AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT	1. CONTRACT ID CODE	PAGE OF PAGES
		1 | 3

2. AMENDMENT/MODIFICATION NO.	3.EFFECTIVE DATE	4. REQUISITION/PURCHASE REG. NO.	5. PROJ NO. *(if applicable)*
01	8 OCT 2004		

6. ISSUED BY CODE	N00164	7. ADMINISTERED BY *(if other than Item 6)* CODE	
CONTRACTING OFFICER NAVSURFWARCENDIV 300 HWY 361 CRANE IN 47522-5001 BUYER/SYMBOL: VONDA POLLOCK/1165ZH PHONE: 812 854-3683 FAX: 812 854-5066			

8. NAME AND ADDRESS OF CONTRACTOR *(No., street, State and ZIP Code)*		9A. AMENDMENT OF SOLICITATION NO.
		9B. DATED *(SEE ITEM 11)*
	X	10A. MODIFICATION OF CONTRACT/ ORDER NO. N00164-04-R-8534
TIN NO.		10B. DATED *(SEE ITEM 13)*
CAGE CODE 96214 FACILITY CODE		17 SEP 2004

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

[ ] The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers[x] is extended, [ ] is not extended.

Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended by one of the following methods:

(a) By completing items 8 and 15, and returning __1__ copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER . If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA *(If required)*

13. THIS ITEM APPLIES ONLY TO MODIFICATIONS AND CONTRACTS/ORDERS, IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.

[ ] A. THIS CHANGE ORDER IS ISSUED PURSUANT TO *(Specify authority)* THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.

[ ] B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES *(such as changes in paying office, appropriation data, etc.)* SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b).

[ ] C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:

[ ] D. OTHER *(Specify type of modification and authority.)*

E. IMPORTANT: Contractor ( ) is not, ( ) is required to sign this document and return ____ copies to the issuing office.

14. DESCRIPTION OF AMENDMENT/MODIFICATION *(Organization by UCF section headings, including solicitation/contract subject matter where feasible.)*

see page 2

Except as provided herein, all terms and conditions referenced in Item 9A and 10A, as heretofore changed, remains unchanged and in full force and effect.

15A. NAME AND TITLE OF SIGNER *(Type or print)*		16A. NAME AND TITLE OF CONTRACTING OFFICER *(Type or print)*	
15B. CONTRACTOR/OFFEROR	15C. DATE SIGNED	16B. UNITED STATES OF AMERICA BY	16C. DATE SIGNED
(Signature of person authorized to sign)		*(Signature of Contracting Officer)*	

This amendment is being issued to extend the closing date **until 25 OCT 2004,** replace the statement of work, performance specification, CDRL A014, to add CDRL A019, R384 Env. Database and to change paragraph u of FAR 52.212-4, type size of offers.

The following documents are hereby added:

1) Statement of Work (SOW) Attachment 1-1 replaces the SOW (Attachment 2) in the solicitation in full.
2) Performance Specification Rev. 1.07 (Attachment 1-2) replaces the PS (attachment 3) in the solicitation in full.
3) CDRL A014 is replaced with Attachment 2.
4) CDRL A019 is hereby added (Attachment 3).
5) R384 Environmental Database (Attachment 4).
6) Answers to questions (Attachment 5).

The following changes are hereby made to the solicitation:

Change paragraph (u) of 52.212-4 to the following:

(u) PERFORMANCE BASED LOGISTICS (PBL) INCENTIVE CRITERIA

THE PURPOSE OF PBL: The purpose of the use of PBL incentives in this procurement is to reduce the overall cost to the Government through the use of incentives to ensure a focus on improving Mean Time Between Failures and to provide an incentive for quick delivery of units submitted for repair.

METHOD OF ASSESSMENT:

A. **Return Asset Mean Time Between Failure (MTBF).** The MTBF threshold (minimum requirement) as set forth in the Performance Specification of 1440 hours shall be used as the performance requirement STANDARD minimum. Systems that fail before the MTBF based on the internal counter of individual unit will be repaired under warranty at no additional cost to the Government.

B. Average Contractor Response Time (ACRT): The Contractor shall be responsible for maintaining an ACRT of no more than 10 calendar days including warranty and non warranty repairs. ACRT is a measurement of the time the contractor takes to deliver systems in response to orders issued for nonwarranty repairs CLINS (0005 and 0006) and repairs completed under warranty. Measurement of time begins for nonwarranty repairs when the contractor receives the funded order and system, whichever is later, and ends when a Ready For Issue (RFI) repairable is submitted to the Government for inspection and acceptance. Warranty repairs measurement of time begins when the contractor receives at their facility the product to be repaired and ends when the RFI repaired product is forwarded to the Government. For a system to be considered in the ACRT calculation it must be accepted by the Government.

ACRT is calculated by dividing the **sum of the CRTs, described above, for all repairs (both warranty and non-warranty) performed in** a 12-month period of time by the number of systems received for repair.
See ACRT table below for the performance metric to be used to measure this performance incentive criteria.

ACRT Metric (Calendar Days)	Incentive
< 5	Unit Price Adjustment - Maximum 3% negotiated prior to contract award. (TO BE FILLED IN AT TIME OF AWARD
5 –9	Unit Price Adjustment - Maximum 1.5%) negotiated prior to contract award. (TO BE FILLED IN AT TIME OF AWARD)
10 (Standard)	No Adjustment
11-30	Vendor is to provide "hot spare" to government from rotatable pool
>30	Vendor is to provide "hot spare" and to add two additional hot spares to the rotatable pool at no cost to Government
>60	Vendor is to provide "hot spare" and add two additional hot spares to the rotatable pool PLUS provide additional 12 month full warranty for the repaired product upon delivery of the product

Hot spare is defined as a replacement system(s) for the failed system(s).

Incentives
If the annual ACRT achievement is standard or less than the standard the contractor shall not be considered for an annual unit price adjustment.

FOR YEARS TWO THROUGH FIVE, if the annual ACRT is **above the standard**, the Government shall award the contractor through unit price increases on ordering quantities in the next 12-month contract period. The Government shall calculate the ACRT and make contract unit price adjustments beginning one year after the contract award date. The incentive calculation will continue to occur annually during the entire incentive period.

If the ACRT is **below the standard** the contractor shall provide Hot spares through the warranty period of the last system ordered.

Administration: It is anticipated a resultant contract will be administered by the cognizant DCMA. In that capacity, DCMA shall be responsible for verifying the date of receipt at the contractor's facility and date of shipment from the contractor's facility.

PERFORMANCE ASSESSMENT CRITERIA

The Government intends to utilize Performance Based Logistics Incentives (both positive and negative) in the administration of this contract. The Performance of the product as measured by **Mean Time Between Failure (MTBF)** will be subject to a negative incentive.

The Performance of the Repair Turn Around Time will be measured by the **Average Contractor Response Time (ACRT)** and is subject to positive/negative incentives.

Instructions to Offerors: Type size is changed to No smaller than 10 point font for text and 9 points for captions is acceptable.

R384 Environmental Database

1. (U) Atmospheric Attenuation.

1.1 (U) Atmospheric Model. (U) The atmospheric model that will be used by the Navy to evaluate thermal imaging performance is the Random 384 Observation Database (R384). This database was complied from a larger set of approximately 10,000 surface ship weather observations and calculated infrared (IR) parameters from 14 different locations throughout the world. These observations were made from 1964 to 1973. The points chosen represent an equal number of observations from the Baltic Sea, the Yellow Sea, the Gulf of Oman, and the Caribbean Sea. Thus, the R384 has 25% of the samples in the north latitudes, 25% of the samples in the tropics, and 50% of the samples in the mid-latitudes.

(U) The environment described by the R384 is usually expressed as a percentage, such as the 90% environment. This means that the environment modeled would be representative of the 90 percentile point in the database. Thus, the environment would be expected to have a higher transmittance than modeled 90% of time, worse 10% of the time. For more information concerning the R384, please consult "Use of the NSWCDD Weather Databases for Prediction of Atmospheric Transmission in Common Thermal Imaging Sensor Bands", (NSWCDD/TR-94/89), by Daniel E. Austin, Dr. Kenneth C. Hepfer, and Marilyn R. Rudzinsky, Ship Defense Systems Department, Naval Surface Warfare Center Dahlgren Division, October 1995.

1.2 (U) Imaging Sensors. (U) The following equation describing atmospheric transmission, τ, has been found to more accurately reflect the naval environment than the standard form of the atmospheric attenuation equation.

$$\tau = e^{-\alpha R^{\beta}}$$

(U) This equation requires specification of two atmospheric attenuation coefficients, α and β, to calculate the transmission for a particular set of conditions, as well as the range, R, in kilometers. Atmospheric attenuation in the midwave infrared (MWIR) bands has been modeled by performing LOWTRAN analyses on the R384 database. The coefficients necessary to fit the equation to predict the atmospheric transmission for the 90% weather condition are provided for a number of common MWIR bands in Table 1. Coefficients for other MWIR bands can be determined on an as-needed basis.

Table 1 (U) Coefficients to Predict IR Band Transmission for the R384.

IR Band	α (R384 90% point)	β (R384 90% point)
3.0 - 5.0 μm	0.89427	0.61522
3.4 - 5.0 μm	0.70145	0.68179
3.8 - 4.2 μm	0.38563	0.89658
3.8 - 4.8 μm	0.77214	0.63792
3.8 - 5.0 μm	0.82936	0.61911

STATEMENT OF WORK

FOR THE

EO SENSOR

CRANE

CRANE DIVISION
NAVAL SURFACE WARFARE CENTER
MICROWAVE SYSTEMS DIRECTORATE
NIGHT VISION AND CHEM/BIO SENSORS

STATEMENT OF WORK
FOR THE

ELECTRO-OPTIC SENSOR

1.0 SCOPE. This Statement of Work (SOW) describes the work tasks necessary to produce an Electro-Optic (EO) Sensor meeting the requirements of Integrated Radar Optical Surveillance and Sighting System (IROS3). This SOW provides for the procurement, manufacturing, test, system spares, repair, Integrated Logistics Support and technical documentation for the EO Sensor. This SOW and performance specification embrace and incorporate Performance Based Logistics practices/methods to be used in the manufacture of the item and execution of the Integrated Logistics Support Program. The EO Sensor will be installed and operated as part of the IROS3 on military maritime crafts and exposed to harsh operating and environmental conditions.

2.0 LISTING OF APPLICABLE DOCUMENTS. The following specifications and documents form a part of this SOW to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto.

2.1 Performance Specification.

Performance Specification for EO Sensor

2.2 Military Handbooks.

MIL-HDBK-61A	Configuration Management, Feb 2001
MIL-PRF-49506	Logistics Management Information, Nov 1996

2.3 Other Publications.

ANSI/ASQC Q9001	Quality Systems – Model for Quality Assurance in Design/ Development, Production, Installation, and Servicing, 1994
OPNAVINST 5100.27	Navy Laser Hazard Control Program, Enclosure (2), 20 Nov 2001
ANSI Z136.1-2000	Safe Use of Lasers, 2000
46 CFR Part 111	Electric Systems – General Requirements,

2.4 ORDER OF PRECEDENCE. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document supersedes applicable Federal, State or Local Laws and regulations unless a specific exemption has been obtained.

2.5 AVAILABILITY OF DOD DOCUMENTS. Government standards, and handbooks are available from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094. The Performance Specification is available from NSWC Crane.

3.0 REQUIREMENTS. The Contractor shall provide the EO Sensor in accordance with this SOW and the performance requirements contained in the EO Sensor Performance Specification, referred herein as Performance Specification. The EO Sensor shall consist of: a stabilized gimbal assembly with a minimum of (4) sensors which shall include as a minimum; a daylight imaging television sensor (TVS), a forward looking infrared (FLIR) sensor, an eye safe laser range finder (ESLRF), a spotter scope and a Shipping Case which stores EO sensor.

The Contractor shall perform the following tasks to support production of an EO Sensor, which meet all the requirements of the Performance Specification. The acceptance testing performed does not relieve the Contractor of its responsibility for full compliance with all requirements of the Performance Specification.

The EO Sensors to be delivered under this contract must be capable of meeting all requirements of the Performance Specification. This includes product sample tests, acceptance tests and quality surveillance tests.

