prevent level dropping below Top of plates.
 ii. Remove any dirt deposits or electrolyte spilling from around batteries and Connections and apply lubricant to terminals.
 iii. Check the following
 a. Specific gravity of electrolyte
 b. Individual cell voltage
 iv. Check tightness of electrical connections and apply white petroleum jelly.
 iv. Clean the battery acid from the battery box and tray.

2. SPEEDO METER

Check & adjust wheel dia setting accordingly to wheel dia.

Check the clock time & adjust, if necessary.

Ensure proper clamping of PG cable, maintaining adequate sag.

Attend the bookings, if any.

Change the packing ring whenever PG cover is opened

Calibrate master and slave unit.

3. FIRE DETECTION UNIT

- i. Calibrate the unit & put up the value in between zero volts to ± 100 mV for Trolex make and between zero volts to ± 50 mV for Siemens/ Cerberus make.

INSP Check List For Measurement Of Wheels & Tyre Of WAG-9								
Loco No.:								
Type OF Inspection:								
Date:								
Wheel No.	Bogie No.	Flange Thickness Min.29 mm, Max.32 mm Flange wear: Max. 3 mm	Root wear at flange Max. 6mm	Flat wear Max 6.5 mm	Dist. Between wheel faces 1596 ± 0.5 mm	Tread Dia. 1092 mm 1016 mm	Condition of Tyre 1. Good, 2. Dull sound, 3. Cracked, 4. Skidded, 5. Proud Metal,	Remarks
1								
2								

INSP	Check List For Body And Bogie Alignment (WAG-9)														
Loco No:															
Type of inspection:															
Date:															
Buffer center to rail level Height =1100 + 5 mm, - 10 mm Condemned limit = 1030 mm				Rail guard to rail level Height = 102 mm to 119 mm				Y) Sanding nozzle height from rail 28 to 32 mm X) Distance to inner wheel flange 68 to 72 mm.							
H1	H2	H3	H4	1	2	3	4	1	2	3	4	5	6	7	8
								Y=	Y=	Y=	Y=	Y=	Y=	Y=	Y=
								X=	X=	X=	X=	X=	X=	X=	X=

INSP	PRIMARY AND SECONDARY SUSPENSION LATERAL AND VERTICAL CLEARENCE -WAG9											
Loco No.:												
Type Of Inspection:												
Date:												
LIMITS OF CLEARENCE	WHEEL NO / AXLE BOX NO											
	1	2	3	4	5	6	7	8	9	10	11	12
Primary vertical - 27 to 35												
Primary lateral - 15 to 22												
Secondary vertical - 32 to 40												
Secondary lateral - 45 to 55												

DETAILS OF SUB-SYSTEMS ISOLATION & PROTECTION ACTIVITIES FOR VARIOUS FAULTS IN 3-PHASE LOCOS

S.No	FAULT MESSAGE		No. of times	Isolation Sub system No.	Protective activity
	DDS	Front end			
1	SLG1:0008-Disturbance interrupter task	F 02 01 P1	01	SR1 (02)	PTO
2	SLG1:0015-Converter oil pressure limit1	F 02 06 P1	01	SR1 (02)	VCB
3	SLG1:0019-Transformer temperature > limit2	F 01 05 P1	01	MAIN POWER (01)	VCB, SH
4	SLG1:0022-Motor temperature > limit1	F 02 07 P1	01	SR1 (02)	TR
4	SLG1:0023-Filter current above Maximum	F04 01 P1	02	HF(04)	VCB
5	SLG1:0024-BUR current above Maximum	F01 09 P1	01	MAIN POWER (01)	VCB, SH
5	SLG1:0025-Primary current above Maximum	F 01 08 P1	01	MAIN POWER (01)	VCB, SH
5	SLG1:0028-Disturbance tractive Braking effort	F 02 01 P1	03	SR1 (02)	TR
	SLG1:0033-Time out ALG with PTO	F 02 01 P1	01	SR1 (02)	PTO
	SLG1:0035-Disturbance GUSP stuck off	F 02 03 P1	01	SR1 (02)	PTO
	SLG1:0037-Precharge contactor stuck on fatal	F 01 07 P1	00	MAIN POWER (01)	SH
	SLG1:0038-Precharge contactor stuck OFF	F 02 02P1	01	SR1 (02)	PTO
	SLG1:0039-Converter contactor stuck 0N	F 02 02P1	0	SR1 (02)	PTO
	SLG1:0040-Converter contactor stuck 0FF	F 02 02P1	01	SR1 (02)	PTO
	SLG1:0042-Disturbance MUB test	F 02 01P1	01	SR1 (02)	PTO
	SLG1:0043-DC link voltage does not rise	F 02 01P1	01	SR1 (02)	PTO
	SLG1:0051-Time out ALG without PTO	F 02 01P1	0	SR1 (02)	-
	SLG1:0052-Time out SLG	F 02 01P1	0	SR1 (02)	-
	SLG1:0056-Contactor 8.2 stuck OFF Fatal	F 04 02 P1	0	HF (04)	VCB
	SLG1:0057-Contactor 8.2 stuck ON Fatal	F 04 02 P1	0	HF (04)	VCB
	SLG1:0058-Contactor 8.1 stuck OFF Fatal	F 04 02 P1	0	HF (04)	VCB
	SLG1:0059-Contactor 8.1 stuck ON Fatal	F 01 06 P1	0	MAIN POWER (01)	SH
	SLG1:0060-Contactor 8.41stuck OFF Fatal	F 04 02 P1	0	HF (04)	VCB
	SLG1:0061-Contactor 8.41 stuck ON Fatal	F 04 02 P1	0	HF (04)	VCB
	SLG1:0075-Ventilation Bogie BUR1 disturb	F 02 01 P1	0	BUR1 (06)	TR

S.No	FAULT MESSAGE	No. of times	Isolation Sub system No.	Protective
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					activity
	DDS	Front end			
	SLG1:0077-Potective Turn Off ALG extern	F 02 01 P1	03	SR1(02)	PTO
	SLG1:0079-Ventilation Bogie BUR2 disturb	F 07 04 P1	0	BUR2(07)	TR
	NSC1:0071-Trigginger unit check fail	F02 01 P1	0	SR1(02)	-
	NSC1:0072-Wrong numb of triggering unit	F02 01 P1	0	SR1(02)	-
	NSC1:0073-ADC not ready	F02 01 P1	1	SR1(02)	PTO
	NSC1:0074-ADC time out	F02 01 P1	1	SR1(02)	PTO
	NSC1:0075-MICAS disturbance	F02 01 P1	0	SR1(02)	PTO
	NSC1:0076-Error software	F02 01 P1	0	SR1(02)	PTO
	NSC1:0078-ERROR MVB	F02 01 P1	1	SR1(02)	PTO
	NSC1:0079-ZK not discharged	F02 01 P1	3	SR1(02)	PTO
	NSC1:0080-Error PS hardware	F02 01 P1	3	SR1(02)	PTO
	NSC1:0081-PS fault storage CGP	F02 01 P1	3	SR1(02)	PTO
	NSC1:0082-PS fault storage GBC	F02 01 P1	3	SR1(02)	PTO
	NSC1:0083-PS fault storage MC-PERI	F02 01 P1	3	SR1(02)	PTO
	NSC1:0084-Error CTR synchronization	F02 01 P1	3	SR1(02)	-
	NSC1:0085-Error calibration test	F02 01 P1	1	SR1(02)	-
	NSC1:0086-Error comparator test	F02 01 P1	1	SR1(02)	-
	NSC1:0087-Error transducer test	F02 01 P1	1	SR1(02)	-
	NSC1:0088-Error 100 Hz test	F02 01 P1	3	SR1(02)	-
	NSC1:0089-Error FSP direct test	F02 01 P1	3	SR1(02)	-
	NSC1:0090-Error GUSP test	F02 01 P1	3	SR1(02)	-
	NSC1:0031-Error plausibility Ud	F02 01 P1	3	SR1(02)	PI
	NSC1:0032-Error plausibility Iq1	F02 01 P1	3	SR1(02)	PI
	NSC1:0033-Error plausibility Iq2	F02 01 P1	3	SR1(02)	PI
	NSC1:0034-Error plausibility Iq3	F02 01 P1	3	SR1(02)	PI
	NSC1:0035-Error Reference voltage	F02 01 P1	1	SR1(02)	PTO
	NSC1:0036-Error operating software	F02 01 P1	0	SR1(02)	PTO
	NSC1:0039-Error set current limit	F02 01 P1	3	SR1(02)	PI
	NSC1:0040-Error I controller limitation	F02 01 P1	3	SR1(02)	PI
	NSC1:0041-Error actuator voltage limit	F02 01 P1	3	SR1(02)	PI
S.No	FAULT MESSAGE		No. of times	Isolation Sub system No.	Protective

					activity
	NSC1:0042-Error plause DSP measure limit	F02 01 P1	3	SR1(02)	PI
	ASC1:0071-Triggering unit check failed	F 02 01 P1	0	SR1(02)	-
	ASC1:0072-Wrong number of Triggering unit	F 02 01 P1	0	SR1(02)	-
	ASC1:0073-ADC not ready	F 02 01 P1	1	SR1(02)	PTO
	ASC1:0074-ADC Time out	F 02 01 P1	1	SR1(02)	PTO
	ASC1:0075-Micos disturbance	F 02 01 P1	0	SR1(02)	PTO
	ASC1:0076-Error software	F 02 01 P1	0	SR1(02)	PTO
	ASC1:0078-Error MVB	F 02 01 P1	1	SR1(02)	PTO
	ASC1:0079-ZK not discharged	F 02 01 P1	3	SR1(02)	PTO
	ASC1:0080-Error PS hardware	F 02 01 P1	3	SR1(02)	PTO
	ASC1:0081-Error -PS fault storage CGP	F 02 01 P1	3	SR1(02)	PTO
	ASC1:0082-PS fault storage GBC	F 02 01 P1	3	SR1(02)	PTO
	ASC1:0083-PS fault storage MC-Peri	F 02 01 P1	3	SR1(02)	PTO
	ASC1:0084-Error CTR synchronization	F 02 01 P1	3	SR1(02)	-
	ASC1:0085-Error calibration test	F 02 01 P1	1	SR1(02)	-
	ASC1:0086-Error comparator test	F 02 01 P1	1	SR1(02)	-
	ASC1:0087-Error Transducer test	F 02 01 P1	1	SR1(02)	-
	ASC1:0088-Error 100 Hz test	F 02 01 P1	3	SR1(02)	-
	ASC1:0089-Error FSP direct test	F 02 01 P1	3	SR1(02)	-
	ASC1:0090-Error GUSP test	F 02 01 P1	3	SR1(02)	-
	ASC1:0031-Error CTR computing time	F 02 01 P1	0	SR1(02)	PTO
	ASC1:0032-Error CAM full	F 02 01 P1	0	SR1(02)	PTO
	ASC1:0033-Error watchdog DSP	F 02 01 P1	0	SR1 (02)	PTO
	ASC1:0034-Error BS/MUG-GBC1	F 02 01 P1	0	SR1 (02)	PTO
	ASC1:0035-Error BS/MUG-GBC2	F 02 01 P1	0	SR1 (02)	PTO
	ASC1:0036-Error BS/MUG Resistor interrupt	F 02 01 P1	0	SR1 (02)	PTO
	ASC1:0037-Error plausibility Ud	F 02 01 P1	3	SR1 (02)	PI
	ASC1:0038-Error plausibility Ud1	F 02 01 P1	3	SR1 (02)	PI
	ASC1:0039-Error plausibility Ud1	F 02 01 P1	3	SR1 (02)	PI
	ASC1:0040-Error U reference	F 02 01 P1	1	SR1 (02)	PTO
S.No	FAULT MESSAGE		No. of times	Isolation Sub system No.	Protective

