Expression of Interest (EOI) for Functional Requirement Specification for Conversion of Diesel Locomotive to Electric Locomotive (Development of Specification):

Motive Power Directorate of Research, Designs & Standards Organisation (RDSO), Lucknow, under the Ministry of Railways (MOR), is interested in Conversion of Diesel Locomotive to Electric Locomotive. Details of such item, for which this part of EOI intends to cover the stage of *development of specification*, are as follows:

S. No.	Description	Details of Specification	Contact Details
1	FUNCTIONAL REQUIREMENT SPECIFICATION FOR CONVERSION OF DIESEL LOCOMOTIVE TO ELECTRIC LOCOMOTIVE	Specification No. MP.0.0400.16, (Revision - 00) December' 2017	P. Srinivasu, Director/Motive Power-EC Room No: 103 Building: Manak Bhawan Telephone No.: 0522-2465732, email: mp.directorec@gmail.com

Details of the above-mentioned *Functional Requirement Specification (FRS)* are attached herewith.

Firms who have enough experience/capabilities in the field, have ISO certificate and are interested in developing and supply of above items are requested to submit details in the prescribed format attached herewith to the concerned officer mentioned against each item.

In case of any doubt, please contact the concerned officer mentioned against each item in office at Lucknow, on any working day.

Annexures: A & AA

Executive Director
Motive Power Directorate.

Annexure A

FORMAT FOR LETTER OF RESPONSE

Respondents Ref No.:

Date:

Designation of officer to whom the respondent replies
Room No: ,
Building:
Research Designs & Standards Organization
Ministry of Railways
Manak Nagar
Lucknow,
INDIA 226011

Dear Sir,

Subject: RESPONSE TO – EOI FOR PARTICIPATION _____

1. We, the undersigned, offer the following information in response to the Expression of Interest sought by you vide your Notification No._____, dated _____.

2. We are duly authorized to represent and act on behalf of _____ (hereinafter the "respondent")

3. We have examined and have no reservations to the EOI Document including Addenda No(s) _____.

4. We are attaching with this letter, the copies of original documents defining: -
   4.1. the Respondent's legal status;
   4.2. its principal place of business;
   4.3. its place of incorporation (if respondents are corporations); or its place of registration (if respondents are cooperative institutions, partnerships or individually owned firms);
   4.4. Self-certified financial statements of Last three years, clearly indicating the financial turn over and net worth.
   4.5. Copies of any market research, business studies, feasibility reports and the like sponsored by the respondent, relevant to the project under consideration

5. We shall assist MOR and/or its authorized representatives to obtain further clarification from us, if needed.

6. RDSO and/or its authorized representatives may contact the following nodal persons for further information on any aspects of the Response:

S. No.	Contact Name	Address	Telephone	E Mail
1				
2				

7. This application is made in the full understanding that:
   7.1 Information furnished in response to EOI may be used confidentially by RDSO for the purpose of development of the product.
   7.2 RDSO reserves the right to reject or accept any or all applications, cancel the EOI and subsequent process without any obligation to inform the respondent about the grounds of same.
   7.3 We confirm that we are interested in participating in development of the product.

8. We certify that our turnover and net worth in the last three years is as under:

Financial Year	**Turn over**	**Net worth**

9. In response to the EOI we hereby submit the following additional details annexed to this application.
   9.1 Details of various items being manufactured/consultancy undertaken.
   9.2 Details of customer(s) and supplies made in the field of item under EOI.
   9.3 Experience and expertise for the items proposed in EOI.
   9.4 Details of man-power with their qualification and experience.
   9.5 Detailed proposal for items proposed in EOI including alternative proposal, if any.
   9.6Details of Intellectual Property Rights (IPR) held, patent filed/held and MOU/agreement signed.
   9.7 Details of ISO certification.
   9.8 Undertaking as per Annexure-AA

10. The undersigned declare that the statements made and the information provided in the duly completed application are complete, true, and correct in every detail. We also understand that in the event of any information furnished by us being found later on to be incorrect or any material information having been suppressed, RDSO may delete our name from the list of qualified Respondents. We further understand that RDSO will give first preference to the applicants considered relevant for the purpose.

11. Our response is valid till (date in figures and words):_____

Yours sincerely,

(Sign)
Name
In the Capacity of
Duly authorized to sign
the response for and on behalf of
Date

Annexure-AA

(To be taken on non-judicial stamp paper of appropriate value as applicable in the respective state and duly notarised and witnessed)

UNDERTAKING

I, son of …… aged about …..... Years resident of …….. do hereby solemnly affirm as under:

1. That the deponent is the Authorised signatory of *(Name of the Sole Proprietorship Concern/Partnership Firm/ Registered Company/ Joint Venture).*

2. That the deponent declares on behalf of *(Name of the Sole Proprietorship Concern/ Partnership Firm/ Registered Company/Joint Venture)* that:

   a) In regard to matters relating to the security and integrity of the country, no charge sheet has been filed by an agency of the Government and/or conviction awarded by a Court of Law for an offence committed by the ----------(*name of the entity)* or by any sister concern of the ----------*(name of the entity*) which would constitute disqualification of----------(*name of the entity or any of it's sister concerns*).

   b) In regard to matters other than the security and integrity of the country, ----------(*name of the entity*) has not been convicted by a Court of Law or indicted / passed any adverse order by a regulatory authority against it or it's any sister concern which relates to a grave offence, or would constitute disqualification. Grave offence is defined to be of such a nature that it outrages the moral sense of the community.

DEPONENT

VERIFICATION

I declare that the contents of para 1 to 2 above are true as per my knowledge and nothing has been hidden.

DEPONENT

R.D.S.O

भारत सरकार, रेल मन्त्रालय

GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

FUNCTIONAL REQUIREMENT SPECIFICATION FOR

CONVERSION OF DIESEL LOCOMOTIVE TO ELECTRIC LOCOMOTIVE

Specification No. MP.0.0400.16

(Revision - 00)

December' 2017

अनुसंधान अभिकल्प और मानक संगठन
लखनऊ–226 011
RESEARCH DESIGNS & STANDARDS ORGANISATION
LUCKNOW - 226 011

CONTENTS

SPECIFICATION FOR

CONVERSION OF DIESEL LOCOMOTIVE TO ELECTRIC LOCOMOTIVE

1.0 Introduction

Railway Board vide the letter no. 2017/M(L)/466/21 dt. 14.11.2017 directed RDSO to examine the feasibility for conversion of existing fleet of diesel locomotive to electrical locomotives. Subsequently, RDSO conducted a meeting with the existing suppliers of AC-AC system and MBCS for initial deliberations on the subject.

After studying various issues associated and deliberations held, Railway Board was advised vide letter no, SD.Dev.Dual Mode Loco dt. 16.11.2017 that prima facie it is possible to convert the diesel locomotives duly retaining the Motorized Truck assembly, CCB etc. suitably redesigning the underframe and superstructures in addition to design, supply and fitment of conversion kit for the proposed electric loco.

In response to the RDSO letter no. SD.Dev.Dual Mode Loco dt. 16.11.2017, Railway Board vide letter no. 2017/Elect/Dev;440/11 dt. 29.11.2017, mandates the following boundary conditions

(i) At this stage it is proposed to plan for conversion of HHP Diesel locomotives (capacity 4000/4500 HP each) to twin Co-Co Electric locomotives (about 10000 HP capacity) involving minimum changes by retaining existing traction motor and drive side traction converter.

(ii) Starting tractive effort of each unit of each converted electric locomotive should not be less than existing diesel locomotive (about 540 kN).

(iii) Continuous TE in full power range of each converted locomotive (single unit) should match with that of 5000 HP WAG 7 locomotives.

(iv) Detailed technical feasibility report along with budgetary offer may be obtained from Siemens, EMD, Medha, Alstom, Bombardier and GE.

Though it is planned to convert both HHP and ALCo class locomotives, in the first phase HHP locomotives would be taken up.

Accordingly, RDSO developed this functional requirement specification and involve industry for development of detailed technical specification by publishing EOI.

CHAPTER - 1

1.1 Brief Scope

The basic scope covers development of specification for conversion of two HHP locomotives to twin Co-Co electric locomotives. The proposed locomotives would have features similar to the Bo-Bo Alstom IR locomotive to the specification no. RDSO/2006/EL/SPEC/0044, Rev '13'.

The scope shall include the following.

- MTA of the HHP locomotives along with the under frame would be retained and a integration kit consists of suitable transformer, control system, auxiliaries, etc. shall be developed for conversion to electric locomotive by retaining under frame and Motorized Track Assembly (MTA).
- The HP is limited by the maximum rating of the traction motor under use in HHP locomotive.
- The car body/ superstructure shall be redesigned for electric locomotive retaining the structure to the maximum possible extent (ie. minimum changes to the under frame and car body).
- Design new car body is open to both monocoque design similar to the electric locomotive and to semi monocoque design like diesel locomotive. While re-designing the car body, ease of maintenance shall be taken care duly retaining original under frame. Cost effective design of car body with minimum changes in the underframe without compromising the mechanical strength of under frame is paramount importance. The newly designed car body shall be validated by simulation studies.
- The prototype locomotive would undergo oscillation trials as per the conditions of the Policy circular no. 6 and meet the requirements of third criteria committee of RDSO to the existing speed potential of the HHP locomotive.