The Contractor shall provide a certificate of conformance that the EO Sensor delivered meets the Contract requirements cited herein and the Contractors Proposal and shall be provided with each delivered EO Sensor. The Contractor is encouraged to propose technological improvements as appropriate. The Contractor shall have an integrated support process that includes having all management, administration, and product description data available digitally on optical media (i.e. CD-ROM). The Government will conduct a Post Award Conference within 30 days after contract award at a mutually agreeable time.

3.1 CONFIGURATION MANAGEMENT.

3.1.1 Configuration Management Program. The Contractor shall have an established, Government verifiable, Configuration Management Program with control systems in place for the complete EO Sensor including configuration identification of each hardware and software configuration item for the Contract Life. The Contractor shall control the Product Baseline (PBL) using their change control and engineering release processes. The PBL shall support interchangeability and interoperability to the replaceable part level. All baselines shall be documented in the Contractor's configuration status accounting database. The contractor shall maintain a configuration management (CM) program, inclusive of all hardware and software, consisting of the following elements:

a. Configuration Identification
b. Configuration Control
c. Configuration Status Accounting
d. Configuration Audits

3.1.2 Configuration Identification Baseline. The Contractor shall establish the Product Baseline (PBL) and Build of Materials (BOM) at the time of contract award. It is the Government's intention to take delivery of the Contractor's complete PBL and BOM documentation within 180 days of receipt of order by the contractor, after verifying its accuracy. **(CDRL A001)**

The product baseline shall be established by:

a. Configuration Item Specification
b. Outline Drawings (Mechanical & Electrical schematic) Level II
c. Bill of Materials
d. Engineering Drawing Tree Flowchart
e. Shipboard Cable Drawings Level III

The product baseline may be reviewed by the Government at any time. All drawings shall at a minimum be in AutoCad 2002. The Government shall have limited data rights to include the ability to reproduce this data for internal Government purposes only.

3.1.3 Configuration Control. Only an approved Engineering Change Proposal (ECP) shall change designated product baseline documents. **(CDRL A002)**

3.1.3.1 Engineering Change Proposal. The Contractor shall implement and control changes to the PBL and BOM via the Engineering Change Proposal (ECP) Process for Contractor and Government recommended and Government approved changes. The Contractor shall submit for approval by the Government, Class I ECPs, Request for Deviations, Request for Waivers and Notice of Revisions for those proposed changes affecting (as a minimum) form, fit, function, reliability, cost and maintainability for both hardware and software. The Contractor shall provide engineering change proposals via electronic mail and hard copy. Preparation of ECPs shall be IAW MIL-HDBK-61 for submission. **(CDRLs A002, A003, A004, A005).**

3.1.3.1.1 Class I ECPs shall be defined as any change to the configuration item's specification or outline drawing, which affects form, fit, or function. All Class I ECP's shall be tracked to LRU serial number effectivity.

3.1.3.1.2 Class II ECP's shall be defined as any which does not meet the definition of a Class I ECP. Class II ECP's shall be further categorized as tracked or non-tracked. Any ECP to a piece part, subassembly or assembly which changes the design, material, process, or lessons tolerances shall be categorized as tracked. Class II tracked ECP's shall be tracked to serial number effectivity. If an ECP has no potential impact on life or performance, that ECP shall be categorized as non-tracked. The Government shall review each Class II ECP and be notified of a proposed ECP 45 calendar days prior to execution.

3.1.4 Configuration Status Accounting. The contractor shall maintain a configuration status accounting system that identifies the status of changes to the baseline and the status of implementation of approved changes.

3.1.4.1 Serialization. Sequential serial number, in ascending order, shall be assigned and permanently attached in a clearly visible place to each deliverable meeting the requirements of this contract. Serialization shall also be accomplished through use of unique identification standards.

3.1.4.2 Replacement Assets. If a serialized asset is replaced, the replacement shall have a new serial number. Documentation shall include the serial number of the asset being replaced along with the new replacement serial number.

If an asset is replaced under a warranty provision of the contract, the replacement asset shall be subject to the remainder of the warranty period, which began with the original asset. Additionally, an asset returned under a warranty provision may be repaired and be resubmitted for acceptance in accordance with the contract.

3.1.5 INTEGRATED LOGISTICS SUPPORT (ILS).

3.1.5.1 Logistics Systems Engineering. The Contractor shall implement a Logistics Systems Engineering Program to fully support the EO Sensor for its operating life through the ECP process. The contractor shall incorporate and implement Performance Based Logistics into the Logistics Systems Engineering Program. The contractor shall implement continuous modernization by insertion of state-of-the-art technologies into the items and spares being manufactured and supported in order to achieve Government goals of increasing performance availability, improving reliability and mitigating obsolescence issues. These efforts shall support additional goals of the Government's by lowering sustainment costs while increasing the capability of the unit to meet evolving Warfighter requirements throughout the product's service life. The Contractor shall establish an Integrated Support Plan to ensure that supportability requirements are consistent with the requirements contained in this Contract. The Contractor shall provide ILS in the most cost effective manner possible utilizing existing ILS documentation and resources to the maximum extent possible.

3.1.5.2 Data Validation. The Contractor shall have a process in place that provides for the validation of the adequacy and technical accuracy of the ILS documentation for the EO Sensor. The Government will verify and approve the accuracy of all ILS documentation provided by the Contractor. The Contractor at no additional expense to the Government shall correct any discrepancies in the ILS documentation. All ILS documentation shall be kept current for the EO Sensor contract life.

3.1.5.3 Repair Turnaround Time. The Contractor shall possess sufficient resources and procure and maintain an adequate supply of Lowest Replaceable Units (LRU) to respond to a service turnaround of ten (10) calendar days upon receipt of LRU.

3.1.5.4 Maintenance Planning. The EO Sensor shall be maintained under a two level concept, Organizational (O) to Depot (D), as defined in MIL-PRF-49506.

3.1.5.5 End of Life Considerations. The contractor shall prepare and submit to the Government via electronic media a report which documents any material(s) in the item that require special attention prior to disposal of items at the end of their life. Examples of such materials are precious metals, hazardous materials or carcinogens. This report shall be submitted one time with the delivery of (CDRL A001) in contractor format.

3.2 QUALITY PROGRAM. The Contractor shall have a quality system that ensures conformance to contractual requirements and meets the requirements of ISO 9001, or an equivalent quality system model.

3.2.1 Quality Audits of Contractors. The Government reserves the right to perform quality audits to verify the contractor's compliance with the established quality program. The Government shall notify the contractor 5 business days prior to an audit. Such audits may consist of, but not be limited to, evaluation of records, processes and product. The contractor shall be notified in writing of deficiencies found during these audits and shall be given a mutually agreed period of time to correct noted deficiencies. Failure to correct quality deficiencies may result in withholding of acceptance of the contract end item.

3.3 RELIABILITY/MAINTAINABILITY.

3.3.1 Field Failure Summary Analysis and Corrective Action Reporting. The Contractor shall have an established closed loop failure reporting system, procedures for analysis of failures to determine cause, and documentation for recording corrective action taken. The Contractor shall have a mechanism for feedback of field product performance, problems, failures, and shall implement an effective cause and corrective action system. The Contractor's existing data collection, analysis, reporting and corrective action system shall be used for field failure reporting. Failure data shall be isolated to the lowest replaceable unit (LRU). The Field Failure Reporting and Corrective Action System shall identify failures, prioritize failure trends, analyze failure modes and causes and track solution effectiveness. The Contractor shall provide a monthly Failure Summary Analysis Report for each EO Sensor/LRU repaired or replaced under warranty service and shall be included as part of the Monthly Progress Report. **(CDRL A006).**

3.3.2 Performance. The Contractor shall notify the Government immediately after identification of any and all performance related data that would both positively and negatively impact the reliability, maintainability, availability, and/or supportability of the EO Sensor System. The Government may test, validate, verify, and/or certify any and all of the EO Sensor's performance parameters to verify compliance with the Contract.

3.3.3 Reliability Centered Maintenance. The Contractor shall generate a Reliability Centered Maintenance analysis on components at the LRU and the submit the data to the Government. **(CDRL A007).**

3.3.4 **Reliability Data.** The contractor shall collect data on components at the LRU and submit the data to the Government. **(CDRL A008)**

3.4 **LASER SAFETY.** The Class I Eye Safe Laser Range Finder and Laser Pointer shall be compliant with the requirements of OPNAVINST 5100.27 and ANSI Z136.1-2000. The EO Sensor will be evaluated by the Navy Laser Safety Review Board (LSRB) for compliance with these requirements. The Contractor shall accept and comply with the findings and requirements of the LSRB. If the proposed laser is currently certified to these standards, the contractor shall submit a copy of the certification with their proposal.

3.5 **WARRANTY RETURNS.** All assets returned under the warranty provisions of this contract shall be subject to failure analysis by the contractor at the contractor's expense. All assets returned under warranty shall be tested in accordance with the same tests used for acceptance. The contractor shall execute all warranty repairs within ten (10) calendar days of the item being received by the contractor.

3.6 **NON-WARRANTY RETURNS.** The contractor shall implement a repair program for non-warranty repairs. Upon receipt of items from the Government, estimates of repairs shall be created and submitted to the Government at no cost to the Government within 5 calendar days of receipt at the contractor facility. Repair prices will be negotiated individually and documented on specific delivery orders for each repair. Delivery of repaired non-warranty items shall not exceed ten (10) calendar days.

3.7 **INSPECTION AND ACCEPTANCE.** The Contractor shall generate and submit a Contractor's Acceptance Test Plan via electronic media for review and approval by the Government. **(CDRL A009).** The contractor shall also be responsible for documenting the acceptance test procedure utilized for this item via electronic media for review and approval by the Government **(CDRL A010).**

3.7.1 **Testing.** The Contractor shall make available for Government's review, all previous and current test results concerning the performance, reliability, maintainability, availability, environmental conditions, shock, vibration, electromagnetic interference (EMI) emission and susceptibility and safety on the EO Sensor (Refer to Specification Appendix "B"). The Contractor shall provide a Certificate of Conformance stating the above testing is in full compliance with the standards referenced in this Contract.

3.8 **TRAINING AND TRAINING SUPPORT (PRODUCTION).**

3.8.1 **Course Curriculum Training Materials.** The Contractor shall provide a training support package that will provide operator and maintenance training to support "Train the Trainer/Train the Maintainer" type of New Equipment Training. The training support package shall consist of a Student and Instructor Trainee Guide, Course Objectives with Lesson Plans, Test Package, Program of Instruction including Training Course Schedule and syllabus, and other training aids for a maximum of 20 students and provided on a CD-ROM. **(CDRL A011).** All training shall be provided by the Contractor utilizing a fully operational EO Sensor at the Government's Facility utilizing contractor assets. If the Contractor requires the use of a Government owned asset, they shall notify the Government within 30 days prior to conducting the training. The Contractor shall identify any technical training equipment required to support EO Sensor training and provide any identified materials to the Government via electronic media.

3.8.2 **Operator Course.** The Operator training shall be provided and comprised of those functions that the equipment user is required to perform in order to operate and maintain the EO Sensor. The training instructions shall include fundamentals of thermal imaging, theory of operations, operation, skill development and practical applications required to set up, check out, operate all equipment and run diagnostics. The course shall support all operator tasks.

3.8.3 **Maintenance Course.** The Maintenance course shall be provided and include the O and D level maintenance concepts, the use of support equipment, troubleshooting techniques, LRU removal and replacement, adjustments, Built-In-Test/Fault Isolation Test (BIT/FIT), and performance verifications. The training course shall be set up to indoctrinate the students to become proficient in operation, installation/removal procedures, maintenance and repair to the level of training other students (train-the-trainer).

3.8.4 **Training Materials.** Training aids for presentation shall be a form suitable for overhead projections (Powerpoint), whiteboard presentations, drawings and/or CD-ROM. An Operator and Maintenance Technical Manual shall be provided to each student. A certificate of training shall be completed by the Contractor and provided to each student who satisfactorily completes a Contractor's training course. The Contractor shall grant the Government the authority to reproduce, update, or change the data contained in the Training Curriculum and Training Materials. All Training Materials shall duplicate as much as necessary those items that will be used in the real operational environment.

