सत्यमेव जयते

भारत सरकार
रेल मंत्रालय

GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

Conversion Scheme of Conventional Electric Locomotives to Battery Cum Electric locomotives

Report No. RDSO/2021/EL/RM/0195 (Rev. '0')

Issued on 21.10.2021

Approved by	Signature
PEDSE	SUNIL KUMAR Digitally signed by SUNIL KUMAR Date: 2021.10.21 19:02:36 +05'30'

विद्युत निदेशालय
अनुसंधान अभिकल्प और मानक संगठन
मानकनगर, लखनऊ– 226011

ELECTRICAL DIRECTORATE
RESEARCH DESIGNS & STANDARDS ORGANISATION
MANAK NAGAR, LUCKNOW - 226011

Prepared by	Checked by	Issued by
Girish Meena Digitally signed by Girish Meena Date: 2021.10.21 18:28:08 +05'30'	Jaiprakash Singh Kutiyal Digitally signed by Jaiprakash Singh Kutiyal Date: 2021.10.21 17:47:01 +05'30'	ARVIND PANDEY Digitally signed by ARVIND PANDEY Date: 2021.10.21 17:27:10 +05'30'
SSE/D/12	SSE/D/11	JDSE/System

Status of Revision

SN	Date of Revision	Page No.	Revision	Reason for Revision
1.	---	All	0	First issue

Table of contents

1.0 Dual Mode Loco Concept & Scope

Shunting operations are often performed by Zonal Railways using diesel shunting locomotives, although these tasks mostly take place beneath the electrified tracks. Diesel locomotives are more expensive in terms of energy and maintenance costs. Also, because of noise and air pollution, their use is undesirable. The dual-mode Shunter Locomotive is basically an electric locomotive with the ability to operate from 25kV AC OHE supply as well as from Lead Acid /Ni-Cd OR similar Advanced Chemistry Cell(ACC) battery set where yards are not fully electrified so that seamless operation in transition zones is possible.

This report defines the standard scheme for converting the tap changer based WAM4 & WAG5 locomotives into Battery Cum Electric Locomotives, which can work under 25kV Over Head Equipments (OHE) as the primary power source and work as Battery operated locomotive by drawing power from Battery set in non-electrified yards/station area.

The purpose of the report is to provide the technical scheme for the integration of Lead Acid /Ni-Cd OR similar ACC battery set in existing WAM4 & WAG5 locomotives to facilitate the operation of these locomotives with battery supply. Instead of evolving a new design of a dual mode shunting locomotive with transfer of technology which will be a time consuming process & may not be cost effective, Electric Loco Sheds/workshops may adopt the standard scheme defined in this report for converting the existing WAM4 & WAG5 locomotives which have completed their codal life or about to complete the useful life in near future into Battery Cum Electric Locomotives, hereafter termed as 'Dual Mode Shunting Locomotives(DMSL)' which can be operated on 25kV AC as well as on Battery supply.

The advantages of the DMSL may be summarized as follows:

- Improved operational flexibility in last mile operation in goods yards, sidings and in shunting operation which are non-electrified.
- Dependency on diesel locos will not be there. Further; the population of diesel locos are decreasing as same are being phased out for various reasons.
- Free of Air & Noise Pollution which is prime concern in station area, sheds & yards.

2.0 Technical Particulars of Converted WAM4 /WAG5 loco into Battery Cum Electric Locomotive

SN	Parameter	Requirement
1.	Dimension	Same as of WAM4/WAG5 loco
2.	Battery	Ni-Cd Battery /Lead Acid battery OR any other suitable ACC battery may also be used.
3.	Weight	Shall be same as that of WAG5H (+/-1%)
4.	Duration for which loco can work with battery	60 minutes
5.	Speed (Light loco)	Battery Mode: 20kmph OHE mode: 80kmph

3.0 Scheme for Conversion of Conventional Electric Loco to Dual Mode Shunting loco

Based upon the examination of conversion schemes received from ER & CR for WAG5 locomotives, following standard scheme is proposed for conversion of WAM4/WAG5 locos:

3.1 The WAM4 / WAG5 locomotives, which have completed their codal/useful life or completing in near future, may be considered for conversion to battery Cum Electric locomotives. The converted loco will operate in two modes i.e. 'OHE mode' under 25kV AC OHE and will charge the traction batteries and in 'Battery mode' when 25kV OHE is not available.

3.2 Under 25kV OHE, the loco should operate with full capacity with 4 (Four) Traction Motors in service. TM-2 and TM-5 are required to be removed. The features of dynamic braking (Rheostatic) and Field weakening are not required while working in Battery mode. As such, these features may be removed in Battery mode.

3.3 Under Battery Mode, the Transformer, GR, SL, RSI will remain idle. The Traction Motors will operate up to 5% (equivalent to TM voltage at 2 notches) of its rated voltage. All the Blowers (MVRH, MVMT, MVSI, MVSL) will remain switched off. There is no requirement of DBR & associated equipments in converted DMSL & as such, may be removed. The vacuum brake equipments, if installed, may also be removed.

3.4 Two (2) suitable capacity of 110V DC compressors shall be provided e.g. 1175LPM, 110V DC (EMU Type) in this locomotive. These compressors shall be fed by two nos. 33kVA, 415/110V Transformer fed from Aux. Winding of TFP and rectified. A rectifier i.e. existing Battery Charger may be used for the purpose in OHE mode and 2x32 Ni –Cd battery (3.6V, 199Ah) in Battery Mode. Battery charger 500A for charging of 2x32 Ni –Cd battery (3.6V, 199Ah) to be used.

3.5 Traction Battery Requirement to work under Battery mode is as under:
Type of battery: Ni-Cd (3.6V, 199Ah) / Lead Acid battery (8V, 500Ah) OR any other suitable ACC battery may be used. The kWh requirement and in turn the battery bank size may be decided as per period required for loco to work in Battery Mode.

3.6 Traction battery charger of suitable rating is required for charging the traction & compressor battery.

3.7 A manual selection switch may be provided for selecting the operating mode of loco in Battery Mode. The existing BL key may be used for interlocking purpose i.e. Same BL key may be used for selecting of either of the operating mode. The Driver can select only one mode at a time by selecting/inserting the BL key. Alternatively, one additional rotary switch may be provided for selecting the either mode of operations. The additional key for operating the loco in battery mode may be kept in both cab behind LP. The circuitry related to dynamic braking to be utilized for notching in Battery mode. Battery contactor panel to be provided for changing the battery combination as per notches. The compressors (DC EMU type) will operate normally as per requirement from RGCP in "OHE mode" and in Battery mode" compressor operation is same as OHE mode, i.e. if there is requirement as per RGCP, the compressors are ON.

3.8 **Battery Combination**

3.8.1 The Nickel Cadmium (Ni-Cd) 199AH 3.6V batteries are used for traction purpose and to supply the

Main Compressors during Battery Mode of operations. Total 256 no. batteries are divided into three blocks with different Series-Parallel electrical connections, the details of which are given below:

Location	**No of batteries(3.6V,199Ah each)**	**Combination**
Traction Bogie 1 and Traction Bogie 2	96 batteries in each Traction Bogie	**1st Notch:** 8 batteries in series in a limb and such 12 limb in Parallel i.e. 8x3.6V =28.8V,2388Ah **2nd Notch:** 16 batteries in Series in a limb and such 6 limb in Parallel i.e. 16x3.6V=57.6V,1194Ah
Main Compressor	64 batteries	32 batteries in series in a limb & such 2 limb in Parallel i.e. 32x3.6=115.2V,398Ah.

Total 96 batteries per traction bogie may be used with combination shown above. This covers the power supply for traction motors of each bogie.
Set of 32 batteries with all batteries connected in series to provide 115V for running DC compressor as well as feeding inverter for other applications. There are two compressor battery sets in parallel to feed the two compressors (32S-2P).Thus; the total Ni-Cd battery to be installed is 96+96+64 = 256 batteries.

3.8.2 Battery combination with Lead Acid type batteries

Battery capacity: 500 AH, 8 V
Per Traction Bogie: 16 batteries

Battery Mode Notch position	Combination of batteries	Voltage of combination	Ah capacity of combination
1ST Notch	4S-4P=16 Batteries	8VX4=32V	500X4=2000Ah
2ND Notch	8S-2P=16 Batteries	8VX8=64V	500X2=1000Ah

For two Traction bogies: 16x2=32 batteries
For 2 no main compressor (DC compressor of 1150lpm, 100V DC)

Battery combination for compressors	Voltage of combination	Ah capacity of combination
14 Batteries in series	14X8=112V	500Ah

Total Batteries= 32 (for Traction) + 14 (for DC compressor) =46

3.9 All the equipments related to Vacuum Brake, Shunting/field weakening and Dynamic Braking shall be removed or customised as per availability of space. Proposed Layout drawing of Converted loco is shown in **Annexure 1**. The equipments have been relocated in such a way so that loco remains balanced after removal/addition of equipments. The layout may be further modified as per actual space available in the locomotives & may be customized accordingly. However, the layout of equipments i.e. addition of new equipments & relocation of existing equipments etc. should be done in such a way that loco remains balanced to ensure stability of converted loco.

