

Clause No.	Description	KRCL	Eastern Railway	SEZ	NWR	WR	WCR	SCR	ECR	Motive Power Div./RDSO	Wabaco	Vocastep	Progress Rail	ApraTech	Carri Solutions	Novus Technologies	ITSS comments	Tecstra Technologies	ET Khargapur	ET/Rooske	Remarks from RDSO																											
2.3	The system should be capable of automatic detection of approaching train along with identification of type of rolling stock (Locomotives, Wagons, ICF or LHB Coach, BV, etc.) automatic measurement of relevant sensors, automatic measurement of vehicle number and temperature while the train is in motion, automatic transmission of data, alarms and reports and automatic archiving of relevant sensors to conserve electrical power.					The system should be capable of further automatic detection of vehicle number and particular bearing / frame disc wheel axle.		The system shall be capable to differentiate WAG 12B (at axle with conventional Loco 9 axle)			No change. Question: The Specification does not provide information on how this functionality is to be achieved. RDSO should clarify what mode of detection shall be considered for representation of the requirement. For instance, can the suppliers consider that there be RFID tags fixed to the axles?	Partially compliant, train or wagon type recognition is done by calculating the axle distances. If no RFID system is installed, please refer to para 2.6 for explanation regarding the archiving of relevant sensors.			Comply	ok						WR: Please refer clause 3.15. SCR: Clause 3.1 clearly defines the requirement of compatibility of system for various types of rolling stocks based on ICF. Wabaco: Identification of type of rolling stocks (Locomotives, wagons, ICF or LHB Coach, BV, etc.) may be done by calculating axle distances and torque wheel base. Vocastep: Presence of brake disc may be assured by identifying type of rolling stocks based on axle distance. As already mentioned in the data, this may be suitably termed at the processing stage to avoid confusion in reporting. ET Khargapur: Requirement already defined.																										
2.4	The bidder should refer typical track profile - As per RPWM 2004 amended from time to time. The bidder shall acquire terrain with the existing track geometry, installation site before offering the system.														Comply	ok					SCR: Agreed with remarks. New clause 5.4 for "Site Selection Criteria" has been included in the specification.																											
2.16	The relevant National/international standards are given below. The equipment should conform to the relevant clauses of the applicable standards.																				"Certification for conformance shall be submitted" has been included in para 2.17																											
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2.18	The system should be modular and remotely maintainable.																				No comments																											
2.17	The system should be equipped with robust, networked, alarm-management software which suite of graphical analysis and diagnostic tools. All TCP/IP support should be built into the system to facilitate smooth integration into an existing railway data network.																				WR, Novus Technologies: For smooth integration and analysis provision for their proprietary integration is already in the specification. Therefore, all hardware detectors may be integrated on a platform. ET Khargapur: Requirement already defined.																											
2.19	The system should be able to withstand shock and vibration generated/produced during train operation.																				No remarks have been received or clarification sought																											
2.19	The system should have provision for interfacing with RFID based automatic vehicle identification module																				SCR: WCR is in process of professional of RFID vehicle identification which is more accurate and reliable than PWS/Concom based identification. Reliability of PWS system is not too high as per clause 7.05. Therefore, no change required. Tecstra Technologies: It is in process of professional of RFID. After professional vehicle identification will be done automatically.																											
2.20	The system should have capability to integrate with 3rd party system for which hardware control software (HCS) may be provided by Indian railways. Firm will supply the ICD for the relevant system to the Indian railways.																				No comments																											
3.0	Functional requirements:																																															
3.1	Train parameters to be acquired - Temperature of axle boxes, wheels rim and brake disc and speed of a wheel set of identified stock.										Measurement of temperature of MSU bearing may be included under train parameters to be acquired.										Motive Power Div.: System is intended to measure axle box bearing and brake disc, wheel rim/brake temperature. Therefore measurement of temperature of MSU bearing may not be included at this point.																											
3.2	System shall log the date of train passing, time of train passing, speed of train, number of axle passed, total number of vehicles in the rake and type of stock.																				NWR: Direction of movement of train has already been covered in clause 2.8.6 of output requirement. However, as suggested the same has been included here and modified clause is as under: "System shall log the date of train passing, time of train passing, speed of train, direction of train, number of axle passed, total number of vehicles in the rake and type of stock and ambient temperature."																											