3.9 TECHNICAL DATA.

3.9.1 **Technical Manuals.** The Contractor shall provide a System Technical Manual to reflect complete operation and maintenance for the EO Sensor. The Contractor shall incorporate all approved changes to the PBL into the technical manuals for the life of the contract within 30 days of the approved change. The Contractor shall provide an Illustrated Parts Breakdown (IPB) with tabulated parts information in the Technical Manual to support the ability to order repair items and consumables as defined in the maintenance chapters. The Interface Control Drawings shall be included in the Technical Manual. The Government shall have limited data rights to include the ability to reproduce this data for internal Government purposes only. Physical delivery shall be by hard copy and CD-ROM in Microsoft Word/Excel/Powerpoint with viewer software **(CDRL A012).**

3.9.2 **Technical Manual Validation/Verification.** The Contractor shall validate the completeness and technical accuracy of the technical manual by applying the following steps:

a. Performing each procedure.
b. Performing a desktop validation of all non-procedure text and graphics.
c. Supply validated copies of the Technical Manual to the Government.
d. Provide a certificate of validation certifying accuracy.
e. Coordinate a verification meeting with the Government to complete validation / verification of technical manual.

The Government will perform a verification to ensure the accuracy and completeness of the technical manuals. Upon completion of the verification effort, the Contractor shall incorporate all verification changes at no additional cost to the Government.

3.9.3 **System Drawings.** The Contractor shall provide level II System Drawings as part of the PBL (CDRL A001) that will include drawings that clearly show the LRUs, cable assemblies and interconnects, and installation components. The level II System Drawings shall clearly denote mechanical and electrical footprint of the system.

The contractor shall provide level III shipboard system cable drawings. The shipboard system cable drawings shall clearly show, at a minimum, the complete cable assembly, connectors, back-shells, wiring diagram (pin-out), and other pertinent data required for cable assembly to include part numbers and vendor information. The drawings shall include tables that clearly describe in full detail all cable signal functions and descriptions and connector information that will aid the Government to troubleshoot the system.

The Government shall have limited data rights to include the ability to reproduce the level II data drawings for internal Government purposes only. The Government shall have unlimited data rights for the level III data drawings. All drawings shall be in AutoCad 2002 or newer.

3.9.4 Interface Control Documentation. The contractor shall define and document the interface parameters between co-functioning system segments relative to all software control functions **(CDRL A013)**

3.10 SUPPLY SUPPORT.

3.10.1 Provisioning Technical Documentation. The Contractor shall develop and provide provisioning technical documentation that supports the competitive re-procurement of spare, repair and consumable items from the Original Equipment Manufacturer (OEM) and Vendors/Subvendors with top down breakdown drawings (i.e. PBL and BOM). The Contractor shall prepare Provisioning data for all LRUs, equipment, and related engineering design changes. The Contractor shall develop and provide Provisioning data for any nonstandard equipment or assembly obtained from any source of supply unable to furnish Provisioning data, and any equipment or assembly which the Contractor modifies and any unique special purpose test equipment (if applicable). The Contractor shall ensure that this data is kept current for the life of the contract.

In order for the Government to establish items of support and to determine repair parts, certain data describing the relevant characteristics of the items are required. The data elements for provisioning are as follows: (1) Source (CAGE Number); (2) Part Number (Contractor/OEM); (3) Item Name/nomenclature (Descriptive Name); (4) National Stock Number (if applicable); (5) Unit of Issue; (6) Unit of Issue Price; (7) Quantity per assembly; (8) Mean Time To Repair (MTTR); (9) Mean Time Between Failures (MTBF); (10) Mean Time Between Mission Critical Failure; (11) Reliability and (12) Shelf Life. The Contractor shall submit all required data 120 days after contract award and approval of the Product Baseline (PBL) and Bill Of Material (BOM). The Government shall have limited data rights to include the ability to reproduce this data for internal Government purposes only.

As part of the provisioning technical documentation, the Contractor shall provide a complete listing of all the parts that identifies the end item that can be removed and replaced at the O level and repaired at D Level. The Master Materials Parts List (i.e. BOM) shall be delivered in a top-down breakdown format of the end item(s) and shall include repairable, replacement parts (consumables) and long lead-time items (LLTI). The Master Materials Parts List shall include spare and repair parts for any associated support equipment required to support and maintain the system. The Contractor shall identify which items are repairable, consumables, Long Lead Time Items, common bulk items, and support equipment spare and repair parts each item on the list shall be priced and available for ordering. All Common and bulk items such as gaskets, fuses, or similar items shall be identified to the equipment level. The Master Materials Parts List shall be developed based upon the approved PBL. The listing shall contain the part number, nomenclature, CAGE, quantity, and unit price**.** The Contractor shall validate the provisioning data and ensure the data is in accordance with the PBL and BOM and is traceable to the Technical Manual. **(CDRL A014).**

3.10.2 Recommended Spare Parts List for Spares Acquisition Integrated with Production (SAIP). The contractor shall employ the concept of concurrent release of spares orders with identical parts as installments on the production unit. The Contractor shall provide a recommended 90-day and a 12-month initial recommended spares list for both O and D level sustainment based upon initial quantities of EO Sensors ordered and provide updates as the number of sensors changes. The Government shall have limited data rights to include the ability to reproduce this data for internal Government purposes only. This shall include spares and repair parts for any associated support equipment. **(CDRL A015).**

3.11 PROGRAM SUPPORT. The contractor shall host and/or attend a production status review meeting quarterly for all Navy production and technical personnel, normally not to exceed one day. Format of the review meetings is not specified, but will function to a mutually agreed to agenda and list of attendees. Dates for these meetings shall be established by Naval Surface Warfare Center Crane Division (NSWCC) Crane, Indiana, Code 805C, a minimum of 14 calendar days in advance of the meeting date. For planning purposes, the contractor shall assume the meetings will alternate quarterly between NSWC Crane, Indiana and the contractor's facility. The Contractor shall be prepared during all Production status review to address the contract performance at the total level and at lower level elements and performing organization levels. Contractor performance discussions shall include but not be limited to: schedule, technical performance, risk elements and assumptions, work around plans, anticipated problems, and estimates to complete remaining work. The Contractor shall prepare agenda and minutes for each meeting and provide via electronic access and electronic mail within seven days of the Production Status Reviews. **(CDRL A016, A017)**

3.11.1 Program Management. The Contractor shall develop and execute an innovative plan to manage the EO Sensor Program, which includes incorporating and implementing Performance Based Logistics practices, methods and strategies. The Contractor shall be responsible for overall EO Sensor performance and shall define and maintain appropriate subcontract and associate contract relationships to support all necessary requirements, allocations and interfaces. The Contractor shall designate a central point of contact for substantive communication with the Government.

3.11.2 Plan of Action & Milestones (POA&M). The Contractor shall develop, maintain, and use a POA&M. The POA&M shall include a description of the system engineering management and integrated logistic management approaches including all key personnel, processes and approaches. The POA&M shall provide the EO Sensor Program with necessary information to monitor progress, identify significant problems, and implement corrective action as applicable. The contractor shall provide access to all records, data and plans for Government review. The contractor shall generate this information in MSProject format to ensure NMCI compliance.

3.11.3 Monthly Progress Reports. The Contractor shall submit monthly progress reports identifying detailed work and schedule status of on-going work, action items, and risk items. **(CDRL A018).**

3.11.4 PACKAGING, HANDLING, STORAGE AND TRANSPORTATION. The Contractor shall ensure that each EO Sensor is packaged in a commercially available (i.e. Pelican) reusable, ruggedized plastic shipping container with easily securable latches and rugged internal and pull handle. The EO Sensor shall be fully assembled and placed as compactly and efficiently as plausible to protect the equipment from damage during shipping and handling. The Contractor shall ensure these containers are waterproof and shall ensure the containers have multiple handles, pressure relief valve, custom foam inserts that do not absorb fresh or salt water and provisions for securing with a padlock. The Contractor shall ensure the EO Sensor, when packed in its shipping containers, will be protected from marine environments, shock and vibration and capable of being transported on standard transportation systems, by commercial or military carriers.

Each container shall have permanently affixed a Radio Frequency Identification Tag (RFID). The RFID shall be affixed to the exterior of each case. The RFID shall be passive, class 1. Refer to www.dodrfid.org.

3.12 FOREIGN MILITARY SALES (FMS)

The EO Sensor is intended for use by the United States Navy. In order to prevent unauthorized release regarding the EO Sensor, the Contractor shall sign a non-disclosure statement with the Government agreeing not to share or release EO Sensor specific technical data without express

written concurrence by the Contracting Officer at NSWC Crane Division. In event where EO Sensor specific technical data duplicates technical data for the Contractor's existing or future products, the Contractor shall insure such technical data is not referenced to the United States Navy EO Sensor program.

PERFORMANCE SPECIFICATION

for the

ELECTRO-OPTICS SENSOR (EOS)

Version 1.7
12 October 2004

Prepared by:
Code 805C, NSWC Crane, IN 47522

1. Introduction

Naval vessels require a fully integrated and seamless system that provides Anti-Terrorism Force Protection (ATFP) capabilities against asymmetric threats. The U.S. Navy has changed emphasis from open ocean "blue water" operations to that of gaining access into and operating within the littorals. U.S. Naval forces require increased force protection capability and situational awareness in the littorals, including transiting restricted waters, at anchor and pierside at ports throughout the world. Ships must rely on organic force protection capability using integrated sensor packages to provide close-range, 360°, situational awareness for detection and recognition of asymmetric threats. The Navy must increase surveillance and be prepared to intercept large numbers of small, fast surface craft, and low slow flying aircraft. Electro-optical and infrared (EO/IR) sensor systems provide needed capability for intrusion detection and threat recognition.

The primary mission of the electro-optical and infrared (EO/IR) sensor systems is to provide surface ships with a day/night, high-resolution, infrared and visible band imaging capability, as well as laser rangefinding capability, to augment existing optical and radar sensors. The primary (EO/IR) mission is to perform surveillance tasks to enhance the detection and tracking of small surface and near-surface targets such as small boats and low slow flying aircraft.

The EO sensor shall be highly reliable and capable of withstanding the Naval shipboard environment.

1.1. General Standards and Applicable Documents

The following specification, standards, and handbooks form a part of this specification to the extent specified herein. In keeping with the most recent Department of Defense and Secretary of the Navy policy, the provider is encouraged to propose alternatives to the specification and standards cited herein for government concurrence. Unless otherwise specified, the issues of the military documents are those listed in the issue of the Department of Defense Index of Specification and Standards on the date of this specification. The issue of non-government standards are those in effect on the date of this specification. Invoked documents and standards specifically called out in Section 2 and Section 3 are to be followed. Guidance documents provide a reference to use as a general guide in the development of processes, documents or data. See ***Appendix A*** for a list of standards and applicable documents that shall be considered as guidance materials.

1.2 Order of Precedence

In the event of a conflict between the text of this document and the reference cited herein, the text of this document takes precedence. Nothing in this document supersedes applicable Federal, State or Local laws and regulations unless a specific exemption has been obtained.

2. Electro-optic sensor (EOS) Top Level Requirements

The EOS shall comply with the following electrical and mechanical specifications. For the purpose of this specification the suite of electro-optic payloads and gimbal assembly is considered a single EOS unit.

