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**RESEARCH DESIGNS & STANDARDS ORGANIZATION
MANAK NAGAR, LUCKNOW – 226011**

ELECTRONIC INTERLOCKING

FOR

BIG YARDS

SPECIFICATION NO. FDSO/SPN/203/2011

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Abstract This document defines Electronic Interlocking For big Yards.			

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**GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(RAILWAY BOARD)
INDIAN RAILWAY
STANDARD SPECIFICATION
FOR
ELECTRONIC INTERLOCKING FOR BIG YARDS
(DRAFT)
SERIAL NO. FDSO/ SPN/ 203/ 2011**

0.0 FOREWORD:

0.1 This specification is issued under the fixed serial No. FDSO/SPN/203/2011 followed by the year of original adoption as standard or in case of revision, the year of latest revision.

1.0 SCOPE

- 1.1. This specification covers the technical requirements of Electronic Interlocking for big yards. The EI covered in this specification shall be normally provided at big stations having more than 200 routes where reliability requirement are very high. It may also be provided at stations with lesser routes but having more number of signaling input/output functions.
- 1.2. The EI covered in this specification shall be Microprocessor/ Microcontroller based equipment used for the operation of points, signals, all types of Track circuits, level crossing gates, block working with adjacent station, releasing of crank handle for manual operation of points and other controls like slots etc. through a VDU based control terminal. It shall be capable of interfacing with ATP, TPWS, ETCS, Radio Block Centre & CTC and other advanced systems using serial/ Ethernet ports.
- 1.3. Electronic interlocking shall consist of VDU/Operator PC, Central Interlocking Unit, Object Controller, Maintenance Terminal & Data logger, etc. The command is generated from the VDU/Operator PC and given to central interlocking unit which performs all the interlocking and fail safety functions. After processing the command the necessary output is given to object controller. The object controller gives command to signalling gears directly or using interface relays. The object controllers shall be kept at strategic locations in yards to directly or through the relays to drive the signalling gears to reduce requirement of signalling cables and interface relays. The connectivity between central interlocking unit and object controller shall be through optical fibre cable. This optical fibre shall be connected in such a way to avoid failure in case of one cable cut. After the given command is executed, the inputs from the field are read by object controller and transmitted to CIU for further process and for display at VDU/Operator PC as acknowledgement.
- 1.4. The whole interlocking of a yard shall be controlled by central operation but it shall be possible to place one VDU/Screen at end cabins, if required, to show yard status but the control shall be from the central location only. VDU PC shall have provision for connecting multiple screens/VDUs. The details of VDU PC & VDU Screen are given at Para 8.5.

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2.0 Applicable/ reference documents:

This specification requires reference to the latest version of following specifications:

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1.	IFS S36	Relay interlocking systems
2.	IFS S23*	Electrical signalling and interlocking equipment
3.	FDSO/SPN/144	Safety and reliability requirement of electronic signalling equipment.
4.	IS 9000*	Basic environmental testing procedures for electronic and electrical items.
5.	IS2147-62*	Degrees of protection provided by enclosure for low voltage switchgear and control gear.
6.	ISO 9001	Quality Systems- model for quality assurance in design, development, production, installation and serving.
7.	EN50126*	Railway applications- specification and demonstration of reliability, availability, maintainability and safety.
8.	EN50128*	Railway applications- signaling and communication- Software for Railway control and protection system.
9.	EN50129*	Railway applications- Safety related electronic systems for signaling.
10.	EN50159-1 & 2*	Railway applications- Signaling and Communication Safety related communication in closed and open transmission system.
11.	IEC 529/ EN 60529*	Specification for degree of protection provided by enclosures (IP code).
12.	EN 61000.4.2*	Electromagnetic compatibility (EMC) - testing and measurement techniques- electrostatic discharge immunity test and basic EMC.
13.	EN 61000.4.4*	Electromagnetic compatibility - testing and measurement techniques- electrostatic fast transient/ burst immunity test and basic EMC publication.
14.	EN 61000.4.5*	Electromagnetic compatibility - testing and measurement techniques- surge and immunity test.
15.	IFS S-99	Data Logger System.
16.	FDSO/SPN/197/2008	Code of Practice for Earthing and Bonding System for Signalling Equipments.
17.	IFS: S-24/2002, Rev. 2, Amd. 1	Electric Point Machine
18.	FDSO SPN 153/2004, Rev. 3, Amd.12008	LED Signal
19.	IFS: S-57/2005, Rev. 4	Electric Lamp for Railway Signalling
20.	<u>FDSO SPN 146/ 2001</u>	<u>Audio Frequency Track Circuit</u>
21.	<u>FDSO SPN 175/ 2005, Ver. 1.0</u>	<u>Solid State Block Proving by Digital Axle Counter</u>
22.	<u>FDSO SPN 176/ 2005, Ver. 2.0</u>	<u>Multi-section Digital Axle Counter</u>
23.	<u>FDSO SPN 177/ 2005, Ver. 1.0</u>	<u>Single Section Digital Axle Counter</u>
24.	<u>IFS TC55-2006, Rev. 1.0</u>	<u>24F Armored Optical Fiber Cable</u>
25.	IFS: 63-2007, Rev. 3, Amd. 2	PVC insulated underground unscreened cable for Railway signalling
26.	IFS: S76-89, Amd. 3	PVC insulated indoor cables for Railway signaling

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27.	EN 50121*	Railway Applications - Characteristics of Railway Systems that affect EMC behaviour
28.	FDSO/SPN/183/2011 V 2.0	Train Protection Warning System

* Or equivalent Recognized International standard. The supplier shall submit a copy of the same for verification.

