SPOORNET

A DIVISION OF TRANSNET LIMITED

RAILWAY ENGINEERING SPECIFICATION

INTEGRATED TRAIN CONDITION MONITORING SYSTEM FOR GENERAL FREIGHT BUSINESS

First authorisation: _____
Dr. B.M Steyn
Principal Engineer
Railway Engineering

Date: July 2000

Circulation restricted to:

Spoornet

Relevant third parties

DOCUMENT APPROVAL

Signatories shall ensure the complete impact assessment and analysis of the document contents. Verify that any change is valid, necessary and methods of implementation are feasible.

_____

J.O. VAN NIEKERK

SENIOR ENGINEER

RAILWAY ENGINEERING

_____

G.C. PIENAAR

TECHNOLOGIST

RAILWAY ENGINEERING

_____

J. VAN AARDT

SENIOR MANAGER

RAIL AND TERMINAL SERVICES

_____

P. BENADE

TECHNICAL FLEET MANAGER (ROLLSTOCK)

RAIL AND TERMINAL SERVICES

_____

J. MARAIS

PRINCIPAL ENGINEER

RAILWAY ENGINEERING

CONTENTS

INTEGRATED TRAIN CONDITION MONITORING SYSTEM FOR GENERAL FREIGHT BUSINESS (GFB)

1 SCOPE

1.1 Identification

Integrated train condition monitoring system for General Freight Business (GFB)

1.2 System overview

The aim of the integrated train condition monitoring system for GFB is twofold:

- Obtain and make available train condition and alarm information from condition monitoring systems
- Initiate actions when emergency conditions are detected on trains
- Initiate action when condition monitoring systems fails

1.3 Document overview

This document presents a preferred system composition together with the functional and interface requirements that the integrated train condition monitoring system for GFB must conform to.

2 APPLICABLE DOCUMENTS

2.1 Integrated documents

The following specifications, standards and drawings of the exact issue shown form a part of this specification to the extent shown herein. In the event of conflict between the referenced document and this specification, the contents of this specification shall be considered a superseding requirement.

2.1.1 Transnet documents

Environmental specification of SPOORNET railway signalling systems.	CSE-1154-001 CAT E48
Standard specification for documentation for signals equipment.	CSE-1159-001 CAT E48
Permanent way instructions	
Protocol specification for the TS91 hot box detector	

2.1.2 Other documents

Radio regulations of the S.A. Department of Posts and Telecommunications.

2.2 Reference documents

Required operational capability of the Integrated train condition monitoring system for GFB	BBB1189 Version 1

3 REQUIREMENTS

3.1 System definition

The Integrated train condition monitoring system for GFB shall consist of

- an office processing system (OPS) for receiving information from remote sites, storing of information, initiation of emergency conditions and handling of user queries.
- a field concentrator system (FCS) to integrate all information at a specific measurement point and communicate this information to the OPS
- an operational alarm terminal (OAT) for communicating high priority train condition alarms to the train control officer (TCO)

- a maintenance alarm terminal (MAT) for communicating low priority train condition alarms to the maintenance departments
- a manager/technician terminal allowing the system manager and technician access to the system

The system diagram is shown in paragraph 3.2 “System diagram”. The specific functionality of each system is described in detail in paragraph 5 “Major component characteristics” while the interfaces are described in detail in paragraph 3.3 “Interface definitions”.

3.2 System diagram

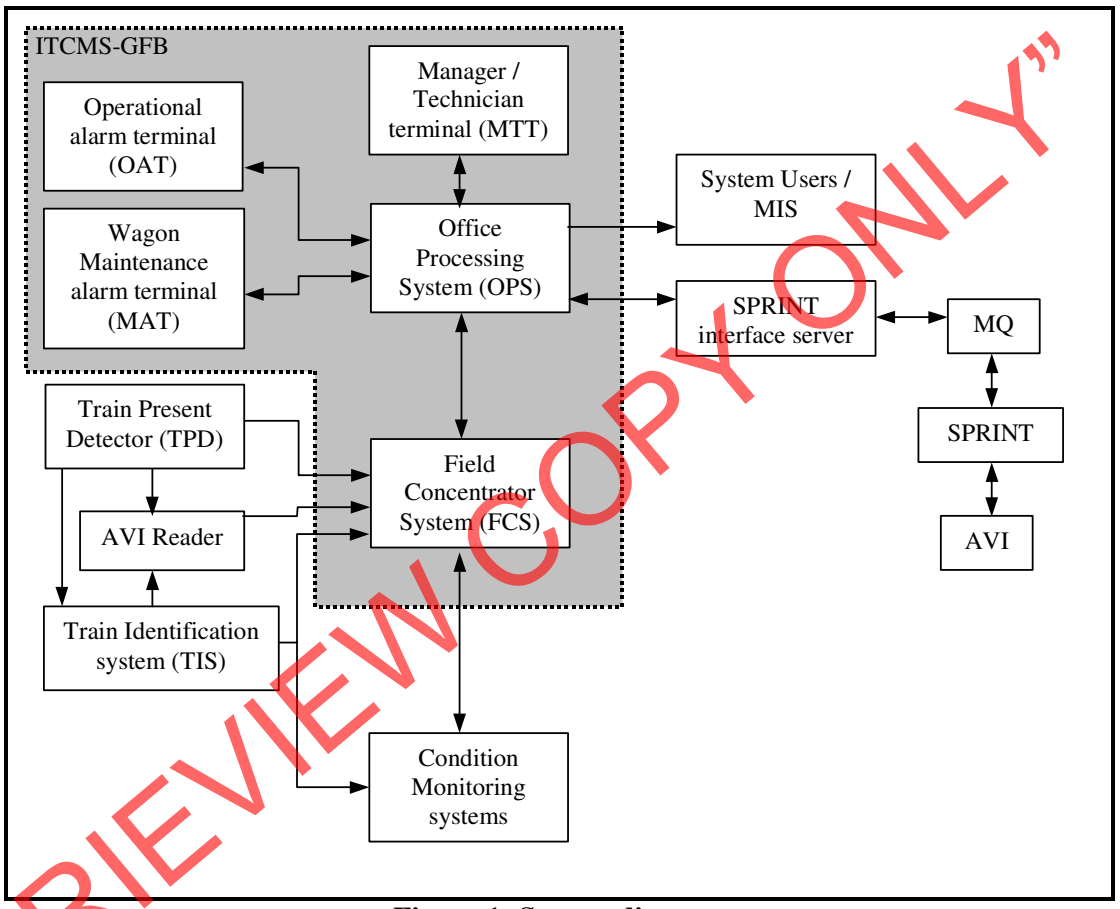

Figure 1: System diagram

3.3 Interface definitions

3.3.1 Field concentrator system (FCS) to condition monitoring systems communication

The system shall communicate with TS91 hot box detectors, the new hot bearing detector system, in-motion mass measurement systems (IMMM), skew bogie detectors and wheel impact monitor and weigh in motion systems (WIM-WIM). Provision shall be made to accommodate up to four different measurement systems on a single FCS, each measurement system to be on its own hardware interface. The interface requirements for these measurement systems are described in more detail in the following paragraphs.

3.3.1.1 TS91 hot box detector communication

The interface shall be C.C.I.T.T RS-232C V.24 standard. Baudrate, number of data bits, stop and start bits must be configurable to interface with the equipment.
The baudrate selection shall include
1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200. {The baudrate selected shall always be the maximum allowed by the available communication medium.}
The databits selection shall include
4, 5, 6, 7, 8 bits.
The stopbit selection shall include
1, 1.5, 2 bits.
The parity bit selection shall include
None, Odd, Even, Mark, Space.
The flow control selection shall include
Xon/Xoff, Hardware, None.
The communication protocol is described in detail in the document "Protocol specification for the TS91 hot box detector" referred to in paragraph 2.1.1 "Transnet documents".

Provision shall be made to accommodate one to four TS91 hot box detectors on a single FCS hardware interface. Each system shall have its own address (Address 0 to Address 3) and can be connected in a multi-drop modem configuration.