PARAGRAPH NUMBER	TOP LEVEL ATTRIBUTE	THRESHOLD	OBJECTIVE
2.1	**Height**	EOS height shall be ≤ 24 inches	EOS height shall be ≤ 18 inches
2.2	**Width**	EOS width shall be ≤ 18 inches	N/A
2.3	**Depth**	EOS depth shall be ≤ 18 inches	N/A
2.4	**Weight**	EOS weight shall not exceed 112 Pounds in accordance with MIL-STD-1472F.	EOS weight shall not exceed 74 Pounds in accordance with MIL-STD-1472F.
2.5	**Power (Input)**	EOS shall be capable of running on ship's power: 115VAC ± 5% ≤ 10 Amps ± 5% 60 Hz ± 5% Single Phase Or 440VAC ± 5% ≤ 5 Amps ± 5% 60 Hz ± 5% Three Phase	N/A
2.6	**Heat Dissipation**	Above Deck Equipment: 2.3kw / 7,855 BTUs/hour Below Deck Equipment: 2.3kw / 7,855 BTUs/hour	N/A

2.7	**Sea State (Based On Pierson –Moskowitz Sea Spectrum Scale)**	Operational: EOS shall operate up to and including sea state 3. Survival: EOS shall be functional after being subjected to sea states up to and including sea states 8.	N/A
2.8	**EOS Control**	See Appendix C	See Appendix C
2.9	**EOS Interface**	EOS Interface shall be RS-232, RS-422, or Ethernet.	N/A
2.10	**Cooling/Positive Pressure**	If OEM requires, dry air shall be provided as follows: The EOS shall be cooled at ≤ 6 cfm at ≤ 100 psi. No chilled water shall be provided. No hazardous materials shall be used to keep system cool.	The EOS shall not require dry air, or desiccant packs,
2.11	**Equipment Marking**	Nameplates and markings for all pieces of equipment shall be clean, concise, legible, and durable. Markings shall be provided for all controls, lamps, switches, fuses, jacks, test points, and other components	N/A

2.12	**Radar Cross Section**	The Radar Cross Section (RCS) shall be in accordance with Radar Cross Section Requirements for IROS[3] CONFIDENTIAL/NO FORN letter dated 30 December 2002.	N/A
2.13	**BIT Diagnostics**	The EOS shall be capable of running BIT Diagnostics to determine faults within the EOS to the LRU level without the aid of separate test equipment. The EOS in BIT mode shall detect ≥ 80% of all specified faults or failures to within one LRU.	The EOS in BIT mode shall detect ≥ 90% of all specified faults or failures to within one LRU. The BIT should complete testing in ≤ 2 minutes.
2.13.1	**BIT False Alarms**	The percentage of BIT false alarms shall be ≤ 10%	The percentage of BIT false alarms shall be ≤ 5%
2.13.2	**BIT Types**	The EOS shall have a Manual BIT Test Manual BIT: A test that excludes rebooting or refreshing of default settings. This shall be an operator-initiated test.	Power-On BIT: Automatic BIT that provides diagnosis of the components during the power on procedure. The EOS shall have an Automatic BIT with a user option to bypass Automatic BIT Continuous BIT: Test that is active during regular components use. It can be triggered by momentary functions such as zoom or focus.
2.14	**Cable Diameter**	No shipboard cable shall exceed 2 Inches in diameter	No shipboard cable shall exceed 1 Inch in diameter

2.14.1	**Cable Type**	All shipboard cables shall be low smoke in accordance with MIL-C-24643B (See Appendix A).	N/A
2.14.2	**Cable Length**	All shipboard cables shall support cable runs up to and including 300 feet.	All shipboard cables shall support cable runs up to and including 1 kilometer.
2.14.3	**Shipboard Fiber Optic Cable**	If shipboard fiber optic cabling is used, it shall adhere to the specifications and requirements per MIL-STD-2042B, MIL-C-28876D, and MIL-PRF-85045F (*See Appendix A).*	N/A
2.14.4	**Shipboard Fiber Optics Spares**	If single mode fiber optic or multimode fiber optic is used in a shipboard fiber optic cable, there shall be at least a one to one ratio of fibers utilized to spare fibers in the fiber optic cable	N/A
2.15	**On-time Counter**	The EOS shall place an easily accessible and visible on time counter on all major components. The counter shall record operating hours of each major component. Counter shall be a minimum of 4 digits with minimum lowest valued digit in hours.	N/A
2.16	**Connectors**	All exterior EOS connectors shall be in accordance with MIL-DTL-38999K (See Appendix A)	N/A

2.17	**Mean Time Between Failures (MTBF)**	Mean Time Between Failures (MTBF) is the predicted mean time between failures, in terms of operating hours. MTBF shall be calculated by the following formula: MTBF = Average Uptime/Number of Failures The EOS shall have a MTBF ≥ 720 hours	The EOS shall have a MTBF ≥ 1440 hours
2.18	**Mean Time To Repair (MTTR)**	Mean Time To Repair (MTTR) is the predicted mean time to repair the item, in elapsed hours. This factor is used to compute A_o of the equipment and to provide estimates of maintenance shop workloads. The EOS shall have a MTTR ≤ 1 hour	The EOS shall have a MTTR ≤ 30 minutes
2.19	**Equipment Finish**	All equipment shall be Navy Haze Gray, Color #26270 per FED-STD-595B Per one of the following as applicable: a.) Hard coat anodize per MIL-A-8625F, type III, class1 or, b.) Commercial grade powder coat epoxy with appropriate priming system	N/A
2.20	**Environmental**	The EOS shall be functional and meet the Environmental Requirements in Appendix B.	N/A

2.21	**UID Tag**	The EOS shall have Unique IDentification (UID) tags at the LRU level Government shall provide UID tag part numbers prior to production of the EOS.	N/A
2.22	**Safety**	The EOS shall be designed to ensure the system is safe to use, and there shall be no electrical, mechanical, or radiation hazard to users as specified in MIL-STD-882D.	N/A
2.23	**Maintenance Level**	Organizational: The EOS shall provide an LRU level of corrective and preventative maintenance to be performed by ship's force. This shall include the utilization of BIT. The EOS shall be designed to minimize the requirement for preventative maintenance. Intermediate: The EOS shall not require intermediate level maintenance at the system level Depot: The EOS shall require depot level maintenance only for items that have been agreed to by the Government as being non-repairable by the ship's force. The OEM shall perform depot level maintenance.	N/A

2.24	**Maintenance Test Equipment**	Organizational level preventive/corrective maintenance shall not require any special purpose test equipment. General-purpose test equipment is allowed if necessary.	N/A
2.25	**Local Kill Switch**	The EOS shall be equipped with a local kill switch that shall secure the power during manual troubleshooting or manipulation of the gimbal.	N/A
2.26	**System Feedback**	The EOS shall contain component sense lines that provide system feedback concerning operation of the sensor.	N/A
2.27	**Fiber Cable Interconnect**	N/A	All EOS fiber equipment shall utilize International Fiber Systems hardware, and shall be configured prior to delivery.
2.28	**Noise Level**	The EOS audible noise level shall be no louder than 63 decibels in accordance with MIL-STD-740-1, Grade A3.	N/A

3. EO Sensor Description

As a minimum, the EOS shall consist of a stabilized gimbal containing the following payloads: daylight imaging television sensor (TVS), a forward-looking infrared sensor (FLIR), an eye-safe laser range-finder (ESLRF), and a spotter scope.

3.1 Stabilized Gimbal Performance Thresholds and Objectives.

The Stabilized Gimbal shall meet the performance requirements as outlined below.

3.1.1 Stabilized Gimbal Requirements

The Stabilized Gimbal shall provide Line of Sight (LOS) capabilities as stated in Table 2.

Table 2 *Stabilized Gimbal Requirements*

Characteristic	Requirement	
	Threshold	Objective
Azimuth Field of Regard	360° continuous	NA
Elevation Field of Regard	–120° to +90°	–135° to +105°
Bearing Slew Rate	≥ 60 deg/sec	≥ 75 deg/sec
LOS Jitter	LOS Jitter ≤ 35 micro-radians	LOS Jitter ≤ 20 micro-radians
Vibration/Isolation	2 axes (Azimuth and Elevation)	3 axes(must include Azimuth and Elevation axes)
Gimbal/Gyro Drift	EOS shall be able to correct for gimbal/gyro drift via software. After correction, the gimbal shall not drift again for at least 1 hour.	EOS shall be able to correct for gimbal/gyro drift via software. After correction, the gimbal shall not drift again for at least 4 hours.
Boresight Characteristics	EOS shall be able to verify and correct bore sight errors. Boresight retention interval shall be at least 8 hours. EOS shall retain the reticle position of the last boresight before power-down and restore the reticle to that position without operator intervention on power-up.	EOS shall be able to verify and correct bore sight errors. Boresight retention interval shall be at least 12 hours. EOS shall retain the reticle position of the last boresight before power-down and restore the reticle to that position without operator intervention on power-up.
Window Heater	N/A	EOS shall have window heater(s) to remove exterior moisture accumulation

3.1.1.1 Ship Motion Parameters

As an objective the EOS shall meet performance requirements under the ship motion parameters outlined in Table 3.

Table 3 **Ship Motion Parameter Performance Objectives**

Ship Motion	Objective	Performance
Roll	11 second period 0° to 15° port and starboard 15° to 30° port and starboard 30° to 45° port and starboard	without operational degradation with operational degradation without damage
Pitch	7 second period Between 0° and 5°	without operational degradation
Yaw	7 second period between –5° and +5°	without operational degradation
Turning Rate	2° per second	without operational degradation
Roll, Pitch and Yaw are Sinusoidal and Non-synchronous		
TEST METHOD:MIL-HDBK-2036		

Sensor Requirements

FLIR Sensor Requirements

FLIR Sensor shall meet capabilities as stated in Table 4.

Table 4: **FLIR Sensor Requirements**

Characteristic	Requirement	
	Threshold	Objective
Thermal Imaging Sensor(s) IR Band	midwave IR band (nominally 3-5 μm)	N/A
NETD (deg C)	≤ 0.05	≤ 0.025
Thermal Imaging Sensor FOV (Optical)	WFOV ≥ 35° 17.5° ≤ MFOV ≤ 20.5° NFOV ≤ 0.9° or variable FOV (wide to narrow) (horizontal field of view)	Threshold FOVs With At Least 2 Additional FOVs With The Following Characteristics: 26° ≤ WMFOV ≤ 30.5° 9° ≤ MNFOV ≤ 11° (horizontal field of view) -or- Continuous zoom between the Threshold WFOV and NFOV (horizontal field of view)
Narcissus Effect	Narcissus effect shall not be visible in the observed image	N/A

The FLIR Sensor shall provide:

(a) black hot/white hot polarity;
(b) automatic gain and level control; and
(c) manual gain and level adjustments
(d) ability to calibrate FLIR sensor through software.

At minimum, full FLIR operational performance shall be achieved in < 10 minutes (threshold), with a goal of < 8 minutes (objective).

FLIR Resolution and Sensitivity

The resolution thresholds and objectives were determined using a 7m RHIB, radial inbound, with 0.75 degree delta-T, in "very poor" weather (i.e. 90% point of the R384 environmental database). The standard 2D Johnson criteria for detection and identification shall apply. Additionally the range at which the discrimination task is required to be performed was extended as follows:

- Detection Threshold – As a threshold, the probability of detection (i.e. operator confidence) for above 7m RHIB shall be greater than 90% at a range greater than or equal to 4000 yards. This range equates to the maximum objective programmable Surface Warfare intruder keep out region.

- Detection Objective – As an objective, the probability of detection (i.e. operator confidence) for above 7m RHIB shall be greater than 90% at a range greater than or equal to 6000 yards. This range equates to the maximum objective programmable Surface Warfare intruder keep out region.

- Identification Threshold – As a threshold, the probability of identification (i.e. operator confidence) for above 7m RHIB shall be greater than 90% at a range greater than or equal to 1000 yards. This shall allow the operator to successfully perform the discrimination task against various surface targets in various environments.

- Identification Objective – As an objective, the probability of identification (i.e. operator confidence) for above 7m RHIB shall be greater than 90% at a range greater than or equal to 2000 yards. This shall allow the operator to successfully perform the discrimination task against various surface targets in various environments.

Daylight TVS Camera:

The TVS shall be a CCD color camera (or equivalent) and shall meet the requirements in Table 5.

Table 5

Characteristic	Requirement	
	Threshold	Objective
TVS Sensitivity	0.5 lux to full daylight (10,752 lux)	0.2 lux to full daylight (10,752 lux)
TVS Resolution	≥ 470 NTSC	NA
TVS FOV (color) (Optical)	WFOV ≥ 17° NFOV ≤1.7° With continuous zoom	WFOV ≥ 25° NFOV ≤1.0° With continuous zoom

Spotter Scope Requirements

As a threshold, the spotter scope shall be a CCD color camera (or equivalent) and shall meet the requirements in Table 6.

Table 6

Characteristic	Requirement	
	Threshold	Objective
Spotter Scope Sensitivity	0.5 lux to full daylight (10,752 lux)	0.2 lux to full daylight (10,752 lux)
Spotter Scope Resolution	≥ 470 NTSC	NA
Spotter Scope FOV (color) (Optical)	FOV ≤ 0.4°	NA

Eye Safe Laser Range Finder Requirements

The EyeSafe Laser Rangefinder (ESLRF) shall have the following characteristics:

(a) Be Class 1 eyesafe in accordance with ANSI Z136.1-2000;
(b) Nominal Ocular Hazard distance for the unaided human eye shall be zero;
(c) Be able to range targets at 14,000 meters;
(d) Threshold Range accuracy of ± 5 meters, Objective Range accuracy of ± 2 meters;
(e) Display range in nautical miles, statute miles, meters, yards, and/or feet;
(f) Range display shall not display a numerical range for no return situations but shall provide an indicator to the Operator that no return occurred.

