

LME:012:C

LOCOMOTIVE ENGINEERING DEPTT.

PURCHASE SPECIFICATION

LME: PUR:324
ISSUE DATE :25.03.2015
REV. No.: 01
REV DATE:15.03.2019
Sheet: 1 of 19

SUBJECT:

**PURCHASE SPECIFICATION OF 400HP DIESEL
ENGINE FOR 800 HP (TPP) DIESEL ELECTRIC
SHUNTING LOCOMOTIVE**

Enclosures:Annexure – I Annexure-II, Annexure-III and Annexure-IV, Annexure-V

Rev	Date	Prepared	Rev	Date	Prepared	Rev	Date	Prepared
01	15.03.19	Approved			Approved			Approved
Clause 2.1 modified. Spec Updated								
Rev	Date	Prepared	Rev	Date	Prepared	Rev	Date	Prepared
		Approved			Approved			Approved

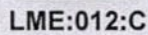
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Prepared by

Checked by

Approved by

(GIRISH RAO)
Sr. Manager (Loco Engineering)
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1) GENERAL

This Specification covers technical requirement, scope of supply and erection and commissioning of 400 HP diesel engine which is to be installed on BHEL built diesel electric shunting locomotive to be supplied to various industries for shunting application.

- 1.1) The particular model of diesel engine offered shall be one, which has been well proven in rail traction service, preferably in India.
- 1.2) The engine shall be suitable for operation using high speed diesel oil.
- 1.3) The locomotive shall be required to operate in various climatic conditions. The range of such conditions is as follows:

Temperature inside loco	:	0° to 55° C
Altitude	:	0 - 1000 M
Relative Humidity	:	40% - 100%
Maximum sun	:	70°C
Temperature		

2) CAPACITY:

CONTINUOUS RATING

- 2.1) The diesel engine to be used on the locomotive shall be capable of delivering 400hp at 2100 rpm. The rating of engine shall conform to latest BS 5514. The manufacturer shall furnish the notch wise continuous power

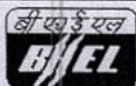
NOTCH	RPM	Gross Output Power (HP)
8.	2100	
7.		
6.		
5.		
4.		
3.		
2.		
1.	750	

Prepared by

Checked by _____

Approved by:

Approved by: 
Dr. J. K. Singh (Vice-Chancellor, H.N.O. Engineering College)
H.N.O. Engineering College, H.N.O., Sonbhadra, U.P.



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The Notch wise power values shall be verified during testing of the engine

Tolerance:

Power Output : 0%, -5%
Speed = $\pm 1\%$,

- Power at climatic condition as in para 1.3 should be 400 HP considering deration of 3% max.
- The engine shall be matched to supply power to traction generator.
- The power consumption of engine mounted 24 Volt charging alternator, radiator fan etc shall be furnished by engine supplier along with offer.
- On above table the speed Vs. power output is shown for first and last notch only for intermediate notches load RPM and power output shall be specified by tenderer. However, it is to be ensured that speed & power for intermediate notches must be discrete & shall increase gradually.
- The specified values of speed & power at all notches is to be submitted along with offer. The Engine performance curves i.e Power , Torque & BSFC curve are also to be submitted along with offer.

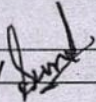
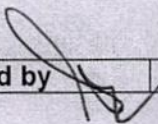
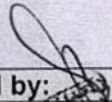
- 2.2 The following locomotive auxiliaries shall be belt driven off the engine from the non-drive-end of the traction generator:

- | | | | |
|-----|-----------------------|---|-----------------|
| i) | Air compressor | - | 10 HP (nominal) |
| ii) | Traction motor blower | - | 10 HP |

- 2.3 The required HP to generator and Loco-Auxiliaries at full power shall be in the most economic specific-fuel-consumption range of the engine. The guaranteed values of SFC of the engine shall be given in the offer, which shall be binding at the time of testing at BHEL works and manufacturer's works.

- 2.4 Having regard to the duties involved, the required output of the engine shall be its Intermittent (overload power) traction; rating in accordance with British Standard Specification BS 5514:1987.