1.2 The current fleet of HHP locomotive with some features are given below:

Sl. No.	Class of loco	HP	No. of Locos.	No. of TM/Loco	Type of TM	Rating of TM/Max. RPM	Staring/ Continuous TE (KN)	GTO/ IGBT
1	WDP4	4000	92	4	PAC	1758V, 251A, 637KW, 3776 RPM	270/200	GTO-32 IGBT-60
2	WDG4	4000	275	6	MAC	1520V,202A, 485W, 3320 RPM	540/400	GTO-129 IGBT-146
3	WDP4B	4500	84	6	MAC		400/217	IGBT
4	WDP4D	4500	449	6	MAC		400/217	IGBT
5	WDG4D	4500	463	6	MAC		540/400	IGBT
6	WDG4	4500	915	6	MAC		540/400	IGBT

1.3 In the first phase WDG4 HHP GTO locomotives with single cab would be taken up for conversion to twin Co-Co to IGBT Electric locomotive. The utility/disposal of the TCC and LCC, ECC of the existing IGBT locos would be considered for discussion in the due course of time when IGBT HHP locos taken up for conversion.

1.4 The industry partner shall provide comprehensive design including the Electrical conversion kit along with the Mechanical design of modification to the car body and under frame. The mechanical design and manufacturing drawings shall be provided by the industry partner which would become the property of the Indian Railway. On successful oscillation trials mechanical modifications would be frozen by Indian Railway with scope open to the different manufacturer for supply and fitment of electrical integration kit within the space and weight envelope of the frozen design.

1.5 The technical and functional requirements specified in the chapter -8 are tentative technical requirements in the lines of the existing fleet of electrical locomotives and these requirements/specification would be tweaked based on the inputs received where ever required.

1.6 Based on the inputs received from the industry partners through EOI, a technical specification would be finalized similar to the lines of the functional requirement specification. PU identified by Railway Board would float a tender for conversion of initial lot of diesel locomotive as per the RSP sanction provided by Railway Board.

CHAPTER - 2

2.1 Proposed Retention of existing equipments and subassembly:

Following items are likely items to be retained for the conversion of existing dual cab HHP diesel locomotive into electric locomotive

2.1.1 Bogie

2.1.2 Coupler, Draft gear & Side buffers

2.1.3 Cattle guard

2.1.4 Brakes

Locomotive are equipped with CCB 2.0 (computer controlled air brake) system to RDSO Specification No.MP.0.01.00.24 (Rev.01) January 2010.

2.1.5 Air drier

2.1.6 Traction Motor

2.1.7 Battery

2.1.8 MU coupler

2.1.9 Horn

2.1.10 Sanding

CHAPTER - 3

3.1 Proposed Items to be customized/Design review/building and testing of loco

3.2 Under frame

Under frame shall be suitably modified to suit the new general arrangement required for conversion of diesel locomotive into electric locomotive.

3.3 Complete super structure

Existing super structure of diesel locomotive is semi monocoque design whereas the electric locomotive is monocoque design. There are modifications required in superstructure of existing diesel locomotive due to removal of radiator fan compartment, engine, engine system, brake grid. Hence, super structure shall be completely modified as per the design of electric locomotive. Complete superstructure of existing HHP loco is given at Annexure-II for reference.

3.4 There would not be any change in the integration of bogie assembly and also the axle loads shall be maintaining by suitable ballasting.

3.5 Brief scope of design review/ building and testing of loco

- Detailed study of the existing HHP/Alco loco design
- Getting 3D files from IR (RDSO/DLW)
- Specification finalization in association with IR.
- Finalization of general layout of equipment, weight balancing, maintaining the axle load of existing loco by suitable ballasting.
- Finalization of scope of supply of electrical integration kit.
- Finite element analysis (Meshing and Solving) and modal analysis.
- Dynamic performance analysis of locomotive on suitable software and clearance of the dynamic analysis by IR meeting the requirements of criteria committee report is essential before finalizing the design.
- Finalization of the design in association with RDSO/DLW.
- Preparing necessary jigs and fixtures for manufacture and supply of additional structural items.
- Dismantle/stripping of unwanted items/structures in association and under the supervision of DLW.
- Ultrasonic/X-ray/Dye penetrant testing of structures where ever required.
- Preparation of the under frame structure for structural additions/ modifications.
- Supply and installation of electrical integration kit along with harnessing parallely, with the structural modifications/additions as per the assembly plan.
- Commissioning and performance testing of the locomotive through stationary/limited field trials.
- Oscillation trials for proving out road worthiness of the locomotive.
- Re work based on re engineering if tweaking of design required based on the oscillation trials report.

CHAPTER – 4

4.1 Tentative list of addition of Electrics for Electric locomotive

Followings are the tentative additional items to be fitted on HHP locomotive for conversion to Electric loco. The list is not exhaustive and apart from above additional items may be fitted by the firm, if required to meet the functional requirement of electric loco.

1. Pantograph with mounting Insulators, Servo Motor
2. VCB (Main Circuit Breaker) along with Earthing Switch
3. 2 Nos. Surge Arrestors
4. PT (Voltage Transformer)
5. HV Cable (with Bushings)
6. CT (Current Transformer)
7. Roof Line Insulators (If two pantos are equipped)
8. Line Converter along with Contactors
9. 100 Hz Filter Circuit with Capacitor
10. Harmonic Filter Resistor with Contactors and Capacitors
11. OCU (Oil Cooling Unit for Transformer oil cooling)
12. TM Blower 1&2 (Motor driven)
13. Aux Converter 1&2 (for Transformer Oil Pump, TM Blower1&2, Air Compressor, Oil Cooler Blower)
14. Battery Charger Module
15. DC Link Earthing Switch
16. Earth fault detection Circuit
17. Auxiliary Compressor for Panto (with Cylinder, Check valves, Pipe line)
18. Traction Transformer
19. Transformer oil pumps
20. Motor driven Air Compressors 2 Nos.
21. Earth Return Brush arrangement on Wheel Axle
22. Earthing Choke

CHAPTER – 5

Tentative list of items to be removed from HHP loco for conversion of HHP Loco to Electric locomotive.

Following items are likely to be removed from the existing HHP locomotives to convert into Electric Loco.

1. Diesel Engine along with Turbo, Air filter unit, W.W. Governor.
2. Main Generator Assembly
3. Auxiliary Generator and TM & TA Blower Assembly
4. Equipment Rack, (Water tank, Fuel oil strainer, Lube oil Filter drum, Lube oil cooler)
5. Cooling Hood along with RCF Motors
6. Electrical Control Cabinet # 3
7. Shaft driven Air Compressor
8. After Cooler
9. Fuel Tank
10. Electrical Control Cabinet #2
11. Fuel Oil Pump

CHAPTER – 6

6.1 Tentative Design requirements for goods

Sharpest curve to be negotiated Single unit without buffer Double unit with buffer	174m radius and 1 in 8½ turnout in either direction.
Locomotive weight Nominal Axle Load	123 T (Max.) +123.T(Max.) 20.5 T
Wheel diameter (mm)	1092 mm (new) 1016 mm (condemning)
Gear ratio	17:90
Maximum operating Speed	100 km/hr
Starting Tractive Effort	540 kN x 2
Braking effort	230 kN x 2
Power to the wheels (The final HP would be decided based on the extent to the rating of the existing traction motor can be extended without effecting the life and performance.)	(4000 HP to 5000 HP) x 2

CHAPTER – 7

Tentative weight schedule of the converted locomotives from HHP Diesel locomotive

Sl.	Item Description	Likely Weight Addition (Kg)	Likely Weight Removed (kg)	Likely Weight retained/modified (kg)	Net Effect (Kg)
1.	Fuel Tank 5000L		-5809		
2.	Auxiliary Generator and Blower		-558		
3.	Air reservoir		-240		
4.	Engine air filter		-200		
5.	Dustbin blower		-212		
6.	Inertial filter		-185		
7.	Radiator ASM		-2586		
8.	Equipment rack		-1406		
9.	Cooling water & piping		-1470		
10.	Long hood str		-5084		
11.	Engine asm		-18371		
12.	Lube oil		-949		
13.	Electrical cable		-745		
14.	Air brake piping		-907		
15.	ECC2		-590		
16.	Main generator		-7366		
17.	Battery & Battery box		-654		
18.	Engine Driven Compressor		-1043		
19.	Misc		-2079		
20.	ECC1		--	1021	1021
21.	DB grid		--	1778	1778
22.	Buffer, coupler & cattle guard		--	2377	2377
23.	TCC		--	3030	3030
24.	Air dryer		--	87	87
25.	Bogies (2 Nos.)		--	41700	41700
26.	underframe		--	19282	19282
27.	Air brake rack CCB		--	244	244
28.	Cab equipped (2 Nos.)		--	3350	3350
29.	Main Transformer	9900			9900
30.	Power Converter (2 Nos.)	6660			6660
31.	Oil cooler Blower (2 Nos.)	1740			1740
32.	Harmonic Filter	520			520
33.	Traction Motor Blower (2Nos.)	808			808
34.	Auxiliary Converter-1	615			615

