



LOCOMOTIVE ENGINEERING DEPTT.

PURCHASE SPECIFICATION

LME: PUR:069

REV. No.: 04

Sheet: 1 of 17

SUBJECT:

**SPECIFICATION OF DIESEL ENGINE
FOR 350 HP B.G.
DIESEL ELECTRIC SHUNTING LOCOMOTIVE
(SINGLE POWER PACK)**

Enclosures:

Annexure – I Annexure-II, Annexure-III and quality plan.

Re	Date	Prepared - <i>Sd</i> -	Re	Date	Prepared - <i>Sd</i> -	Re	Date - <i>Sd</i> -	Prepared - <i>Sd</i> -
01	08.11.00	Approved - <i>Sd</i> -	02	26.03.04	Approved - <i>Sd</i> -	03	31.03.07	Approved - <i>Sd</i> -
Clause 2.4 in Annexure-IV added			Annexure-1 revised to add scope of supply of CAT engine			Specification, annexure-I & II revised QAP added & IV deleted.		
Re	Date	Prepared	Re	Date	Prepared	Re	Date	Prepared
v								
04	19.03.09	Approved			Approved			Approved
Clause 8(x) is added.								

Prepared by: *[Signature]*Checked by: *[Signature]*Approved by: *[Signature]*

Distribution: Loco prodn. (001) Loco PPC (002) Loco QC (003) Tech. (004) CQX (005)

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1. GENERAL

This Specification covers technical requirement, scope of supply and erection and commissioning of 350 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 in side loco	:	0° to 55° C
Altitude	:	0 - 1000 M
Relative Humidity	:	40% - 100%
Maximum sun	:	70°
Temperature	:	

2. CAPACITY:

2.1 The engine shall deliver powers in various notches at its corresponding speed as specified below:-

NOTCH	Rated lead speed (RPM)	Total HP output from the engine at standard climatic conditions.
8.	2100	350
7.		
6.		
5.		
4.		
3.	650	10
2.		
1.		

Tolerance:

Power Output : 0% , -5%

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Speed = $\pm 1\%$

- Power at climatic condition as in para 1.3 should be 350 HP considering duration of 3% max.
- On above table the speed Vs power out put is shown for ist and last notch only for intermediate notches load RPM and power out put shall be specified by tender

The engine shall be matched to supply power to traction generator and loco auxiliaries as given below:

- HP input to Traction generator = 315 HP at 2100 rpm at site conditions
- Locos auxiliaries as listed in para 2.2 = 20 HP at 2100 rpm.

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:

- 3.1 The exhaust outlet from the turbo-charger shall be so arranged as to facilitate installation of the exhaust slack at the flywheel-end of the engine.
- 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.
- 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.

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- 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 – III 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 charging alternator should be able to charge the batteries at low idle speed of 650 rpm.

Battery will not be supplied with the engine.

- 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 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.

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- 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. FLEXMASTERS 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 (One Mechanical analog type over engine and another digital type in driver's cabin).
- ii) Engine service hour counter.
- iii) Water temperature gauge (Mechanical type) to be supplied loose with approx. 5.0 meters long capillary for mounting in driver's cabin.
- iv) Lub. oil temperature gauge (Mechanical type).
- v) Lub. oil pressure gauge (Mechanical type) to be supplied loose with approx. 5.0 meters long capillary for mounting in driver's cabin.
- vi) Fuel pressure gauge (Mechanical type).
- vii) 30 Amps battery charging ammeter to be supplied loose for mounting in driver's cabin.

3.11.2 The supply shall include following protections:

- i) Over speed trip with sensing device.
- ii) Sensing and tripping device for high water temperature.
- iii) Sensing and tripping device for low lub oil pressure.
- iv) Sensing and tripping arrangement for low water level with 1 NC + 1 No. contacts from RDSO approved supplier.

