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## SOLICITATION AMENDMENT MODIFICATION DE L'INVITATION

The referenced document is hereby revised; unless otherwise indicated, all other terms and conditions of the Solicitation remain the same.

Ce document est par la présente révisé; sauf indication contraire, les modalités de l'invitation demeurent les mêmes.

### Comments - Commentaires

Vendor/Firm Name and Address  
Raison sociale et adresse du  
fournisseur/de l'entrepreneur

Issuing Office - Bureau de distribution  
TPSGC/PWGSC  
601-1550, Avenue d'Estimauville  
Québec  
Québec  
G1J 0C7

<b>Title - Sujet</b> DUAL-COLOR MWIR IMAGER	
<b>Solicitation No. - N° de l'invitation</b> W7701-166079/A	<b>Amendment No. - N° modif.</b> 003
<b>Client Reference No. - N° de référence du client</b> W7701-166079	<b>Date</b> 2015-10-05
<b>GETS Reference No. - N° de référence de SEAG</b> PW-\$QCL-029-16542	
<b>File No. - N° de dossier</b> QCL-5-38151 (029)	<b>CCC No./N° CCC - FMS No./N° VME</b>
<b>Solicitation Closes - L'invitation prend fin</b> <b>at - à 02:00 PM</b> <b>on - le 2015-10-13</b>	
<b>Time Zone</b> Fuseau horaire Heure Avancée de l'Est HAE	
<b>F.O.B. - F.A.B.</b> Specified Herein - Précisé dans les présentes <b>Plant-Usine:</b> <input type="checkbox"/> <b>Destination:</b> <input type="checkbox"/> <b>Other-Autre:</b> <input checked="" type="checkbox"/>	
<b>Address Enquiries to: - Adresser toutes questions à:</b> Champoux, Nicolas	
<b>Buyer Id - Id de l'acheteur</b> qcl029	
<b>Telephone No. - N° de téléphone</b> (418) 649-2821 ( )	<b>FAX No. - N° de FAX</b> (418) 648-2209
<b>Destination - of Goods, Services, and Construction:</b> <b>Destination - des biens, services et construction:</b> RDDC-R ET DÉFENCE CANADA-VALCARTIER DRDC-DEFENCE R & D CANADA-VALCARTIE BATISSE 53 2459 ROUTE DE LA BRAVOURE QUEBEC Québec G3J1X5 Canada	

Instructions: See Herein

Instructions: Voir aux présentes

<b>Delivery Required - Livraison exigée</b> VOIR DOC	<b>Delivery Offered - Livraison proposée</b>
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<b>Signature</b>	<b>Date</b>

Solicitation No. - N° de l'invitation

W7701-166079/A

Amd. No. - N° de la modif.

003

Buyer ID - Id de l'acheteur

qc1029

Client Ref. No. - N° de réf. du client

W7701-166079

File No. - N° du dossier

QCL-5-38151

CCC No./N° CCC - FMS No/ N° VME

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### AMENDMENT 003

- Questions and answers 11 and 12;
- Modifications to the Request for Proposals (RFP)

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### QUESTIONS AND ANSWERS 11 AND 12

**Q11:** “Is it acceptable to propose a solution were each band be imaged by 1.31M pixels? It correspond to regular HD format of 1280 x 1024 pixels.”

**A11:** It is an accepted alternative to image each band of the 2C-IR imager to a HD detector of format 1280x1024 pixels. Using HD detectors implies that each band of the 2C-IR shall have a resolution of 1280 horizontal x 1024 vertical pixels. No further image size reduction will be authorized by the TA.

**Q12:** “Is it possible to have an extension until Friday, October 16?”

**A12:** No, the schedule does not allow us an additional extension.

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### MODIFICATIONS TO THE RFP

*Please DELETE Annex A in your possession and REPLACE by the following:*

### ANNEX “A”

### REQUIREMENT

#### 1. REQUIREMENT

To provide and deliver a cooled high-pixel density 2-Color MWIR imager and accessories to Defence Research and Development Canada - Valcartier Research Centre.

#### 2. BACKGROUND

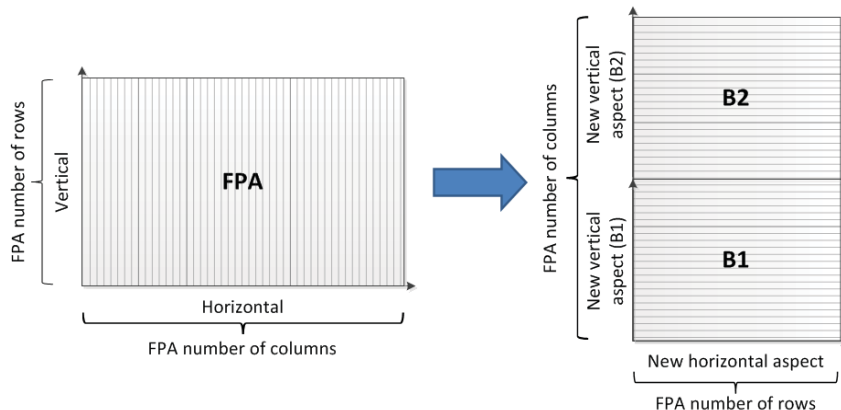
DRDC is pursuing imaging technologies studies in the mid-wave infrared (MWIR) region of the electromagnetic spectrum. To fulfil the studies, DRDC is looking to acquire one (1) cooled high-pixel density 2-Color MWIR imager (2C-IR imager) and two (2) MWIR objectives.

This requirement consists of the design and fabrication of a 2C-IR imager that delivers synchronized imagery of two distinct bands (B1 and B2) in the MWIR region sensed using a single optical aperture. The detector must be cooled via a Stirling and made of Indium Antimonide (InSb). Both bands must be imaged on a unique detector (\* see Note 1), each using half (50%) of the detector pixels, an example is shown in Figure 1. Each band must have, as a minimum, 1.4M pixels to provide sufficient resolution for wide Field-of-View (FOV) applications. The images created on the detector must be identical if B1 and B2 characteristics are matched. Thus, performing band subtraction via image processing would produce a black or null image.