Sl.	Item Description	Likely Weight Addition (Kg)	Likely Weight Removed (kg)	Likely Weight retained/modified (kg)	Net Effect (Kg)
35.	Auxiliary Converter-2	800			800
36.	Contr. Circuit Cubilcal-1	160			160
37.	Contr. Circuit Cubilcal-2	170			170
38.	Aux. Control Cubical-1	220			220
39.	Aux. Control Cubical-1	105			105
40.	Machine room blower(2 Nos.)	280			280
41.	Equip. Boxes/Misc	2132			2132
42.	Brake Rack	448			448
43.	Reservoir (450 ltrs.) 2 Nos.	660			660
44.	Reservoir (240 ltrs.)	210			210
45.	Aux. Compressor	50			50
46.	Pneumatic Equip. Misc	815			815
47.	Operator Cab Misc	3051			3051
48.	Pantograph Hatch (2 Nos.)	2070			2070
49.	Converter Hatch	502			502
50.	Pantograph (2 Nos.)	372			372
51.	Primary voltage transformer	50			50
52.	Earthing switch	29			29
53.	Main circuit breaker	140			140
54.	Surge arrestor (2 Nos.)	72			72
55.	Filter resistor	130			130
56.	Roof equip. misc	477			477
57.	Oil cooler ventilation	593			593
58.	T/M ventilation (2 Nos.)	340			340
59.	T/M scavenger fan (2 Nos.)	150			150
60.	M/R ventilation(2 Nos.)	177			177
61.	M/R scavenger fan (2 Nos.)	70			70
62.	Ventilation misc	174			174
63.	MR floor	478			478
64.	Misc	210			210
65.	Ballast	310			310
66.	Electrically Driven Compressor (2 Nos.)	1000			1000
67.	Carbody Structure	6189			6189
68.	Additional Ballast to achieve axle load of WDP4D loco i.e.20.5t				7000
Total Loco Weight (kg)					**122746**

Sl.	Item Description	Likely Weight Addition (Kg)	Likely Weight Removed (kg)	Likely Weight retained/modified (kg)	Net Effect (Kg)
Axle Load (t)					**20.5**

CHAPTER - 8

Technical and functional requirements (Please refer Clause 1.5 of Chapter -1)

8.1 General arrangement and Equipment layout

The general arrangement and equipment layout of the locomotive shall be jointly worked out by RDSO, DLW and the firm based on the envelope of the additional equipment offered.

8.2 Controls

Existing Dual cab HHP Diesel locomotives have been provided with AC-AC Traction Control System as per RDSO Specification no. MP.0.2400.43, Rev.5 for single cab loco and MP.0.2400.67, Rev.3 for dual cab loco. There are three sources viz. M/s Medha, M/s Siemens, M/s EMD, which have provided AC-AC traction Control system in HHP Locomotives. These firms have integrated their system Loco Control Computer with Traction Converter Cabinet as complete integrated system and these are their proprietary design meeting the functional requirement as per RDSO Specification. AC –AC Traction control suppliers also integrate with Computer controlled brake system which is being provided by M/s Knorr Bremse.

It is proposed to make twin co-co loco by converting two diesel HHP loco into single unit of electric locomotive to cater power equivalent of multi loco as given in the tentative sketch at Annexure-I. Hence, to have a common interface for driver working in regular electric loco and converted electric loco, cab lay out and driver interface shall be similar to the electric loco to the extent possible.

8.2.1 Propulsion Control System

8.2.1.1 Functional Requirement of Locomotive Control System:

i) Functional requirement of complete propulsion control system shall be as per RDSO Specification no. RDSO/2008/EL/SPEC/0071, Rev. 5 or latest applicable for electric loco.

8.2.1.2 Functional requirements of Traction Converter

i) Existing Traction converter to be modified to meet the functional requirement of propulsion control system of electric locomotive as per RDSO Specification no. RDSO/2008/EL/SPEC/0071, Rev. 5 or latest for which additional line converter needs to be added with existing traction converter of the diesel locomotive.

Note : Options are open for a completely new design TCC and LCC or tweaking the existing as given at clause no.3.4.

8.2.1.3 Functional requirements of Auxiliary Converter:

In the existing HHP Locomotive, there is no auxiliary converter. The auxiliary load is fed power through rotating electrical machine Auxiliary Generator and companion Alternator mechanically coupled with diesel engine. However, with the removal of diesel engine the auxiliary generator and companion alternator are also removed and hence solid state auxiliary converter is to be provided in stead similar to electric loco that will get power input directly from traction transformer secondary windings. The auxiliary converter will drive electric driven blower for Traction Motor cooling, Transformer cooling, Traction Converter cooling, Auxiliary converter cooling, electrically driven compressor, battery charging and auxiliary voltage to all auxiliaries, etc.

Auxiliary converters of adequate capacity identical in all respects and a battery-charging unit shall be provided in each Co-Co unit of the Locomotive.

The output rating of Auxiliary Converter ie. Wattage, voltage and frequency shall be same as in electric loco to cater the auxiliary loads as the auxiliaries being used in the three phase electric locomotive are to be used to the extent possible. This will reduce additional developmental cost for converted electric loco and these auxiliaries are already developed and proven.

8.2.2 It shall be possible to use the Locomotive in multiple unit operations of up to two Locomotives in one group. The control of both the Locomotives shall be achieved from either of the Locomotives being used under the multiple unit operations. Provision shall be made to enable the driver in the driving cab to monitor the parameters of the other Locomotive as well as to identify the fault in both the Locomotives.

8.3 **Cables**

8.3.1 Electron-beam irradiation cross-linked type Power and Control cables of standard metric sizes shall be provided as per specification no. EDPS – 304 and EDPS – 179 respectively. It is desired that existing cables should be reused to the extent possible.

8.4 **Control console**

Control console and lay out shall be similar to three phase Electric loco for having common driver interface as per RDSO specification.

8.4.1 **Master Controller**

A master controller shall be provided in each cab. It shall be integrated with step less traction / braking lever, forward/reverse switch, etc. In the design of the driver's controls, the following features shall be incorporated:

i. Master controller to be operational only after operation of cab activation switch;
ii. it shall not be possible for unauthorized persons to operate the master controller;
iii. the reverser handle shall be so inter-locked that master controller handle can move only when the reverser is placed in an operative position. Conversely, it shall be necessary for the master control to be returned to the off position, before the reverser handle can be returned to the off position;
iv. interlocks with braking system shall be incorporated in the master controller;
v. only one cab shall be activated in the Locomotive at a time; and
vi. Provision shall be made to ensure operation of the Locomotive in the event of failure of master controller.

8.5 **Interference current limits:**

The electric and electronic apparatus used in propulsion system shall comply emission and immunity aspects of EMC according to CENELEC standard EN-50121-3-2. The internal EMC shall cover a combination of earthing, shielding and isolation of interference sources so that conducted and radiated noises are properly segregated or suppressed and no other equipment is affected due to operation of propulsion equipments.

The tracks over which the offered locomotive propulsion system shall work shall be equipped with DC track circuits, 83-1/3 Hz track circuits as well as track circuits at higher frequencies. Similarly, other devices like axle counters, block instruments, point machines, etc., shall also be employed. On the communication network, control circuits, teleprinter circuits, as well as VHF/UHF and micro-wave circuits are employed.

The harmonic currents injected in the overhead supply system (as also the track return current) can introduce voltage harmonics on power supply and can interfere with signal and telecom circuits. The design of the traction transformer, power electronics and control electronics provided on the propulsion system shall be such as not to cause levels of interference exceeding the levels specified below at any point in the operating envelope of the locomotive:

Sl.	**Interference Current**	**Overall limit**
1.	Psophometric current AC traction	10.0A
2.	DC components in AC mode	4.7A
3.	Second Harmonic component (100Hz) in AC traction	8.5A
4.	Frequencies 1400Hz to 5000Hz	400 mA
5.	Frequencies 5000Hz to 50000Hz	270 mA

8.6 **Redundancy requirement**

Redundancy shall be built in with the design of the sub-systems and systems in order to ensure reliability and availability. In the vital units of the power control circuit, where any defect/failure of a component would cause complete failure of Locomotive's electrical system, suitable redundancy shall be provided preferably with automatic substitution features to avoid Locomotive failure due to such defects. The power supplies to the control circuit shall be hot redundant.