3. ENGINE FEATURES:

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- 3.1 The exhaust outlet from the turbo-charged shall be so arranged as to facilitate installation of the exhaust slack at the flywheel-end of the engine.
(The Details of loco layout shall be furnished by BHEL as and when demanded by engine manufacturer, after placement of order.)
- 3.2 The engine air intake shall be so positioned as to facilitate location of the air filter and air intake openings in a separate compartment alongside the engine. Air filters shall be of dry type. (The Details of loco layout shall be furnished by BHEL as and when demanded by engine manufacturer, after placement of order.)
- 3.3 The drives for loco auxiliaries shall be taken from the non-drive end of the traction generator. The suitable power take-off unit shall be supplied with the engine.
- 3.4 The engine shall be provided with a single front-mounted radiator and suitable duct, leading the air from engine mounted fan to the front radiator.
- Annexure – IV** shows the cross-section of the engine hood above the deck plate in which the radiator is to be mounted. The radiator shall be of the dimensions to be within the confines of the hood.
- 3.5 As the fuel tank shall be located below the mounting level of the engine, a suitable fuel transfer pump shall be incorporated in the supply with a primary fuel filter before the pump. A water separator also has to be provided in the fuel intake line.
- Flexible end-connections (Hoses) shall be supplied to connect fuel supply line to the fuel inlet/return lines of the engine.
- 3.6 The oil filters shall be located so as to enable easy access from the side of the engine. Suitable by-pass filters shall be provided to ensure adequate oil filtration in case main oil filters get clogged.
- 3.7 Engine starter motor is not required since engine will be cranked through traction generator. 24V DC battery charging alternator (Engine driven) of rating 30 Amps. Shall be supplied with engine. Battery charging ammeter shall also be supplied. The changing alternator should be able to charge the batteries at low idle speed of 700 rpm.

Battery will not be supplied with the engine.

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Approved by

DR. RAJ
General Manager (Loco Engineering Deptt.)
JHANSI

3.8 The engine shall drive a BHEL make single bearing traction generator type TG4302AZ. The generator frame is foot mounted on the deck-plate of the locomotive and the generator-rotor shall be directly supplied with the engine flywheel. Flywheel housing adopters for flywheel/flywheel housing shall be supplied along with their complete hardware/fasteners.

3.9 The Electro-pneumatic 8-notch governor shall be supplied with the engine. The locomotive is equipped with 24/32 volt DC supply and therefore all electrical solenoid, coils etc. should be suitable for continuous operation at 24V DC / minimum pickup voltage 18V with negative isolated.

Detailed leaflet of governor shall be supplied along with the engine.

3.10 Pipes For both air (intake/exhaust) and cooling water line would be provided to suitable sizes w.r.t. the installation diagram of Engine. FLEX MASTERS pipe couplings are required for water pipe connection between radiators and engine. Hoses not accepted for such use.

A corrosion inhibitor shall be provided in the coolant water pipe.

3.11. Metering and Protection System:

3.11.1 The supply shall include the following meters/gauges with respective sensing devices:

- i) Engine speed indicators with service hour counter (One Mechanical analog type over engine and one digital type for one driver's desk of the cabin).one MPU shall be used for driving digital tachometer i.e total 1 no. MPU shall be supplied.
- ii) Water temperature gauge (Electronic type) (One no. on engine and another of on driver's desk of cabin) – 2 nos 24 V
- iii) Lube oil temperature gauge (Electronic type) (One no. on engine and another of on driver's desk of cabin) – 2 nos 24 V
- iv) Lube oil pressure gauge (Electronic type) (One no. on engine and another of on driver's desk of cabin) – 2 nos 24 V

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Dr. Girish K (Senior Engineer)
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- v) Fuel pressure gauge (Mechanical type/Electronic type).
- vi) 30 Amps battery charging ammeter to be supplied loose for mounting in driver's cabin.

