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लोकोमोटिव के लिए गवर्नर

**MICROPROCESSOR BASED GOVERNOR
FOR
DIESEL ELECTRIC LOCOMOTIVES (HHP)**

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Brief Description

This document describes the requirements for the development of Microprocessor Based Control Governor for Diesel Electric Locomotives. The complete specification details the functional requirement of the unit, scope of supply and testing of the equipment ensuring reliability and fail-safe operation

FOREWORD

Microprocessor Based Governor System (MPBG) enables Notch wise speed control of the Engine, Load control function in case of engine over load and provide other safety feature for satisfactory performance of Engine. MPBG shall display the relevant engine parameters along with the fault display, fault logging and downloading the logged data for analysis.

This document specifies the requirements, testing and evaluation criteria of micro processor based governor (MPBG) suitable for all WDG4/WDP4 type HHP diesel electric locomotives for Indian Railways

The specification of the MPBG is for standalone type. After gaining the experience in standalone MPBG, communication protocol will be developed for display all the messages in the Common display unit DIALS and the date and time sharing through Loco Control Computer (LCC) and will be incorporated in next update of the specification.

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LIST OF AMENDMENTS

S. No.	Amendment Date	Revision	Details
1.	27/08/2014	0	First Issue

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S. No.	Document name / number
1.	IEC 60571
2.	IEC 60812
3.	IEC 60529
4.	IEC 62262
5.	IS 2500
6.	EDPS 179
7.	MP. 0. 2400.43 (Latest) for AC - AC traction system for 4500HP WDG-4/WDP-4B Diesel - Electric Locomotives
8.	MP.0.2400.67 (Latest) for AC - AC traction system for Dual Cab 4500HP WDG-4D/WDP-4D Diesel - Electric Locomotives

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Annexure 3	Methodology for Inspection and testing of MPBG
Annexure 4	Infrastructure Requirements for MPBG Manufacturers
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0 Background

The micro processor based governor (MPBG) is perceived as an alternative to Electro Hydraulic Governor for simpler maintenance with modular system and minimum moving parts, complete flexibility in various adjustments like engine speed, notch wise low lube oil shut down pressure and maximum allowable fuel rack as a function of engine notch position and booster air pressure.

1 Objectives

The function of the Micro Processor Based Governor (MPBG) is Notch wise speed control of the Engine, Load control function in case of over load on the engine and also to provide other safety feature for satisfactory performance of Engine.

This document specifies the requirements, testing and evaluation criteria of micro processor based governor (MPBG) system suitable for all WDG4/WDP4 type HHP diesel electric locomotives for Indian Railways.

The scope shall also include necessary engineering design for retrofitting the proposed micro processor based governor (MPBG) on the existing engine. The system shall display the relevant engine parameters along with the fault display, fault logging and downloading the logged data for analysis. The system parameters limits shall be user settable.

The micro processor based governor (MPBG) would need to have prototype approval, prove-out, field trials and bulk supplies thereafter.

2 Scope of supply

The deliverables to this specification for MPBG shall include:

- i. Control cum Display unit along with mounting accessories.
- ii. Actuator unit along with mounting accessories.
- iii. Pressure sensor box along with mounting accessories.
- iv. Engine Speed sensors - 02 nos. along with mounting accessories.
- v. Interconnecting cables with connectors as per Annexure- 1.
- vi. Booster pump (Optional)

All control cables shall be governed by EDPS-179.

3 Terms and abbreviations

S. No	Term / Abbreviation	Description
1.	DLW	Diesel Locomotive Works, Varanasi
2.	DLMW	Diesel Loco Modernisation Works
3.	LCC	Locomotive Control Computer
4.	MBCS	Microprocessor Based Control System
5.	PU	Production Units
6.	RDSO	Research Designs & Standards Organisation
7.	ZR	Zonal Railways
8.	EPD	Engine Protection Device
9.	EDPS	Engineering Design Performance specification

4 General requirements

4.1 Manufacturers qualification

The manufacturer of the equipment shall be a reputed organization dealing with manufacture / integration of electronic systems. The manufacturer shall be capable of providing spares and support services during the operational life of the equipment from setups located within the international boundaries of the India.

4.2 Equipment Requirements

The equipment supplied against this specification shall meet the following general requirements.

- 4.2.1. The equipment shall be designed for installation on diesel electric locomotives. The equipment manufacturer shall get the equipment design approved by RDSO before fitment on locomotives.
- 4.2.2. The equipment supplied shall be of good quality, rugged and reliable and capable to withstand environmental and use conditions. The individual components shall meet the lifecycle requirements for that category of equipment as elaborated at clause no.15
- 4.2.3. The offered MPBG shall be retrofittable with the existing woodward governor. The MPBG shall be accommodated in the existing envelope. Envelope is intended to mean the space available within the existing superstructure and existing accessory connections.
- 4.2.4. Wherever outsourced equipment is used, care shall be taken to ensure that the equipment is sourced from reputed manufacturers.
- 4.2.5. The supplier of equipment supplied under this specification shall ensure proper interfacing and connectivity between equipment / software.
- 4.2.6. Failure Mode Effects and Criticality Analysis of the equipment shall be done during the design process in conformance to IEC 60812. The records of this analysis shall be provided upon requirement.
- 4.2.7. The availability of the offered MPBG shall be minimum 90 days before any attention is paid to the power pack.
- 4.2.8. The supplier shall have a plan for indigenization of MPBG.
- 4.2.9. Existing Alternator, power pack and controls shall be used. In case modified, it becomes the part of the scope of supply of the supplier for the modifications / additions based on optimising the asset so that maximum gains can be achieved.

5 Environmental/Climatic requirements

The equipment shall be tested as per the environmental requirements of IEC 60571(Latest).

6 Functional requirements

The MPBG supplier must meet the following requirements of the existing governor fitted on WDG4/WDP4 type HHP diesel electric loco

6.1 Speed Control

The MPBG shall maintain eight engine speeds according to the steps commonly, called Notches. To maintain the required engine speed according to notch input is given in a particular sequence of electrical signal by MBCS/LCC as shown in the Table-1 given below.

It shall have provision of user settable provision to alter engine speed at any notch, to suit the requirement arisen from fuel economy or engine performance considerations. Drop-out voltage of relays, if provided, at notch input signals shall be within 15-18 Volts & pick-up Voltage shall be above 30 Volts.

Table1

Notch Position	Wires Energised	Engine Speed (Rpm) Free from hunting with or without Load for 4000 HP	Engine Speed (Rpm) Free from hunting with or without Load for 4500 HP
Shut-Down	3	0	0

Low Idle	15,3	200	200
Idle/1	-	269	269
2	15	343	354
3	7	490	486
4	15, 7	568	572
5	12, 7, 3	651	675
6	15,12, 7, 3	729	764
7	12, 7	820	863
8	15,12, 7	904	954

6.2 Speed Stability

MPBG is required to maintain stable engine speed i.e. free from hunting at each notch position in both conditions - with or without load.