					activity
	ASC1:0041-Error BS/MUB short circuit	F 02 01 P1	0	SR1 (02)	PTO
	ASC1:0042-Error BS/MUB overload	F 02 01 P1	3	SR1 (02)	PTO
	ASC1:0043-Error Ud too small	F 02 01 P1	3	SR1 (02)	PI
	ASC1:0044-Error FIFO memory full	F 02 01 P1	3	SR1 (02)	PI
	ASC1:0045-Error all rot. Speed chans.1	F 02 01 P1	3	SR1 (02)	PI
	ASC1:0047-Error plausibility Imot1	F 02 01 P1	3	SR1 (02)	PI
	ASC1:0049-Error clock frequency 1	F 02 01 P1	3	SR1 (02)	PI
	STB1:0001-Lifesign missing from FLG missing	F 13 02 P1	0	CAB1 (13)	VCB
	STB1:0002-Primary current above maximum	F 01 08 P1	1	MAIN POWER (01)	VCB, SH
	STB1:0004-VCB will not open	F 01 01 P1	0	MAIN POWER (01)	SH
	STB2:0001-Lfesign from FLG missing	F 14 02 P1	0	CAB2 (14)	VCB
	HBB1:0001-Lifesign from FLG missing	F 13 01 P1	0	CAB1 (13)	VCB
	HBB1:0002-VCB will not open	F 01 01 P1	0	MAIN POWER (01)	SH
	HBB1:0003-VCB will not close	F 01 02 P1	0	MAIN POWER (01)	SH
	HBB1:0002-VCB will not open	F 01 01 P1	0	MAIN POWER (01)	SH
	HBB2:0001-Lifesign from FLG missing	F 14 01 P1	0	CAB2 (14)	VCB
	FLG1:0001-Lifesign from FLG-2 missing	F 18 01 P1	0	FLG2 (18)	VCB
	FLG1:0002-Lifesign from SLG-1 missing	F 02 01 P1	0	SR1 (02)	VCB
	FLG1:0003-Lifesign from SLG-2 missing	F 03 01 P1	0	SR2 (03)	VCB
	FLG1:0004-Lifesign from STB-1 missing	F 13 02 P1	0	CAB-1 (13)	VCB
	FLG1:0005-Lifesign from STB-2 missing	F 14 02 P1	0	CAB-2 (14)	VCB
	FLG1:0006-Lifesign from HBB-1 missing	F 13 01 P1	0	CAB-1 (13)	VCB
	FLG1:0007-Lifesign from HBB-2 missing	F 14 01 P1	0	CAB-2 (14)	VCB
	FLG1:0010-Lifesign from BUR-1 missing	F 06 01 P1	0	BUR-1 (06)	VCB
	FLG1:0011-Lifesign from BUR-2missing	F 07 01 P1	0	BUR-2 (07)	VCB
	FLG1:0012-Lifesign from BUR-3 missing	F 08 01 P1	0	BUR-3 (08)	VCB
	FLG1:0014-Lifesign from BUR-1 missing	F 06 01 P1	0	BUR-1 (06)	VCB
	FLG1:0014-Trainbus disturbance-master	F 19 01 P1	2	T/BUS (19)	VCB
	FLG1:0015- Train bus disturbance-slave	F 19 01 P1	2	T/BUS (19)	VCB
	FLG1:0025- Cab1 forward & Reverse selected	F 13 03 P1	1	CAB-1 (13)	VCB
S.No	FAULT MESSAGE		No. of times	Isolation Sub system No.	Protective

					activity
FLG1:0045-	Cab2 forward & Reverse selected	F 14 03 P1	1	CAB-2 (14)	VCB
FLG1:0046-	Time out initialization end B1	F 02 01 P1	0	SR1 (02)	VCB
FLG1:0047-	Time out initialization end B2	F 03 01 P1	0	SR2 (03)	VCB
FLG1:0048-	Time out peri. test end B1	F 02 01 P1	0	SR1 (02)	VCB
FLG1:0049-	Time out peri. test end B2	F 03 01 P1	0	SR2 (03)	VCB
FLG1:0050-	Time out ALG test 1 end bogie1	F 02 01 P1	0	SR1 (02)	VCB
FLG1:0051-	Time out ALG test 1 end bogie2	F 03 01 P1	0	SR2 (03)	VCB
FLG1:0052-	Time out ALG test 2 end bogie1	F 02 01 P1	0	SR1 (02)	VCB
FLG1:0053-	Time out ALG test 2 end bogie2	F 03 01 P1	0	SR2 (03)	VCB
FLG1:0054-	Time out ALG ready bogie1	F 02 01 P1	0	SR1 (02)	VCB
FLG1:0055-	Time out ALG ready bogie2	F 03 01 P1	0	SR1 (02)	VCB
FLG1:0056-	Time out ext.prot.sh.dwn.B1	F 02 01 P1	0	SR1 (02)	VCB
FLG1:0057-	Time out ext.prot.sh.dwn.B2	F 03 01 P1	0	SR2 (03)	VCB
FLG1:0058-	Time out GUSP on bogie1	F 02 01 P1	0	SR1 (02)	VCB
FLG1:0059-	Time out GUSP on bogie2	F 03 01 P1	0	SR2 (03)	VCB
FLG1:0060-	Time out DC link ckt.charge B1	F 02 01 P1	0	SR1 (02)	VCB
FLG1:0061-	Time out DC link ckt.charge B2	F 03 01 P1	0	SR2 (03)	VCB
FLG1:0062-	Time out conv.cont.on bogie1	F 02 01 P1	0	SR1 (02)	VCB
FLG1:0063-	Time out conv.cont.on bogie2	F 03 01 P1	0	SR2 (03)	VCB
FLG1:0064-	Time out pulse enable bogie1	F 02 01 P1	0	SR1 (02)	VCB
FLG1:0065-	Time out pulse enable bogie2	F 03 01 P1	0	SR2 (03)	VCB
FLG1:0066-	Time out filter config. Bogie1	F 02 01 P1	0	SR1 (02)	VCB
FLG1:0067-	Time out filter config. Bogie2	F 03 01 P1	0	SR2 (03)	VCB
FLG1:0068-	Time out NSC pulse Bogie1	F 02 01 P1	0	SR1 (02)	VCB
FLG1:0069-	Time out NSC pulse Bogie2	F 03 01 P1	0	SR2 (03)	VCB
FLG1:0070-	Time out ASC pulse Bogie1	F 02 01 P1	0	SR1 (02)	VCB
FLG1:0071-	Time out ASC pulse Bogie2	F 03 01 P1	0	SR2 (03)	VCB
FLG1:0072-	Time out release shutdown B1	F 02 01 P1	0	SR1 (02)	VCB
FLG1:0073-	Time out release shutdown B2	F 03 01 P1	0	SR2 (03)	VCB
FLG1:0074-	Time out shutdown end Bogie1	F 02 01 P1	0	SR1 (02)	VCB

FLG1:0075- Time out shutdown end Bogie2	F 03 01 P1	0	SR2 (03)	VCB
FLG1:0076- Time out DC link precharge B1	F 02 01 P1	0	SR1 (02)	VCB
FLG1:0077- Time out DC link precharge B2	F 03 01 P1	0	SR2 (03)	VCB
FLG1:0078- Time out PTO act end bogie 1	F 02 01 P1	0	SR1 (02)	VCB
FLG1:0079- Time out PTO act end bogie 2	F 03 01 P1	0	SR2 (03)	VCB
FLG1:0085- Disturbance in filter	F 04 01 P1	1	HF (04)	VCB
FLG1:0086- Dist. Both trafo oil circuits	F 01 05 P1	1	MAIN POWER (01)	VCB, SH
BUR1:0001-lifesign missing from FLG missing	F 06 01 P1	0	BUR-1 (06)	VCB
BUR1:0002-Inverter fault	F 06 02 P1	1	BUR-1 (06)	VCB
BUR1:0003-Inverter over current	F 06 02 P1	1	BUR-1 (06)	VCB
BUR1:0004-DC link voltage too low	F 06 02 P1	1	BUR-1 (06)	VCB
BUR1:0005-DC link over current	F 06 02 P1	1	BUR-1 (06)	VCB
BUR1:0006-DC link over voltage	F 06 02 P1	1	BUR-1 (06)	VCB
BUR1:0007-Freequency disturbance	F 06 02 P1	1	BUR-1 (06)	VCB
BUR1:0009-Contactor 52/4 will not close	F 06 03 P1	0	BUR-1 (06)	VCB
BUR1:0011-Contactor 52/5 will not close	F 06 03 P1	0	BUR-1 (06)	VCB
BUR1:0012-Self-test periph.I/O failed	F 06 02 P1	1	BUR-1 (06)	VCB
BUR1:0013-Input voltage not ok	F 06 02 P1	1	BUR-1 (06)	VCB
BUR1:0001-lifesign missing from FLG missing	F 06 01 P1	0	BUR-1 (06)	VCB
BUR2:0008-Contactor 52/1 will not open	F 07 03 P1	0	BUR-2 (07)	VCB
BUR2:0009-Contactor 52/1 will not close	F 07 03 P1	0	BUR-2 (07)	VCB
BUR2:0010-Contactor 52/2 will not open	F 07 03 P1	0	BUR-2 (07)	VCB
BUR2:0011-Contactor 52/2 will not close	F 07 03 P1	0	BUR-2 (07)	VCB
BUR2:0012-Contactor 52/4 will not open	F 07 03 P1	0	BUR-2 (07)	VCB
BUR2:0013-Contactor 52/4 will not close	F 07 03 P1	0	BUR-2 (07)	VCB
BUR2:0021-Self-test periph.I/O failed	F 07 02 P1	1	BUR-2 (07)	VCB
BUR2:0022-Input voltage not ok	F 07 02 P1	1	BUR-2 (07)	VCB
BUR3:0009-Contactor 52/3 will not close	F 08 03 P1	0	BUR-3 (08)	VCB
BUR3:0017-Self-test periph.I/O failed	F 08 02 P1	1	BUR-3 (08)	VCB
BUR3:0018-Input voltage not ok	F 08 02 P1	1	BUR-3 (08)	VCB

