EXPRESSION OF INTEREST (EOI)

For

Identification of Indian Industry for Setting up of Infrared Scene Generation and Projection System based Hardware-in-the-loop (HIL) Test facility for Electro-Optical (EO) Sensors

Instrument Research & Development Establishment (IRDE)

Dehradun

Defence Research & Development Organization (DRDO)

Government of India, Ministry of Defence

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Brief Introduction of Lab/Estt:

Instrument Research & Development Establishment is a Lab of Defence Research & Development Organization (DRDO), under Ministry of Defence and is situated at Raipur Road, Dehradun, Uttarakhand, India - 248008. IRDE is involved in research & development in the field of Electro-optical Instrumentation.

1. Objective of EOI:

The broad objective of this EOI are as follows:

- This EOI is being published to get the proposal of Indian Industry for setting up of Infrared Scene Generation and Projection System based Hardware-in-the-loop (HIL) Test facility for Electro-Optical (EO) Sensors.
- The lab is in the process of pre-qualification of the Indian industries based on their responses for this EOI and its evaluation by a Technical Assessment Committee (TAC).
- Subsequently, an RFP will be floated on Limited Bidding Mode (LBM) to obtain techno-commercial proposal from qualified Indian industries post evaluation of this EOI. The industry offering lowest bid (L1) (subject to the fulfillment of all the techno-commercial conditions of RFP) will be chosen for the placement of order.
- The Indian Industry should have domain knowledge about this kind of activity. It should also possess human resources, which are highly skilled and capable of understanding and executingthe work mentioned in the subsequent section.
- The EOI is being issued with no financial committement, and the Ministry of Defence reserves the right to withdraw the EOI and change or vary any part thereof at any stage. The Government of India and the agency nomiated by GOI (DRDO) also reserves the right to disqualify any prospective industry should it be so necessary at any stage on grounds of National Security.

2. Introduction

IRDE is working on development of different advanced EO system like Infrared Search and Track (IRST) systems, Electro-optical fire control systems, Optical Sensor Shield (OSS), Compact Airborne Multi-sensor Optronic Payload (CAMOP), long range target detection system etc. For development of these systems automatic target detection and tracking of multiple threats (or targets)

in varied environment and clutter are required. Development of these systems and their performance evaluation require that these systems to be extensively test for their response to the maximum possible operational scenario (scene) with single and multiple threats. Using Infrared Scene Projectors (IRSP) based hardware-in-the-loop (HIL) test facility, performance of these system can be evaluated inside the laboratory. The HIL facility provides user to project the simulated scene equivalent to the actual operational scenarios. The IRSP based HIL facility will drastically reduce the required flight/field trials and therefore will reduce the development time and cost of different systems. IRDE intends to develop the HIL test facility with Indian industries only and would assess the firm's capabilities in this direction, as per the scope of work given below.

3. Technical specifications (brief):

Hardware-in-the-loop facility will be used to test & evaluate the performance of Electro-optical systems. The infrared scene Simulation and Infrared scene emitter with optical projection system along with the Flight Motion Simulator (FMS) and Target Motion Simulator (TMS) are key elements of the infrared imaging hardware-in-the-loop (HIL) facility.

Typical block diagram of this test facility is shown in Figure 1.