- **Note 1: Acceptable equivalent:** It is possible to image the same scene on two distinct detectors as long as the specifications are met as described in Annex A herein. In a case where the two detectors options is chosen, the control software shall be able to program both detectors

simultaneously (integration time, ROI, Windowing, Binning, NUCs, etc.) in order to avoid potential manipulation errors during trials.

- **Note 6: Acceptable equivalent:** It is an accepted alternative to image each band of the 2C-IR imager to a HD detector of format 1280x1024 pixels. Using HD detectors implies that each band of the 2C-IR shall have a resolution of 1280 horizontal x 1024 vertical pixels.



**Figure 1: Example of imaging bands B1 and B2 on a single FPA**

The Contractor must design and develop a 2C-IR imager and its MWIR objectives in accordance with the SOR. Acceptance tests will be performed by the Contractor and DRDC. For the tests performed by the contractor, a Technical Authority (TA) from DRDC must witness and sign-off (upon qualification) the contractor acceptance document (Section 9). For the acceptance tests performed by DRDC, the contractor will obtain the test results within 120 days after the delivery of the 2C-IR imager.

The requirements for the 2C-IR imager are all mandatory with additional features (rated style). The MWIR bands centre wavelengths (B1\_λcentre, B2\_λcentre) and bandwidths (B1\_bandwidth, B2\_bandwidth) will be provided after contract award and after a Non-Disclosure Agreement (NDA) is signed between the Contractor and DRDC.

### 3. ACRONYMS

2C-IR	2-Color MWIR Imager
AD	Applicable Document
CDR	Critical Design Review
DRDC	Defence Research and Development Canada
DVD	Digital Video Disc
FOV	Field-of-View
FPA	Focal Plane Array
FWHM	Full Width Half Maximum
fps	frame per second
I2C	Inter Integrated Circuit
IEEE	Institute of Electrical and Electronics Engineers
InSb	Indium Antimonide
IP	Indice of Protection
IRIG	Inter-Range Instrumentation Group
LED	Light Emitting Diode
MTF	Modulation Transfer Function
MTTF	Mean Time To Failure
MWIR	Mid-Wave InfraRed (3-5 μm)
N/A	Not Applicable

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NDA	Non-Disclosure Agreement
NETD	Noise Equivalent Temperature Difference
NUC	Non-Uniformity Correction
OD	Optical Density
OEM	Original Equipment Manufacturer
PDR	Preliminary Design Review
PTP	Precision Time Protocol
QE	Quantum Efficiency
RA	Roughness Average
ROI	Region of Interest
SBIR	Santa Barbara InfraRed
SDK	Software Development Kit
SOR	Statement of Requirement
SRR	System Requirement Review
TA	Technical Authority
Tpk	Transmittance Peak
TTL	Transistor-Transistor Logic
UNF	Unified National Fine

#### 4. APPLICABLE DOCUMENTS & REFERENCES

**AD1:** MIL-STD-810G Method 514.6 VIBRATION

**AD2:** MIL-PRF-8805F

#### 5. MANDATORY REQUIREMENTS

The Contractor must provide a 2C-IR imager meeting all the specifications from Subsection 5.1 and MWIR objectives meeting all the specifications from Subsection 5.2.

##### **5.1 2C-IR IMAGER**

It is mandatory that the 2C-IR imager meets the following specifications:

###### **5.1.1 Optical aperture**

A single optical aperture in the MWIR region (3-5  $\mu\text{m}$ ) of the infrared spectrum.

###### **5.1.2 Spectral response**

Two bands of operation in the MWIR region of the infrared spectrum. The bands are labeled B1 and B2 with their center wavelengths localized at B1\_ $\lambda_{\text{center}}$  (B1\_bandwidth) and B2\_ $\lambda_{\text{center}}$  (B2\_Bandwidth), respectively, as shown in Figure 2.

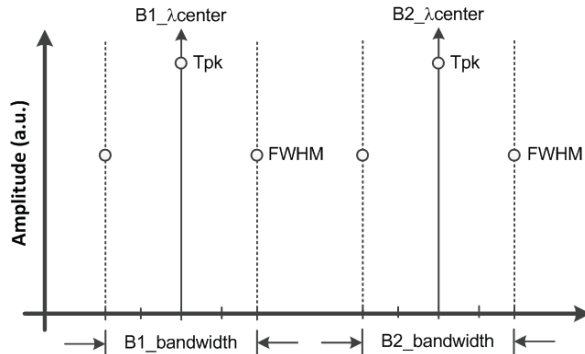


Figure 2: 2C-IR imager MWIR bands B1 and B2

### 5.1.3 Imaging detector specifications

The detector must meet the specifications from Table 1.

Table 1 : Imaging detector specifications

Specifications	Value	Notes
FPA pixels	Greater than or equal to 2.8 M pixels	Greater than or equal to 1.4 M pixels per band (see Note 6)
Material	InSb	
Quantum Efficiency (QE)	Greater than or equal to 50 %	from 3.2 $\mu\text{m}$ to 5.2 $\mu\text{m}$
Pixel Pitch	Smaller than or equal to 20 $\mu\text{m}$	
Pixel Operability	Greater than or equal to 99 %	
Digital resolution	Greater than or equal to 13-bit	
Frame Rate	Greater than or equal to 80 fps	
Gain	Selectable Gains	
Stirling Cooler MTTF	Greater than or equal to 10 000 hours	

### 5.1.4 Modulation Transfer Function (MTF)

MTFs at 20 % that are equal to or greater than 0.4 cycle/mrad for bands B1 and B2, using the objective #1 from Table 5.

### 5.1.5 Noise Equivalent Temperature Difference (NETD)

A temporal NETD that is less than or equal to 30 mK.