Condition and alarm information shall be transmitted from the TS91 hot box detector using three tables, namely an axle table, a wagon table and an alarm table. The communication protocol is described in detail in the document "Protocol specification for the TS91 hot box detector" referred to in paragraph 2.1.1 "Transnet documents". The format of the tables are described in the following paragraphs:
The format of the axle table is as follows:

Axle number, Distance, Bolo1_raw, Bolo2_raw, Bolo1_mod, Bolo2_mod.
Eg. 1 3421 21 21 23 23
The Bolo1_mod and Bolo2_mod values are values between 0 and 255 representing the temperature measurement. To convert the values to the actual temperature in Degrees Celsius the following conversion formula must be used.
Y = -0.0137x^5 + 0.1655x^4 + 0.181x^3 - 10.299x^2 + 73.076x + 24.13. The result can be rounded off to the nearest Degree Celsius. Bolometer 1 is defined as being on the left-hand side of the track when looking in the UP direction as defined on the Signalling Diagrams.

The format of the wagon table is as follows:

Wagon number, Starting Axle, Amount of axles, Type of wagon.
Eg. 1 1 6 L

The format of the alarm table is as follows:

Alarm number, Wagon number , Axle on the wagon , Side, Alarm value
Eg. 1 1 6 1 255
The alarm value shall be converted to Degrees Celsius using the same formula given above.

The FCS shall update the configuration parameters on the hot box detector system immediately after the system manager has modified it in the OPS. The communication protocol is described in detail in the document "Protocol specification for the TS91 hot box detector" referred to in paragraph 2.1.1 "Transnet documents".

The FCS shall receive configuration parameters from the hot box detector system. The communication protocol is described in detail in the document "Protocol specification for the TS91 hot box detector" referred to in paragraph 2.1.1 "Transnet documents".

The FCS shall transmit the date and time to all the hot box detector systems in order to synchronise the date and time of all the measurement systems. This shall be done every 30 minutes. Time delays over transmission mediums shall be taken into account when synchronisation is done. The communication protocol is described in detail in the document "Protocol specification for the TS91 hot box detector" referred to in paragraph 2.1.1 "Transnet documents".

The FCS shall receive self-check failure reports from the TS91 hot box detector system. The communication protocol is described in detail in the document "Protocol specification for the TS91 hot box detector" referred to in paragraph 2.1.1 "Transnet documents".

The FCS shall transmit a self-check request to the TS91 hot box detector system. The communication protocol is described in detail in the document "Protocol specification for the TS91 hot box detector" referred to in paragraph 2.1.1 "Transnet documents".

The FCS shall continuously poll the TS91 hot box detector to obtain information. The communication protocol is described in detail in the document "Protocol specification for the hot brake detector" referred to in paragraph 2.1.1 "Transnet documents".

3.3.1.2 Hot bearing detector system

A hot bearing detector can have two communication channels. The primary communication channel is used for normal operation. When the primary communication channel is not available, a secondary or backup communication channel is invoked when an alarm condition on a train is detected. The secondary communication channel is mainly used to communicate train condition alarm information but will also communicate train condition information once the link is established.

3.3.1.2.1 Primary communication channel

The interface shall be C.C.I.T.T RS-232C V.24 standard. Baudrate, number of data bits, stop and start bits must be configurable to interface with the equipment.
The baudrate selection shall include
1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200. {The baudrate selected shall always be the maximum allowed by the available communication medium.}
The databits selection shall include
4, 5, 6, 7, 8 bits.
The stopbit selection shall include
1, 1.5, 2 bits.
The parity bit selection shall include
None, Odd, Even, Mark, Space.
The flow control selection shall include
Xon/Xoff, Hardware, None.
The communication protocol and message format is to be determined.

Provision shall be made to accommodate one to four hot bearing detectors on a single FCS hardware interface. Each system shall have its own address (Address 0 to Address 3) and can be connected in a multi-drop modem configuration.

Condition and alarm information shall be transmitted from the hot bearing detector system to the FCS. The communication protocol and message format is to be determined.

The FCS shall update the configuration parameters on the hot bearing detector system immediately after the system manager has modified it in the OPS. The communication protocol and message format is to be determined.

The FCS shall receive configuration parameters from the hot bearing detector system. The communication protocol and message format is to be determined.

The FCS shall transmit the date and time to all the hot bearing detector systems in order to synchronise the date and time of all the measurement systems. This shall be done at configurable time intervals for each hot bearing detector. Time delays over transmission mediums shall be taken into account when synchronisation is done. The communication protocol and message format is to be determined.

The FCS shall receive self-check failure reports from the hot bearing detector system. The communication protocol and message format is to be determined.

The FCS shall transmit a self-check request to the hot bearing detector system. The communication protocol and message format is to be determined.

The FCS shall continuously poll the hot bearing detector system to obtain information. The communication protocol and message format is to be determined.

3.3.1.2.2 Secondary communication channel

The interface shall be C.C.I.T.T RS-232C V.24 standard. Baudrate, number of data bits, stop and start bits must be configurable to interface with the equipment.
The baudrate selection shall include
1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200. {The baudrate selected shall always be the maximum allowed by the available communication medium.}
The databits selection shall include
4, 5, 6, 7, 8 bits.
The stopbit selection shall include
1, 1.5, 2 bits.
The parity bit selection shall include
None, Odd, Even, Mark, Space.
The flow control selection shall include
Xon/Xoff, Hardware, None.
The communication protocol and message format is to be determined.

Provision shall be made to accommodate the secondary communication channel of multiple hot bearing detectors on a single FCS hardware interface.

Condition and alarm information shall be transmitted from the hot bearing detector system to the FCS. The communication protocol and message format is to be determined.

3.3.1.3 Wheel impact monitor and weigh in motion (WIM-WIM) system

The interface shall be C.C.I.T.T RS-232C V.24 standard. Baudrate, number of data bits, stop and start bits must be configurable to interface with the equipment.

The baudrate selection shall include
1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200. {The baudrate selected shall always be the maximum allowed by the available communication medium.}
The databits selection shall include
4, 5, 6, 7, 8 bits.
The stopbit selection shall include
1, 1.5, 2 bits.
The parity bit selection shall include
None, Odd, Even, Mark, Space.
The flow control selection shall include
Xon/Xoff, Hardware, None.

The communication protocol shall make provision for XMODEM checksum, XMODEM CRC, XMODEM 1K or XMODEM 1K9.

Four types of reports shall be sent to the FCS from the WIM-WIM, namely an alarm report, a full train report, a maintenance report and a status report. The format of the reports is described below.
The format of the reports is as follows:

Header

Row 1	Measurement Site ID	(20 alphanumeric characters)
Row 2	Time	(5 alphanumeric characters (24:00))
Row 3	Date	(10 alphanumeric characters (CCYY/MM/DD))
Row 4	"NORMAL, Cloud report" or "NORMAL, Maintenance report" or "STATUS report" or "ALARM!"	
Row 5	"U" or "D"	(1 alphanumeric character)
Row 6	Bridge offset values for channels 1 to 14 - (Engineering values) e.g. (0.10,-12.20,0.41,0.21,0.16,1.25,0.26,0.30,0.53,0.76,0.45,0.48,0.72, 1.12)	
Row 7	Bridge offset values for channels 15 to 28 - (Engineering values) e.g. (0.10,-12.20,0.41,0.21,0.16,1.25,0.26,0.30,0.53,0.76,0.45,0.48,0.72,1.12)	
Row 8	Wheel counts per channel - for verticals 1 to 18 e.g. (824,824,824,824,824,824,824,824,824,824,824,824,824,824,824,824,824,824)	
Row 9	Bridge effectivity - ("M" = Need maintenance, "G" = Results good)	
Row 10	Column / Field headers	
Row 11 to n	Data :(Columns 1 to 27)	
Col 1	Vehicle number (1 to n) {Inclusive of locomotives}	
Col 2	Vehicle descriptor (Locomotive type ie. 11E or "W" for wagon)	
Col 3	Speed	
Col 4	Mass - Vehicle	
Col 5	Mass - Leading bogie	
Col 6	Mass - Trailing bogie	
Col 7	Mass - Left side	
Col 8	Mass - Right side	
Col 9	Skew Front bogie	
Col 10	Skew Rear bogie	
Col 11	Flanging Axle 1	
Col 12	Flanging Axle 2	
Col 13	Flanging Axle 3	

Col 14 Flanging Axle 4
Col 15 Dynamic Load Wheel 1 Left
Col 16 Dynamic Load Wheel 2 Left
Col 17 Dynamic Load Wheel 3 Left
Col 18 Dynamic Load Wheel 4 Left
Col 19 Dynamic Load Wheel 5 Left
Col 20 Dynamic Load Wheel 6 Left
Col 21 Dynamic Load Wheel 1 Right
Col 22 Dynamic Load Wheel 2 Right
Col 23 Dynamic Load Wheel 3 Right
Col 24 Dynamic Load Wheel 4 Right
Col 25 Dynamic Load Wheel 5 Right
Col 26 Dynamic Load Wheel 6 Right
Col 27 Alarms - (Alarms and maintenance schedule)
"F" = Flat wheel, "S" = Skewing, "G" = Flanging axle, "M" = Mass overload.
"L" = Skew overloading, "B" = Bogie mass overload.
If more than one condition exist per vehicle the alarm becomes a combined code ie. FS = Flat and skewing

The four reports generated by the WIM-WIM system have the following extensions:

*.STP - ALARM Report (Only two alarm conditions exist: "F" for flat wheel and "M" for mass overloaded) Row 4 = ALARM!