6.3 Governor Response:

Time taken for speed adjustment from IDLE to FULL speed shall be of the order of 15-20 seconds. For intermediate notch positions, the time taken to adjust engine RPM shall be in the same proportion.

6.4 Load Control:

The MPBG shall generate the Load control output voltage signal to interface with Microprocessor Control system. This signal shall be in the form of Analog voltage which varies from 74 to 0 volts DC. In Engine normal condition the LCP output voltage is 74 volts and in Engine overload condition the LCP should vary from 74 volts to 0 volts to reduce the load on the Engine through Microprocessor Control system. MPBG shall be capable of load control and fuel limiting w.r.t BAP.

6.4.1 Supply Ratings:

Voltage..... 74±1 V DC
Current..... 0.5 Amps.

6.4.2 Load Control Timing:

- Load control timing from maximum to minimum field position change shall be 5 – 9 seconds.
- Load control timing from minimum to maximum field position change shall be 5 – 9 seconds.

6.5 Emergency Shut down

Governor should be able to shut down engine in case of emergency and/or actuation of EPD (Engine Protection device)

7 AUXILIARY FEATURES

The MPBG offered shall cater for the following auxiliary features:-

7.1 Air Manifold Pressure Bias Fuel Limiter:

The MPBG shall regulate the movement of fuel control shaft as a function of absolute air manifold pressure (boost air pressure). The MPBG shall satisfy the load limit requirements for 4000 HP/4500 HP locomotives.

The system shall however, have the facility of fuel limit adjustment to any other fuel limit curve, if required.

7.1.1 Boost Air Pressure (BAP) transducer:

Requirements of Boost air pressure transducer will be:

- Working range : 0 to 3.5 kg/cm²
- Temperature of Boost air: 120°C max.

7.2 Engine over Speed Trip Facility:

MPBG shall shut down the engine in the event of engine RPM increase beyond the set limit. Engine shut down RPM setting shall be user settable.

7.2.1 Mechanical and Electronic Engine over Speed Trip-Test Facility:

MPBG shall have facility to slowly increase the engine speed above its rated speed for checking the setting of the mechanical over speed trip mechanism and over speed trip function of MPBG. It shall be possible to easily revert back to the normal setting of engine speeds in the event of Mechanical OSTA and Electronic OST test failed.

7.3 Status Display of Engine Parameters:

7.3.1 General requirements

An industrial robust display shall be provided on the controller unit. The display shall be such that it is clearly visible under day and night conditions from a distance of 2 metre.

7.3.2 Typical requirements:

The display shall either be

a) A bluish green vacuum fluorescent display (VFD) with four lines of 20 characters.

or

b) Graphic colour LCD operator interface terminal with QVGA display with soft key or touch screen to the following specification:

- Typical power 8W
- Battery: internal rechargeable Lithium ioncell. Typical lifetime of 10 years
- LCD Display

Size/Type	4 to 6 inch/STN
Colours/ Pixels	256/320X240
Brightness/ Backlight	165 cd/m ² /20,000 hr (typical values).

or

c) OLED with four lines of 20 characters

The display shall be in the format given below:

LOP (kg/cm ²)				FOP (kg/cm ²)				BAP(kg/cm ²)										
L	.	L						F	.	F					B	.	B	B
N			S	S	S	S		R	R	.	R			H	H	:	M	M

NOTCH

ENGINE

FUEL RACK

LCP (hrs:minutes)

SPEED (rpm)

(degree)

- Soft Key (desired 5-key) keypad: for on-screen menus or Capacitive/resistive (in case of touch screen) suitable for use on locomotives.

7.4 Fuel oil Pressure (FOP) Transducer

Requirements of Fuel oil pressure transducer will be as under:

- Working range : 0 to 5 Kg/cm²
- Temperature of Fuel oil : 55°C max.

7.5 Lube Oil Pressure (LOP) Transducer

Requirements of Lube oil pressure transducer will be as under:

- Working range : 0 to 10 Kg/cm²
- Temperature of Engine Lubricating oil : 125° C max.

7.6 Real-time clock

The system shall have a real-time clock with accuracy of better than +/- 5 seconds over 30 days. The RTC shall be capable of time synchronization through laptop/ Display. The battery of RTC Clock should work for minimum 3 years and should be replaceable easily. Time synchronization through Laptop/Display based on Password protection should be provided.

8 Safety Features/Devices

Provision shall be kept for the following safety features/devices in the MPBG being offered.

8.1 Low Lube Oil Pressure Shut-Down (LOPS)

A safety feature to protect the engine in the event of low lube oil pressure shall be provided to shut down the engine, whenever the lube oil pressure falls below the following stipulated limits:

Table 2

Notch	Engine Low Lop Settings (kg/cm ²)
Low Idle	0.5 kg/cm ²
Idle	0.9 kg/cm ²
1	0.9 kg/cm ²
2	1.1 kg/cm ²
3	1.4 kg/cm ²
4	1.7 kg/cm ²
5	2.1 kg/cm ²
6	2.7 kg/cm ²
7	3.0 kg/cm ²
8	3.3 kg/cm ²

LOPS setting values are tentative and shall be user settable. It shall be possible to delay the operation of this device at each notch position. The governor shall also have a provision for adjustment of the LOPS setting values independently at each notch position. In the event of locomotive engine shutting down due to low lube oil pressure on affecting the low idle feature, the MPBG shall log the fault as "Engine Shut Down due to Low LOP at Low Idle".

8.1.1 Time Delay Feature

A time delay of 50 – 60 seconds shall be provided in low oil pressure shut down, system at idle/notch-1 speed steps to enable the engine driven lube oil pump to build up the requisite lube oil system pressure while starting the engine. It shall be possible to provide time delay facility at other notches as well. This time delay can be different for different notches

8.2 Low Water Pressure Shut-down

A safety feature to protect the engine in the event of low water pressure shall be provided to shut down the engine. This Low water pressure shut-down feature by MPBG is by sensing the Lube oil pressure of the engine from the outlet of Engine Protective device, i.e. in the Locomotive in the event of Low water pressure the Engine protective device (EPD) will drain the Lube oil pressure which is going to Governor and the Governor will shut-down the engine due to Low lube oil pressure. The Low Lube oil pressure shut-down limits are given in Clause No: 8.1.

