Sub: Reasoned document based on comments received from nominated committee members on provisional draft of Autonomous Thermal Vision Camera based Loco Pilot Assistance System (ATLAS) for finalization of FINAL Draft of ATLAS

Clause No.	Description of Provisional Draft	Discussion/ decision of committee members	RDSO Remarks
0	**Introduction:** The death of animals – especially elephants – on railway tracks has been a cause of concern to Indian railways. Due to growing population pressure and consequent expansion of physical infrastructure (roads, railway tracks) into forested land have increased the probability of train-animal collision. Animal crosses rail track frequently in search of food and water and other habitat resources. To avoid train-elephant collision, Indian railways has imposed speed restrictions as low as 30 kmph in elephant corridors. For protection of elephant, it has become a necessity to provide an autonomous driver assistance system that will aid loco pilot/crew in alerting/pre-warning the presence of elephant on the track from a reasonable headway. Thermal Imaging Camera generally enhances the range of visibility irrespective of day and night for warm blooded animals. Use of Artificial Intelligence with the live videos generated from Thermal Imaging Camera will be helpful for autonomous recognition of adult elephants on track in almost real time. This standard defines the functional, technical requirements, design, inspection and test schedules required for development and deployment of **A**utonomous **T**hermal Vision Camera based **L**oco Pilot **A**ssistance **S**ystem **(ATLAS)** on Indian Railway locomotives and any other self-propelled vehicle treated as train of Indian Railways.	No change in para is required	Nil
1.	**Objective and Scope** This document lists the functional requirements of **A**utonomous **T**hermal Vision Camera based **L**oco Pilot **A**ssistance **S**ystem **(ATLAS)** for Indian Railways to alert the crew of big wild animals specially adult elephant. This document has been prepared with an aim of defining the requirements for development of a system which shall enable locomotive pilot (termed as crew herein) to visualise and warn about wild animals on track from a reasonable headway so as to enable him/her to apply brakes sufficiently in advance to avoid collision in normal day and night.	No change in para is required	Nil

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Clause No.	Description of Provisional Draft	Discussion/ decision of committee members	RDSO Remarks
3.	**Scope of Supply** The proposed Autonomous **T**hermal Vision Camera based **L**oco Pilot **A**ssistance **S**ystem **(ATLAS)** for one loco shall contain following major components which are within the scope of supply of the vendor: • Thermal Cameras (LWIR) with processing Units - 02 Sets (One at either end of loco). • Display Unit (not less than 10.1" display size) - 02 Sets (One on each Control desk). • DC-DC converter as applicable to the type of Locomotive (Input supply 72 V for Diesel Loco or 110V for Electric Loco). • GPS module • Required cables and interfacing equipment. • Hardware from for mounting and cabling. *Note :* *a. The vendor shall supply any additional components, if required, as per their own design for satisfactory performance of the system.* *b. The system shall be robust.* *c. Scope of Supply proforma has to be submitted by the firm as per Annexure-1(A).* *d. All the microcontrollers, communication equipment and electronic hardware must comply with the* *guidelines pertaining to national security issued from time to time by government of India*	No change in para is required	Nil

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<table>
<tr><th>Clause No.</th><th>Description of Provisional Draft</th><th>Discussion/ decision of committee members</th><th>RDSO Remarks</th></tr>
<tr><td>4.</td><td>Functional requirements
The equipment shall enhance range of visibility and display the same in the form of a real-time video on display screen located ergonomically near the operator"s seat.
The system shall generate audio-visual alarm upon detection/ recognition of wild animals like adult elephant on track well in advance by processing digital image captured through Thermal imaging camera in almost real time through Artificial Intelligence.
Followings are the brief functional requirements to be met by ATLAS in normal weather day and night and when line of sight is uninterrupted.
• Object Size to detect: Adult Elephant
• Autonomous Recognition of Adult Elephant: 500 mtrs (Euclidean Distance)
• Functional trials shall be conducted to verify the recognition range.
• System shall record and store the video for at least one week duration.

Detection range:
The equipment shall detect the Adult Elephant ahead and display the same in the form of a realtime video on display screen located ergonomically near the operator"s seat and generate the autonomous audio visual alarm at least 500 mtr. ahead so that Loco pilot can apply brake well in advance.
The table below shows the tentative Emergency Braking Distance of Train on Level Track at various
speeds.
59 Loaded Wagon hauled by Locomotive
SN Initial Speed in Kmph Emergency Braking Distance in Mtr.
<table>
<tr><th>SN</th><th>Initial Speed in Kmph</th><th>Emergency Braking Distance in Mtr.</th></tr>
<tr><td>1.</td><td>60</td><td>539</td></tr>
<tr><td>2.</td><td>50</td><td>389</td></tr>
<tr><td>3.</td><td>40</td><td>260</td></tr>
<tr><td>4.</td><td>30</td><td>164</td></tr>
<tr><td>5.</td><td>20</td><td>87</td></tr>
<tr><td>6.</td><td>10</td><td>30</td></tr>
</table>
Note: The above table is only for guidance purpose only obtained through computer</td><td>Committee members proposed to add following comment in clause no. 4 as note.
“The system should be upgradable to recognise other class of animals such as cow, buffaloes etc”</td><td>Comment incorporated in clause no. 4 of final draft</td></tr>
</table>

