भारत सरकार
रेल मंत्रालय

GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

डीजल इलेक्ट्रिक लोकोमोटिव (एलको) के लिए माइक्रोप्रोसेसर आधारित कन्ट्रोल सिस्टम और ऑटोमेटिक ट्रेन रन हेतु सीमुलेटर की विशिष्टि

SPECIFICATION OF SIMULATOR FOR MICROPROCESSOR-BASED CONTROL SYSTEM AND AUTOMATIC TRAIN RUN FOR DIESEL ELECTRIC LOCOMOTIVES (ALCO)

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अगस्त– 2008

Specification No. MP.24.00.54 (Rev. 00),
AUGUST - 2008

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CONTENTS

1.0 BACKGROUND

A large number of ALCo locomotives have been provided with microprocessor-based controls systems (MBCS), bringing with it immense benefits in maintenance and operation of diesel locomotives. The majority suppliers of MBCS provide a versatile user-interface for settable parameters. This interface can be used more effectively if this exercise of change in parameters can be simulated on a computer system; such a simulator can then be used not only for various fine-tuning work on the system but also for familiarisation & training of design as well as maintenance personnel. Another aspect of development of microprocessor based control system is its use for adding on many beneficial features in preference to similar stand alone systems to avoid multiplicity of hardware such as VCD, AEB, Power Setter, Auto Flasher, Speed Recorder etc. and functions thereof one such feature is the train run simulation software for driver guidance systems.

The consumption of fuel in driving a locomotive with load depends upon the skill of the driver to a very large extent and the consumption varies from driver to driver. For a given load, the fuel consumption depends upon factors such as train speed, acceleration (and rate of acceleration), braking pattern, extent of coasting, gradients and curves etc. The skill is in taking advantage of the terrain to maximise coasting, with insignificant or limited impact on the time taken for the trip; an optimum driving technique should result in corresponding optimum fuel consumption. Train run simulation software with a user interface can also be made a part of such a simulator. This specification has been prepared to lay down the technical requirements of a simulator for microprocessor-based control system used on ALCo locomotives with a train run simulation interface.

2.0 SCOPE

The scope covers:

2.1 Purchase, installation, commissioning of simulator for microprocessor based control system used on ALCo locomotives with facility of feeding various inputs of different subsystems/machines/assemblies to create a database, simulation software, control unit of microprocessor based control system and means of displays and outputs.

2.2 Development of a train run simulation package for driver guidance systems to calculate the following for any given section fed into the system;

2.2.1 Time taken to cover any given section.
2.2.2 The balancing speed attainable for a given load and power (locomotives)
2.2.3 Capability of any load to clear a given gradient.
2.2.4 Controllability of a train on down gradients
2.2.5 Calculation of braking distances for a given load, type of stock and locomotive.
2.2.6 Calculation of Emergency Braking distance (EBD) for given stock, load and locomotive.
2.2.7 Fuel consumption for covering any section based on pre-fed fuel consumption data for various locomotives.

2.3 The complete system is to be installed and commissioned in Motive Power laboratory. The scope excludes the procurement of various sensors for measuring different parameters. However, the necessary control electronics required for simulating the various circuits shall be in the scope of supply.

2.3.1 The tenderer shall quote separately for the following in his offer in two parts as under:

a. Simulator hardware and software
b. Automatic train run software with additional hardwares, if any.

2.4 Hardware/ peripherals to be supplied for microprocessor simulator

a. **Lap top – 1 no.:** this would be needed for proving out the software on locomotive run as well as to ensure portability of all software and programs.

b. **Heavy-duty printer – 1 no**.: this would be required for taking the printouts of the simulation results and trouble shooting logs of the microprocessor testing software.

c. **UPS** (Uninterrupted Power Supply) with PCs used for simulator

d. **Digital screen/ display board 32” (plasma/ LCD) – 2 nos.** These shall be used for displaying the output of the software and programs. A large screen is needed for displaying the information to large section of persons, as the microprocessor lab utility shall be used for training purpose also. Furthermore, the simulation package data and profiles generated shall be used for training of drivers and loco inspectors.

e. **Workstation for mounting of lab equipment;** this should comprise of adequate nos. of tables with wire control etc as well as 4 chairs.

f. **Storage rack:** Four no’s of storage racks of suitable size and over head storage type design from M/s. Godrej & Boyce Mfg. Co. Ltd. or equivalent shall be needed for storage of peripherals, storage device, printer out put, manuals, etc.

2.5 **OPTIONAL FEATURES**

Any optional features, which is in the opinion of the tenderer can contribute to higher capabilities a marginal cost, should be clearly indicated and quoted separately.

3.0 TECHNICAL REQUIREMENTS

3.1 The simulator for microprocessor control system should be provided as per RDSO specification no. MP.0.24.00.26 (Rev. 0.05), May 2008 or latest. Micro processor control system provided on diesel locomotive are having following salient features:

a. Pre and Post lubrication
b. Power setter
c. Vigilance control device

d. Fire Alerter
e. Event recorder
f. Automatic emergency braking
g. Automatic flasher control
h. Wheel slip/ slide control

3.2 Software provided shall be capable of simulating the performance of the different functions of control system of diesel locomotive. The simulation shall be such that the various fault conditions in the MBCS produces a corresponding response in the form of following interfaces to the system and the results of these actions are reflected in the appropriate displays.