8.3 Positive Crankcase Pressure Shut-down

A safety feature to protect the engine in the event of Positive crank case pressure in the engine shall be provided to shut-down the engine. This positive crank case pressure shut-down feature by MPBG, is by sensing the Lube oil pressure of the engine from the outlet of Engine Protective device, i.e. in the Locomotive in the event of Positive crank case pressure the Engine protective device will drain the Lube

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oil pressure which is going to Governor and the Governor shall shut-down the engine due to Low lube oil pressure. The Low Lube oil pressure shut-down limits are given in Clause No 8.1.

8.4 Hot Engine Shut-down

A safety feature to protect the engine in the event of Hot engine shall be provided to shut down the engine. This Hot engine shut-down feature by MPBG is by sensing the Lube oil pressure of the engine from the outlet of Engine Protective device i.e. in the Locomotive in the event of Hot engine the device Thermostat valve will open and drain the Lube oil pressure which is going to Governor and the Governor will shut-down the engine due to Low lube oil pressure. The Low Lube oil pressure shut-down limits are given in Clause No: 8.1.

8.5 Fail-safe Feature

The MPBG shall be provided with fail-safe feature so as to cause shut-down of the diesel engine by pulling the fuel rack to "NO FUEL" position in the event of malfunctioning of the governing equipment.

- a) Power Supply Failure
- b) Control card failure
- c) LOP sensor Failure

9 Diagnostic and Fault Logging System

- 9.1. The MPBG offered shall include suitable fault diagnostic facility to carry out troubleshooting and to assist maintenance personnel in the rectification of the defect/ defects.
- 9.2. Suitable memory to register Fault messages (Error Log) with Date and time stamp and their retrieval on a Laptop/Personal Computer/ Pen Drive and analysing through Fault Data Analysis software. A facility shall be provided to set the current date and time in the MPBG.
- 9.3. Suitable memory to register the Fault Data pack i.e. fault along with the status of MPBG parameters shall be provided. This fault data pack shall be of 30 seconds with one second interval for retrieval on a Laptop/Personal Computer/ Pen Drive and analysing through Fault Data Analysis software.
- 9.4. Recording of time spent on each notch shall be made in 24 hours format. The sampling interval should not be more than one second. This is required for calculation of load factor of locomotives. For this purpose eight counters shall be provided in MPBG memory for cumulative time spent on each notch in seconds. There should be a provision to read these counters through a Laptop/Personal computer any time to get the cumulative time spent on each of the 8 notches. All these counters should be capable of being reset to zero, at any time, through a Laptop/Personal computer.

Note: Minimum 32 MB non-volatile flash memory as on board user memory for data logging and minimum 1 No. USB port (Preferred 2 Nos.) complied to USB 2.0 specification and OTG compatible are required in control unit.

10 Adjustment of Various Engine Parameters

A simple arrangement shall be provided in the software to adjust the following parameters on the locomotive.

- a. Notch wise engine speed
- b. Notch wise minimum lube oil pressure for loco shut down
- c. Maximum permissible fuel rack limit at each notch
- d. Maximum permissible fuel rack limit in relation to booster air pressure
- e. Over speed trip setting
- f. Governor response time
- g. Load control timing from max to min. field position of LCP & min. to max. field position of LCP.

These adjustments should be possible with a laptop/personal computer running in windows environment. A provision shall be made to restrict accessibility to governor adjustments to avoid misuse.

All the relevant parameters shall be configurable through Laptop with two tier password protection based on sensitivity of parameter setting.

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10.1 Software:

Necessary software for adjusting the user settable parameters of the MPBG shall be provided.

11 Governor Output Shaft and Linkage

11.1 Stroke:

The governor output shaft travel shall be of a rotary and the total rack travel in MPBG shall be maximum 30 degrees.

11.2 Work Capacity:

The work capacity on the governor output shaft for actuation of fuel control shaft shall be at least 16.3 Nm (12 ftlb).

12 Mounting Arrangement

12.1 Control cum Display unit:

The Control unit cum Display unit shall be suitably mounted in the Driver's cabin. List of messages to be displayed which is indicative and for reference is enclosed at **Annexure-5**. Manufacturer has to get the list of display messages approved from RDSO to incorporate during prototype approval and also any change in message later on. The manufacturer will submit the condition when the specific message will pop up.

Proposed Control unit dimensions are 390(H) X 350(W) X 290(D) in mm with tolerance of +/-5%.

Electronic & Mechanical OSTA testing keys, Dry run switch and Allied or Amphenol make Connectors viz. MG 3102R 20-29P PTC, MG 3102R 18-1PZ-PTC, MG 3102R 18-1PY-PTC, MG 3102R 16S-1PW-PTC and MG 3102R 10SL-4P-PTC shall be fitted on the control unit. Connection of cable is detailed at Annexure-1. Use of equivalent connectors requires specific permission from RDSO.

The weight of the control unit shall not exceed 30 kg. and shall be with matching connectors. The fitment drawing of the control unit shall be given by the supplier.

12.2 Actuator unit:

The Actuator unit shall be designed for mounting on the existing Woodward governor mounting location. The Actuator unit mounting arrangement shall be designed to match for fitment on the existing Woodward governor drive housing.

Allied or Amphenol make Connectors viz. MG 3102R-18-1PZ and MG 3102R-18-11PX shall be fitted on the actuator unit. Connection of cable is detailed at Annexure-1. Use of equivalent connectors requires specific permission from RDSO. These connectors shall be so located that they are easily accessible for tightening or removal of mating connectors provided on cable ends.

12.3 Pressure sensor box:

Pressure sensor box shall be designed for mounting in a suitable location.

LOP, FOP and BAP transducers, Allied or Amphenol make Connectors viz. MG-3102R-18-1PY and MG 3102R-18-11PX shall be fitted on the pressure sensor box. Connection of cable is detailed at Annexure-1. Use of equivalent connectors requires specific permission from RDSO.

12.4 Engine Speed Sensors

Two Engine Speed sensors shall be supplied along with the MPBG for sensing the engine RPM. If one Engine speed sensor fails then the system shall change over to another healthy Engine speed sensor. Mounting connectors on both the ESS shall be same.

Allied or Amphenol make Connectors viz. MS 3102R 12SP-10P. Connection of cable is detailed at Annexure-1. Use of equivalent connectors requires specific permission from RDSO.

Speed Sensor to be located near the Ring Gear. L - Bracket for mounting the ESS is enclosed at Annexure 2B.

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12.5 Numbering

Each Control unit, Actuator unit, Pressure sensor box and Engine Speed sensors shall contain a number plate indicating

- a. Serial number
- b. Date of manufacturing
- c. Name of manufacturer
- d. Model number.

The major sub assemblies going into each unit should also be numbered and recorded with the supplier for future reference.