Whenever, reference to any specification appears in this document, it shall be taken as a reference to the latest version of that specification.

3.0 TERMINOLOGY:

3.1 For the purpose of this specification, the terminology given in latest version of IRS S23 and FDSO/SPN/144 latest version shall apply.

4.0 ABBREVIATIONS:

SL. NO.	ABBREVIATION	EXPANDED FORM
1.	ABS	AUTOMATIC BLOCK SIGNALLING
2.	AFTC	AUDIO FREQUENCY TRACK CIRCUIT
3.	ATP	AUTOMATIC TRAIN PROTECTION
4.	CA	CROSS ACCEPTANCE
5.	CD	COMPACT DISC
6.	CENELEC	EUROPEAN COMMITTEE FOR ELECTRO TECHNICAL STANDARDIZATION
7.	CIU	CENTRAL INTERLOCKING UNIT
8.	CCIP	CONTROL CUM INDICATION PANEL
9.	CMU	CENTRAL MONITORING UNIT
10.	CTC	CENTRALISED TRAIN CONTROL
11.	DAC	DIGITAL AXLE COUNTER
12.	EI	ELECTRONIC INTERLOCKING
13.	EMU	ELECTRICAL MULTIPLE UNIT
14.	EPROM	ERASABLE PROGRAMMABLE READ ONLY MEMORY
15.	ESM	Electrical Signal Maintainer
16.	FAT	FACTORY ACCEPTANCE TEST
17.	IBS	INTERMEDIATE BLOCK SIGNALLING
18.	I/O	INPUT/OUTPUT
19.	ISA	INDEPENDENT SAFETY ACCESSORY
20.	LCD	Liquid Crystal Display
21.	LED	Light Emitting Diode
22.	MTBF	MEAN TIME BETWEEN FAILURE
23.	MTBWSF	MEAN TIME BETWEEN WRONG SIDE FAILURE
24.	MTTF	MEAN TIME TO REPAIR
25.	MT	MAINTENANCE TERMINAL
26.	OC	OBJECT CONTROLLER
27.	OFC	OPTICAL FIBRE CABLE
28.	PC	PERSONAL COMPUTER
29.	PCB	PRINTED CIRCUIT BOARD
30.	QA	QUALITY ASSURANCE

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31.	QAF	QUALITY ASSURANCE PROGRAM
32.	FBC	RADIO BLOCK CENTER
33.	FE	RAILWAY ELECTRIFICATION
34.	FDSO	Research Development and Standards Organisation
35.	ROM	Read Only Memory
36.	RTC	REAL TIME CLOCK
37.	SAT	SITE ACCEPTANCE TEST
38.	SEM	SIGNAL ENGINEERING MANUAL
39.	SIL	SAFETY INTEGRITY LEVEL
40.	SM	STATION MASTER
41.	STF	SCHEDULE OF TECHNICAL REQUIREMENTS
42.	TOT	TRANSFER OF TECHNOLOGY
43.	TPWS	TRAIN PROTECTION WARNING SYSTEM
44.	UV	ULTRA VIOLET
45.	UFSBI	Universal Failsafe Solid state Block Interface
46.	VDU	VISUAL DISPLAY UNIT
47.	VGA	VIDEO GRAPHIC ARRAY

5.0 DEFINITIONS:

ABSOLUTE BLOCK SIGNALLING : Absolute block signal of railway signaling is to facilitate the safe operation of a railway by preventing more than one train from occupying a defined block section at the same time with the use of block instruments, block proving through axle counter etc.

AUTOMATIC BLOCK SIGNALLING: A system of block working where auto signals in the block section control the train movements to achieve the headway requirements.

AUTOMATIC TRAIN PROTECTION: Automatic Train Protection System is to help prevent collisions through a driver's failure to observe a signal or speed restriction. It consists of two parts – one part is on-board equipment to protect the train and the second is trackside equipment to transmit the interlocking information to the on-board equipment.

CENTRAL INTERLOCKING UNIT: Central Interlocking unit is a microprocessor based interlocking system, which holds the firmware and the station specific application logic for an interlocking. It processes the station specific application logic based on the vital inputs received from the field and non-vital commands given by user and generates vital outputs to control the field gears. The CIU may be connected to object controllers to control the field gears in a distributed interlocking environment.

CENTRALISED TRAIN CONTROL: Centralised traffic control system is used in places where more than one stations are controlled from a central place. The command to an interlocking can be given from a central place and after the commands are executed by the interlocking in the station, the field status is updated on the CTC screen. It shall also manage the traffic schedules and plans.

DATA LOGGER: It is a FDSO approved software based system to log events of a station in chronological manner pertaining to signalling gears.

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CENTRAL MONITORING UNIT OF DATA LOGGER: A remote centralized system for monitoring the status of signalling gears and systems through data loggers located at wayside stations.

OBJECT CONTROLLER: Object controller is a miniature version of interlocking system that will be placed close to the field gears. The object controller will communicate with CIU to get the commands to drive outputs and send the status of field gears back to CIU.