*.PRN - Full train report. Row 4 = NORMAL, Cloud report.

*.MAN - Maintenance table. The format of the table is as the "full report" but only includes exception data ie. Col 27 not blank. Row 4 = NORMAL, Maintenance report.

*.STA - The format of the "Status Report" is as follows:

Row 1	Measurement Site ID	(20 alphanumeric characters)
Row 2	Time	(5 alphanumeric characters (24:00))
Row 3	Date	(10 alphanumeric characters (CCYY/MM/DD))
Row 4	"Status Report"	
Row 5	"U" or "D"	(1 alphanumeric character)
Row 6	Bridge offset values for channels 1 to 14 - (Engineering values) e.g. (0.10,-12.20, 0.41, 0.21, 0.16, 1.25, 0.26, 0.30, 0.53, 0.76, 0.45, 0.48, 0.72, 1.12)	
Row 7	Bridge offset values for channels 15 to 28 - (Engineering values) e.g. (0.10,-12.20, 0.41, 0.21, 0.16, 1.25, 0.26, 0.30, 0.53, 0.76, 0.45, 0.48, 0.72, 1.12)	
Row 8	Wheel counts per channel - for verticals 1 to 18 e.g. (824,824,824,824,,,,,,,, to 18 verticals)	
Row 9	Bridge effectivity - ("M" = Need maintenance, "G" = Results good)	
Row 10	Date of last train measured (10 alphanumeric characters (CCYY/MM/DD))	

Priority of conversion and transmission is :

Priority 1 - *.STP
Priority 2 - *.MAN
Priority 3 - *.PRN
Priority 4 - *.STA

In the *.STP file, the flat wheel alarm shall have a severity of stop train. Mass alarms shall have a severity of continue to next station.

Reporting mass overload alarms, skew overloading alarms and bogie mass overload alarms shall be configurable options in the integrated train condition monitoring system, ie. to report or not to report. Mass overload alarms are reported along with flat wheel alarms in the *.STP file. Skew overloading and bogie mass overload shall be extracted by the integrated train condition monitoring system from the *.MAN file.

The status report (*.sta) shall be used to determine the system health. The report shall be transmitted automatically to the integrated train condition monitoring system at a configurable time period. This time period shall also be configurable in the integrated train condition monitoring system.

3.3.1.4 In-motion mass measurement system (IMMM)

The communication interface for the In Motion Mass Measurement System shall be C.C.I.T.T RS-232C V.24 standard. Baudrate, number of data bits, stop and start bits must be configurable to interface with the equipment.
The baudrate selection shall include
1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200. {The baudrate selected shall always be the maximum allowed by the available communication medium.}
The databits selection shall include
4, 5, 6, 7, 8 bits.
The stopbit selection shall include
1, 1.5, 2 bits.
The parity bit selection shall include
None, Odd, Even, Mark, Space.
The flow control selection shall include
Xon/Xoff, Hardware, None.

The communication protocol shall be XMODEM.

The FCS shall receive condition information from the IMMM. The format of the information is described below.

A file containing good measurements.
Line 1: "AD"
Line 2: "199807061258"
Line 3: 2,2,1.9,2.1,2,2,2,1.6,2,2,2,2
Line 4: 430,430,430,430,430,430,430,430,430,430,430,430
Line 5: "L"
Line 6: "7E",120.82,50
Line 7: "T"
Line 8: 79.51, 1, 50.4, 1.01, 1.02, 1.03, 1.04, 1.05, 1.06, 1.07, 1.08, 1.09, 1.10, 1.11, 1.12, 1.13, 1.14, 1.15, 1.16

Description of lines:
Line 1: Quality and direction of the measurements of the last train. The first character is an ASCII "A" indicating a good measurement. The second character can be ASCII characters "U" or "D" indicating the direction. "U" is the "UP" direction and "D" is the "DOWN" direction as defined in the operating rules. A third character can be present indicating that spurious measurements were detected but the system was able to process the measurements. This is indicated by an ASCII "C". The record is enclosed in the quotation marks.

Line 2: This line contains the century, year, month, day, hour, minute of the measurements. The record is enclosed in the quotation marks.

Line 3 and 4: The peak and valley values used for fault finding of the equipment.

Line 5: This line indicates the start of the locomotive measurements. The character is an ASCII "L" enclosed in quotes.

Line 6: The locomotive type in ASCII characters enclosed in quotes. The next value is the measured vehicle mass in tons followed by the speed of the vehicle. The different values are seperated by commas and the line is terminated by a carriage return. Each locomotive is entered as a new line.

Line 7: This line indicates the start of the wagon measurements. The character is an ASCII "T" enclosed in quotes.

Line 8: From this line onwards are all the measurement values of the wagons. A new line is generated for each wagon and contains the following information: Wagon Mass, Wagon mass confidence value, Wagon speed, Axle 1 Left wheel mass, Axle 1 Left wheel confidence value, Axle 1 Right wheel mass, Axle 1 Right wheel confidence value, Axle 2 Left wheel mass, Axle 2 Left wheel confidence value, Axle 2 Right wheel mass, Axle 2 Right wheel confidence value, Axle 3 Left wheel mass, Axle 3 Left wheel confidence value, Axle 3 Right wheel mass, Axle 3 Right wheel confidence value, Axle 4 Left wheel mass, Axle 4 Left wheel confidence value, Axle 4 Right wheel mass, Axle 4 Right wheel confidence value.

Left and Right is defined as the left and right side of the train when looking in the direction of increased mast pole numbers.

A comma separates each value and a carriage return character terminates the line.

A file containing values for an incorrectly measured train.
Line 1: "ND"
Line 2: "199807061258"
Line 3: 2,2,1.9,2.1,2,2,2,1.6,2,2,2,2
Line 4: 430,430,430,430,430,430,430,0,430,430,430,430

In Line 1 the "A" is replaced by a "N" character indicating a problem with the measurement. The direction character is the same as described above.

Line 2 contains the date in the same format as described for a good measurement.

Lines 3 and 4 shows the peak and valley measurements with error conditions to assist the maintenance personnel with fault finding.

3.3.2 AVI reader to field concentrator system (FCS) communication

The physical connection between the AVI system and the FCS shall be a standard C.C.I.T.T RS-232C V.24 port. The protocol and message format is to be determined.

The AVI reader shall communicate a text file to the FCS after a train has passed the measurement point. The format of the file shall be

- Line 1: Date/time
- Line 2: Error codes
- Line 3: 16 digit train number (if available)
- Line 4-n: An entry for each vehicle containing vehicle position, vehicle orientation and vehicle number. The fields are to be comma delimited.

Receiving train composition information from an AVI reader shall be a configurable option per FCS in the system, so as to make provision for both sites with AVI readers and sites without it.

3.3.3 Train presence detector (TPD) to field concentrator system (FCS) communication

The physical connection between the train present detector and the FCS shall be two wires. The wires shall be connected to a relay contact on the train present detector side and a suitable input port on the FCS.

The train present detector shall provide a train present indication to the FCS using a relay contact. The contact shall be open when a train is not present and closed when a train is present.