DETAILS OF PROTECTION ACTIVITIES(WITHOUT ISOLATION OF SUB SYSTEMS) FOR VARIOUS FAULTS IN 3-PHASE LOCOS

S.No	FAULT MESSAGE		No. of times	Protection activity	Remarks
	DDS	Front end			
1	SLG1:0010-ASC1 pulsing not started	F02 01 P1	-	TR	
2	SLG1:0011-NSC1 pulsing not started	F02 01 P1	-	TR	
3	SLG1:0012-ASC1 pulsing stopped	F02 01 P1	-	TR	
4	SLG1:0013-NSC1 pulsing stopped	F02 01 P1	-	TR	
6	SLG1:0062-Converter Temperature >limit1	F 02 01 P1	-	TR	
7	SLG1:0063-Transformer temperature >limit 1	F 01 05 P1	-	TR	
	SLG1:0075-Ventilation Bogie BUR1 disturb	F 02 01 P1	-	TR	
	NSC1:0038-Error synchronization	F 02 01 P1	-	PI	
	ASC1:0051-Error speed exceed max.	F 02 02 P2	-	TR	
	STB1:003-VCB will not close	F 01 02 P1	-	VCB	
	STB2:0002-No pressure in pan 2	F 01 03 P1	-	VCB	
	HBB:0002-No pressure in Pan 1	F 01 03 P1	-	VCB	
	FLG1:0017-Angle transmitter failed	F 17 03 P1	-	TR	
	FLG1:0018-Emergency stop- shut down	F 10 08 P1	-	SH	
	FLG1:0020-Emergency brake vigilance	F 10 03 P1	-	TR	
	FLG1:0021-Over speed-110%	F 16 01 P1	-	TR	
	FLG1:0022-Brake electronics failed	F 10 01 P1	-	TR	
	FLG1:0023-Regenerative brake failed	F 10 07 P1	-	TR	
	FLG1:0024-MCE off-pan was down 10 min	F 09 03 P1	-	SH	
	FLG1:0035- SR I/L -loco brake	F 10 09 P1	-	SR	
	FLG1:0036- SR I/L -auto brake	F 10 05 P1	-	SR	
	FLG1:0037- SR I/L -Brake cock	F 10 04 P1	-	SR	
	FLG1:0038- SR I/L -park brake	F 10 06 P1	-	SR	
	FLG1:0039- SR I/L -emgbrk out	F 10 10 P1	-	SR	
	FLG1:0040- SR I/L -main res. low	F 10 02 P1	-	SR	
	FLG1:0041- Primary voltage below minimum	F 01 04 P1	-	VCB	
	FLG1:0042- Primary voltage above maximum	F 01 04 P1	-	VCB	
	FLG1:0043- Simulation fault	F 17 04 P1	-	SH	

	FLG1:0044- Fire alarm	F 15 01 P1	-	SR	
	FLG1:0083- SLG1 S/W version mismatch	F 17 02 P1	-	SH	
	FLG1:0084- SLG2 S/W version mismatch	F 17 02 P1	-	SH	
	FLG1:0090- plausibility detect BoBo/CoCo	F 17 02 P1	-	SH	
	BUR2:0018-Battery voltage below 86 volts	F 09 02 P1	-	TR	
	BUR2:0019-Battery voltage below 82 volts	F 09 01 P1	-	SH	
	BUR2:0014-Battery voltage below 86 volts	F 09 02 P1	-	TR	
	BUR3:0015-Battery voltage below 82 volts	F 09 01 P1	-	SH	

3 PHASE LOCO TROUBLE SHOOTING GUIDE LINES TO PPO SHIFT

Sl.	Processor	Message ID	Description	Trouble shooting	Action by PPO	Action to be taken by
1	STB2	0004	Earth fault Auxiliary circuits	Check earth fault relay no.89.2 in HB-2 Isolate all Auxiliary motor MCBs in HB1&2 (Except MRB 1&2, and its Scavengers) , if found earth fault If no earth fault, then normalize one by one MCB and find the defective Auxiliary motor.	Replace 89.2 Check the Aux. motor IR values	Advise E4,E2, E3 (aux)
2			Main power OFF due to isolation of two BURs in sequence with inverter over current/DC link over current	Identify the defective auxiliary motor as per the enclosed procedure. Check the isolated BURs thoroughly, Measure/ record phase voltages	Check the Identified motor IR values If BURs phase voltages unequal	Advise E3 (aux), E4
3	FLG1	0002	Life sign from SLG1 missing	Visually check 1)Fiber optic cable condition.2) MCB 127.1/1 in SB-1. 3)Switch in power supply card in CCU-1	Further advise.	Advise E2
4	FLG1	0003	Life sign from SLG2 missing	Visually check 1)Fiber optic cable condition.2) MCB 127.1/2 in SB-2. 3)Switch in power supply card in CCU-1	Further advise	Advise E2
5	FLG1	0010	Life Sign from BUR1 missing	Visually check 1)Fiber optic cable condition.2) MCB 127.22/1 in SB-1 3)Switch in power supply card in BUR-1 rack.	Further advise	Advise E4, E2
6	FLG1	0011	Life Sign from BUR2 missing	Visually check 1)Fiber optic cable condition.2) MCB 127.22/2 in SB-2 3)Switch in power supply card in BUR-2 rack.	Further advise	Advise E4, E2
7	FLG1	0012	Life Sign from BUR3 missing	Visually check 1)Fiber optic cable condition.2) MCB 127.22/3 in SB-1. 3)Switch in power supply card in BUR-3	Further advise	Advise E4, E2
8	FLG1	0017	Angle Transmitter failed	Check the angle transmitter and its connector Check sub"D" connector at OD,EA in VCU-1 for cab-1 and VCU-2 for cab-2	Further advise	Advise E2
9	FLG1	0022	Brake Electronics' failed.	Check for brake electronics MCB no. 127.7 in SB-2	Further advise	Advise M3&5
10	FLG1	0035	SR interlock-loco brakes	Run the loco above 10kmph speed and observe for this message. Check pressure switch of (269.6/1 & 269.6/2) brake cylinder 1&2. Check by Isolating one by one switch.	Further advise	Advise M3&5
11	FLG1	0036	SR interlock-auto brakes	Check releasing of auto brakes, pressure switch (269.5)	Further advise	Advise M3&5, E2
12	FLG1	0039	SR interlock-emgbrk out	To check the emergency exhaust coc.	Normalize	---
13	FLG1	0041	Primary voltage	This comes whenever DJ is attempted to be closed against	Further advise	Advise E2

			below minimum	no voltage in the OHE. Normally, this message should not come if the driver observes OHE Voltmeter. However, if the driver records this message occurring in spite of OHE voltage available in the volt meter then, the problem lies in the OHE measuring circuit. Check PT fuse, working of fans in CCU.		
14	FLG1 FLG1 SLG1 SLG2	0086 0087 0018 0018	Dist. Both trafo oil circuits. Dist. One Trafo oil circuits. Pressure oil Trafo not OK	Check working of TFP MPH. Check the pressures in DDS, check the position of values, check the leakages in TFP circuit.	Further advise	Advise E5, E2
15	HBB1 STB1	0002 0004	VCB will not open	Do not attempt to close DJ. Switch OFF the MRB 1&2 MCBs. Check DJ and its Auxiliary inter locks visually. If possible replace L & Q slot card in VCU1	Further advise	Advise E2, E4
16	HBB1 STB1	0003 0004	VCB will not close	Check DJ and its Auxiliary inter locks visually. If possible replace L & Q slot card in VCU1	Further advise	Advise E2, E4
17	HBB1	0012	Earth fault 415/110 Volts circuit	Check earth fault relay no.89.5 in HB-1 Check MRB 1&2 , its Scavengers, cab Fans and Heaters	Further advise	Advise E2, E4, E3Aux.
18	HBB1	0013	Earth fault control circuit	Check spot lights wiring in both cabs. Check earth fault relay no.89.7 in SB-1	Further advise	Advise E2, E4
19	HBB1	0014	Earth fault Filter circuit	Megger Harmonic filter winding. Check earth fault relay no.89.6 in harmonic filter.	Further advise	Advise E2,E4
20	HBB1 HBB2	0018 0018	Capacitor MR Blower not OFF	Check MR blower timer relay no.54.2/1 in HB-1,54.2/2 in HB-2. Ensure it's interlocks functioning.	Further advise	Advise E2
21	NSC1/2 ASC1/2	0081 0081	PS Fault storage CGP	Find out Z info. Check the concerned valve set values.	Further advise	Advise E2,E5,E3TM
22	NSC1/2 ASC1/2	0082 0082	PS fault storage GBC	Find out Z info. Check the concerned valve set values.	Further advise	Advise E2, E5
23	NSC1/2	0083	PS fault storage MC-Peri	Check Gate Unit Power Supply (GUSP)	Further advise	Advise E2
24	NSC1 NSC1	0086 0087	Error Comparator test	Find out Z info	Further advise	Advise E2
25	SLG1	0011	NSC1 pulsing not started	Replace NSC card if possible	Further advise	Advise E2
26	SLG1	0012	ASC pulsing stopped	Replace ASC card if possible	Further advise	Advise E2