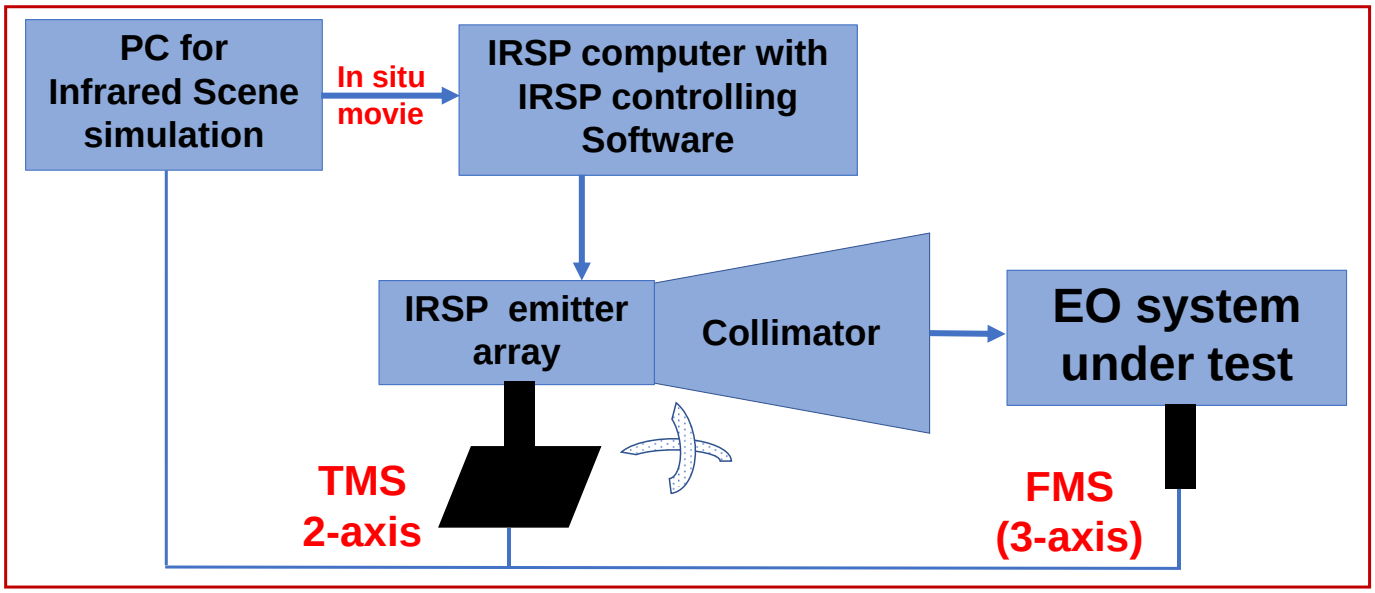

Figure 1: Typical Block diagram of HILS Facility for EO Sensor, where two axes of the TMS are azimuth and elevation. The Flight Motion Simulator (FMS) is three axes stage which are Yaw, pith and roll.

Abbreviations:

- *VMIC: Memory Interface*
- *CIGI: Common Image Generator Interface*
- *UUT: Unit Under Test*

To test and carry out performance evaluation, the UUT should be mounted on the Flight Motion Simulator (FMS) and infrared scene projection optical system to be also mounted on high precision target motion simulator (TMS). The FMS and TMS will be three-axis and two-axis motion stage as shown in the Figure 2.