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<table>
<tr><th>Clause No.</th><th>Description of Provisional Draft</th><th>Discussion/ decision of committee members</th><th>RDSO Remarks</th></tr>
<tr><td></td><td>simulation.

Followings are the performance metrics expected from the System for recognition of elephant based on
Confusion matrix ie. True Positive(TP), True Negative (TN), False Positive (FP) and False Negative (FN)
using the following equations:

• True positive rate (TPR) = TP/(TP+FN)
• Positive predictive rate (PPV) = TP/(TP+FP)
• False positive rate(FPR) = FP/(FP+TN)
• F1 - score = 2.(TPR.PPV)/(TPR+PPV)
• Accuracy = (TP+TN)/(TP+TN +FP+FN)

<table>
<tr><th>Ambient (Daylight/ Night)</th><th>Speed in kmph</th><th>Average Autonomous Recognition Range in mtr.</th><th>True Positive Rate (TPR) in %</th><th>Positive Predictive Rate (PPV) in %</th><th>F1-Score in %</th><th>Accuracy in %</th></tr>
<tr><td>(A)</td><td>(B)</td><td>(C)</td><td>(D)</td><td>(E)</td><td>(F)</td><td>(G)</td></tr>
<tr><td>Day/ Night</td><td>0-60</td><td>≥ 500</td><td>94</td><td>88</td><td>91</td><td>84</td></tr>
</table>

4.1.1. Train speed ranges given at column (B) are indicative.
4.1.2. Autonomous Recognition Range at column (C) should be referred as Distance of the driver cab from the target object (Elephant) at the time of generation of Audio visual alarm.</td><td></td><td></td></tr>
</table>

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Clause No.	Description of Provisional Draft	Discussion/ decision of committee members	RDSO Remarks
	4.1.3. To validate the above functional requirement, trials will be conducted in the real field condition and parameters will be recorded. It is possible that due to various factors, some variations in the result during test are expected. Hence, statistical analysis of the obtained data using Chi Square test will be followed to find the goodness of fit of the test statistic at 95% confidence interval for the above parameters, if the Accuracy in % observed during test is below the limit given at column (G) of above table. 4.1.4. The system should continue to recognize autonomously in the lower range to the train except the target in blind/dead zone of camera. 4.1.5. Firm has to arrange for necessary measuring and test equipment for functional trials along with the documentary proof of calibration having traceability up to national/ international standard. 4.1.6. Confusion matrix to be worked out on the basis of Elephant class with respect to background. True Positive: Elephant is present and detected also. True Negative: Non detection of object in the background other than elephant. False Positive: Detection of any other object in the background as Elephant. False Negative: Non detection of elephant as Elephant. In case of multi class confusion matrix, evaluation shall be done with respect to Elephant class		

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Clause No.	Description of Provisional Draft	Discussion/ decision of committee members	RDSO Remarks
4.2	**GPS feature and logging of Events** The system should have GPS feature for synchronization of real time clock of the system, Logging of coordinates of the events/autonomous alarm with time stamp in the system.	No change in para is required	Nil
4.3	**Field Of View (FOV)** Imaging system should enable to detect whether elephant is on the same track or not and virtual fencing on both sides at a distance of 2.5 m from centerline of the track is desirable. Horizontal Field of View should be approx.6.5 Degree.	No change in para is required	Nil
4.4	**Anti-blooming mechanism** The system shall have an anti-blooming mechanism to prevent obscuring of information due to the bright source (headlight of passing locomotive or any other blooming effect).	No change in para is required	Nil
4.5	**System sensitivity** Thermal imaging camera, the Noise Equivalent Temperature Difference (NETD) of the system should be lower or equal to 60mK in the full operating temperature range. If the recommended NETD is not used, firm may furnish the NETD for selected camera with justification to meet the functional requirement with their offer for their design appraisal.	No change in para is required	Nil