(a) Simulation Interface

The simulator should have capabilities:

- Functional test of different sub system like propulsion, excitation control, wheel slip / slide control, fault annunciation and display.
- Perform self test
- Set any notch position of master controller settings (traction and dynamic braking), road speed
- Engine speed control, motor transition controls and field weakening
- The control of auxiliaries, including radiator fan drive.

(b) Sensor Interface

All parameters measured by the microprocessor shall be simulated as per the following:

- All the variables of digital input signals by software logic
- All the analog signals like lube oil pressure, booster air pressure, lube oil temperature, water temperature by varying the signals

(c) Fault interface

- Induce any type of faults like low water, hot engine, low lube oil pressure and can also be reset
- Fault messages and get trouble shooting guidelines
- Fault logging can also be seen

3.3 The simulation package (guidance for optimised driving – GOLD) should be able to generate the most optimum-driving pattern for any section to minimize fuel consumption. Based on this optimum driving pattern, the system should be able to advise the drivers on driving pattern so as to minimize fuel consumption for any trip. This shall be based on the following principles:

The driving pattern, i.e. the speed over time diagram, has a considerable influence on the energy consumed by a train on a given trip. For given restrictions (time table, stops, speed restrictions on the way and installed traction power) a shortest time driving strategy can be determined, which is basically given by

- Full acceleration up to maximum speed given either by speed limit or by maximum traction power

- Speed holding at maximum speed until train has to start braking. The phase of speed holding may be more complicated due to varying speed limits. In this case, the shortest time driving strategy implies full exploitation of speed limits using maximum acceleration and braking power.
- Braking at the latest possible point in order to come to a stop when reaching the station.

This driving strategy is illustrated in Figure 1 for a hypothetical service between two stations.

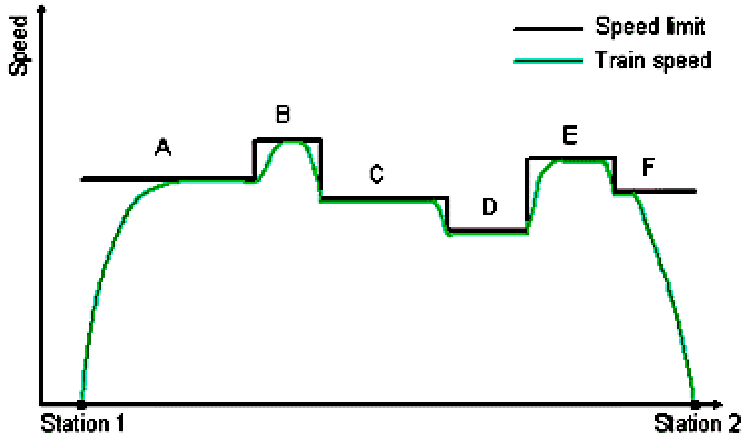

Figure 1: Shortest time driving strategy (hypothetical example)

The shortest time driving strategies are not geared for fuel efficiency. IR has generally worked with this strategy whereas in most of the freight and even in some passenger services although there is a good scope to adopt an **alternate energy-efficient driving strategy** which would reduce fuel consumption drastically without compromising the run time significantly.

3.4 Energy efficient driving strategies

Principle of operation: The energy savings will result from the systems ability to anticipate the upcoming geography ie, increasing/decreasing grades, horizontal curves and speed limits, while using the known performance characteristics of the train such as tractive effort, weight, length, rolling resistance etc to calculate and communicate the optimal driving profiles for any given journey. The system has to generate a driving strategy that minimizes fuel consumption subject to completing the required journey within a given time. On a level track the solution would be power, speedhold, coast, brake strategy in which dominant speedhold mode is a singular control. This form of solution is preserved on non-steep track but on a steep track it is necessary to switch to power before the train reaches the steep gradient and to coast before a steep decline.

There are several possible driving strategies which may save energy in comparison with the shortest time driving strategy:

- Reduced maximum speed: Train accelerates to a speed inferior to speed limit.
- Reduced acceleration rate: Train accelerates to maximum speed using less acceleration power.
- Coasting: Train shuts off traction as early as possible before station in order to reach station without braking.

A combination of these strategies can be used as well.

Each of these strategies increases running time. This does not pose any problem as long as *time buffers* provided by timetable are exploited.

3.5 **Realization of energy efficient driving strategies**

For a given timetable efficient driving strategies can be realized in two ways:

1. Instruction and training of drivers and/or use of special internal timetables indicating to the driver when to shut off traction or what maximum speed to drive at.
2. Driving advice systems; the system (GOLD) will assist the locomotive driver in driving the locomotive by advising the ideal acceleration and deceleration profiles to reduce/optimize the consumption of fuel and ensure trains run on time. This will also help in reduction of emissions and green house gases.