13 Applicable drawings

Annexure 1	: Details of interconnecting cables
Annexure 2	: Governor Housing (Part no. 8163123)
Annexure 2A	: Governor Control Linkage
Annexure 2B	: Proposed Mounting Details of Engine Speed Sensor
Annexure 3	: Methodology for Inspection and testing of MPBG
Annexure 4	: Infrastructure Requirements for MPBG Manufacturers
Annexure 5	: List of Display Messages in Control unit of MPBG

14 Referred standards

The following standards are referred by this specification. It is requested to kindly ensure operational understanding of all the referred standards.

- IEC 60571
- IEC 60812
- IEC 60529
- IEC 62262
- IS 2500
- EDPS 179

15 Life cycle management

The equipment supplier shall ensure that the lifecycle requirements of the equipment be met as detailed in the paragraphs below.

15.1 Expected life

The expected life of the equipment shall be 12 years or more.

15.2 Support during lifetime

The equipment manufacturer shall ensure that the following support is available on demand during the equipment lifetime:

- Service / spares support for the equipment
- Options for comprehensive maintenance contracts
- Modifications in equipment design to meet new requirements or to improve reliability

The options for demanding these support services shall be reserved by the Indian Railways and the equipment manufacturer shall provide the same on demand.

The equipment manufacturer shall submit an undertaking to support the equipment during its declared lifetime. This undertaking shall be provided during type testing and design approval and also while entering into purchase contracts.

Note: Cost of the services shall be determined through a mutually acceptable process between the manufacturer and the users on the Indian Railways.

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15.3 End of equipment life management

The equipment manufacturer shall provide options to upgrade / refurbish equipment at the end of life of the equipment when requested by the Indian Railways.

The equipment manufacturer shall submit an undertaking to provide options for end of life management when required by Indian Railways. This undertaking shall be provided during type testing and design approval and also while entering into purchase contracts.

16 Documents required from supplier

The manufacturer shall supply the following documents with the equipment. All documents shall be provided in both hard copies and soft copies (PDF)

- a. Product catalogue and standard data sheet of offered system
- b. Outline and general arrangement drawings
- c. Schematic circuit, functional description and protection scheme
- d. Schedule of supply, listing all equipment with part numbers
- e. Operating instruction and trouble shooting hand book
- f. Maintenance manual with full description of maintenance and repair procedures
- g. maintenance schedules required along with list of components which are required to be replaced in those schedules
- h. List of maintenance spares required for normal maintenance and emergency repairs
- i. A copy of detailed bill of materials
- j. Recommended list of spares with cost for 3 years maintenance after warranty
- k. Test protocol with procedure of testing
- l. Details of technical support and training offered
- m. Detailed calibration procedure

17 Warranty

The manufacturer shall provide warranty as per IRS terms and conditions.

18 Training

The supplier shall train adequate number of IR personnel in operation and maintenance of the offered MPBG. Adequate documentation shall be provided. Personnel of Indian Railways shall be nominated to attend.

The equipment manufacturers shall arrange training for operations and maintenance of the equipment, as an integral part of the equipment supply.

19 Tests & Verification

The equipment shall be tested for functional capability, ability to withstand environmental conditions and for reliable performance under field conditions.

20 Sampling plan

Sampling shall be done as per IS2500 wherever not specified but required. Sampling shall be done as per the requirements wherever specified in this document. If the specific contract includes specific clause for sampling, the same shall be applicable.

21 Types of tests

The equipment shall be subjected to the following types of test during different stages of design approval. Prove out, field trials and testing of the offered MPBG - Testing including prove out & validation shall be in accordance with the referred spec.

SN	Category of Test	Remarks
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1.	Type tests (Prototype)	These tests shall be done on a sampled lot of prototypes as per IEC 60571. Such tests are required only on initial approval, change of design and change of manufacturing processes. These tests shall be done as pre-requisite for design approval.
2.	Field trials	These trials shall be conducted for establishing equipment reliability under field conditions. A minimum sample size shall be installed to work under field conditions and performance monitored for a specified time. These shall be conducted after type tests.
3.	Routine tests	Tests are required to verify the functional working of the system. These may require simulated inputs for testing the operations under full range of inputs. These tests shall be done by the manufacturer during manufacturing and records maintained for inspection.
4.	Acceptance tests	These tests shall be done on all or sample of lot for bulk supply. Sampling shall be done as per IS2500. These tests shall normally consist of routine tests and additionally those specified in the specific contract.

21.1 Type test and field trials:

The prototypes of the equipment shall be subjected to type tests and field trials prior to approval as per the Annexure 3.

Prove-out and validation - One MPBG shall be subjected to durability and performance test on suppliers test bed as per the referred standards in presence of IR personnel.

Note: RDSO shall be apprised and approval taken for testing of the equipment at any specific testing agency prior to the tests.

21.2 Field trial

At least one loco set of equipment (or as decided by IR) shall be subjected to field trials for 12 months before clearance is given for bulk supply. During this period, the performance of the equipment shall be closely monitored and evaluated by RDSO. These trials are intended to prove

- Reliability under rigorous environmental and operating conditions
- Advantages for locomotive operation and maintenance
- Maintainability of the equipment.

If modifications found necessary as a result of the tests, the supplier at his own cost shall carry out trials after the relevant modifications have been approved by RDSO.

21.3 Makers test certificate for outsourced item

All items that are outsourced by the equipment manufacturer shall be indicated so. The type and extent of quality control that has been exercised shall be provided with proper documentation.

The manufacturers (of the outsourced sub-assembly) test certificates shall be provided.

22 Painting, labeling and marking

The equipment shall be appropriately painted for operational use, aesthetics and protection. The parts, connector ports, mounting points etc. shall be clearly marked in a manner that these are easily readable and remain legible over the lifetime of the equipment.

The offered MPBG and all major components and parts shall have proper identification and traceability to facilitate failure analysis and life cycle data.

ID plate Name of Component, Make, Sl. No, Date of Manufacture, Ratings shall be provided on all assemblies/subassemblies.

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23 Packaging and delivery/shipment

The equipment consists of sensitive and fragile electronic systems. These should be packed with precautions required to prevent damage in transit.

All requirements of IRS conditions for packaging and delivery shall be applicable.

24 IPR disclaimer pin pointing responsibility for violation if any on supplier

24.1 Undertaking by equipment manufacturer

All the specifications issued by RDSO shall include a requirement of undertaking to be signed by Vendors on "INFRINGEMENT OF PATENT RIGHTS". The undertaking can be as under

Indian Railways shall not be responsible for infringement of patent rights arising due to similarity in design, manufacturing process, use of similar components in the design & development of this item and any other factor not mentioned herein which may cause such a dispute. The entire responsibility to settle any such disputes/matters lies with the manufacturer/ supplier.