Receiving a train present indication from a TPD shall be a configurable option per FCS in the system, so as to make provision for both sites with a TPD and sites without it.

3.3.4 Train identification system (TIS) to field concentrator system (FCS) communication

The physical connection between the train identification system and the FCS shall be a standard C.C.I.T.T RS-232C V.24 port. The protocol and message format is to determined.

The train identification system shall communicate a 16-digit train number to the FCS, within 30 seconds, after the lead locomotive has passed the measurement point. The format of the file shall be

- Line 1: Date/time
- Line 2: Error codes
- Line 3: 16-digit train number

Receiving train identification information from a TIS shall be a configurable option per FCS in the system, so as to make provision for both sites with a TIS and sites without it.

3.3.5 Field concentrator system (FCS) to office processing system (OPS) communication

The physical connection between the FCS and the OPS shall be a standard C.C.I.T.T RS-232C V.24 port, either directly connected or working with four wire lease line modems over a dedicated four wire lease line or with dialup cell modems working over the MTN cellphone network.

The communication medium shall be configurable in the system with any of the following options:

- Direct cable connection
- Four wire lease line communication only
- Cellphone communication only
- Four wire lease line communication as primary medium with cellphone communication as standby/backup medium.

The FCS shall transmit train composition, train condition and train condition alarms to the OPS. The protocol is to be determined by the contractor but preferred, by Spoornet, to be as far as possible the same as for the FMS to DCS communication in the Coallink ITCMS.

The FCS shall transmit self-check results to the OPS. The protocol is to be determined by the contractor but preferred, by Spoornet, to be the same as for the FMS to DCS communication in the Coallink ITCMS.

The OPS shall transmit self-check requests to the FCS. The protocol is to be determined by the contractor but preferred, by Spoornet, to be the same as for the FMS to DCS communication in the Coallink ITCMS.

The OPS shall transmit configuration parameters for the condition measurement systems to the FCS. The protocol is to be determined by the contractor but preferred, by Spoornet, to be the same as for the FMS to DCS communication in the Coallink ITCMS.

The FCS shall transmit configuration parameters received from the condition measurement systems to the OPS. The protocol is to be determined by the contractor but preferred, by Spoornet, to be the same as for the FMS to DCS communication in the Coallink ITCMS.

The OPS shall transmit the current date/time to the FCS. The protocol is to be determined by the contractor but preferred, by Spoornet, to be the same as for the FMS to DCS communication in the Coallink ITCMS.

3.3.6 Office processing system (OPS) to operational alarm terminal (OAT) communication

The communication medium and protocol between the office processing system (OPS) and the operational alarm terminal (OAT) shall be an Ethernet connection using TCP/IP.

The OPS shall transmit high priority (Stop immediately or Stop at the next station) train condition alarms to the OAT. The message format is to be determined by the contractor but preferred, by Spoornet, to be the same as for the DCS to TCO information unit communication in the Coallink ITCMS.

The OPS shall transmit critical system failure alarms to the OAT. The message format is to be determined by the contractor but preferred, by Spoornet, to be the same as for the DCS to TCO information unit communication in the Coallink ITCMS.

The OAT shall transmit acknowledgement information and repair reports to the OPS. The message format is to be determined by the contractor.

The OAT shall transmit system status to the OPS. The message format is to be determined by the contractor but preferred, by Spoornet, to be the same as for the DCS to TCO information unit communication in the Coallink ITCMS.

The OPS shall transmit requests for system status to the OAT. The message format is to be determined by the contractor but preferred, by Spoornet, to be the same as for the DCS to TCO information unit communication in the Coallink ITCMS.

3.3.7 Office processing system (OPS) to wagon maintenance alarm terminal (MAT) communication

The communication medium and protocol between the office processing system (OPS) and the wagon maintenance alarm terminal (MAT) shall be the Spoornet wide-area network using TCP/IP.

The OPS shall transmit low priority (Continue to the depot) train condition alarms to the MAT. The message format is to be determined by the contractor but preferred, by Spoornet, to be the same as for the DCS to Carriage and wagon information unit communication in the Coallink ITCMS.

The MAT shall transmit acknowledgement information and repair reports to the OPS. The message format is to be determined by the contractor.

The MAT shall transmit system status to the OPS. The message format is to be determined by the contractor but preferred, by Spoornet, to be the same as for the DCS to Carriage and wagon information unit communication in the Coallink ITCMS.

The OPS shall transmit requests for system status to the MAT. The message format is to be determined by the contractor but preferred, by Spoornet, to be the same as for the DCS to Carriage and wagon information unit communication in the Coallink ITCMS.

3.3.8 Office processing system (OPS) to system user / MIS communication

The communication medium and protocol between the office processing system (OPS) and the system user / MIS shall be the Spoornet wide-area network using TCP/IP.

The OPS shall replicate all train condition and alarm information to a management information system. The protocol is to be determined.

The OPS shall accommodate user queries for information using Open Database Connectivity (ODBC) and Structured Query Language (SQL).

The OPS shall transmit query results to the users.

The OPS shall send automatic reports on condition and alarm information to selected users using email. Users receiving automatic reports shall be configurable in the system. Type of reports to send to a user shall also be configurable. The following is examples of typical situations:

- Send all condition information for a specific condition monitoring system
- Send all condition alarm information for a specific condition monitoring system
- Send all condition information for a specific type of condition monitoring systems
- Send all condition alarm information for a specific type of condition monitoring systems
- Send all system failures of a specific condition monitoring system
- Send all system failures of a specific type of condition monitoring systems
- Send condition information in a specific range for a specific condition monitoring system
- Send condition information in a specific range for a specific type of condition monitoring systems
- Etc.

3.3.9 Office processing system (OPS) to manager / technician terminal (MTT)

The communication medium and protocol between the office processing system (OPS) and the manager / technician terminal (MTT) shall be the Spoornet wide-area network using TCP/IP.

The OPS shall transmit system composition information to the MTT. The message format is to be determined by the contractor but preferred, by Spoornet, to be the same as for the MPS to system manager interface in the Coallink ITCMS.

The OPS shall transmit self-check results to the MTT. The message format is to be determined by the contractor but preferred, by Spoornet, to be the same as for the MPS to system manager interface in the Coallink ITCMS.

The OPS shall transmit component and event logs to the MTT. The message format is to be determined by the contractor but preferred, by Spoornet, to be the same as for the MPS to system manager interface in the Coallink ITCMS.

The OPS shall transmit configuration parameters to the MTT. The message format is to be determined by the contractor but preferred, by Spoornet, to be the same as for the MPS to system manager interface in the Coallink ITCMS.

The MTT shall transmit requests for self-checks, component logs, event logs, system composition and configuration parameters to the OPS. The message format is to be determined by the contractor but preferred, by Spoornet, to be the same as for the MPS to system manager interface in the Coallink ITCMS.

The MTT shall transmit repair reports to the OPS. The message format is to be determined by the contractor but preferred, by Spoornet, to be the same as for the MPS to system manager interface in the Coallink ITCMS.

The MTT shall transmit updated configuration parameters to the OPS. The message format is to be determined by the contractor but preferred, by Spoornet, to be the same as for the MPS to system manager interface in the Coallink ITCMS.

The OPS shall transmit a maintenance schedule to the MTT. The message format is to be determined by the contractor but preferred, by Spoornet, to be the same as for the MPS to system manager interface in the Coallink ITCMS.

The MTT shall transmit update maintenance schedules to the OPS. The message format is to be determined by the contractor but preferred, by Spoornet, to be the same as for the MPS to system manager interface in the Coallink ITCMS.

3.3.10 Office processing system (OPS) to SPRINT interface server communication

The communication medium and protocol between the office processing system (OPS) and the SPRINT interface server shall be an Ethernet network connection using TCP/IP.

The OPS shall request train composition information by quering the SPRINT interface server using Open database Connectivity (ODBC) and Structured Query Language (SQL). Two different request options shall be available. The query for each option shall contain the following:

Option 1:

- Measurement Site Identification
- Date/time
- Direction of travel
- Time window

Option 2:

- 16-digit SPRINT train number

The OPS shall receive train composition information from the SPRINT interface server as an answer from the above request. The information shall be a table with the following fields:

- Date/time
- 16-digit SPRINT train number
- Vehicle position
- Vehicle number
- Vehicle type
- Vehicle orientation

Obtaining train composition information from the SPRINT interface server shall be a configurable option per measurement site. If enable, the system shall use the available information received from the measurement site to determine which option (ie. option 1 or option 2 mentioned above) to use.