6.0 GENERAL REQUIREMENTS:

- 6.1 The system shall provide all the interlocking, control and indication functions as per approved interlocking plan, and selection table and panel diagram of the station.
- 6.2 The system shall have facility of monitoring of internal variables as well as specific status of I/O through the Maintenance terminal and data logger network of the railway. External Data logger shall be used for logging of analogue functions and for rest the inherent diagnostic facility of EI shall be used. It may also be possible to connect EI with central monitoring unit kept at HQ control unit. MT shall be used to diagnose problems/events related to hardware and software of EI. MT shall have facility for automatic serial data transfer to a central monitoring unit. The common protocol for this communication shall be as per Data Logger specification No. IFS S-99 latest version for interface only. FDSO approved external data logger shall be supplied with EI unless specified otherwise by the purchaser.
- 6.3 The system shall be suitable for working in RE as well as non-RE sections for all type of passenger/freight trains as per Indian railway conditions.
- 6.4 The system shall have capability to interface with Block Working Systems. It shall also be capable of interfacing with DAC, AFTC and all kinds of track circuits, UFSBI, Solid State Block Systems, IBS, ABS, Radio Block Center (RBC) including interfacing with outlying yards and sidings.
- 6.5 The system shall be provided in a dust protected cabinet with the suitable dust filters. The entry of wires/cables shall be such that to avoid any gap to arrest dust entry. If forced cooling is required, the cooling fans shall operate on separate power supply with over current protection arrangement. The supply of cooling fans shall be isolated from the supply of EI and other electronic circuits. The failure of any one of the fans or temperature rise shall give an alarm to the operator.
- 6.6 The terminals through which common positive or negative supply is provided to number of circuits shall be duplicated.
- 6.7 The equipment shall be so constructed as to prevent unauthorized access to the system.
- 6.8 Necessary provision shall be made in the hardware and software for modular expansion of the system. One EI shall be suitable for minimum 800 vital Input or Output or both functions. The supplier will indicate the maximum number of input/output functions supported by one EI.

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6.8.1 For large stations, which cannot be covered by one EI:

- (i) **Interconnection** of EIs in same room shall be through a serial/Ethernet port or OFC connection. The Ethernet switch/modem used shall be compliant to international safety standards (EN50159-1 & 2) for communication.
- (ii) Interconnection of EIs installed in different room or location shall be through RDSO approved OFC cable (Refer clause 2.0) in redundant configuration.

6.8.2 The communication provided between various EI shall comply with the requirements for transmission of vital safety information as laid down in relevant clause of latest version of RDSO/SPN/144 and EN50159. In case any peripheral equipment (such as VDU, MT, Data logger etc.) needs to be connected to the EI through serial ports and the EI system requires this serial to be isolated from the peripheral system, then suitable isolators shall be used for connecting the peripheral devices.

6.9 LED/LCD display shall be provided on all the modules of EIs to indicate status/ errors of the module.

6.10 EI shall have user-friendly graphic based design tool to generate station specific application software to carry out future yard modifications. It shall be possible for Railway to carryout minor yard modifications without the help of firm and the training shall be imparted to Railway maintenance staff for the same as per agreement with the Railway.

6.11 OFC (for communication between different buildings/rooms) connectivity shall be used for all vital serial connections.

7.0 FUNCTIONAL REQUIREMENT OF ELECTRONIC INTERLOCKING:

7.1 The system shall meet the interlocking requirements of the station as per the approved Interlocking plan and approved selection/control table provided by purchaser.

The features of Signal control circuits including Cascading of Signal aspects etc. shall be achievable through application Software only.

7.2 The audio-visual alarm shall be available for Approach locking, command held high for more than a specified duration etc. in EI as specified by the user railway.

7.3 The RTC of EI system(s) shall be updated/synchronized and it shall be possible to log the events in chronological order in case of use of either single/multiple EI with Data logger through CMU (Central Monitoring Unit) if provided in network otherwise through protocol converter.

7.4 The system shall have log of all the counters like Emergency Route cancellation, Calling On signal, Emergency Point operation, Overlap release operation etc. and that will be logged in Maintenance terminal. It shall be possible to read all counters as and when required. If Railway required, it shall also be possible to provide a counter box having non-resettable counters.

Real
Time
Clock

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7.5 The system shall meet the interlocking requirements of the station as per the approved Interlocking plan and approved selection/control table provided by Zonal Railway.

8.0 TECHNICAL REQUIREMENTS:

8.1 The E1 system shall consist of the following:

8.1.1 Microprocessor based interlocking equipment to read the yard and VDU inputs, process them in a fail-safe manner as per the selection/control table, rules of Indian Railways as defined in various specification, Signal Engineering Manual (SEM), G&SR etc., and generate required outputs

8.1.2 The response time of the system for the longest/complex route of a particular station shall be less than 5 seconds if Points are in favorable condition in that route. The response time indicated is the time from which command is given for operation of signal to receipt of signal aspect on VDU/CCIP

8.1.3 Industrial grade VDU as per details given at Clause 8.5.

8.1.4 Maintenance terminal (MT) with display, keyboard, printer with minimum 320 GB Memory storage capacity for event logging as per Clause 10.0.

