

**Reasoned documents based on Comments received on Specification of Machine Vision Based Inspection System for Rolling Stock
(Spec. No. RDSO -SPN-RE-MVIS-2018(Rev -1))**

Clause No.	Description	Comments received from Siemens Ltd.	Comments received from Track IQ.	Comments received from Trimble	Comments received from IEM Corporation	Comments received from Tata Consultancy Services Ltd.	Comments received from Apna Technologies & Solutions Pvt Ltd.	Remarks from RDSO
1.0	This specification is based on the studies of various literatures/papers available worldwide by RDSO. Although every care is taken in specifying details adequately and unambiguously, RDSO shall not be liable for any kind of damages / losses incurred by any and all due to errors or omissions in this document. This document may mention numerous commercial and proprietary trade names, registered trademarks and the like (not necessarily marked as such), patents, production and manufacturing procedures, registered designs, and designations. RDSO wishes to point out very clearly that the present legal situation in respect of these names or designations or trademarks must be carefully examined before making any commercial use of the same. Names of industrially produced apparatus and equipment may be included to a necessarily restricted extent only and any exclusion of products not mentioned in this document does not imply that any such exclusion has been based on quality criteria or any other qualifying consideration.							<p>Trimble: - As the firm has not provided the para wise comments against this specification so it is not possible to incorporate their comments in this sheet. However the suggestion has been considered.</p> <p>Since the details of the camera specification have been removed from this specification all the potential suppliers can quote their product meeting the specific functional requirements.</p>
2.0	RDSO has the copyright of all its publications. No part of these publications may be reproduced in any form without the prior permission of RDSO. Enquires relating to the copyright should be addressed to Executive Director (Administration), RDSO.							No Change
3.0	Address for communication: -For this specification, the address for communications is: - Director – Research (Mechanical), Research Directorate, Research Designs & Standards Organization, Manak Nagar, Lucknow, Uttar Pradesh, India, Pin: 226 011 Fax: +91 (522) 2465746 Phone: +91 (522) 2465746, 2450179 E-mail: - rds0.drrm@gmail.com							No Change
4.0	Introduction: Current practice for preventive maintenance inspections of rolling stock over IR is largely based on manual inspection which is either trackside or pit examination of stock in stationary or slow moving condition. Visual inspections are performed by trained manpower either in a pit or trackside location but remains dependent on						On a high level, we feel that this specification is very monolithic and needs to be structured such that IR can procure sub systems for example	New para added as under "Tenderer shall acquaint himself/his design team about various types of rolling stocks operational on IR network and the types of defects required to be detected by proposed MVIS system under this specification.

	<p>individual judgment. Besides, the stationary inspection deprives the maintenance staff of significant information of dynamic behavior of the vehicle.</p> <p>Automated inspection by machine vision based systems has the potential to overcome these limitations of human inspection. The systems can be placed closer to the track or between the rails where it may be considered unsafe for a human to be positioned when a train passes. This specification covers requirements for design, development and supply of all- weather Machine Vision Based Inspection System, herein after referred as MVIS, of Rolling Stock based on trackside/ within track mounted Equipments. The purpose of this specification is to spell out the functional and technical requirements of a MVIS system.</p>					<p>a wheel profile measurement system or a brake measurement system and its related requirement should be detailed out. This will help in procurement and proliferation of the required systems in IR. If we install all the cameras recommended, then we might be able to measure all the parameters required but such a system would cost Indian Railways to the tune of Rs 25Cr for each site which might not be value for money.</p>	<p>The specification is generic in nature with focus on functional requirements. The system meeting the specified functional requirement will qualify this specification however, since the specification is generic in nature and pertains to a technology being introduced for the first time on Indian Railway the tendering agency/procurement agency should define the eligibility criteria in terms of a minimum number of system in service for specific period of time for the bidders to qualify as capable supplier for the system.”</p>
5.0	Technical Requirements: -		<p>Generally achievable; however, as mentioned in the generic comments, some algorithms will require tuning, enhancement and/ or development based on the rolling stock design and location of the components to be monitored. Furthermore, to achieve the desired outputs, location of the sensors would also need to be optimized. A detailed set of rolling stock drawings/ images should be</p>			<p>We suggest to highlight the end use such wheel profile measurement, brake wear measurement etc instead of Side View, Top View and Underframe Defects. We request you to specify the actual parameters to be measured for these subsystems and their accuracy of measurements required.</p>	<p>Track IQ: - For desired output location of sensors has been left on suppliers as per their existing systems working globally. The system should have inbuilt standard library of rolling stock defects being used worldwide such as bogie defects, under-frame defects, wheel defect and brake gear defects. However, standard component templates applicable to IR shall be provided to successful bidder. It is the responsibility of the bidder to acquaint himself with the components/assemblies of rolling stocks and various defects detected in Railway yards/workshops/depots/sheds etc, before offering the system.</p> <p>Apna Tech: - Defect parameters have been specified in details in Side view, top view and under-frame defects with their reliability of measurement in para 5.0 2 (L).</p>
1	<p>The MVIS System for Inspection of running trains should be able to monitor the following parameters/defects for all types of Rolling Stocks, at speeds upto 100 Kmph.</p>		<p>location of the sensors would also need to be optimized. A detailed set of rolling stock drawings/ images should be</p>			<p>Currently many trains are running beyond 100 Kmph. In that case what will be MVIS role? Please confirm if MVIS is not required to capture data in those cases?</p>	<p>Since the system has been introduced in IR for the first time, considering the availability of proven systems as per input received from industries the para has been revised as under- “The MVIS System for Inspection of running trains should be able to monitor the following parameters/defects for all types of Rolling Stocks, at train speed of 5 to 100 Kmph.</p>