3.9.1 List of Equipments to be removed

SN	Description	Quantity	Remarks
1.	Main Compressor 1,2 & 3	3	DC EMU type MCP to be used in place of MCP1 to MCP3.
2.	DBR	1	Not required
3.	BA-3 Panel	1	As DBR removed
4.	Gear Ratio 21:58	6	
5.	CTF-1&2	2	DBR removed
6.	Shunting Contactor	2	Not required
7.	Resistance for Shunting(RS)	1	Not required
8.	C 145	1	DBR removed
9.	QF Shunt	2	DBR removed
10	ATFEX	1	DBR removed
11	TM2 & TM5	2	Not required for Shunting purpose due to restricted speed limit of 20kmph

3.9.2 List of Equipments to be relocated

SN	Description	Qty	Remarks
1	RCAPTFP	2	For creating space for Traction Battery Bank
2	DC-DC Converter	1	For creating inverter space

3.9.3 List of Equipments to be added:

SN	Description	Qty	Remarks
1	Compressor DC(1175LPM)	2	To create air pressure in BA/OHE mode
2	Contactor panel (2 nos. CTF)	1	Changeover OHE & BA mode
3	ATFEXTFP, 415/33V AC	2	Traction BA Charger
4	Battery Charging Transformer, 415/110V,22kVA	1	BA-MCP Charger
5	Battery(260x190x350mm)	256	BA Mode Operation
6	Battery Rack	8	For installation of BA bank
7	Resistance for MCP, 0.05 Ohm	2	To limit starting current
8	Contactor for MCP, 200A,150VDC	8	To operate MCP in OHE/BA mode
9	CHBA for MCP, 510Ax2	2	For battery charging purpose
10	CHBA for Tr. Battery of Bogie 1, 510Ax2	1	For battery charging purpose
11	CHBA for Tr. Battery of Bogie -2, 510Ax2	1	For battery charging purpose
12	Inverter, 2.5kVA,110V DC/230V AC	1	Exhaust Fan & Meter supply
13	Control Panel, 2.5 KVA Inverter, 110V DC /230V AC	1	To operate Inverter
14	Gear Ratio 15:62	6	
15	Exhaust Fan, 230V, 38W	4	BA cooling
16	Digital DC Voltmeter for Tr. BA-1 & 2,	4	For indication of battery voltage

	Range :0-300V DC		
17	Analog DC Voltmeter for MCP, Range : 0-150V DC	2	For indication of battery voltage
18	Traction Battery Lower voltage indicator+ Buzzer	2	For indication of battery voltage & alarm in case of touching the lower limit of battery voltage
19	MCP DC Charging TFP, 415/110±10V, 33kVA	2	BA-MCP Charging

Note: The gear ratio of existing WAM4 i.e. 21:58 may be changed to 15:62, if required. Otherwise, GR 21:58 may be retained in converted locos.

3.10 Weight Distribution and stability

Existing Loco		
SN	**Equipment**	**Weight(kg)**
1.	3 nos. MCP 1000 LPM	450x3=1350
2.	2 nos. MVMT	350x2=700
3.	DBR Unit	800
4.	1 no. ATFEX	300
5.	1 no. Ba1	256
6.	1 no. Ba 2-3	712
7.	RSI1 & 2	800x2=1600
8.	1 no. ARNO	1120
9.	1 no. RC damping	54
10.	1 no. CHBA	160
11.	DC –DC converter	20
12.	C-118 & R-118	75
13.	1 no. Distributor Valve	95
14.	---	---
15.	---	---
16.	---	---
17.	---	---
18.	---	---
19.	---	---

Converted DMSL	
Equipments added	**Weight(kg)**
2 nos. 110V DC MCP(1175LPM)	425x2=850
2 nos. MVMT	350x2=700
---	
2 nos. ATFEX + Contactor panel	(300x2)+ 328=928
1 no. Ba1	287
1 no. Ba2	285
RSI 1 & 2	800x2=1600
1 no. ARNO	1120
----	----
1 no. CHBA	160
DC-DC converter	20
C-118 & R-118	75
1 no. Distributor Valve	95
1 no. CHBA TFP-1	411.2
1 no. CHBA TFP-2	451
1 no. CHBA for Tr. battery	45
1 no. SJ	330
1 no. Inverter	30
1. 256 nos. 199 Ah, 3.6 V Battery (Ni-Cd) including 8 nos. Rack	7296+300=7596
2. 46 nos , 8 V ,500Ah lead acid battery including 4	140x46=6440+ 300=6740

	Total weight	**7242 kg**

rake	
Total Weight	**14983.2 kg or 14127.2 kg**

Resultant additional weight in WAM4 after converting it into Dual Mode Shunting Locomotive is 7741.2 Kg (or 6585 kg with Lead acid battery), i.e. 7.7 Tonnes (6.5 tonnes) approximately. As nominal weight of a WAG5A/B/C locomotive is 119 Tonnes, the increase in weight is approximately 6.45 %(5% with Lead Acid battery).The net increase of 7.7 tonnes approx. (6.5 tonnes approx.) or 1.29 tonnes (1.01 tonnes) per axle load is within permissible range. The total weight of converted locomotive with addition of 7.7 t will be 126.5t (same as of WAG5H loco i.e. 126t ±1%). Therefore, this additional load has no major effect in Loco operation if this Loco is used on main line in OHE mode. Further, this additional load has been distributed symmetrically across Centre Line of loco by placing 8 Battery racks (128 batteries) on each cab side. Since, the battery racks account for 7.6 tonnes approx. (which is close to the extra weight added) and are symmetrically placed, the effect of other changes is negligible as they have been placed in the vacated space of similar weighing equipment.

3.11 Modification of Electrical and Pneumatic Equipments

3.11.1 Power Circuit Modification

3.11.1.1 Two (2) nos. CTF Drum controllers may be used for making Changeover switch for selecting "OHE Mode" and "Battery Mode".

3.11.1.2 Battery charger circuit for Bogie-1, Bogie-2 may be provided by modifying ATFEX into 415/36V two winding transformer supplied from Main TFP aux. winding.

3.11.1.3 Supply TFVT may be shifted from ARNO to Inverter.

3.11.1.4 All equipments related to Dynamic Braking and Field Weakening to be removed.

3.11.1.5 Two Special Transformers 415/130V and two rectifiers may be provided to supply the DC Compressors and charging the Battery Bank for Compressors in OHE Mode.

3.11.1.6 The Schematic Plan for Power and Auxiliary circuit incorporating above modifications is shown in **Annexure 2.**

3.11.1.7 One Inverter 110V DC to 230V AC of 2.5KVA to be provided to supply the 4 nos. Cab fan and 4 nos Battery cooling fans. The connection is shown in **Annexure 3**.

3.11.2 Pneumatic Circuit Modification

3.11.2.1 The Circuits Related to MREQ and BCEQ to be removed.

3.11.2.2 Three (3) nos. 1000LPM AC compressors to be replaced by 2 nos 1175LPM DC Compressors used in EMUs. The layout is given in **Annexure-11**.

4.0 Main Features considered for converted loco & it's Operation

4.1 In battery mode operation, provision of only two notches have made considering the operational requirement. For notching operation in battery mode, the control has been provided through MPS.

4.2 The converted locomotive will run as usual under 25kV OHE & the changeover switch i.e. termed as HBH is to be kept in 'OHE' position for the purpose.

4.3 When HBH switch is put in 'BATTERY' position (for Battery operations), VCB Pantograph circuit, LS-GROUP lamp get electrically isolated, Energising of locomotive through 25 kV AC is not possible.

4.4 Provision of Overload protection in Traction circuit (for Battery mode) has been made. If Traction current exceeds 1800 A DC for any reason, the Traction will get isolated.

4.5 All others normal operations (Sanders, VEF, VCD, AFACP, Speedometer etc) will remain active in BATTERY mode.

4.6 Cooling of Battery Bank has been considered by providing Exhaust Fan (230V, 38 W 4 nos.) near Battery rack. Inverter (2.5 kVA, 110V DC/230V AC) has been considered for supply of Cab Fan & Exhaust fan and Digital meters.

4.7 MCP-1 & MCP-2 will work normal through BLCP/BLCPD switch with MR pressure governor (RGCP) in Battery mode. The charger for Battery of MCPs (BA-MCP) will be active through HCP, BLCP/BLCPD switch.

4.8 For energising of locomotive, MPS handle & MP to be put in 'O' position followed by HBH switch in 'OHE' position and normal operation under 25kV OHE may be carried out.

4.9 During running in BATTERY Mode, check UBA at Switch Board, if control voltage below 85 V DC, any operation in Battery Mode should not be done. Battery shall be charged in HT Mode.

4.10 VCD (Vigilance Control Device) remains active in BATTERY MODE operations.

4.11 In OHE Mode, nothing will happen if MP is put in BATTERY position or MPS handle in 1 or 2 positions.

4.12 Manual operations of CTF-31 & CTF-32 and Line Contactors are strictly prohibited in converted Locomotive.

4.13 Normal LT testing operations with BV box (HOM) grounding are possible in OHE mode only (With MCP-1, MCP-2 runs automatically through RGCP).

4.14 In BATTERY Mode, Individual Traction Motor or Bogie isolation possible through HVMT-1, 2 or HVSI-1, 2 or HMCS -1, 2 switch.

Protection Features

All the electrical safety protection features of the locomotives like Earth Fault, over voltage, under voltage and overload protections have not been altered for the loco running in OHE mode. For Battery mode of operation, following extra protections have been considered in the converted loco:

- **Battery Overload Protection:**

OLR relays used in Conventional EMUs may be used in Traction Battery circuit for overload protection (as shown in **FIG: 4)**. The traction will be cut off when total current drawn from one of the Traction Battery Bank exceeds 1800A.

- **Traction Battery Overcharging Protection:**

To prevent traction battery from getting overcharged, there is need to shut off the battery charger once the desired module voltage is reached i.e. approx 4.2 V per module. The requirement is performed by the solid state over charge protector which takes feed from the battery bank and monitors it continuously. Till the bank voltage reaches 33.5 volts (of 8 cells in series), charging contactors should remain closed through the interlock provided by the circuit. The same shall be indicated by green LED which remains on till battery

bank is charged to desired level. Once the battery bank voltage reaches set limit, the charging contactors are opened by through series interlock of circuit. The charging indication LED (green) also goes off. The circuit has provision that will allow charging to be enabled only after certain drop in the battery bank voltage.

- **Battery Bank Temperature:**

Suitable temperature sensor may be utilized for monitoring the temperature of battery bank & temperature readings shall be displayed on driver's desk in both cabs.

- **Traction Battery Deep Discharge Indication:**

To protect batteries from deep discharge, a solid state protection circuit has been considered which senses the traction battery voltage during battery mode and gives a low battery warning by blinking LED and buzzer at driver's desk once the bank voltage drops below the set limit & the warning goes off when battery voltage reaches above the set limit.

- **In Battery Mode, Pantograph Switch, MP, DJ are deactivated. Driver cannot activate loco through OHE. In this mode,**
  - Battery Power will be isolated if loco operate in Battery Mode in overload condition.
  - In OHE Mode, Batteries will go into Charging automatically. Driver cannot take Battery notches.