### 5.1.6 Optical power degradation

A maximum optical power degradation per band less than or equal to 4 dB (i.e.: a residual transmission of 40 % to the detector) excluding the objective losses.

### 5.1.7 Center wavelengths “blue shift” with a 45 degrees angle of incidence

A center wavelength “blue shift” smaller than or equal to 2 % for a  $45 \pm 2$  degrees horizontal angle of incidence for both bands (B1 and B2).

### 5.1.8 Maximum volume excluding the objective

A volume less than or equal to 500 cubic inches.

### **5.1.9 External enclosure material**

An external enclosure made at least 85 % of aluminum of type 6061-T6. The contractor is authorized to use different corrosion resistant materials for the 2C-IR imager internal design.

### **5.1.10 Mounting holes**

Four (4) 10-32 UNF threaded mounting holes, as per Figure 3.

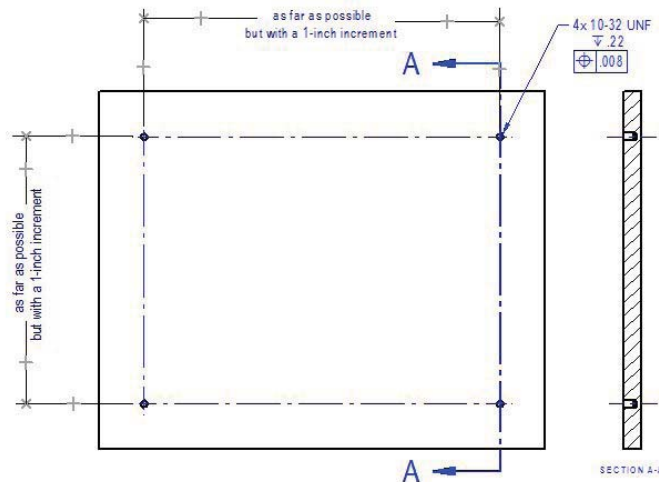


Figure 3: Mounting holes localization underneath the 2C-IR imager

### **5.1.11 Top handle for handling**

A strong top handle providing a good grip made of 6061-T6 aluminum anodized-class II (black color).

### **5.1.12 Protective cover**

A protective cover made of 6061-T6 aluminum anodized-class II (black color) using a twist-lock bayonet mechanism to protect the optical aperture.

### **5.1.13 Exterior finish**

An exterior finish anodized-class II (silver color) with a mechanical finish M-31 (sanded with 320-400 grit aluminum oxide). If the 2C-IR imager is composed of additional smaller aluminum 6061-T6 parts, they must be anodized-class II (black color) with the same mechanical finish.

**Note 2: Acceptable equivalents:** The exterior finish for the 2C-IR contract shall be in accordance to MIL-A-8625F standard (Type-II, Class 2) with the exception of paragraph 3.7.1.2 (Salt Spay Testing), which is not required. The dye colors will be discussed at PDR. The 2C-IR shall have a surface Roughness Average (RA) equal or smaller than 1.6 um.

### **5.1.14 Laser marking**

Laser engraved markings providing strong contrast for the connectors and indicators functions, and if required, warnings regarding the operational limits (e.g.: maximum input voltage, power).

### **5.1.15 Heat management**

A heat transfer via conduction cooling (internally) and via forced convection (externally). The forced convection must be activated automatically when the 2C-IR imager is powered up. Figure 4 shows a sketch, not to scale, of the required separation for the internal conduction and the external forced convection. The forced convection conduit may be located differently according to the final location of the detector Stirling cooler and the associated optical components.

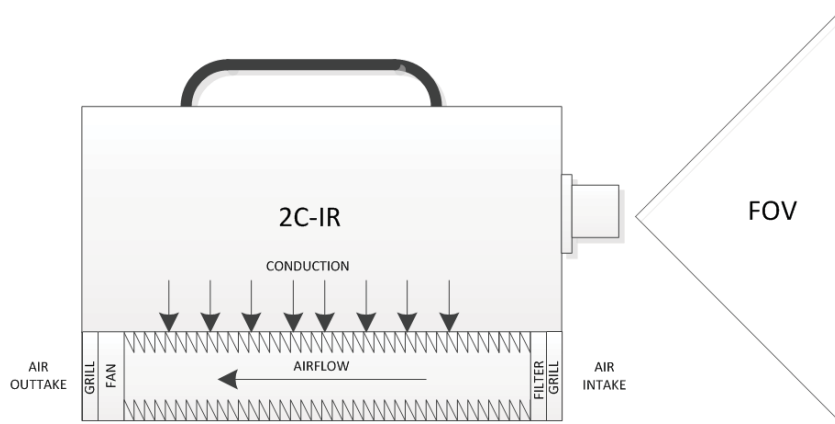


Figure 4: Sketch of conduction/convection cooling concept for the 2C-IR imager  
The heat management topology goal is to ensure that the internals of the 2C-IR imager are sealed against dust and humidity and still allow for proper cooling.

#### **5.1.16 Heat management fan**

A brushless heat management fan that automatically operates with the function of extracting heat from the 2C-IR imager when the power is applied.

#### **5.1.17 Data connector**

A data connector connected via a MIL-DTL-38999 - Series III panel-mount circular connector that supports up to 10GBASE-T Ethernet communication, as shown in Figure 5. The connector must have additional unused pins for future growth.



Figure 5: Typical "MIL-DTL-38999 - Series III" panel-mount connector for high-bandwidth applications

**Note 3: Acceptable equivalents:** Any equivalent metal alloy connector that is: 1) Circular; 2) scoop-proof; 3) meeting the IP64 rating; and 4) expressly made for military or aerospace applications will be accepted.

#### **5.1.18 Power/Control/Configuration connector**

A power/control/configuration connector connected via a MIL-DTL-38999 - Series III panel-mount circular connector, as shown in Figure 6, to support power and the available controls and configurations that cannot be managed via the Data connector. For example, IRIG synchronization, Sync signal or RS-232 communication. The connector must have additional unused pins for future growth.