	A. Side view defects		made					
	i. Broken / Missing Axle Box covers		available by Indian Railways highlighting the components of interest. It would also be helpful to identify the specific points of interest in a component image. It is often the case that there are		Yes, Please provide us photographs and drawings of all the different types of Axle Box covers used in the railroad.			IEM: - The system should have inbuilt standard library of rolling stock defects being used worldwide such as bogie defects, under-frame defects, wheel defect and brake gear defects. However, standard component templates applicable to IR shall be provided to successful bidder. It is the responsibility of the bidder to acquaint himself with the components/assemblies of rolling stocks and various defects detected in Railway yards/workshops/depots/sheds etc., before offering the system.
	ii. Major damages in Wheel Disc		multiple points of interest in a single component.		Yes, Please define "Major damages" against this point.			IEM:- Major damages in Wheel Disc like wheel tread shelling, rim shattering/ tread breakage, cracks in the disc, etc.
	iii. Open/hanging Doors of Wagons				Yes, Please provide us photographs and drawings of all the different types of Wagon Doors used in the railroad.			IEM: - Standard component templates applicable to IR shall be provided to successful bidder.
	iv. Laterally displaced Springs/ Shock Absorbers, as applicable				Yes, Please provide us photographs and drawings of the "applicable Springs/Shock Absorbers" described in this point.			IEM: - Standard component templates applicable to IR shall be provided to successful bidder.
	v. Measurement of wheel diameter	This function can be achieved through a separate WPMS (Wheel Profile Measurement System) module			Yes			No comments
	vi. Standard Wheel Profile defects (hollow tyre, deep flange, thin flange)	This function can be achieved through a separate WPMS (Wheel Profile Measurement System) module			Yes			No comments
	vii. Brake pads/ brake block Worn or missing	This function can be achieved through a separate BPMS (Brake Pad Measurement System) module			Yes, We would request you to please share us photographs and "as-built" drawings of all the various types of braking systems used throughout the fleet. 1. Are all brake			IEM: - The system should have inbuilt standard library of rolling stock defects being used worldwide such as bogie defects, under-frame defects, wheel defect and brake gear defects. However, standard component templates applicable to IR shall be provided to successful bidder. It is the responsibility of the bidder to

viii. Broken or missing Brake beams and pull rods	This function can be achieved through a separate BSMS (Brake Shoe Measurement System) module	
ix. Broken or missing suspension springs		
x. Missing/ Damaged Springs		
xi. Missing Brake Block or key		
xii. Missing/ damaged hand brake wheels		
B. Underframe defects:		
i. Visually detectable structural integrity defects like cracks etc. of underframe, as visible from ground below the underframe between the tracks.	Please define the size of cracks to be detected.	
ii. Yoke pin support plate bolts missing or broken for CBC stock		

	pads/brake blocks of a standard common design? Please clarify. 2. Are all brake pads / brake blocks clearly visible from the wayside or do some types of equipment block visual access to the brakes? Please clarify.			acquaint himself with the components/assemblies of rolling stocks and various defects detected in Railway yards/workshops/depots/sheds etc., before offering the system.
	Yes, Please provide photographs and "as -built" drawings of all the various types of brake beams and pull rods used throughout the fleet.			
	Yes			
	Yes, Kindly describe the meaning of "Damaged" in this point.			Damaged springs means cracked or broken or deformed.
	Yes			
	Yes, We would like to get the clarification on the below points 1. Are all hand brake wheels in the same location relative to a common reference point? Please clarify. 2. Kindly describe the meaning of "Damaged"			IEM: - 1.As IR uses different types of rolling stock so location of hand brake wheels may defer. 2.Damaged means cracked or broken hand brake wheels. It is the responsibility of the bidder to acquaint himself with the components/assemblies of rolling stocks and various defects detected in Railway yards/workshops/depots/sheds etc., before offering the system.
	Yes, Please provide us drawings and photographs of all the different frame designs.			Siemens: - The offered system should comply with the best practices being followed on various railroads across the world. However specific template applicable to IR shall be provided to successful bidder. IEM: - Clarified above
	Yes, Please provide us photographs and "as -built" drawings of all the various types of yoke pin			IEM: - Standard component templates applicable to IR shall be provided to successful bidder. It is the responsibility of the bidder to acquaint himself with the

iii. Damaged Centre sill or other under frame members as visible to the human inspector's naked eye.		
iv. Missing CBC knuckle pins		
v. Missing CBC operating handles		
vi. Damaged/broken Empty Load devices		
vii. Missing Brake gear items		

	support plates used throughout the fleet.			components/assemblies of rolling stocks and various defects detected in Railway yards/workshops/depots/sheds etc., before offering the system.
	Yes, Please quantitatively define "Damaged" term and provide us photographs (if possible.) And please provide a comprehensive list of "other underframe members"(1), Kindly refer note.			
	Yes, 1. Please provide drawings of the CBC knuckles. 2. Are all knuckles the same design? Please clarify. And If not then please provide us drawings of each design.			
	Yes			
	Yes, 1. Please define "Empty Load" devices. 2. Please provide drawings of each design used in the railroad.			IEM: - 1.Empty Load device is a mechanical device, which enables to provide two different leverage ratios to the brake rigging of the wagon for the empty and the loaded conditions.
	Yes, 1. Please provide a comprehensive list of items to be inspected including engineering drawings. 2. If different designs are used, please provide us drawings of each design.			IEM: - 1.List of brake gear items- <ul style="list-style-type: none"> • Brake beam • Brake beam hanger & safety bracket • Brake safety wire rope • Brake shoe & key • Floating lever • Curved pull rod • Equalizing truss bar • Palm end 2.Standard component templates applicable to IR shall be provided to successful bidder. It is the responsibility of the bidder to acquaint himself with the components/assemblies of rolling stocks and various defects detected in Railway yards/workshops/depots/sheds etc., before offering the system.