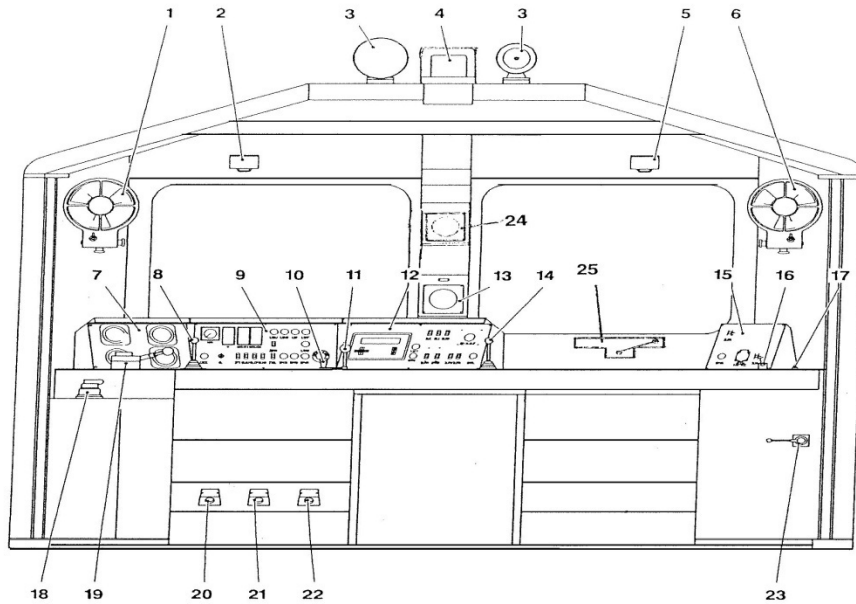
27	SLG1	0013	NSC pulsing stopped	Replace NSC card if possible	Further advise	Advise E2
28	SLG1 SLG1	0015 0017	Conv. oil pressure < limit 1	Ensure working of SR MPH. Check the pressures in mic-view any leakages in converter oil circuit	Further advise	Advise E3(A), E5,E2
29	SLG1 SLG2 SLG1 SLG2	0019 0019 0063 0063	TFP temp. > limit 2 TFP temp> limit 1	Ensure working of TFP MPH, OCB and its air flow value. Check TFP oil flow and oil level and any leakages.	Further advise	Advise E3(A), E2
30	SLG1 SLG2	0022 0022	Motor temp. > limit 1	Ensure working of TMB & its air flow values.	Further advise	Advise E3 (TM), E2
31	SLG1 SLG2	0025 0025	Primary current > maximum	Visually check the TFP for any abnormality/ oil splashing.	Further advise	Advise E5,E2
32	SLG1/2 SLG1/2	0027 0030	Earth fault DC link positive Earth fault DC link negative	Check the earth fault relay (89.4) and DC link voltage sensor.	Further advise	Advise E2, E3TM, E4
33	SLG1/2	0031	Earth fault in Trafo or motor	Check the earth fault relay (89.4) and DC link voltage sensor.	Further advise	Advise E2, E4,E3TM
34	SLG1/2	0039	Converter contactor struck on	Check the working of converter contactor, its aux Interlocks ,Cartridge	Further advise	Advise E2
35	SLG1/2	0040	Converter contactor struck off	Check the working of converter contactor, its aux. interlocks and cartridge .Check position of Pneumatic cock at pneumatic panel and pipe line for any air leakages.	Replace cartridge. Further advise	Advise E2 M3&5
36	SLG1/2	0043	DC link voltage does not rise.	Check converter earthed condition, Check the DC link voltage sensor. Check the operation of pre-charging contactor.	Further advise	Advise E2,E4
37	SLG1/2	0056	Contactor 8.2 struck off fatal	Check the working of contactor filter adoption. And its cartridge.	Replace cartridge. Further advise	Advise E2
38	SLG1	0075	Ventilation bogie BUR-1 disturbed.	Ensure the working of MRBs Check the working of fans in Electronic Tray of BUR 1,2&3. Ensure working of fans in CCU 1&2.	Further advise	Advise E3, AUX, E4,E2
39	STB1	0007	MCE temperature > 70 Deg	Check the working of VCU cooling fans and its supply.	Further advise	Advise E2
40	STB1	0008	MCB of Compressor	Check the MCP1 (IR values, Resistance & Inductance),	Further advise	Advise E3 AUX

			1 open	current drawn by MCP Check continuity & Milli volt drop across MCB Check the BUR3 phase voltages		Advise E4 Advise E2
41	ASC1/2	0049	Error clock frequency-1	If message logged more no. of times then replace ASC card.	Further advise	Advise E2
42	BUR1	0001	Life sign from FLG missing	Visually check Fiber optical cable between FLG to BUR1.	Further advise	Advise E2,E4
43	BUR1/2/3	0002	Inverter fault	Check WRE modules fault indication lamp in BUR electronics	Further advise	Advise E4
44	BUR1/2/3	0003	Inverter Over Current	Check WRE modules, Current transducers Note: After load sharing on isolation of one BUR with Inverter over current, the other BUR also gets isolated for the same message then find out defective motor with enclosed procedure.	Further advise	Advise E3 AUX,E4
45	BUR2 BUR3	0019 0015	Battery voltage below 82 Volts	Charge Batteries duly giving external supply. Check the Batteries and conduct load test Check MCB100, Battery charger module output voltage.	Further advise	Advise E2 BA
46	ASC1/2	0085	Error Calibration test	Find out Z-info. If possible replace ASC/NSC Peri Card.	Further advise	Advise E2
47	ASC1/2	0087	Error Transducer Test	Find out Z-info. If possible replace ASC/NSC Peri Card.	Further advise	Advise E2
48	ASC1/2 ASC1/2 ASC1/2	0052 0053 0054	Error Tacho Gen-1 Error Tacho Gen-2 Error Tacho Gen-3	TM-1/4 SUB-D-Connector, HA TM-2/5 SUB-D-Connector, HC TM-3/6 SUB-D-Connector, HE	Connect spare connector in CCU Further advise	Advise E3TM
49	BUR1 BUR2 BUR3	0013 0022 0018	Input voltage not OK.	Check input fuse no.40 & Surge arrestor no.40.1 inside BUR	Further advise	Advise E4
50	BUR2 BUR3	0016 0012	MCB Battery charger open	Reset MCB100 and observe. Check BUR-2 &3 output voltages	Further advise	Advise E4
51	SLG1 SLG2	0083 0084	SLG1 S/W mismatch SLG2 S/W mismatch	Software to be downloaded.	Further advise	Advise E2
52	HBB2 STB2	0002	No pressure pan1 No pressure pan2	Check auxiliary compressor MCB no. 4801 in SB-2 Check panto pipeline connection. Check pressure switch 130.4	Further advise	Advise E2, M3&5

PROCEDURE TO BE FOLLOWED WHEN TWO BURs ARE ISOLATED IN SEQUENCE WITH "INVERTER OVER CURRENT OR DC LINK OVER CURRENT"

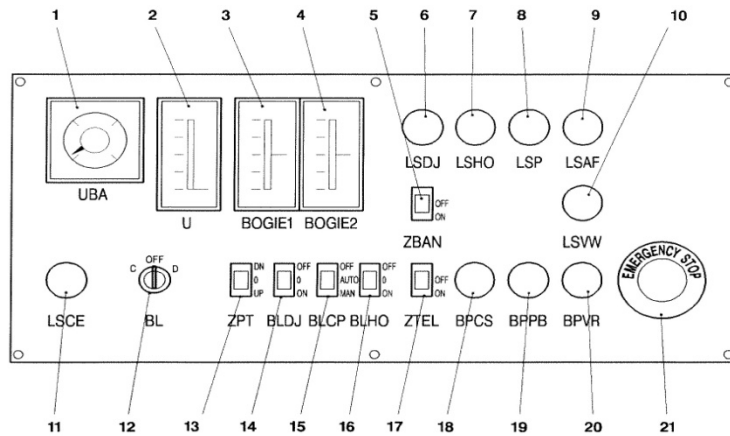
ISOALTION OF BURS IN SEQUENCE	TROUBLE SHOOTING	IDENTIFICATION OF DEFECT	ACTION TO BE TAKEN BY
Initially BUR1 gets isolated on inverter over current or DC link over current and when loco in working with, BUR2 & BUR3 only, BUR2 also gets isolated on inverter over current or DC link over current.	1) Switch OFF control electronics, trip OCB1 MCB , switch ON control electronics and Close VCB. If normal. If problem do not over come 2) Switch OFF control electronics, close OCB1 MCB and trip OCB2 MCB , switch ON control electronics and Close VCB. If normal.	Check OCB1 IR value and MCB healthiness Check OCB2 IR value and MCB healthiness	Advise E3 AUX., E2
Initially BUR2 gets isolated on inverter over current or DC link over current and when loco in working with, BUR1 & BUR3 only, BUR1 also gets isolated on inverter over current or DC link over current	1) Switch OFF control electronics, trip TMB1 MCB , Switch ON control electronics and close VCB. If normal. If problem do not over come 2) Switch OFF control electronics, close TMB1 MCB and trip TMB2 MCB , switch ON control electronics and close VCB. If normal.	Check TMB1 IR value and MCB healthiness Check TMB2 IR value and MCB healthiness	Advise E3 AUX, E2
Initially BUR2 gets isolated on inverter over current or DC link over current and when loco in working with, BUR1 & BUR3 only, BUR3 also gets isolated on inverter over current or DC link over current	1) Switch OFF control electronics, trip TFP1 MPH MCB , switch ON control electronics and close VCB. If normal. If problem do not over come 2) Switch OFF control electronics, close TFP1 MPH MCB and trip TFP2 MPH MCB , switch ON control electronics and close VCB. If normal. If problem do not over come 3) Switch OFF control electronics, close TFP2 MPH MCB trip SR1 MPH MCB , switch ON control electronics and close VCB. If normal, If problem do not over come 4) Switch OFF control electronics, close SR1 MPH MCB and trip SR2 MPH MCB , switch ON control electronics and close VCB. If normal,	Check TFP1 MPH IR value and MCB healthiness Check TFP2 MPH IR value and MCB healthiness Check SR1 MPH IR value and MCB healthiness Check SR2 MPH IR value and MCB healthiness	Advise E3 AUX, E2
Initially BUR3 gets isolated on inverter over current or DC link over current and when loco in working with, BUR1 & BUR2 only, BUR1 also gets isolated on inverter over current or DC link over current	1) Switch OFF control electronics, trip Scav Blower 1 MCB , switch ON control electronics, Close VCB. If normal, If problem do not over come 2) Switch OFF control electronics, close Scav Blower 1 MCB and trip Scav Blower 2 MCB , Switch ON control electronics and Close VCB. If normal,	Check Scav Blower1 IR value and MCB healthiness Check Scav Blower2 IR value and MCB healthiness	Advise E3 AUX, E2
Initially BUR3 gets isolated on inverter over current or DC link over current and when loco in working with, BUR1 & BUR2 only, BUR2 also gets isolated on inverter over current	1) Switch OFF control electronics, trip MCP1 MCB , switch ON control electronics, Close VCB. If normal, If problem do not over come 2) Switch OFF control electronics, close MCP1 MCB and trip MCP2 MCB , Switch ON control electronics and Close VCB. If normal,	Check MCP1 IR value and MCB healthiness Check MCP2 IR value and MCB healthiness	Advise E3 AUX, E2

or DC link over current			
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CAB OVER VIEW