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- 3.11.3 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 antivibration 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.
- 3.11.4 All gauges shall be frame-mounted over the engine except the digital tachometer, which is to be mounted in drivers cabin.
- 3.11.5 All gauges shall be of internally illuminated type of device and should have labels for identification. All cables should have ferrules for identification.
- 3.11.6 All dial faces shall have black background with white lettering.
- 3.11.7 All dial faces shall also carry the international symbols denoting the respective functions and graduation.
- 3.11.8 All engine protection and sensing devices shall be mounted directly on the engine.
- 3.1.9 Dimensional details for the devices to be mounted away from the engine shall be furnished along with the quotation.
- 3.11.10 Accuracy of all meters should be within $\pm 1\%$.

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4. SCOPE OF SUPPLY:

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

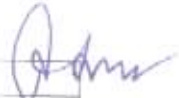
5. INSPECTION AND TESTING:

- 5.1 Each engine shall be tested as per enclosed Test Schedule (Annexure-IV) in the manufacturer's works prior in despatch, 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 r tests shall be witnessed by BHEL's authorised representative.
- 5.2 The complete engine shall be inspected by the BHEL / BHEL authorized agency at supplier works according to quality assurance plan no. **QP/DL/611** and all documents / test certificates as per quality assurance plan must be produced at the time of inspection. One set of such documents shall also be send alongwith engine.
- 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 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.

7. TV ANALYSIS:

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TV analysis shall be submitted by the supplier within one month after placement of order. BHEL reserves the right to cancel the order in the event of results of TV analysis being found unsatisfactory.

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) Schematic drawing of lube oil system, fuel oil system, cooling water system and electrical wiring
- v) Acceptance of Quality plan
- vi) Recommended list of the spares inventories to be maintained with price, for 2 years usage
- vii) List of especial tools and tackles required for engine maintenance if any
- viii) Specification and quantity of recommended lube oil and coolant
- ix) Description of engine governing system.
- x) Supplier to give test format with acceptable value for each parameter recorded during test.

1. Notch power test 1-8

2. Minipatch analysis

3. Diesel dilution etc.

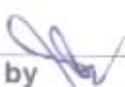
This will be basis for acceptance of engine

9 Documents to be submitted within one month after placement of order

- 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

10. Following documents shall be supplied along with despatch 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

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- ii) Engine operations and maintenance manual and part list shall be supplied in triplicate per engine.
- iii) Manufactures warranty / guarantee certificates
- iv) packing list tool list etc.

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 in side a wooden crate. It should be properly supported in side 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.

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.

ANNEXURE-I TO LME/PUR/069

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- 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.

B0 OTHERS: sub systems shall inter alia include the followings

SL. No.	PART
01	AIR INTAKE SYSTEM Which includes 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 ADAPTOR
04	ENGINE COOLING SYSTEM RADIATOR assembly, CORROSION RESISTOR ASSEMBLY GUARD FAN ASSEMBLY, FAN GUARD, HARDWARES, KIT RADIATOR, CLAMPS, T BOLT, HOSE, MALE CONNECTOR, MALE ELBOW, HOSE MAKE-UP INLET WATER PIPE, INLET WATER PIPE, ELBOW, HOSE (DEAREATION), HOSE OVERFLOW-THIS 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.
6.0	CHARGING SYSTEM CHARGING ALTERNATOR

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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 – TRIP, HIGH WATER TEMP SWITCH – IND. OTHER SAFETY DEVICES AS DEFINED IN PARA 3.11 OF THIS SPECIFICATION
8.0	MISCELLANEOUS)
8.1	TEST CERTIFICATE
8.2	WARRANTY CARD
8.3	O E M MANUAL
8.4	CHART MAINTENANCE
8.5	PARTS BOOK
8.6	TOOL BOX
8.7	FIRST FILL OF LUBE OIL AND COOLANT.

Quantity of all above items shall be sufficient to complete engine installation on locomotive at BHEL Jhansi works.

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**ANNEXURE - II**

Test schedule for 350 hp Diesel Engine suitable for BHEL make 350 hp Diesel Electric Locomotive with Governing System.

1. The testing shall be witness by BHEL Jhansi or their authorised agency.

STAGE - I

2. Engine output test:

2.1 Engine will be tested for one hour with air aspiration at 55°C temperature on full load to deliver the derated (3% max.) power of 350 to 332 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 298 to 283 BHP at 2100 rpm at engine flywheel end.