3.11.2 The supply shall include following audio/visual alarm:

- i) Low Water Level
- ii) Low Lube Oil Pressure
- iii) Over Speed Trip
- iv) High Engine Temperature
- v) Ground Fault
- vi) Overload Alarm

- 3.11.3
 - i) High Engine Water temperature - Engine to idle
 - ii) Low Lube oil Pressure - Engine to shut down
 - iii) Engine Over Speed - Engine to shut down
 - iv) Low Water Level - Engine to idle

- 3.11.4 All terminals for connections to be taken to the locomotive control station for metering/indicating devices shall lead to a single terminal board which should be mounted thru suitable anti vibration pad over the engine at a suitable location determined with the approval of BHEL. The terminals should have nut and bolt arrangement for cable connection.

- 3.11.5 All gauges shall be frame-mounted over the engine except the digital tachometer & water temperature gauge, which is to be mounted in driver's cabin.

- 3.11.6 All gauges shall be of internally illuminated type of device and should have labels for identification. All cables should have ferrules for identification matching with connecting cable of locomotive. No changes in wiring layout prior to the information to BHEL shall be acceptable.

- 3.11.7 All dial faces shall have black background with white lettering.

- 3.11.8 All dial faces shall also carry the international symbols denoting the respective functions and graduation.

- 3.11.9 All engine protection and sensing devices shall be mounted directly on the engine.

- 3.1.10 Dimensional details for the devices to be mounted away from the engine shall be furnished along with the quotation.

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Dr. Central Manager (Locomotive Engineering Deptt.)
HANSI

3.11.11 Accuracy of all meters should be within $\pm 1\%$.

4. SCOPE OF SUPPLY:

The scope of supply shall be as per **Annex-I** enclosed herewith.

5. INSPECTION AND TESTING:

5.1 Each engine shall be tested as per enclosed Test Schedule (Annexure-III) in the manufacturer's works prior in dispatch, in accordance with British Standard Specification BS 5514:1979 as applicable to rail traction diesel engines and manufacturer's certificates shall also be furnished accordingly. These tests shall be witnessed by BHEL's authorized representative.

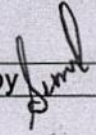
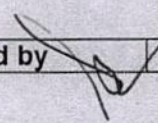
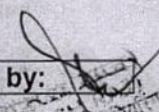
5.2 The power pack (engine coupled to Generator) ;of each engine shall be load tested after assembly of the locomotive to ensure engine's after assembly of the locomotive to ensure engine's compatibility with the BHEL, generator(Refer **Annexure - V** for outline arrangement of TG) and control system. The engine manufacturer's representative should associate in such tests at BHEL's works. The supplier shall carry out any change/modification/part replacement. If required in this stage. The subsequent engines of the contract shall be supplied with the above changes duly implemented in the engines.

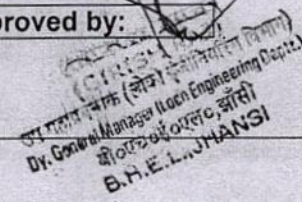
6. DATA SHEET:

Technical data relating to the engine offered in accordance with the stipulated scope of supply must be furnished in triplicate in the format as at Annex -II

7. TV ANALYSIS:

TV analysis shall be submitted by the supplier within one month after placement of order for Prototype. For Series /regular production of diesel engine after prototype, TVA is not required. BHEL reserves the right to cancels the order in the event of results of TV analysis being found unsatisfactory.

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 Dy. General Manager (Loco Engineering Deptt.)
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Submission of documents

8. Following documents shall be sent along with offer

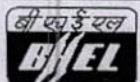
- i. Clause wise comments against this specification.
- ii. Engine installation drawing.
- iii. Drawing for all instrumentations / gauges.
- iv. Data sheet duly filled up by the supplier
- v. Schematic drawing of lube oil system,
- vi. Schematic drawing of fuel oil system,
- vii. Schematic drawing of cooling water system
- viii. Schematic drawing of Intake Air & Exhaust System
- ix. Electrical wiring diagram
- x. Recommended list of the spares inventories to be maintained with price, for 2 years usage.
- xi. List of special tools sand tackles required for engine maintenance if any.
- xii. Specification and quantity of recommended lube oil and coolant.
- xiii. Description of engine governing system.
- xiv. Supplier to give test format with acceptable value for each parameter recorded during test.
 - a. Notch power test 1-8
 - b. Minipatch analysis
 - c. Diesel dilution
 - d. Smoke Level
 - e. TIR Values
- xv. Engine performance curves i.e Power , torque & BSFC curve
- xvi. This will be basis for acceptance of engine