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<table>
<tr><th>Clause No.</th><th>Description of Provisional Draft</th><th>Discussion/ decision of committee members</th><th>RDSO Remarks</th></tr>
<tr><td>5</td><td>Environmental condition
Image quality is often limited by scattering caused by particles present in the imaging medium by losing contrast and resolution. Followings are to be considered in design & development of the system:
• Extreme fog conditions (sometimes normal visibility up to 5 meters)
• Requirement of very fast real time image processing / stabilization system
• High vibration of train in real time (loco speed up to 160 kmph)
• Environmental protection (heavy rain fall, humidity, oil/dust inside the loco etc.)
• High temperature variations
Following Environmental condition is given for reference purpose.
Table 1
<table>
<tr><td>Atmospheric temperature</td><td>Maximum temperature of metallic surface under the sun: 75ºC.
Minimum temperature: -10ºC (Also snow fall in certain areas during winter season.)</td></tr>
<tr><td>Reference site conditions</td><td>Ambient temperature: 50ºC
Humidity: 95-100%
Altitude: 1776 m above mean sea level</td></tr>
<tr><td>Humidity</td><td>100% saturation during rainy season</td></tr>
<tr><td>Rainfall</td><td>Very heavy in certain areas</td></tr>
<tr><td>Atmospheric conditions</td><td>Extremely dusty and desert terrain in certain areas. The dust content in air may reach a high value of 1.6 mg / m³ inn many iron ore and coal mine areas, the dust concentration is very high affecting the filter & air ventilation system.</td></tr>
<tr><td>Coastal area</td><td>Humid & salt laden atmosphere with maximum pH value of 8.5, sulphate of 7 mg per litre, maximum concentration of chlorine 6 mg per litres and maximum conductivity of 130 micro siemen/cm</td></tr>
<tr><td>Wind speed</td><td>High wind speed in certain areas, with wind pressure reaching 150 kg/m2</td></tr>
</table></td><td>No change in para is required</td><td>Nil</td></tr>
</table>

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Clause No.	Description of Provisional Draft	Discussion/ decision of committee members	RDSO Remarks
6	6.1 The system should be user friendly as well as hands free to the extent possible. 6.2 The system will be highly rugged for external environment, which will be tested as per IEC-60571 and IEC-60529 standards. 6.3 Proper vibration isolation technology should be provided for the system at physical level. 6.4 Video stabilization algorithms to stabilize real time videos may be provided, if required. 6.5 Hermetic sealing shall be provided for critical components mounted outside the cab with minimum IP-65 level which will be tested as per IEC-60529 standard. 6.6 Every component of the system shall be mounted on locomotive itself. The system shall be self-sufficient and there shall not be any installation on the track side. 6.7 Device must work in all types of weathers encountered in India, including rain, fog conditions, etc. as mentioned in Para 5. 6.8 The device must not distract the driver of locomotive with too many alarms/blinking lights/flasher etc. during the course of his normal working and especially when no abnormal conditions are existing on the track ahead. 6.9 The Display in front of the Loco Driver must show all alarms/blinking/lights/flasher etc in case of abnormal conditions with this device so as to avoid distraction of Loco Driver to watch at different places for such alerts/alarms. 6.10 The display before the driver of the locomotive should support colour display. Visuals on the screen should be uncluttered with only relevant information being displayed. The elephant so detected should be in bounded box with distinguished colour on the display. 6.11 The device must record Display recordings in clear video format for post-event analysis. The storage capacity must be sufficient to store at least 7 days of video. Industrial grade Solid state drive should be used for storing the data. 6.12 The video so stored as above must be in a format that can be copied to a portable Hard Disk (USB) or a USB flash drive using software that shall be a part of the system installed on locomotive and it should be possible to simply copy it without need for any other devices. Quality of video so transferred should be as clear as the original video. The downloaded video should overlay the Camera no., Timestamp and the co-ordinates of the location obtained from GPS. Recorded and live video should overlay the detection box for elephant, GPS time, GPS co-ordinate, Loco No., Cab Location.	No change in para is required	Nil