Figure 6: Typical "MIL-DTL-38999 - Series III" panel-mount connector

**Note 4: Acceptable equivalents:** Any equivalent metal alloy connector that is: 1) Circular; 2) scoop-proof; 3) meeting the IP64 rating; and 4) expressly made for military or aerospace applications will be accepted.

#### **5.1.19 Power "up/down" button**

A power up/down capability via a MIL-PRF-8805 "vandal resistant/flush-dome" panel-mount push-button, as shown in Figure 7.



Figure 7: Typical "vandal-resistant flush-dome" panel-mount push-buttons

#### **5.1.20 Power status**

A "power status" indication via a panel-mount flush-dome LED-based indicator, as shown in Figure 8, turning green when the power is applied and separated from the power up/down push-button.

#### **5.1.21 Cooler temperature ready status**

A "cooler temperature ready" status indication via a panel-mount flush-dome LED-based indicator, as shown in Figure 8, turning from red to green when ready. Having the control software reporting the "cooler temperature ready" status is an accepted alternative to the LED-based indicator.

#### **5.1.22 IRIG status**

A "IRIG sensed" indication via a panel-mount flush-dome LED-based indicator, as shown in Figure 8, turning green when an IRIG signal is connected to the imager. Having the control software reporting the "IRIG sensed" status is an accepted alternative to the LED-based indicator.



Figure 8: Typical "flush-dome" panel-mount indicator

#### **5.1.23 Temperature sensors**

The ability to inform the user about its internal temperature. Table 2 shows the four (4) required measurement points:

Table 2: Temperature sensor specifications

Sensor (#)	Location	Tolerance (°C)	Range (°C)	Read-out
1	Internal Stirling Cooler	N/A	N/A	Data connector ( <b>Ethernet</b> ) and/or Power/Control/Configuration connector ( <b>I2C</b> )
2	External Stirling Cooler	± 1	-40 to +85	Data connector ( <b>Ethernet</b> ) and/or Power/Control/Configuration connector ( <b>I2C</b> )
3	Optical Components	± 1	-40 to +85	Data connector ( <b>Ethernet</b> ) and/or Power/Control/Configuration connector ( <b>I2C</b> )
4	Optical Components	± 1	-40 to +85	Data connector ( <b>Ethernet</b> ) and/or Power/Control/Configuration connector ( <b>I2C</b> )

#### **5.1.24 Power supply**

A power supply voltage of 18~28 VDC ±10% with a maximum power consumption of 150 W. The "Power/Control/Configuration" connector, shown in Figure 6, must be the power input to the 2C-IR imager.

#### **5.1.25 Ethernet**

A 10GBase-T Ethernet communication according to the Institute of Electrical and Electronics Engineers (IEEE) and supporting the «PTP-1588» timing protocol and the «GigE Vision» interface standard via the data connector. Ethernet must be the main data and communication flow method for the 2C-IR imager.

**Note 5: Acceptable equivalent:** A Camera-link communication interface through the data connector is an accepted alternative to the 10GBase-T Ethernet.

#### **5.1.26 RS-232**

A RS-232 communication via the "Power/Control/Configuration" connector, shown in Figure 6, to configure the 2C-IR imager as an option to Ethernet configuration. Both, Ethernet and RS-232 configuration methods must be available to configure the 2C-IR imager.

#### **5.1.27 IRIG & TTL Sync. signals**

A support for external signals such as the Inter-Range Instrumentation Group (IRIG) and Transistor-Transistor Logic Synchronization (TTL Sync.) signals, as external synchronization sources. The objective is to ensure that the 2C-IR imager can be synchronized with range instrumentation during field trials. The "Power/Control/Configuration" connector, shown in Figure 6, must be the entry port for these signals.

#### **5.1.28 Control software**

A control software able to perform at least the functions shown in Table 3.

Table 3: Control software functions list

Functions list
Perform Non-Uniformity Corrections (NUC)
Load stored NUCs from memory
Pixel binning
Windowing
Region of Interest (ROI)
Selectable Gains

Selectable integration modes

In addition, the Contractor must provide the control software with a Software Development Kit (SDK) for a future integration of the detector functionalities in DRDC's proprietary software.

### 5.1.29 Operational temperature

An operational temperature range between -20 °C and +45 °C, excluding solar loading.

### 5.1.30 Storage temperature

A storage temperature range (non-operational) between -40 °C and +70 °C.

### 5.1.31 Dust & Water

An IP64 rating against dust and water.

### 5.1.32 Humidity

A relative humidity operating range from 0 % to 100 %.

### 5.1.33 Vibration

Remain functional after being subjected to the vibration profile of the "composite wheeled vehicle vibration exposure" of MIL-STD-810G, Method 514.6, Annex C, as shown in Figure 9. If the Contractor foresees difficulties in passing the vibration requirement, DRDC authorizes the Contractor to derate the Method 514.6 procedure according to Table 4.

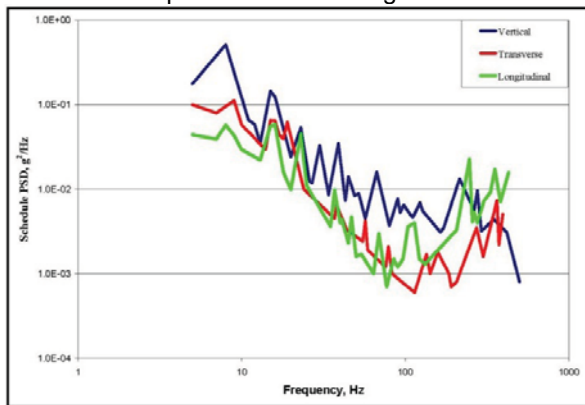


Figure 9: Composite wheeled vehicle vibration exposure (Ref: MIL-STD-810G, Method 514.6)

Table 4: Deviations authorized from Method 514.6

Parameter	Method 514.6	Authorized derating
Test Time	120 minutes per axis	60 minutes per axis
Exaggeration Factor	1.375	1
Set-up	2C-IR imager secured directly on the vibration table.	2C-IR imager secured in a "Pelican-type" transport case which is attached to the vibration table.