5.0 New /Modified equipment details provided in Dual Mode Shunting Loco

Modified DC Compressor 3 nos. TRC-1000 LPM Loco type ELGI make compressor, replaced by DC compressor; Make – KPCL/3HC55, 110 V DC Free Air Delivery – 1175 LPM, Wt. – 425 Kg.(Approx) The EMU type MCP with modification done as per Loco compressor to supply air during battery mode & OHE operation. Intercooler is provided on top of the MCP.	
Battery 3.6V, 199 Ah, 256 nos. Ni-Cd battery / Lead Acid battery 8V, 500 AH batteries (46 numbers) OR ACC battery may be provided.	

	
Battery Rack Dimension: 1700mm(h) x 1700mm(l) x 280mm(w). For rack fabrication slotted (50*50*3.15mm) angles may be used. Each Rack designed to keep 32 nos battery. All the racks rest on the loco base structure duly ensuring rigidity and avoid undue vibration.	
Traction Battery Charger Traction Battery Charger 1 & 2 are of same type and each consisting of two full wave bridge rectifier connected in same input and with two separate output each diode having load capacity of 510A. Diode Type – S36AR510 of Hirect make. Four identical power diodes mounted on Heat sink and constructed for air natural cool. Interconnections between bridges are made by Copper Bar (30mmx 5 mm) with proper separator and support with insulators. Each unit having dimension of 540mmx 470mmx 750mm and a weight of approx. 45 kg.	
Rectifier for Main Compressor MCP 1 & 2 Battery Chargers are housed in a single unit each consisting of a full wave bridge Rectifier with separate input and output. The load capacity of the charger's is 510 A DC for each Set. Rectifier is to be fed from Two nos. 415/110V, 33kVA Transformers to be supplied from Aux. Windings.	
Transformer for Battery Charger 2 nos. ATFEX are being used for traction battery charger unit 1 & 2. It is placed near BA Panel -1 & contactor panel is placed over it. Rating: 60kVA , Input rated voltage-1000V, Output rated Voltage -80V, Output rated current-750A	

Contactor Change over Panel Two nos. of CTF Drum controllers (CTF3) are used to work like changeover switch between "OHE Mode" and "Battery Mode: One Program Switch (HBH) is provided in Driving Desk for making this change over from Drivers Cab	
Modified BA Panel All the BA panel modified after removing all sorts of resistance mounting on it to reduce size of the panels and accordingly electrical connections made. The pneumatic feed pipe line to the BA panels modified and properly layout done. BA PANEL -1 & 2 : Equipments used: Reverser(1500A)-01 Line Contactor(1500A)-03 nos Shunting contactor(325A)-02 nos Overload relay-01 no QD relay-01 RQOP(3200ohm)-03nos QVS realy-01no. SHAA-01no Power terminal -02 nos	
Exhaust Fan 4 nos. Exhaust fan, 230V, 50Hz, 38W fitted in loco in place of sky light glass on Loco body. This is required for exhaust the heat from the loco during battery operation for battery and other equipments cooling. This exhaust fan is feed by 110V DC/230V AC, 2.5kW Inverter.	
Inverter for exhaust fan Spec.	2.5 kVA, 110V DC/ 230V AC
Resistance for MCP, 0.05 Ohm	This resistance is connected with DC Compressor to control the starting & running current of compressor.
Digital DC Voltmeter for Tr. BA-1 & 2, Range : 0-300 V DC	These meters are being used to display the Tr. Battery voltage in Cab-1 & -2
Analog DC Voltmeter for MCP, Range : 0-150 V DC	These voltmeters are being used to indicate

	compressor battery voltage in Cab-1 & 2.
Additional Cable requirement (with approx. length)	300 sq mm 1500V (30m) 240sqmm 1500V (140m) 150sq mm1500V (22m) 10sq mm1500V(100m) 4 sq mm 1500V(200m) 50 sq mm750V(150m) 3 sq mm 750V(1300m)

6.0 Abbreviations

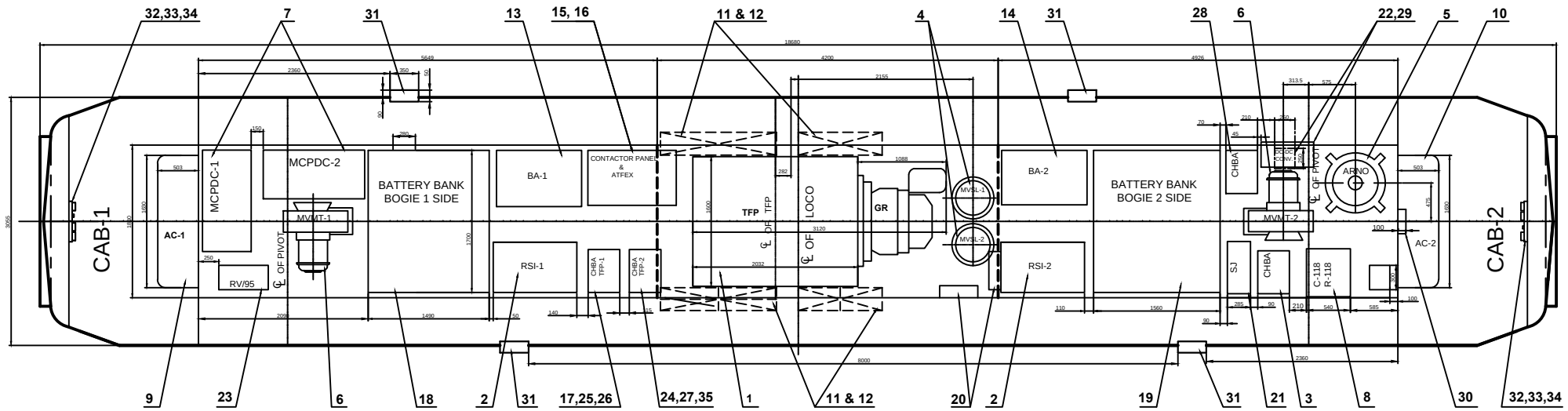
1.	ACC-Advanced Chemistry Cell
2.	BA-BG-1 : Battery for Bogie 1
3.	BA-BG-2 : Battery for Bogie 2
4.	BA-MCP : Battery for MCP-1 and MCP-2
5.	C-1 : Contactor for MCP-1
6.	C-2 : Contactor for MCP-2
7.	C-3 : Contactor for Rectifier unit - MCP 1
8.	C-4 : Contactor for BA-MCP (Battery for Main Compressor)
9.	C-5: Contactor for - MCP 1 in Battery mode.
10.	CTF 31 : Drum type controller for HV to Battery converter , Bogie 1
11.	CTF 32 : Drum type controller for HV to Battery converter , Bogie 2
12.	CHBA 1 : Battery charger for Bogie 1
13.	CH 1 : Contactor for CHBA 1
14.	CHBA 2 : Battery charger for Bogie 2
15.	CH 2 : Contactor for CHBA 2
16.	HCHT : Rotary switch for Traction Battery Charger Isolation
17.	HCP : Rotary switch for MCP-1, MCP-2 and BA-MCPT Charger
18.	HBH : Rotary switch for HV to Battery mode(HBH 1 Cab 1 & HBH 2 at Cab 2)
19.	HVSI-1 : Rotary switch for Rectifier blower -1
20.	HVSI-2 : Rotary switch for Rectifier blower -2
21.	HVMT-1 : Rotary switch for Traction blower -1
22.	HVMT-2 : Rotary switch for Traction blower -2
23.	HMCS-1 : Traction Motor Selection switch for Bogie -1
24.	HMCS-2 : Traction Motor Selection switch for Bogie -2
25.	OLR : Over Loading Relay
26.	QHT : HT protective relay
27.	QVS 1 : Voltage sensor Relay for CHBA 1
28.	QVS 2 : Voltage sensor Relay for CHBA 2
29.	RCP1 : Rectifier for MCP -1
30.	RCP2 : Rectifier for MCP -2
31.	TFPA-1: Auxiliary transformer (415/140 V) for MCP-1

32.	TFPA-2: Auxiliary transformer (415/140 V) for MCP-2
33.	MP : Master Controller
34.	ZPR : DC-DC Converter Isolation Switch

7.0 References:

(i) Conversion scheme of WAG5 loco into DMSL by Central Railway (ELS/BSL).
(ii) Conversion scheme of WAG5 loco into DMSL by Eastern Railway (KPA workshop).
(iii) Conversion scheme of WAG5 loco into DMSL by Southern Railway (ELS/AJJ).
(iv) Conversion scheme of WAG5 loco into DMSL by Southern Railway (LW/PER/SR).
(v) Conversion scheme of WAG5 loco into DMSL by West Central Railway (ELS/NKJ).

========



EQUIPMENT INDEX

ITEM NO.	DESCRIPTION	QTY.
1	MAIN TRANSFORMER	1
2	RECTIFIER (800 Kg Approx.)	2
3	LOCO BATTERY CHARGER (160 Kg Approx.)	1
4	SMOOTHING REACTOR (1455 Kg Approx.)	2
5	ARNO (1120 Kg Approx.)	1
6	T.M BLOWER (350 Kg Approx.)	2
7	COMPRESSOR DC(1000 LPM) (425 Kg Approx.)	2
8	ARNO STARTING RESISTOR(C118 &R118) (75 Kg Approx.)	1
9	PNEUMATIC CABINET	1
10	AUXILIARY CABINET	1
11	LOCO BATTERY UNITS	10
12	LOCO BATTERY BOX	4
13	Ba - 1 PANEL (287 Kg Approx.)	1
14	Ba - 2 PANEL (285 Kg Approx.)	1
15	CONTACTOR PANEL (328 Kg Approx.)	1
16	ATFEXTFP, 415/33V AC (300 Kg Approx.)	2
17	BATTERY CHARGING TRANSFORMER, 390/140 ÑÍ0V AC, 22 KVA (325 Kg Approx.)	1
18	BATTERY BANK BOGIE 1 SIDE	23