Details / design/documents given by them are not infringing any IPR and they are responsible in absolute and full measure instead of railways for any such violations. Data, specifications and other IP as generated out of interaction with railways shall not be unilaterally used without the consent of RDSO and right of Railways / RDSO on such IP is acceptable to them.

24.2 Declaration of confidentiality of submitted documents by manufacturers

While submitting a new proposal/design, manufacturer must classify their documents confidentiality declaration, such as

This document and its contents are the property of M/s XYZ (Name of the vendor) or its subsidiaries. This document contains confidential proprietary information. The reproduction, distribution, utilization or the communication of this document or any part thereof, without express authorization is strictly prohibited. Offenders will be held liable for the payment of damages. Indian Railways/RDSO is granted right to use, copy and distribute this document for the use of inspection, operation, maintenance and repair etc.

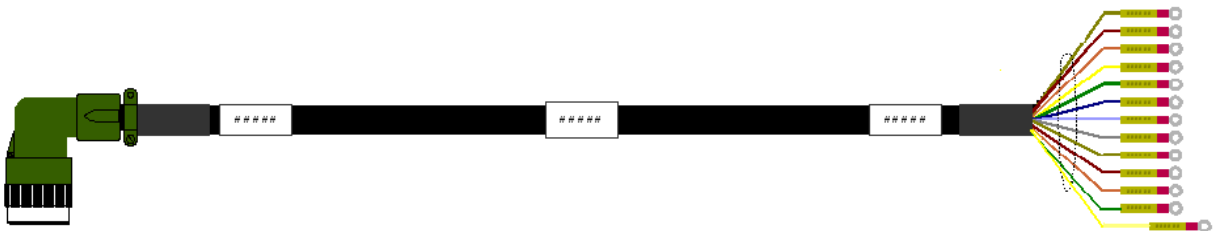
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ANNEXURE 1

CABLES:

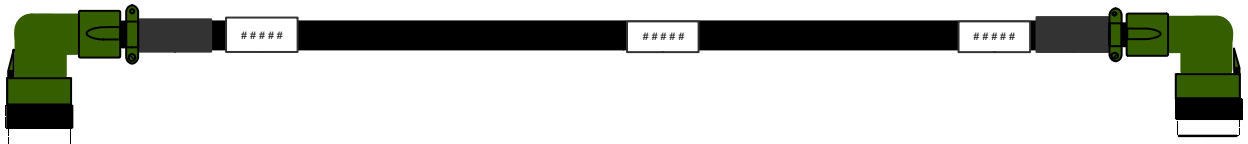
Details of cables	No. of Cores/Length
Between Locomotive TB and Control unit of MPBG	14 core/ 7mtrs
Between MPBG Control unit and MPBG Pressure Sensor box	10core/18mtrs
Between MPBG Control unit and MPBG Actuator unit	6 core/21mtrs
Between MPBG Actuator unit and MPBG Pressure sensor box	4 core/8mtrs
Between MPBG Control unit to MPBG Engine Speed sensors 1 & 2	6 core/17mtrs

1. INPUT & OUTPUT CABLE BETWEEN MPBG CONTROL UNIT TO LOCO TB NO 43E IN DRIVER CONTROL STAND-02



CONNECTOR TYPE	CONNECTOR PIN NO	LOCOMOTIVE WIRE NUMBER	LENGTH OF CABLE	OF	CONNECTOR TYPE
BAYONET CONNECTOR MG 3108F 20-29S	K	GVA	7 mtrs (14 core) (Tentative cable length provided. Final cable lengths shall be decided after 01 or 02 installation of the units in the Locomotive)		COPPER LUG WIRE DIA:3.56mm, STUD 5mm To Loco Terminal Board
	L	GVB			
	M	GVC			
	A	GVD			
	D	STFB			
	F	LWSFB/Spare			
	B	PT3 / BP			
	C	N4 / BN			
	J	LOSFB			
	S	LRV			
	G	SPARE-1			
H	SPARE-2				

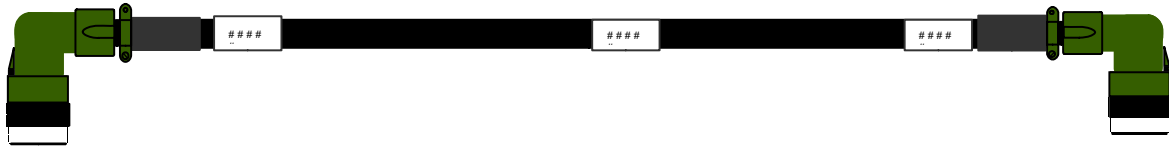
2. PRESSURE SENSOR CABLE BETWEEN MPBG CONTROL UNIT TO PRESSURE SENSOR BOX



CONNECTOR TYPE	LENGTH OF CABLE	CONNECTOR TYPE
BAYONET CONNECTOR MG 3108F-18-1SY	18mtrs (10 core) (Tentative cable length provided. Final cable lengths shall be decided after 01 or 02 installation of the units in the	BAYONET CONNECTOR MG 3108F-18-1SY

	Locomotive)	
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3. MOTOR & CLUTCH CABLE, BETWEEN MPBG CONTROL UNIT TO ACTUATOR UNIT



CONNECTOR TYPE	LENGTH OF CABLE	CONNECTOR TYPE
BAYONET CONNECTOR MG 3108F-18-1SZ	21 mtrs (6 core) (Tentative cable length provided. Final cable lengths shall be decided after 01 or 02 installation of the units in the Locomotive)	BAYONET CONNECTOR MG 3108F-18-1SZ

4. FUEL RACK POSITION SENSOR CABLE, BETWEEN MPBG ACTUATOR UNIT TO PRESSURE SENSOR BOX



CONNECTOR TYPE	LENGTH OF CABLE	CONNECTOR TYPE
BAYONET CONNECTOR MG 3108F-18-11SX	8 mtrs (4core) (Tentative cable length provided. Final cable lengths shall be decided after 01 or 02 installation of the units in the Locomotive)	BAYONET CONNECTOR MG 3108F-18-11SX