## 5.2 MWIR OBJECTIVES

The MWIR objectives must meet the following specifications:

### 5.2.1 MWIR objectives

Two (2) MWIR objectives with a manual focus and mountable to the 2C-IR imager via a standard MWIR twist-lock bayonet mechanism must be provided. The vertical FOVs stated in Table 5 may be adjusted (\*), to maintain the same vertical and horizontal instantaneous FOVs for a given objective, when the detector is selected by the Contractor. In all cases, the widest FOVs must be along the horizontal axis.

Table 5: MWIR objectives FOVs

Objective (#)	Qty	Horizontal FOV (°)	Vertical FOV(°)
1	1	40 ± 2.5	25*
2	1	144 ± 5	90*

### 5.2.2 Protective covers

A total of four (4) "clippable" front and rear protection covers to protect the objectives from Table 5.

### 5.2.3 Filter holding capability

A rear-end inside wall threaded to 1.7"-32, as shown in Figure 10, to allow the installation of a screw-on adapter. The screw-on adapter (not to be designed under this contract) will allow DRDC to install a 38 mm diameter neutral density filter that may be used to move the 2C-IR imager dynamic range.



Figure 10: Screw-on filter adapter with the objective inside wall threads  
6. ADDITIONAL FEATURES

This section describes the additional features that the 2C-IR imager and the MWIR objectives may meet in Subsections 6.1 and 6.2, respectively. There are eight (8) additional features that will allow the bidders to obtain up to a maximum number of 114 points.

The bidder will obtain a number of points associated with the features to be implemented on the 2C-IR imager according to the quality, innovation, and description of the proposed solution, up to the stated maximum number of points.

*At contract award, this section will be adjusted in function of the winning bidder proposition. Only the features proposed by the winning bidder will be kept in the final contract.*

### 6.1 2C-IR IMAGER

Additional Features that the 2C-IR may meet in order to obtain additional points:

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#### **6.1.1 Internally actuated Non-Uniformity Correction (NUC) – Up to 25 points**

An internal infrared shutter capability in order to perform 1-point or 2-points NUCs via the control software. As per the evaluation grid.

#### **6.1.2 Center wavelengths “blue shift” with a 45 degrees angle of incidence – Up to 15 points**

A center wavelength “blue shift” for both bands, less than or equal to the percentage from the evaluation grid. The shifts will be measured for a horizontal angle of incidence of  $45 \pm 2$  degrees.

#### **6.1.3 Tunable bandwidths – 15 points**

Ability to interchange optical component(s) that is used to determine B1 and B2 bandwidths, according to the evaluation grid.

This capability must be mounted in such a way that an experienced optical engineer would be able to change the optical component(s) to modify the 2C-IR imager bandwidths while keeping the same center wavelengths; B1\_λ<sub>center</sub> and B2\_λ<sub>center</sub>.

#### **6.1.4 Internal optical density filtering – 15 points**

Ability for an experienced optical engineer to introduce Optical Density (OD) filter in the optical path (internal to the imager and not behind the objective) to shift the 2C-IR imager dynamic range, according to the evaluation grid.

#### **6.1.5 Optical compensation – 15 points**

Adjustable opto-mechanical platform(s) to compensate for drift that may have been caused by undesired thermal and vibration effects or system aging.

The adjustable platform(s) must be mounted in the critical optical path(s), in such a way that an experienced optical engineer would be able to perform the compensation to obtain Original Equipment Manufacturer (OEM) performance. To be evaluated according to the evaluation grid.

#### **6.1.6 Maximum volume excluding the objective – 15 points**

The 2C-IR imager maximum volume is equal to or less than 420 cubic inches, according to the evaluation grid.

#### **6.1.7 Temperature sensors – Up to 4 points**

The temperature information is passed via the data connector, shown in Figure 5, for temperature read-out via Ethernet instead of I2C, according to the evaluation grid.

### **6.2 MWIR OBJECTIVES**

Additional MWIR objectives that may be provided for this contract:

#### **6.2.1 Additional MWIR objectives – Up to 10 points**

Additional objectives for the 2C-IR imager may be provided by the contractor in order to obtain additional points. The objectives must have horizontal FOVs as per Table 6, and meeting the requirements of Subsection 5.2. The vertical FOVs stated in Table 6 may be adjusted (\*) to maintain the same vertical and horizontal instantaneous FOVs when the detector is selected by the Contractor. In all cases, the widest FOVs must be along the horizontal axis.

Table 6: Additional MWIR objectives

Objective (#)	Qty	Horizontal FOV (°)	Vertical FOV(°)
3	1	80 ± 2.5	50*
4	1	6.4 ± 0.5	4*

## 7. ACCEPTANCE TESTS FOR MANDATORY REQUIREMENTS

The 2C-IR imager must undergo acceptance testing before the final payment is made to the Contractor. The acceptance tests will have to be witnessed by (or in some cases performed by) DRDC Valcartier. For each test performed by the Contractor, a DRDC TA will sign the contractor acceptance test document (Section 9) and only when the 2C-IR imager meets the requirement. The 2C-IR imager must pass all the acceptance tests presented in this section.

*The acceptance tests that are under the "Contractor responsibility" are to be performed at the Contractor's premises before the expedition of the 2C-IR imager. The acceptance tests that are under "DRDC responsibility" are to be performed by a Canadian government entity.*

### **7.1.1 Optical aperture (Contractor responsibility)**

The 2C-IR imager must have a single optical aperture in the MWIR region of the infrared spectrum. This demonstration must be performed by the Contractor with DRDC TA witnessing the demonstration.