The firm shall develop this simulation software for locomotive guidance, which shall be implemented on two locomotives in the beginning and proved out. For this purpose, the firm shall also have to plot at least two sections (identified by RDSO) on GPS for identification of stations, signals, grades etc.

3.6 Real-time software modelling techniques shall be employed to accommodate the required simulations of different conditions. The simulator modelling software shall also allow to specify typical fault conditions.

3.7 Simulator modelling software shall accesses and co-ordinate the modes and communications within the system components and perform modelling tasks using real-time modelling techniques and shall display output data

3.8 The simulator shall be provided with a self checking diagnostic system to allow to check the operational integrity of all the subsystems. The system must display recommended remedial measures at 2 or 3 levels in the event of a failure.

4.0 INSTALLATION / COMMISSIONING & TRAINING

4.1 The simulator of microprocessor based control system shall be delivered, installed and commissioned in Motive Power Laboratory of RDSO, Lucknow.

4.2 The supplier shall be responsible for demonstration & satisfactory working of SIMULATOR OF MICROPROCESSOR BASED CONTROL SYSTEM installed.

4.3 The supplier shall be responsible for free of cost onsite training of simulator of microprocessor based control system to RDSO personnel.

5.0 MANUALS

The supplier shall submit complete documentation viz. contract drawings clearly describing the system hardware and software design, system installation and operation, approved test plans with complete testing results, maintenance procedures and training course materialof simulator of MBCS on hard copy and on soft copy.

6.0 INSPECTION & TESTING

The tenderer shall be required to prepare and submit test plans for conducting subsystem level tests and system acceptance testing that verifies proper operation of all equipments and software included in the simulator. The test plans shall include a description of the subsystem or system test levels employed, test objectives and a description of the methods for verifying acceptable operation of the hardware and software configuration. In addition, the test plans shall clearly describe the test sequence and procedures, test equipment; and data reporting format. The test plans are subject to the approval of RDSO who shall reserve the right to witness all factory and on-site testing.

The loco simulator as a whole as well as all materials including software shall be guaranteed for satisfactory performance for a period of 24 months from the date of successful commissioning of the simulator. All aspects of workmanship and design shall be covered by this warranty. The warranty period would also cover preventive maintenance, which will be inclusive of all spares, material and labour cost. Only consumable those require replacement shall be excluded

7.0 ANNUAL MAINTENANCE CONTRACT

7.1 DURATION AND SCOPE

7.1.1 The simulator will be supported for a period of 8 years after expiry of the warranty through AMC. Annual Maintenance Contract will include preventive maintenance as well as breakdown maintenance including all spares as required to restore the simulator in working order.

7.1.2 The contractor shall quote maintenance charges for simulator per year for the maintenance of the complete system including all concomitant accessories. The rate for the AMCs should be quoted year-wise including supply of spare parts of each simulator.

7.1.3 Software maintenance will cover corrections, adoptions due to hardware replacement, repair/ updation of database and system software up gradation, if necessary.

7.1.4 The tenderer shall furnish a list of spares required for three years maintenance. The spares shall be maintained by the supplier. The supplier will use spares for warranty/ AMC period from this stock subjected to replenishing the same. Any other spare or material needed for the maintenance and upkeep of the simulator shall also be arranged by the supplier as a part of AMC.

7.2 DOWN TIME

i. Penalty shall be levied on the tenderer in case of simulator breakdown beyond 10% after discounting for grace period. Penalty shall be calculated as %age of quarterly payment and will be deducted from the respective annual payments. Penalty calculation will be done over quarterly period as per following slabs:

SN	Measured down time excluding grace period	Penalty applicable on AMC value of one simulator
1.	Between 10% and 20%	1%
2.	Between 20 % and 30%	3%
3.	Over 30%	Penalty @ 0.75% of AMC for that simulator shall be levied for fall of each %age point in availability below 90%.

ii. The down time will be calculated based on three working shifts per day (8 hour shift), six days a week. For purpose of imposing the penalty, the accountal of down time will be accumulated over a three month period. Down time will include all breakdown time for any type of failure resulting in complete or partial degradation in simulator performance requiring repair, irrespective of its effect on training capability. The bogging down time shall commence from the time information is conveyed to the contractor for the fault, which shall be the time of transmission of Phone/FAX/email/ per bearer to a telephone number/address designated by the contractor.

7.3 PREVENTIVE MAINTENANCE

The contractor will carry out preventive maintenance at the recommended intervals preferably on weekends/public holidays through mutual agreement with the consignee so that preventive maintenance does not affect the uptime of the equipment.

The details of preventive maintenance services to be provided under AMC shall be provided by the tenderer in the following format:

SN	TYPE OF PREVENTIVE SCHEDULE	PERIODICITY	ITEMS TO BE CHECKED	ITEMS OF REPLACEMENT	EXPECTED DOWN TIME

7.4 PAYMENTS TERMS

AMC payment will be made annually after deducting the penalty amount and any other charges due during the year as per contract.