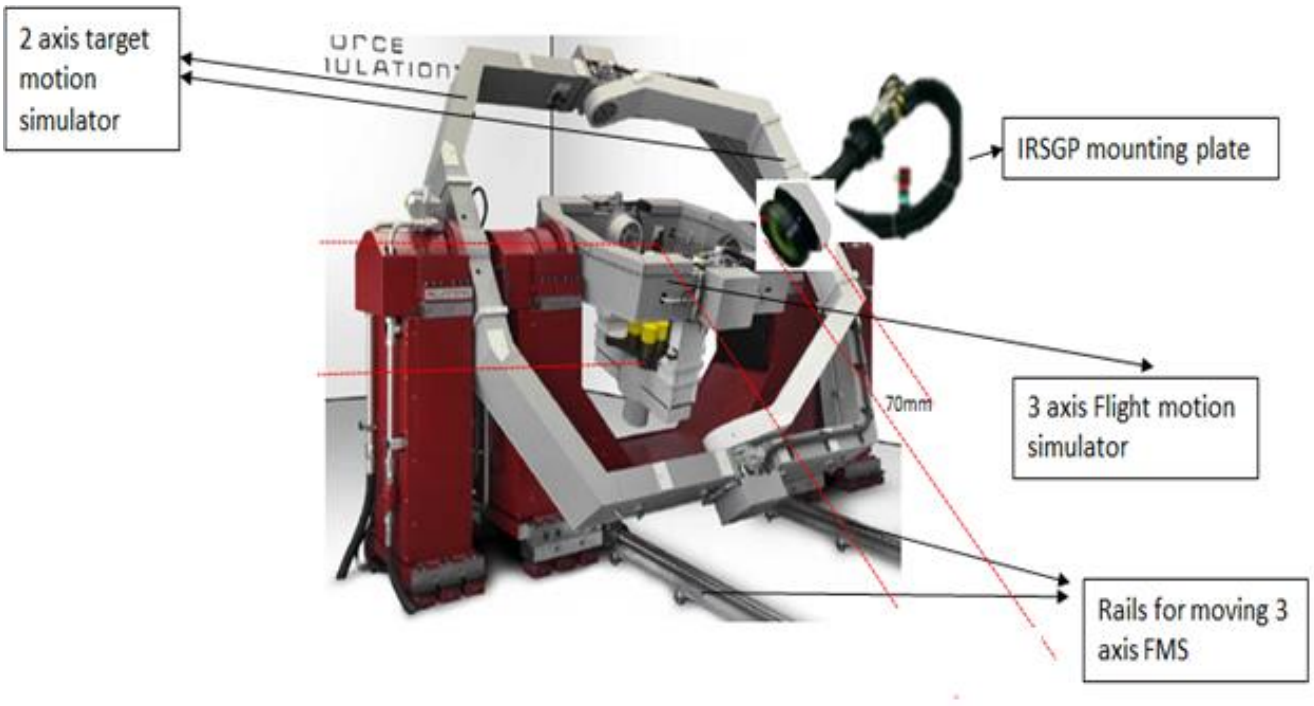

Figure 2: Indicative figure for motion stages for HIL setup. Arrangement of The FMS and TMS are shown with the IR scene projector and collimator unit is mounted on the TMS. The UUT will be mounted on FMS (3-axis).

Complete HIL test facility will have the following subsystems or/ technologies:

(I) Infrared Scene simulation and projection: this will be consisting of

(A) Infrared scene simulation system

(B) Infrared scene projection optical system

(i) Digital Emitter Engine (DEE) along with other subsystems

(ii) Suitable projection optical assembly (collimators)

(C) Calibration Radiometry System

(II) Precision mounting of UUT and IRSP

(i) Flight motion simulator (FMS)

(ii) Target motion simulator (TMS

(III) Integration of complete HIL facility for closed loop operation

The detailed technical specifications are as:

S. No.	Details	Comment by vendor
I	**(A) Infrared scene simulation system** Real-time, multi-spectral imaging sensor scene generator for simulating high frame rate sensor and projector system in the 0.2 - 15.0 micron spectrum. It should fully meet the scene generation requirements of a hardware-in-the-loop (HWIL) laboratory environment. It should consist of an integrated combination of unique subsystems, each with dedicated hardware and software components. Physics-based, real-time spectral EO/IR sensor scene simulator, to load materially-encoded targets and terrain to predict correlated, radiometrically-correct 2D sensor imagery for arbitrary sensor bands, under arbitrary weather conditions and spatio-temporal viewing locations. The high-fidelity simulation of arbitrary imaging sensor in the UV through far IR (0.2-15.0 μm) spectrum with highly-optimized, physics-based models for: ▪ Ephemeris ▪ Natural and man-made irradiance ▪ Full-transient, angle dependent thermal modeling based on material properties & user-defined boundary conditions ▪ Spectral BRDF reflection ▪ Signature synthesis and MODTRAN based atmospheric modeling ▪ Special effects and countermeasures ▪ Physics based sensor modeling, including all major optical, detector and electronics effects such as: o Diffraction and design blur o 3rd order optical aberrations o Motion & Platform jitter Blur o Gaussian, Poissan, 1/f noise o NVG haloing o Scanning effects o Gain, level, AGC	

Key features

Optical projection and digital injection mode.