The output power of eyesafe laser shall be such that the Nominal Ocular Hazard Distance (NOHD) as defined by ANSI Z136.1-2000 shall be 0 meters under optically aided as well as unaided viewing conditions. The aided viewing condition is defined as ≤ 20 times magnification. The output power of the eyesafe laser shall not exceed the maximum permissible exposure limit for ANSI Class 1, and shall be certified as eyesafe by a U.S. Navy Laser Safety Review Board following the guidance of ANSI Z136.1-2000.

Automatic Video Tracker (AVT) Requirements

The AVT shall have the following characteristics:

The EOS shall have an AVT capability that can accept video from either the FLIR or the TVS, as selected, and automatically or manually track contacts from the video signal. The EOS shall have the ability to acquire and track stationary, crossing, and maneuvering contacts. As a threshold, the EOS shall automatically re-establish auto-track on contacts through changes of sensor FOV. An electro-optic sensor shall be capable of auto-tracking a single contact within the FOV and have an objective of dual contact tracking within a FOV.

As a threshold, the AVT shall have at least two distinct modes of tracking to optimize tracking under various environmental and contrast conditions. As an objective, the AVT shall automatically select the best tracking mode based on environmental and contrast conditions.

As a threshold, the AVT shall track closed contour regions of contrast in the image. The AVT shall be able to acquire and track the contact ranging in size from 1% to 75% of the currently commanded FOV when the LOS to the contact is not obscured. After a contact has been acquired, the AVT shall be able to maintain track on a contact as small as 0.5% of the FOV dimension.

As an objective, an AVT coast function shall be provided that shall allow a contact that has been obscured, to be automatically re-acquired if the same contact becomes unobscured within 3 seconds.

Mounting Requirements

The EOS shall include all the necessary mounting hardware to allow the EOS to be easily and safely installed and made fully operational. The EOS shall be capable of being mounted in an upright or inverted position. The EOS shall have removable handles to assist in Installation/ De-installation of the EOS.

EOS Environmental Requirements

In order to perform the surface Navy mission, the EOS shall operate in the open ocean and littoral environment, and shall be subjected to a severe marine weather environment. The EOS shall operate and be maintained in the environmental extremes as specified in Appendix B without degradation to mechanical capabilities or material condition. The EOS shall meet the environmental requirements of Appendix B.

Electromagnetic Compatibility (EMC) Requirements.

The EOS shall be electro magnetically compatible with all shipboard systems/equipments, and shall not degrade, nor be degraded by, own-ship systems. The EOS shall meet the EMI/EMC requirements of Appendix B.

Shock and Vibration

The EOS shall meet the Shock and Vibration requirements of Appendix B.

4. Ancillary Equipment

This specification has been written with the intent of only documenting requirements for a single EOS unit (EOS and gimbal assembly if required). As an objective, ancillary equipment to support the EOS shall not be required. As a threshold, ancillary equipment is permissible to support the EOS unit. Ancillary equipment shall be evaluated in conjunction with the EOS requirements. Preference shall be given in regards to the ancillary equipment in the following order: no ancillary equipment, 19" rack mountable ancillary equipment, bulkhead mountable ancillary equipment. Less ancillary equipment shall have preference over more ancillary equipment, and smaller/lighter ancillary equipment shall have preference over larger/heavier ancillary equipment.

It is anticipated that this component shall be integrated into a larger ship system. As such, it is not anticipated or desired that ancillary equipment (such as hand controllers, displays, shipboard cables, etc...) be provided as part of this contract. As a threshold shipboard cable drawings shall be provided with enough detail for the IROS^3 system integrator to build independently.

5. Acronym Definitions

Amps	Amperes
A_O	Operational Availability
ATFP	Anti-Terrorism Force Protection
AVT	Automatic Video Tracker
BIT	Built In Test
BTU	British Thermal Unit
CCD	Charge-Coupled Device
COTS	Commercial-Off-The-Shelf
EMI/EMC	Electromagnetic Interference/ Electromagnetic Compatibility
EO/IR	Electro-optical and Infrared
EOS	Electro-optic Sensor
ESLRF EyeSafe	Laser Rangefinder
FOV	Field Of View
GFE	Government Furnished Equipment
ID	Identification
IROS^3	Integrated Radar Optical Surveillance and Sighting System
kw	Kilowatts
LAD	Large Area Display
LCD	Liquid Crystal Display
LOS	Line Of Sight
LRU	Lowest Replaceable Unit
MTBF	Mean Time Between Failures
MTBMCF	Mean Time Between Mission Critical Failures
MTTR	Mean Time To Repair
NOHD	Nominal Ocular Hazard Distance
NSWC	Naval Surface Warfare Center
NTSC	National Television Standards Committee
OEM	Original Equipment Manufacturer
PC	Personal Computer
PCI	Peripheral Component Interconnect
PSI	Pounds Per Square Inch
POSIX	Portable Operating System Interface
RFID	Radio-Frequency Identification
RCS	Radar Cross Section
SOW	Statement Of Work
SUW	Surface Warfare
SPS	Shipboard Protection System
TBD	To Be Defined
TVS	Television Sensor

UPS	Un-interruptible Power System
VAC	Volts AC

Appendix A

MIL-HDBK-2036	01 NOV 1999	Preparation Of Electronic Equipment Specifications
Federal Acquisition Register	JAN 1998	Y2K Document
MIL-HDBK-46855A	17 MAY 1999	Human Engineering Requirements For Military Systems, Equipment, And Facilities
MIL-STD-2525B	30 JAN 1999	Common Warfighting Symbology
MIL-DTL-38999K	12 JUL 2002	Connectors, Electrical, Circular, Miniature, High Density, Quick Disconnect (Bayonet, Threaded, And Breech Coupling), Environment Resistant, Removable Crimp And Hermetic Solder Contacts, General Specification For
MIL-DTL-5015H	18 MAY 2000	Connectors, Electrical, Circular Threaded, AN Type, General Specification For
MIL-C-24643A	14 MAR 1994	Cable And Cords, Electric, Low Smoke, For Shipboard Use, General Specification For
MIL-STD-2042B	25 JUL 2002	Fiber Optic Cable Topology Installation Standard Methods For Naval Ships
MIL-C-28876D	04 MAY 1995	Connectors, Fiber Optic, Circular, Plug And Receptacle Style, Multiple Removable Termini, General Specification For
MIL-PRF-85045F	12 AUG 1999	Cables, Fiber Optics, (Metric), General Specification For
FED-STD-595B	11 JAN 1994	Colors Used In Government Procurement

MIL-A-8625F	10 SEP 1993	Anodic Coatings For Aluminum And Aluminum Alloys
MIL-STD-810F	30 AUG 2002	Department Of Defense Test Method Standard For Environmental Engineering Considerations And Laboratory Tests
MIL-STD-167-1	19 JUN 1987	Mechanical Vibrations Of Shipboard Equipment (Type 1 – Environmental And Type II - Internally Excited)
MIL-S-901D	17 MAR 1989	Shock Tests. H.I. (High Impact) Shipboard Machinery, Equipment, And Systems, Requirements For
DOD-STD-1399/70-1	30 NOV 1989	Interface Standard For Shipboard Systems Section 070 - Part 1 D.C. Magnetic Field Environment (Metric)
MIL-STD-461E	20 AUG 1999	Requirements For The Control Of Electromagnetic Interference Characteristics Of Subsystems And Equipment
OPNAVINST 3000.12	30 SEP 1999	Operational Availability Handbook
MIL-STD-882D	10 FEB 2000	Standard Practice For System Safety
MIL-STD-1399-300A	11 MAR 1992	Interface Standard For Shipboard Systems Section 300A Electric Power, Alternating Current (Metric)
MIL-STD-1472F	23 AUG 1999	Department Of Defense Design Criteria Standard, Human Engineering
MIL-STD-740-1	30 DEC 1986	Airborne Sound Measurements And Acceptance Criteria Of Shipboard Equipment
ANSI Z136.1-2000	26 OCT 2000	Safe Use Of Lasers
CONFIDENTIAL/NO FORN	30 DEC 2002	Radar Cross Section (RCS) Requirements For Integrated Radar Optical Surveillance And Sighting System (IROS^3)

ENVIRONMENTAL SPECIFICATIONS (OPERATING)			
Ambient Temperature	-28 °C to 65 °C	MIL-STD-810F Method 501.4 and 502.4, Procedure II	Above Deck Equipment
Ambient Temperature	0 °C to 50 °C	MIL-STD-810F Method 501.4 and 502.4, Procedure II	Below Deck Equipment
Storage Ambient Temperature	-40 °C to 70 °C	MIL-STD-810F, Method 501.4 and 502.4, Procedure I	Above Deck Equipment And Below Deck Equipment
Solar Radiation	350 BTU/hr/ft^2	MIL-STD-810F, Method 505.4, Procedure II, Basic Hot	Above Deck Equipment
Rain	Rainfall rate 6 cm/hr, wind speed 18 m/s, water pressure 377 kPa	MIL-STD-810F, Method 506.4 Procedure I (Blowing rain).	Above Deck Equipment
Humidity	100% condensing	MIL-STD-810F, Method 507.4	Above Deck Equipment And Below Deck Equipment
Salt Fog	MIL-STD-810F, Method 509.4 Procedure I	MIL-STD-810F, Method 509.4 Procedure I	Above Deck Equipment And Below Deck Equipment
Ice	4.5 lbs/ft^2	MIL-STD-810F, Method 521.2 Procedure I	Above Deck Equipment
Fungus	MIL-STD-810F, Method 508.5	MIL-STD-810F, Method 508.5	Above Deck Equipment And Below Deck Equipment
Sand/Dust	MIL-STD-810F, Method 510.4 Procedure I (Blowing Dust)	MIL-STD-810F, Method 510.4 Procedure I (Blowing Dust)	Above Deck Equipment
Wind velocity	90 knots	To be incorporated into design and supported by analyses	Above Deck Equipment
Vibration	MIL-STD-167-1 Type 1 and MIL-STD-810F, Method 514.5 Categories 2 and 21 (Transportation and Shipboard vibration)	MIL-STD-167-1 Type 1 and MIL-STD-810F, Method 514.5 Categories 2 and 21 (Transportation and Shipboard vibration)	Above Deck Equipment And Below Deck Equipment
Shock	Grade A, Type A, Class III	MIL-HDBK-2036 (Shock); MIL-S-901D	Above Deck Equipment
Shock	Grade A, Type A, Class III	MIL-HDBK-2036 (Shock); MIL-S-901D	Below Deck Equipment
DC Magnetic Field	DOD-STD-1399-70-1	DOD-STD-1399-70-1	Below Deck Equipment
Non-Operating Altitude	MIL-STD-810F, Method 500.3 Procedure I	MIL-STD-810F, Method 500.3 Procedure I	Above Deck Equipment And Below Deck Equipment
EMI/EMC	MIL-STD-461E surface ships	MIL-STD-461E surface ships	Above Deck Equipment And Below Deck Equipment

Appendix B

Appendix C

2.8 EOS CONTROL REQUIREMENTS			
PARAGRAPH NUMBER	**TOP LEVEL ATTRIBUTE**	**THRESHOLD**	**OBJECTIVE**
2.8.1	**EOS Power On/Off**	EOS shall be able to receive a remote message to turn EOS on/off	EOS shall be able to receive a remote messge to turn EOS on/off and give an EOS on/off status
2.8.2	**EOS Positional Data**	EOS shall give current positional data (elevation and azimuth) at the rate of ≤ 50 msec. EOS shall accept positional commands to move EOS. EOS shall provide a positional data accuracy of ≤ 3 milliradians.	EOS shall give current positional data (elevation and azimuth) at the rate of ≤ 33 msec EOS shall accept positional commands to move EOS. EOS shall provide a positional data accuracy of ≤ 1 milliradians.
2.8.3	**EOS Movement Commands**	EOS shall receive variable slew rate commands for both azimuth and elevation axis	EOS shall receive variable slew rate commands for both azimuth and elevation axis EOS shall move to a commanded azimuth and elevation
2.8.4	**EOS Status Reports**	EOS shall periodically update (≤ 50 msec) status	EOS shall periodically update (≤ 33 msec) status and be able to give status report when queried
2.8.5	**EOS Stow Position**	EOS shall have a configurable stow position	N/A
2.8.6	**EOS Software Updates/Upgrades**	EOS shall have the capability to receive software updates and upgrades	N/A
2.8.7	**EOS Software Stops/Keep-out Zones**	EOS shall have configurable and programmable software stops/keep-out zones. Software stops shall not allow physical movement of the EOS past these configurable positions.	N/A
2.8.8	**EOS BIT**	EOS BIT shall communicate with software when a fault occurs detailing what fault occurred	N/A
2.8.9	**EOS Auto Null**	The drift of the EOS shall be capable of being zeroed out by software	N/A