5. ENGINE SPEED SENSOR CABLE, BETWEEN MPBG CONTROL UNIT TO ENGINE SPEED SENSORS (ESS1 & ESS2)



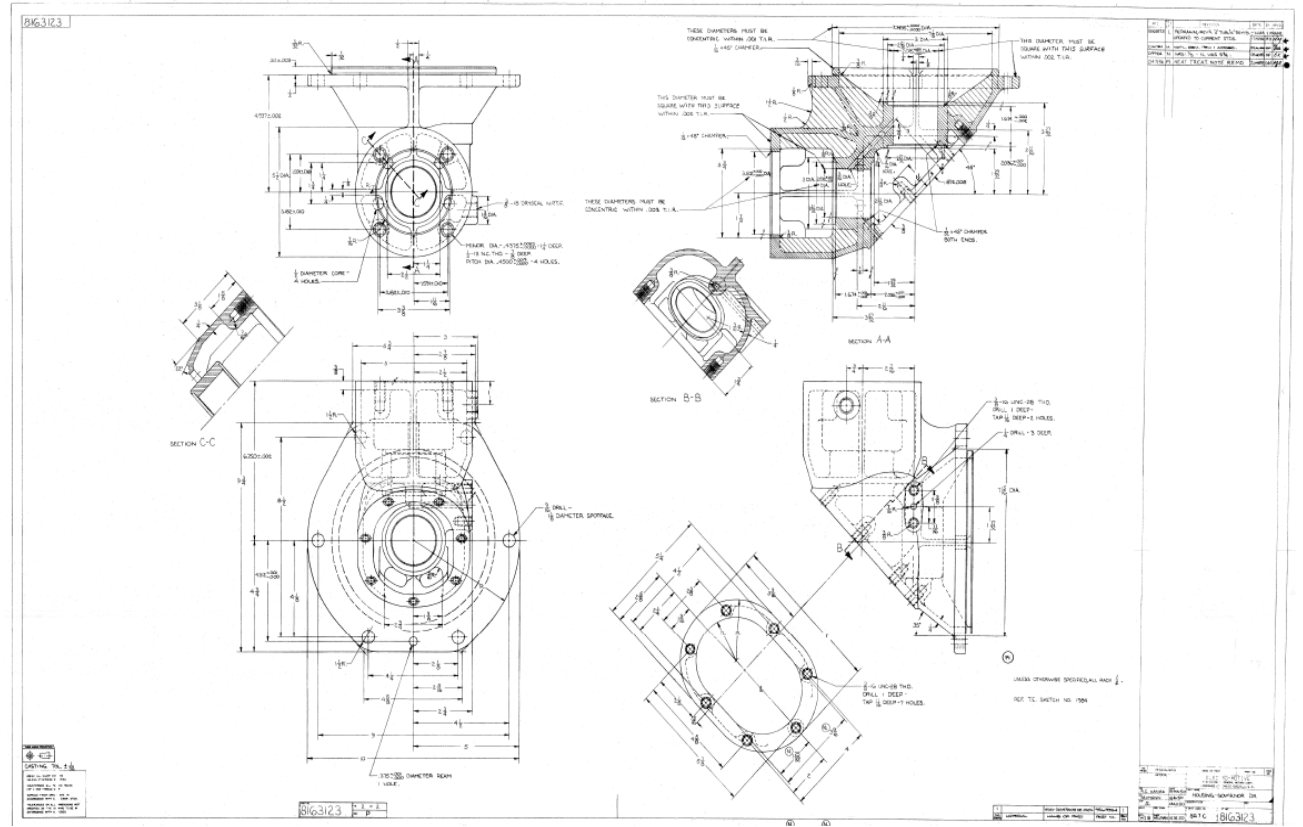
CONNECTOR TYPE	LENGTH OF CABLE	CONNECTOR TYPE
BAYONET CONNECTOR MG 3108F-16S-1SW	17 mtrs (6 core) (Tentative cable length provided. Final cable lengths shall be decided after 01 or 02 installation of the units in the Locomotive)	MS Round Connector MS 3108F-12SP-10S (2 Nos.)

6. SHIELD OR EARTH CABLE, BETWEEN MPBG CONTROL UNIT TO LOCOMOTIVE BODY



LUG TYPE	LENGTH OF CABLE	LUG TYPE
CRIMP LUG RING TYPE 4-6 SQMM HOLE-6.4MM	2.5 mtrs (1 core – 6 Sq.mm)	CRIMP LUG RING TYPE 4-6 SQMM HOLE-6.4MM

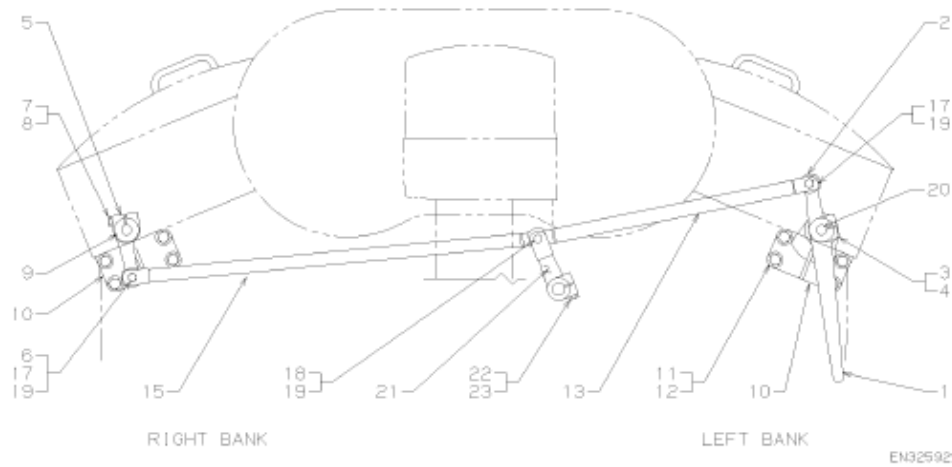
ANNEXURE-2



Governor Housing (Part no. 8163123)

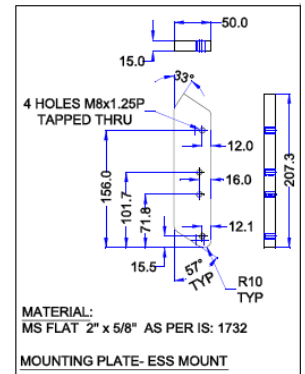
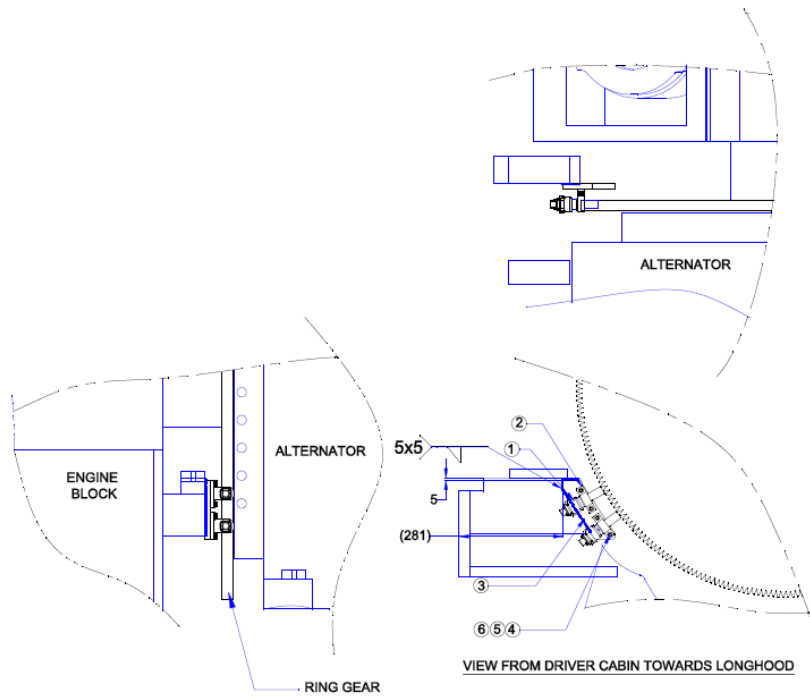
ANNEXURE-2A