Controllable target super-sampling

IR window dynamic heating

Dynamic target thermal signature

GUI based scenario generation

Physics based spectral signature synthesis

On-the-fly MODTRAN based atmospherics

Synchronized multi-channel capability

The Infrared scene simulation should consist of an integrated combination of unique subsystems, each with dedicated hardware and software components:

Scene simulation component	Specification requirement
(a) Host Control Unit (HCU)	• GUI based scenario and trajectory definition • Scenario and sensor parameters to SGU via CIGI • Position/orientation updates to SGU via CIGI • Automated configuration of SGU, DIU and, FGU • Tools to generate material classification for terrains and 3D models • Signature modelling tools
(b) Scene Generator Unit (SGU)	• Read scenario, sensor, and entity updates from host vis CIGI • Read ownship sensor position/orientation updates from user's real time simulation computer (RTSC) via VMIC or shared memory • Processes phenomenology and sensor physics to produce upto 16 bit (or more) imagery

(c) Digital Unit Interface (DUI)	• Direct digital injection of a simulated scene vis DVI, LVDS, camera link, MIPI, Aurora-fiber link or custom format • Video passthrough for IR Scene Projection • Customizable digital interface format capable • USB control from SGU or HCU specifies arbitrary Sync / frame rate, resolution, and windowing • 2x full-bandwidth Camera Link outputs • Genlock: source (house) or passthrough (UUT)
(d) Frame Grabber Unit (FGU)	• Capture high frame rate 16-24 bit video stream from scene generator for later playback
(e) Real-time simulation Computer Emulator (RTSC)	• Emulates the Unit-Under-Test (UUT) flight motion feeds into VMIC or shared memory

Sensor Plug-in should allow the user to easily create and simulate a dynamic tactical sensor scenario. In a Sensor-Plugin-enabled project, one should be able to load a 3D terrain database, specify any number of arbitrary sensors, atmospheric and weather conditions, place 3D vehicle models in the scene, and create sequence files to animate entity motion.

The SDK to be provided with customizable plugin code, so that one may perform different actions in a programmatic way while on-the-fly like:

- Sensor parameter changes
- Sensor position & orientation changes
- Vehicle active thermal region & undercarriage reflection state changes
- Environmental and Date/Time-of-Day changes (as long as these are also coordinated with corresponding changes to existing Unreal sun/sky assets, for OTW correlation).
- Programmatic capture and scenario-time-tagging of FPF image output.

Different Type of terrains data base with enough sizes and resolution, and land, air & sea based targets with their IR signature profile to be provided to carryout IR scene simulation and hardware-in-loop testing.

(B) Infrared scene projection optical system

The Infrared Scene Projector optical system will be composed of a Digital Emitter Engine (DEE) and Suitable projection optical assembly (collimators) with supporting mechanical stands and/or mounting hardware. When using the IRSP system with the infrared imaging System Under Test (SUT), there need to be two primary operational environment configurations: static and dynamic. Optical alignment of both the SUT and the IRSP system must be performed prior to suitable Hardware in the Loop (HWIL) testing.