4.0	Scope of supply:																				Carri Solutions: Agreed with remarks. The clause has been included as under: "The HAWW system shall be supplied on turnkey basis. The HAWW system shall include all equipment for the site of the track, electric cables, sensor computer, website, client computer/tablet, modem, SMS delivery system, software of the track site equipment and software of the central server and any other element necessary for optimal functioning of the system. The scope shall include complete HAWW site equipment along with consumable accessories, maintenance tools etc. for full functioning of system."																											
4.1	Installation at site - Installation of the system should be done by and under the supervision of firm's Engineers. It shall include the following:																				No Comments																											
4.1.1	Provision of substructure to house accessories/ auxiliaries to be installed at site along with the supplied systems within the scope of supply of supply.																				No Comments																											
4.1.2	Laying of power cables including trenching & associated works from the site to the main power distribution box where the consignee has made the availability of electrical power of 230 V, 50 Hz ac. The length of cable will depend upon the distance between location of equipment and the site of main power distribution box.										At the railway assets like DBT cables and location boxes are to be taken care of while laying power cables.										SCR: Requirement already defined. No change required. Vocastep, Carri Solutions, Novus Technologies: For better clarity on the length of cable, new clause 5.4 has been included in clause 4.1.2 reworded as under: "Laying of power cables including trenching & associated works from the site to the main power distribution box where the consignee has made the availability of electrical power of 230 V, 50 Hz ac."																											
4.1.3	Provision of internet connection for transfer of data and display of reports and audio-visual alarms from site of installation to centralized location (as decided by consignee of concerned division of Indian Railways). The recurring expenditure on internet connectivity during warranty from the date of commissioning.										Provision of internet connection for at least two locations of the system as 4G/5G network connection for the system as well as internet connection shall be provided as well as OPC connection for data and display of reports from site of installation to centralized location.										SCR: SCR: To ensure communication of alarms and detailed reports to central server system from remote sites, number of mobile connections and network selection internet connection whether 3G/4G/5G and OPC connection has been left on supplier. The site shall log into the website for necessary reports and alarms. Dedicated communication channels to centralized control appear reasonable and acceptable. NWR: Divisonal Rly staff shall be trained for disassembling and re-assembly of the system. 40 man-days of training on site in disassembled installation has been provided. Novus Technologies: It is the responsibility of supplier to arrange internet connectivity by suitable means to ensure communication of alarms as stipulated in the clause. Zonal Rly may include an ILMC provision. For better clarity, the clause has been reworded as under: "4.1.3 The installed system should be capable of transferring data from the HAWW site in real-time via available cable or wireless." 4.1.4 Post-protection display of reports and audio-visual alarms from site of installation in centralized location/response centers should be designed for the consignee. The internet connectivity during warranty from the date of commissioning shall be in the scope of contractor's biller.																											
4.2	Web-server - The supplier shall search and maintain an internet web-server at any location in India with following features:																				No comments																											
4.2.1	Multiple User password protected login																				No Comments																											
4.2.2	Differential access and usage rights to multiple level of users e.g. write-only, read-only, administrative rights																				No Comments																											
4.2.3	Facility to export data in other data base formats e.g. MS-Excel and XML.										Exported data should match the web data for correct date and numbers of axle and wheels.										SCR: Requirement already defined in output requirement. The clause has been reworded as under: "Facility to export data in other data base formats e.g. MS-Excel and XML, and of different software based format of data after railway applications. Firm shall also provide ICD (interface control document) for system database."																											
4.2.4	Adequate capability to handle data transfer for all authorized users (to be controlled by providing usernames and password) who shall access through public internet.																				No Comments																											
4.3	Ownership and confidentiality of data and software: All the data being generated by the HAWW equipment, website, servers etc. with respect to Indian Railway operations shall be the property of Indian Railways.																				No Comments																											
4.3.1	The data shall be compiled, stored in a medium, transferred and made available in a format as finally decided by Indian Railways in consultation with final supplier preferably in MS-Excel or present but other formats may be accepted later by consignee if found suitable.																				Clause redefined as under: "The data shall be compiled, stored in a medium, transferred and made available in a format as finally decided by Indian Railways in consultation with final supplier in suitable database (responsive to MS-Excel or present but other formats may be accepted later by consignee if found suitable). Data Localization rules of the government of India shall be applicable for the system."																											
