SUBJECT:

SPECIFICATION OF DIESEL ENGINE FOR 700 HP B.G. BO-BO DIESEL ELECTRIC SHUNTING LOCOMOTIVE (SINGLE POWER PACK)

Enclosures:

Annexure – I – 02 sheets. Annexure-II – 03 sheets
Annexure – III, 01 sheet.

Rev	Date	Prepared	Rev	Date	Prepared	Rev	Date	Prepared
01	01.02.97	Approved			Approved	03	10.11.00	Approved
Type test, clause 5.1 is added			Clause no. 3.10 and 3.11 added			clause 2.5 added in Annexure IV		

Rev	Date	Prepared	Rev	Date	Prepared	Rev	Date	Prepared
04	19.03.09	Approved			Approved			Approved
Specification, annexure I to III revised QAP added annexure- IV deleted and clause 8(x) added.								

Prepared by: Checked by: Approved by:

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

Prepared by	Checked by	Approved by:

1. GENERAL:

This specification relates to the diesel engine required for a 700 hp BG Bo-Bo diesel electric locomotive, powered by one single power pack.

The locomotive is intended for heavy shunting duties.

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%
Temperature	:	70° C

Due to note shall be taken of the locomotive being required to operate in the dust laden atmosphere of Steel Plants and Coal Washeries & Cement Factories.

2. CAPACITY:

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

Notch	Rated load speed(RPM)	Total HP output from the engine at standard climatic condition
8	1800	730
7	1700	600
6	1575	450
5	1450	350
4	1260	250
3	1100	150
2	930	90
1	750	30

Tolerance:

Power output = +0%, -5%
Speed> 8th notch = +1%, other notch = ± 2%

- Maximum HP at climatic condition as in para 1.3 should be 700 HP considering deration of 3% max.

- The engine shall be matched to supply power to traction alternator and loco auxiliaries as given below.

  - HP input to Traction Alternator = 638 HP at 1800 rpm.
  - Locos auxiliaries as listed in para 2.2 = 40 HP at 1800 rpm.

2.2 The following locomotive auxiliaries shall be belt driven from the ;engine:

From power-take-off unit at front end of engine:

(i) Charging Alternator - 16.5 HP
(ii) Traction motor blower - 10 HP

From the non-drive-end of the traction alternator:

(i) Air compressor - 16.5 HP (Nominal)
(ii) Traction motor blower - 10 HP

2.3 The required HP to Alternator 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 (over-load 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 stack 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 alternator and also from the engine through a suitable power-take-off unit at the fan end. The suitable power take-off unit shall be supplied with the engine.

3.4 The engine shall be provided with two side-mounted radiators and suitable duct, leading the air from engine mounted fan to the side radiators. Both ducts should have a sealed window in each chamber for attending radiator from inside.

Annexure-II 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 pumping system 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 exhaust should meet exhaust norms as per euro stage - I

3.7 The engine shall be supplied along with 2 Nos. 32 volts DC electric starters connected in series or one No. 64 volt starters have sufficient cranking capacity. The starting circuitry should ensure proper synchronization of both starter motors together with pinion solenoids and magnetic switches. Two nos. time delay relays rated at 72 volts and with time delay of 10 seconds and 80 seconds & minimum time between two of the uses of 80 secs. respectively. Each time delay relay has 2 nos. changeover 1 NO +1 NC contact with the current rating of 5 Amps.

3.8 The engine shall drive a two-bearing traction alternator BHEL type TA6301AZ. The alternator frame is foot mounted on the deck-plate of the locomotive and the alternator-rotor shall be coupled with the engine flywheel through a flexible coupling, which shall be supplied with the engine. The flexible coupling shall be supplied with finish machined bore and suitable hardware for fitment.

3.9 Electro-8 notch governor to control engine speed and alternator excitation shall be supplied with the engine. The locomotive is equipped with 64/72 volt DC supply and therefore all electrical solenoid, coils etc. should be suitable for continuous operation at 72 volts DC (Minimum pickup voltage 48V) with negative isolated

3.10 Alternatively supplier can offer electronic 8 notches LCC governor of GAC, USA make..

3.11 The governor shall be set as per traction alternator characteristics curve LME:1278 rev. 01 enclosed with this specification.

- 1500:5A current transformer shall be in BHEL scope of supply, which shall be required to give input to electronic controller.
- Potential transformer shall be in scope of supply of engine supplier in kit.
- Fuel actuator shall be supplied by engine supplier. Current requirement of actuator shall be clearly indicated. Series resistor for actuator shall be in BHEL scope.
- 2 separate magnetic pick-up unit shall be required. One for providing input to electronic controller and other for digital tachonter. Single MPU shall not be acceptable.