The test "**optical aperture**" will be accepted as a "**SUCCESS**" when successfully demonstrated by the Contractor.

### **7.1.2 Spectral response – (DRDC responsibility)**

The 2C-IR imager spectral response from 2.5 µm to 5.5 µm must be measured by DRDC at ambient temperature using a scanning monochromator. The monochromator and the 2C-IR imager must be warmed-up for 0.5 hour before characterizing the spectral response with a normal angle of incidence. For this test, the 2C-IR imager must be mounted with the objective #1 from Table 5.

The test "**spectral response**" will be accepted as a "**SUCCESS**" if the bands B1 and B2 lower and upper edges are within ± 10 nm of the specified FWHM values.

### **7.1.3 Imaging detector specifications – (Contractor responsibility)**

The contractor must demonstrate and show supporting evidence that the imaging detector used for the 2C-IR imager meets the requirements from Table 1. This test must be performed by the Contractor with DRDC TA witnessing the demonstration.

The test "**imaging detector**" will be accepted as a "**SUCCESS**" if the detector meets the requirements from Table 1.

### **7.1.4 Modulation Transfer Function (MTF) – (DRDC responsibility)**

The 2C-IR imager MTFs must be measured by DRDC at ambient temperature for bands B1 and B2 using a knife-edge (half-moon) target and the Santa Barbara InfraRed (SBIR) IRWindows 4 software.

The test "**modulation transfer function**" will be accepted as a "**SUCCESS**" if the MTFs at 20 % are equal to or greater than 0.4 cycles/mrad when using objective #1 from Table 5.

### **7.1.5 Noise Equivalent Temperature Difference (NETD) – (DRDC responsibility)**

The 2C-IR imager temporal NETD must be measured by DRDC at ambient temperature using the SBIR IRWindows 4 software.

The test "**NETD**" will be accepted as a "**SUCCESS**" if the temporal NETD is less than or equal to 30 mK using objective #1 from Table 5.

#### **7.1.6 Optical power degradation (Contractor responsibility)**

The 2C-IR optical power degradation from the optical aperture (no objective) to the detector cold stop must be measured at ambient temperature. For B1 and B2, a band-limited signal with known power must be fed into the optical aperture of 2C-IR imager. The signal must be sampled again at the cold stop. The optical power degradation test must be performed by the contractor with DRDC TA witnessing.

The test "**optical power degradation**" will be accepted as a "**SUCCESS**" if the optical power degradation is less than or equal to 4 dB (i.e.: a residual transmission of 40 % to the detector) for each band.

#### **7.1.7 Center wavelengths "blue shift" with a 45 degrees angle of incidence – (DRDC responsibility)**

The 2C-IR center wavelength "blue shift" with the angle of incidence must be measured at ambient temperature. For this test, the 2C-IR imager must be installed on a rotary table, providing a horizontal  $45 \pm 2$  degrees angle of incidence, and mounted with the objective #2 from Table 5. A monochromator will stimulate the 2C-IR imager at B1 and B2 center wavelengths.

The test "**center wavelength "blue shift" with at 45 degrees angle of incidence**" will be accepted as a "**SUCCESS**" if the "blue shift" is less than or equal to 2 % for B1 and B2 center wavelengths.

#### **7.1.8 Maximum volume excluding the objective – (Contractor responsibility)**

The 2C-IR imager must have a total volume, excluding the objective, less than or equal to 500 cubic inches. This demonstration must be performed by the Contractor with DRDC TA witnessing the demonstration.

The test "**maximum volume excluding the objective**" will be accepted as a "**SUCCESS**" when successfully demonstrated by the Contractor.

#### **7.1.9 External enclosure material – (Contractor responsibility)**

The 2C-IR imager must have an enclosure made of aluminum type 6061-T6 of proportion greater than or equal to 85 %. This demonstration must be performed by the Contractor with DRDC TA witnessing the demonstration.

The test "**external enclosure material**" will be accepted as a "**SUCCESS**" when successfully demonstrated by the Contractor.

#### **7.1.10 Mounting holes**

The bottom section of the 2C-IR imager must have four (4) 10-32 UNF threaded mounting holes with a depth of 0.22 in.  $\pm$  0.08, as per Figure 3. This demonstration must be performed by the Contractor with DRDC TA witnessing the demonstration.

The test "**mounting holes**" will be accepted as a "**SUCCESS**" when successfully demonstrated by the Contractor.

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#### **7.1.11 Top handle for transport – (Contractor responsibility)**

The 2C-IR imager must have a handle for transportation meeting the requirement. This demonstration must be performed by the Contractor with DRDC TA witnessing the demonstration.

The test “**top handle for transport**” will be accepted as a “**SUCCESS**” when successfully demonstrated by the Contractor.

#### **7.1.12 Protective cover – (Contractor responsibility)**

The 2C-IR imager must have a protective cover meeting the requirement of the twist-lock bayonet mechanism of the optical aperture. This demonstration must be performed by the Contractor with DRDC TA witnessing the demonstration.

The test “**protective cover**” will be accepted as a “**SUCCESS**” when successfully demonstrated by the Contractor.

#### **7.1.13 Exterior finish – (Contractor responsibility)**

The 2C-IR imager must have an anodized-class II (silver color) exterior finish with a mechanical finish M-31 (sanded with 320-400 grit aluminum oxide). If the 2C-IR imager is composed of additional smaller aluminum 6061-T6 parts, they must be anodized-class II (black color) with the same mechanical finish. This demonstration must be performed by the Contractor with DRDC TA witnessing the demonstration.

The test “**exterior finish**” will be accepted as a “**SUCCESS**” when successfully demonstrated by the Contractor.

#### **7.1.14 Laser marking – (Contractor responsibility)**

The 2C-IR imager must be laser engraved with lettering providing a strong contrast to mark above all the connectors, indicators, functions, and if required, warnings regarding the operational limits (e.g.: maximum input voltage, power). This demonstration must be performed by the Contractor with DRDC TA witnessing the demonstration.