4.3.2	The data shall not be divulged by the supplier to anyone other than consignee and to those authorized by consignee.																				No Comments																											
5.0	Installation requirements:																																															
5.1	The HAWW system shall not infringe dimensions as per envelope drawing given in annexure-I.																				Comply																											
5.2	AC power 230V, 50 Hz, shall be made available at installation site by consignee. The maximum load on the power supply system shall not exceed one KVA.										For seamless working of HAWW, AC power supply should be made available through AT supply (DHE supply) instead of Direct track electric supply to avoid any power cut problem.										Comply																											
5.3	UPS system having at least 8 hours backup power.																				Comply																											
6.0	Software requirements:																																															
6.1	The database equipment shall have the capability to record and locally store raw captured data for last up to 500 trains and the processed reports for up to 5000 trains.																				Comply																											
6.2	The supplier shall be responsible for providing required software for collecting data, storage and presentation of reports sent by the trackside equipment.																				Comply																											
6.3	The database equipment shall have the capability to record and locally store raw captured data for last up to 500 trains and the processed reports for up to 5000 trains.																				WR, WCR: Raw captured data for last up to 500 trains and the processed reports for up to 5000 trains will be stored locally at site. However, data for last 5 years will be available on web server as per Clause 6.1. Therefore, no change required.																											
6.4	The supplier shall be responsible for providing required software for collecting data, storage and presentation of reports sent by the trackside equipment.																				WR: Trending/History of temperature of axle bearing/wheel/rail/brake disc of identified vehicle from all the hot box detectors in Indian Railway can be shown only after interfacing of system with RFID. Since, HAWW system has provision for RFID interface. Therefore, after professional of RFID which is in process and done by R, history of temperature may be seen. The clause has been reworded as under: "The supplier shall be responsible for providing required software for collecting data, storage and graphical and tabular presentation of reports sent by the trackside equipment. The database management shall also be done by the supplier of regular intervals."																											

Reasoned Document Based on Comments Received from Zonal Railways, Academics & Firms for Draft Specification of Hot Axle Box Heat Detector (HAHW) System																				
Clause No.	Description	KRCL	Eastern Railway	SER	NWR	WR	WCR	SCR	ECR	Mumbai Power Co./RDSO	Wabtec	Comments Received from Zonal Railways, Academics & Firms				Remarks from RDSO				
												Voespa	Progress Rail	ApnaTech	Carri Solutions	Novax Technologies	ITSS comments	Tecstra Technologies	ET Kharigpur	ET/Roorkee
7.0	Safety Requirements: The equipment shall not fail on wrong side due to harmonic interference generated by traction, chopper controlled by charger drives or other such technologies in locomotives.		In any condition system should not hamper signaling track circuit.	Adequate protection (Surge Protection Device) against electrical surges arising from high voltage traction systems, low impedance and lightning should be provided to avoid electromagnetic interference of the system.				Safety and Security As the Charger is provided to monitor safety of the Rolling Stock, installed at track side which is prone for theft, it is required that there shall be a Mechanism to ensure security of the gadget. In this regard it is suggested that provision of surveillance camera by the supplier may be incorporated.				Compliant				Comply	OK			E, Ry, SER, SCR, ET Roorkee: Agreed with remarks. Clause 7.0 Safety requirement mentioned as under: The system shall be designed in fail-safe principles and adequate safety margins must be incorporated in the design for systematic and random operations. HAHW system shall not adversely due to any type of fault (a hardware, software, electrical, electromagnetic, etc. in the system, or other systems, or danger to personnel. The spark may become a new hot source which could be far hotter than bearing. Hence, the temperature value may be very high and this could lead to a false alarm.
8.0	Cloud requirement: The supplier shall launch, operate and maintain an internet-based website during warranty and during comprehensive maintenance period for making available train reports to remote users authorized by consignee. The website shall have the following features:-			Software should have provision of strong and encrypting the data pending to being stored generating alarms as well as action taken report by the maintenance depot. There should be no option of editing the readings recorded by the equipment.				The supplier shall launch, operate and maintain an internet based website in Secure Hypertext transfer protocol (HTTPS) instead of HTTP.				Compliant, if requested PHOENIX CMS Central Management Software will be included in the offer.				Comply	OK		IoT provision may be requested to be able to access the data from anywhere.	SER: Provision for password based access to enter/view/download data and reports to authorized users has already been included in clause 8.1.1 & 8.1.2. No change required. SCR, ET Kharigpur: Provision to be secured access to the data through web from anywhere has already been defined under clause 8.11.