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Clause No.	Description of Provisional Draft	Discussion/ decision of committee members	RDSO Remarks
	Enable/Disable feature of Auto Braking System through ATLAS is mandatory. The system software should be configurable as such it should not require modification in the software for change in the user settable parameters. List of other user settable parameters will be provided by the firm as per their design for meeting the functional and technical requirements 6.13 Suitable event data logging feature should also be provided that can be copied to a USB flash drive in the ASCII format with the Date Time stamp, auto alarm generation, co-ordinate of location, braking trigger status from the system and the speed from GPS. 6.14 If the imaging system device fails, then it should give a positive indication to the driver/loco pilot that the system has become inoperative/ unreliable/ defective. This should be an act of positive alarm to the driver. Such alarm/warning should be acknowledged by the driver through a positive act of acknowledgement. 6.15 The system video output shall be according to the following specification: 6.15.1 Video resolution of display shall be at least XGA (1024x768 pixels). 6.15.2 Video refresh rate of Display shall be at least 30Hz. 6.15.3 Video latency of the system shall be less than 100 mSec 6.15.4 Detector resolution for IR camera shall be minimum VGA 640 x480pixel. 6.15.5 Display Unit size should be minimum 10.1” 6.16 System control shall preferably be implemented by a HMI with touch panel for display which uses a multi-mode display and context sensitive keys (like a mobile phone) or with buttons. Resolution and pixels size shall be informed by the supplier as mentioned at Annexure-1(B). 6.17 The ATLAS System shall be powered from the locomotive battery power supply of 74 volts DC (for HHP locos) or 72 volts DC (for ALCO locos) and 110V DC (for Electric Loco, DEMU, EMU and MEMU). The offered design shall accommodate the voltage variation permitted as per IEC 60571. System shall be designed to minimize the power requirement. Maximum permitted Power requirement is 300W The electromagnetic compatibility inside the locomotive shall be as per IEC-62236. System shall be designed to minimize the power requirement. The electromagnetic compatibility inside the locomotive shall be as per IEC-62236. 6.18 LWIR Camera should be installed at suitable location. Mounting arrangement of camera shall be such that clear view is available and it is robust to sustain and isolate jerk and vibration experienced while locomotive running.		

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	6.19 Overall dimension, Weight with location of fitment in loco for ATLAS System and its sub assembly should be furnished by the firm before Prototype Inspection. However, the overall dimension and weight of the equipment should be able to be accommodated in the space available in the driving cab of both diesel and electric locomotives, without causing any inconvenience to the driver in having clear view ahead and discharging his functions. It is desired that the system mounted inside the cab should be housed in one enclosure It is recommended to visit the diesel loco and electric loco for understanding the space availability for fitment of the System. HMI (Display for Video) shall be installed for clear view to the Loco pilot in the cab of the locomotive. 6.20 The components installed at the locomotive's exterior shall not infringe the maximum moving dimension. The Drawing indicating maximum moving dimension of loco is attached at Annexure-3. 6.21 Anti-pilferage and vandal proof mechanism should be provided for external equipment. 6.22 Connectors used with ATLAS System should be compliant to MIL standard or equivalent. 6.23 The system shall run built in self-test on power up, and could give warning to the driver if the system fails and is not functioning as expected. 6.24 Power up time shall be less than 2 minute. 6.25 System should preferably be portable so that it can be easily dismounted from one locomotive and mounted on the other locomotive. 6.26 System should preferably be mountable on the rooftop of the locomotive with proper locking mechanism. 6.27 In low temperature climatic conditions there is a chance of condensation (moisture) on the external surface of the front lens of the camera, thus a proper mechanism may be provided to tackle this unwanted condition. 6.28 Firm has to submit the detailed technical report on functional trials. This Report shall mention exclusive Para on the relation between autonomous recognition range, pixel size of image and locomotive speed. 6.29 Firm shall submit Annexure-1(B). 6.30 Normally Open potential free contact (rated upto 110 V @2 Amp) to be provided by the system, which should hold for 40 seconds (configurable) in case of detection of Elephant for interfacing with the existing Brake system of Locomotive		

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Clause No.	Description of Provisional Draft	Discussion/ decision of committee members	RDSO Remarks
7	**Life cycle management** The equipment supplier shall ensure that the lifecycle requirements of the equipment be met as detailed in the paragraphs below.	No change in para is required	Nil
7.1	**Expected life** The expected life of the equipment shall be 12 years or more.	No change in para is required	Nil
7.2	**Support during lifetime** The equipment manufacturer shall ensure that the following support is available on demand during the equipment lifetime: • Service / spares support for the equipment • Options for comprehensive maintenance contract • Modifications in equipment design to meet new requirements or to improve reliability The options for demanding these support services shall be reserved by the Indian Railways and the equipment manufacturer shall provide the same on demand. Note: Cost of the services shall be determined through a mutually acceptable process between the manufacturer and the users on the Indian Railways.	No change in para is required	Nil
7.3	**End of equipment life management** The equipment manufacturer shall provide options to upgrade / refurbish equipment at the end of life of the equipment when requested by the Indian Railways.	No change in para is required	Nil
8	**Safety requirements** The equipment shall meet all statutory and regulatory criteria required for public safety. The device must be safe in all respects to humans – both to locomotive personnel and to trespassers on railway track who are being scanned and imaged.	No change in para is required	Nil