The OPS shall update the SPRINT interface server if train composition is received from a FCS. The message format and protocol is to be determined.

3.4 Major component list

- Office processing system (OPS)
- Field concentrator system (FCS)
- Operational alarm terminal (OAT)
- Wagon maintenance alarm terminal (MAT)
- Manager / technician terminal (MTT)

3.5 Spoornet supplied property list

- Voice grade, lease-line telephone line at the measurement point
- Sim-cards to gain access to the MTN network
- Electricity supplies at the measurement point and offices. The supply voltage is 220V±20% at 50Hz.

3.6 Spoornet loaned property list

Not applicable

4 SYSTEM CHARACTERISTICS

4.1 Performance characteristics

The system shall be able to collect train condition measurements and alarm information as provided by the various condition monitoring systems. If the condition monitoring system do not have the functionality to provide alarm information it shall be generated by the ITCMS system.

The system shall be able to obtain information on the train composition from either a SPRINT interface server in the CTC or an AVI reader at the measurement point. The system shall process train condition and alarm information by adding train composition information (if available) to the train condition and alarm information.

The system shall initiate action on alarm conditions by determining the severity of the alarm and the persons who will take action on the alarm condition. The system shall communicate the alarm information to the identified responsible persons for further processing. The system shall also inform other users who requested alarm information.

The condition and alarm information shall be stored distributed in the various Office Processing Systems (OPS's) in the CTC's from where it shall be made available to the users and management

information systems for further processing. The system manager shall be able to maintain information in this distributed database.

The system shall provide scheduled maintenance information and corrective maintenance information on request to allow for the maintenance of the system.

The system shall execute self-checks to ascertain the operational status of the system. System failures shall be communicated to the identified technician using email and also shown on the manager/technician terminal (MTT). In addition hereto, critical system failures shall be communicated to a responsible person using an operational alarm terminal (OAT). Normally, a critical system is a condition monitoring system that generates "Stop immediately" condition alarms. For a critical system, the integrated train condition monitoring system shall continuously check all subsystems and interfaces in the path between the condition monitoring system and the operational alarm terminal. Any failures of these subsystems or interfaces shall immediately be reported.

The system shall provide information to assist in the modification and commissioning of the system.

The system shall continuously monitor the system security status and raise an alarm in the case of a security violation.

The system shall provide information on disposal of the system or part of the system.

4.2 Physical characteristics

All track-mounted and track side components shall be clear of the minimum structure gauge, as defined in the Permanent Way Instructions, quoted in section 2.1.1.

The system, excluding track-mounted equipment shall be installed in an equipment container, relay room or CTC centre.

All equipment shall be mounted inside a suitable cabinet that can be floor or wall mounted. The cabinet shall allow for easy access to all components for maintenance purposes.

4.3 System availability factors

The mean time between failures for any electronic sub-system shall not be less than 12 months. Contractor to provide data to prove these figures.

4.4 Environmental conditions

All equipment shall comply with the relevant sections of Infrastructure (Signals) standard specification no. CSE-1154-001 CAT E48 as applicable to both coastal and inland areas.

Track-mounted, track side and train-mounted equipment shall operate in ambient temperatures varying from -15 degrees Celsius to 50 degrees Celsius, with humidity ranging from 0 to 95% non-condensing.

All track-mounted, track side and office equipment shall have comprehensive lightning protection to enable the equipment to withstand, without damage or loss of functionality, severe lightning activity, except for a direct hit. The lightning protection shall comply with the relevant sections of Infrastructure (Signals) standard specification no. CSE-1154-001 CAT E48.

Track-mounted, track side and train-mounted equipment shall not be affected by exposure to full sunlight, rain, snow, hail or dust.

Track-mounted, track side and train-mounted equipment shall be resistant to spillage from bulk loads commonly found in the railway environment, e.g. coal, lime, sulphur, petroleum products and salts.

Track-mounted, track side and train-mounted equipment shall be resistant to vandalism, flying ballast stones and equipment dragging from the train.

The system shall be suitable for operation in 3-kilovolt DC traction, 25-kilovolt AC traction and 50 kilovolt AC traction areas. The system shall be immune to the traction profiles as specified in the relevant sections of Infrastructure (Signals) standard specification no. CSE-1122-103 CAT E97.

All track-mounted and trackside equipment shall be capable of withstanding, without damage or loss of functionality, the vibration experienced with the passage of a train. Vibration resistance shall comply with the relevant sections of Infrastructure (Signals) standard specification no. CSE-1154-001 CAT E48. The same is valid for locomotive mounted equipment, which must withstand continuous locomotive vibration.

Electromagnetic susceptibility limits of the system and all its components shall comply with Infrastructure (Signals) standard specification no. CSE-1154-001 CAT E48.

The system and its components shall comply with the Radio Regulations of the S.A. Department of Posts and Telecommunications. All electrical components of the system shall be certified in terms of Chapter 7 of the Radio Regulations of the S.A. Department of Posts and Telecommunications.

The individual environmental conditions are described in the individual paragraphs for each of the major components.

4.5 Portability

All spare replacement modules shall be small enough to be handled by one technician. If special packaging is required for any module in the railway environment, it shall be supplied as part of the system.

4.6 Transportability

All spare replacement modules shall be small enough so that it can be transported to site in the boot of a car on a Spoornet service road. If special packaging is required for any module in the railway environment, it shall be supplied as part of the system.

4.7 Fail-safe requirements

Not applicable.

4.8 Flexibility and expansion

The design of the system shall be modular so as to ease maintenance and upgrade activities.

5 MAJOR COMPONENT CHARACTERISTICS

5.1 Office processing system (OPS)

5.1.1 Description

The Office Processing System (OPS) gathers information from all the Field Concentrator Systems (FCS's) connected to it. The train numbers and wagon numbers are added (if so configured and composition information is available) to the Train Condition information and Train Alarm information. The OPS also processes the Train Alarm Information to determine the persons to be informed of the alarm condition.

Information pertaining to the wagon condition is stored in the OPS for replication to management information systems (MIS) and retrieval by the users of the system. The OPS processes the queries from the users and returns the requested information. The OPS also automatically generates train condition reports and transmits them to the users requiring the information.

A system manager and/or technician shall maintain the OPS and its subsystems. The OPS shall transmit system information to the system manager and/or technician and obtain input from the system manager and/or technician. The system manager shall maintain security of the OPS and its subsystems.

The OPS shall contain a daily backup system to prevent loss of information. The Daily Backup System saves information in the OPS for retrieval in the event of a failure of the OPS. This daily backup routine shall be automatic with user intervention only required in exceptional cases.

5.1.2 Physical characteristics

The OPS shall be located in an office environment. The OPS shall be a fixed installation in a suitable rack that can be floor mounted. The dimensions of the OPS shall allow for the equipment to be transported through the normal access points of the building during installation.

5.1.3 Main environmental characteristics

The equipment shall conform to grade A of CSE -1154 -001 CAT E48 for temperature, humidity, vibration, electromagnetic radiation and electromagnetic susceptibility.

5.1.4 Performance characteristics

The OPS shall receive Train Alarm Information from the FCS's using a standard communication medium, protocol and format as described in the interface paragraph Field Concentrator System (FCS) to Office Processing System (OPS) communication. Completeness of the information received shall be verified by the OPS using suitable communication validation algorithms.

The OPS shall receive Train Condition Information from the FCS's using a standard communication medium, protocol and format as described in the interface paragraph Field Concentrator System (FCS) to Office Processing System (OPS) communication. Completeness of the information received shall be verified by the OPS using suitable communication validation algorithms.

The OPS shall obtain train composition information from the SPRINT interface server and link it with the train condition information and train alarm information received from the the FCS's, unless train composition has already been added at the FCS or the system is configured not to obtain train composition for that site.

Obtaining train composition information from the SPRINT interface server shall be a configurable option per condition monitoring system to accommodate the various methods of obtaining train composition.