EQUIPMENT INDEX

ITEM NO.	DESCRIPTION	QTY.
19	BATTERY BANK BOGIE 2 SIDE	23
20	RCAPTFP (54 Kg Approx.)	2
21	INDUCTIVE SHUNT (SJ) (330 Kg Approx.)	1
22	DC-DC CONVERTER (20 Kg Approx.)	1
23	DISTRIBUTOR VALVE WITH TANK (95 Kg Approx.)	1
24	RESISTANCE FOR MCP , 0.5Ý (1 Kg Approx.)	2
25	CONTACTOR FOR MCP, 200A, 150V DC (41.2 Kg Approx.)	8
26	CHBA FOR MCP, 510A x 2 (45 Kg Approx.)	1
27	CHBA FOR Tr. BATTERY OF BOGIE -1 , 510A x 2 (45 Kg Approx.)	1
28	CHBA FOR Tr. BATTERY OF BOGIE - 2 , 510A x 2 (45 Kg Approx)	1
29	INVERTER, 2.5KVA 110V DC/230V AC (30 Kg Approx.)	1
30	CONTROL PANEL, 2.5KVA INVERTER, 110V DC/230V AC (8 Kg Approx)	1
31	EXHAUST FAN, 230V, 38W	4
32	DIGITAL DC VOLTMETER FOR Tr. BA -1 & 2, RANGE: 0-300V DC	4
33	ANALOG DC VOLTMETER FOR MCP , RANGE : 0-150V DC	2
34	TRACTION BATTERY LOW VOLTAGE INDICATOR + BUZZER	2
35	MCP DC CHARGING TFP, 415 /140Ñ10V AC, 33 KVA(405 Kg Approx.)	1

EQUIPMENT ADDED

SL NO.	INDEX SL NO.	DESCRIPTION	QTY.
1	7	COMPRESSOR DC (1000 LPM)	2
2	15	CONTACTOR PANEL	1
3	16	ATFEXTFP, 415/33V AC	2
4	17	BATTERY CHARGING TRANSFORMER, 390 / 140Ñ10V AC, 22 KVA	1
5	18	BATTERY BANK BOGIE SIDE 1	
6	19	BATTERY BANK BOGIE SIDE 2	
7	24	RESISTANCE FOR MCP , 0.5Ý	2
8	25	CONTACTOR FOR MCP, 200A, 150V DC	8
9	26	CHBA FOR MCP , 510A x 2	1
10	27	CHBA FOR Tr. BATTERY OF BOGIE -1, 510A x 2	1
11	28	CHBA FOR Tr. BATTERY OF BOGIE - 2, 510A x 2	1
12	29	INVERTER , 2.5 KVA,110V DC/230V AC	1
13	30	CONTROL PANEL, 2.5KVA INVERTER, 110V DC/230V AC	1
14		GEAR RATIO 15 : 62	6
15	31	EXHAUST FAN , 230V, 38W	4
16	32	DIGITAL DC VOLTMETER FOR Tr. BA -1 & 2, RANGE: 0-300V DC	4
17	33	ANALOG DC VOLTMETER FOR MCP, RANGE : 0-150V DC	2
18	34	TRACTION BATTERY LOW VOLTAGE INDICATOR + BUZZER	2
19	35	MCP DC CHARGING TFP, 415 /140Ñ10V AC, 33 KVA	1

EQUIPMENT REMOVED

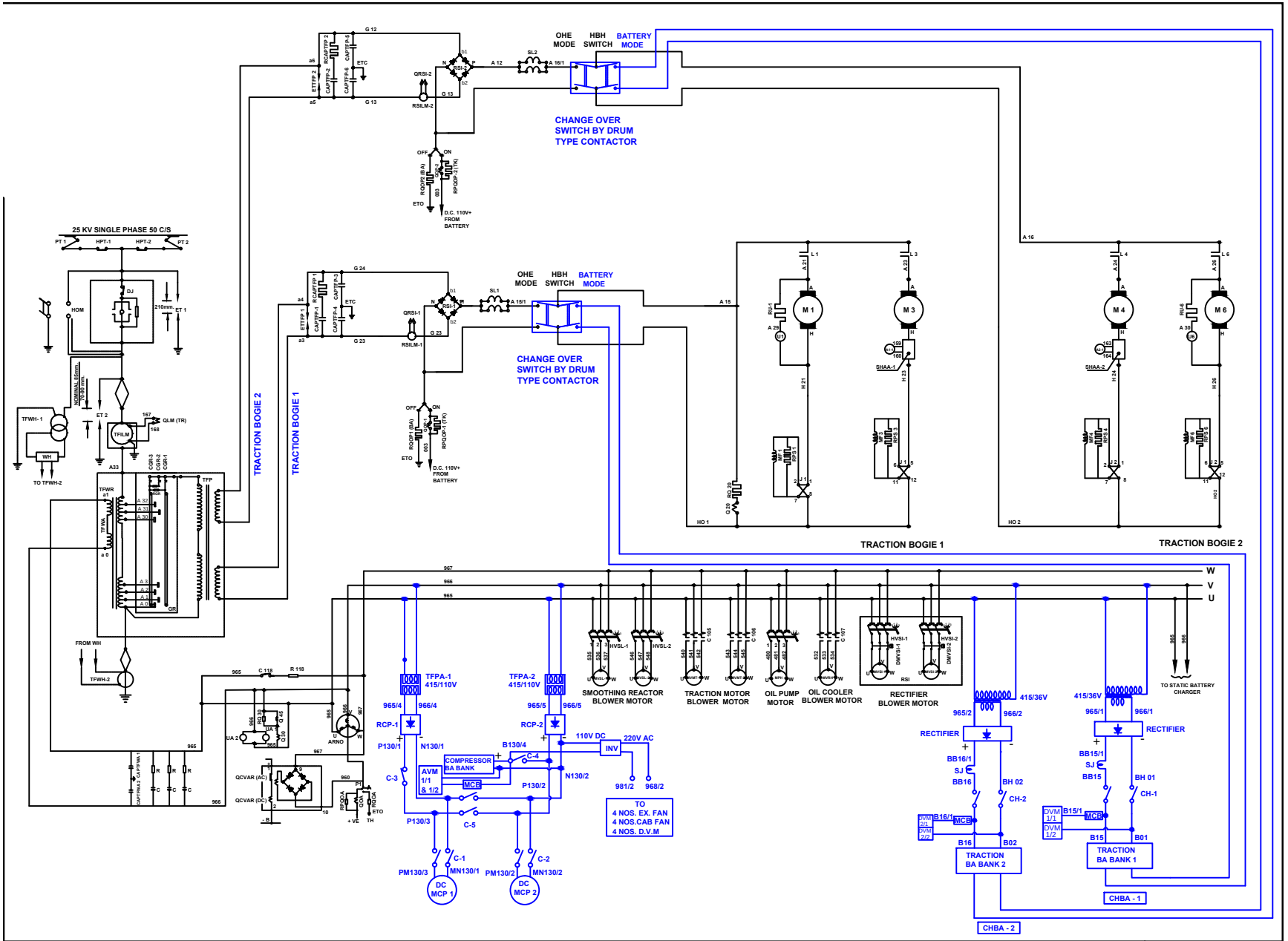
SL NO.	DESCRIPTION	QTY.
1	MAIN COMPRESSOR 1,2 & 3	3
2	DBR	1
3	BA-3 PANEL	1
4	GEAR RATIO 21:58	6
5	CTF - 1 & 2	2
6	SHUNTING CONTACTOR	2
7	RESISTANCE FOR SHUNTING (RS)	1
8	C145	1
9	QF SHUNT	2
10	ATFEX	1