(i) Digital Emitter Engine (DEE)

Parameters	Value
Spectral band	MWIR and LWIR
Emitter Array Resolution (or pixel image format)	1024×1024 or better
Pixel effective fill factor	>80%
Pixel Operability/ or Dead Pixels	>99.9% /< 0.1%
Effective/ Apparent Temperature Range	MWIR (): from lower than ambient temperature to > 1,500°C LWIR (): from lower than ambient to > 3,000°C
Amplitude dynamic range	Upto ≥14 bit
Amplitude Resolution	MWIR: 0.2°C at 1000°C LWIR: 0.2°C at 1500°C
Maximum Input frame rate	Up to 200Hz or more
Maximum 12-bit frame rate	>140 Hz
Thermal resolution (MWIR)	<50 mK at 320K <200 mK at 400K (or drive resolution)
Projected imaging beam	Collimated
Projected image size	200 mm

Projected minimum image size	8 mm
Post-correction nonuniformity	<1%
Frame update modes	Snapshot and raster
Input Scene Data	Suitable interface with the scene simulation software to give input and local memory image (video data) upload
Projected Imaging Beam	Collimated
10-90 % Radiance Rise and 90-10 % Radiance Fall Times	The IRSP 10-90 % Radiance rise time should be less than 6.5msec, The IRSP 90-10 % Radiance fall time should be less than 6.5msec For transitions between zero and maximum drive, when configured for raster update mode.
Noise Equivalent Step,	3-5 µm: maximum 5mK
Projector Assembly weight and size	Within the specifications provided for flight motion simulator (FMS) and target simulator, respectively.
Relative Humidity	< 50%
Acceleration	Should withstand and function upto ±7g of acceleration on both Y and Z axes.
Required System Features	• IRSP should provide continuous emission over the entire 3-12 micron band • Test stand for table top operations • Mechanical interfaces for mounting to projection optics and for focus and alignment optimization • Graphical user interface (GUI) for convenient control and monitoring of system operation.

	• Remote Control interface enabling an external computer to command IRSP functions and receive status information from the IRSP • DVI input interface capable of receiving streams of DVI image data at frame rates between 20 and 200Hz • Capability to load, process and project a sequence of images stored in on the local hard drive of the C&CE computer • Ability to capture image frames from the image data stream at multiple states of processing • Ability to update in either raster or snapshot mode • External frame synchronisation • User customizable real-time non-uniformity correction (NUC) • User-customizable pixel drive transformation lookup tables (LUTs) • Image Orientation control • Continuous built-in test (BIT), telemetry read back and failsafe monitoring.
For scene projection User Interface (GUI), a graphical front-end to the software to be provided that monitors and controls the operation of the Scene Projector. The GUIs should function to monitor and direct the operation of all the instruments involved in the time critical path.	

(ii) Suitable projection optical assembly (collimators)

The Infrared scene from the projector (or emitter engine) will be projected into the entrance aperture of the UUT. Different UUTs covering a wide range of FOVs will be tested by the IRSP facility. Therefore, suitable collimators or optical system to be provided to cover wide range of FOV.

Optical parameters	value
Spectral range	3 µm – 5 µm
Pupil diameter UUT	Up to 150 mm
FOV ranges	3° to 50 °
Line-of-sight (LOS) accuracy	≤±5 mrad
Optical performance	Near diffraction limited performance
Focus Adjustment	Manual: A procedure is required for the assessment of the focus quality.
Field of View Adjustment	Manual adjustment for setting and locking at the required FOV throughout FOV range; A suitable indication of the set FOV should be available
Optical Standoff Distance	All are required to provide for different FOVs for Element to FMS/TMS Centre of rotation
Mechanical Stand Off Distance	
Mechanical Protrusion Length	

(C) Calibration Radiometry System (CRS)

A CRS system to be included in the HIL facility. The CRS system should allow user to compare emitter output on pixel-by-pixel basis to the output of a blackbody, yielding a uniform and accurate radiant output over the full dynamic range of the emitter.