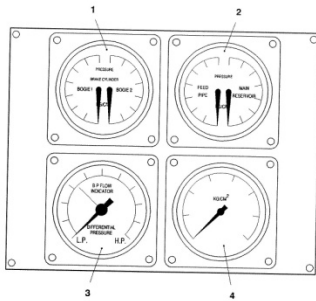
- | | | | |
|----|--|----|---|
| 1 | <i>Crew fan</i> | 14 | <i>Control lever for horn</i> |
| 2 | <i>Lamp Loco pilot's desk illumination</i> | 15 | <i>Panel D</i> |
| 3 | <i>Pneumatic horn</i> | 16 | <i>Operation of window wipers/washers</i> |
| 4 | <i>Emergency flash light</i> | 17 | <i>Rotary switch cab heater/fan device</i> |
| 5 | <i>Lamp assistant Loco pilot's desk illumination</i> | 18 | <i>Brake handle direct loco brake</i> |
| 6 | <i>Crew fan</i> | 19 | <i>Brake handle automatic train brake</i> |
| 7 | <i>Panel B</i> | 20 | <i>Foot switch "SANDING"</i> |
| 8 | <i>Control lever for horn</i> | 21 | <i>Foot switch "PVEF" for release of loco brake</i> |
| 9 | <i>Panel A</i> | 22 | <i>Foot switch "VIGILANCE"</i> |
| 10 | <i>Reverser</i> | 23 | <i>Emergency brake Cock</i> |
| 11 | <i>TE/BE Throttle</i> | 24 | <i>Parking Brake (PB) gauge</i> |
| 12 | <i>Panel C</i> | 25 | <i>Wiper motor</i> |
| 13 | <i>MEMOTEL</i> | | |



PANEL- A

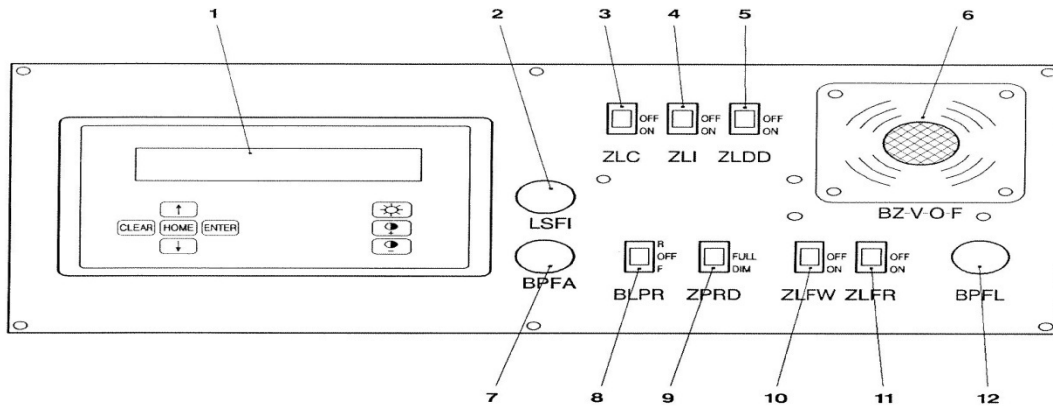
- 1 UBA Voltmeter Battery voltage
- 2 U Voltmeter Catenary voltage
- 3 BOGIE 1 TE/BE meter - Traction / braking effort, bogie 1
- 4 BOGIE 2 TE/BE meter - Traction / braking effort, bogie 2
- 5 ZBAN Spring loaded switch – Banking operation “ON” / “OFF”
- 6 LSDJ Indication lamp, red - Main circuit breaker “OFF”
- 7 LSHO Indication lamp, yellow - Hotel load “ON” (Inactive on WAG—9)
- 8 LSP Indication lamp, yellow - Wheel slipping
- 9 LSAF Indication lamp, red - Train parting
- 10 LSVW Indication lamp, yellow - Vigilance warning
- 11 LSCE Lamp, amber - Over temperature CEL
- 12 BL Key switch - Activation of Loco pilot's cab
- 13 ZPT Spring—loaded switch - Raise / Lower Pantograph
- 14 BLDJ Spring—loaded switch – Main circuit breaker “ON” / “OFF”
- 15 BLCPC Spring—loaded switch - Main compressors AUTO mode “ON” / “OFF”
- 16 BLHO Spring—loaded switch - hotel load “ON” I “OFF” (Inactive on WAG—9)
- 17 ZTEL Switch - Max. Traction limitation
- 18 BPCS Illuminated pushbutton – green-constant Speed control
- 19 BPPB Illuminated push—button- red - Parking brake
- 20 BPVR Push—button, yellow Resetting vigilance
- 21 Emergency Stop - button – red - Emergency stop

GAUGES – PANEL-B



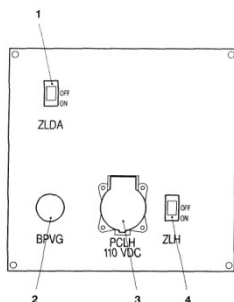
- | |
|--|
| <p>1. Pressure Brake Cylinder Bogie 1+2
 2. Pressure Brake Feed Pipe/Main Reservoir
 3. Air Flow Meter
 4. Pressure Brake Pipe</p> |
|--|

PANEL-C



- 1 Screen Display of messages diagnosis
- 2 LSF1 Indication lamp, red - Fault message, priority 1
- 3 ZLC Switch - Loco pilot's cab lighting
- 4 ZLI Switch - Instrument lighting
- 5 ZLDD Switch - Loco pilot's desk illumination
- 6 B-Z-V-O-F- Buzzer - Warning signal, 3 frequencies
- 7 BPFA Illuminated push - button, yellow - Acknowledgement all fault messages
- 8 BLPR Switch - Head Light, Bright
- 9 ZPRD Switch - Headlights, Dim
- 10 ZLFW Switch - Marker lights, white
- 11 ZLFR Switch - Marker lights, red
- 12 BPFL Illuminated push - button, yellow - Emergency flash light

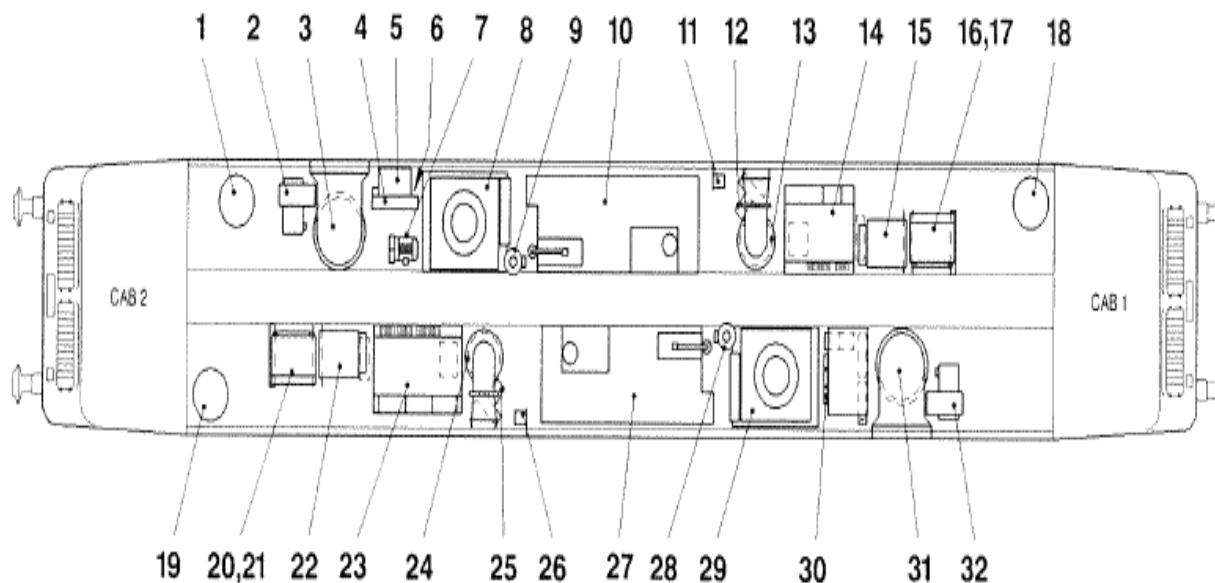
PANEL-D



- 1. Asstt Loco pilot Desk Lamp
- 2. Vigilance Ack push button
- 3. 110V socket
- 4. 110 V socket ON/OFF button