The test “**laser marking**” will be accepted as a “**SUCCESS**” if the 2C-IR imager markings are descriptive of the functions, provide a strong contrast and are successfully demonstrated by the Contractor.

#### **7.1.15 Heat management – (Contractor responsibility)**

The 2C-IR imager must manage heat transfer via conduction cooling (internally) and via forced convection (externally). This demonstration must be performed by the Contractor with DRDC TA witnessing the demonstration.

The test “**heat management**” will be accepted as a “**SUCCESS**” if the 2C-IR imager uses conduction and forced convection cooling and is successfully demonstrated by the Contractor.

#### **7.1.16 Heat management fan – (Contractor responsibility)**

The 2C-IR imager must incorporate a heat management fan to cool the 2C-IR imager via forced convection. The heat management fan must be activated when the 2C-IR imager is powered-up. This demonstration must be performed by the Contractor with DRDC TA witnessing the demonstration.

The test “**heat management fan**” will be accepted as a “**SUCCESS**” when the capability is successfully demonstrated by the Contractor.

#### **7.1.17 Data connector – (Contractor responsibility)**

The 2C-IR imager video output must be connected via a MIL-DTL-38999 Series III panel-mount circular connector that supports up to 10GBASE-T Ethernet communication. This demonstration must be performed by the Contractor with DRDC TA witnessing the demonstration.

The test “**data connector**” will be accepted as a “**SUCCESS**” when the capability is successfully demonstrated by the Contractor.

#### **7.1.18 Power/Control/Configuration connector – (Contractor responsibility)**

The 2C-IR imager must use a MIL-DTL-38999 Series III panel-mount circular connector to support power and the available controls and configurations that cannot be managed via the Ethernet port (Data connector). This demonstration must be performed by the Contractor with DRDC TA witnessing the demonstration.

The test “**power/control/configuration connector**” will be accepted as a “**SUCCESS**” when the capability is successfully demonstrated by the Contractor.

#### **7.1.19 Power “up/down” button – (Contractor responsibility)**

The 2C-IR imager must be powered up/down via a MIL-PRF-8805 “vandal resistant/flush-dome” panel-mount push-button. This demonstration must be performed by the Contractor with DRDC TA witnessing the demonstration.

The test “**power up/down button**” will be accepted as a “**SUCCESS**” when the capability is successfully demonstrated by the Contractor.

#### **7.1.20 Power status – (Contractor responsibility)**

The 2C-IR imager must have a power status indicated via a panel-mount flush-dome LED-based indicator turning green when the power is applied and separated from the power up/down push-button. This demonstration must be performed by the Contractor with DRDC TA witnessing the demonstration.

The test “**power status**” will be accepted as a “**SUCCESS**” when the capability is successfully demonstrated by the Contractor.

#### **7.1.21 Cooler status – (Contractor responsibility)**

The 2C-IR imager cooler ready status must be indicated via a panel-mount flush-dome LED-based indicator turning from red to green when ready or indicated via the control software. This demonstration must be performed by the Contractor with DRDC TA witnessing the demonstration.

The test “**cooler status**” will be accepted as a “**SUCCESS**” when the capability is successfully demonstrated by the Contractor.

#### **7.1.22 IRIG status – (Contractor responsibility)**

The 2C-IR imager must provide a status of an “IRIG sensed” via a panel-mount flush-dome LED-based indicator turning green when an IRIG signal is connected to the imager or indicated via the control software. This demonstration must be performed by the Contractor with DRDC TA witnessing the demonstration.

The test “**IRIG status**” will be accepted as a “**SUCCESS**” when the capability is successfully demonstrated by the Contractor.

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#### **7.1.23 Temperature sensors – (Contractor responsibility)**

The 2C-IR imager must have the ability to inform the user about four (4) internal temperature measurements. This demonstration must be performed by the Contractor with DRDC TA witnessing the demonstration.

The test “**temperature sensors**” will be accepted as a “**SUCCESS**” when the capability is successfully demonstrated by the Contractor.

#### **7.1.24 Power Supply – (Contractor responsibility)**

The 2C-IR imager must function using a 18~28 VDC  $\pm 10\%$  voltage having a maximum power consumption of 150 W. This demonstration must be performed by the Contractor with DRDC TA witnessing the demonstration.

The test “**power supply**” will be accepted as a “**SUCCESS**” when the voltage, power and the connectivity to the “Power/Control/Configuration” connector are successfully demonstrated by the Contractor.

#### **7.1.25 Ethernet – (Contractor responsibility)**

The 2C-IR imager must use 10GBase-T Ethernet communication supporting the «PTP-1588» timing protocol and the «GigE Vision» interface standard via the data connector. This demonstration must be performed by the Contractor with DRDC TA witnessing the demonstration.

The test “**Ethernet**” will be accepted as a “**SUCCESS**” when the capability and its connectivity to the data connector are successfully demonstrated by the Contractor.

#### **7.1.26 RS-232 – (Contractor responsibility)**

The 2C-IR imager must use RS-232 communication via the “Power/Control/Configuration” connector to configure the 2C-IR imager as an option to Ethernet configuration. Both, Ethernet and RS-232 configuration methods must be available to configure the 2C-IR imager. This demonstration must be performed by the Contractor with DRDC TA witnessing the demonstration.

The test “**RS-232**” will be accepted as a “**SUCCESS**” when the capability to configure the 2C-IR imager and its connectivity to the “Power/Control/Configuration” connector are successfully demonstrated by the Contractor.

#### **7.1.27 IRIG & TTL Sync. signals – (Contractor responsibility)**

The 2C-IR imager must support external signals such as the IRIG and TTL Sync. signals as external synchronization sources. The “Power/Control/Configuration” connector must be the entry port for these signals. This demonstration must be performed by the Contractor with DRDC TA witnessing the demonstration.