2.8.10	**EOS Feedback**	EOS shall provide feedback for all commands from software	N/A

2.8.11	**EOS Field Of View (FOV)**	EOS shall receive FOV commands in either FLIR mode or TVS mode	EOS shall receive FOV commands in either FLIR mode or TVS mode EOS shall receive FOV commands and report current FOV setting in either FLIR mode or TVS mode
2.8.12	**EOS FLIR Polarity**	Software shall change the polarity of the FLIR setting on the EOS	Software shall change the polarity of the FLIR sensor FLIR sensor shall report current polarity settings
2.8.13	**EOS Focus**	Software shall change the focus of the EOS	Software shall change the focus of the EOS EOS shall report current focus settings
2.8.14	**EOS Gimbal Mode**	Software shall be able to change the mode of the EOS gimbal; at a minimum, modes shall include Rate Control, and Stow	Software shall be able to change the mode of the EOS gimbal; at a minimum modes shall include Rate Control, Stow, and Position The EOS shall report which mode it is in
2.8.15	**EOS Interface Protocol**	EOS interface protocols shall be fully disclosed	EOS interface protocols shall be fully disclosed and non-proprietary
2.8.16	**EOS Iris Mode**	EOS iris shall be controllable by software to change between automatic and manual modes Means shall be provided for control of the iris when in manual mode	EOS iris shall be controllable by software to change between automatic and manual modes Means shall be provided for control of the iris when in manual mode EOS shall report current iris settings

2.8.17	**EOS Laser Fire**	EOS laser range finder shall be able to be fired by software and return a range	EOS laser range finder shall be able to be fired by software and return a range EOS shall have a quality of return indication in the laser range
2.8.18	**EOS Mode**	Software shall switch between the EOS camera devices, including FLIR, TVS, and Spotter Scope	Software shall switch between the EOS camera devices, including FLIR, TVS, and Spotter Scope EOS shall report which mode EOS is in
2.8.19	**EOS Payload On/Off**	EOS shall be able to receive a remote message to turn any of the four EOS payloads on/off	EOS shall be able to receive a remote message to turn any of the four EOS payloads on/off and give individual EOS payload on/off status
2.8.20	**EOS Stabilization Mode**	Software shall have the ability to toggle EOS stabilization on/off	Software shall have the ability to toggle EOS stabilization on/off EOS shall provide feedback on EOS stabilization mode
2.8.21	**EOS Tracking**	EOS tracking shall be on/off controllable by software	EOS tracking shall be on/off controllable by software EOS shall be capable of scanning defined areas and auto-tracking a contact, configurable by software interface EOS shall report EOS tracking status

PERFORMANCE SPECIFICATION

for the

ELECTRO-OPTICS SENSOR (EOS)

Version 1.7
12 October 2004

Prepared by:
Code 805C, NSWC Crane, IN 47522

8/25/0414 October 2004

2. Introduction

Naval vessels require a fully integrated and seamless system that provides Anti-Terrorism Force Protection (ATFP) capabilities against asymmetric threats. The U.S. Navy has changed emphasis from open ocean "blue water" operations to that of gaining access into and operating within the littorals. U.S. Naval forces require increased force protection capability and situational awareness in the littorals, including transiting restricted waters, at anchor and pierside at ports throughout the world. Ships must rely on organic force protection capability using integrated sensor packages to provide close-range, 360°, situational awareness for detection and recognition of asymmetric threats. The Navy must increase surveillance and be prepared to intercept large numbers of small, fast surface craft, and low slow flying aircraft. Electro-optical and infrared (EO/IR) sensor systems provide needed capability for intrusion detection and threat recognition.

The primary mission of the electro-optical and infrared (EO/IR) sensor systems is to provide surface ships with a day/night, high-resolution, infrared and visible band imaging capability, as well as laser rangefinding capability, to augment existing optical and radar sensors. The primary (EO/IR) mission is to perform surveillance tasks to enhance the detection and tracking of small surface and near-surface targets such as small boats and low slow flying aircraft.

The EO sensor shall be highly reliable and capable of withstanding the Naval shipboard environment.

1.1. General Standards and Applicable Documents

The following specification, standards, and handbooks form a part of this specification to the extent specified herein. In keeping with the most recent Department of Defense and Secretary of the Navy policy, the provider is encouraged to propose alternatives to the specification and standards cited herein for government concurrence. Unless otherwise specified, the issues of the military documents are those listed in the issue of the Department of Defense Index of Specification and Standards on the date of this specification. The issue of non-government standards are those in effect on the date of this specification. Invoked documents and standards specifically called out in Section 2 and Section 3 are to be followed. Guidance documents provide a reference to use as a general guide in the development of processes, documents or data. See ***Appendix A*** for a list of standards and applicable documents that shall be considered as guidance materials.

1.3 Order of Precedence

In the event of a conflict between the text of this document and the reference cited herein, the text of this document takes precedence. Nothing in this document supersedes applicable Federal, State or Local laws and regulations unless a specific exemption has been obtained.

2. Electro-optic sensor (EOS) Top Level Requirements

The EOS shall comply with the following electrical and mechanical specifications. For the purpose of this specification the suite of electro-optic payloads and gimbal assembly is considered a single EOS unit.

PARAGRAPH NUMBER	TOP LEVEL ATTRIBUTE	THRESHOLD	OBJECTIVE
2.1	**Height**	EOS height shall be ≤ 24 inches	EOS height shall be ≤ 18 inches
2.2	**Width**	EOS width shall be ≤ 18 inches	N/A
2.3	**Depth**	EOS depth shall be ≤ 18 inches	N/A
2.4	**Weight**	EOS weight shall not exceed 112 Pounds in accordance with MIL-STD-1472F.	EOS weight shall not exceed 74 Pounds in accordance with MIL-STD-1472F.
2.5	**Power (Input)**	EOS shall be capable of running on ship's power: 115VAC ± 5% ≤ 10 Amps ± 5% 60 Hz ± 5% Single Phase Or 440VAC ± 5% ≤ 5 Amps ± 5% 60 Hz ± 5% Three Phase	N/A
2.6	**Heat Dissipation**	Above Deck Equipment: 2.3kw / 7,855 BTUs/hour Below Deck Equipment: 2.3kw / 7,855 BTUs/hour	N/A

2.7	**Sea State (Based On Pierson –Moskowitz Sea Spectrum Scale)**	Operational: EOS shall operate up to and including sea state 3. Survival: EOS shall be functional after being subjected to sea states up to and including sea states 8.	N/A
2.8	**EOS Control**	See Appendix C	See Appendix C
2.9	**EOS Interface**	EOS Interface shall be RS-232, RS-422, or Ethernet.	N/A
2.10	**Cooling/Positive Pressure**	If OEM requires, dry air shall be provided as follows: The EOS shall be cooled at ≤ 6 cfm at ≤ 100 psi. No chilled water shall be provided. No hazardous materials shall be used to keep system cool.	The EOS shall not require dry air, or desiccant packs,
2.11	**Equipment Marking**	Nameplates and markings for all pieces of equipment shall be clean, concise, legible, and durable. Markings shall be provided for all controls, lamps, switches, fuses, jacks, test points, and other components	N/A

2.12	**Radar Cross Section**	The Radar Cross Section (RCS) shall be in accordance with Radar Cross Section Requirements for IROS[3] CONFIDENTIAL/NO FORN letter dated 30 December 2002.	N/A
2.13	**BIT Diagnostics**	The EOS shall be capable of running BIT Diagnostics to determine faults within the EOS to the LRU level without the aid of separate test equipment. The EOS in BIT mode shall detect ≥ 80% of all specified faults or failures to within one LRU.	The EOS in BIT mode shall detect ≥ 90% of all specified faults or failures to within one LRU. The BIT should complete testing in ≤ 2 minutes.
2.13.1	**BIT False Alarms**	The percentage of BIT false alarms shall be ≤ 10%	The percentage of BIT false alarms shall be ≤ 5%
2.13.2	**BIT Types**	The EOS shall have a Manual BIT Test Manual BIT: A test that excludes rebooting or refreshing of default settings. This shall be an operator-initiated test.	Power-On BIT: Automatic BIT that provides diagnosis of the components during the power on procedure. The EOS shall have an Automatic BIT with a user option to bypass Automatic BIT Continuous BIT: Test that is active during regular components use. It can be triggered by momentary functions such as zoom or focus.
2.14	**Cable Diameter**	No shipboard cable shall exceed 2 Inches in diameter	No shipboard cable shall exceed 1 Inch in diameter

2.14.1	**Cable Type**	All shipboard cables shall be low smoke in accordance with MIL-C-24643B (See Appendix A).	N/A
2.14.2	**Cable Length**	All shipboard cables shall support cable runs up to and including 300 feet.	All shipboard cables shall support cable runs up to and including 1 kilometer.
2.14.3	**Shipboard Fiber Optic Cable**	If shipboard fiber optic cabling is used, it shall adhere to the specifications and requirements per MIL-STD-2042B, MIL-C-28876D, and MIL-PRF-85045F (*See Appendix A).*	N/A
2.14.4	**Shipboard Fiber Optics Spares**	If single mode fiber optic or multimode fiber optic is used in a shipboard fiber optic cable, there shall be at least a one to one ratio of fibers utilized to spare fibers in the fiber optic cable	N/A
2.15	**On-time Counter**	The EOS shall place an easily accessible and visible on time counter on all major components. The counter shall record operating hours of each major component. Counter shall be a minimum of 4 digits with minimum lowest valued digit in hours.	N/A
2.16	**Connectors**	All exterior EOS connectors shall be in accordance with MIL-DTL-38999K (See Appendix A)	N/A

2.17	**Mean Time Between Failures (MTBF)**	Mean Time Between Failures (MTBF) is the predicted mean time between failures, in terms of operating hours. MTBF shall be calculated by the following formula: MTBF = Average Uptime/Number of Failures The EOS shall have a MTBF ≥ 720 hours	The EOS shall have a MTBF ≥ 1440 hours
2.18	**Mean Time To Repair (MTTR)**	Mean Time To Repair (MTTR) is the predicted mean time to repair the item, in elapsed hours. This factor is used to compute A_o of the equipment and to provide estimates of maintenance shop workloads. The EOS shall have a MTTR ≤ 1 hour	The EOS shall have a MTTR ≤ 30 minutes
2.19	**Equipment Finish**	All equipment shall be Navy Haze Gray, Color #26270 per FED-STD-595B Per one of the following as applicable: c.) Hard coat anodize per MIL-A-8625F, type III, class1 or, d.) Commercial grade powder coat epoxy with appropriate priming system	N/A
2.20	**Environmental**	The EOS shall be functional and meet the Environmental Requirements in Appendix B.	N/A

2.21	**UID Tag**	The EOS shall have Unique IDentification (UID) tags at the LRU level Government shall provide UID tag part numbers prior to production of the EOS.	N/A
2.22	**Safety**	The EOS shall be designed to ensure the system is safe to use, and there shall be no electrical, mechanical, or radiation hazard to users as specified in MIL-STD-882D.	N/A
2.23	**Maintenance Level**	Organizational: The EOS shall provide an LRU level of corrective and preventative maintenance to be performed by ship's force. This shall include the utilization of BIT. The EOS shall be designed to minimize the requirement for preventative maintenance. Intermediate: The EOS shall not require intermediate level maintenance at the system level Depot: The EOS shall require depot level maintenance only for items that have been agreed to by the Government as being non-repairable by the ship's force. The OEM shall perform depot level maintenance.	N/A

2.24	**Maintenance Test Equipment**	Organizational level preventive/corrective maintenance shall not require any special purpose test equipment. General-purpose test equipment is allowed if necessary.	N/A
2.25	**Local Kill Switch**	The EOS shall be equipped with a local kill switch that shall secure the power during manual troubleshooting or manipulation of the gimbal.	N/A
2.26	**System Feedback**	The EOS shall contain component sense lines that provide system feedback concerning operation of the sensor.	N/A
2.27	**Fiber Cable Interconnect**	N/A	All EOS fiber equipment shall utilize International Fiber Systems hardware, and shall be configured prior to delivery.
2.28	**Noise Level**	The EOS audible noise level shall be no louder than 63 decibels in accordance with MIL-STD-740-1, Grade A3.	N/A

3. EO Sensor Description

As a minimum, the EOS shall consist of a stabilized gimbal containing the following payloads: daylight imaging television sensor (TVS), a forward-looking infrared sensor (FLIR), an eye-safe laser range-finder (ESLRF), and a spotter scope.