- Fitting provisions for MPU shall be in engine supplier scope.

- Supplier shall furnish installation drg. For controller and care shall be taken in mounting to reduce vibration to minimum by using rubber pads.

- Electronic controller shall have VCLP feature and shall be highly suitable for all values of supply voltage between 0.7U and 1.25U; where U is the supply voltage.

- Supplier to ensure that these controller shall be easily available on demand as spare and spare controller shall always be pre-set as per alternator characteristics as attached.

Detailed technical leaflet of governor shall be supplied alongwith the engine.

3.12 Pipes for both air (intake /exhaust) and cooling water line would be provided to suitable sizes with reference to the installation diagram of Engine. FLEXMASTERS pipe couplings are required for water pipe connection between radiators & engine. Hoses not accepted for such use.

3.13 Metering and Protection system:

3.13.1 The supply shall include the following meter/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) 72/24V, 5 amps DC-DC convertor from RDSO approved supplier for Electrical gauges to be operated at 24V DC.

iv) Water temperature gauge (Electrical type).

v) Lub. Oil temperature gauge (Mechanical type).

vi) Lub. Oil pressure gauge (Electrical type).

vii) Fuel pressure gauge (Mechanical type).

Viii) Cooling water pressure gauge with sensing device,

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.
v) sensing and tripping device for air filter clogging.

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 through suitable anti-vibration pad over the engine at a suitable location determined with the approval of BHEL. The terminals should have nut & 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.

3.11.9 Dimensional details for the devices to be mounted away from the engine shall be furnished alongwith the quotation.

3.11.10 Accuracy of all meters should be within ± 1%.

4. **SCOPE OF SUPPLY;**

The scope of supply in general shall cover all the modules as per Annexures-I enclosed herewith. How,ever supplier shall submit detailed packing list along with the engine

5. **: INSPECTION AND TESTING:**

5.1 Each engine shall be tested as per enclosed Test Schedule (Annexure-II) 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 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:**

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

Submission of documents

8 **following documents shall be send alongwith 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 sand tackles required for engine maintenance if any
viii) Specification and quantity of recommended lub 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

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 ease 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

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	**Starting system** Engine starter motor complete with pinion
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	**Engine control System** Electronic governor to control engine speed and alternator excitation.
10	**Coupling** Holeset coupling between engine and alternator with connecting hardware.
11	**MISCELLANEOUS)** TEST CERTIFICATE WARRANTY CARD O & M MANUAL CHART MAINTENANCE PARTS BOOK TOOL BOX 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.

ANNEXURE - II

Test schedule for 700 hp Diesel Engine suitable for BHEL make 700 hp Diesel Electric Locomotive with Governing System.

1. The testing shall be witnessed 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 700 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 590 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 (RPM)	Total HP output from the engine power at stand climatic conditions
8	2100	
7		
6		
5		
4		
3		
2		
1	650	10

Tolerance:

Power = +0%, -5%
Speed > = ± 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 devises 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.