	viii. Broken or Bent Brake beams				Yes, 1. Please provide a comprehensive list of items to be inspected including engineering drawings. 2. If different designs are used, please provide us drawings of each design.			IEM: - Clarified above
	ix. Missing/damaged brake pipe hose/feed pipe hose				Yes, 1. Please provide a comprehensive list of items to be inspected including engineering drawings. 2. If different designs are used, please provide us drawings of each design.			IEM: - Clarified above
	x. Hanging parts				Yes, Please confirm that the Hanging parts will be identified by a dragging equipment detector.			IEM: -. The detection module has been left on supplier.
	C. Top view defects:							
	i. Deformed/Bulged side walls, uneven loading of consignment etc.				Yes, 1. Please provide a comprehensive list of items to be inspected including engineering drawings. 2. If different designs are used, please provide us drawings of each design	This may not hold good for Covered Wagon, Hoper/Tank types of wagon.		TCS: - Defined clause is self-explanatory. IEM: -. Defined clause is self-explanatory.
	ii. Open/hanging doors of wagons				Yes, 1. Please provide a comprehensive list of items to be inspected including engineering drawings. 2. If different designs are used, please provide us drawings of each design.			IEM: -. Defined clause is self-explanatory.
2	It should confirm to following national/international standards:				Yes			
	A. Degree of protection for electronics- IP66				Yes			

	B. Degree of protection for optics- IP 65				Yes			
	C. Wheel contacts- IP67				Yes			
	D. Auto calibration functionality should be inbuilt into the system, details of which shall be submitted along-with the offer.	Our MVIS has in built self-monitoring and auto-check functionality. Please define what is meant by auto-calibration. Does this mean there is never a requirement to place calibration blocks for similar reference frames in front of the system?	Auto calibration is not practical for vision systems as calibration will need to be against a known object/ reference within the correct field of view at a desired focal length. This cannot be achieved by passing rolling stock through the system as is the case with measuring vehicle weights. Routine annual calibration will be required to maintain system's accuracy. It is rather important for the system to detect anomalies in performance and issue alerts.		Yes			Agreed with remarks. Para revised as "OEM recommended Calibration methodology of the system/subsystem/sub-assembly shall be submitted along-with the offer."
	E. It should function in either direction of movement of train.				Yes			
	F. Time between passing of the train and communication to the central control server should not exceed 10 minutes.				Yes, Kindly confirm us the maximum number of cars in a train?			IEM: -. Train length upto 1000 axles have been specified.
	G. The system should be capable of automatic detection of approaching train, automatic switching-on of relevant sensors, automatic monitor the defects while the train is in motion, automatic transmission of data, alarms and				Yes,			

	reports and automatic switching off of relevant sensors to conserve electrical power.							
	H. The system should be able to work in ambient temperature range of - 10° to 70°C and relative humidity up to 100%.	Ambient temperature of 70°C is too high and unrealistic. We recommend 50°C since many cameras only operate up to 45-50°C. For temperatures higher than 50°C a cooling system would be required additionally			Yes,			Siemens: - Not agreed to as proposed temperature range is not suitable for proper functioning of system on Indian climatic condition.
	I. System should have character recognition feature to extract details painted on side walls of rolling stock for use in automatic report generation.	For character recognition feature to be able to extract details painted on the rolling stock, consistent format, consistent location and consistent font is necessary. Alternatively, RFID tags could be used for identification of rolling stock since they have higher immunity to interference.	Although one can deploy Optical Character Recognition software to extract the manually painted vehicle tags, having RFID tags fitted on the vehicles to be read by RFID readers is preferable. This is because accuracy of the OCR application depends on many factors that may compromise its performance : <ul style="list-style-type: none"> ● Poorly written/painted tags on the vehicle's body, often not or barely readable to a human eye. ● Inconsisten 		Yes, Request you to please confirm a consistent typeface, location, and resolution for the character recognition system. (IEM understanding is that previous attempts to identify cars based on visual analysis failed due to the lack of consistency in the format and presentation of the existing signage. Please refer note 1 below.)			A new para added as "The drawings pertaining to location of stencil of vehicle particulars on side walls shall be provided to successful bidder."

			<p>cy in tags' pattern causing alpha-numeric characters placed very closely to each other resulting in invalid characters.</p> <ul style="list-style-type: none"> • Undulation of the surface, often dented, where tags are painted resulting in text distortion. Accumulation of dirt including oil on the painted tags resulting in tags being obscured. Part of the vehicle covered with tarpaulin resulting the tags completely invisible 				
	J. Supply, installation and commissioning of Suitable illumination for round- the-clock working of equipment shall be provided				Yes,		
	K. Camera Features (for all three types of camera)		Track IQ believe that the specifications on the type of cameras are too tight. Such a stringent specification can lead to bias, limit potential number of suppliers, and hence,		Yes,	<p>We suggest that Instead of mentioning the cameras for a monolithic system, we request you to specify the cameras for each subsystem. Or if possible not to specify the cameras and put the requirement on the lines of what each subsystem needs to measure, its accuracy levels and</p>	<p>Based on the suggestions received from various global suppliers and the fact that Indian railways is going to use this system for the first time selection of cameras and its features have been left on suppliers.</p> <p>Relevant Para deleted.</p>