3.1 Stabilized Gimbal Performance Thresholds and Objectives.

The Stabilized Gimbal shall meet the performance requirements as outlined below.

3.1.1 Stabilized Gimbal Requirements

The Stabilized Gimbal shall provide Line of Sight (LOS) capabilities as stated in Table 2.

Table 2 *Stabilized Gimbal Requirements*

Characteristic	Requirement	
	Threshold	Objective
Azimuth Field of Regard	360° continuous	NA
Elevation Field of Regard	–120° to +90°	–135° to +105°
Bearing Slew Rate	≥ 60 deg/sec	≥ 75 deg/sec
LOS Jitter	LOS Jitter ≤ 35 micro-radians	LOS Jitter ≤ 20 micro-radians
Vibration/Isolation	2 axes (Azimuth and Elevation)	3 axes(must include Azimuth and Elevation axes)
Gimbal/Gyro Drift	EOS shall be able to correct for gimbal/gyro drift via software. After correction, the gimbal shall not drift again for at least 1 hour.	EOS shall be able to correct for gimbal/gyro drift via software. After correction, the gimbal shall not drift again for at least 4 hours.
Boresight Characteristics	EOS shall be able to verify and correct bore sight errors. Boresight retention interval shall be at least 8 hours. EOS shall retain the reticle position of the last boresight before power-down and restore the reticle to that position without operator intervention on power-up.	EOS shall be able to verify and correct bore sight errors. Boresight retention interval shall be at least 12 hours. EOS shall retain the reticle position of the last boresight before power-down and restore the reticle to that position without operator intervention on power-up.
Window Heater	N/A	EOS shall have window heater(s) to remove exterior moisture accumulation

3.1.1.1 Ship Motion Parameters

As an objective the EOS shall meet performance requirements under the ship motion parameters outlined in Table 3.

Table 3 **Ship Motion Parameter Performance Objectives**

Ship Motion	Objective	Performance
Roll	11 second period 0° to 15° port and starboard 15° to 30° port and starboard 30° to 45° port and starboard	without operational degradation with operational degradation without damage
Pitch	7 second period Between 0° and 5°	without operational degradation
Yaw	7 second period between –5° and +5°	without operational degradation
Turning Rate	2° per second	without operational degradation
Roll, Pitch and Yaw are Sinusoidal and Non-synchronous		
TEST METHOD:MIL-HDBK-2036		

Sensor Requirements

FLIR Sensor Requirements

FLIR Sensor shall meet capabilities as stated in Table 4.

Table 4: **FLIR Sensor Requirements**

Characteristic	Requirement	
	Threshold	Objective
Thermal Imaging Sensor(s) IR Band	midwave IR band (nominally 3-5 μm)	N/A
NETD (deg C)	≤ 0.05	≤ 0.025
Thermal Imaging Sensor FOV (Optical)	WFOV ≥ 35° 17.5° ≤ MFOV ≤ 20.5° NFOV ≤ 0.9° or variable FOV (wide to narrow) (horizontal field of view)	Threshold FOVs With At Least 2 Additional FOVs With The Following Characteristics: 26° ≤ WMFOV ≤ 30.5° 9° ≤ MNFOV ≤ 11° (horizontal field of view) -or- Continuous zoom between the Threshold WFOV and NFOV (horizontal field of view)
Narcissus Effect	Narcissus effect shall not be visible in the observed image	N/A

The FLIR Sensor shall provide:

(e) black hot/white hot polarity;
(f) automatic gain and level control; and
(g) manual gain and level adjustments
(h) ability to calibrate FLIR sensor through software.

At minimum, full FLIR operational performance shall be achieved in < 10 minutes (threshold), with a goal of < 8 minutes (objective).

FLIR Resolution and Sensitivity

The resolution thresholds and objectives were determined using a 7m RHIB, radial inbound, with 0.75 degree delta-T, in "very poor" weather (i.e. 90% point of the R384 environmental database). The standard 2D Johnson criteria for detection and identification shall apply. Additionally the range at which the discrimination task is required to be performed was extended as follows:

- Detection Threshold – As a threshold, the probability of detection (i.e. operator confidence) for above 7m RHIB shall be greater than 90% at a range greater than or equal to 4000 yards. This range equates to the maximum objective programmable Surface Warfare intruder keep out region.

- Detection Objective – As an objective, the probability of detection (i.e. operator confidence) for above 7m RHIB shall be greater than 90% at a range greater than or equal to 6000 yards. This range equates to the maximum objective programmable Surface Warfare intruder keep out region.

- Identification Threshold – As a threshold, the probability of identification (i.e. operator confidence) for above 7m RHIB shall be greater than 90% at a range greater than or equal to 1000 yards. This shall allow the operator to successfully perform the discrimination task against various surface targets in various environments.

- Identification Objective – As an objective, the probability of identification (i.e. operator confidence) for above 7m RHIB shall be greater than 90% at a range greater than or equal to 2000 yards. This shall allow the operator to successfully perform the discrimination task against various surface targets in various environments.

Daylight TVS Camera:

The TVS shall be a CCD color camera (or equivalent) and shall meet the requirements in Table 5.

Table 5

Characteristic	Requirement	
	Threshold	Objective
TVS Sensitivity	0.5 lux to full daylight (10,752 lux)	0.2 lux to full daylight (10,752 lux)
TVS Resolution	≥ 470 NTSC	NA
TVS FOV (color) (Optical)	WFOV ≥ 17° NFOV ≤1.7° With continuous zoom	WFOV ≥ 25° NFOV ≤1.0° With continuous zoom

Spotter Scope Requirements

As a threshold, the spotter scope shall be a CCD color camera (or equivalent) and shall meet the requirements in Table 6.

Table 6

Characteristic	Requirement	
	Threshold	Objective
Spotter Scope Sensitivity	0.5 lux to full daylight (10,752 lux)	0.2 lux to full daylight (10,752 lux)
Spotter Scope Resolution	≥ 470 NTSC	NA
Spotter Scope FOV (color) (Optical)	FOV ≤ 0.4°	NA

Eye Safe Laser Range Finder Requirements

The EyeSafe Laser Rangefinder (ESLRF) shall have the following characteristics:

(g) Be Class 1 eyesafe in accordance with ANSI Z136.1-2000;
(h) Nominal Ocular Hazard distance for the unaided human eye shall be zero;
(i) Be able to range targets at 14,000 meters;
(j) Threshold Range accuracy of ± 5 meters, Objective Range accuracy of ± 2 meters;
(k) Display range in nautical miles, statute miles, meters, yards, and/or feet;
(l) Range display shall not display a numerical range for no return situations but shall provide an indicator to the Operator that no return occurred.

The output power of eyesafe laser shall be such that the Nominal Ocular Hazard Distance (NOHD) as defined by ANSI Z136.1-2000 shall be 0 meters under optically aided as well as unaided viewing conditions. The aided viewing condition is defined as ≤ 20 times magnification. The output power of the eyesafe laser shall not exceed the maximum permissible exposure limit for ANSI Class 1, and shall be certified as eyesafe by a U.S. Navy Laser Safety Review Board following the guidance of ANSI Z136.1-2000.

Automatic Video Tracker (AVT) Requirements

The AVT shall have the following characteristics:

The EOS shall have an AVT capability that can accept video from either the FLIR or the TVS, as selected, and automatically or manually track contacts from the video signal. The EOS shall have the ability to acquire and track stationary, crossing, and maneuvering contacts. As a threshold, the EOS shall automatically re-establish auto-track on contacts through changes of sensor FOV. An electro-optic sensor shall be capable of auto-tracking a single contact within the FOV and have an objective of dual contact tracking within a FOV.

As a threshold, the AVT shall have at least two distinct modes of tracking to optimize tracking under various environmental and contrast conditions. As an objective, the AVT shall automatically select the best tracking mode based on environmental and contrast conditions.

As a threshold, the AVT shall track closed contour regions of contrast in the image. The AVT shall be able to acquire and track the contact ranging in size from 1% to 75% of the currently commanded FOV when the LOS to the contact is not obscured. After a contact has been acquired, the AVT shall be able to maintain track on a contact as small as 0.5% of the FOV dimension.

As an objective, an AVT coast function shall be provided that shall allow a contact that has been obscured, to be automatically re-acquired if the same contact becomes unobscured within 3 seconds.

Mounting Requirements

The EOS shall include all the necessary mounting hardware to allow the EOS to be easily and safely installed and made fully operational. The EOS shall be capable of being mounted in an upright or inverted position. The EOS shall have removable handles to assist in Installation/ De-installation of the EOS.

EOS Environmental Requirements

In order to perform the surface Navy mission, the EOS shall operate in the open ocean and littoral environment, and shall be subjected to a severe marine weather environment. The EOS shall operate and be maintained in the environmental extremes as specified in Appendix B without degradation to mechanical capabilities or material condition. The EOS shall meet the environmental requirements of Appendix B.

Electromagnetic Compatibility (EMC) Requirements.

The EOS shall be electro magnetically compatible with all shipboard systems/equipments, and shall not degrade, nor be degraded by, own-ship systems. The EOS shall meet the EMI/EMC requirements of Appendix B.

Shock and Vibration

The EOS shall meet the Shock and Vibration requirements of Appendix B.

4. Ancillary Equipment

This specification has been written with the intent of only documenting requirements for a single EOS unit (EOS and gimbal assembly if required). As an objective, ancillary equipment to support the EOS shall not be required. As a threshold, ancillary equipment is permissible to support the EOS unit. Ancillary equipment shall be evaluated in conjunction with the EOS requirements. Preference shall be given in regards to the ancillary equipment in the following order: no ancillary equipment, 19" rack mountable ancillary equipment, bulkhead mountable ancillary equipment. Less ancillary equipment shall have preference over more ancillary equipment, and smaller/lighter ancillary equipment shall have preference over larger/heavier ancillary equipment.

It is anticipated that this component shall be integrated into a larger ship system. As such, it is not anticipated or desired that ancillary equipment (such as hand controllers, displays, shipboard cables, etc...) be provided as part of this contract. As a threshold shipboard cable drawings shall be provided with enough detail for the IROS^3 system integrator to build independently.

5. Acronym Definitions

Amps	Amperes
A_O	Operational Availability
ATFP	Anti-Terrorism Force Protection
AVT	Automatic Video Tracker
BIT	Built In Test
BTU	British Thermal Unit
CCD	Charge-Coupled Device
COTS	Commercial-Off-The-Shelf
EMI/EMC	Electromagnetic Interference/ Electromagnetic Compatibility
EO/IR	Electro-optical and Infrared
EOS	Electro-optic Sensor
ESLRF EyeSafe	Laser Rangefinder
FOV	Field Of View
GFE	Government Furnished Equipment
ID	Identification
IROS^3	Integrated Radar Optical Surveillance and Sighting System
kw	Kilowatts
LAD	Large Area Display
LCD	Liquid Crystal Display
LOS	Line Of Sight
LRU	Lowest Replaceable Unit
MTBF	Mean Time Between Failures
MTBMCF	Mean Time Between Mission Critical Failures
MTTR	Mean Time To Repair
NOHD	Nominal Ocular Hazard Distance
NSWC	Naval Surface Warfare Center
NTSC	National Television Standards Committee
OEM	Original Equipment Manufacturer
PC	Personal Computer
PCI	Peripheral Component Interconnect
PSI	Pounds Per Square Inch
POSIX	Portable Operating System Interface
RFID	Radio-Frequency Identification
RCS	Radar Cross Section
SOW	Statement Of Work
SUW	Surface Warfare
SPS	Shipboard Protection System
TBD	To Be Defined
TVS	Television Sensor