8.1.5 E1 shall have object controllers having solid state Point & Signal modules to drive signals and points directly but it shall also be possible to interface E1 with points as per Indian railways specifications directly and it shall also be possible to drive points and signals using FDSO approved relays.

8.2 SYSTEM ARCHITECTURE

8.2.1 One of the following architectures shall be employed in the system.

(a) Two out of two hardware architecture with identical hardware and identical or diverse software. In addition, hot standby processor(s)/ system using similar 2 out of 2 hardware and software architecture shall be provided with facility of automatic changeover.

The train operation shall not be affected due to change over. It shall also be ensured that the fault, which affected the main processor/ system, does not affect the hot standby processor/ system.

(b) Two out of three hardware architecture with identical hardware and identical or diverse software.

8.3 SOFTWARE REQUIREMENTS:

8.3.1 The software of system shall have two layers:

(a) **Executive Software or System Software**

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This Executive Software shall define what the system can do and how the various parts of the system operate together. It shall include all start up and operational safety tests (including checking the Executive Software itself) that are the parts of the processor for continual assurance of safety operation.

(b) Application Software

It shall be containing the logic that defines how the inputs and outputs for a particular station are related. This shall be station specific.

The Executive Software and Application Software shall be programmed into Read Only Memories (ROM) by the manufacturer. It shall not be possible to modify Executive Software. However, Application engineers shall have the facility to modify application software as and when required.

It shall be possible to prevent unauthorized access for modifying the application software through a password protection.

8.3.2 The followings are to be ensured in case of application software:-

- a) The **checksum** of application software at the time of Factory Acceptance Test (FAT) matches with the checksum at the site (SAT) if there is no modification in yard layout after FAT.
- b) In case of yard modification, the changes in application software between modified yard and old yard shall be shown in different color using software comparator at the circuit level for verification by Railways.

8.3.3 The system shall conform to software requirements and self-check procedures as laid down in relevant clause of latest version of FDSO/SPN/ 144.

8.4 OBJECT CONTROLLER:

8.4.1 **OC** shall be a **Processor based system** having similar architecture as of CU or minimum **2 out of 2 architecture**. It shall work as **slave unit of CU through duplicated serial OFC communication**. The OC shall drive the field gears (Points, Signals & Relays) and take feedback (Inputs) from various field gears without any modification/ change in the design of outdoor Signalling equipment. The specifications of various field gears used over Indian Railways given in Clause 2.0 may be referred for technical details.

8.4.2 The object controller shall have Solid state Point & Signal modules and duly validated and meeting all safety requirements to directly drive Points & Signals. The Point and Signal modules shall be able to interface with Signals and point machine as per FDSO/SPN/153 with latest amendments and Point Machine IRS/S/24 with latest amendments. The purchaser shall give the details of interface requirements of outdoor gears.

8.4.3 The other field gears shall be driven through relay interface using Relay driver modules. The object controller shall be kept as close as possible to the field gears. The purchaser shall give the location of object controller. The limitation of distance shall be same which is followed on Indian Railways for direct feeding of

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an outside gear. If the field gear is directly driven from the OC without interface relays then protection filter modules, surge arrestors or suitable surge protection shall be provided to prevent damage of cards due to surges and undesirable operation due to induction.

- 8.4.4 The medium of communication between CIU and OCs shall be FDSO approved **Mono-mode OFC** (Refer Clause 2.0) provided on a ring basis for better reliability and availability. In case of communication failure between CIU & OC, all the outputs shall be brought to safe state. The communication devices switch/Modem used for connecting Central EI with Object controllers placed in the field shall be compliant to international safety standards. A network monitoring system shall be provided at to check whether the OFC network connection is perfect and there is no communication failure. NMS shall report alarms for failures of OFC network communication, modems, Ethernet switches etc.
- 8.4.5 All the inputs and outputs of OCs shall be isolated. **Maximum of 32 functions** shall be driven from one OC, irrespective of its capacity.
- 8.4.6 OC shall carry out the supervisory function to check the proper level of system voltages at critical points to ensure proper working of the system and shall also check the health of the complete system. Visual indications shall be provided on OC to indicate availability of proper voltage at critical points and error/failure.
- 8.4.7 Occurrence of any error in any OC or hardware fault leading to unsafe condition shall immediately withdraw all output commands and remove the source supply to outputs. Functionally, each OC shall be **independent** from other OC. Error in one OC shall not affect the working of other OCs. Failure of one OC shall not shutdown other OCs.

8.5 CONTROL TERMINAL WITH VDU DISPLAY:

- 8.5.1 Control terminal (PC) with VDU monitor display shall be provided with full redundancy in hot standby mode. Each system shall consist of:
- i) A latest industrial graded embedded fan less PC with no external drive, colour VDU monitor with minimum size of **30"** (or as specified by purchaser depending upon the size of station interlocking) (53 cm.) widescreen having aspect ratio of 16: 9 or 16:10, minimum resolution of 2560 X 1600, high contrast ratio, high level of colour accuracy, high response time, higher viewing angle (more than 150^o) with stand having height, tilt and pivot adjustments. If it is not possible to accommodate station interlocking in one screen then it shall be possible for VDU computer to get connected with multiple screens. In case of multiple screens, it shall be possible to select a route if entrance point is in one screen whereas, exit point is in another screen.
 - ii) A Key Board & mouse and
 - iii) Suitable interface to continuously display the current position/ status of various field equipment and track circuits.