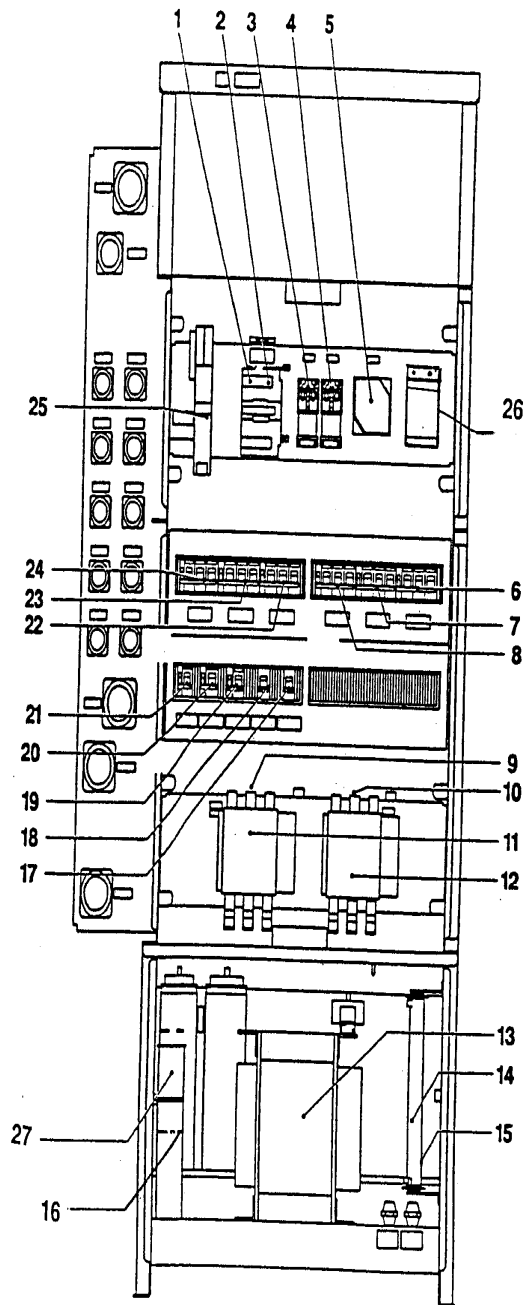
MACHINE ROOM LAYOUT

WAG-9/WAP-7



- 1 Auxiliary reservoir
- 2 Scavenge blower to traction motor blower 2 / oil cooling unit 1
- 3 Traction motor bogie 2
- 4 Vigilance control equipment
- 5 Control electronics pneumatic manifold
- 6 Pneumatic panel
- 7 Auxiliary compressor
- 8 Oil cooling unit, transformer / converter 1
- 9 Oil pump converter 1
- 10 Traction converter 1
- 11 Capacitor to Scavenge blower for machine room blower 1
- 12 Scavenge blower to machine room blower 1
- 13 Machine room blower 1
- 14 Auxiliary converter box 1
- 15 Cubicle auxiliary circuits 1
- 16 Cubicle control circuits 1
- 17 Central electronics 1 (CEL 1)
- 18 Main reservoir
- 19 Main reservoir
- 20 Central electronics 2 (CEL 2)
- 21 Cubicle control circuits 2
- 22 Cubicle auxiliary circuits 2
- 23 Auxiliary converter box 2
- 24 Machine room blower 2
- 25 Scavenge blower to machine room blower 2
- 26 Capacitor to Scavenge blower for machine room blower 2
- 27 Traction converter 2
- 28 Oil pump converter 2
- 29 Oil cooling unit, transformer / converter 2
- 30 Filter cubicle
- 31 Traction motor blower bogie 1
- 32 Scavenge blower to traction motor blower 1 / oil cooling unit 2

Auxiliary Circuits, Cubicle – 1 (HB1)

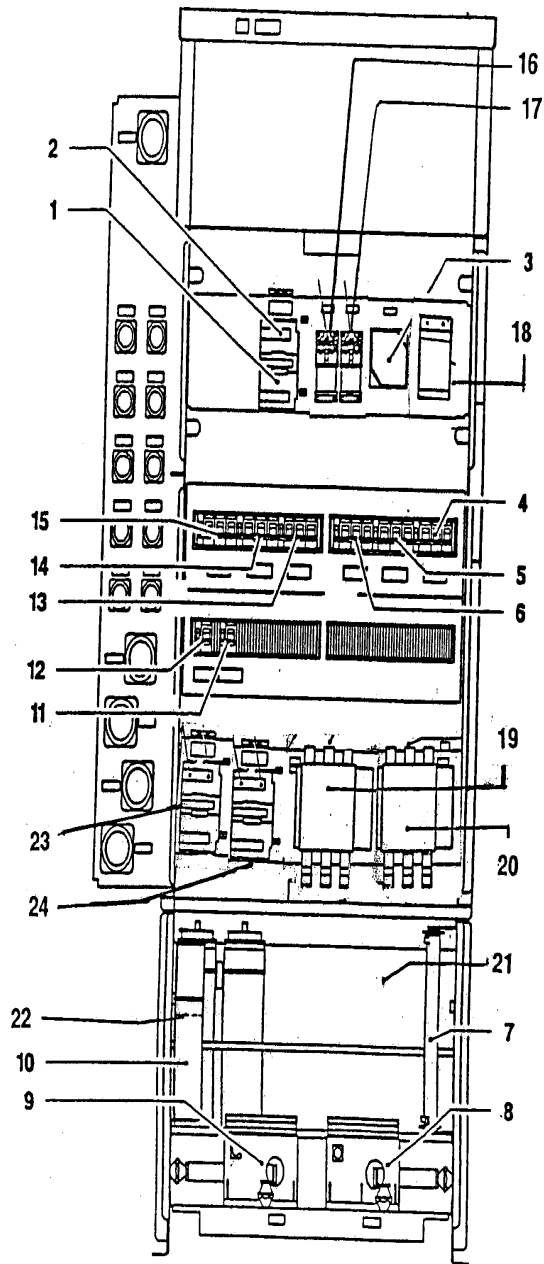


Auxiliary Circuits, Cubicle – 1 (HB1)

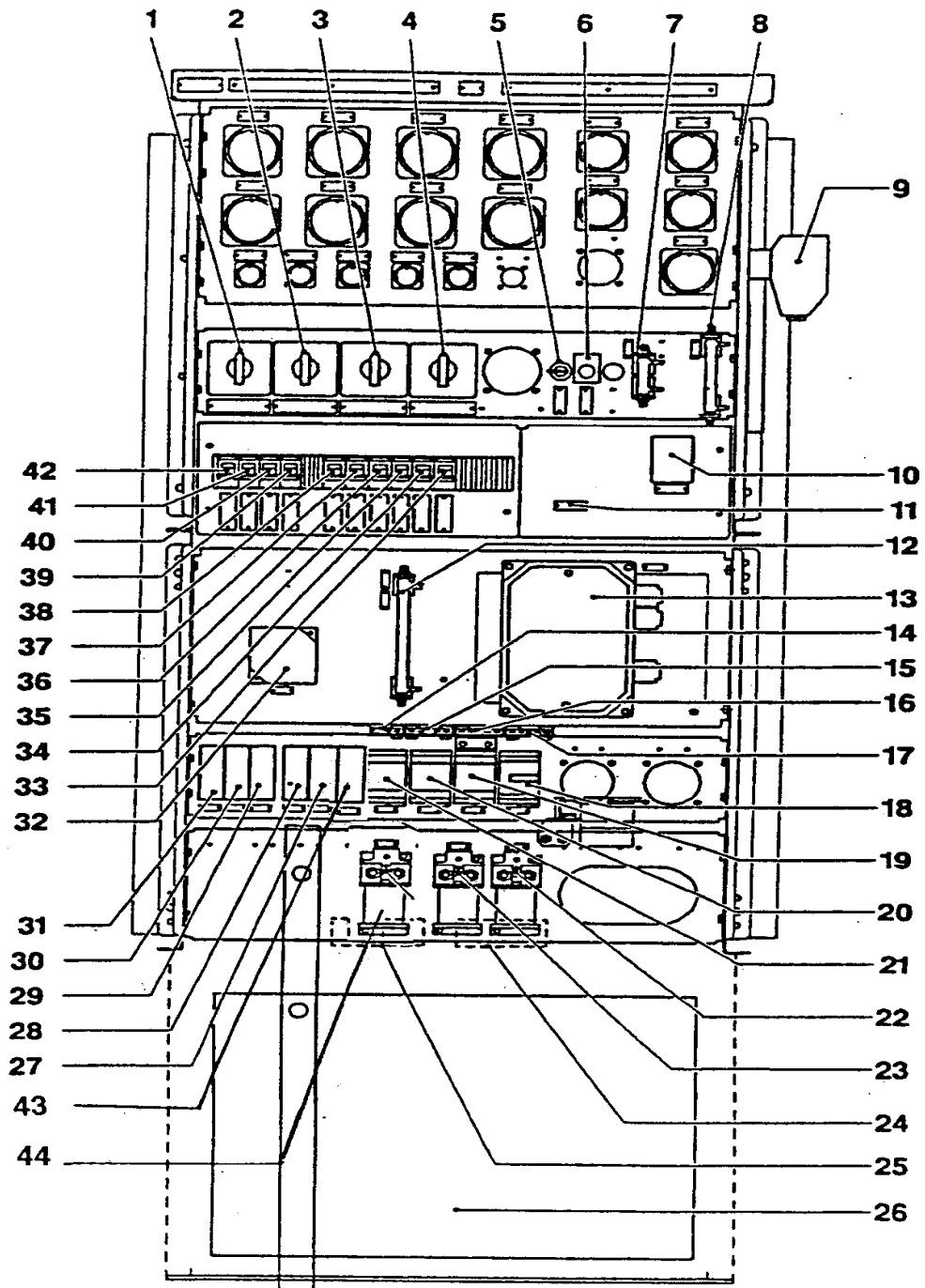
- 1.47.2 -Contactor, main compressor
- 2.47.2A/1-Snubber circuit to item 47.2
- 3.52.3/4-Auxiliary contactor to item 52
- 4.52.3/5-Auxiliary contactor to item 52
- 5.89.5 Earth fault relay 415/110 V
- 6.59.1/1-Circuit breaker, oil cooling unit, transformer/converter
- 7.55.1/1-Circuit breaker, scavenge blower to traction motor blower and oil cooling unit
- 8.53.1/1-Circuit breaker, traction motor blower
- 9.52.A/4-Snubber circuit to item 52
- 10.52.A/5-Snubber circuit to item 52
- 11.52/4-Contactor auxiliaries
- 12.52/5-Contactor auxiliaries
- 13.67-Transformer,auxiliary circuits 415/110 V
- 14.90.41-Earthing resistor earth fault detection 415/110 V
- 15.90.42-Earthing resistor earth fault detection 415/110 V
- 16.54.4/1-Capacitor to MR blower motor
- 17.69.71-Circuit breaker, crew fan
- 18.69.62-Circuit breaker, cab heater
- 19.69.61-Circuit breaker, cab ventilation
- 20.56.1/1-Circuit breaker, scavenge blower to machine room blower
- 21.54.1/1-Circuit breaker, machine room blower
- 22.47.1/1-Circuit breaker, main compressor
- 23.63.1/1-Circuit breaker oil pump converter
- 24.62.1/1-Circuit breaker oil pump transformer
- 25.41 -Fuse auxiliary 415/110 V.
- 26.54.2/1-Time, relay for MR blower
- 27.54.8/1-Capacitor to MR blower

Auxiliary Circuits, Cubicle-2 (HB2)

- 1.47.2A/2-Snubber circuit to item 47.2
- 2.47.2/2-Contactor, main compressor
- 3.89.2 -Earth fault relay, auxiliary converter
- 4.59.1/2-Circuit breaker, oil cooling unit, transformer/converter
- 5.55.1/2-Circuit breaker, scavenge blower to traction motor blower and oil cooling unit
- 6.53.1/2-Circuit breaker traction motor blower
- 7.90.3/1-2-Earthing resistor earth fault detection auxiliary converter
- 8.42.3/2-Current sensor, auxiliary circuits
- 9.42.3/1-Current sensor, auxiliary circuits
- 10.54.5/2-Capacitor to MR blower motor
- 11.56.1/2-Circuit breaker, scavenge blower to machine room blower
- 12.54.1/2-Circuit breaker, machine room blower
- 13.47.1/2-Circuit breaker, main compressor
- 14.63.1/2-Circuit breaker, converter oil pump
- 15.62./12-Circuit breaker, transformer oil pump
- 16.52.6/1-Auxiliary contactor to item 52.4
- 17.52.6/2-Auxiliary contactor to item 52.5
- 18.54.2/2-Time relay for MR blower
- 19.52.5/1-Contactor oil pumps
- 20.52.5/2-Contactor oil pumps
- 21.49-Input filter Auxiliary converter
- 22.54.8/2-Capacitor to MR Blower (Start up)
- 23.52.4/1-Contactor Scavenge Blower
- 24.52.4/2-Contactor, Scavenge Blower