<p>i. 8 bit monochromatic camera or better</p> <p>ii. CCD types or better</p>		<p>compromise the integrity of the project. From both practical and performance perspectives, a supplier should have flexibility to choose the types of cameras and associated components to produce the output as desired by a customer. It is therefore suggested that RDSO should focus on achieving the desired outputs rather than dictating particular cameras, associated peripherals and techniques to be used. Flexibility will allow a range of solution options from the supplier experts, and therefore, a better solution in the long term. Furthermore, the number of camera and positions may differ from the arrangement</p>	<p>Yes,</p> <p>Yes,</p>		<p>the kind of alerts expected from the system. The thought that ideal camera to use keeps changing but what needs to be measured stays the same and defining that will improve the way these subsystems can be procured by IR.</p>	
<p>iii. Camera interface GigE</p>			<p>Yes,</p>			
<p>iv. Camera types</p>			<p>Yes,</p>			
<p>a. Line Scan camera</p>		<p>Function of Line Camera is achieved through scanner in our MVIS system, since scanners can also create 3D profile of the train that is then used as a reference to detect anomalies in a more reliable way. Therefore, it is requested to leave this at the discretion of the bidder to use camera/scanner. A line scanner provides additional info above a line scan camera as they include both distance and image data.</p>				
<p>i. Resolution 4K (4096 px * 1 px) or better</p> <p>ii. Min. Line rate 48 KHz</p> <p>iii. Sensor size 14.3 mm or better</p> <p>iv. Max. Pixel size 7 µm * 7 µm</p>			<p>Yes,</p>			
<p>b. Area Scan camera</p>		<p>It is physically not possible to get frame rate of 500 with GigE camera at 2M resolution. We recommend having a scalable frame rate depending on train speed to ensure complete vehicle image capture. Instead of having a fixed pixel size, we recommend having a pixel size suitable to provide the required functionality in combination with illumination source.</p>				
<p>i. Resolution 1920*1080 or better</p> <p>ii. Min. Frame rate (frames per second) 500</p> <p>iii. Sensor size 2/3 inch or better</p> <p>iv. Max. Pixel size 4.8 µm * 4.8 µm</p>			<p>Yes,</p>			<p>Based on the suggestions received from various global suppliers and the fact that Indian railways is going to use this system for the first time selection of cameras and its features have been left on suppliers.</p> <p>Relevant para deleted.</p>

		(suggest pixel size range)	shown in sketch 1 that appears to show a simplistic view. The number and positions of the cameras and associated sensors will be based on the actual location of components to be monitored.				
	e. Stereo camera	Function of Stereo Camera is achieved by using scanner since scanners can also create 3D profile of the train that is then used as a reference to detect anomalies in a more reliable way. Therefore, it is requested to leave this at the discretion of the bidder to use camera/scanner. Scanners provide a direct distance measurement whereas stereo cameras require processing and results in a less accurate distance.			Yes,		
	<p>i. Image resolution 1920*1080 or better</p> <p>ii. Min. Frame rate 60</p> <p>iii. Baseline distance (max.) 0.5 m</p> <p>iv. Sensor size 2/3 inch or better</p> <p>v. Depth 6 meter & depth resolution 10 cm at 6 m</p>						
	v. Auto Exposure/Auto Gain	This feature is not reqd, because we provide controlled lighting. Auto Exposure/Auto Gain should be turned off to get consistent image quality for analysis			Yes,		
	vi. Auto Tap Balance & Pixel Correction	These functions are not applicable since we are using newer camera technologies			Yes,		
	vii. The system should have at least 11 (2 line type, 2 stereo vision camera and 7 area scanning type) camera arrangement as per sketch no. 1 of this specification fitted suitably to cover wide range of Coach/Wagon designs so as to cover required parameters/defects as per Para 5.0(1). The general arrangement of camera will be as follows:	We recommend using a combination of cameras and laser scanners for a more holistic and reliable inspection and detection. Our cameras and scanners are arranged for comprehensive 360 degree inspection and the arrangement may slightly vary from the one in Sketch No.1. However, we			Yes, The most cost-effective design will be created upon receipt of the data requested above and a site visit. The design scheme laid out in paragraphs K vii may or may not be optimal based on currently available technology.		Based on the suggestions received from various global suppliers and the fact that Indian railways is going to use this system for the first time selection of cameras and its features have been left on suppliers. Relevant para deleted.

confirm that this difference in arrangement will in no way affect the system functionality.

Camera No. as per sketch 1	Camera scan type	Location as indicated in sketch 1	Parameters to capture	Approx. Distance from camera to object (mm)	Approx. area of Object (mm)
A	Area	Between the rails	To capture under-frame defects	1200	Width 3250
B, C	Line	Side of track	Wheel profile data	700	Line scan
D, E	Area	Both Side of track	Bogie side view related	1000	Vertical height upto 1200 mm from rail level
F, G	Area	Both Side of track	Side view of rolling stock superstructure including text	1000	3200 mm vertical height starting from 1200 mm from rail top level
H, I	Stereo vision camera	On the portal/ top side corners suitable	To capture uneven loading, top view of consignment/roof/coupler top view	3000 to 5000	3250
J, K	Area	On the portal/ top side corners	Deformed/Bulged side wall panels, hanging/open doors	3000 to 5000	1000

Para deleted.