8.1.1	Password based access to the only authorized personnel by consignee can download/view/download data and reports.											Compliant, if requested PHOENIX CMS Central Management Software will be included in the offer.				Comply	OK		No comments	
8.1.2	Differential privileges to different levels of users to access the resources of the website.											Compliant, if requested PHOENIX CMS Central Management Software will be included in the offer.				Comply	OK		No comments	
8.2	The supplier shall supply a desktop computer laptop at minimum price by consignee of the configuration as specified in the clause on concomitant accessories.											Compliant, if requested desktop computer can be supplied.				Comply	OK			NWR: Additional display if required can be provided by the Zonal railways.
8.3	The system output shall consist of data reports. Data acquired by the system shall be sent to a web server and the following reports shall be available to the users on demand.											Compliant, if requested PHOENIX CMS Central Management Software will be included in the offer.				Comply	OK		No comments	
8.4	Disabled report: This report shall be in detail showing all parameters as acquired by the sensors through detector.											Compliant, if requested PHOENIX CMS Central Management Software will be included in the offer.				Comply	OK		No comments	
8.5	Exception report: This report shall be an abridged version of the disabled report showing only the list of axes where the parameters have exceeded the prescribed limits.											Compliant, if requested PHOENIX CMS Central Management Software will be included in the offer.				Comply	OK		No comments	
8.6	Alarms report through SMS: Reports for alarms based on parameters exceeding the prescribed limits shall be sent to users through SMS. In case of delay in transmission of full reports, the system shall have the capability to send SMS directly to limited number of users. The delay shall be deemed to have occurred if the data is not dispatched within 5 minutes from the passage of last wheel of the train.							The "prescribed limits" should be defined and there should be a mechanism to set the limit as per equipment. Minimum number of user for SMS alerts must be defined.				Compliant, if requested PHOENIX CMS Central Management Software will be included in the offer.				Comply	OK		An alert message with auto calling should be implemented as standard phone no. based on GSM technology. SER: Alert protocols to raise graded alerts will be user suitable and shall be decided by consignee as per their requirements. WCR: Consignee shall nominate authorized users for SMS facility and access of report through web. NWR: Considering the processing time for output requirements as desired in clause 8.0 of captured data for 1000 axes & network issues on remote site, time between passing of train and communication to the central control server has been kept maximum upto 5 minutes. Progress Rail: Requirement already defined. Tecstra Technologies: Audio-visual alerts, SMS facility and alerts through mobile app models are defined and sufficient for alert communications. Therefore, no change required.	
8.7	Alarms report through App: The firm should develop a mobile application for the user to get vehicle alerts along with relevant positions through push notifications.							Alert message should be delivered to users as early as possible. At present it is sent via sometimes alert message is not received even after 5-10 minutes of passing the train.				Compliant, function can be offered if requested.				Comply	OK			WCR: Considering the processing time for output requirements as desired in clause 8.0 of captured data for 1000 axes & network issues on remote site, time between passing of train and communication to the central control server has been kept maximum upto 5 minutes. Progress Rail: Mobile application should be developed for alerts as per requirement. Therefore, no change required.
8.8	Diagnostic reports: The system shall be capable of running self diagnosis programs and report the result through the website and by SMS.							The system shall have a provision to diagnose and display mechanism to identify cause of failure to analyze performance and for ease of troubleshooting.				Compliant				Comply	OK			SCR: The system is intended to measure the temperature of axle bearing and brake disc irrespective of cause of rise in temperature and this alerts as per user suitable threshold limits. Progress Rail: Provision for self diagnosis programs and report the result through the website and by SMS should be included.