9.1. Documents to be submitted within one month after placement of order for prior approval of BHEL.

- i. Installation drawing of the engine with BHEL-Generator
- ii. OGA drawing of the engine indicating dimensionally relative locations of all engine accessories to be fitted away from the engine
- iii. Drawing of coolant water piping, air intake / exhaust piping
- iv. Complete engine wiring diagram
- v. Technical write-up on various sub systems of diesel engines

9.2. Following Document shall be required for Dispatch Clearance

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- i. Engine Output Test (Ref. Clause 2.1 & 2.2 of Annexure -III)
- ii. Test Report of Lifting Capacity of Fuel Pump (Ref. Clause 2.4 of Annexure -III)
- iii. Diesel Dilution Test Report (Ref. Clause 2.5 of Annexure -III)
- iv. Mini Patch Analysis Test Report
- v. Test Report of Smoke & Fuel Consumption (Ref. Clause 2.3 of Annexure -III)
- vi. Notch Trail Test Report (Ref. Clause 3 of Annexure -II)
- vii. TIR Value of Flywheel & flywheel housing (Ref. Clause 4 of Annexure -III)
- viii. Test/Calibration Report of Following Safety Devices on test bench:
 - a) Lube oil Pressure Switch
 - b) Over Speed safety Switch
 - c) High Water Temperature Switch
 - d) Setting of Thermostat
 - e) Setting value of LOPS & ETS (WTS)

ix) Calibration test record /test report of all measuring instrument/gauges.

10. Following documents shall be supplied along with dispatch documents by the supplier:

- i. Engine test certificate and test report and other documents as per quality plan shall be supplied in triplicate with each engine
- ii. Engine operations and maintenance manual and part list shall be supplied in triplicate per engine.
- iii. Manufactures warranty / guarantee certificates
- iv. Packing list
- v. Engine Tool kit
- vi. One copy of all document presented to inspection agency

11. PACKING:

The engine shall be processed with rust preventive oil and painted by anticorrosive paint before packing the engine. The engine shall be properly packed against transit damage. The engine duly covered shall be packed rigidly inside a wooden crate. It should be properly supported inside the crate so that it does not have relative movement due to vibration/jerk during transit. Other major accessories viz. radiator etc. shall be packed in separate individual crates.

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Approved by:

Dr. General Manager (Loco Engineering Deptt.)
बी.ए.ई.एल. जंशंसि
B.H.E.L., JHANSI



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Packing list (Part number wise) made in line with contract scope of supply must accompany the engine for inspection at BHEL. All items/parts must carry the part number or tag bearing the respective part number for case in identification of parts at BHEL.

12. WARRANTY

Supplier must give warranty for successful performance of diesel engine for 12 months from the date of commissioning of locomotive at site or 18 month from the date of supply of the diesel engine whichever is early.

13. ERECTION AND COMMISSIONING

During installation of diesel engine on locomotive at BHEL Jhansi works the representative of manufacturer must be present for assistance. Any short supply of items required for installation of sub systems noticed during erection it will be responsibility of the manufacturer to arrange the material immediately.

While testing the diesel engine the performance of diesel engine as per specification must be ensured by the manufacture and if any system is not working well or failed during the testing the replacement must be arranged.

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उप निदेशक (लोकमोटर इंजीनियरिंग विभाग)
Dy. General Manager (Loco Engineering Deptt.)
बीएल जंक्शन, झांसी
- 471 001, JHANSI



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ANNEXURE-I TO LME/PUR/324Scope of Supply:

A) BASE ENGINE COMPLETE WITH TURBOCHARGER, INTAKE & EXHAUST MANIFOLD, AFTER COOLER, PT FUEL PUMP, FLYWHEEL AND FLYWHEEL HOUSING, LUB. OIL & FUEL FILTERS, LUB. OIL PUMP & COOLER, CHARGING ALTERNATOR ETC. MOUNTED ON ENGINE.