UPS	Un-interruptible Power System
VAC	Volts AC

Appendix A

MIL-HDBK-2036	01 NOV 1999	Preparation Of Electronic Equipment Specifications
Federal Acquisition Register	JAN 1998	Y2K Document
MIL-HDBK-46855A	17 MAY 1999	Human Engineering Requirements For Military Systems, Equipment, And Facilities
MIL-STD-2525B	30 JAN 1999	Common Warfighting Symbology
MIL-DTL-38999K	12 JUL 2002	Connectors, Electrical, Circular, Miniature, High Density, Quick Disconnect (Bayonet, Threaded, And Breech Coupling), Environment Resistant, Removable Crimp And Hermetic Solder Contacts, General Specification For
MIL-DTL-5015H	18 MAY 2000	Connectors, Electrical, Circular Threaded, AN Type, General Specification For
MIL-C-24643A	14 MAR 1994	Cable And Cords, Electric, Low Smoke, For Shipboard Use, General Specification For
MIL-STD-2042B	25 JUL 2002	Fiber Optic Cable Topology Installation Standard Methods For Naval Ships
MIL-C-28876D	04 MAY 1995	Connectors, Fiber Optic, Circular, Plug And Receptacle Style, Multiple Removable Termini, General Specification For
MIL-PRF-85045F	12 AUG 1999	Cables, Fiber Optics, (Metric), General Specification For
FED-STD-595B	11 JAN 1994	Colors Used In Government Procurement

MIL-A-8625F	10 SEP 1993	Anodic Coatings For Aluminum And Aluminum Alloys
MIL-STD-810F	30 AUG 2002	Department Of Defense Test Method Standard For Environmental Engineering Considerations And Laboratory Tests
MIL-STD-167-1	19 JUN 1987	Mechanical Vibrations Of Shipboard Equipment (Type 1 – Environmental And Type II - Internally Excited)
MIL-S-901D	17 MAR 1989	Shock Tests. H.I. (High Impact) Shipboard Machinery, Equipment, And Systems, Requirements For
DOD-STD-1399/70-1	30 NOV 1989	Interface Standard For Shipboard Systems Section 070 - Part 1 D.C. Magnetic Field Environment (Metric)
MIL-STD-461E	20 AUG 1999	Requirements For The Control Of Electromagnetic Interference Characteristics Of Subsystems And Equipment
OPNAVINST 3000.12	30 SEP 1999	Operational Availability Handbook
MIL-STD-882D	10 FEB 2000	Standard Practice For System Safety
MIL-STD-1399-300A	11 MAR 1992	Interface Standard For Shipboard Systems Section 300A Electric Power, Alternating Current (Metric)
MIL-STD-1472F	23 AUG 1999	Department Of Defense Design Criteria Standard, Human Engineering
MIL-STD-740-1	30 DEC 1986	Airborne Sound Measurements And Acceptance Criteria Of Shipboard Equipment
ANSI Z136.1-2000	26 OCT 2000	Safe Use Of Lasers
CONFIDENTIAL/NO FORN	30 DEC 2002	Radar Cross Section (RCS) Requirements For Integrated Radar Optical Surveillance And Sighting System (IROS^3)

ENVIRONMENTAL SPECIFICATIONS (OPERATING)			
Ambient Temperature	-28 °C to 65 °C	MIL-STD-810F Method 501.4 and 502.4, Procedure II	Above Deck Equipment
Ambient Temperature	0 °C to 50 °C	MIL-STD-810F Method 501.4 and 502.4, Procedure II	Below Deck Equipment
Storage Ambient Temperature	-40 °C to 70 °C	MIL-STD-810F, Method 501.4 and 502.4, Procedure I	Above Deck Equipment And Below Deck Equipment
Solar Radiation	350 BTU/hr/ft^2	MIL-STD-810F, Method 505.4, Procedure II, Basic Hot	Above Deck Equipment
Rain	Rainfall rate 6 cm/hr, wind speed 18 m/s, water pressure 377 kPa	MIL-STD-810F, Method 506.4 Procedure I (Blowing rain).	Above Deck Equipment
Humidity	100% condensing	MIL-STD-810F, Method 507.4	Above Deck Equipment And Below Deck Equipment
Salt Fog	MIL-STD-810F, Method 509.4 Procedure I	MIL-STD-810F, Method 509.4 Procedure I	Above Deck Equipment And Below Deck Equipment
Ice	4.5 lbs/ft^2	MIL-STD-810F, Method 521.2 Procedure I	Above Deck Equipment
Fungus	MIL-STD-810F, Method 508.5	MIL-STD-810F, Method 508.5	Above Deck Equipment And Below Deck Equipment
Sand/Dust	MIL-STD-810F, Method 510.4 Procedure I (Blowing Dust)	MIL-STD-810F, Method 510.4 Procedure I (Blowing Dust)	Above Deck Equipment
Wind velocity	90 knots	To be incorporated into design and supported by analyses	Above Deck Equipment
Vibration	MIL-STD-167-1 Type 1 and MIL-STD-810F, Method 514.5 Categories 2 and 21 (Transportation and Shipboard vibration)	MIL-STD-167-1 Type 1 and MIL-STD-810F, Method 514.5 Categories 2 and 21 (Transportation and Shipboard vibration)	Above Deck Equipment And Below Deck Equipment
Shock	Grade A, Type A, Class III	MIL-HDBK-2036 (Shock); MIL-S-901D	Above Deck Equipment
Shock	Grade A, Type A, Class III	MIL-HDBK-2036 (Shock); MIL-S-901D	Below Deck Equipment
DC Magnetic Field	DOD-STD-1399-70-1	DOD-STD-1399-70-1	Below Deck Equipment
Non-Operating Altitude	MIL-STD-810F, Method 500.3 Procedure I	MIL-STD-810F, Method 500.3 Procedure I	Above Deck Equipment And Below Deck Equipment
EMI/EMC	MIL-STD-461E surface ships	MIL-STD-461E surface ships	Above Deck Equipment And Below Deck Equipment

Appendix B

Appendix C

2.8 EOS CONTROL REQUIREMENTS			
PARAGRAPH NUMBER	**TOP LEVEL ATTRIBUTE**	**THRESHOLD**	**OBJECTIVE**
2.8.1	**EOS Power On/Off**	EOS shall be able to receive a remote message to turn EOS on/off	EOS shall be able to receive a remote messge to turn EOS on/off and give an EOS on/off status
2.8.2	**EOS Positional Data**	EOS shall give current positional data (elevation and azimuth) at the rate of ≤ 50 msec. EOS shall accept positional commands to move EOS. EOS shall provide a positional data accuracy of ≤ 3 milliradians.	EOS shall give current positional data (elevation and azimuth) at the rate of ≤ 33 msec EOS shall accept positional commands to move EOS. EOS shall provide a positional data accuracy of ≤ 1 milliradians.
2.8.3	**EOS Movement Commands**	EOS shall receive variable slew rate commands for both azimuth and elevation axis	EOS shall receive variable slew rate commands for both azimuth and elevation axis EOS shall move to a commanded azimuth and elevation
2.8.4	**EOS Status Reports**	EOS shall periodically update (≤ 50 msec) status	EOS shall periodically update (≤ 33 msec) status and be able to give status report when queried
2.8.5	**EOS Stow Position**	EOS shall have a configurable stow position	N/A
2.8.6	**EOS Software Updates/Upgrades**	EOS shall have the capability to receive software updates and upgrades	N/A
2.8.7	**EOS Software Stops/Keep-out Zones**	EOS shall have configurable and programmable software stops/keep-out zones. Software stops shall not allow physical movement of the EOS past these configurable positions.	N/A
2.8.8	**EOS BIT**	EOS BIT shall communicate with software when a fault occurs detailing what fault occurred	N/A
2.8.9	**EOS Auto Null**	The drift of the EOS shall be capable of being zeroed out by software	N/A

2.8.10	**EOS Feedback**	EOS shall provide feedback for all commands from software	N/A

2.8.11	**EOS Field Of View (FOV)**	EOS shall receive FOV commands in either FLIR mode or TVS mode	EOS shall receive FOV commands in either FLIR mode or TVS mode EOS shall receive FOV commands and report current FOV setting in either FLIR mode or TVS mode
2.8.12	**EOS FLIR Polarity**	Software shall change the polarity of the FLIR setting on the EOS	Software shall change the polarity of the FLIR sensor FLIR sensor shall report current polarity settings
2.8.13	**EOS Focus**	Software shall change the focus of the EOS	Software shall change the focus of the EOS EOS shall report current focus settings
2.8.14	**EOS Gimbal Mode**	Software shall be able to change the mode of the EOS gimbal; at a minimum, modes shall include Rate Control, and Stow	Software shall be able to change the mode of the EOS gimbal; at a minimum modes shall include Rate Control, Stow, and Position The EOS shall report which mode it is in
2.8.15	**EOS Interface Protocol**	EOS interface protocols shall be fully disclosed	EOS interface protocols shall be fully disclosed and non-proprietary
2.8.16	**EOS Iris Mode**	EOS iris shall be controllable by software to change between automatic and manual modes Means shall be provided for control of the iris when in manual mode	EOS iris shall be controllable by software to change between automatic and manual modes Means shall be provided for control of the iris when in manual mode EOS shall report current iris settings

2.8.17	**EOS Laser Fire**	EOS laser range finder shall be able to be fired by software and return a range	EOS laser range finder shall be able to be fired by software and return a range EOS shall have a quality of return indication in the laser range
2.8.18	**EOS Mode**	Software shall switch between the EOS camera devices, including FLIR, TVS, and Spotter Scope	Software shall switch between the EOS camera devices, including FLIR, TVS, and Spotter Scope EOS shall report which mode EOS is in
2.8.19	**EOS Payload On/Off**	EOS shall be able to receive a remote message to turn any of the four EOS payloads on/off	EOS shall be able to receive a remote message to turn any of the four EOS payloads on/off and give individual EOS payload on/off status
2.8.20	**EOS Stabilization Mode**	Software shall have the ability to toggle EOS stabilization on/off	Software shall have the ability to toggle EOS stabilization on/off EOS shall provide feedback on EOS stabilization mode
2.8.21	**EOS Tracking**	EOS tracking shall be on/off controllable by software	EOS tracking shall be on/off controllable by software EOS shall be capable of scanning defined areas and auto-tracking a contact, configurable by software interface EOS shall report EOS tracking status

R384 Environmental Database

1. (U) Atmospheric Attenuation.

1.1 (U) Atmospheric Model. (U) The atmospheric model that will be used by the Navy to evaluate thermal imaging performance is the Random 384 Observation Database (R384). This database was complied from a larger set of approximately 10,000 surface ship weather observations and calculated infrared (IR) parameters from 14 different locations throughout the world. These observations were made from 1964 to 1973. The points chosen represent an equal number of observations from the Baltic Sea, the Yellow Sea, the Gulf of Oman, and the Caribbean Sea. Thus, the R384 has 25% of the samples in the north latitudes, 25% of the samples in the tropics, and 50% of the samples in the mid-latitudes.

(U) The environment described by the R384 is usually expressed as a percentage, such as the 90% environment. This means that the environment modeled would be representative of the 90 percentile point in the database. Thus, the environment would be expected to have a higher transmittance than modeled 90% of time, worse 10% of the time. For more information concerning the R384, please consult "Use of the NSWCDD Weather Databases for Prediction of Atmospheric Transmission in Common Thermal Imaging Sensor Bands", (NSWCDD/TR-94/89), by Daniel E. Austin, Dr. Kenneth C. Hepfer, and Marilyn R. Rudzinsky, Ship Defense Systems Department, Naval Surface Warfare Center Dahlgren Division, October 1995.

1.2 (U) Imaging Sensors. (U) The following equation describing atmospheric transmission, τ, has been found to more accurately reflect the naval environment than the standard form of the atmospheric attenuation equation.

$$\tau = e^{-\alpha R^{\beta}}$$

(U) This equation requires specification of two atmospheric attenuation coefficients, α and β, to calculate the transmission for a particular set of conditions, as well as the range, R, in kilometers. Atmospheric attenuation in the midwave infrared (MWIR) bands has been modeled by performing LOWTRAN analyses on the R384 database. The coefficients necessary to fit the equation to predict the atmospheric transmission for the 90% weather condition are provided for a number of common MWIR bands in Table 1. Coefficients for other MWIR bands can be determined on an as-needed basis.

Table 1 (U) Coefficients to Predict IR Band Transmission for the R384.

IR Band	α (R384 90% point)	β (R384 90% point)
3.0 - 5.0 μm	0.89427	0.61522
3.4 - 5.0 μm	0.70145	0.68179
3.8 - 4.2 μm	0.38563	0.89658
3.8 - 4.8 μm	0.77214	0.63792
3.8 - 5.0 μm	0.82936	0.61911