A flashing indication shall be provided on the VDU screen to indicate healthy condition communication status between VDU & EI. OFC cable shall be used to connect VDU & CIU.

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Three dot markers in Red, Blue & Green colours respectively shall also be displayed prominently at conspicuous location on the VDU screen to indicate that the colour monitor is healthy and all the three colours (Red, Blue & Green) are present in right proportion. FBG indication will flash in sequence. In case of emergency Cancellation through VDU, reconfirmation from operator shall be taken. Diagnostic functions shall not be possible from the VDU terminal. For big yards, LCD based indications panel shall be provided if desired by user railways.

- iv) Operation of signal gear shall not be possible simultaneously through both VDUs. Hot standby VDU switch over is required in the following conditions:
- VDU to EI communication failure
 - VDU computer failure
 - VDU monitor failure
 - One VDU is not controllable due to mouse failure.

8.5.2 The basic power supply shall be provided by the Railways as per Para 8.12 and all other subsequent power supply for VDU shall be arranged by the supplier.

8.5.3 It shall be possible to display the complete yard layout including the section on the monitor. It shall also have facility for displaying a portion of the yard or section in an enlarged mode, if required.

8.5.4 The current position/ status of various field equipment and track circuits shall be displayed on the VDU screen/monitor using different colors/symbols.

8.5.5 VDU shall have hard SM key/smart card to authenticate the operator for operation and transfer from one VDU to another VDU. The control transferred status shall be prominent & displayed on VDU.

8.5.6 Availability of communication channel shall be indicated by a constantly flashing indication. Whenever the communication channel goes faulty, a suitable error message shall be displayed on the terminal. There shall be provision for automatic changeover from the faulty communication channel to standby communication channel.

8.5.7 Blocking of functions (points, signals, track circuits etc.) shall be possible through VDU. The blocking operations shall be achieved in fail-safe manner.

8.5.8 The software of VDU PC (Software and Hardware) shall be validated to SIL2. For safety related functions like Emergency operation of points, emergency route cancellation, crank handle release, and blocking function the VDU shall be compliant to SIL 4 for both hardware and software

8.6 HARDWARE AND FAIL-SAFETY:

Requirements of SEM as laid down in relevant clause of latest version of RDSO/SPN/144 or other international standards shall be complied.

8.7 COMPONENTS:

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Components used shall comply with relevant clause of latest version of FDSO/SPN/144.

8.8 PROTECTION AGAINST ELECTROMAGNETIC AND ELECTROSTATIC INTERFERENCE

The requirements laid down in relevant clause of latest version of FDSO/SPN/144 shall be complied. The equipment chassis shall be connected to suitable earth.

8.9 PRINTED CIRCUIT BOARD:

8.9.1 The requirements laid down in relevant clause of latest version of FDSO/SPN/144 or other international standards shall be complied.

8.9.2 Each card shall be marked with running serial number for identification of individual cards.

8.10 FAIL-SAFETY :

8.10.1 The requirements laid down in relevant clause of latest version of FDSO/SPN/144 shall be complied.

8.10.2 Either or both of hardware and software redundancy shall be provided to ensure that any single fault does not lead to unsafe failure.

8.10.3 **MTBWSF** of the system shall be as per **SIL4** requirements of CENELEC standards.

8.11 SELF CHECK PROCEDURES:

8.11.1 Self-check of the associated functional hardware as required by the hardware design shall be performed periodically as laid down in relevant clause of latest version of FDSO/SPN/144. Sufficient self-check shall be built into the system to detect possible hardware faults.

8.11.2 Integrity of the final vital output of the system for control of the field equipment shall be continuously checked by failsafe hardware and software along with reading front (in case of Metal to carbon relay) or both contacts (in case of Metal to Metal relay) of relays to guard against inadvertent operation of the equipment.

8.12 POWER SUPPLY REQUIREMENTS:

8.12.1 Non-regulated 230 Volts, 50 Hz. single phase or three phase, one or multiple supply shall be provided by Railways for E functioning to the vendor/manufactures and rest all subsequent power supply requirements for E, MT, VDU, OC etc. including backup of atleast four hours (to prevent shutting down of system due to fluctuations in main supply) for E system shall be

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arranged by the vendor. The system shall work satisfactorily with input voltage variation from 150V to 275V AC and frequency variation from 48Hz to 52 Hz. This shall also include provision of Power Supply change over panel for selection of power supply from available multiple sources. The details of Power supply shall be specified by the purchaser.

- 8.12.2 The short circuit & over voltage protection of self restoring type shall be provided.
- 8.12.3 The required protection shall be provided to protect from any malfunctioning due to false/spurious feed.
- 8.12.4 Suitable surge protection and proper earthing arrangement shall be provided in the power supply system to protect against transient voltages, lightning & spikes etc. RDSO SPN 197/2008 shall be applicable for surge protection and earthing arrangement.
- 8.12.5 A detailed Power supply arrangement diagram/ circuit shall be submitted to Purchaser.
- 8.12.6 As far as possible, power supply arrangement for individual processor shall be such that, in case of fault in power supply of one processor, all processors shall not cease to function simultaneously.
- 8.12.7 It shall be possible to switch off and take out faulty processor for repairing/replacement without affecting working of the balance system.