B) OTHERS:

SL. No.	PART
01.	AIR INTAKE SYSTEM AIR CLEANER ASSEMBLY, ELBOW, CLAMP T-BOLT, CLAMP T-BOLT, ELBOW 90 DEG, CLAMP T-BOLT, PRECLEANER HOOD HUMP HOSE, ELBOW REDUCER, BRACKET AIR CLEANER, TUBE AIR INLET, CLEANER AIR, VACUUM INDICATOR, HEX SCREW, NUT, LOCK WASHER, PLAIN WASHER, ELBOW REDUCER, DUST CAP etc.
02	EXHAUST SYSTEM SILENCER, CONNECTION EXHAUST, TUBE EXHAUST, FLANGE CONNECTION EXHAUST, CONNECTION TURBO. Etc.
03	FUEL SYSTEM FUEL FILTER ASSEMBLY, HOSE BETWEEN PUMP ;AND ;FILTER WATER SEPARATOR, NRVs, MUTC ASSEMBLY, HOSES, ADAPTORs
04	ENGINE COOLING SYSTEM RADIATOR ASSEMBLY, CORROSION RESISTOR ASSEMBLY GUARD FAN ASSEMBLY, FAN GUARD, HARDWARES, KIT RADIATOR, CLAMPS, T BOLT, HOSE, MALE CONNECTOR, MALE

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Approved by:

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Dy. General Manager (Loco Engineering Deptt.)
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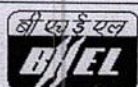
	ELBOW, HOSE MAKE-UP INLET WATER PIPE, INLET WATER PIPE, ELBOW, HOSE (DEAREATION), HOSE OVERFLOW-TTHIS FORMS A PARTS OF RADIATOR LIFTING EYE BOLTS ETC.
5.0	ENGINE LUB OIL SYSTEM BYPASS FILTER ASSEMBLY, BRACKET BYPASS FILTER T BOLT CLAMPS, HOSE, ELBOW MALE, HOSE ELBOW BUSHING BY PASS FILTER ETC.
6	CHARGING SYSTEM CHARGING ALTERNATOR 24V DC 30 AMP WITH NEGATIVE ISOLATED
7.0	INSTRUMENTATION AND SAFETY SWITCHES INSTRUMENTS , PRESSURE GAUGE, SWITCH TOGGLE AMMETER, SWITCH, SCREW PUSH BUTTON LIGHT INDICATOR, COUPLING PLAIN, HOSE, HOUR METER ASSEMBLY, HOUR METER, BRACKET HOUR METER, WATER TEMPERATURE GAUGE, TACHOMETER, OVER SPEED TRIP SWITCH, LUB OIL PRESSURE SWITCH-TRIP, LUB OIL PRESSURE SWITCH – IND., HIGH WATER TEMP SWITCH – IDLE, HIGH WATER TEMP SWITCH – IND.
10	COUPLING MOUNTING HARDWARES/FASTENERS FOR TG4302AZ COUPLING WITH ENGINE FLYWHEEL & FLYWHEEL HOUSING
11	MISCELLANEOUS TEST CERTIFICATE WARRANTY CARD O & M MANUAL CHART MAINTENANCE PARTS BOOK TOOL BOX FIRST FILL OF LUBE OIL AND COOLANT.

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ANNEXURE- II

PERFORMA FOR DATA SHEET

1. GENERAL
2. MAKE
3. MODEL
4. TYPE
5. BORE X STROKE
6. ASPIRATION
7. ENGINE OUTPUT AND FUEL CONSUMPTION CURVE
8. OUTPUT RATING

Control Notch	Engine RPM	Climate Condition			
		Standard		Severest	
		Gross Output	Net Output	Gross Output	Net Output

- 8.
- 7.
- 6.
- 5.
- 4.
- 3.
- 2.
- 1.
- Idle

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Remarks: i) 'Standard': To be defined by engine supplier.
ii) 'Severest': Identification from details in Para 1.4 of main Specification
iii) Net output is power available to traction generator & loco Auxiliaries

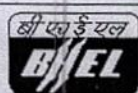
9. Overall dimension (Dimension drawing of the engine envelope to be attached)
Total heat dissipated by coolant and heat dissipation capacity of radiator
10. Sketch showing radiator dimensions & it's position within engine
11. Limits of operating parameters viz. Oil pressure/temp, Fuel pressure, water temp, exhaust air temp, SFC etc
12. Recommended lubricants
13. Diagram showing engine air intake & exhaust alignments
14. List of tools & tackles included in offer
15. Details of fuel transfer pump
16. Details of governor
17. Details of Oil/Fuel/Air Filters
18. Details of dimension of silencers
19. Wiring diagram for sensors, meters, protection devices, starting system, governor system with connecting devices
20. Extent of compliance with provision in this specification no DESL/M/205
(Para wise comments shall be given as below. any deviation shall be clearly mentioned.