Governor Control Linkage with Manual Layshaft on Left Bank



Asm - Ref. No.	Part Number	Qty.	Description
8-1	8451739	1	LEVER ASSEMBLY.. Hand control - Injector control shaft - Left bank
-2	40036565	1	BEARING.. Ball
-3	181377	1	BOLT.. Hex head 3/8-24 x 1-3/4 - Lever clamping
-4	6101225	1	WASHER.. Flat 3/8
-5	8451749	1	LEVER ASSEMBLY.. Injector control shaft - Right bank
-6	40036565	1	BEARING.. Ball
-7	181377	1	BOLT.. Hex head 3/8-24 x 1-3/4 - Lever clamping
-8	6101225	1	WASHER.. Flat 3/8
-9	103608	2	PIN.. Taper - No. 4 x 2 inches long
-10	8451755	2	BRACKET ASSEMBLY.. Support - Outer end bearing - See page 1-22
-11	181428	8	BOLT.. Hex head 1/2-20 x 1-1/8 - Bracket to crankcase
-12	6101229	8	WASHER.. Flat 1/2
-13	9546506	1	LINK ASSEMBLY.. Control - Left bank
-14	40036565	1	BEARING.. Ball (not shown)
-15	9546507	1	LINK ASSEMBLY.. Control - Right bank
-16	40036565	1	BEARING.. Ball (not shown)
-17	8080078	2	BOLT.. Hex head 5/16-24 x 17/32
-18	8194650	1	BOLT.. Hex head 5/16-24 x 2
-19	8032716	3	NUT.. Hex lock 5/16-24
-20	8054047	2	SPACER.. Control lever
-21	8215509	1	LEVER.. Governor to control rod
-22	181377	1	BOLT.. Hex head 3/8-24 x 1-3/4
-23	6101225	1	WASHER.. Flat 3/8
-24	124548	1	KEY.. Woodruff - No. 8 (not shown)

ANNEXURE-2B



6	---	WASHER M8 PLAIN SS	4
5	---	WASHER M8 SPG SS	4
4	---	BOLT M8 HEX.25LG SS	4
3	---	MOUNTING PLATE- ESS MOUNT	1
2	---	ESS MOUNT-G4	2
1	---	ENGINE SPEED SENSORS	2
SL. NO.	DRAWING NO./ CODE NO	DESCRIPTION	QTY

PROPOSED MOUNTING DETAILS OF ENGINE SPEED SENSOR FOR WDG4 / WDP4 LOCOS

ANNEXURE 3

METHODOLOGY FOR INSPECTION AND TESTING OF MPBG

Inspection and testing of the equipment to be supplied by the supplier will be carried out in the following stages.

The supplier will provide without any extra charge, the material equipment, tools and any other assistance which the purchaser or his nominee may consider necessary for any test and examination which he or his nominee shall require to conduct at the supplier's premises and will pay all costs attendant to them.

Type tests:

The equipment (prototypes) shall be subjected to the following tests:

The environmental, EMI/EMC/RFI tests as per IEC 60571 shall be conducted at any reputed agency having required facilities to do so.

Testing for IP / IK rating of the equipment, shall be conducted at any reputed testing agency having required facilities to do so.

The functional tests for compliance to requirements of this document shall be witnessed by RDSO.

These tests will be carried out on the first prototype submitted for approval. These tests may also be conducted at the following stages at the discretion of RDSO:

- i. On the first unit to be supplied under regular production.
- ii. If there is any change in the design or source of supply of any component/subassembly, on the first unit made of the changed design or the new source

The following tests will constitute the type test:

• Environmental tests and other tests compliance:

One prototype unit of the MPBG will be subjected to the environmental tests as detailed in IEC 60571 for railway electronics.

• Functional test:

These tests will be carried out under simulated conditions at supplier's premises to establish that the governor is functioning as per the specification. On satisfactory completion of environmental and functional tests, the prototypes will be subjected to performance tests. Functional tests would also be carried out before and after the environmental tests to check any damage or change in behaviour.

• Performance test:

Performance test of first two prototypes will be carried out on 16 cylinder 710 series diesel engine fitted on HHP type/DLW locomotives of Indian Railways. In addition to validating compliance to this spec. performance tests will consist of the following:

- i. The maximum instantaneous variation in engine speed expressed as percentage of rated speed, after sudden variation of load from the rated value to zero must not exceed 10% of the rated speed.
- ii. Possible faults will be created to test the fail safe features of the governor (to be listed out by the supplier and got approved by RDSO).

On satisfactory completion of the performance tests, the MPBG will be cleared by the inspecting authority for field trials.

• Routine tests:

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The MPBG cleared for regular use will be subjected to routine tests. These tests will consist of functional tests and shall be conducted in the presence of the inspecting authority at supplier's premises.

- **Acceptance test**

The acceptance test shall include:

- a. Verification of equipment conformance by checking of type test reports, manufacturers certificates for outsourced components.
- b. Functional tests of the equipment.