8.9	Alarms: Parameters exceeding the specified limits require alarms to be sent to users. These alarms should be sent in the form of SMS. Transmission delay should not exceed 5 minutes from the passage of the last axle. The message should convey the following information: 8.9.1 Name of train 8.9.2 Direction of movement 8.9.3 Vehicle position from start of train 8.9.4 Axle number where the parameters were found out of range. 8.9.5 Short description of error code. In case of error in recording or any system failure, alarms shall be generated and transmitted similarly.						Transmission delay should not exceed 5 minutes from the passage of the last axle. Vehicle detail should be sent including the bogie, loco / coach number and axle bearing / wheel details should be captured. The system must be able to identify the vehicle location and included in the alert. 8.9.4 Side of the affected wheel (left or right side) also to be mentioned along with Axle number.					Compliant, if requested PHOENIX CMS Central Management Software will be included in the offer. 8.9.1 Compliant 8.9.2 Compliant 8.9.3 Compliant 8.9.4 Compliant				Comply	OK			NWR: Considering the processing time for output requirements as desired in clause 8.0 of captured data for 1000 axes & network issues on remote site, time between passing of train and communication to the central control server has been kept maximum upto 5 minutes. Progress Rail: Requirement already defined. WCR: System will automatically detect vehicle position, particular wheel, axle number, direction of motion, date, time etc. For vehicle identification, IR is in process of proliferation of RFID for vehicle identification. SCR: The system has provision for interfacing with RFID, therefore vehicle identification (number) will be done via RFID. Alarms: Parameters exceeding the specified limits require alerts to be sent to users. These alerts should be sent in the form of SMS message beyond the passage of the last axle of the last train. These messages will convey the following information: 8.9.1 Vehicle RFID identification (if available provided on the Rolling Stock) 8.9.2 Vehicle type 8.9.3 Date / time of train 8.9.4 Direction of movement 8.9.5 Vehicle position from start of train 8.9.6 Axle number, side of axle bearing/wheel/disc, bogie where the parameters found out of range. 8.9.7 Short description / error code as per requirement/scheme developed in case of error in recording or any system failure, alarms shall be generated and transmitted similarly.
8.10	Range of alarms: It should be possible to raise graded alarms, at least for the following conditions: 8.10.1 When the temperature of the axle box or the wheel or brake disc exceeds the specified temperature. 8.10.2 When the temperature of the axle box or the wheel or brake disc exceeds beyond a certain limit above the ambient temperature. 8.10.3 When the difference in temperature of the axle boxes on the same axle is different beyond a certain limit. 8.10.4 When the temperature of wheels or brake disc of an axle, a bogie/bogies or a vehicle exceeds the average temperature of the bogie or the vehicle beyond a certain limit. 8.10.5 In case, IR decides to include new types of alarms in the system, then supplier shall modify the software within a reasonable time at no extra cost to Indian Railways.						8.10.1 Option to set the temperature ranges should be available. 8.10.2 Feasibility to set the temperature limit should be provided. 8.10.3 Scope to set the limit should be provided. 8.10.4 Scope to set the limit should be available in software.					8.10.1 Compliant 8.10.2 Compliant 8.10.3 Compliant 8.10.4 Compliant, but no standard types of alarms may lead to additional R&D cost				Comply	OK			Each alarm level corresponding to different situations may be designed in such a way that on it minimizes the chances of false alarming. The alarm level can be more specific if the temperature difference during absolute temperature is to be considered. SER: For better clarity and understanding, the clause has been redefined as under: 8.10.1 Basis of alarms - It should be possible to raise graded alarms, at least 8.10.2 When the temperature of the axle box or the wheel or brake disc exceeds the specified temperature (BPC for bearings, 200°C for wheels and Brake Disc). These should be of multiple level thresholds and user suitable absolute temperature is to be considered. 8.10.3 When the difference in temperature of the axle boxes on the same axle is different beyond a certain limit (currently 20°C). 8.10.4 In case, IR decides to include new types of alarms in the system, then supplier shall modify the software within a reasonable time at no extra cost to Indian Railways. 8.10.5 Threshold limits for graded alarms shall be user suitable and will be decided by consignee in view of varying site conditions. WCR: Provision for user suitable alerts has already been included in clause 8.9. Therefore, system will identify the stock as per alarm protocols. SCR: For critical cases above threshold the system will generate Audio-Visual alerts. ET Roorkee: As the provision for user suitable graded alerts has been defined, iterative changes of user table is negligible.