(II) Precision mounting of UUT and IRSP

For HIL test facility, the IRSP (along with the collimator in use) has to be mounted on the target motion simulator (TMS) and the UUT (or EO sensor) to mounted on the flight motion simulator (FMS).The IRSP along with the collimator has to be mounted as per the size and FOV of the UUT (EO sensor) to cover the complete entrance aperture of the UUT. The detailed specifications for FMS and TMS are as:

(A) Flight motion simulator (FMS): 3-axis platform with accessories for UUT

Specifications	Roll Axis	Yaw Axis	Pitch Axis
Angular freedom	continuous	continuous	continuous

Position			
Accuracy	Accuracy ≤2 arc sec	Accuracy ≤2 arc sec	Accuracy ≤2 arc sec
Command resolution	≤0.0001°	≤0.0001°	≤0.0001°
Repeatability	±0.0005°	±0.0005°	±0.0005°
Rate			
Range	800 deg/sec	300 deg/sec	300 deg/sec
Command resolution	≤0.0001°/s	≤0.0001°/s	≤0.0001°/s
Dynamic			
Bandwidth (-3 dB, w/ load)	55 Hz	40 Hz	35 Hz
Acceleration (w/ nominal load)	8,000 deg/sec^2	4,000 deg/sec^2	4,000 deg/sec^2
Mechanical			
Wobble	± 2 arc sec max	± 2 arc sec max	± 2 arc sec max
Orthogonality	≤10 arc sec	± 10 arc sec	
Intersection of Axes	± 0.025 in		

Should allow details for UUT to be mounted:

Mass (max)	200 kg (or more)
Maximum envelope	500mm x 500mm x 500mm (Approximately)
Sliprings to UUT	Signal 90 ways, 2 A @ 150VDC Power 8 ways, 20 A @ 400VAC (custom options available)

(B)Target Motion Simulator (TMS)

On target motion simulator, IRSP with suitable collimator for projection of the dynamic scene into the entrance aperture of the UUT will be mounted.

Motion Simulator should have three degrees of-freedom with high torsional stiffness.

Since the gimbals/scanning (or movement) of the light-of-sight of UUT are to be done symmetrical about the axis of rotation, the balancing weights to minimize or compensate for unbalances due to the payload will be provided.

Specifications for the target motion simulator are:

Specifications	**TMS**

	Azimuth	Elevation
Angular freedom	continuous	± 90 deg

Position		
Accuracy Command resolution Repeatability	± 2 arc sec 0.00001 deg ± 1 arc sec	± 2 arc sec 0.00001 deg ± 1 arc sec
Rate		
Range	250 deg/sec	250 deg/sec
Command resolution	± 0.00001 deg/sec	± 0.00001 deg/sec
Range Command resolution		
Dynamic		
Bandwidth (-3 dB, w/ load)	17 Hz	14 Hz
Acceleration (w/ nominal load)	500 deg/sec2	500 deg/sec2
Mechanical		
Wobble	± 2 arc sec max	± 2 arc sec max
Orthogonality	± 10 arc sec	
Intersection of Axes	± 0.025 in	

Major Simulator Dimensions (Approximately)	
Simulator (L x W x H)	230 in x 96 in x 182 in (Approximately)
Maximum operating space (L x W x H)	230 in x 208 in x182 in (Approximately)
Payload / table top height (from floor)	78 in (Approximately)

III **Integration of Complete facility for closed loop operation**

TO test different EO sensors, integration of (i) IR scene simulation and projection, (ii) Infrared scene projection (IRSP) and collimator, (iii) IRSP and collimator with target motion simulator, (IV) provision to mount different UUT (EO sensors) on FMS, (V) FMS and TMS, (VI) integration of all the elements scene simulation, projection and collimation, FMS (with UUT) and TMS(with IRSP and collimator) for closed loop operation is required.

IV **General Terns & Conditions:**

(a) Site Acceptance Test (SAT):	After delivery at IRDE, installation, commissioning and site acceptance are required to be carried out by supplier as per the ATP document.
(b) Training & FAT	Basic Training on the system to be provided at manufacturer's site for minimum five persons for ten working days. This training must be during FAT. More detailed training to be provided to IRDE team during SAT. The training to include: a. Introduction to system configuration and design b. Explanation on Hardware and Realisation of system c. Demonstration of software settings and features. d. Training on overall working of the system e. Detailed training on Operation and maintenance. f. Basic training on preventive Maintenance. g. Training on fault finding at module level. h. Training on Calibration. Training should be provided for changing of collimators (LWIR &MWIR) to integrate with DEE.