In the event of breakdown of any component or basic unit of equipment, it shall be possible to continue to haul the train with the least reduction possible in its services, operating within restricted but permissible conditions. The basic principles and procedures to be followed in the event of a breakdown shall be:

(i) Breakdown of drive side converter / traction motor:
The power of the Locomotive shall be reduced only by 1/12th, only isolating the broken down equipment;

(ii) Breakdown of power unit during traction or electrical braking:
The faulty power unit may be isolated;

(iii) Breakdown of an auxiliary converter:
Redundancy in auxiliary converter shall be provided so that in the event of its failure, the traction capacity of the Locomotive does not get affected;

(iv) Breakdown in the air braking system of a bogie:
It shall be possible to isolate the air brake in the bogie;

(v) Breakdown in the electric control of the automatic air brake:
It shall be substituted by the emergency brake;

(vi) Battery charger:
The battery charger of each Co-Co unit shall be able to take care of battery charging needs of other Co-Co unit in case of failure of the battery charger; and

(vii) Control electronics (VCU) shall have adequate redundancy so that a breakdown shall not affect the traction, braking and safety related control operations.

8.7 All the safety features and indications to be displayed in cab shall be in line with three phase electric loco as per RDSO specification no. RDSO/2008/EL/SPEC/0071, Rev. 5 or latest for electric loco.

The following audio-visual signals or indication(s) shall be provided in both the cabs for single and multiple operation of the locomotives.

1. Sanding
2. Wheel slip
3. Auto-flasher
4. TE limit
5. Alerter
6. PCS Open
7. Brake Warning

8.8 Event recorder

The event recorder shall monitor and record various events so that data is available for analysis to assist in determining the cause of accident, incident or operating irregularities. The equipment shall provide an intelligence based recording of the following parameters against the time axis (time interval shall be decided by recorder itself whenever there is a change in the respective parameter).

The following parameters shall be recorded:

(a) Speed in Kmph;
(b) OHE voltage;
(c) OHE current;
(d) tractive/braking effort;
(e) battery voltage;
(f) brake pipe pressure;
(g) brake cylinder pressure;
(h) cab1/cab2 activated cab;
(i) pantograph up/down position;
(j) status of main circuit breaker i.e., open/close;
(k) mode of operation i.e., traction mode/braking mode;
(l) direction of travel i.e., forward/reverse with respect to activated cab;
(m) head light status on/off;
(n) flasher light status on/off;
(o) horn status on/off;
(p) status of penalty brake application;
(q) status of emergency brake by assistant driver;
(r) wiper on/off; and
(s) any other parameter considered necessary.

The event recorder shall be in accordance with a recognised international standard such as the UK Railway Group Standard GM/RT2472.

8.9 There shall be provision of energy metering of the Locomotive for the monitoring and recording of energy consumption and regeneration.

8.10 There shall be provision of receiving shore supply of 415 volts, 50 Hz, 3 phase supply, on both ends of the Locomotive, for testing, movement of the Locomotive up to maximum speed of 2 Kmph in a locomotive shed/ workshop under no OHE area and for battery charging.

8.11 The two Co-Co units of the Locomotive shall be connected at 25 kV level, through a 25 kV HT coupler so that in the event of failure of one HT equipment including pantograph, main circuit breaker and HT coupler, the whole Locomotive can still be powered.

8.12 Prototype test standard:

The prototype of the equipment or sub assembly shall be tested as per following test standard.

1.	Inverters (Traction Inverter, Auxiliary Inverter, Line Converter, etc.)	IEC 61287-1
2.	Electronics and Control System	IEC 60571
3.	Transformer	IEC 60310, Type test as per Spec No. CLW/ES/3/0456
4.	System Integration test	As per test protocol approved by RDSO

If the equipments are complying the given standard and sources are already approved for the equipments in CLW or RDSO Vendor Directory, the fresh prototype test of the equipments for installation in converted electric locomotive may not require.

8.13 Power Supply System for 25 kV AC Traction:

Nominal supply voltage	22.5 kV (rms), 50 Hz, single phase, AC	
Normal variation in supply voltage	19 kV to 27.5 kV (rms)	
Occasional maximum voltage	31 kV (rms)	
Occasional minimum voltage	17 kV (rms)	
Normal variation in frequency	± 8% (46 to 54 Hz)	
Stagger of the contact wire	± 200mm on straight track Up to +300mm on curves	
Normal contact wire height in mid span	Normal OHE	High rise OHE
	5.5 m from rail level	7.42 m from rail level
Max. contact wire height	5.8 m from rail level	7.52 m from rail level
Min. contact wire height	4.58 m from rail level	7.37 m from rail level
Neutral Sections	After every 25 to 50 Kms	

8.14 Pantograph

i) The Locomotive shall be equipped with two pantographs. The pantograph selector switch shall be provided in the driver's cab for raising either or both of the pantographs. The raising or lowering of the pantograph, with the Locomotive in motion, shall not cause any undue disturbance to OHE.

ii) It shall be possible for each of these pantographs to be electrically disconnected from the roof equipment and earthed in case of damage.

iii) The profile of the pantograph shall be in accordance with the drawing no. SKEL-3871. Metalised carbon strip complying with RDSO's technical circular no. ELRS/TC/0071 shall be used on the pantograph.

iv) The pantograph shall be air operated type and suitable to work in areas having high wind pressure upto 150 kg/m^2. The pantograph shall also be suitable to work both in normal OHE and high rise OHE areas having height range as specified in clause 8.13 of these Specifications and Standards.

8.15 Main Transformer

i) The kVA rating of the transformer will be specified at a line voltage of 22.5 kV and will be designed to deliver a total power corresponding to the continuous rated traction motor currents at 22.5 kV. The transformer traction winding will also be designed to deliver the rated power at the maximum the voltage of 27. 5 kV.

ii) The Transformer will be designed with adequate overload capacity to permit full utilisation of the traction motor capacity during starting as well as running.

iii) The transformer will be designed to conform to IEC 60310 and the temperature rise limits on the windings and the oil will correspond to IEC 60310 limit minus 20 ºC under all conditions of operation.

iv) The transformer will be oil immersed and forced oil cooled by means of oil circulating pump and radiator. The oil cooler (radiator) will be air blast cooled by means of a motor driven blower set. The transformer will be equipped with an expansion tank in the machine room. Explosion valves will prevent mechanical damages of transformer set. Means will be provided for letting out the oil from the transformer to the underside of the locomotive, in event of any fault / electrical disturbance in the transformer causing oil to rush out.

v) **Standards**

The following specifications shall generally be followed for manufacture and testing of the transformer and reactor units:-

- IEC-60310 - Rules for traction transformers and reactors
- IEC-60076 - Recommendations for power transformers
- IEC-61373 - Rules for Electrical Traction Devices
- IEC-38 - Standard voltages IEC-60296 -Transformer Oil

vi) **Description**

Each Co-Co unit requires one transformer for feeding supply to traction converters / traction motors. This transformer will consist of Primary winding, four traction windings and one auxiliary winding (on requirement). In addition, if required it can include psophometric filter winding.

The transformer tank also contains 02 series resonant chokes (one for each converter).

Transformer is oil cooled and external cooling of the oil is designed with two independent oil circuits with cooling units located within the machine room of locomotives. However, the cooling units / circuit component do not form part of transformer supply.

The special features of the transformer are

- Transformer is mounted under slung on under frame
- Transformer is designed for feeding IGBT based Power and Auxiliary converter load.
- Suitable impedance between primary & traction windings to fulfill line harmonic limits
- High de-couplings between windings
- Use of continuous transposed conductor for windings
- Transformer and conservator tank of Aluminum Alloy or stainless steel.
- Rapid action coupling between transformer and conservators in oil circuit

vii) **Additional apparatus of the transformer**

- Overflow valve (In case of over pressure, the tank must not be damaged and overflowing oil shall be drained off the transformer cover)
- Oil drain tap, oil level screw
- Slide of oil intake and drainage
- Transformer tank fastening
- Two conservator tanks including
    - Air dehumidifier including valve
    - Oil level gauge

- Connection to the transformer including rapid action coupling
- Oil filler tap
- Oil drainage screw

- Earthing.

General arrangement of transformer will be similar to CLW Drawing No.CLW/ES/3/SK-I/0135 of WAP7/WAP5 loco transformer.

8.16 Main Circuit Breaker

Vacuum circuit breaker of proven design will be provided.

8.17 Lightning Arrestor

A gapless type lightning arrestor of well proven design will be provided on the roof of the locomotive for protection against the line voltage transients caused by lightning or system switching.