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Clause No.	Description of Provisional Draft	Discussion/ decision of committee members	RDSO Remarks
9	**Tests and Trials** **9.1 Testing** **9.1.1 Testing to be done during Prototype Inspection:** This shall be done as per details attached at **Annexure-2(A)** at firm"s premises or at lab accredited by NABL/accreditation bodies, which are Signatories to Mutual Recognition Arrangement of the International Laboratory Accreditation Co-operation (ILAC) or Asia Pacific Accreditation Co-operation (APAC). **9.1.2 Fitment Trials in Loco** Fitment trials of the ATLAS system shall be carried out as per **Annexure-2(B)** in the shed after mounting the system in the locomotive. **9.1.3 Functional Trials** Functional Trials comprising of Static and Dynamic Trials shall be conducted with the system mounted on Locomotive in real condition. Format for Functional Trials on loco is attached at **Annexure-2(C)**. **9.1.4 Field Trial** Based on the compliance of the above, field trials (six months period for one locoset) for performance evaluation shall be closely monitored and evaluated by RDSO for: □ Reliability under actual operating conditions □ Advantages for locomotive operation □ Maintainability of the system Notwithstanding anything that may be specified in this specification, the final responsibility for the suitability of the design and complete integration shall lie with the supplier and shall carry out all modifications for satisfactory functioning during the period of field trials.	No change in para is required	Nil

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<table>
<tr><th>Clause No.</th><th>Description of Provisional Draft</th><th>Discussion/ decision of committee members</th><th>RDSO Remarks</th></tr>
<tr><td>10</td><td>Documents required from Firms
Documents required at different stages of the development are listed below:
10.1 List of Documents to be furnished by Firms along with the offer:
Table 2
<table>
<tr><th>Sr No</th><th>Description of the Document</th><th>Relevant clause of Specification</th><th>Annexure of proforma</th></tr>
<tr><td>1</td><td>Proforma for Scope of Supply</td><td>3</td><td>Annexure-1(A)</td></tr>
<tr><td>2</td><td>Proforma for Design detail and Functional Requirement</td><td>4&6</td><td>Annexure-1(B)</td></tr>
<tr><td>3</td><td>Proforma for Undertaking by Equipment manufacturer</td><td>14</td><td>Annexure-1(C)</td></tr>
<tr><td>4</td><td>Proforma for Declaration of Confidentiality</td><td>15</td><td>Annexure-1(D)</td></tr>
<tr><td>5</td><td>Proforma for Undertaking for confidentiality of Data</td><td>16</td><td>Annexure-1(E)</td></tr>
<tr><td>6</td><td>System Design Document</td><td>3,4,6 & 8</td><td>Annexure-1(F)</td></tr>
</table>
Note: Documents listed above at clause 10.1 shall be submitted as part of the offer. All fields of proforma are mandatory unless otherwise specified.</td><td>No change in para is required</td><td>Nil</td></tr>
</table>

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<table>
<tr><th>Clause No.</th><th>Description of Provisional Draft</th><th>Discussion/ decision of committee members</th><th>RDSO Remarks</th></tr>
<tr><td>10.2</td><td>List of Documents to be furnished by Firms before Prototype Inspection:
Table 3
<table>
<tr><td>Sr No.</td><td>Description of the Document</td></tr>
<tr><td>1</td><td>Test protocol for prototype inspection and Acceptance Test Procedure #</td></tr>
<tr><td>2</td><td>Performance specification of the equipment</td></tr>
<tr><td>3</td><td>Test certificates and test compliance of outsourced components.</td></tr>
<tr><td>4</td><td>Overall dimension and Weight of major components with location of fitment in loco</td></tr>
<tr><td>5</td><td>List of User settable parameters for operator.</td></tr>
<tr><td>6</td><td>Installation, commissioning, operation, maintenance and troubleshooting manuals*</td></tr>
<tr><td>7</td><td>Parts catalogue*</td></tr>
<tr><td>8</td><td>LRU (line-replaceable unit) module details, if any*</td></tr>
<tr><td>9</td><td>List of consumables and Must-Change spare(as per Schedule Maintenance) and Essential spares (required for breakdown maintenance)*</td></tr>
<tr><td>10</td><td>Any other document which is essential for operation, testing and operational safety health hazards pertaining to equipment</td></tr>
</table>
Irrespective of the details brought out here, all information and documentation which are essential for operation, testing and maintenance of the equipment supplied shall be submitted on request of Indian Railways.
Note :
* Marked document is not mandatory to be submitted before Prototype Inspection. However, it should be submitted before field trials clearance.
# Test protocol may include any other test as deemed necessary by OEM, apart from the tests mentioned in Annexure 2(A)</td><td>No change in para is required</td><td>Nil</td></tr>
</table>