8.11	Captured Data Reports: The report of the data captured by the system shall be relayed to the website device via suitable communications media to a secure web server on the internet when it receives that the passage of the last axle. The server shall be maintained and operated by the bidder. These servers shall be capable of storing and displaying upon demand, parameter reports for up to 5 years. The access to these reports shall be provided by web based clients optimized for use from desktop / laptops / notebooks and smart phones. Users of the system shall be provided login / passwords for accessing the data.											Compliant, server can be provided if requested.				Comply	Not 5 years- 5000 hours data			NWR, Novax Technologies: The clause is self explanatory and satisfactory. No change required.
8.12	Type of Tests: Inspection and testing of the equipment shall include all inspections, tests, checks, procedures etc. whether mechanical, electrical or software related as required to ensure that the equipment supplied meets the technical & functional requirements stipulated in the specification. The bidder shall submit details of test plan for proposed system for each level of testing. However any additional/extra/extraordinary tests/inspections to be carried out on the site/acceptance basis. The successful bidder shall provide team or contractors to perform all level of testing and ensure availability of testing facilities, lifting tools and spare parts in adequate quantity for tests/ tests. All the requirements, reports, devices, sensors etc. used during all levels of inspection and testing should have valid calibration certificate issued by an independent authority or mutually approved by M&B/EC or accredited lab.											Compliant, can be offered if requested.				Comply	OK			During demonstration of the system, during technical evaluation stage, high speed thermal camera may be used to validate the resolution and accuracy of the installed wireless system.
8.13	Factory Acceptance Test: All technical and design features shall be inspected and witnessed by nominated inspection agency at the firm's premises. During the factory acceptance test, firm shall demonstrate the capability of the system to sense temperature at designated speed mentioned in specification. Test scheme shall be finalized by inspecting tendering agency jointly with the firm. Necessary consumables, rig, calibrated gauges / equipment etc. may be provided by firm at its premises for FAT.											Compliant, can be offered if requested.				Comply	OK			WCR: Tendering agency shall nominate inspection agency. Progress Rail: Simulator may be configured to represent IR conditions specified where live testing is not possible. In addition to this, firm shall demonstrate the functionality of the system at component level also.
8.14	Proving-out tests at site: All functional requirement will be checked at installation site of IR by consignee Zonal Railway as per test protocol finalized by consignee Zonal Railway in consultation with the supplier. The supplier and consignee shall conduct the following proving out tests after commissioning:											Compliant, can be offered if requested.				Comply	OK			No comments
8.15	The trackside equipment shall be calibrated by a black-body source or other method to be elaborated by the tenderer in the offer. The error should not exceed 2% in (weightage axis). The system should be calibrated by the supplier at every six months.							The statement "Error should not exceed 2%" The statement may be reviewed. It may be 2%.				Compliant, can be offered as part of a service contract if requested.				Comply	OK			ET: Accuracy on calibration should be within the stipulations of para 3.2. SCR: Joint Calibration can be included as part of the tendering process. The clause has been modified as under: "The trackside equipment shall be calibrated by a black-body source or other method to be elaborated by the tenderer in the offer. The accuracy of sensor should be as defined in clause 3.2. The system should be calibrated by the supplier at every six months or earlier if requested by consignee."
8.16	All the trains should be correctly recorded with regard to direction of motion, date and time of passing, speed, no. of axes, no. of vehicles other than locomotives and type of rolling stock (Locomotives, Wagons, CF or LHB Coach, BV, etc).											Compliant				Comply	OK			No comments
8.17	The complete data report (without missing any axis) including temperatures for 100% of the axes passed shall be generated.											Compliant				Comply	OK			If it mention that the Complete data report (without missing any axis) including temperatures for at least 99% of the axes passed shall be generated. Note: As it is without missing the axis then it should be 100%.
8.18	Since the trackside equipment's sensors are specially designed to take measurement of temperatures while it is in motion at a high speed, normal methods e.g. hand-held resistance pyrometers may not be used for direct correlation of temperature of axes and wheels taken by HAHW system. Therefore, some of the indirect methods which can be used for verification of temperatures recorded for each train by the HAHW equipment are as under:											Compliant				Comply	OK			No comments
8.19	The ambient temperature reported by the HAHW equipment and any other parameter is a 2°C.											Compliant				Comply	OK			No comments
8.20	The temperature of axle boxes and wheels are not below ambient for each train.											Compliant				Comply	OK			Voespa/Novax: Requirement stipulated in clause 8.9 for proving out of system during normal conditions. However, in specific conditions as stated by firm, the requirement may be relaxed.