L. Operational capability requirements –

i. Operating speed – up to 100 Kmph (Max.)	We recommend to keep operating speed at 40-50 kmph for maximum accuracy in detection					Siemens: - Not agreed. Para revised as “ Operating speed- 5 to 100 Kmph.																										
ii. Train length- upto 1000 axles																																
iii. Typical track profile- As per IRPWM 2004 amended from Latest correction Slip(ACS-144)																																
M. Tolerance Applicable for Various Parameters / Defects:																																
<table border="1"> <thead> <tr> <th>S.no.</th> <th>Parameters/Defects</th> <th>Tolerances</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Broken in two pieces or missing Axle box covers</td> <td rowspan="11"> <ul style="list-style-type: none"> False positive alarms should not be more than 10%. False negative alarms should not be more than 5% Reporting should match the seeded test condition </td> </tr> <tr> <td>2</td> <td>Hanging parts</td> </tr> <tr> <td>3</td> <td>Major Damages in Wheel Discs</td> </tr> <tr> <td>4</td> <td>Open/hanging Doors of Wagons</td> </tr> <tr> <td>5</td> <td>Laterally displaced Springs/ Shock Absorbers</td> </tr> <tr> <td>6</td> <td>Brake Pad missing</td> </tr> <tr> <td>7</td> <td>Broken or missing Brake beams and pull rods</td> </tr> <tr> <td>8</td> <td>Broken or missing suspension springs, in the visible range</td> </tr> <tr> <td>9</td> <td>Structural integrity of underframe, as seen from bottom area between the track</td> </tr> <tr> <td>10</td> <td>Yoke pin support plate bolts missing or broken for CBC stock</td> </tr> <tr> <td>11</td> <td>Damage in Wagons</td> </tr> </tbody> </table>	S.no.	Parameters/Defects	Tolerances	1	Broken in two pieces or missing Axle box covers	<ul style="list-style-type: none"> False positive alarms should not be more than 10%. False negative alarms should not be more than 5% Reporting should match the seeded test condition 	2	Hanging parts	3	Major Damages in Wheel Discs	4	Open/hanging Doors of Wagons	5	Laterally displaced Springs/ Shock Absorbers	6	Brake Pad missing	7	Broken or missing Brake beams and pull rods	8	Broken or missing suspension springs, in the visible range	9	Structural integrity of underframe, as seen from bottom area between the track	10	Yoke pin support plate bolts missing or broken for CBC stock	11	Damage in Wagons		As per the generic comments mentioned earlier, a focussed list of key primary (tier 1) Components that can expand over time would be a recommended approach.				No comments
S.no.	Parameters/Defects	Tolerances																														
1	Broken in two pieces or missing Axle box covers	<ul style="list-style-type: none"> False positive alarms should not be more than 10%. False negative alarms should not be more than 5% Reporting should match the seeded test condition 																														
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Standard Wheel Profile defects																																
1 Measurement of wheel diameter +/- 4 mm		As per the generic comments mentioned earlier, measurements and accuracies should be repeatable (consistent) rather than highly accurate within tight tolerances		Yes,		Para deleted																										
2 Deep Flange +/- 0.5 mm				Yes,																												
3 Thin Flange +/- 0.5 mm				Yes,																												
4 Brake Pad/brake block Worn +/- 0.5 mm				Yes,																												

			that may not be feasible in the dynamic railway operational environment				
	N. Regulation and norms applicable-						
	i. EMVA 1288 ii. EN 55011:98 + A 1:99 + A2:02: class B iii. EMV550121-4:00(immunity test) iv. 73/23/CE, 93/68/CE v. EC Directive 2006/860/CE vi. EN55022:98 class A vii. EN55024:98 viii. EN61000-6-4:01 ix. EN61000-4-2:2009 x. EN61000-4-3:2006 +A1:2008+A2:2010 xi. xi. EN61000-4-4:2004 +A1:2010 xii. EN 301489-1 xiii. EN 55011-2-3:2017 xiv. EN 55022:2010 xv. EN 55024:2010+A1:2015 xvi. EN 55032 xvii. IEC 61000-6-4:2018 xviii. IEC 61643-12, 61312, 61214 & VDE 0100-534 xix. EN 50125-1:2014			Yes,			
	<p>The system design shall relate and comply with the above mentioned standards. (In case of any contradiction, the strictest standard shall apply). In addition to above, any other national/international standard which is relevant to the technology for similar application in the railway domain will also have to be complied with.</p> <p>The system should be modular, auto-calibrating with self-diagnostic features. The system should be designed for compatibility with all important Railway Standards, some of which have been mentioned in this document above. The MVIS is expected to run in 24x7 mission critical modes (available around the clock) without any human intervention. The system should be programmed for two self-checks daily. This self-test must test all vital elements. The result of self- tests shall be indicated on central server.</p> <p>The system should be equipped with robust, networked, alert-management software with full suite of graphical analysis and diagnostic tools. Full TCP/IP support should be inbuilt into the system to facilitate smooth integration into all</p>				Yes,	Please specify the auto-calibration requirements with details such as the specific parameters that needs to be adjusted.	<p>"Auto calibration" deleted.</p> <p>Relevant para regarding self-test modified as 'The MVIS is expected to run in 24x7 mission critical modes (available around the clock) without any human intervention. The system should be programmed for self-checks periodically. This self-test must test all vital elements. The result of self-tests shall be indicated on central server.'</p>