8.18 Safety measures

i) All equipment will be adequately earthed, insulated, screened or enclosed and provided with essential interlocks and keys as may be appropriate to ensure the protection of the equipments and safety of those concerned with its operation and maintenance.

ii) Earth fault detection will be provided by the Contractor.

iii) All electrical circuits will be fully insulated from the superstructure on both the positive and negative sides and the super-structure will not be used as a portion of an earth return circuit.

iv) Fire prevention measure: The design of equipment will incorporate all measure to prevent fires and will be such that should may fire take place, the effects will be minimised and no spread of fire should take place. Materials which are not fire- retardant will not be used. The locomotive will be provided with suitable fire detection and extinguishing equipment of proven design. The extinguishing equipment will be operated manually.

v) Protective / Safety devices

1. The locomotive will be provided with a manually operated two position earthing switch. The operation of the switch will enable earthing of the power circuit of the locomotive and attention the HT equipment by releasing interlocked keys from a box fitted the earthing switch.
2. Standard protective systems for protection of the electrical equipments against abnormal currents, excessive voltages etc. as well as indication of normal and abnormal conditions so as to ensure safe and correct operations will be provided. While working in multiple, the faults in the trailing locomotive will be indicated in the leading locomotive.

8.19 Traction Motors

Existing traction Motor is to be retained. The technical details of the traction motor of HHP Diesel loco is furnished as below.

Parameter	Value
Nominal starting torque	9500 Nm
Maximum continuous power according to IEC 60349-2 at motor shaft with DC link voltage = 2600V.	630 KW min at 1460 rpm
Maximum continuous power according to IEC 60349-2 at motor shaft at rated voltage.	485 KW min at 685 rpm (20% additional for bogie cut out)

Maximum current (RMS value of fundamental wave)	270A
Maximum permissible speed	3320 rpm
Inverter Frequency Maximum	120 Hz
Circuit	Y
Electrical characteristics	Shall match the existing traction motor type such that there is complete compatibility with the existing locomotive and traction equipment, particularly the computers and there is no need for any change in the relevant OEM software.
Gear ratio	Passenger loco: 77/17, Freight loco: 90/17
Air flow Req	1.2 m^3/sec

Traction Motors are provided as per RDSO Specification no. MP.0.2400.52 (Latest Version).

8.20 Storage Battery

Existing Storage Battery 500 AH Lead Acid battery as per DLW specification no. DEL/SPN/193, Rev. 3 to be retained.

8.21 Regenerative braking

Regenerative braking should be used similar to three phase electric loco to save energy during regenerative braking. This will also eliminate the use of dynamic braking grids being used for dissipation of power during dynamic braking.

8.22 Mechanical design, Weight balance, Vehicle dynamics

Though the bogies and under frame are retained, major changes in the superstructure are required to locate the electrics of converted electric loco after removal of diesel engine, shaft driven compressor, alternator, shaft driven blower being used in diesel loco. Weight balance after the distribution of electrics, Vehicle dynamics simulation after weight balance is required. Hence, the firm undertaking the conversion shall have to integrate the complete loco after installing the electrics and control system to comply the running of locomotive safely on the track.

The tentative general arrangement diagram for proposed conversion of diesel loco is attached at Annexure-1 for reference purpose. The firm shall work jointly for development of GA and other changes required in consultation with DLW/RDSO

8.23 Development and Design clearance

The integration kit for design details of additional and uncommon items along with weight and envelope size required for conversion of diesel loco into electric loco shall be furnished for design clearance of DLW/RDSO before the successful tenderer start manufacturing of the items. These items shall be designed/manufactured and supplied as an integration kit. The integration kit shall consist of all the uncommon and additional items irrespective whether indicated in the specification or not.

8.24 Salient differences between Diesel HHP loco and Three phase Electric Loco for electric controls and assembly

Electrics	Diesel HHP Loco	Three Phase Electric Loco
Control Voltage supply	72V DC	110 V DC
Battery Charger	Supply from rotating Auxiliary Generator coupled with Engine	Static
Master Controller	Notch based with 8 notch	Step less type
Orientation of Master Controller in Cab	Left to the Driver	Right to the Driver

Battery	72 V, 500 Ah Lead acid battery for goods loco	110 V, Ni-Cd Battery
Relay and contactors	To be operated with 72 V DC	To be operated with 110 V DC
Traction Converter	Air cooled	Water Cooled
Rectification to DC	Through Rectifier in built with Alternator coupled to Engine	Static Line converter inbuilt with Traction Converter
Control	Both Bogie and axle control available	Only axle control
Cab	Both single and dual cab	Only dual cab
TM Blower and compressor	All are mechanically driven through engine shaft	Electrically driven through auxiliary converter

CHAPTER - 9

Dimensions, Clearances and Track Geometry

9.1 Overall Carbody Dimensions

Locomotives dimensions and profile shall within or fully conform to IR SOD 1D-clearance diagram (EDO T-2202) latest revision.

9.2 Climatic and environmental conditions

1.	Maximum Temperature (Atmospheric)	Under sun 70ºC In shade 50ºC Temperature inside locomotive may reach 60 ºC at turbocharger inlet.
2.	Humidity	100% saturation during rainy season
3.	Reference site conditions	(i) Ambient Temp. 47ºC (ii) Humidity 60% (iii) Altitude 600 m
4.	Rainfall	Very heavy in certain areas. The locomotive shall be designed to permit its running at 10 km/h in a flood water level of 102 mm above rail level.
5.	Atmosphere during hot weather	Extremely dusty and desert terrain in certain areas. (Air filtration system of engine to be designed accordingly)
6.	Coastal area	Locomotive and equipment shall be designed to work in coastal areas in humid and salt laden atmosphere.
7.	Vibration	The equipment, sub-system and their mounting arrangement shall be designed to withstand satisfactorily the vibration and shocks encountered in railway traction, unless otherwise prescribed or specifically defined in the manufacturer's design criterion.

9.3 Track Geometry

1	Gauge	Broad Gauge (BG) 1676 mm (nominal)
2	Track structure	The track is to a standard of 60 kg, 90 UTS rails on Pre-stressed concrete sleepers of 1660 per km 300 mm depth of ballast cushion below the sleepers Or 52 kg. 90 UTS rails on Pre-stressed concrete sleepers of 1540 per km 250 mm depth of ballast cushion below the sleepers.
3	Sharpest curve and turn out to be negotiated	174 m radius. The locomotive shall also be checked for passage in both directions over standard BG 1 in 8-1/2 turnouts. Vogel's layout or its internationally-accepted equivalent for negotiability, throw over at head stock and coupler movement with details of clearances shall be submitted.
	Maximum Super elevation	185 mm
	Maximum cant deficiency	100 mm
4	Schedule of dimensions	Indian Railways 'Schedule of Dimensions' for Broad Gauge (1676 mm), 2004

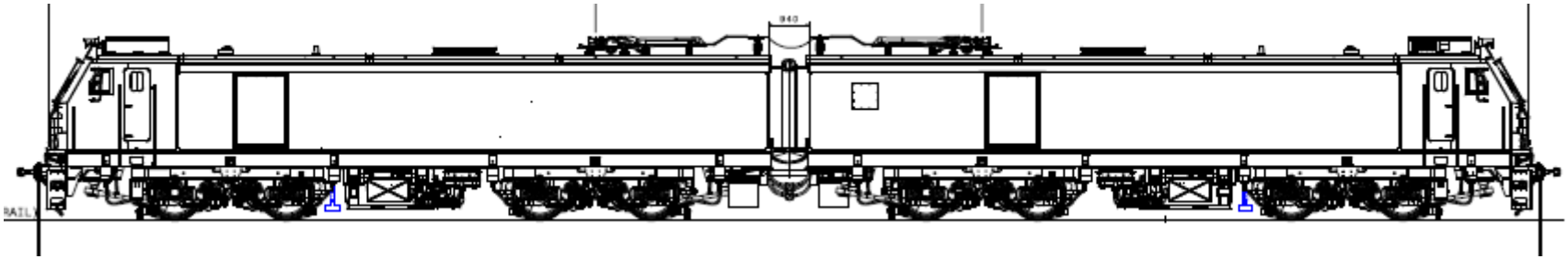
5	Overall moving dimensions	The locomotive with new wheels and in empty condition shall be within the dimensions shown in IR MMD as per diagram EDO/T-2202.	
6	Clearance above the rail level	The locomotive shall be so designed that no component shall infringe minimum clearance of 95 mm above rail level with the locomotive fully loaded and wheels in fully worn condition.	
7	Permissible track tolerances:	**BG Main Line**	**BG High Speed Route (C&M 1 Vol 1)**
	Unevenness (3.6 m base)	< 15 mm	< 10 mm
	Twist (3.6 m base)	< 2.78 mm/meter	< 2.08 mm/meter
	Gauge variation	<± 6 mm	<± 3 mm
	Alignment (versine on 7.2 m chord)	< 5 mm	< 5 mm
	Gauge widening:		
	On curves of > 350m radius	-5mm to +3mm	
	On curves of < 350m radius	Up to +10mm	

9.4 Rating Performance and Oscillation Trials :

First converted prototype electric locomotive shall be subjected to Rating and performance trials and Oscillation trials to validate the complete loco integration electrically and mechanically.