EQUIPMENT RELOCATED

SL NO.	DESCRIPTION	QTY.
1	RCAPTFP	2
2	RSI- 1 & 2	2
3	DC-DC CONVERTER	1
4	INDUCTIVE SHUNT (SJ)	1

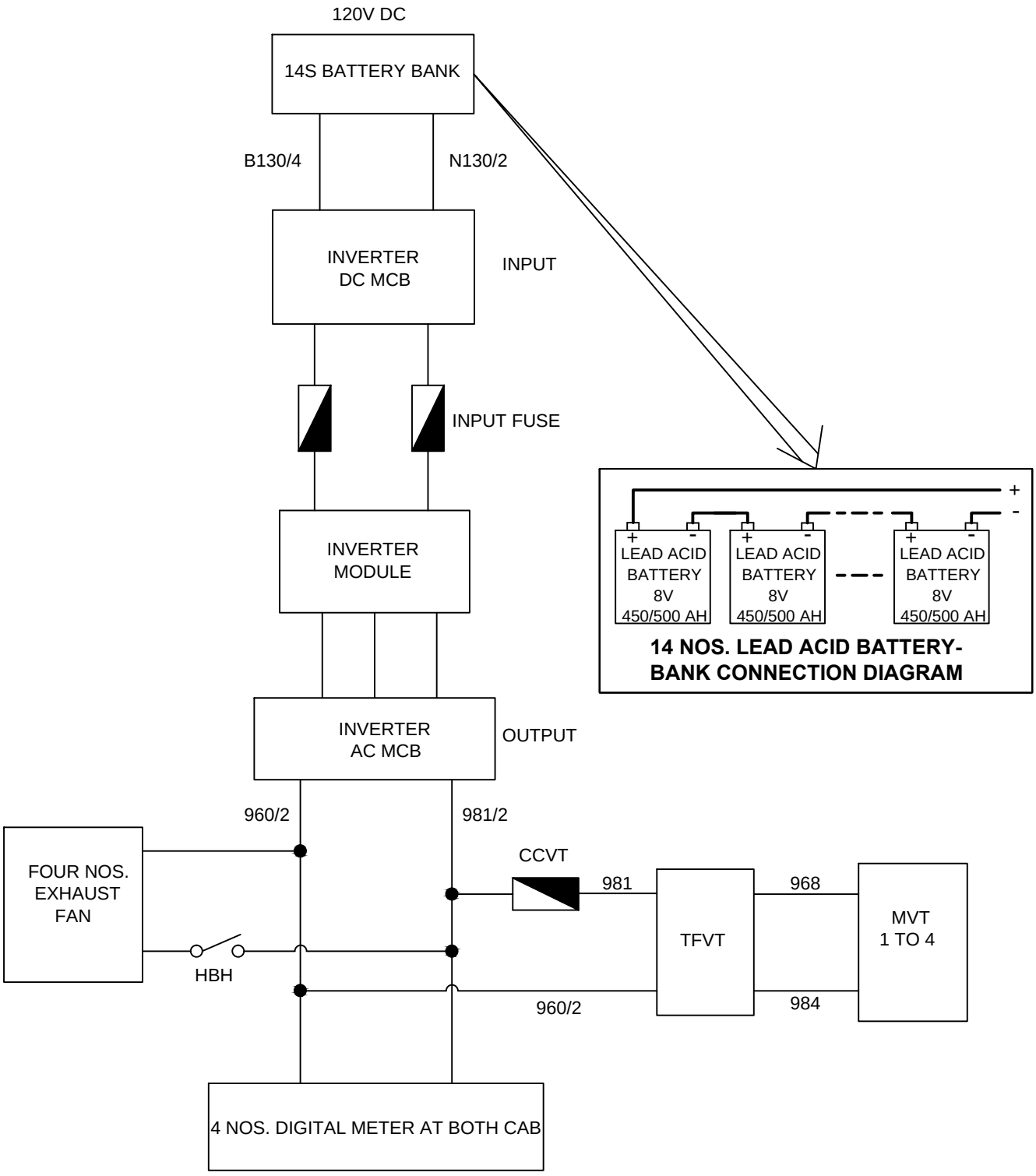
EQUIPMENT LAYOUT OF PROPOSED DUAL MODE SHUNTING LOCO

ANNEXURE-1

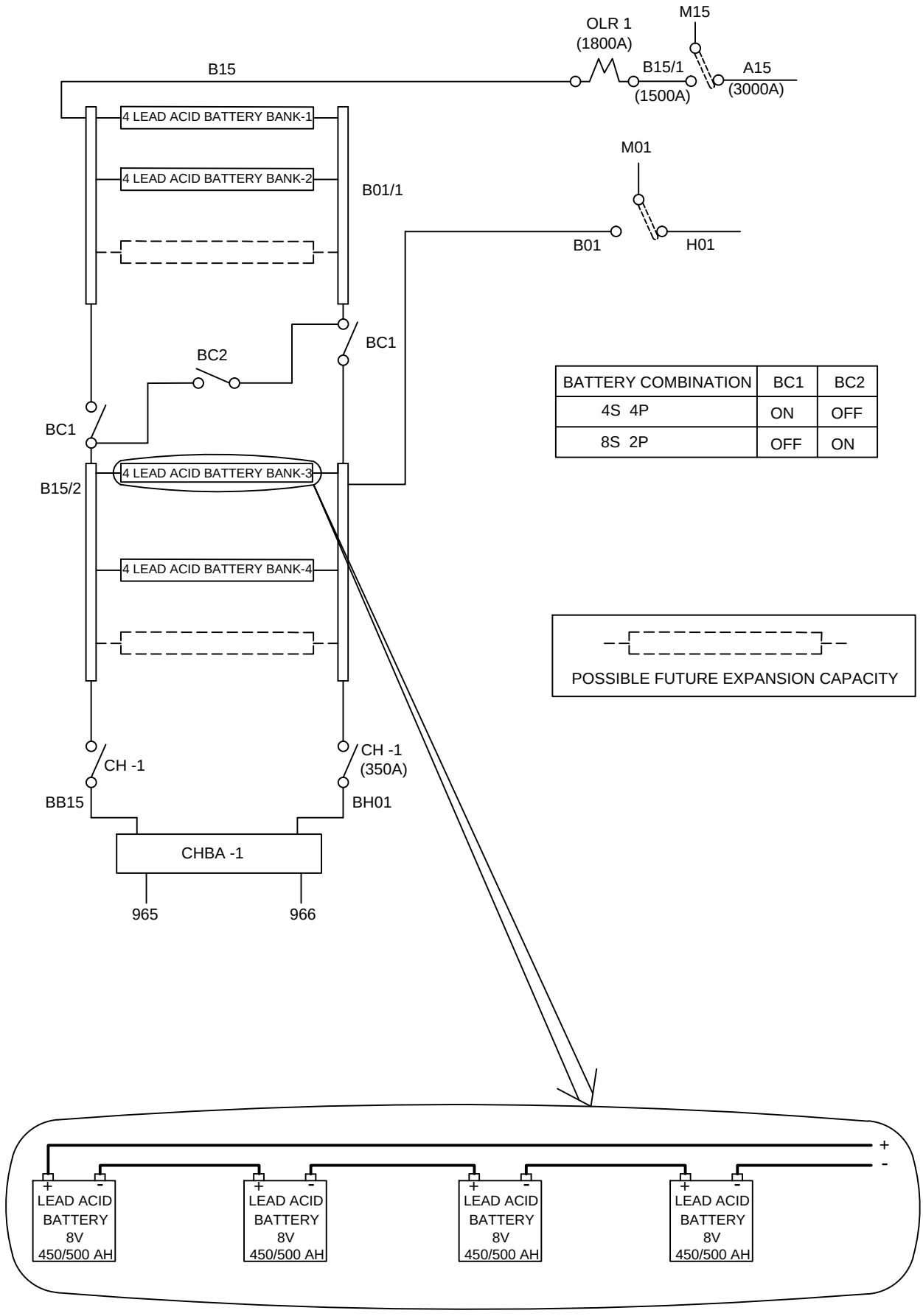


SCHEMATIC PLAN OF POWER & AUXILIARY CIRCUIT

ANNEXURE-2



TFVT & BATTERY COOLING FAN CIRCUIT | **ANNEXURE-3**

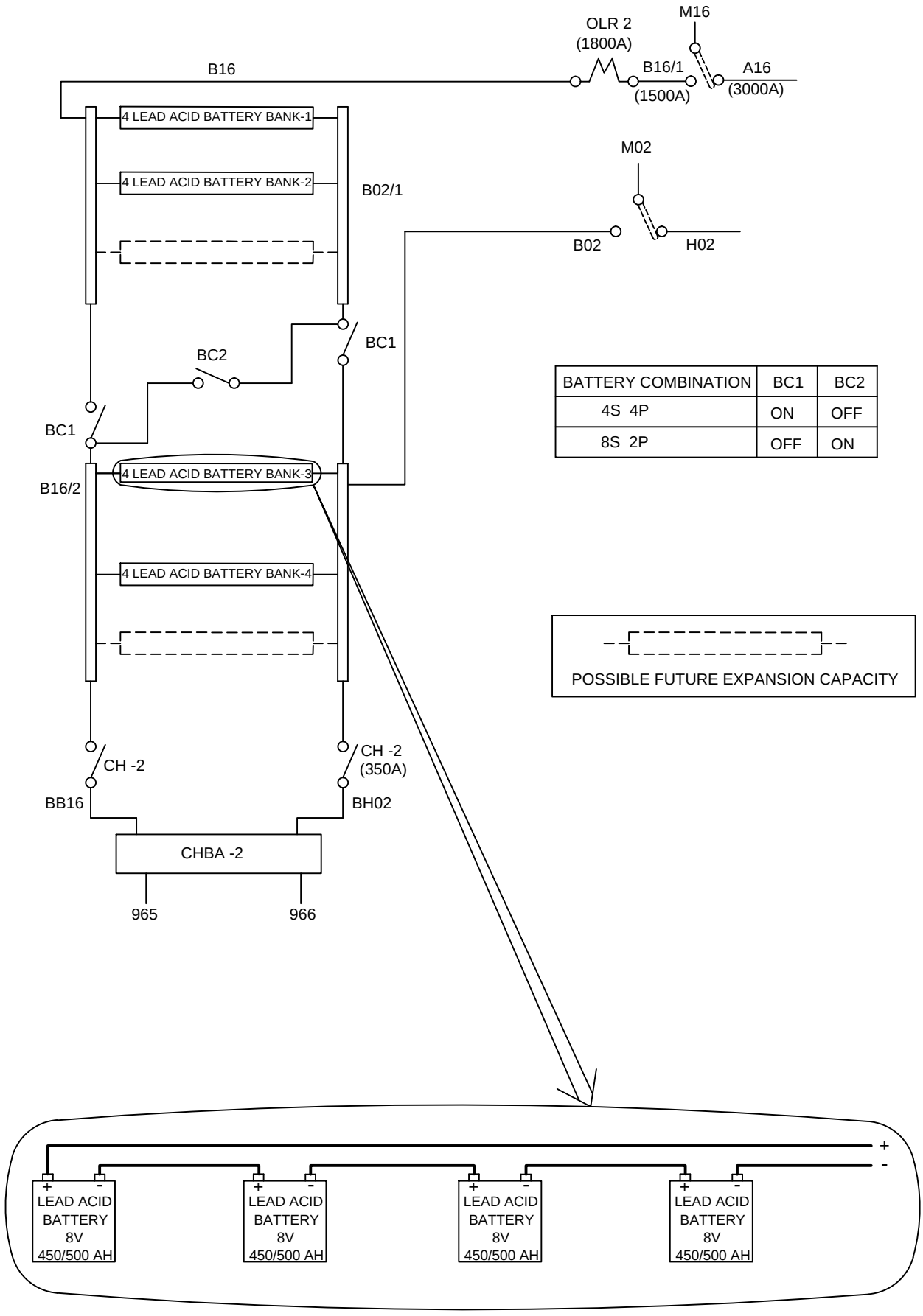


BATTERY COMBINATION	BC1	BC2
4S 4P	ON	OFF
8S 2P	OFF	ON

(BLOCK-1)