	existing railway data networks.						
6.0	Installation requirements: -						
	The MVIS system shall not infringe the IRSOD and shall be installed in consultation with authorised Railway Engineer. The tenderer must submit the installation drawings of equipments for scrutiny and approval by the purchaser. Installation clearance for specific sites shall be provided for individual sites by the respective DRM-Mechanical based on the equipment drawings and other documents submitted by the tenderer, as required by DRM-Mechanical.				Yes,	Please mention about network (3G, 4G and LAN) availability at site	No comments
	i. The MVIS systems shall be installed such that they do not either require or cause stoppage of train traffic when they are functioning/not functioning/under breakdown/under maintenance.				Yes,		
	ii. AC voltage range 110V to 230V, 50 +/-3Hz. shall be made available at installation site by Railway. The maximum load on the power supply system should not exceed 5 KVA.	Would need more than 5KVA since air conditioning system and lighting system would also be there.			Yes,		Siemens: - Agreed with remarks. Relevant para modified as "The maximum load on the power supply system shall be indicated in the offer".
7.0	Functional requirements: -						
	i. The system should be able to monitor all parameters/defects as mentioned in Para 5.0(1).				Yes,		Para modified as "The system should be able to detect and report all parameters/defects as mentioned in Para 5.0.1.
	ii. System shall log the date of train passing, time of train passing, speed of train, number of axles passed, total number of vehicles in the rake				Yes,	This data must be associated with train number to ensure traceability. So we would suggest the below change: System shall log the Train number, date of train passing, time of train passing, speed of train, number of axles passed, total number of	TCS: - Not agreed as logging of train number is not feasible. New para (iii) added as "System shall be designed for a headway (time between two consecutive trains pass) of 3 minutes."

						vehicles in the rake.	
8.0	Hardware requirements: -						
	i. In case the cameras are mounted on the rail or tie/sleeper or specially designed sleeper by tenderer, the technical details and drawing(s) of such sleeper shall be submitted along-with the offer.				Yes,		
	ii. UPS system of at least 8 hours on back-up power and to charge the back-up batteries from main power shall be provided to automatically switch to back-up battery power in case of failure of main power.				Yes,		Para modified as "System will be equipped with UPS for graceful shutdown of equipment in case of power failure. System should have feature of self-start/boot on resumption of power supply."
	iii. The MVIS system shall have provision for integration with RFID reader likely to be installed by IR in future for automatic identification of vehicles.				Yes,	Please mention where RFID will be placed in future	Para modified as "The MVIS system shall have provision for integration with RFID reader likely to be installed by IR in future for automatic identification of vehicles. The location of RFID tags on rolling stock shall be provided to successful bidder."
	iv. System should have capability to integrate with 3rd party system for which Interface control document (ICD) will be provided by Indian railways. Firm will supply the ICD for the MVIS to the Indian railways.				Yes,	Pls include the EDGE cyber security features such as Trusted Platform Module, data hashing and data encryption requirements	No comments
9.0	Software requirements: -					Please mention the following dependencies in relevant section • To train the ML/DL/Image analytics model for object detection and defect detection. Initially one month data/ 100 trains (for each type) data is needed. Post training the model, subsequent testing should be carried out in the field. • There will be around 3	No comments

					months effort needed for training model.		
	i. The trackside equipment shall have the capability to record and locally store raw captured data/images for last upto 500 trains and the processed reports for upto 10000 trains.				Yes, Please include the EDGE Analytics related requirements such as realtime EDGE Image /Video analytics without connecting with cloud or back end server Is there no limitation on days? Ideally data should be stored for minimum 7 days.		No comments
	ii. The supplier shall be responsible for providing required software for collecting data, storage and presentation of reports sent by the trackside equipment.				Yes, We would request the below change in this clause: The supplier shall be responsible for providing required software for collecting data, storage and presentation of reports in pdf and excel format, sent by the trackside equipment. Also, If IR need report any other format, it should be mentioned specifically.		<p>iii. The system should have self-learning capability to improve its performance as it acquires different types of defects passing over it during warranty of the system.</p> <p>iv. The system should have inbuilt standard library of rolling stock defects being used worldwide such as bogie defects, under-frame defects, wheel defect and brake gear defects. However, standard component templates applicable to IR shall be provided to successful bidder. It is the responsibility of the bidder to acquaint himself with the components/assemblies of rolling stocks and various defects available in Railway yards/workshops/depots/sheds etc, before offering the system."</p>
10.0	Safety Requirements: -						
	The equipment shall not fail on wrong side due to harmonic interference generated by 3 phase thyristor, single phase thyristor, chopper controlled, tap changer or other such technologies, locomotives and 25 KV Single Phase OHE Supply.				Yes, Please specify the fault rate and safety integrity level (SIL) required		
11.0	Output requirement: -				Please specify the IoT modular architecture consisting of EDGE Layer,		No comments

					Platform Layer and Application and Analytics layer. Please specify the analytics using AI/ML which will be required	
	i. The supplier shall launch, operate and maintain an internet-based website during warranty and during comprehensive maintenance period for making available the train reports.			Yes,		
	ii. The website shall have the following features:- a) Password based access so that only authorized personnel by DRM- Mechanical can enter/edit/view/download data and reports b) Differential privileges to different levels of users to access the resources of the website			Yes,		
	iii. The supplier shall supply a desktop computer at nominated place by DRM- Mechanical of the configuration as specified in the clause on concomitant accessories.			Yes,		
	iv. 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.			Yes,		
	v. Detailed report: - This report shall be in detail showing all parameters as acquired by the remote wayside detector.			Yes,		
	vi. The Software should produce a train consist list, comprising train arrival & departure times, number of axles, axle spacing, axle speed, vehicle type, number & image number for each vehicle.			Yes,	The system captures lot of images and these images are required to be stored for verification purpose and training of image analytics algorithms if required. So we would suggest the below change: The backend server systems shall be maintained and operated by the system provider.	TCS: - Minimum requirements have been covered in 11.0 (output requirements).