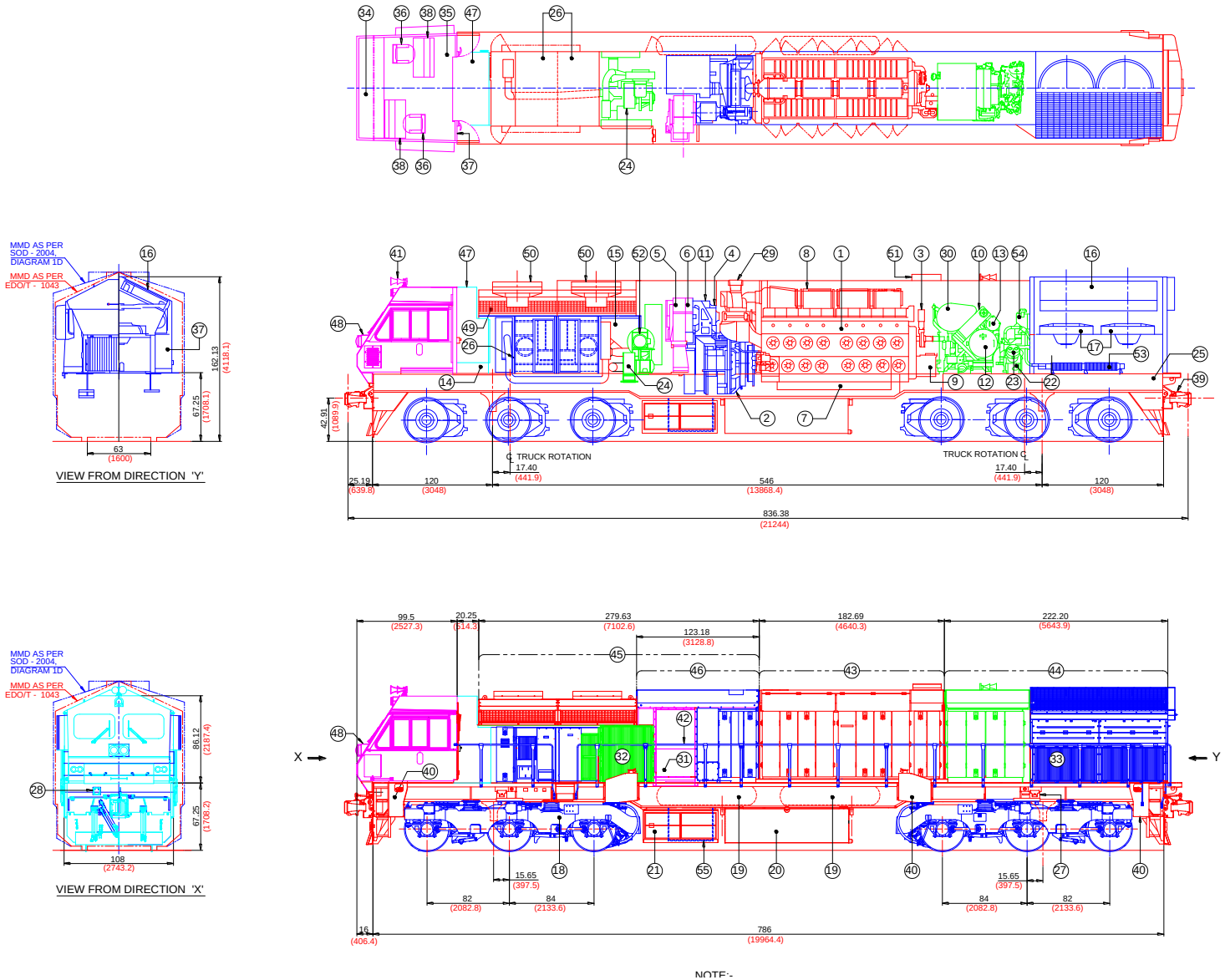
Annexure-I

Tentative General Arrangement of Proposed Converted Electric Locomotive on HHP Locomotive platform



Annexure-II

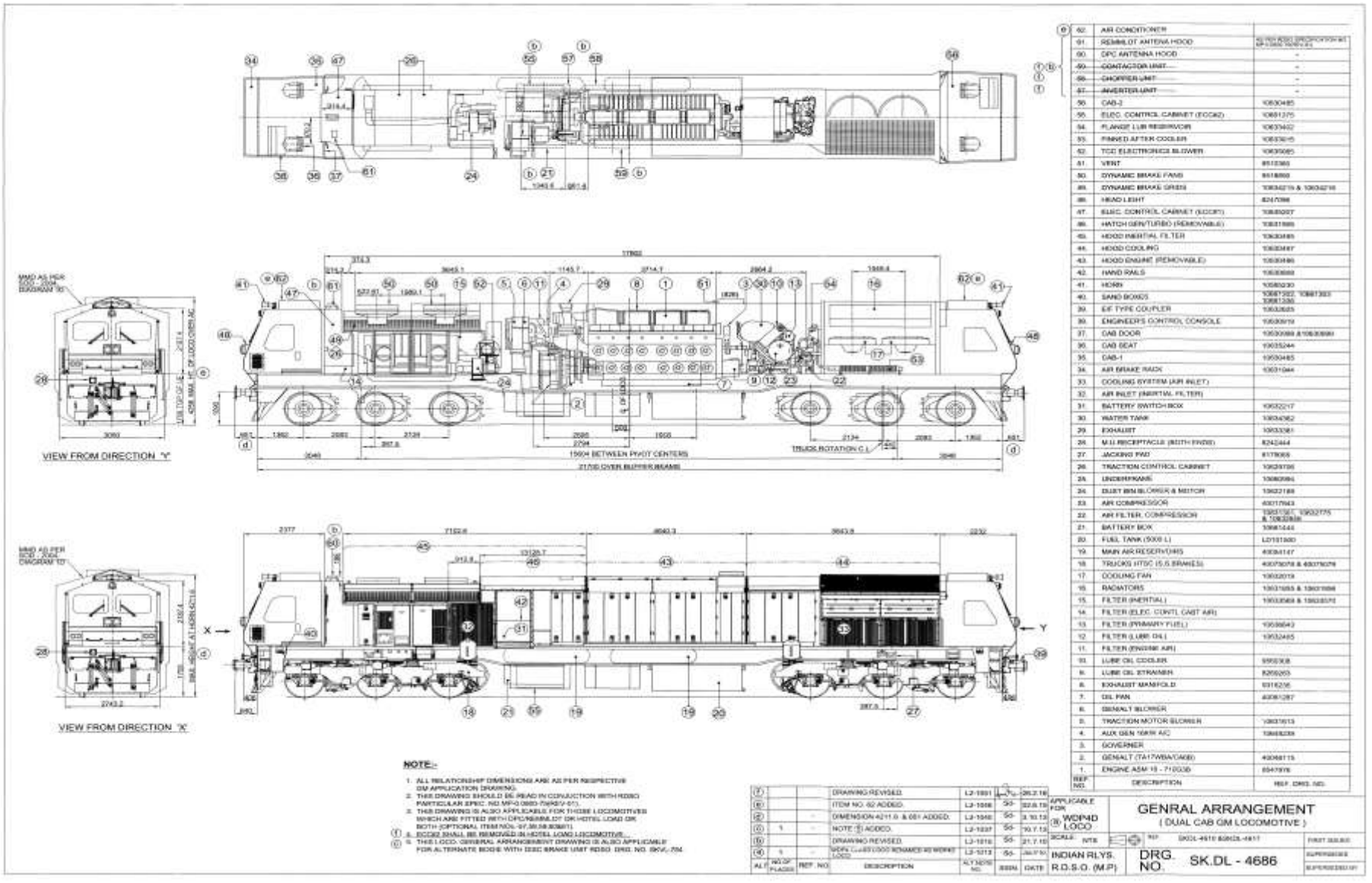
General Arrangement of existing Single Cab HHP Locomotive