2.3 Various parameters will be recorded during the above test as per suppliers 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.

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	Total HP output from the
-------	------------------	--------------------------

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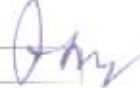
	(RPM)	engine at stand climatic conditions
8	2100	360
7		
6		
5		
4		
3		
2		
1	650	10

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 TOR 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.
- 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 lub. oil pressure switch.
 - 5.3 Starter safety switch.
 - 5.4 Over speed stop switch.

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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 will be submitted
 - 7.4 Crankshaft.
 - 7.5 Cylinder block.
 - 7.6 Cylinder head.
 - 7.7 Cylinder liner.
 - 7.8 Connecting rods.
 - 7.9 Gears
 - 7.10 Piston
 - 7.11 Camshafts.
 - 7.12 Oil pan.

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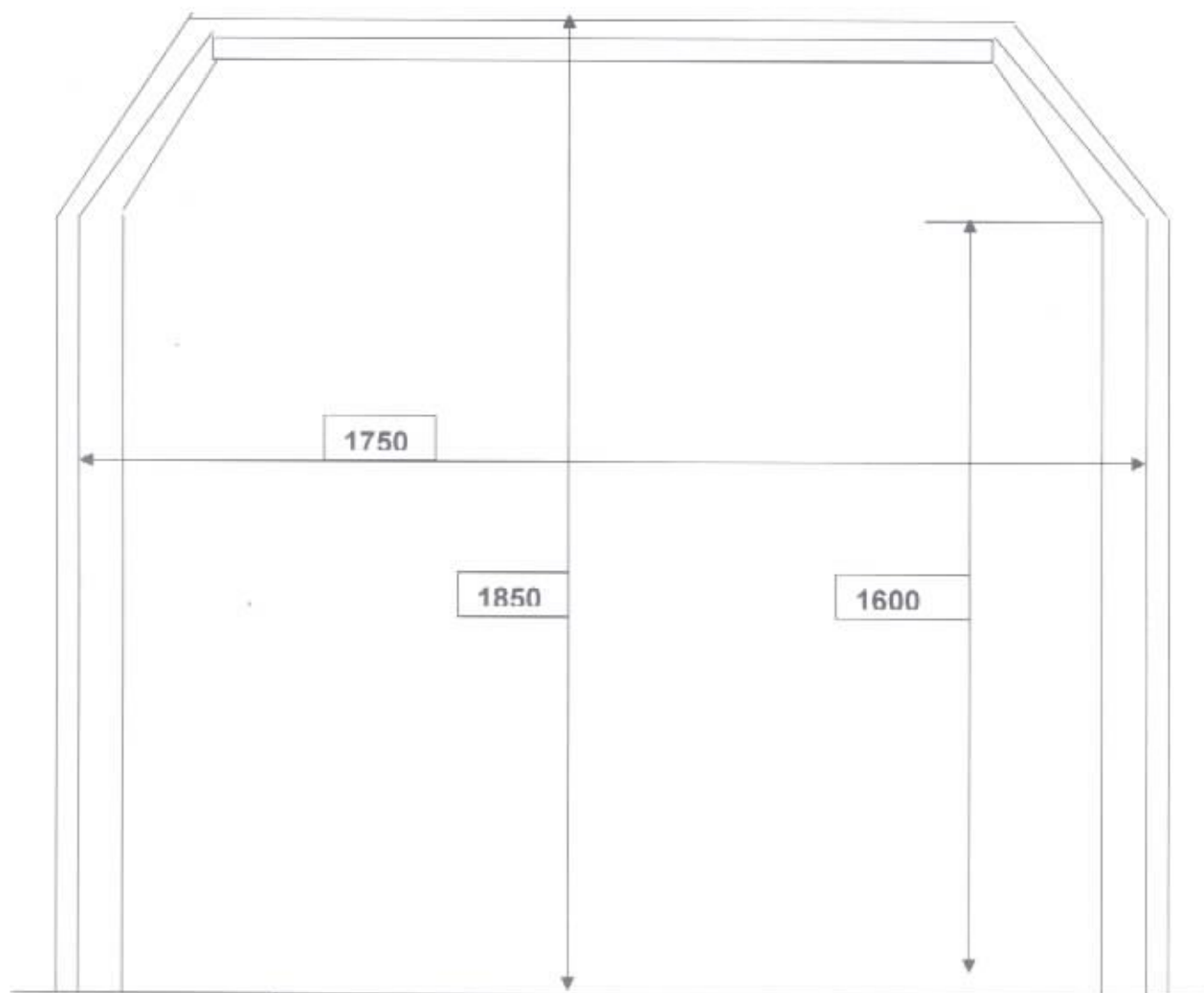
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Annexure-III