					These servers shall be capable of storing and displaying (upon demand) parameter reports for up to last 5 years. Also there should be an image store for the images captured in the last 6 months (the duration can be decided by IR)	
vii. The system shall generate alarms based on the interpretation of the data. It should give exception report and audio-visual alarm at preset value of defects. It should be possible to individually set preset value for different type of alarms at each site from Central Control. The Tenderer will work jointly with IR and assist in developing acceptable limits for the various parameters. For providing relevant alarms to Divisional controllers, it should be possible to map each site to one or more C&W Divisional controller.				Yes,		Para modified as "The system shall generate alarms based on the interpretation of the data. It should give exception report. It should be possible to individually set preset value for different type of alarms at each site from Central Control. It is the responsibility of the bidder to acquaint himself with various types of defects on Indian Railway's rolling stocks listed in this specification. Allowable limits/range/ (Pass/Fail criteria) for defects diagnostics, wherever applicable, shall be communicated to successful bidder."
viii. 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				Yes,		Para modified as "Bidder shall submit the sample templates of dashboard report for each type of defect mentioned in this specification, as generated by the proposed system elsewhere worldwide alongwith offer."
i. Detailed report: - This report shall comment on all parameters as acquired by the Machine Vision Based Inspection System for parameters/defects mentioned in Para 5.0(1) respectively and shall be saved for review/reference.				Yes,		Para deleted
ii. Exception report: - This report shall be an abridged version of the detailed report showing only the list of rolling stock where the parameters have exceeded the prescribed limits. This shall serve as a working report for the maintainer and shall be used for planned repair.				Yes,		Para deleted
iii. Diagnostic reports: - The system shall be capable of running self- diagnosis programs and report the result through the website. The system shall be able to communicate alarms and				Yes,		Para modified as "All reports/ messages shall convey the following minimum data: a) Date / time of train

	<p>acquired data to users immediately after passage of a train without any human intervention. All reports/ messages shall convey the following minimum data:</p> <p>a) Date / time of train b) Direction of movement c) Vehicle position from start of train d) Rolling Stock Number, if recognizable by the system, where the parameters were found out of range. e) Short description / error code (should be easily understandable without need of referring to a table). f) The image of defective portion in the rolling stock shall be uploaded on web report.</p>						<p>b) Direction of movement c) Vehicle position from start of train d) Rolling Stock Number, if recognizable by the system, in which the parameters were found out of range. e) Short description / error code (should be easily understandable without need of referring to a table) f) The image of defective portion in the rolling stock shall be uploaded on web report."</p>
	<p>iv. 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 during AMC/ Warranty.</p>			Yes,			
	<p>v. Where required by special site conditions, OFC / Copper cable / RF-Link connectivity shall be provided by the system provider for transfer of data.</p>			Yes,			
	<p>vi. The backend server systems shall be maintained and operated by the system provider. These servers shall be capable of storing and displaying (upon demand) parameter reports for up to last 5 years.</p>			Yes,			
	<p>vii. The access to these reports shall be provided by web based clients suitable for use from desktops / laptops / netbooks and smart phones. Users of the systems shall be provided logins / passwords for accessing the data</p>			Yes,			
12.0	Submission of documents:						

	(i) Test certificates: Test records, test certificates, performance curves, tables, etc., of all inspections and tests, whether or not witnessed by IR personal, shall be supplied as soon as practicable after performance of each inspection or tests. Two (02) sets of above mentioned documents shall be supplied properly bound in books.			Yes,			
	(ii) All test certificates shall be endorsed with sufficient information for identification of the equipment and, material to which the certificates refer.			Yes,			
13.0	Type of Tests:						
	(i) 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 requirements of the specification.			Yes,			
	(ii) Inspection and testing shall comprise, but not limited to: a. Mechanical and chemical testing of materials b. Destructive and non-destructive tests of materials c. Checks of fits and assemblies. d. Dimensional checks. e. Inspection of paints and coatings f. Electrical tests g. Functional tests performance tests h. Acceptance tests: • Type tests • Routine tests • Proving-out tests	Please confirm destructive tests is required as this would lead to high costs and components will not be reused after these tests		Yes,	System Integration Test can also be included in Section ii (g)		Para modified as " Acceptance tests: a. Type tests: Factory Acceptance Test (FAT) - All sub-systems/assemblies shall be demonstrated for satisfactory working of sub systems & assemblies. Calibration of systems/sub-assemblies (wherever applicable) shall also be demonstrated by firm. Successful capture of data/analysis by software by input of a simulated data file (wherever possible) shall be demonstrated at firm's premises before supply of equipment. The detailed test plan for FAT shall be prepared finalized by successful bidder in consultation with RDSO. b. Proving-out test requirement: - The supplier and the DRM-Mechanical shall conduct the following proving out tests after commissioning: - i. Consistency test: - Detailed Test scheme for consistency test shall be prepared by RDSO in consultation with successful bidder. This test is intended to establish the following performance parameters: (i) To examine and ensure the capability of equipment for faithful capture of details like direction of motion, type of rolling stock(wagon/LHB coach/ICF coach/Locomotive), date and time