PROPOSED SCHEMATIC CIRCUIT DIAGRAM FOR TRACTION BATTERY WITH 2ND NOTCH PROVISION

ANNEXURE-4

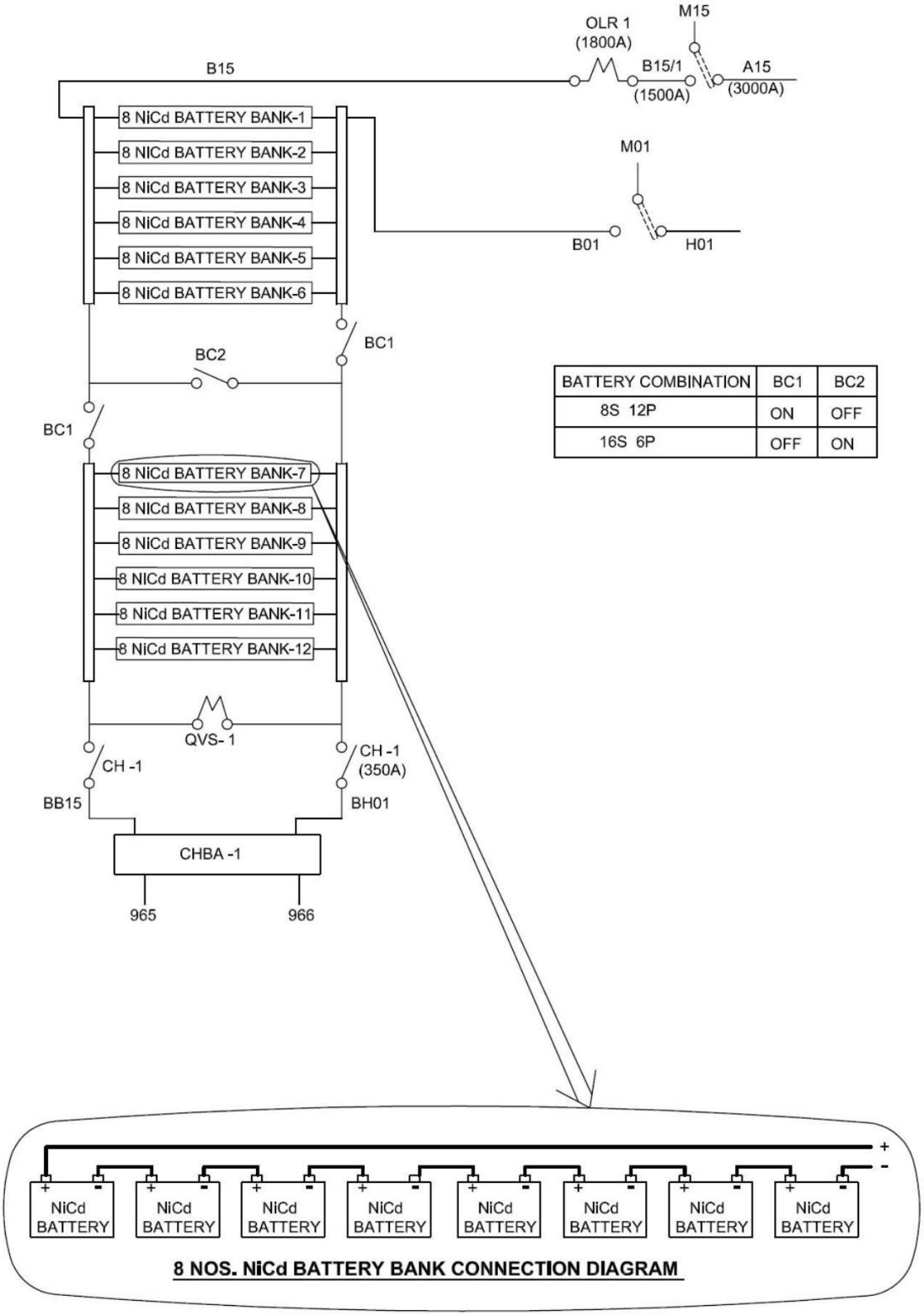


BATTERY COMBINATION	BC1	BC2
4S 4P	ON	OFF
8S 2P	OFF	ON

(BLOCK-2)

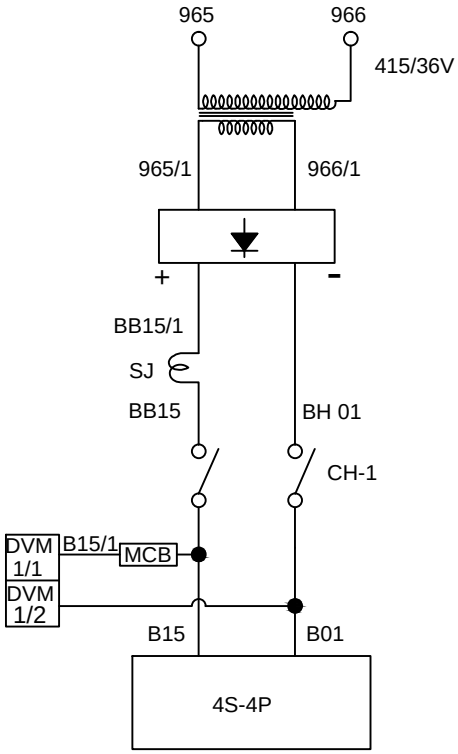
PROPOSED SCHEMATIC CIRCUIT DIAGRAM FOR TRACTION BATTERY WITH 2ND NOTCH PROVISION

ANNEXURE-5

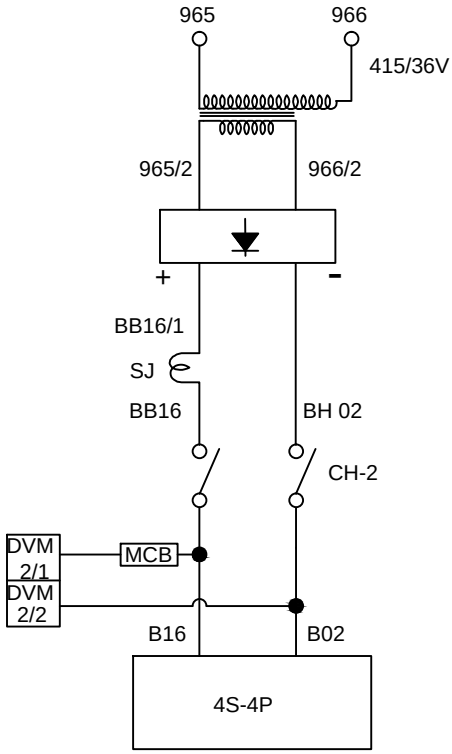


BATTERY COMBINATION	BC1	BC2
8S 12P	ON	OFF
16S 6P	OFF	ON

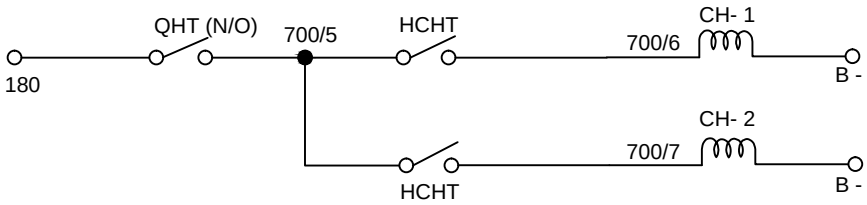
8 NOS. NiCd BATTERY BANK CONNECTION DIAGRAM