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Checked by

Approved by

(Signature)
Manager (Locomotive Engineering Deptt.)
BHEL, Varanasi



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ANNEXURE - III

Test schedule for 400 hp Diesel Engine suitable for BHEL make 800 hp (TPP) Diesel Electric Locomotive with Governing System.

1. The testing shall be witnessed by BHEL Jhansi or their authorized agency.

STAGE - I

2.1 Engine output test:

2.1 Engine will be tested for one hour with air aspiration at prevalent ambient temperature on full load to deliver the rerated (3% max.) power of 400 BHP (min. guaranteed power) at the engine flywheel end at 2100 rpm. No accessories like radiator fan, charging generator shall be fitted during this test.

2.2 **Subsequently, engine will be tested for three hours with air aspiration at 55°C temperature on 85% load of rated output to deliver 340 to 330 BHP at 2100 rpm at engine flywheel end.

2.3 Various parameters will be recorded during the above test as per supplier's standard engine test format. This shall include trial of fuel consumption rate, smoke reading also.

2.4 **Capacity of fuel pump to lift the fuel for an effective head of 8.0 feet will be demonstrated.

2.5 The viscosity of crank case oil shall be checked prior and after completion of three hour load (as per above clause 2.2) to check oil dilution. Result shall be submitted for approval.

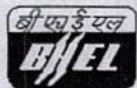
**Test to be done for Prototype Diesel Engine Only.

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Approved by:

Dr. Gopal K. Mishra (Asst. Engineer Deptt.)
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3.0 Notch Trial

3.1 Power output engine flywheel excluding power required by the engine auxiliaries shall be measured at their specified rated speed as per the table given below. This trial shall be carried at the ambient condition of manufacturer's test bed (temp. should be recorded).

NOTCH	Rated load speed (RPM)	Total HP output from the engine at stand climatic conditions
8	2100	
7		
6		
5		
4		
3		
2		
1	750	

Tolerance:

Power = +0%, -5%

Speed > = $\pm 1\%$ STAGE - II

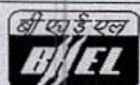
4. TIR values of engine alignment for flywheel and flywheel housing shall be maintained within following specified values in accordance with recommended values for BHEL generator TG-4302AZ to be coupled with the engine.
- 4.1 Eccentricity of flywheel housing and flywheel both not to exceed TIR of 0.18 mm.
- 4.2 Axial run out of flywheel housing not to exceed TIR of 0.18 mm.
- 4.3 Axial run out of flywheel not to exceed TIR of 0.13 mm.

Prepared by

Checked by

Approved by

Div. General Manager (Loco Engineering Deptt.)
HANSI



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- 5.0 Functional bench test of following safety devices shall be demonstrated w.r.t. the specified value of trip and the values shall be recorded:
- 5.1 High water temperature switch.
- 5.2 Low lube oil pressure switch. (Starter Safety Switch)
- 5.3 Over speed stop switch.
6. Meggar test for electrical wiring, at 500 V will be done. Minimum permissible values of resistance is 1.0 M-ohm.
7. Following certificates shall be submitted to the Inspection agency:-
- 7.1 Calibration certificate for all the measuring instruments used on the test cell shall be submitted.
- 7.2 Minipatch analysis report shall be submitted.
- 7.3 Manufacturer's certificates for following components:-
- a) Crankshaft.
 - b) Cylinder block.
 - c) Cylinder head.
 - d) Cylinder liner.
 - e) Connecting rods.
 - f) Gears
 - g) Piston
 - h) Camshafts.
 - i) Oil pan.
- 7.4. Diesel Dilution Test Report

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बी.ए.ई. लोको
B.M.E.L. ...