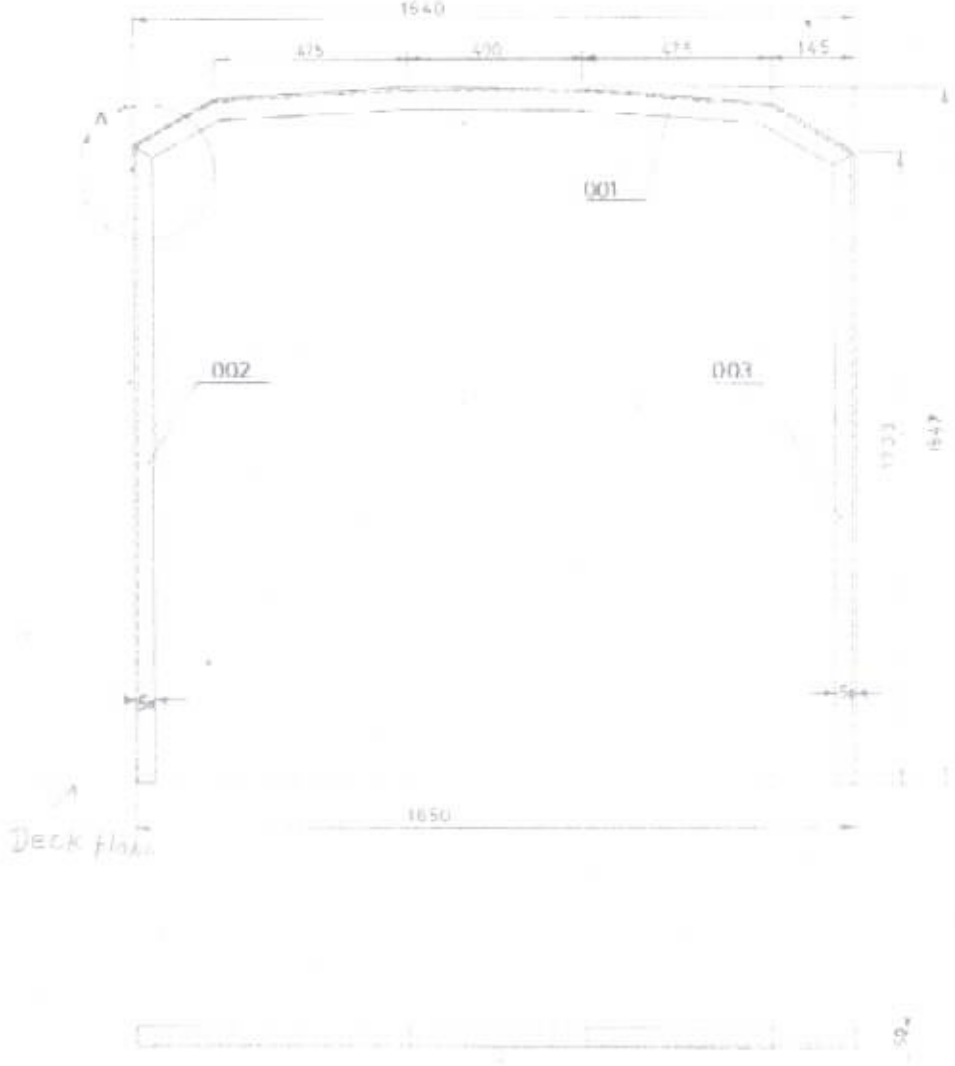
6. Meggar test for electrical wiring, at 500 V will be done. Minimum permissible values of resistance is 1.0 M-ohm.

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.

Annexure - III



Prepared by	Checked by	Approved by:

BHARAT 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/511 REV.No.: 00 DATE : 02.03.07 PAGE : 1 OF 2

SL.No.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY M	AGENCY C	AGENCY N	REMARKS
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/OS/ Format Check list.	P	V	-	
2.	Crank Shaft	a) Material b) NDT (As applicable) c) Dimensions	A A A	T T T								
3.	Connecting Rod	a) Material b) NDT (As applicable) c) Dimensions	A A B	T T I								
4	Cylinder Block	a) Material b) NDT (As applicable) c) Dimensions d) Pressure Test	A A B A	T T I T								
5.	Cylinder Head	a) Material b) NDT (As a a) Material c) Dimensions d) Pressure Test	A A B A	T T I T								
6. 7. 8. 9.	Gears Hard wares Bearing Couplings	a) Material b) NDT (As applicable) c) Dimensions	B	I &T	100%	Relevant IS/ Specification/Drg.	Relevant IS/ Specification/Dr.	TC/OS/ Format Check list	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
CHP: CUSTOMER HOLD POINT
O.S.-OBSERVATION SHEET

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BHARAT 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 REV.No.: 00 DATE : 02.03.07 PAGE : 2 OF 2

SL.No.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY M	AGENCY C	AGENCY N	REMARKS
10.	Engine Testing	a) IR & HV	B	T	100%	BS– 5514/ IS	Relevant IS/ Specification	TC/OS/ Format Check list	P	V	-	* Test Schedule to be get approved By BHEL
		b) Testing	C	T	100%							
		c) Cotinuity Test of Wiring d) Setting and Functioning e) Functioning of Safety Devices f) Diesel Dilution Tet	B	I	100%	BS– 5514/ IS /Drg.	BS– 5514/ IS /Drg.	TC	P	W	-	
		g) Final Testing	C	T	100%	BHEL Approved * Test Schedule	BHEL Approved Test Schedule	Test Report	P	W	-	
		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	D	100%	Relevant IS / Drg.	Relevant IS / Drg.	Record	P	V	-	
		b) Coating Thickness	B	I	Sample							
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
CHP: CUSTOMER HOLD POINT
O.S : OBSERVATION SHEET

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