9.0 SAFETY REQUIREMENTS/ DETAILS OF STANDARDS FOLLOWED AND VALIDATION:

- 9.1 Both vital hardware & software of EI individually in case of single system or a whole when more than one system required shall meet SIL-4 as defined in CENELEC Standards. If the system is developed using any equivalent International standard other than CENELEC, a copy of standards followed shall be submitted with application. The certificate of Independent Safety Assessor certifying that the system is equivalent to SIL-4 compliant shall also be submitted.
- 9.2 The EI system software as well as standby changeover software shall have been independently verified and validated including its offered configuration by third party. User Railway shall verify application software pertaining to yard data as contained in the table of controls.
- 9.3 The firm manufacturing EI, when applying for type approval or cross – acceptance approval shall submit documentary proof of independent validation as per CENELEC Standards or equivalent standard along with complete safety case.
- 9.4 The firm shall give details of all modifications carried out in the system after initial validation/ approval. Date of each modification with brief reasons for undertaking modifications shall be given.
- 9.5 Software used in EI shall be in conformity with a software engineering standard issued by recognized standards body such as CENELEC with special relevance to

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9.6 safety critical applications. Particular software engineering standards used shall be specified and one complete set of such standards shall be made available to FDSO. As specified in the software Engineering Standards, full documentation on Quality Assurance Program specially the Verification and Validation (V&V) procedures carried out shall be made available to FDSO to check their conformity to the standards. If the procedure and documentation for V & V is considered inadequate, FDSO reserves the right to get the verification and validation of software and hardware done by an independent agency at the cost of the supplier.

10.0 MAINTENANCE AND DIAGNOSTIC AIDS

10.1 MT consisting of an Industrial grade PC with printer from a reputed manufacturer shall be provided for following Operations: -

- i) Display of the current status of points, signals, controls etc. of the yard.
- ii) Storage capacity of minimum 320 GB.
- iii) Display of recorded events and
- iv) Data transfer to CD, flash memory or any other latest storage media.
- v) Transfer of recorded events to external data logger.
- vi) Generation of exception reports shall be possible on MT for analysis purpose and past events simulation on yard layout etc. exactly as per Data Logger specification No. IFS S-99 latest version.
- vii) The soft copy of Signalling circuits/manuals provide at the station shall also be loaded on MT for ready reckoner of ESM in simple/local language.
- viii) MT shall be preferably connected to E through OFC. If copper cable is used for connectivity the MT port shall be isolated from the port of E. At both ends RS232 isolator/industrial grade opto-isolator shall be used.

10.2 In case of any module/ card becoming faulty, this fact shall be displayed on MT with diagnostic facility to identify faulty module/ card and the details of the fault occurred shall be highlighted with corrective action required.

The failure of any card/module in the system shall be clearly indicated on Maintenance Terminal through alarm. The supplier shall also indicate process of replacing such defective cards/ modules.

10.3 Control operation of yard functions shall not be possible from the maintenance terminal.

10.4 It shall be possible to keep MT anywhere at station.

10.5 The basic power supply shall be provided by the Railways as per Para 9.12 and all other subsequent power supply for MT shall be arranged by the supplier.

11.0 INFORMATION/ DOCUMENTS TO BE FURNISHED BY THE MANUFACTURER / SUPPLIER:

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11.1 The firm/manufacturer shall be responsible for the authenticity of documents submitted. The manufacturer shall supply the following information to FDSO:

- a) Design approach for the system. Type of architecture used.
- b) Functions achieved in hardware & software. Architecture and functions supported by one OC and number of OCs supported by single E.
- c) Mode of interaction between hardware & software.
- d) Salient feature through which fail safety has been achieved e.g. use of a watchdog timer, automatic shut down etc.
- e) Proof of safety in the form of process adopted for safety analysis and result thereof.
- f) Full documentation of Software Engineering followed during development.
- g) Full documentation of verification and validation procedure, Quality Assurance Program along with report and certificate from in-house Quality Assurance (QA) Group or an Independent Safety Auditor (ISA).
- h) Despite details at g above, if the FDSO consider software validation necessary, the manufacturer/ supplier will supply all the documents etc. to the Independent Safety Assessor nominated by the FDSO.
- i) Environmental/Climatic test (EMI/EMC) to be submitted.

11.2 The manufacturer shall supply the following documentation/ manuals:

- i) Installation & Maintenance Manual with pre-commissioning check list.
- ii) Diagnostic aids including troubleshooting charts: A trouble-shooting chart shall also be provided to indicate the step-by-step actions to be taken in case of failure of the equipment. It shall be possible to rectify the fault by replacement of defective PCB card by the maintainer at site.
- iii) Details of Hardware e.g. schematic diagrams of the system circuits/ components, details for each type of assembled PCB.
- iv) Details of software algorithm flow chart along with test/validation procedure used and the results thereof.
- v) Version No. of Signalling equipment shall be as per FDSO/SPN/ 144. In case of Cross-acceptance, Version No. as per manufacturer's practice may be accepted.
- vi) Software checksum of EPROM(s) shall be provided as per FDSO/SPN/ 144.
- vii) System design and proposed configuration for the station.
- viii) Detailed power supply arrangement including battery backup of the station.
- ix) Cable plan for the station.
- x) Type of relays to be used with E.