The OPS shall store the system composition in a parent-child relationship. The naming convention of all the subsystems shall be as follow:
OPS: VHX (a CTC abbreviation)
FCS: VHX.COM (a CTC abbreviation followed by a monitoring site, separated with a full stop)
Monitoring system: VHX.COM.HBD.01 (a CTC abbreviation followed by a monitoring site followed by a measurement type followed by a unique number, all separated with a full stops).

The OPS shall store all the configuration parameters for itself and all its subsystems (FCS's and condition monitoring systems). These shall include system composition, communication set-up parameters, measurement specific parameters, criticality status, maintenance cycles, etc.

The OPS shall have a configurable Alarm Responsible Person Register of all the responsible persons for the processing of an alarm condition. The contents of the Alarm Responsible Person Register shall be:

- Subsystem ID
- Direction of travel
- Severity rating
- Applicable operational alarm terminal for train condition alarms
- Applicable rolling stock maintenance alarm terminal for train condition alarms
- Applicable operational alarm terminal for critical system failures
- Information of personnel to contact
  - Name and surname
  - Department
  - Telephone numbers (work, home, cell, fax)
  - Email address

It shall be possible to root critical system failures to a different operational alarm terminal than the one used to communicated train condition alarms too.

The OPS shall have a configurable Equipment Maintenance Technician Register of all the responsible persons for the processing of system failures. The contents of the Equipment Maintenance Technician Register shall be:

- Subsystem ID
- Information of technician
  - Name and surname
  - Department
  - Telephone numbers (work, home, cell, fax)
  - Email address
- Applicable operational alarm terminal (if subsystem is a critical system)

The OPS shall have a configurable User Registry of all the users with access to the system. The content of the User Registry shall be:

- Sign-on name
- Name and surname
- ID number
- Business unit

- Department
- Password
- Office address
- Telephone number
- Fax number
- Cell number
- Email address
- Type of user (manager, client, other)
- User access rights
  User rights shall be configurable for each individual user by the system manager. Possible authorisations shall be No Access (Default setting), Read only and Full Read and Write Access. Authorisation shall be given for the following:
  - Measured condition and alarm values (Read only in all cases)
  - Alarm limits
  - Absolute minimum and maximum values
  - Severity ratings
  - Measurement point configuration settings
  - System configuration settings

The OPS shall generate automatic email reports on condition and alarm information. These reports shall be configurable with the following options:

- Condition monitoring system ID or group of specific type of condition monitoring systems
- Recipient's email address
- Type of information (condition, alarm, condition within preset limits)

The OPS shall determine the responsible person to inform when receiving alarm information by using the site ID, measurement type, direction of travel and severity rating of the alarm.

The OPS shall communicate high priority (Stop immediately and Continue to next station) train condition alarms to the operational alarm terminal identified in the Alarm responsible person registry. This information shall be communicated to the operational alarm terminal the moment it is received from the FCS. Information communicated will be updated on the operational alarm terminal as additional information such as wagon numbers is obtained.

The OPS shall communicate low priority (Continue to depot) train condition alarms to the rolling stock maintenance alarm terminal identified in the Alarm responsible person registry. This information shall be communicated to the operational alarm terminal the moment it is received from the FCS. Information communicated will be updated on the rolling stock maintenance alarm terminal as additional information such as wagon numbers is obtained.

The OPS shall verify the username and password of all users logging on to the system to determine their authorisation profile. The OPS shall issue a message to notify the user if access is denied. If a valid user enters the incorrect password three times he shall be barred from the system. The system manager shall be the only means of restoring the user's access to the system.

The OPS shall store a routine maintenance schedule for itself and all the subsystem connected to it. The schedule can be based on either elapsed time since last maintained or a certain number of trains passed a monitoring point or a certain number of axles past the monitoring point.

The OPS shall automatically determine when routine maintenance needs to be done, using the current date/time and maintenance schedule and then inform the responsible system technician (determined from the equipment maintenance technician registry) by email.

The OPS shall automatically send email to the responsible technician when corrective maintenance on monitoring equipment is required. The responsible technician shall be identified using the monitoring system ID and the equipment maintenance technician registry.

The OPS shall determine which subsystems are critical systems. This shall be done as follows. If a condition monitoring system is marked as critical in the system, the OPS shall automatically mark all subsystems and interfaces in the path from condition monitoring system to operational alarm terminal as critical. This functionality shall be real-time, ie. marking a condition monitoring system as critical or not shall have an immediate effect on the criticality status of the other subsystems and interfaces in the alarm condition communication path.

The OPS shall have sufficient selfcheck procedures to verify the functionality of the system. Selfcheck procedures shall not influence the normal operation of the system. Any selfcheck failures shall be recorded in an event log and the responsible technician notified using email and also displayed on the manager/technician terminal. In the case of a critical system failure, a responsible person, who is available 24-hours a day shall also be notified using the operational alarm terminal identified in the Alarm responsible person registry. In case of an operational alarm terminal failure, the critical system failure shall be reported to all other operational alarm terminals in that CTC centre.

The OPS shall attach appropriate maintenance manuals in the emails for corrective and routine maintenance. Spoornet shall supply these manuals for all subsystems outside the system.

The OPS shall update the SPRINT interface server if train composition information is received from the FCS. The format and protocol is described in detail in the interface paragraph “Office Processing System (OPS) to SPRINT interface server communication”

5.2 Field concentrator system (FCS)

5.2.1 Description

The Field Concentrator System (FCS) collects the train condition and alarm information from each of the monitoring systems. The FCS also receives train composition information from an AVI reader when it is so configured. The train condition, train alarm and train composition information is then processed and send to the OPS.

The FCS shall generate alarm information for a particular monitoring system if the monitoring system does not provide the alarm information.

The FCS receives configuration parameters from the OPS for use by the FCS or transmission to the monitoring systems. It also receives configuration parameters from the monitoring systems and transmits it to the OPS for storage.

To make use of the multi-drop functionality that certain condition monitoring systems offer, it shall be possible to have the FCS at a CTC centre from where it will be connected to condition monitoring systems using modems. It shall however also be possible to install the FCS in the field next to the condition monitoring systems.

5.2.2 Physical characteristics

The FCS shall be located in a relay room, equipment container or office environment. The FCS shall be a fixed installation in a suitable rack that can be floor and wall mounted. The dimensions of the FCS shall allow for the equipment to be transported through the normal access points of the installation site during installation.

5.2.3 Main environmental characteristics

The equipment shall conform to grade C of CSE -1154 -001 CAT E48 for temperature, humidity, vibration, electromagnetic radiation and electromagnetic susceptibility.

5.2.4 Performance characteristics

The FCS shall receive train condition information and train alarm information from the various monitoring systems. The format and protocol for receiving this information is described in detail in the interface paragraph "Field Concentrator System (FCS) to condition monitoring systems"

The FCS shall receive train composition information from an AVI reader. This functionality shall be configurable to allow for sites with AVI readers and sites without it. The information provided by the AVI reader shall be:

- Date/time
- Error codes
- 16 digit train number
- An entry for each vehicle containing vehicle position, vehicle orientation and vehicle number. The fields are to be comma delimited.

The format and protocol for receiving this information is described in the interface paragraph "AVI reader to Field Concentrator System (FCS)

The FCS shall communicate the information received (train condition, train alarms, system failure alarms and train composition) to the OPS. The format and protocol for transmitting this information is fully described in the interface paragraph "Field Concentrator System (FCS) to Office Processing System (OPS)". Information transmitted successfully can be discarded.

The FCS shall always have a primary communication medium. A secondary communication medium shall be allowed for, but be configurable per FCS.

In the case of a primary communication medium failure, the FCS shall invoke the secondary communication medium if it is configured to have one. If successful, the information shall be communicated and a system failure logged. In case of a communication failure between the FCS and the OPS, sufficient non-volatile memory must be provided in the FCS for the storage of all information for a maximum period of three days. Information older than three days can be discarded.

The OPS shall communicate configuration parameter changes to the FCS whenever the system manager makes changes. The format and protocol is described in detail in the interface paragraph "Office Processing System (OPS) to Field Concentrator System (FCS) communication".