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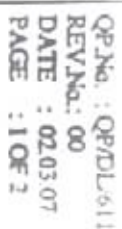
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Sl.No	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY			REMARKS
									M	C	N	
1.	Engine Body	a) Casting b) Material c) NDT (As applicable) d) Dimensions	B B B B	D } V } T } I }	100%	Manufacturer Specification Relevant IS/ Specification / Drg.	Manufacturer Specification Relevant IS/ Specification / Drg.	TC/O/S/ Format Check list	P	V	-	
2.	Crank Shaft	a) Material b) NDT (As applicable) c) Dimensions	A A A									
3.	Connecting Rod	a) Material b) NDT (As applicable) c) Dimensions	A A A									
4	Cylinder Block	a) Material b) NDT (As applicable) c) Dimensions d) Pressure Test	A A B A									
5.	Cylinder Head	a) Material b) NDT (As a a.) Material c) Dimensions d) Pressure Test	A A B A	I & T	100%	Relevant IS/ Specification/Drg.	Relevant IS/ Specification/Drg.	TC/O/S/ Format Check list	P	V	-	
6.	Gears	a) Material	B									
7.	Hard parts	b) NDT (As applicable)	B									
8.	Bearing	c) Dimensions	B									
9.	Couplings											

SHARAT HEAVY ELECTRICALS LIMITED, JHANSI



MANUFACTURING
QUALITY PLAN FOR
SUBMISSION TO
CUSTOMER
STANDARD

STANDARD
QP FOR DIESEL ENGINE
RATED POWER :- 1400 HP / 700 HP /
350 HP

MATERIAL INSPECTION / IN-
PROCESS INSPECTION /
FINAL INSPECTION

SUB VENDORS /
VENDORS /
CONTRACTORS
WORKS

Qp No. : QP/DL
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SL.No	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY			REMARKS
									M	C	N	
10.	Engine Testing	a) IR & HV b) Testing c) Continuity Test of Wiring d) Setting and Functioning e) Functioning of Safety Devices f) Diesel Dilution Test g) Final Testing	B C B C	T T I T	100% 100% 100% 100%	BS-5514/IS BS-5514/IS /Drg. BHEL Approved * Test Schedule	Relevant IS/ Specification BS-5514/IS /Drg. BHEL Approved Test Schedule	TC/OS/ Format Check list TC Test Report	P P P	V W W	- - -	* Test Schedule to be get approved By BHEL
Remark:- Engine testing shall be done generally accordance with BS 5514 / IS with speed control of engine by the actual governor and fuel pump to be supplied with the engine and S.Nos. of the governor and pump to be mentioned on test report												
11.	Painting	a) Shade b) Coating Thickness	B B	D I	100% Sample	Relevant IS / Drg	Relevant IS / Drg	Record	P	V	-	
12.	Gauges	Calibration of Gauges	B	T	100%	Relevant Specifications	Relevant Specifications	Record	P	V	-	

LEGEND:-
CLASS
A: CRITICAL
B: MAJOR
C: MINOR
TYPE OF CHECK
I: INSTRUMENT
T: TEST
D: VISUAL

AGENCY
M: MANUFACTURER / SUB CONTRACTOR
C: BHEL
N: INSPECTING AGENCY / CUSTOMER

OTHERS
TC: TEST CERTIFICATE
V: VERIFICATION
W: WITNESS

SCOPE OF AGENCY
P: PERFORMER
CH: CUSTOMER HOLD POINT
O.S: OBSERVATION SHEET

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