(c) Scope of Work	The following activities are to be completed as part of the scope of work. 1. All hardware, software, accessories should be delivered as per list of deliverables. 2. Integration of all HILS sub-systems viz. IR Scene simulation system, IR Scene Projection system, FMS, TMS, and UUT. 3. Preliminary Design Review (PDR) 4. Critical Design Review (CDR) 5. Factory acceptance Test (FAT)

			• The standalone performance testing should be demonstrated in IRDE as per the final ATP document. • The projecting test images via DEE should be validated with the output of the camera and/or UUT by comparing with the original test images. 6. Site Acceptance Test. (SAT): The installation of the IR scene projection-Hardware (IRSP) system on the Target motion simulator along with other required subsystems including Scene Generation Unit (SGU). • The standalone performance testing should be demonstrated in IRDE as per the final ATP document. • Demonstration of different test scenarios along with following target profiles o Aerial targets with back ground scenario. o Ground targets with back ground scenario. o Sea scenario with targets. The IR cameras should be used by the vendor during the demonstration of above profiles. 7. The above profiles should be validated with close-loop FMS and TMS dynamics also. 8. Training	
	<u>Support services and technical assistance:</u>			
	Other terms and conditions:			
		Vendor Qualification Criteria (VQC)	**Eligibility Criteria:** Based on the response to the EOI, the firm would be evaluated as per the following eligibility criteria. The firm should furnish relevant documents in support of their claims for each point mentioned below: **(a) Technical Capabilities:** ▪ The vendor should have successfully delivered minimum one such type of hard-	

	ware-in-loop facility involving similar complexity in the last 5 years to any Indian Government organization or reputed scientific private entity in India or abroad. The completed hard-ware-in-loop facility should have close loop operation of sensor on flight-motion simulator and target/scene on the Target motion simulator. **(b) Financial Capabilities** ▪ Quality management system, quality control system: Quality standards/certification obtained by the vendor(As 9100, ISO 9001:others) ▪ Average annual turnover of at least INR 50 crores for the last three financial years. The firms will be evaluated based on brief technical compliance and Vendor Qualification Criteria.
Delivery period	Less than 24 months from supply order: ▪ T0: Placement of Supply Order ▪ T0+15 Months: Delivery of all subsystems of HILS ▪ T0+24 Months: Integration of HILS subsystems and UUT.
Warranty & Support	• Warranty for one year. Extended warranty for another two years should be quoted separately. Recommended spare parts should be listed. If the problem occurs with the projection system in future, the integrated cumulative down time should be less than 4 weeks in a year. If calibration is needed during the warranty period, vendor has to take the responsibility without extra charges.

			• Support is required for minimum10 years. • All software updates during the warranty period should be updated without extra charges. • **Trained Manpower:** Trained manpower for running the complete hardware-in-loop test facility should be posted onsite for 03 years.		
		General Terms and conditions	• Firms are required to send their response to this EOI to the Director, Raipur road, Dehradun -248008 on or begore the date & time as given in the advertisement, with the details as required. • The EOI is not to be treated as request for quotation/proposal and is issued with no commitment. IRDE reserves the right to withdraw the EOI or change or vary any part thereof at any stage. IRDE also reserve the right to disqualify any firm/proposal, should it be so necessary at any stage. • After receiving the response to EOI, a DRDO vendor evaluation committee (VEC) will evaluate the vendor's suitability based on the eligibility criteria defined in VQC.		

**The simulated (or apparent) temperature is the effective temperature that is assumed by a blackbody radiator, which delivers the same level of integrated signal radiance within the spectral band of a system.*

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