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GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

एल्को रेलयानों में प्रयोग हेतु इलेक्ट्रॉनिक फ्यूल इन्जेक्शन सिस्टम के लिये विशिष्टिका

**Specification for Electronic Fuel Injection (EFI)
System for ALCo Locomotives**

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Specification for Electronic Fuel Injection (EFI) System for ALCo Locomotives

(Specⁿ No. – MP.0.08.00.91 (Rev. 00) Nov 2009)

1. INTRODUCTION:

This is a specification for introduction of the Electronic Fuel Injection Systems (EFI) on the Turbocharged 4-stroke ALCO 251-B 'V' 16-Cylinder diesel engines used on locomotive. The supplied EFI system shall be integrated with locomotive control system. Fuel Injection to each cylinder shall be through separate Solenoid Valve operated Bosch Jerk type pumps. The Jerk pump will be operated through FIP Cam lobes of camshaft. The injection timings shall be controlled by the ECU by controlling the Solenoid valves.

2. DETAILS OF THE ALCO 251-B ENGINE:

1.	Bore	9" (228.6 mm)
2.	Stroke	10.5" (266.7 mm)
3.	Approx Fuel injection Timings (at full load)	22 deg CA BTDC- 12 deg CA ATDC
4.	Firing order	1R 1L, 4R 4L, 7R 7L, 6R 6L, 8R 8L, 5R 5L, 2R 2L, 3R 3L
5.	Maximum ambient temperature expected	55 ⁰ C
6.	Drg. for Stiffer Fuel Cam profile	DLW Pt No. 10031364 (enclosed)

3. SCOPE OF SUPPLY:

One locomotive set shall comprise of the following:

No.	Description of item	Make	Part no	Qty
01.	EFI Pump	M/s Bosch Limited	B416810385	16 nos.
02.	Check valves/Pressure control valves	M/s Bosch Limited		16 nos.
03.	High pressure tube assembly	M/s Imperial Auto Industries/Faridabad		16 nos.
*04.	Connection from spill port to Fuel Tank	M/s Imperial Auto Industries/Faridabad	Drawing to be developed by supplier	16 nos.
05.	Electronic Control Unit (Hardware & Software)	To be designed and manufactured by supplier.		01 no.
06.	Electric wiring harness including cable, Connectors, clamps shield appropriate for the application	To be designed and manufactured by supplier.	Drawing to be developed by the supplier	01 set

07.	Sensors for Boost Air Pressure, Lube oil Pressure, speed and position sensor	To be designed and manufactured by supplier.		01 set
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* Item No. 04 – The Drawing for ‘Connection from spill port to Fuel Tank’ shall be approved by RDSO only.

Note: In case the tenderer offers a product of a make other than those mentioned, they may do so and include a write up on reasons for doing the same.

4. EFI CONTROL SYSTEM (EFICS):

4.1 The supplier shall enter into understanding with the manufacturer of EFI pump and will obtain the necessary characteristic/response parameters of solenoid valve and pump, pressure control valves and injector to successfully programme the EFI control system. A copy of the MoU/Agreement to this effect shall be presented.

4.2 The control system shall maintain stipulated speed (RPM) on various notches. The notch signal from Master Controller of the locomotive will be in the form of $72 \pm 1V$ DC 4-wires digital signal. The wires are energised by 4 relays (A, B, C & D). The EFI system shall be suitable to maintain the speed at various RPM as stipulated below.

NOTCH POSITION	RPM	Relays
SHUT-DOWN	-	D
1	350	-
2	450	A
3	550	C
4	650	AC
5	750	BCD
6	850	ABCD
7	950	BC
8	1050	ABC

4.3 The control system shall have user settable parameters for injection timings, various safety parameters, RPM ramp rate, etc. to optimise the output hp, Notch RPM, efficiency, emission etc.

4.4 Software Algorithm in the form of flow chart, protocol for communication with Locomotive Controller and hardware architecture shall be approved by RDSO.

- 4.5 The control system shall have self diagnostic system. All the fault data shall be communicated to Locomotive Controller.
- 4.6 The control system shall have the functions for – a) low lube oil pressure protection b) hot engine protection and c) engine over-speed protection.
- 4.7 Tenderer shall provide Design support for any design changes needed on the engine parts to use the EFI system. Fitment of camshaft/crankshaft speed & position sensors shall not require any major design modifications. Lube oil and Boost air pressure & water temperature sensors shall be mounted on the existing lube oil/water/air supply line at suitable locations.
- 4.8 To meet the requirements listed in this clause, the tenderer should have an agreement with a microprocessor supplier of ALCo locos (specification No. MP.0.2400.26 (Rev 0.05) May 2008) to ensure complete integration.
- 4.9 Tenderer shall have to furnish literature, maintenance and operating instructions, spare parts & tools catalogues, drawings etc.
- 4.10 Tenderer shall furnish details for all the major bought out items.

5. INSPECTION:

- 5.1 Tenderer shall offer the relevant specifications to each equipment according to which the offered equipment can be type tested. The inspection and routine test procedure shall be offered to RDSO for approval purpose before undertaking manufacture.
- 5.2 The offered equipment shall be inspected on the test rig at the manufacturer's premises by RDSO for establishing the performance characteristics of the system.

6. PROTOTYPE TEST:

- 6.1 After the prototype fitment of EFI system, the locomotive will go for the field trial of 3 months. Balance fitment shall be done after clearance of RDSO.
- 6.2 Any modification, including change in the software of the EFICS, arising out of prototype fitment shall be done by the supplier.

7. WARRANTY:

The supplier shall provide a warranty for the satisfactory performance for a period of 2 years for all the components of the EFI system from the date of commissioning. Any damage or unsatisfactory performance due to design or manufacturing inadequacies noticed during the above period shall be rectified or component/equipment replaced by the supplier free of cost. The replaced component/equipment shall also be covered under warranty for the balance period of warranty of the original EFI system.

8. MAINTENANCE SPARES:

The offer shall include requirements of spares for a period of 4 year for the upkeep of the equipment after the warranty period is over. The supplier is also expected to supply spares, tools, testing and calibration equipment, jigs and fixtures, which will be required for maintenance and adjustments. The supplier shall ensure continuous availability of spares for maintenance of the EFI system for a period of at least 24 months from the date of supply.

9. TRAINING:

The supplier shall provide a training in the premises of manufacturer's for 4 persons x 5 working days i.e. 20 man days.

10. QUALITY ASSURANCE PLAN (QAP):

A quality assurance plan (QAP) that outlines the suppliers' quality assurance in order to obtain a quality product at the time of regular production shall be submitted to RDSO for approval. The QAP shall be prepared on the lines as indicated in ISO: 9001:2000.

11. APPROVAL:

The final approval of the EFI system for limited application shall be given by RDSO after successful conclusion of field trials. The approval for unrestricted application would be given after an adequate number of units have given satisfactory performance in the field.

12. LITERATURE AND MAINTENANCE INSTRUCTIONS:

The supplier shall supply sufficient copies of operating instructions, maintenance manual with methods of adjustments and calibration of EFI control unit, manufacturing/installation drawings and trouble-shooting manual for the complete EFI system.