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Clause No.	Description of Provisional Draft	Discussion/ decision of committee members	RDSO Remarks
11	**Warranty** The complete system with controls shall be warranted for satisfactory and trouble free operation in conformity with the “Special Condition of Tender”. All aspects of workmanship and design shall be covered by this warranty. The supplier shall immediately provide arrangement for rectification of failures reported under warranty. Warranty period of any equipment of the system may be extended as per mutual agreement between purchaser and supplier if the equipment has undergone major design modifications during the warranty period.	No change in para is required	Nil
12	**Marking and Packing** Each equipment shall bear for identification serial number, type, year of manufacture, manufacturer‟s name as well as important parameters/ratings. All equipment of the complete system shall be suitably packed in strong water proof boxes to prevent any damage during transit and handling.	No change in para is required	Nil
13	**Training** The supplier shall train IR personnel in operation and maintenance of the offered System. The equipment manufacturers shall arrange training for operations and maintenance of the equipment, as an integral part of the equipment supply.	No change in para is required	Nil
14	**Undertaking by equipment manufacturer** Vendor shall provide a signed copy of the undertaking on “INFRINGEMENT OF PATENT RIGHTS” along with the offer. The undertaking shall be as per proforma at Annexure-1(C).	No change in para is required	Nil
15	**Declaration of confidentiality of submitted documents by manufacturers** While submitting a new proposal/design, manufacturer must classify their documents confidentiality declaration along with the offer as per proforma at Annexure-1(D).	No change in para is required	Nil

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Clause No.	Description of Provisional Draft	Discussion/ decision of committee members	RDSO Remarks
16	**Undertaking for Confidentiality of Data** The firm shall furnish the signed copy of “Undertaking for confidentiality of Data” along with the offer. The undertaking shall be as per proforma at Annexure-1(E).	No change in para is required	Nil

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<table>
<tr>
<td></td>
<td>
Annexure-1(A)
Proforma for Scope of Supply as per clause 3 (Ref. Clause 10.1 of this specification)
<table>
<tr><th>SN</th><th>Component name</th><th>Whether Part of Scope of Supply (Yes/No)</th><th>Remarks (If any)</th></tr>
<tr><td>1</td><td>Thermal Cameras (LWIR) with processing units – 02 Sets (One at either end of loco)</td><td></td><td></td></tr>
<tr><td>2</td><td>Display Unit (not less than 10.1” display size) – 02 sets (one on each control desk)</td><td></td><td></td></tr>
<tr><td>3</td><td>DC-DC Converter as applicable to the type of Locomotive (Input supply 72 V for Diesel Loco or 110 V for Electric Loco)</td><td></td><td></td></tr>
<tr><td>4</td><td>GPS Module</td><td></td><td></td></tr>
<tr><td>5</td><td>Any other equipment,(if any)</td><td></td><td></td></tr>
</table>
</td>
<td>No change in para is required</td>
<td>Nil</td>
</tr>
</table>

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Annexure-1(B)
Proforma for Design detail and Functional Requirement (Ref. Clause 10.1 of this specification):

SN	Parameters of Design document	Clause of the specification	Whether provided (Yes/No) or Value	Reference page of System design document as per Annexure-1 (F)	Remarks(If any)
1.	Type of camera used (SWIR/MWIR/LWIR/NIR/ Day camera/CCD)	**3**			
2.	Display size	**3**			
3.	DC-DC Converter	**6.17**			
4.	Accuracy Of Detection	**4.1.3**			
5.	GPS feature	**4.2**			
6.	Horizontal Field Of View (FOV)	**4.3**			
7.	Dead Zone (Camera located at height of 4.2 m from ground)	**4.3**			
8.	Anti-Blooming Mechanism	**4.4**			
9.	Noise Equivalent Temperature Difference (NETD) of the system (In case of Thermal camera)	**4.5**			
10.	IP rating of exterior mounted device	**6.5**			

No change in para is required

Nil

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	11.	Video refresh rate	**6.15.2**				
	12.	Video latency of the system	**6.15.3**				
	13.	Video Display resolution	**6.15.1**				
	14.	Detector resolution for IR camera	**6.15.4**				
	15.	SSD Memory size	**6.11**				
	16.	Type of display(Touch/push button)	**6.16**				
	17.	Power requirement(watts)	**6.17**				
	18.	Approximate Envelop size (Cubic dimension) of the equipment to be mounted inside cab	**6.19**				
	19.	Anti-pilferage and Vandal Proof Mechanism	**6.21**				
	20.	Connectors Standard	**6.22**				
	21.	Power up time	**6.24**				
	22.	Potential free contact	**6.30**				
	23.	Compliance of Safety requirement	**8**				
	24.	Additional information (if any)					