The FCS shall update the configuration parameters in the condition monitoring systems when it is received from the OPS. The format and protocol is described in detail in the interface paragraph "Field Concentrator System (FCS) to condition monitoring systems".

The FCS shall receive configuration parameters from the condition monitoring systems whenever it is updated in the condition monitoring system. The format and protocol is described in detail in the interface paragraph "Field Concentrator System (FCS) to condition monitoring systems".

The FCS shall communicate the configuration parameters received from the condition monitoring systems to the OPS. The format and protocol is described in detail in the interface paragraph "Office Processing System (OPS) to Field Concentrator System (FCS) communication".

The FCS shall receive selfcheck requests from the OPS. The format and protocol is described in detail in the interface paragraph "Office Processing System (OPS) to Field Concentrator System (FCS) communication".

The FCS shall have sufficient selfcheck procedures to verify the functionality of the FCS and it's subsystems. Selfcheck procedures shall not influence the normal operation of the system. All selfcheck results shall be recorded and communicated to the OPS.

The FCS shall request a selfcheck of the condition monitoring system. The format and protocol is described in detail in the interface paragraph "Field Concentrator System (FCS) to condition monitoring systems".

The FCS shall receive selfcheck reports from the condition monitoring systems. The format and protocol is described in detail in the interface paragraph "Field Concentrator System (FCS) to condition monitoring systems". The selfcheck result shall be logged.

Selfcheck results shall be communicated to the OPS from the FCS. The format and protocol is described in detail in the interface paragraph "Office Processing System (OPS) to Field Concentrator System (FCS) communication".

The FCS shall receive a train present indication. The format and protocol is described in the interface paragraph "Field Concentrator System (FCS) to Train Presence Detector (TPD) communication. This functionality shall be configurable to allow for sites with train presence detection and sites without it.

The FCS shall receive a train number within 30 seconds after the lead locomotive has passed the monitoring point. The format and protocol is described in the interface paragraph "Field Concentrator System (FCS) to Train Identification System (TIS) communication. This functionality shall be configurable to allow for sites with train presence detection and sites without it. If a train number is received, the FCS shall combine the train number with the train condition and train alarm information before communicating it to the OPS. If no train number is received, the FCS shall send the train condition and train alarm information without a train number.

It shall be possible to configure a condition monitoring systems as a critical system in the integrated train condition monitoring system. Normally, a critical system is a condition monitoring system that generates "Stop immediately" condition alarms. For a critical system, the integrated train condition monitoring system shall continuously check all subsystems and interfaces in the path between the condition monitoring system and the operational alarm terminal. Any failures of these subsystems or interfaces shall immediately be reported to a configured operational alarm terminal.

The FCS shall receive the current date/time from the OPS. The format and protocol is described in detail in the interface paragraph "Office Processing System (OPS) to Field Concentrator System (FCS) communication".

In order to synchronise time, the FCS shall update the date/time on the FCS and on all the condition monitoring systems (with date/time update functionality) attached to it. The format and protocol is described in detail in the interface paragraph "Field Concentrator System (FCS) to condition monitoring systems communication".

5.3 Operational alarm terminal (OAT)

5.3.1 Description

The operational alarm terminal (OAT) shall be a man-machine interface located in the CTC's where the train control officer (TCO) has access to it. Condition alarms with high severity (Stop immediately and Continue to next station) shall be reported to this terminal. The TCO shall then acknowledge the alarm and initiate procedures to deal with the alarm. The TCO shall then obtain feedback from the maintenance person/s involved and enter it into the system. Critical system failures shall also be reported to this terminal. The responsible person shall acknowledge the failure and initiate corrective action.

5.3.2 Physical characteristics

The OAT shall be located in an office environment. The OAT shall be a fixed installation in a suitable rack that can be floor mounted. The dimensions of the OAT shall allow for the equipment to be transported through the normal access points of the building during installation. The OAT shall be designed for ergonomics.

5.3.3 Main environmental characteristics

The equipment shall conform to environmental grade A of CSE-1154-001 Cat E48 for temperature, humidity, vibration, electromagnetic radiation and electromagnetic susceptibility.

5.3.4 Performance characteritics

The OAT shall display condition alarms with a high severity (Stop immediately & Continue to the next station). The information to be displayed can be divided into 3 section:

- Train related information
  - Date/time the alarm occurred
  - Train number
  - Measurement site identification
  - Direction of travel
  - Most severe type of alarm (Hot bearing, flat wheel, etc)
  - Severity
- Alarm related information for the train
  - Measurement system
  - Type of alarm
  - Severity
  - Vehicle position in the train
  - Alarm position on the vehicle (Bogie 1, Axle 3, etc)
  - Side (If applicable)
  - Measurement value 1
  - Measurement value 2 (if applicable)

- Action to be taken and responsible persons to contact

There shall be only one entry per train per measurement site in the train related information irrespective of the number of alarms on the train. This requirement is to provide focused information to the TCO in order for him to take action (ie. either stop the train or inform the driver to continue to the next station with caution) which shall be his first priority. Only after he has stopped the train or taken action, shall he look at the alarm details for the train.

Alarms with different severity ratings shall be displayed with different background colours. "Stop immediately" alarms shall have a red background, "Continue to next station" alarms shall have a yellow background and "Continue to depot" shall have a white background.

The TCO shall acknowledge all train condition alarms using his username and password. The date/time and who acknowledged the alarm shall be communicated to the OPS for storage. In the case where the OPS is unavailable, the information shall be stored locally on the alarm terminal until such a time it can be communicated to the OPS.

The OAT shall have an audible alarm to draw the TCO's attention to the train condition alarm. This audible alarm shall be silenced when the alarm is acknowledged by TCO.

The TCO shall clear the alarm once feedback from the maintenance personnel attending to the problem has been obtained. The TCO shall be able to enter the following information into the system:

- Maintenance technician that attended to the alarm
- Valid alarm / false alarm
- Permanent fix / temporary fix
- Vehicle removed (Yes/no)
- If removed, where (Pull down list of stations)
- Comment

In addition, the system shall log the date/time and identification of the person entering the information. This information shall be communicated to the OPS for storage. In the case where the OPS is unavailable, the information shall be stored locally on the alarm terminal until such a time it can be communicated to the OPS.

The OAT shall display critical system failures. Information to be displayed is:

- Subsystem ID
- Description of failure

The responsible person shall acknowledge the critical system failure using his username and password. The system shall log the date/time and identification of the person acknowledging the alarm. This information shall be communicated to the OPS for storage. In the case where the OPS is unavailable, the information shall be stored locally on the alarm terminal until such a time it can be communicated to the OPS.

Critical system failures shall be reported once and thereafter on a 12 hourly basis until such time as the subsystem is functional again. This time period shall be configurable but not exceed 12 hours.

The operational alarm terminal shall be configurable to display

- Both train condition alarms and critical system failures
- Display only train condition alarms
- Display only critical system failures

5.4 Rolling stock maintenance alarm terminal (MAT)

5.4.1 Description

The Rolling stock maintenance alarm terminal (MAT) shall be a man-machine interface located in the maintenance depot. All condition alarms shall be reported to this terminal. The maintenance technician shall then acknowledge the alarm and initiate procedures to deal with the alarm. The maintenance technician shall also enter feedback on the alarm into the system.

5.4.2 Physical characteristics

The OAT shall be located in an office environment. The OAT shall be a fixed installation in a suitable rack that can be floor mounted. The dimensions of the OAT shall allow for the equipment to be transported through the normal access points of the building during installation. The MAT shall be designed for ergonomics.

5.4.3 Main environmental characteristics

The equipment shall conform to environmental grade A of CSE-1154-001 Cat E48 for temperature, humidity, vibration, electromagnetic radiation and electromagnetic susceptibility.

5.4.4 Performance characteristics

The MAT shall display all condition alarms. The information to be displayed can be divided into 3 section:

- Train related information
  - Date/time the alarm occurred
  - Train number
  - Measurement site identification
  - Direction of travel
  - Most severe type of alarm (Hot bearing, flat wheel, etc)
  - Severity
- Alarm related information for the train
  - Measurement system
  - Type of alarm
  - Severity
  - Vehicle position in the train
  - Alarm position on the vehicle (Bogie 1, Axle 3, etc)
  - Side (If applicable)
  - Measurement value 1
  - Measurement value 2 (if applicable)

There shall be only one entry per train per measurement site in the train related information irrespective of the number of alarms on the train. The detail of the alarms on the train shall be listed in the alarm related information section.