11.3 The manufacturer shall provide the following certifications from approved validation agency i.e. independent safety assessor:

- i) Correctness and safety of the software.
- ii) Reliability and fail-safety of the interlocking system.
- iii) Details of modifications carried out in the system and its subsequent validation.
- iv) Expected MTBF.
- v) Expected MTBWSF.

12.0 **ENVIRONMENTAL/ CLIMATIC REQUIREMENTS:**

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12.1 The requirements of Environmental/ climatic tests as per relevant clause of latest version of RDSO/SPN/144 (Indoor Equipment) shall be complied.

12.2 The main equipment room shall be made air-conditioned to increase the life of the components/system. However, object controller may be provided in non-air conditioned environment.

13.0 WARRANTY AND AVAILABILITY REQUIREMENTS:

13.1 The E system including its equipment and subsystems shall be under warranty for three years from the date of commissioning of complete system. However, purchaser can specify additional warranty if considered necessary.

13.2 Requirement of spare parts of each type for the first line maintenance shall be indicated for better system availability.

13.3 The MTBF of all vital modules shall be more than one lac hours. System availability (Operational Availability of complete system, including power supply, wiring etc.) shall be 99.98% or better. The supplier to give the detailed calculation to achieve this.

14.0 TESTS AND REQUIREMENTS:

Conditions of Tests

Unless otherwise specified all tests shall be carried out at ambient atmospheric conditions.

14.1 TEST EQUIPMENT:

The firm shall have all essential Testing Equipment as per latest STR to facilitate testing as per Routine/acceptance test format approved by RDSO.

14.2 TYPE TESTS:

14.2.1 The layout of one of the existing stations of IR having routes more than 200 shall be used for conducting type tests.

The following tests shall constitute type tests:

- a) Visual inspection as per Clause 15.1
- b) Insulation Resistance tests as per Clause 15.2
- c) Card-level functional tests on all the cards
- d) Fail-safety tests on one card of each type by Independent Safety Assessor & sample testing by RDSO.
- e) System level functional and fail-safety tests.
- f) Computerised testing for all possible permutations and combinations as per Clause 15.3.
- g) Environmental/ climatic tests as per relevant Clause of latest RDSO/SPN/144 (Indoor Equipment).
- h) System Diagnostics test as per Clause 15.4.

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i) System Software tests as per Clause 15.5.

14.2.2 Any other tests shall be carried out as considered necessary by FDSO.

14.2.3 Only one E shall be tested for this purpose. The equipment shall successfully pass all the type tests for proving conformity with this specification. If the equipment fails in any of the type tests, the purchaser or his nominee at his discretion, may call for another equipment/card(s) of the same type and subject it to all tests or to the test(s) in which failure occurred. No failure shall be permitted in the repeat test(s).

14.3 ACCEPTANCE TEST:

14.3.1 The following shall comprise acceptance tests:

- a) Visual inspection (Clause 15.1)
- b) Insulation Resistance tests (Clause 15.2)
- c) Card level functional test on all the cards.
- d) System level functional tests.
- e) System Diagnostics test (Clause 15.4)
- f) Verification of application software vis-a-vis selection table (This shall be done by user Railway).

14.3.2 Any other tests shall be carried out as considered necessary by the purchaser.

14.4 ROUTINE TEST:

14.4.1 The following shall comprise the routine tests and shall be conducted by manufacturer on every E and the test results will be submitted to the inspection authority before inspection. The application software in proper format shall also be submitted to the inspection authority in advance.

- a) Visual inspection (Clause 15.1)
- b) Insulation Resistance tests (Clause 15.2)
- c) Card level functional test on all the cards.
- d) System level functional test.
- e) Computerised testing for 1,00,000 permutations and combinations (Clause 16.3)
- f) System diagnostics test as per Cl. 15.4.

14.4.2 Any other tests shall be carried out as considered necessary by the purchaser.

15.0 TEST PROCEDURE

The test procedure shall include the following:

15.1 VISUAL INSPECTION:

The equipment shall be visually inspected to ensure compliance with the requirement of Clauses 7 to 10 of this specification. The visual inspection will broadly include :-

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i) System level checking:

Constructional details
Dimensional check
General workmanship
Configuration

ii) Card level checking

PCB laminate thickness
General track layout
Quality of soldering and component mounting
Conformal coating
Legend printing
Green masking

iii) Module level checking

Mechanical polarisation
General shielding arrangement of individual cards
Indications and displays
Mounting and clamping of connectors.
Proper housing of cards

15.2 INSULATION RESISTANCE TEST:

This test shall be conducted between the equipment power supply line terminals and the earth. If there is a possibility of the meggering voltage reaching the cards, these will be taken out before starting the IR test.

This test shall also be carried out after the climatic tests. The measurement shall be made at a potential of not less than 500 V DC.

The IR value shall not be less than 10 Mega ohms. After the climatic tests, this value shall not be less than 10 mega ohms.

15.3 COMPUTERIZED TESTING:

The manufacturer shall provide a computer-based test set up with the required software for automatic testing.

The following tests shall be conducted with the help of this set up.

15.3.1 FUNCTIONAL TESTING:

The system shall be tested functionally for all the signals with all routes, point operation, emergency point operation, route cancellation, emergency route cancellation, operation of G/F control points, level crossings and crank handle as per the selection table of the yard provided by the purchaser.