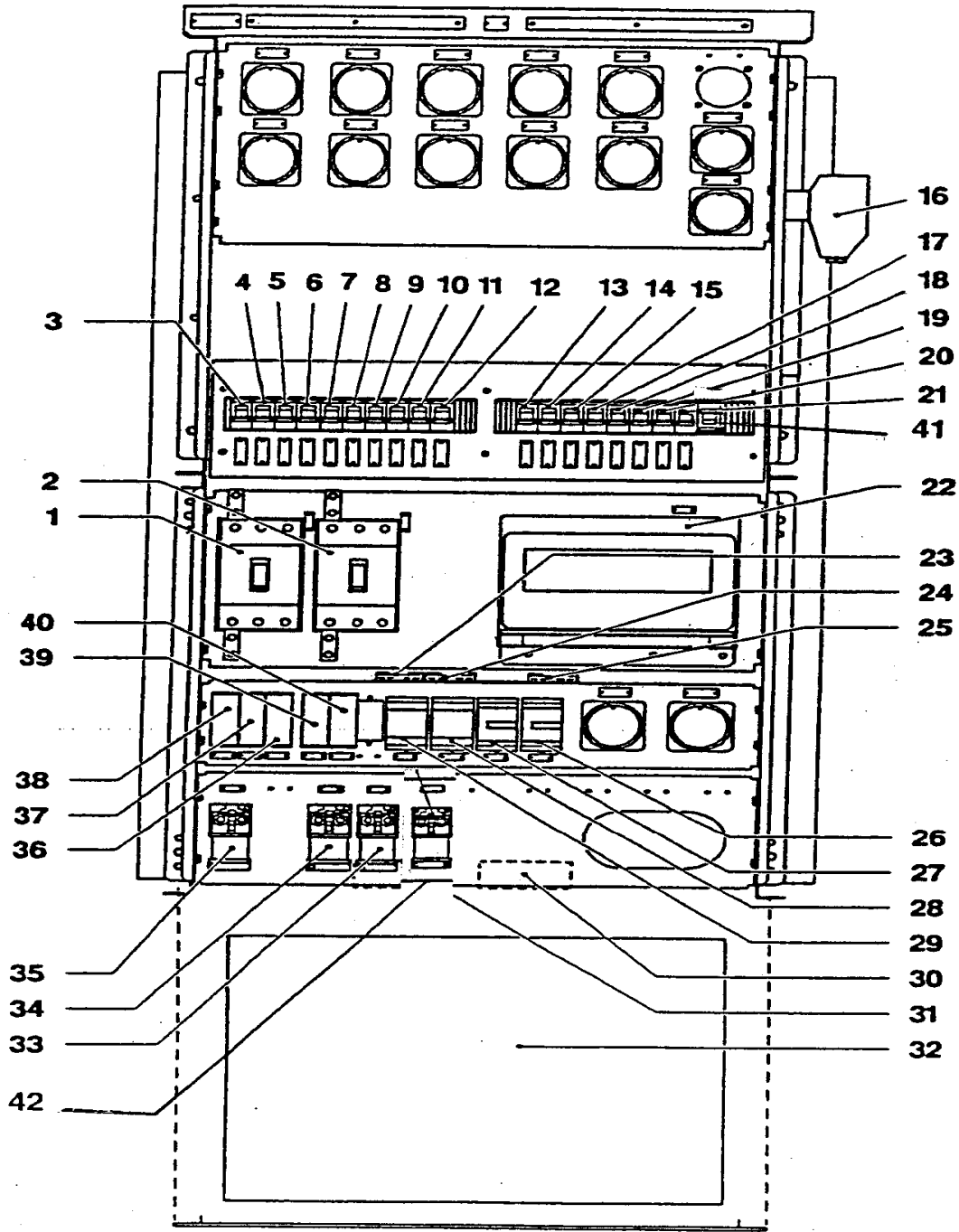
Control Cubicle- (SB1)



Control Cubicle- (SB1)

1	152	Rotary switch	Failure mode operation
2	154	Rotary switch	Bogie cut-out
3	160	Rotary switch	Configuration
4	237.1	Rotary switch	Vigilance device cut-off
5	179	Key switch	Simulation
6	161	Illuminate push-button	Configuration
7	381.71	Wire resistor	Earthing screen Train bus
8	78.1	Resistor	Maximum current relay
9	211.1/1	Thermostat	Control electronics
10	78	Relay	Maximum current
11	86	Relay	Minimum voltage
12	90.7	Resistor	Earth fault detection, Control Circuit
13	381.7	Connecting box	Train bus
14	126.5A	Relay	Control electronics "OFF"
15	136.4A	Snubber circuit to item 136.4	
16	126.7A	Snubber circuit to item 126.7	
17	136.3A	Snubber circuit to item 136.3	
18	136.3	Relay	Time delay VCB
19	136.4	Contactora	Auxiliary contactora VCB
20	126.7/1	Contactora	Power supply cab
21	118.4/1	DC/DC Converter	
22	218	Contactora	Control electronics
23	126	Contactora	Control circuits "ON"
24	118.5/1	DC/DC converter	
25	118.4/1	DC/DC converter	
26	411	Rack	Central electronics (CEL1)
27	123.1/1	Blocking diode	Illumination test
28	123/7	Blocking diode	
29	123/5	Blocking diode	
30	123/3	Blocking diode	
31	123/1	Blocking diode	
32	89.7	Relay earth fault	Control circuit
33	127.9/2	Circuit breaker	Central electronics
34	127.9/1	Circuit breaker	Central electronics
35	127.22/1	Circuit breaker	Electronics, auxiliary converter
36	127.2/1	Circuit breaker	Monitoring
37	127.11/1	Circuit breaker	Power supply Gate Units
38	127.1/1	Circuit breaker	Electronics traction converter
39	310.1/1	Circuit breaker	Lighting front
40	127.91/1	Circuit breaker	Power supply 24V/48V
41	127.12	Circuit breaker	Pantograph/VCB Control
42	127.3/1	Circuit breaker	Drivers cab
43	123/9	Blocking diode	Head light
44	338	Contactora	Head light

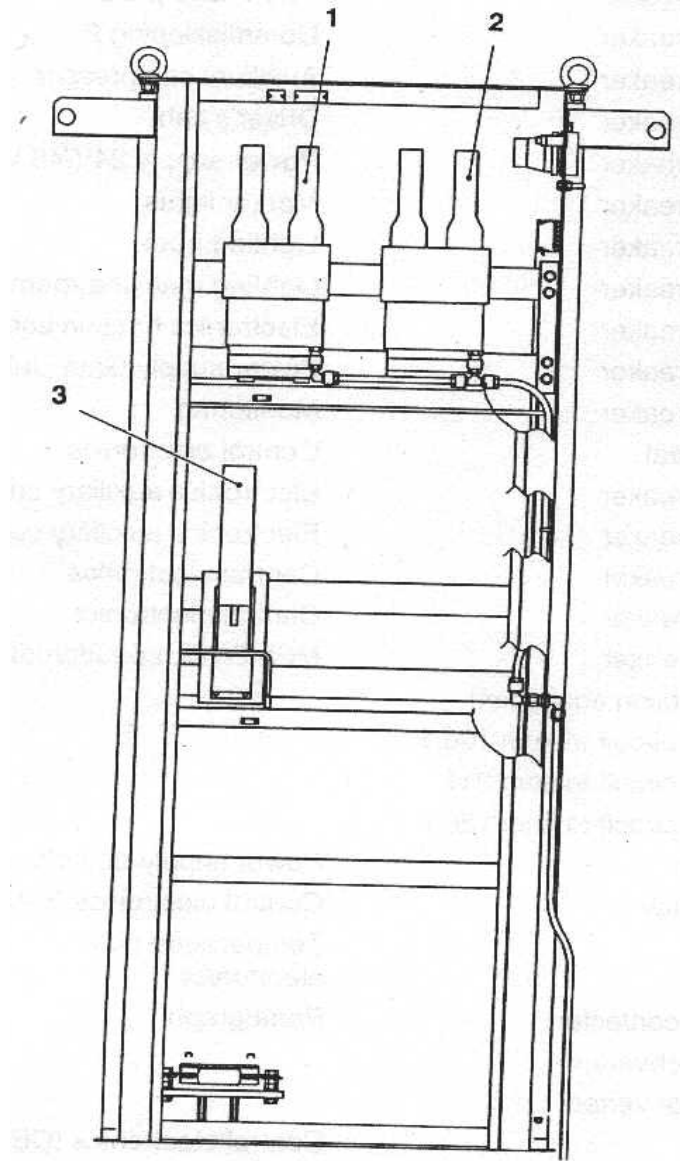
Control Cubicle - 2 (SB2)



Control Cubicle - 2 (SB2)