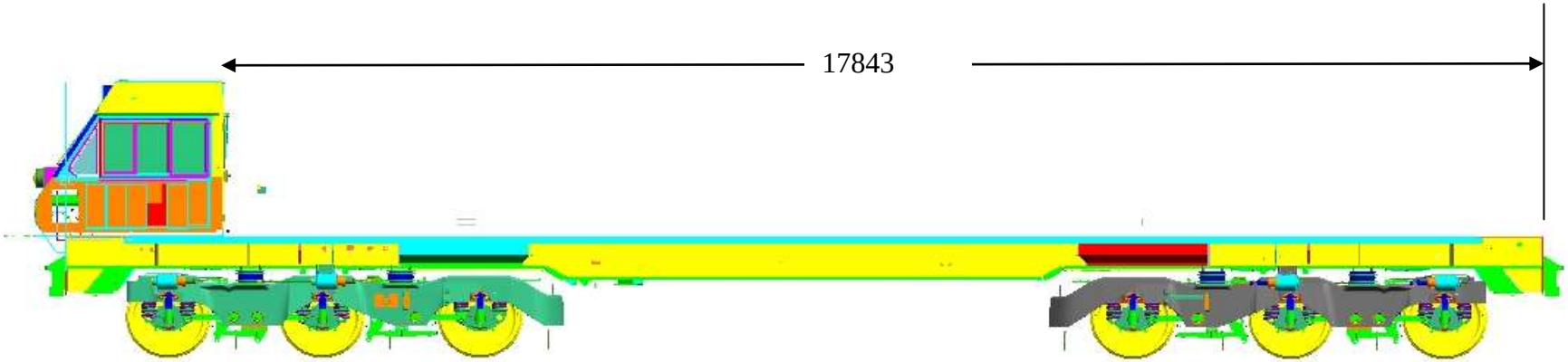
REF. NO.	DESCRIPTION
55.	ELEC. CONTROL CABINET (ECC#2)
54.	FLANGE LUB RESERVOIR
53.	FINNED AFTER COOLER
52.	TCC ELECTRONICS BLOWER
51.	VENT
50.	DYNAMIC BRAKE FANS
49.	DYNAMIC BRAKE GRIDS
48.	HEAD LIGHT
47.	ELEC. CONTROL CABINET (ECC#1)
46.	HATCH GEN/TURBO (REMOVABLE)
45.	HOOD INERTIAL FILTER
44.	HOOD COOLING
43.	HOOD ENGINE (REMOVABLE)
42.	HAND RAILS
41.	HORN
40.	SAND BOXES I/B & O/B
39.	E/F TYPE COUPLER
38.	ENGINEER'S CONTROL CONSOLE
37.	CAB DOOR
36.	CAB SEAT
35.	CAB
34.	AIR BRAKE RACK
33.	COOLING SYSTEM (AIR INLET)
32.	AIR INLET (INERTIAL FILTER)
31.	BATTERY SWITCH BOX
30.	WATER TANK
29.	EXHAUST
28.	M.U.RECEPTACLE (BOTH ENDS)
27.	JACKING PAD
26.	TRACTION CONTROL CABINET
25.	UNDERFRAME
24.	DUST BIN BLOWER & MOTOR
23.	AIR COMPRESSOR
22.	AIR FILTER, COMPRESSOR
21.	BATTERY BOX
20.	FUEL TANK (6000 L)
19.	MAIN AIR RESERVOIRS
18.	TRUCKS HTSC (S.S.BRAKES)
17.	COOLING FAN 52" TYPE
16.	RADIATORS
15.	FILTER (INERTIAL)
14.	FILTER (ELEC. CONTL CABT AIR)
13.	FILTER (PRIMARY FUEL)
12.	FILTER (LUBE OIL)
11.	FILTER (ENGINE AIR)
10.	LUBE OIL COOLER
9.	LUBE OIL STRAINER
8.	EXHAUST MANIFOLD
7.	HIGH CAPACITY OIL PAN
6.	GEN/ALT BLOWER
5.	TRACTION MOTOR BLOWER
4.	AUX GEN 18KW A/C
3.	GOVERNER
2.	GEN/ALT (TA17WBA/CA6B)
1.	ENGINE 16-710G3B

NOTE:-

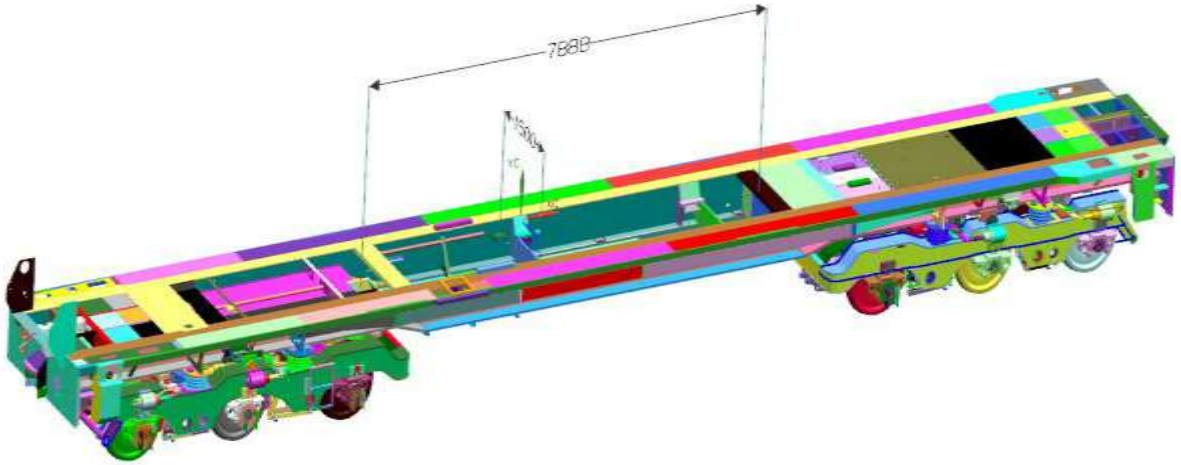
General Arrangement of existing Dual Cab HHP Locomotive