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15.3.2 OPERATIONAL FAIL SAFETY TEST:

These tests are conducted as per procedure given below:

- i) After setting of points in main route & desired overlap, signal is cleared. Back locking of the route and overlap shall be verified. It shall also be checked that other yard functions are free.

The track circuit of the route shall be dropped one by one and it shall be verified that it is not possible to clear the signal. All the routes are checked one by one.

- ii) Conditions required for route setting shall be disturbed in various permutations and combinations and it shall be verified that it is not possible to set the route with the disturbed conditions. Similarly, conditions required only for signal clearance (such as track circuits) shall also be disturbed and it shall be verified that the route is set but the signal is not cleared.

15.4 SYSTEM DIAGNOSTIC TEST:

- 15.4.1 These tests shall be conducted by automatic test procedure through a PC. The diagnostic tests on the system shall be performed to test the integrity of the system software by verifying the checksum. The PC at the end of the test shall print out summary of the tests conducted.

- 15.4.2 It shall be possible to verify the application program vis-a-vis the selection table by the user, preferably through regeneration of the locking table from yard data or relay equivalent circuits.

15.5 SYSTEM SOFTWARE TEST:

Checksum of system software and format of the application software shall be verified. Online checksum view facility shall be provided either in MT or front display of CIU. In case of any change in the system software/ format of application software, the same shall be validated.

16.0 CONDITIONS IN CASE OF CROSS ACCEPTANCE

- 16.1 The systems offered under cross acceptance are not developed to the specification of Indian Railway. These are developed to international or regional standards; therefore, certain deviations from Indian Railway specification are unavoidable. These shall be clearly defined by the manufacturer while offering the system to FDSO. These shall normally be accepted unless there is some serious deficiency likely to affect performance of the system on Indian Railway.

- 16.2 In case of Cross-Acceptance, the firm shall submit additional documents and information as per the latest version of "Procedure order for cross acceptance/approval of software embedded Electronics systems and new/imported technology products for Railway signalling" issued by FDSO.

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- 16.3 The approval of systems offered under cross acceptance shall be governed by “Procedure order for cross acceptance/approval of software embedded Electronic systems and new/imported technology products for Railway Signalling”. Indigenization requirement may be exempted by Railway Board but for continual support, the firm shall have the following:-
- a) Long Term Availability of Spares: It shall be ensured to supply spare parts for a period of 25 years. It shall be required to carry sufficient inventories to ensure an ex-stock supply of consumable spares for the system.
 - b) Training: The manufacturer shall have facility to provide training to Railway officials at its premises in E technology.
 - c) Provision of Test & Repair facility: The manufacturer shall set up test and repair facility with simulation test set-up, fault diagnostic system, test jigs, software for testing of cards/modules along with required test instruments and tools.
 - d) Annual Repair Contract: The manufacturer shall have provision of an annual repair contract after expiry of the warranty period. During the annual repair contract the manufacturer shall repair/replace all faulty cards ensuring availability of all required cards/modules by keeping sufficient inventory at its end.
- 16.4 Type test, Acceptance test and Routine test as given in para 15.2, 15.3 and 15.4 shall not be required in case of Cross- acceptance, The firm has to submit following documents to ensure that the system meets all requirements as mentioned in para 15:
- i) Certificates of Type tests done earlier at the time of development of the system as required by international standards.
 - ii) List of Routine tests done and sample copy of results to be submitted.
 - iii) Acceptance tests to be done at the time of inspection of equipment to be supplied. Routine tests reports to be submitted to RDSO before offering the system for acceptance test.
 - iv) Performance feedback reports from user Railways.
- 16.5 If required by RDSO, for the verification of compliances, one set of equipment of minimum configuration shall have to be installed in RDSO lab/factory premises of the firm in India to prove its performance in Indian conditions especially direct interfacing of solid state modules with signalling gears.
- 16.6 Details of cross acceptance procedure may be referred to in concerned document of RDSO.
- 17.0 QUALITY ASSURANCE**
- 17.1 All materials & workmanship shall be of good quality.
- 17.2 Since the quality of the equipment bears a direct relationship to the manufacturing process and the environment under which it is manufactured, the manufacturer shall ensure QAP of adequate standard.
- 17.3 QAP procedures of the firm including software loading precautions/procedures in addition to other system procedures to ensure quality of the product shall form a part of type approval.

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18.0 PLANT AND MACHINERY:

The firm shall have all essential Plant & Machinery as per latest STR. However, outsourcing may be allowed with the prior approval of FDSO.

19.0 PACKING:

As per relevant clause of latest version of FDSO/SPN/144.

20.0 INFORMATION TO BE FURNISHED BY THE PURCHASER:

- a) Datalogger to be supplied or not (Clause 6.2)
- b) Approved interlocking plan, selection table and panel diagram of the station (Clause 7.1).
- c) Interfacing with outdoor gears using relays or solid state modules (Clause 8.4.2).
- d) Locations of object controllers (Clause 8.4.3).
- e) Power supply details provided by purchaser (Clause 8.12.1).
- f) Detail of VDU control terminal (Clause 8.5.1)
- g) Counter box having non-resettable counters requires or not. (Clause 7.4)
- h) Warranty if required for more than three years of EI system including its equipments and sub system from the date of commissioning of complete system. (Clause 13.1)

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