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	Annexure-1(C) **Proforma for Undertaking by equipment manufacturer (Ref. Clause 14 of this specification): Date:** **Undertaking by equipment manufacturer** Indian Railways shall not be responsible for infringement of patent rights arising due to similarity in design, manufacturing process, use of similar components in the design & development of this item and any other factor not mentioned herein which may cause such a dispute. The entire responsibility to settle any such disputes/matters lies with the manufacturer/ supplier. Details / design/documents given by us are not infringing any IPR and we are responsible in absolute and full measure instead of railways for any such violations. Data, specifications and other IP as generated out of interaction with railways shall not be unilaterally used without the consent of RDSO and right of Railways / RDSO on such IP is acceptable to us. **(Signature with Name & Designation of authorized signatory)** **(Seal of the equipment manufacturer)**	No change in para is required	Nil
	Annexure-1(D) **Proforma for Declaration of confidentiality (Ref. Clause 15 of this specification):** **Declaration of confidentiality Date:** This document and its contents are the property of M/s XYZ(Name of the vendor) or its subsidiaries. This document contains confidential proprietary information. The reproduction, distribution, utilization or the communication of this document or any part thereof, without express authorization is strictly prohibited. Offenders will be held liable for the payment of damages. Indian Railways/RDSO is granted right to use, copy and distribute this document for the use of inspection, operation, maintenance and repair etc. **(Signature with Name & Designation of authorized signatory)** **(Seal of the firm)**	No change in para is required	Nil

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	Annexure-1(E) **Proforma for Undertaking for confidentiality of Data (Ref. Clause 16 of this specification):** **Undertaking for confidentiality of Data Date:** The GPS Mapped Data provided by Indian Railways and the data generated during the Proof of concept trials are the sole property of Indian Railways and shall not be shared in any form by us to any third party without the written consent of RDSO. Data generated will be furnished to RDSO in readable file format of General PC. We shall seek written permission for using this data for any purpose other than ATLAS System. **(Signature with Name & Designation of authorized signatory) (Seal of the firm)**	No change in para is required	Nil
	Annexure-1(F) **System Design Document** The Document shall contain broad concept of design. It shall broadly mention the following; □ Overall functional description of the system □ Description of Technology used □ Description of major components/sub-assemblies □ Schematic diagram of the system □ Parameters as mentioned in Annexure-1(B) □ Standard data sheet of major components (If any)	No change in para is required	Nil

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<table>
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Annexure-2(A)
Tests on Cards, Display Unit & Other Electronic Equipment (Ref. Clause 9.1.1 of this Specification) (1) Tests as per IEC-60571 (Clause 6.2 of this specification):
<table>
<tr><th>Sn</th><th>Reference Standard – Cluse No.</th><th>Test Details</th><th>Type Test</th><th>Routine Test</th></tr>
<tr><td>i</td><td>I EC 60571 – 12.2.2</td><td>Visual Inspection</td><td>√</td><td>√</td></tr>
<tr><td>ii</td><td>I EC 60571 – 12.2.3</td><td>*Performance Test with simulation/ Functionality tests</td><td>√</td><td>√</td></tr>
<tr><td>iii</td><td>I EC 60571 – 12.2.4</td><td>Cooling Test(low temp.storage)</td><td>√</td><td></td></tr>
<tr><td>iv</td><td>IEC 60571 – 12.2.5</td><td>Dry Heat Test</td><td>√</td><td></td></tr>
<tr><td>v</td><td>EC 60571 – 12.2.6</td><td>Damp Heat Test</td><td>√</td><td></td></tr>
<tr><td>vi</td><td>I EC 60571 – 12.2.7</td><td>Supply over voltages</td><td>√</td><td></td></tr>
<tr><td>vii</td><td>I EC 60571 – 12.2.8.1</td><td>Surges</td><td>√</td><td></td></tr>
<tr><td>viii</td><td>I EC 60571 – 12.2.8.2</td><td>Electrostatic Discharge Test</td><td>√</td><td></td></tr>
<tr><td>ix</td><td>I EC 60571 – 12.2.8.3</td><td>Transient Burst Susceptibility test</td><td>√</td><td></td></tr>
<tr><td>x</td><td>I EC 60571 – 12.2.9</td><td>Radio interference Test</td><td>√</td><td></td></tr>
</table>
</td>
<td>No change in para is required</td>
<td>Nil</td>
</tr>
</table>

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xi	I EC 60571 – 12.2.10	IR Test	√	√
xii	I EC 60571 – 12.2.10.3	HV Test	√	√
xiii	I EC 60571 – 12.2.11	Salt Mist Test	√	
xiv	I EC 60571 – 12.2.12 IEC 61373	Vibration and Shock Test	√	
xv	I EC 60571 – 12.2.15	Low temperature storage test	√	

* Performance Test shall also include following:

Sn	Particulars	Ref. Clause of the Specification
a.	Verification of working of Camera display in day and night conditions	4.1
b.	Verification of detection of adult elephant.	4.1
c.	Verification of alert after detection.	4.1
d.	Demonstration of identification of fixed structure through GPS	4.2
e.	Verification of Field Of View (FOV)	4.2
f.	Verification of Dead Zone (at 4.2 m height)	4.2
g.	Verification of Anti Blooming mechanism	4.4
h.	Verification of test certificate of NETD & FOV	4.5 & 4.2