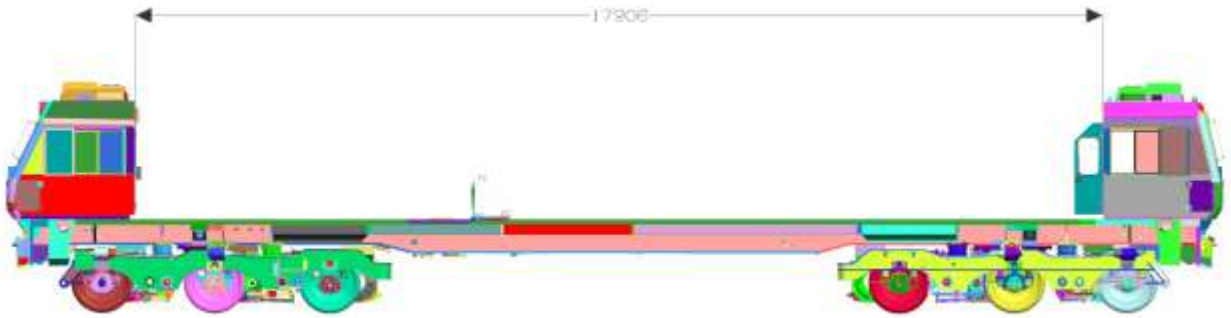
SINGLE CAB HHP LOCO WITHOUT DIESEL COMPONENTS AND ELECTRICS



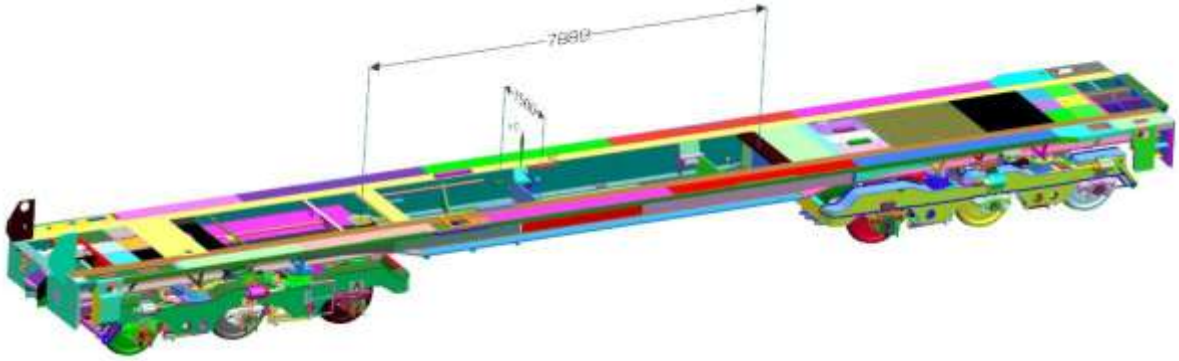
SINGLE CAB HHP LOCO UNDER FRAME PIT AREA



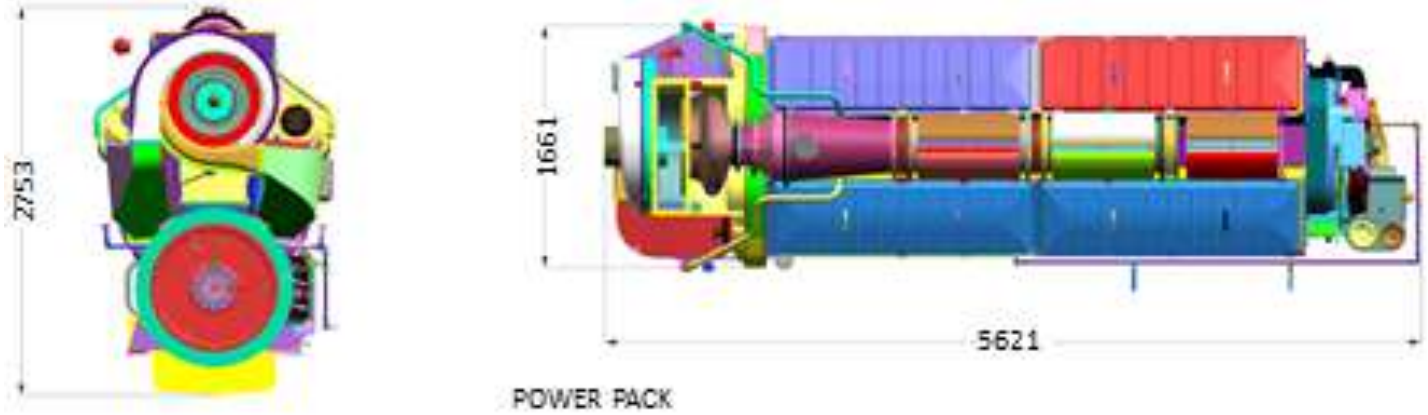
DUAL CAB HHP LOCO WITHOUT DIESEL COMPONENTS AND ELECTRICS



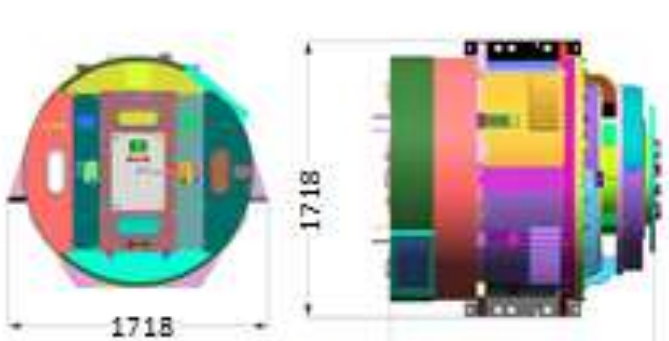
DUAL CAB HHP LOCO UNDERFRAME PIT AREA



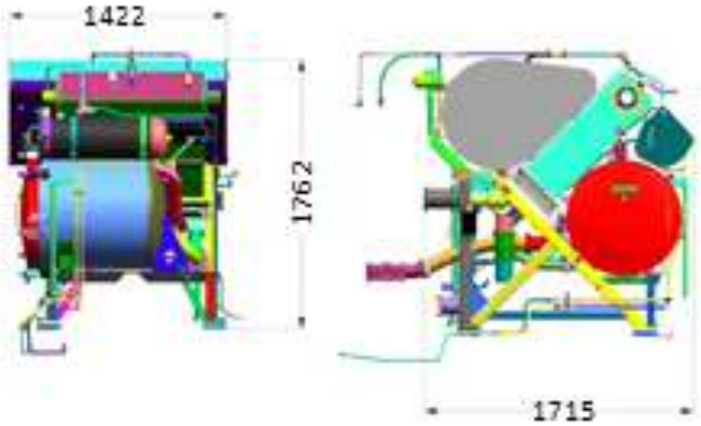
FOOT PRINTS OF MAJOR DIESEL COMPONENTS OF HHP LOCO - BOLTED



POWER PACK

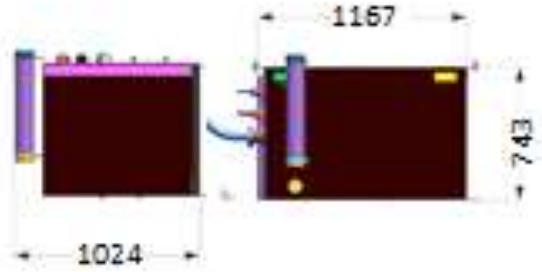


ALTERNATOR



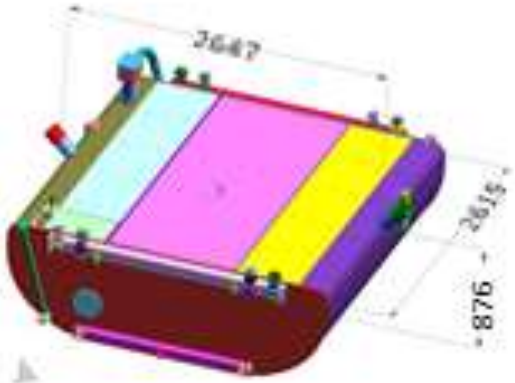
EQUIPMENT RACK – BOLTED COMPONENT

FOOT PRINTS OF MAJOR DIESEL COMPONENTS OF HHP LOCO - BOLTED

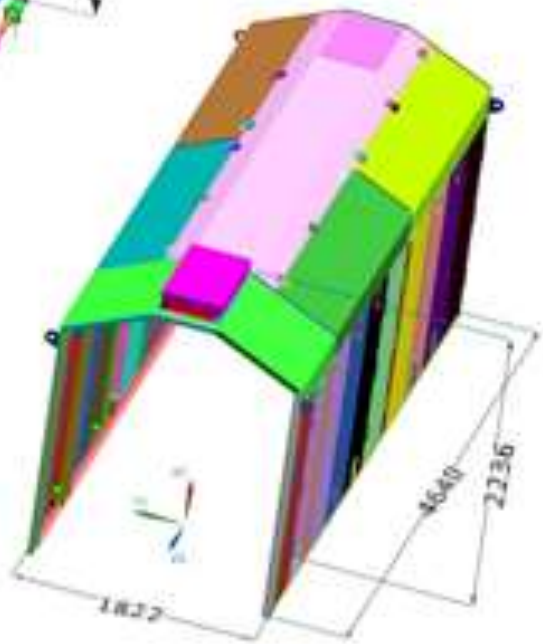


ECC#2

ENG. DRIVEN
COMPRESSOR

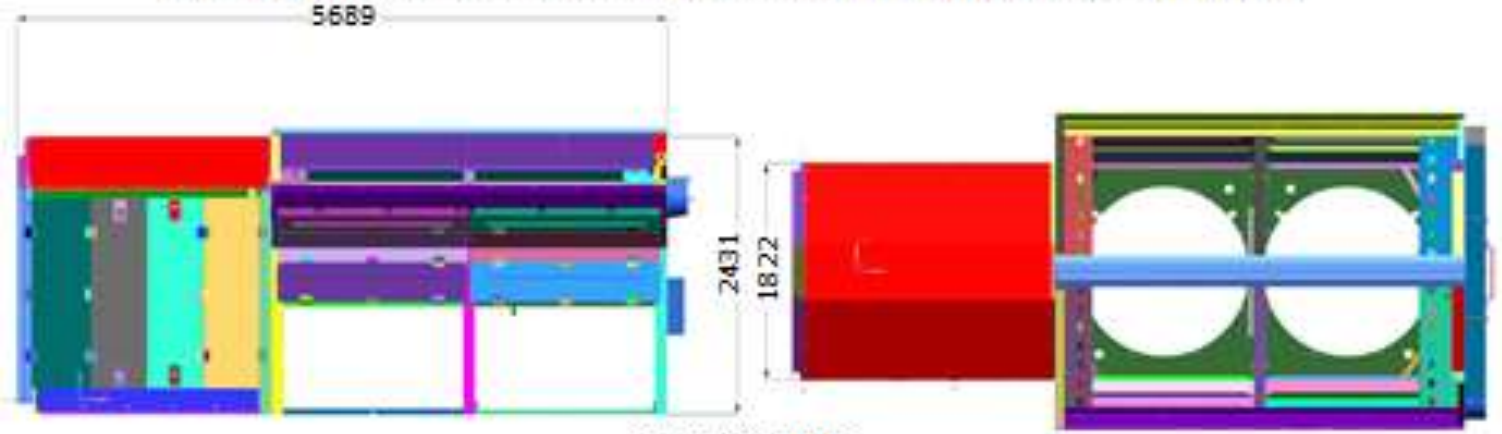


FUEL TANK

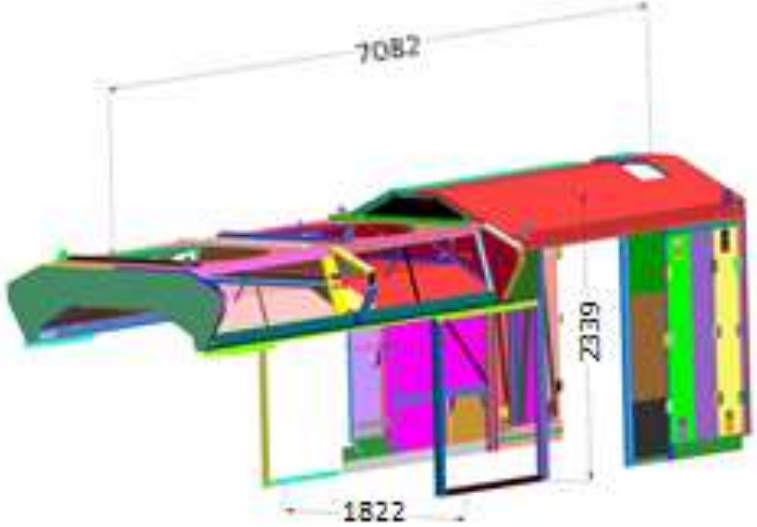


ENGINE HOOD

FOOT PRINTS OF MAJOR DIESEL COMPONENTS IN HHP LOCO - **WELDED**



COOLING HOOD



INERTIAL & DB HOOD

Annexure-III

Tentative Power Flow Diagram of Converted Electric Locomotive from HHP Diesel Locomotive