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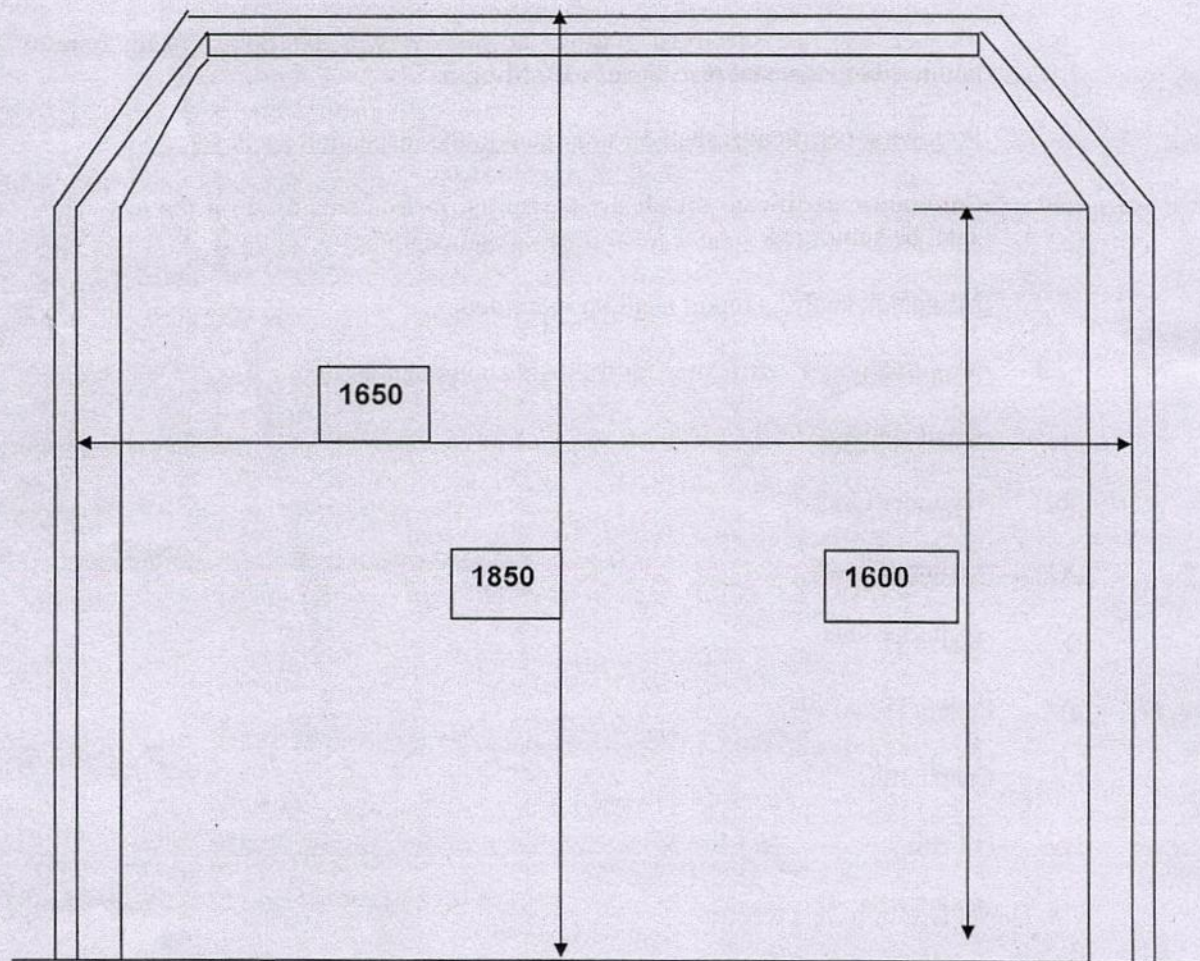
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Annexure-IV



Deck plate

Prepared by

Checked by

Approved by

BHEL, JHANSI
By General Manager (Purchase)
(GIRISH RAJ)
(Signature)
Date: 15/03/2019

[illegible]

Approved by:

प्रमाणित किया जाता है कि
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