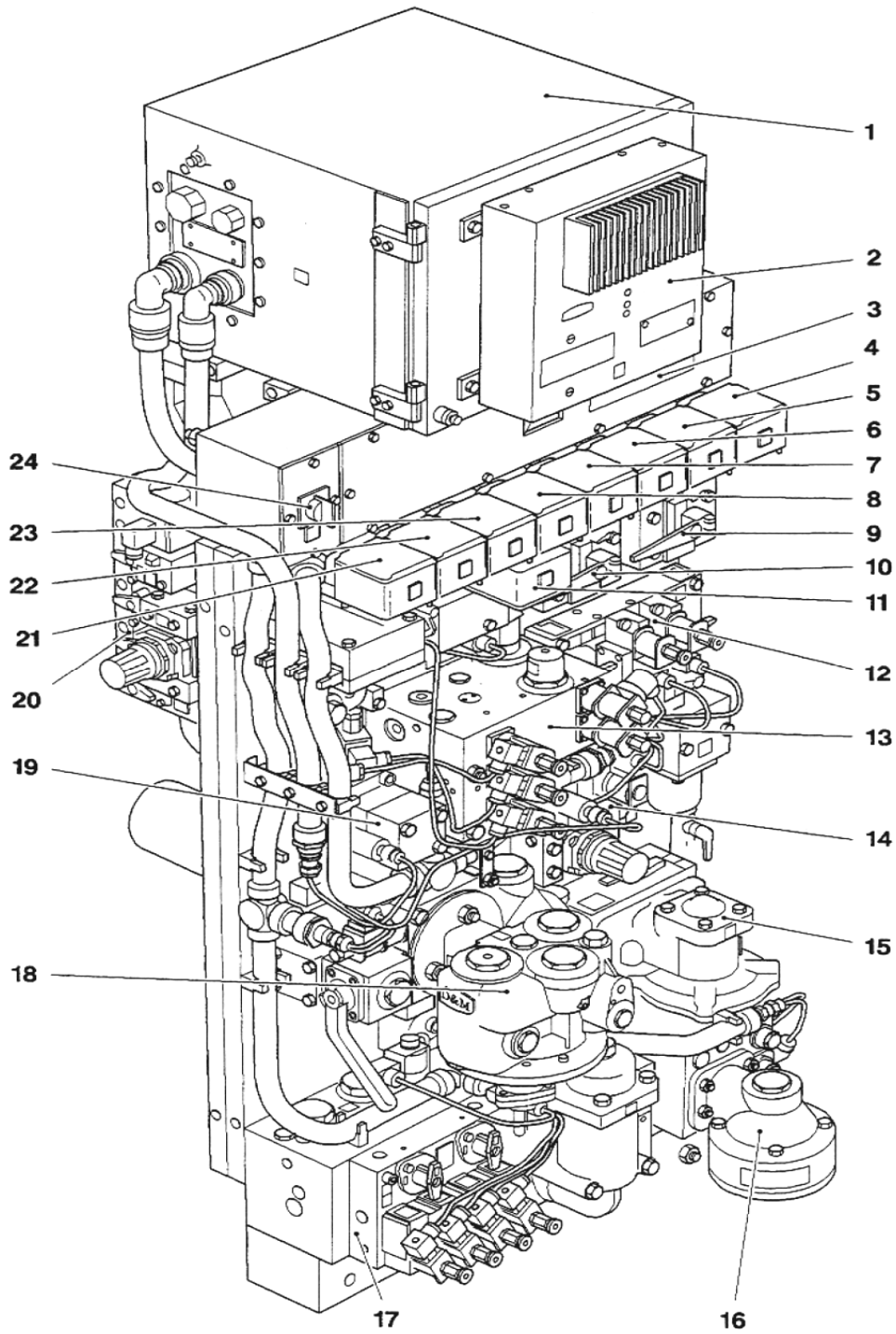
1	110	Circuit Breaker	Output battery charger
2	112.1	Circuit Breaker	Control circuit locomotive
3	127.81	Circuit Breaker	Commissioning 1
4	127.15	Circuit Breaker	Vigilance control
5	127.7	Circuit Breaker	Pneumatic panel
6	127.82	Circuit Breaker	Commissioning 2
7	48.1	Circuit Breaker	Auxiliary compressor
8	127.3/2	Circuit Breaker	Driver's cab
9	127.91/2	Circuit Breaker	Power supply 24V/48 V
10	310.7/1	Circuit Breaker	Marker lights
11	310.1/2	Circuit Breaker	Lighting front
12	310.4	Circuit Breaker	Lighting machine room
13	127.1/2	Circuit Breaker	Electronics traction converter
14	127.11/2	Circuit Breaker	Power supply Gate Units
15	127.2/2	Circuit Breaker	Monitoring
16	211.1/2	Thermostat	Control electronics
17	127.22/2	Circuit Breaker	Electronics auxiliary converter
18	127.22/3	Circuit Breaker	Electronics auxiliary converter
19	127.9/3	Circuit Breaker	Central electronics
20	127.9/4	Circuit Breaker	Central electronics
21	127.92	Circuit Breaker	MEMOTEL speedometer
22	212	Fire detection equipment	
23	130.1A	Snubber circuit to item 130.1	
24	211.A	Snubber circuit to item 211	
25	126.7A/2	Snubber circuit to item 126.7	
26	126.7/2	Contactors	Power supply driver's cab
27	126.6	Safety relay	Control electronics "ON"
28	211	Relay	Temperature control, Electronics
29	130.1	Auxiliary contactor	Pantograph
30	118.5/2	DC/DC Converter	
31	118.4/2	DC/DC Converter	
32	412	Rack	Central electronics (CEL2)
33	300.3/2	Auxiliary contactor	Wheel flange lubrication
34	300.3/1	Auxiliary contactor	Wheel flange lubrication
35	48.2	Contactors	Auxiliary compressor
36	123/6	Blocking diodes	
37	123/4	Blocking diodes	
38	123/2	Blocking diodes	
39	123/8	Blocking diodes	
40	123.1/2	Blocking diodes	Illumination test
41	127.24	Circuit breaker	Electronics auxiliary converter
42	338/2	Auxiliary contactor	Head light

Filter Cubicle



- | | | |
|------|---|-------------------------------------|
| 8.2 | 1 | Contacteur filter adaption |
| 8.1 | 2 | Contacteur filter "ON"/ "OFF" |
| 8.41 | 3 | Contacteur for discharging resistor |

FRONT OF PNEUMATIC PANEL



- 260 1 Control electronics pneumatic manifold
 237 2 Vigilance control equipment

	3	Instructions regarding isolating cock position (see Fig.4.18)
130.4/1	4	Pressure switch pantograph 1
130.4/2	5	Pressure switch pantograph 2
269.1	6	Pressure switch emergency brake
172.4	7	Pressure switch auxiliary compressor
269.3	8	Pressure switch parking brake
293.2	9	Isolating cock brake pipe control system (E70)
237.3	10	Isolating cock on emergency brake/vigilance control
269.2	11	Pressure switch direct brake
	12	Pneumatic equipment, pantograph and VCB
	13	Brake pipe control unit (E70)
	14	Pneumatic equipment, parking brake
	15	Relay valve, automatic brake
	16	Relay valve, direct brake
	17	Pneumatic equipment, sanding
	18	Distributor, automatic brake
	19	Blending unit EBC5
	20	Pneumatic equipment, wheel flange lubrication, traction converter, filter cubicle
269.41	21	Pressure switch, flow indication
269.5	22	Pressure switch, vigilance control
269.42	23	Pressure switch, brake feed pipe
129.1	24	Rotary switch, pantograph selection

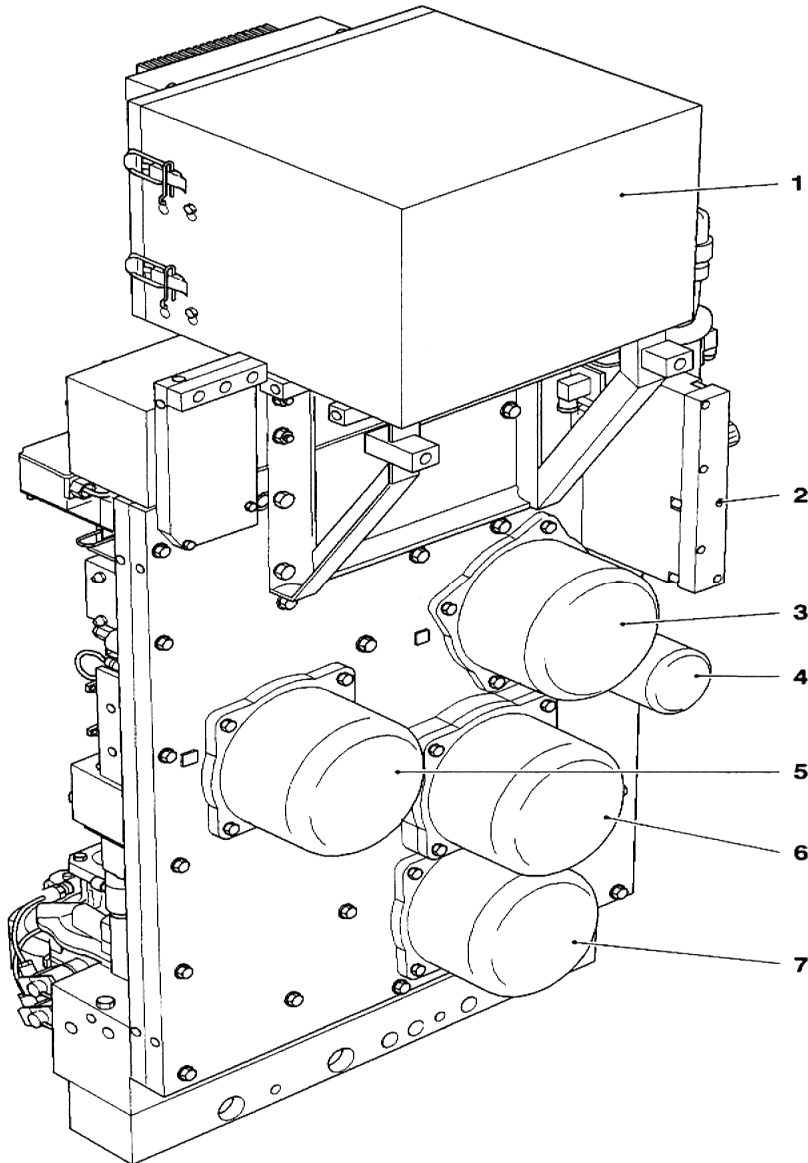
MODE		ISOLATING COCK POSITION			
		47 DEAD ENGINE	74 (EMERGE NCY/ VIG.)	136 (BRAKE FEED PIPE)	70 (E70 BRAKE PIPE)
MULTIPLE UNIT	LEAD (LIVE)	CLOSED	OPEN	OPEN	OPEN
	TRAIL (LIVE)	CLOSED	OPEN	CLOSED	OPEN
	TRAIL (DEAD)	CLOSED	CLOSED	CLOSED	CLOSED
BANKING LOCO (ONLY)		CLOSED	OPEN	CLOSED	CLOSED
TOWED "DEAD "		OPEN	CLOSED	CLOSED	CLOSED

Note:

Towed "DEAD" means that the towed loco is completely "DEAD".

Trail "DEAD" means that on the master loco no tractive effort is available, but the driver's cab of the master loco still controls the slave locomotive.

BACK FACE OF PNEUMATIC PANEL



- 260 1 Control electronics pneumatic manifold
Pneumatic equipment, wheel flange lubrication, traction converter,
filter cubicle
- 3 Capacity reservoir, distributor
4 Control reservoir, brake pipe control unit (E70)
5 Air reservoir, pantograph and VCB
6 Control reservoir, distributor automatic brake
7 Capacity reservoir, sanding valves