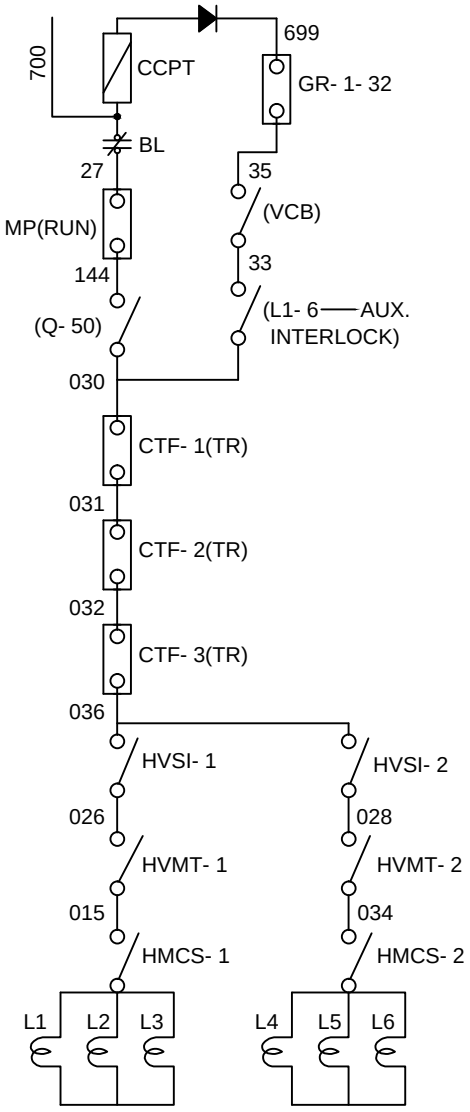
CHBA - 1



CHBA - 2

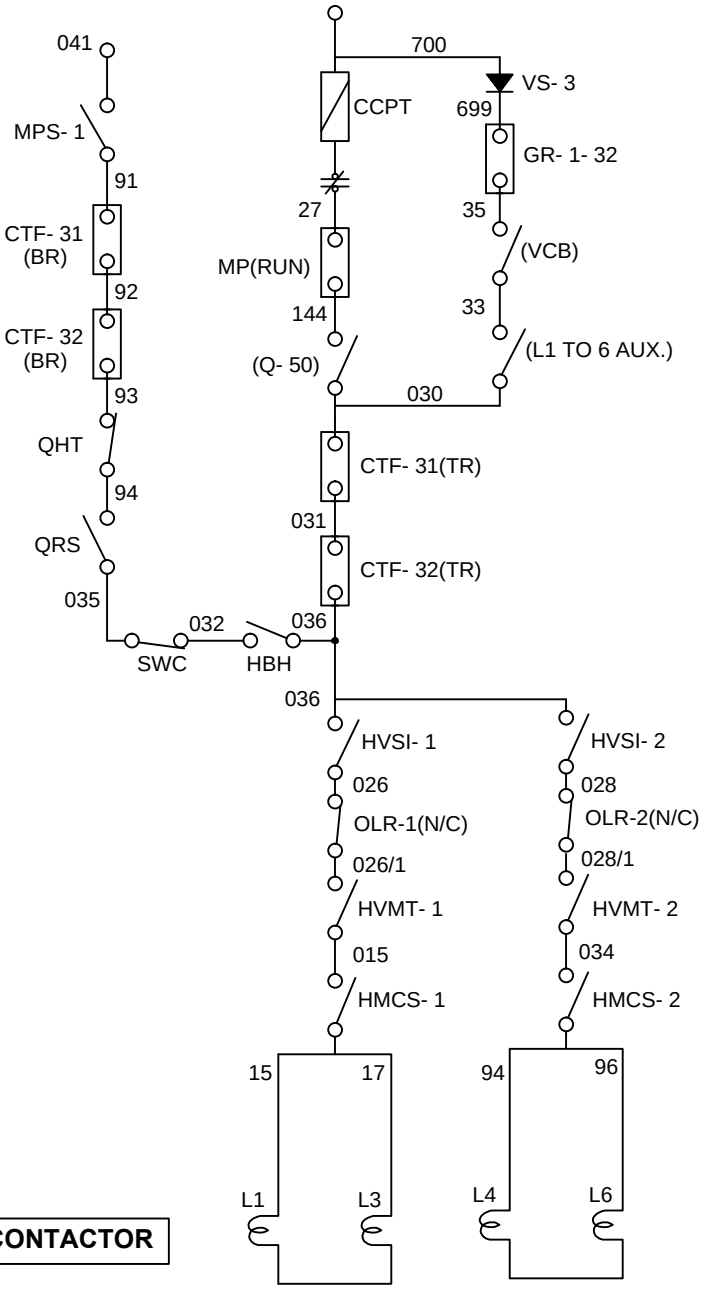


TRACTION BATTERY BANK CHARGER CIRCUIT	ANNEXURE-6



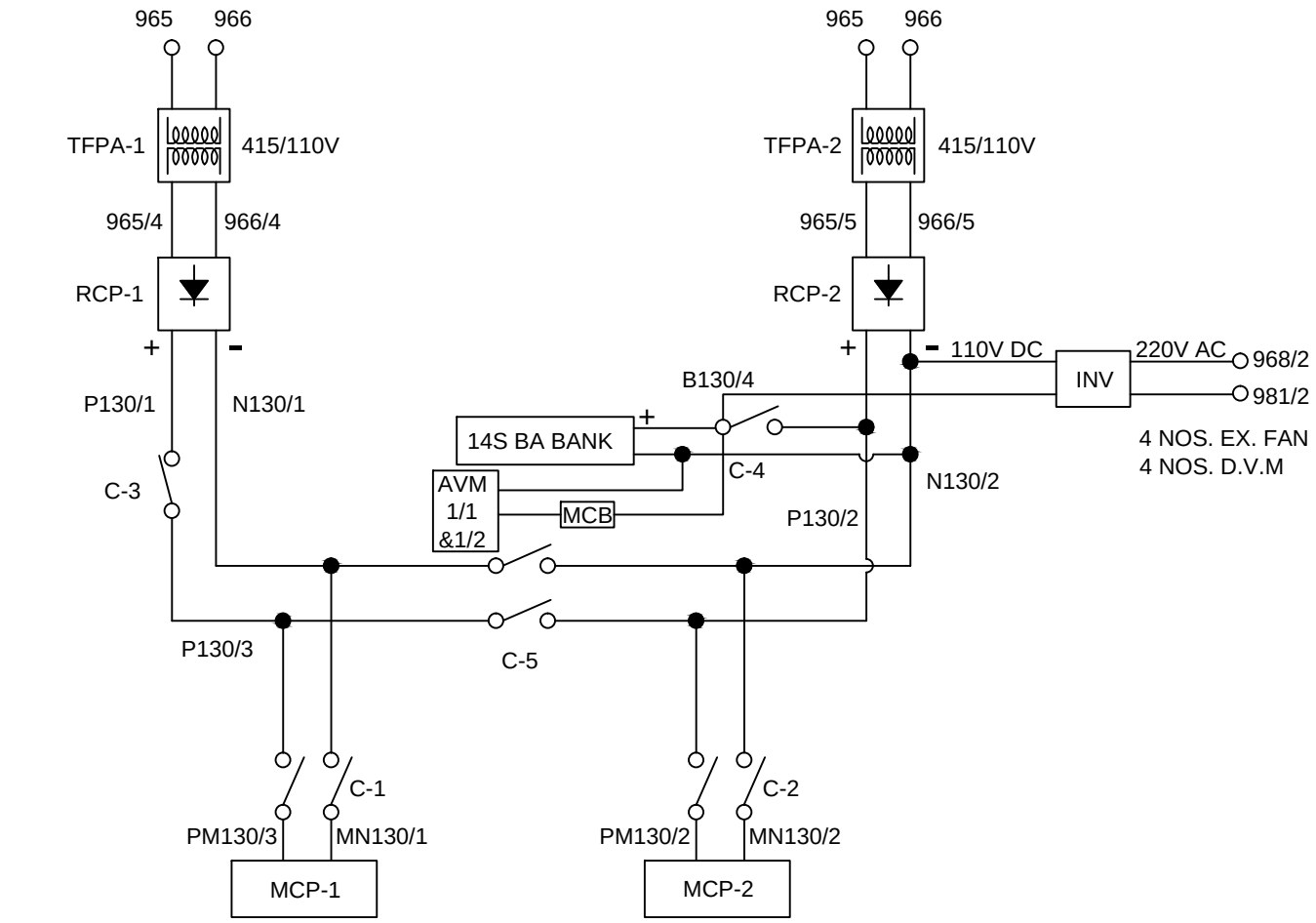
EXISTING

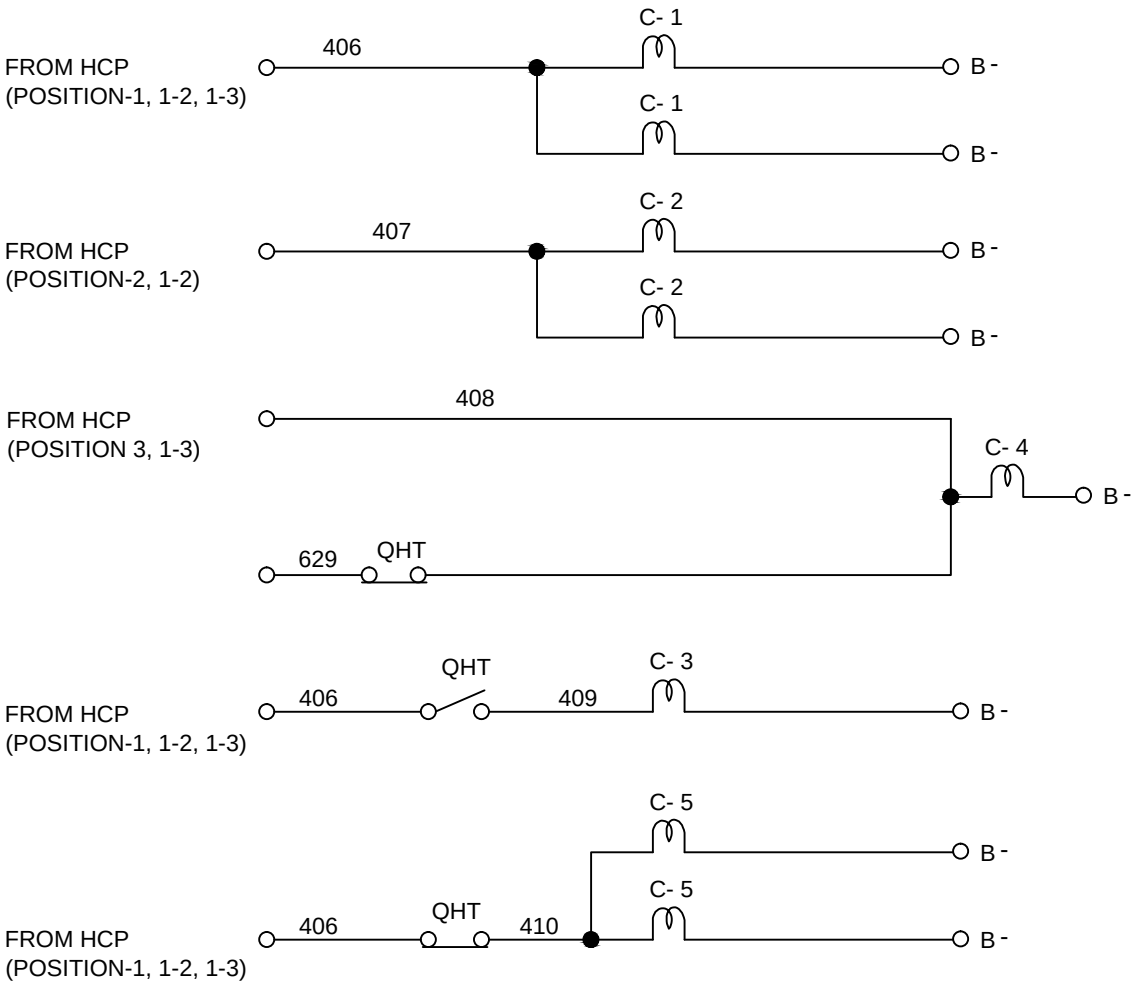
LINE CONTACTOR



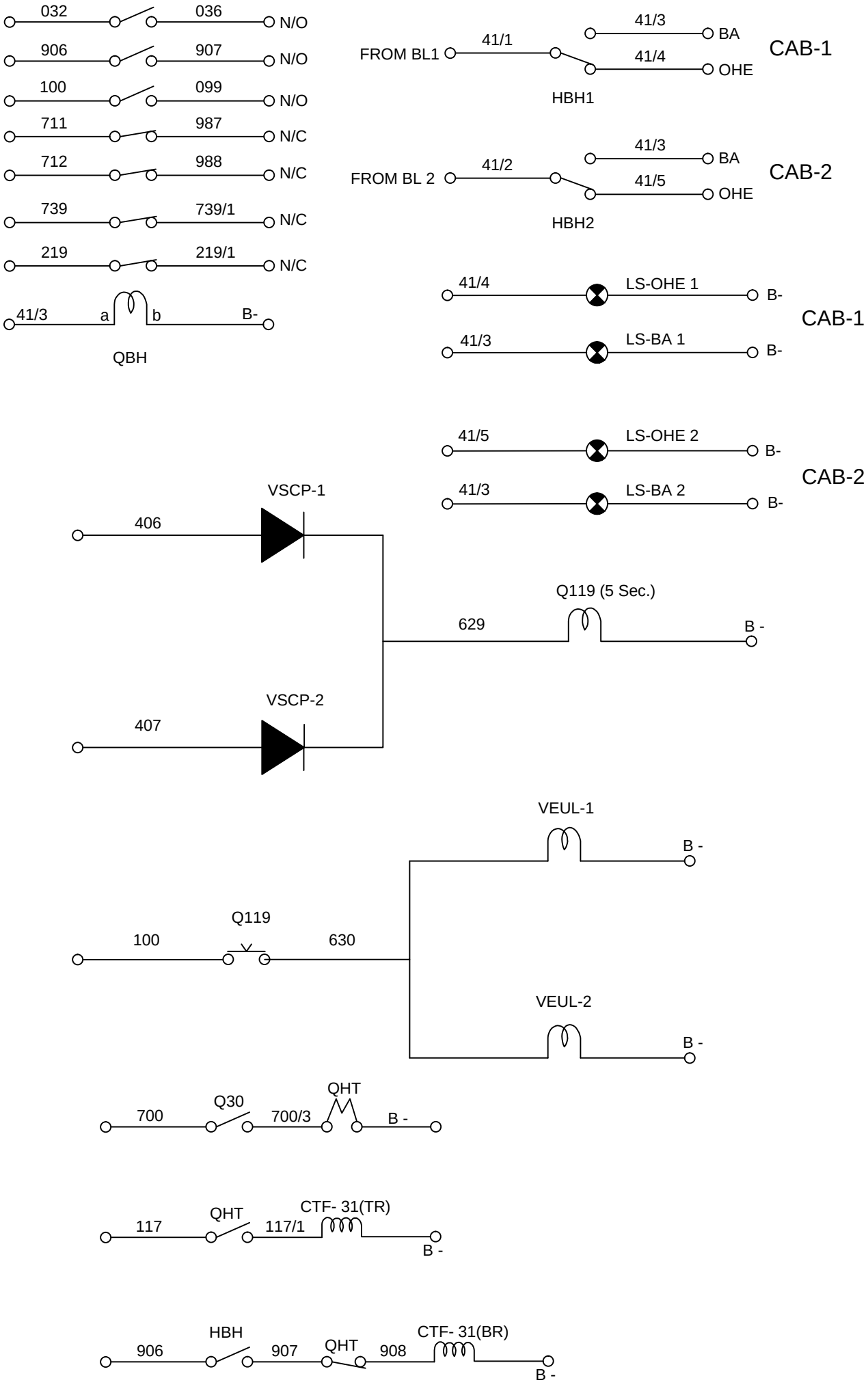
MODIFIED