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	i.	Verification of Keypad functionality	6.1 & 6.16		
	j.	Demonstration of Alarm on detection of obstruction & its verification on display	6.9 & 6.14		
	k.	Verification of Data downloading in the system	6.11		
	l.	Verification of Test certificate/Data sheet of SSD device	6.11		
	m.	Verification of Data Recording in the system	6.11 & 6.13		
	n.	Verification of Alarm generation/Display in case of fault in the system	6.14		
	o.	Verification of Test certificate of Video resolution of camera	6.15.1		
	p.	Verification of Test certificate of refresh rate	6.15.2		
	q.	Verification of working of Power supply unit	6.17		
	r.	Verification of Test certificate of Connectors	6.22		
	s.	Verification of Self-test at Power up	6.23		
	t.	Verification of Power up time	6.24		
	u.	List of User settable parameters for operator	10.2		
	v.	The performance of the overall system shall be verified at firm"s premises by testing the system in physical environmental conditions prevailing at the time of testing	4		

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	(2) Test as per IEC-60529 (Clause 6.2 of this Specification): Ingress Protection (IP) Test - This test shall be conducted as per IEC-60529 standard with minimum required level of IP-65 for equipment mounted to the exterior of cab for prototype unit. **(3) Test as per IEC-62236 (Clause 6.17 of this Specification) :** Test certificate from accredited agency for compliance of ATLAS System as per IEC-62236 is required. **(4)** Any other test as deemed necessary by RDSO to meet the requirement of specification will be done.	No change in para is required	Nil

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Annexure-2(B)
Fitment Trials in Loco (Clause 9.1.2 of this Specification):

SN	Work to be done during fitment trial	Ref. Clause of the Specification	Observation	Remarks
1	Measurement of Display size. There should not be any mars, dents, damages to the display screen.	**3.0**		
2	C heck the functionality of system in all the modes.	**4.0**		
3	No. of adjacent Rails (wide range visibility) seen through display in shed.	**4.3**		
4	Checking of anti-blooming mechanism to prevent obscure of information due to the bright source (headlight of passing locomotive or any other blooming effect).	**4.4**		
5	The keypad module should not have any damaged keys on it. All the legends should be clearly visible.	**6.1 & 6.16**		
6	Check the Cable/wire routing and proper connections. The connectors should	**6.2 & 6.22**		

No change in para is required	Nil

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	not have any damage on the outer body/pins. The cables should not have any cuts, braises or damage to it .						
7	Check the proper mounting of Camera, Display, Keyboard and Power Supply modules of ATLAS system.	**6.16, 6.17, 6.18 & 6.19**					
8	Check for safe tapping of Power Supply.	**6.17 & 8**					
9	Check if any visibility obstruction to Loco Operator due to display.	**6.18**					
10	Check anti-pilferage and vandal proof mechanism for external equipment.	**6.20**					
11	Check system"s built-in self-test feature on power up and warning to the driver if the system fails and is not functioning as expected.	**6.23**					
12	Check for Power up time	**6.24**					

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13	Any other as required by railways					

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	Annexure-2(C) **Functional Trials on Loco (Clause 4.1 & 9.1.3 of this Specification)**	No change in para is required	Nil

Trial Data for wayside Fixed Target						
Date		Loco No.		System (Make & sl. No.)		
Location code : Gateman (G), Level Crossing Building(L), Illuminated object on Level-X (I), Signal (S), Station Building (B),Simulated object(SO) placed at mapped location						
Location Code	Distance in mtr. Object			Loco Speed (Kmph)	Time	Remarks Fog, Clear, Rain, Blooming etc.
	GPS Distance indicated on ATLAS	Image sighted through system Display	Image sighted thorough Lookout Glass			
G/L/I/S/SB/SO	GPS Reading	Fog Pass Reading	Fog Pass Reading			

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Trial Data for Obstacle Target

Date		Loco No.		System (Make & Sl No.)					
Temporary/ Animal (Elephant)	Object Sighted through			Object Crossed (2)	Distance (1)-(2)			Loco Speed (Kmph)	Time (24 hrs format)	Remarks Fog, Clear, Blooming Etc
	Audio/ Visual Detection ATLAS	ATLAS Display	Lookout Glass		Audio/ Visual Detection ATLAS	ATLAS Display	Lookout Glass			
Elephant	Fog Pass	Fog Pass	Fog Pass	Fog Pass						

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	reading	**reading**	**reading**	**reading**						

Note:
1. Any other measurement as deemed necessary by RDSO to meet the requirement of specification will be done
2. Distance measurement may also be carried out by any other ranging system.
3. Visuals recorded in **ATLAS** System will also be utilized for post event data analysis.

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