ANNEXURE-4

Infrastructure requirements for MPBG manufacturers

i.	Dust Free, Air Conditioned and ESD protected environment for PCB Assembly and PCB level Testing.
ii.	Component Lead Forming machines / fixtures for PCB Assembly.
iii.	SMT Assembly Line for SMD components Assembly consisting of Solder Paste Printer, Automatic Pick and Place Machine and Reflow Soldering Machine.
iv.	Temperature Controlled Wave Soldering Machine with Auto Fluxing Facility for Leaded components Soldering.
v.	Ultrasonic Cleaning Machine for cleaning of flux residues from PCBs.
vi.	Customized Test Jigs / Fixtures for PCB level Functional Testing.
vii.	Digital / Analog IC Testers for Inspection of the Incoming material.
viii.	Dual Channel, 200MHz Digital Storage Oscilloscope
ix.	5 ½ digit Digital Multimeter.
x.	Hot and Cold Chamber for Temperature Cycling Test for the PCBs
xi.	Pressure Pump with Calibrated Digital Pressure Indicator of minimum accuracy of 0.05 % of Full Scale reading.
xii.	CNC Lathe and CNC Milling Machines for precision components manufacturing.
xiii.	Gear Hobbing Machine with Microscope Attachment.
xiv.	Check Master – Gear Rolling Tester with Accessories, for Inspection of Gears.
xv.	Digital Vernier Calipers, 0-300mm, LC0.01mm
xvi.	Vernier Height Gauge, 0-1000mm, L.C.0.02mm
xvii.	Flange Micrometer 0-25mm, 75-100mm, 100-125mm L.C. 0.01mm
xviii.	Test Equipment for measuring Plating, Painting and Powder Coating Thickness.
xix.	Special Assembly Rig for Assembly of Rack and Pinion Box and Gear Box.
xx.	Custom Built Test Rig for Functional Testing of the complete MPBG System.
xxi.	Custom Built Test Rig for measuring the work capacity of the Actuator Unit.
xxii.	Engine Test Bed for simulated functional testing of all the functions of MPBG in close loop in load and no load condition with speed measurement facility through hall effect type speed sensor.
xxiii.	All India service network to ensure action within 12 hours on any problem reported by user railway.
xxiv.	Permanently employed mechanical, electrical and electronics engineers with not less than 5 years' experience in their respective fields like electrical, mechanical, electrical and electronics design, machine shop, fabrication etc.

ANNEXURE-5

List of Display Messages in Control unit of MPBG

Sn	DISPLAY MESSAGES
1.	Electronic Governor Power ON Self Check SUCCESSFUL.
2.	Press START Button To Crank Engine.
3.	Setting up Fuel Rack for Cranking.
4.	Ready for Cranking Engine.
5.	Cranking not done.
6.	Failed to Crank due to Low Engine RPM.
7.	Engine Shut Down. Press, START Button to Crank Engine.
8.	Engine Shut Down due to Low LOP/Low EWP/ Positive CCP. RESET EPD to start Engine
9.	Engine Shut Down due to Over Speed. Press START Button to Restart Engine.
10.	Over Speed Trip Test STOPPED
11.	Check OSTA and free Fuel Rack movement. Press START Button To Restart.
12.	Check OSTA. Check ESS Faults. Press START Button To Restart.
13.	Check OSTA. Check Fuel Rack Drive. Press START Button To Restart.
14.	Ready for Engine Fuel Rack Calibration Press DRY RUN key to Move Fuel Rack
15.	Engine Fuel Rack Calibration ON. Should not Crank Loco Now.
16.	Rack Position Sensor Calibration ON. Remove Actuator Shaft Link & Press DRY RUN key.
17.	Wait for 10mins from Power ON, to start Rack Position Sensor Auto Calibration.
18.	Rack Position Sensor Auto Calibration ON.
19.	Lube Oil Pressure Sensor Faulty. Waiting for Recovery
20.	Check BATTERY condition. Check for ESS fault. Press START Button to Restart.
21.	Reset OST. Check free movement of Fuel Rack Linkage with DRY RUN switch
22.	Cranking Abandoned
23.	Failed Crank due to No Engine rpm Signal
24.	Testing Electronic Over Speed Trip. Trip Limit RPM xxxx Engine RPM xxxx
25.	Testing Mechanical Over Speed Trip. Trip Limit RPM xxxx Engine RPM xxxx
26.	Shutting Down Engine Engine RPM xxxx
27.	Cranking Engine. Engine RPM xxxx
28.	Calibrating Engine Fuel Rack with MPBG. MPBG Rack Positioned At xx.x-Degree Now
29.	Load Control Failed.
30.	Configuration Failed Running with Default Parameters.
31.	Lube Oil Pressure Sensor Faulty.
32.	BAP Sensor Faulty.
33.	FOP Sensor Faulty.
34.	Fuel Rack Drive Motor Over Current. Check OSTA

Sn	DISPLAY MESSAGES
35.	OSTA Tripped or Fuel Rack Drive Failed. STOP Cranking Engine
36.	Fuel Rack Position Sensor recovered from Fault.
37.	LOP Sensor recovered from Fault.
38.	BAP Sensor recovered from Fault .
39.	FOP Sensor recovered from Fault.
40.	Load Control Fault Recovered
41.	Unable to Calibrate Rack Position Sensor
42.	Difference between two sensor speeds Is high
43.	ESS1 speed sensor Misbehaving
44.	ESS2 speed sensor Misbehaving
45.	ESS1 speed sensor Wire open fault
46.	ESS2 speed sensor Wire open fault
47.	ESS1 showing high RPM at zero speed
48.	ESS2 showing high RPM at zero speed
49.	ESS1 Sensor Recovered from Faults
50.	ESS2 Sensor Recovered from Faults
51.	TL13 High or Low Fault
52.	TL13 High or Low Fault Recovered
53.	Fuel Pump Breaker Tripped or Low FOP
54.	OSTA Tripped or Fuel Rack Drive obstructed Or Motor Failed. Shutting Down Engine
55.	Low LOP or Low EWP or Positive Crank Case Pressure. Shutting Down Engine
56.	OSTA Tripped or ESS Failed Shutting Down Engine
57.	Over Speed. Shutting Down Engine.
58.	Electronic Over Speed Trip. Test Failed
59.	Mechanical Over Speed Trip Test Failed
60.	Switch OFF power Wait for 5 Minutes. Switch ON power To Restart Engine.
61.	Lube Oil Pr. Sensor Failed. Switch OFF Power & repair Sensor To restart Engine
62.	Fuel Rack Position Sensor Faulty.
63.	BATTERY weak or ESS faulty. STOP Cranking.
64.	OST TRIPPED. Reset OST. Move Fuel Rack Linkages manually To free them.
65.	PEN DRIVE CONNECTED
66.	FILES DOWNLOAD COMPLETED
67.	PEN DRIVE NOT SUPPORTED
68.	DEVICE WRITE PROTECTED
69.	LESS SPACE IN PEN DRIVE
70.	Electronic O.S.T. Test Successful. Trip Limit RPM xxxx Tripped at RPM xxxx
71.	Mechanical O.S.T. Test Successful. Trip Limit RPM xxxx Tripped at RPM xxxx
72.	Mechanical OST Level To be increased Trip Limit RPM xxxx Tripped at RPM xxxx
73.	Rack Position Sensor Calibration Success. Max. Error xx.xxDegreeAT xx.xxDegree
74.	Rack Position Sensor Calibration Failed Max. Error . Deg AT . Deg
75.	Notch Fault
76.	BAP Limit
77.	HP Limit

Sn	DISPLAY MESSAGES
78.	Rack Position Error
79.	BAP Load Control