PROPOSED MODIFIED MOTOR CONTACTOR AND QD CIRCUIT	ANNEXURE-7

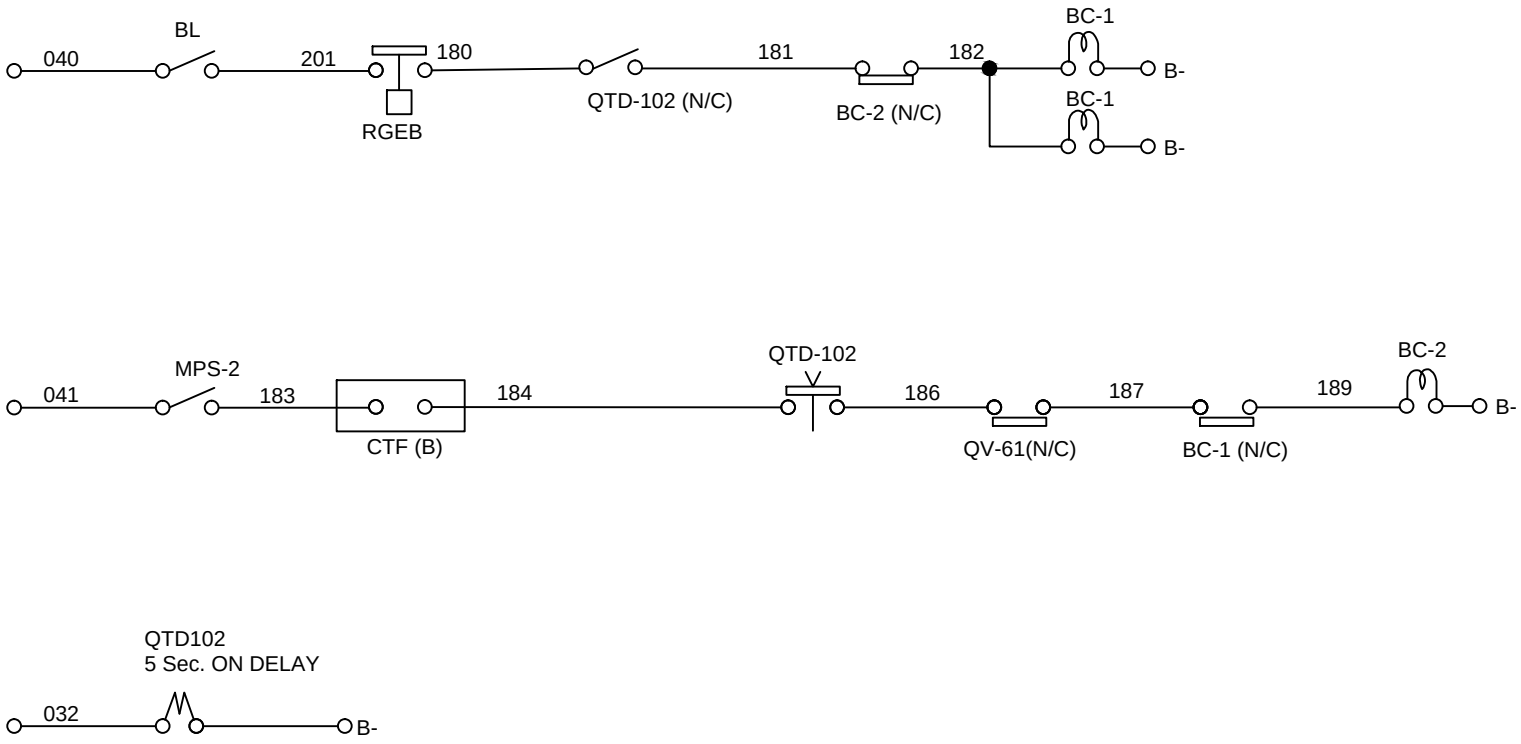




MAIN COMPRESSOR CIRCUIT	ANNEXURE-8

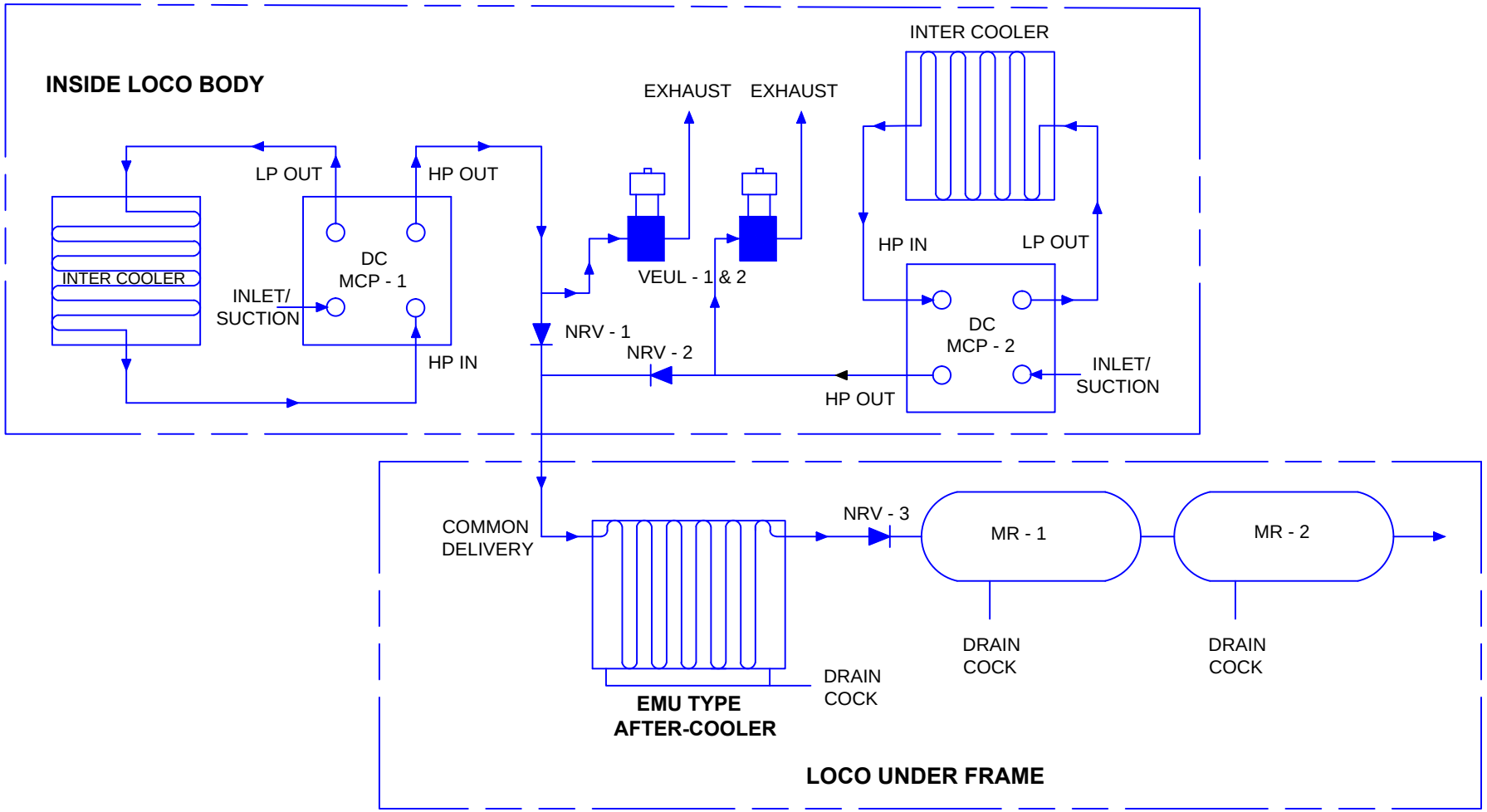


UNLOADER, HBA AND BATTERY OHE CONVERSION CIRCUIT | **ANNEXURE-9**



MODIFIED CONTROL CIRCUIT FOR SECOND NOTCH PROVISION

ANNEXURE-10



LAY OUT DIAGRAM OF DC MCP

ANNEXURE-11