Alarms with different severity ratings shall be displayed with different background colours. “Stop immediately” alarms shall have a red background, “Continue to next station” alarms shall have a yellow background and “Continue to depot” shall have a white background.

The maintenance technician shall acknowledge all train condition alarms using his username and password. The date/time and who acknowledged the alarm shall be communicated to the OPS for

storage. In the case where the OPS is unavailable, the information shall be stored locally on the alarm terminal until such a time it can be communicated to the OPS.

The maintenance technician shall provide feedback on the alarm using the rolling stock maintenance alarm terminal. The maintenance technician shall be able to enter the following information into the system:

- Maintenance technician that attended to the alarm
- Valid alarm / false alarm
- Permanent fix / temporary fix
- Vehicle removed (Yes/no)
- If removed, where (Pull down list of stations)
- Comment

In addition, the system shall log the date/time and identification of the person entering the information. This information shall be communicated to the OPS for storage. In the case where the OPS is unavailable, the information shall be stored locally on the alarm terminal until such a time it can be communicated to the OPS.

5.5 Train Present Detector

5.5.1 Description

The train present detector detects if there is a train present within 10 metres of the measuring point.

5.5.2 Physical characteristics

The Train Present Detector shall be located in a relay room or an equipment container environment. The Train Present Detector shall be a fixed installation in a suitable rack that can be floor or wall mounted. The dimensions of the Train Present Detector shall allow for the equipment to be transported through the normal access points of the installation site during installation.

Any equipment mounted outside the relay room or equipment container shall be in a suitable cabinet or apparatus case and mounted clear of the minimum structure gauge as defined in the Permanent Way Instructions, quote in section 2.1.1.

5.5.3 Main environmental characteristics

The equipment shall conform to environmental grade C of CSE-1154-001 Cat E48 for temperature, humidity, vibration, electromagnetic radiation and electromagnetic susceptibility.

5.5.4 Performance characteristics

The train present detector shall determine if a train is present at the measurement point or within 10m on either side of the measurement point.

The train present detector shall provide two isolated real-time indication (present or not present) to the vehicle identification system (VIS) and the field concentrator system (FCS) respectively. The format and protocol for providing this indication is described in detail in the interface paragraphs 3.3.3 “Train present detector (TPD) to field concentrator system (FCS)” and paragraph 3.3.4 “Train present detector (TPD) to vehicle identification system (VIS) communication”.

6 GENERAL REQUIREMENTS

6.1 Design and construction

6.1.1 Nameplates and markings

All hardware shall be equipped with durable manufacturer's nameplates bearing at least unit identification, the manufacturer's name, date of manufacture, a serial number, revision number with the current revision status marked, operating voltage and power requirements.

6.1.2 Materials and parts

All materials and parts used in the system and sub-systems shall be at least industrial grade.

6.1.3 Reliability

Mean time between failure for any electronic component shall not be less than 12 months.

6.1.4 Workmanship

Suitably skilled personnel shall do installation. Quality of workmanship shall be to an acceptable level for Spoornet.

6.1.5 Interchangeability

Equipment shall be modular and components performing similar functions shall be interchangeable as far as possible.

6.1.6 Safety

All work shall be conducted within the regulations stipulated in ACT 85 of 1993 (Occupational Safety Act) of South Africa or the latest revision. All track side work shall be done in accordance with safety procedures laid down by the by Regional Maintenance manager. All work on rolling stock shall be done in accordance with safety procedures laid down by the Regional Rolling Stock Manager.

6.2 Documentation

The system and its sub-systems shall be fully documented in English in compliance with Infrastructure (Signals) standard specification no. CSE-1159-001 Cat. E48. The list of documents that shall be supplied and their contents is described in Standard Specification CSE-1159-001 Cat. E48. In addition to the requirements of standard specification no. CSE-1159-001 Cat. E48, the technical documentation shall contain all the relevant information of the interfaces to the system. It shall include a full description of the hardware, protocols and message contents used on all interfaces. This shall be adequate to enable the technical staff of SPOORNET to be able to interface with the system for purposes of upgrading the integrated train condition monitoring and vehicle identification system, extraction of information or integration into existing infrastructure systems. All software used by the system to be fully documented, unless it is of the shelve software or the information deemed propriety. The software shall be supplied with the source code and all the compiling software required to produce executable system software unless it is off the shelve software. All code and compiling software shall become the property of Spoornet, unless it is of the shelve propriety software.

6.3 Logistics

6.3.1 Maintenance

Preventative maintenance shall be reduced to the minimum. Any required preventative maintenance shall be clearly defined in the maintenance documentation. Preventative maintenance on track-

mounted, trackside, locomotive and office equipment shall not be required more than once in six months. During preventative maintenance, any component on site shall not require more than 30 minutes of work, averaged over the whole installation for one maintenance cycle. An Engineering Technician shall execute first line maintenance with specific training in the functional operation of the system at unit level. An Engineering Technician shall execute second line maintenance with specific training in the operation of the system at component level. The level of support available after installation shall be clearly indicated.

6.3.2 Supply

Procurement shall be through the standard TRANSNET procedures for the purchase of Railway Signalling Material. The supplier shall guarantee availability of all components of the system, as well as frequently used spares of the components, for a contractually specified period of at least 10 years. The supplier shall guarantee delivery of replacement components or spares for faulty items within 4 weeks of placement of the order. Components that are critical to the functioning of the system shall be available immediately.

6.3.3 Facilities and equipment

Existing facilities for storage and repair will be used.

6.4 Personnel and training

6.4.1 Personnel

Skilled technicians or semi-skilled maintainers will do first line maintenance. This staff will generally not be computer-literate. Highly skilled electronic technicians will do second line maintenance. They will be computer literate. Highly skilled electronic Technicians (T3/S4), Technologists or an Engineer will do third line backup. This staff will have a high level of computer literacy.

6.4.2 Training

The supplier shall provide hands-on training in all aspects of operation of the system to a core group of approximately 15 people. Course duration shall be not more than one week. The supplier shall provide theoretical and practical training in all aspects of first and second line maintenance to a core group of approximately 15 technicians and trainers. The training shall be full-time, lasting not more than two weeks. The supplier shall provide extensive theoretical and hands-on training covering the entire system (including software) to a group of third line technicians and/or technologists and/or engineers (not exceeding 10) from the Engineering department.

6.5 Precedence

Not applicable

7 Quality assurance

7.1 Responsibility of tests

The contractors shall be responsible for the execution of the tests. The minimum tests to be performed shall be determined by mutual consent between Spoornet and the supplier. The responsibility for proving the test results shall reside with the contractor. The tests and test results shall be documented in full by the contractor. All tests shall be observed by SPOORNET. Any tests requiring the use of rolling stock shall be arranged by SPOORNET.

7.2 Tests and examinations

A test procedure to test the functionality of the system using a holistic approach shall be drawn up by the contractor. The tests shall trace the flow of information to and from the various subsystems to ensure the correctness of information throughout the system. The tests shall firstly verify correct operation under normal conditions. The tests shall then be repeated using data with known fault content to verify the operation under fault conditions.

The test procedure shall be documented by the contractor in an Acceptance Test Procedure (ATP) document. This ATP shall then be presented to Spoornet for approval. The contractor shall make any changes to the ATP, deemed necessary by Spoornet. Once approved, this ATP, together with the System Specification will be used to determine system compliance during commissioning.

8 Preparation for delivery

Not applicable

9 Notes

9.1 Glossary

OPS	: Office Processing System
FCS	: Field Concentrator System
VIS	: Vehicle Identification System
OAT	: Operational Alarm Terminal
MAT	: Maintenance Alarm Terminal
TPD	: Train Presence Detector
ATP	: Acceptance Test Procedure

9.2 Conventions

Vehicle	: Vehicle refers to a rail vehicle, which can be either a locomotive or a wagon.
Vehicle list	: A list containing a vehicle position in the train and the vehicle number.
Vehicle information	: Information such as vehicle type, bearing type etc.