								of passing, speed of train, no. of axles, no of locomotives, no of vehicles other than locomotives under repeated running of test train/commercial train without any miss (100%). (ii) Few fault-seeded rolling stocks (faults selected from list in para 5.0.1) shall be passed over through the system. The system should be able to demonstrate the reliability of fault detection as indicated in para 5.0.2(L).
	(iii) The techniques, equipment and instrumentation to be use for these tests, checks, inspection, examinations, etc. shall be in accordance with internationally accepted standards, rules or codes, and in particular those mentioned in the specification				Yes,			
	(iv) If in IR's opinion, instruments, apparatus, devices, etc. used by the supplier need calibration or re-calibration, then such instruments, apparatus, devices, etc. shall be calibrated by an independent authority or institute approved by IR.				Yes,			
14.0	Proving-out test requirement: -							
	The supplier and the DRM-Mechanical shall conduct the following proving out tests after commissioning: -							
	i. Consistency test: - a) All the trains should be correctly recorded with regard to direction of motion, date and time of passing, speed, no. of axles, no of locomotives, no of vehicles other than locomotives. Acceptance shall be at 95%. b) The complete data report of the trains passed shall be generated c) The complete data report generated for various parameters/ defects (as per para 5.0(1)) should be within applicable tolerances as per para 5.0(2-M).				Yes,	Train number can be added		Para modified as "i. Consistency test: - This test is intended to establish the following performance parameters. Test scheme for consistency test shall be prepared by RDSO in consultation with successful bidder. (i) To ensure faithful capture of details like direction of motion, type of rolling stock, date and time of passing, speed, no. of axles, no of locomotives, no of vehicles other than locomotives under repeated running of test train without any miss (100%). (ii) Few fault seeded rolling stock shall be passed over the system. The system should be able to demonstrate reliability of fault detection as indicated in para 5.0(2-L).
	ii. Calibration test: - In addition to calibration test during the commissioning of system, the auto-calibration functionality shall also be demonstrated at the site during the commissioning of the system. The error should not exceed 2%.		Auto-calibration is not feasible as explained earlier.					Para modified as 'As per OEM recommended procedure shall be demonstrated at site after commissioning of equipment with all subsystem operational.'
15.0	Literature: -							

	<p>The supplier shall provide following literature in two copies to DRM-Mechanical along with the delivery of MVIS system.</p> <ul style="list-style-type: none"> i. Complete drawings ii. Operating manual iii. Maintenance manual iv. Spare part catalogue <p>The tenderers shall provide a list of literature to be supplied with the machine in his offer to the tender.</p>	i. Only top level drawings.			Yes,			No comments
16.0	<p>Scope: - The MVIS system shall be supplied on turnkey basis. The MVIS system shall mean and include all equipment by the side of the track, cables – electric, server computer, website, client computer, software of the track-side equipment and software of the central server and any other element necessary for optimal functioning of the system. The scope shall include</p>				Yes,			
	<ul style="list-style-type: none"> i. Supply: - Supply of <ul style="list-style-type: none"> a) MVIS site equipment b) Concomitant accessories c) Spares d) Maintenance tool kit e) Literature f) Material, as required for civil engineering work g) Power cables, as suitable to the trackside equipment h) Modem, as suitable to the trackside equipment 				Yes,			Para h) modified as "Modem/communication equipments, as suitable to the trackside equipment."
	<ul style="list-style-type: none"> ii. Installation at site: - Installation of the system would be done by and under the supervision/direction of firm's Engineers. It shall include the following: - <ul style="list-style-type: none"> a) Civil engineering and other allied works (if required) such as construction of hut of suitable size to house UPS, batteries, electronic and electrical equipment, solar power system etc.; grouting supports for steel enclosures/equipments, control box, battery box etc., necessary work e.g. trench etc. for power cables for a maximum distance of three km. In case the offered system requires track crossing or sleeper replacement, the offer shall be evaluated by Research Directorate of RDSO in consultation with Track Directorate of RDSO and necessary approvals shall be organized. Therefore the supplier shall provide the required technical details in the offer. b) Electrical engineering: laying of power cables for a maximum distance of three km from the site to the main power distribution box where the DRM-Mechanical has made the availability of electrical power of 230 V 50 Hz. c) Provision of mobile connection and internet connection for transfer of data and display of reports and audio-visual alarms from site of installation to centralized location (as finalized by DRM-Mechanical of concerned Division of Indian 				Yes,			

<p>Railways). The recurring expenditure on mobile connectivity for first one year from the date of commissioning shall be borne by the supplier. Subsequent expenditure shall be borne by Indian Railways for which the necessary arrangements have to be done in advance by DRM-Mechanical</p>						
<p>iii. Web-server – The supplier shall launch and maintain an internet web – server at any location with following features-</p> <ul style="list-style-type: none"> a) Multiple User password protected log-in b) Differential access and usage rights to multiple level of users e.g. write- only, read-only, administrator rights c) Facility to export data in other data base formats e.g. MS-Excel and XML. d) The supplier shall offer at least two designs for web-user interface for selection. e) Sufficient capacity to handle data traffic with fast data transfer rate for all authorized users (to be controlled by providing username and password) who shall access through public internet access. 				<p>Yes,</p>		<p>New para added as 'a) A comprehensive web-based software to access all system data and images b) A web based virtual train inspection portal to review all system images and perform a virtual train inspection, when needed.'</p>
<p>iv. Ownership and confidentiality of data and software: - All the data being generated by the MVIS equipment, website, servers etc. with respect to Indian Railway operations shall be the property of Indian Railways.</p> <ul style="list-style-type: none"> i. 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 at present but other formats may be accepted later by Indian Railways if found suitable. ii. The data shall not be divulged by the supplier to anyone other than DRM-Mechanical and to those authorized by DRM-Mechanical. Apart from the details mentioned in this documents, any other accessory/component/system(s) essentially required for proper functionality of the MVIS system, will fall under the scope of supply of the tenderer. 	<p>Some data is internal to the system and will not be accessible due to IP. Measurement data supplied to the Customer would be owned by the Customer</p>			<p>Yes,</p>	<p>This means in future if Private operator will run their Rail, Webserver need to send Rolling Stock defects data to their Central Server. So based on Rolling stock ownership, data needs to segregate and send to Rail company. Please clarify.</p>	<p>Relevant para modified as "All the data being generated by the MVIS equipment, website, servers etc. with respect to Indian Railway operations shall be the property of Indian Railways and shall not be shared with 3rd party without explicit written consent of Indian Railways."</p>