The test “**IRIG & TTL Sync. signals**” will be accepted as a “**SUCCESS**” when their functionalities and connectivities to the “Power/Control/Configuration” connector are successfully demonstrated by the Contractor.

#### **7.1.28 Control software – (Contractor responsibility)**

The 2C-IR imager must be managed via a control software meeting the specifications from Table 3. This demonstration must be performed by the Contractor with DRDC TA witnessing the demonstration.

The test “**control software**” will be accepted as a “**SUCCESS**” when all the functionalities are successfully demonstrated by the Contractor and the control software SDK is provided.

#### **7.1.29 Operational temperature – (DRDC responsibility)**

The 2C-IR imager operational temperature must be between -20 °C and +45 °C excluding solar loading. The test must be performed in a thermal chamber for four (4) hours at -20 °C and then for four (4) hours at +45 °C. The 2C-IR imager must be mounted with the objective #1 from Table 5. The "Cold MTF" and "Hot MTF" must be measured in the last hour of their respective soak and compared against the "Ambient MTF".

The test "**operational temperature**" will be accepted as a "**SUCCESS**" when the 2C-IR imager is demonstrated to have a 20 % "Cold MTF" and a 20 % "Hot MTF" worst case degradation, with respect to the 20 % "Ambient MTF", less than or equal to 15 %. DRDC will measure the worst case for both bands.

#### **7.1.30 Storage temperature – (Contractor responsibility)**

The 2C-IR imager storage temperature (non-operational) must be between -40 °C and +70 °C. The test must be performed in a thermal chamber for four (4) hours at -40 °C and then four (4) hours at +70 °C. Two (2) complete cycles are required for a total test time of 16 hours. After the second hot soak, the 2C-IR imager is brought to ambient temperature and tested for basic functionality. This demonstration must be performed by the Contractor with DRDC TA witnessing the demonstration.

The test "**storage temperature**" will be accepted as a "**SUCCESS**" when successfully demonstrated by the Contractor.

#### **7.1.31 Dust & Water – (Contractor responsibility)**

The 2C-IR imager must be rated IP64 against dust and water according to IP standard. The analysis must be performed by the Contractor and evaluated by DRDC.

The analysis "**dust & water**" will be accepted as a "**SUCCESS**" when DRDC review and accept the analysis from the Contractor.

#### **7.1.32 Humidity – (Contractor responsibility)**

The 2C-IR imager must function with a relative humidity ranging from 0 % to 100 %. The analysis must be performed by the Contractor and evaluated by DRDC.

The analysis "**humidity**" will be accepted as a "**SUCCESS**" when DRDC review and accept the analysis from the Contractor.

#### **7.1.33 Vibration (non-operating) – (DRDC responsibility)**

The 2C-IR imager must remain functional after being subjected to the vibration profile shown in Figure 9 with the Method 514.6 and potentially derated (as per Table 4) by the Contractor.

DRDC must measure the 2C-IR imager pre-vibration 20 % "Ambient MTF" with the objective #1, from Table 5, and perform the vibration evaluation. Following the evaluation, the post-vibration 20 % "Ambient MTF" will be measured with the same objective.

The test "**vibration (non-operating)**" will be accepted as a "**SUCCESS**" if the 2C-IR imager post-vibration "Ambient MTF" worst-case degradation is less than or equal to 5 % when compared to the pre-vibration "Ambient MTF".

**Note 1:** To measure the MTF, the 2C-IR imager must be operating.

**Note 2:** The case used for the "**vibration (non-operating) test**" must be part of the delivery of two (2) "Pelican-type" transport cases.

#### **7.2.1 MWIR objectives – (DRDC responsibility)**

The MWIR objectives FOVs must be measured by DRDC using a rotary plate in front of the collimator exit. The objectives horizontal and vertical FOVs will be measured to ensure they meet Table 5 specifications.

The test “**MWIR objectives**” will be accepted as a “**SUCCESS**” if the objectives meet the specifications from Table 5.

#### **7.2.2 Protective covers – (Contractor responsibility)**

The MWIR objectives must be provided with “clippable” front and rear protection covers for protection against dust and scratches when not in use. This test must be performed by the Contractor with DRDC TA witnessing the demonstration.

The test “**protective covers**” will be accepted as a “**SUCCESS**” if the Contractor demonstrates the four (4) “clippable” protective covers for the objectives of Table 5.

#### **7.2.3 Filter holding capability – (Contractor responsibility)**

The MWIR objectives must be provided with internal threads to attach a standard screw-on filter adapter module, as per Figure 10. This demonstration must be performed by the Contractor with DRDC TA witnessing the demonstration.

The test “**filter holding capability**” will be accepted as a “**SUCCESS**” when successfully demonstrated by the Contractor.

### **8. ACCEPTANCE TESTS FOR THE ADDITIONNAL FEATURES**

The 2C-IR imager must undergo and pass the acceptance testing for the additional features proposed by the Contractor. The acceptance tests will have to be witnessed by (or in some cases performed by) DRDC Valcartier. For each test performed by the Contractor, a DRDC TA will sign the contractor acceptance test document (Section 9) only when the 2C-IR imager meets the additional feature requirement. The 2C-IR imager must pass all the additional features acceptance tests presented in this section.

The acceptance tests that are under the “Contractor responsibility” are to be performed at the Contractor’s premises. The acceptance tests that are under “DRDC responsibility” are to be performed by a Canadian government entity.

*At contract award, this section will be adjusted in function of the winning bidder proposition. Only the acceptance tests for the additional features proposed by the winning bidder will be kept in the final contract.*

#### **8.1.1 Internally actuated Non-Uniformity Correction (NUC) – (Contractor responsibility)**

At the bid evaluation, the Contractor proposed a solution for this feature (YES/NO).

The 2C-IR imager has an internal infrared shutter capability to perform 1-point or 2-points NUCs using the control software. This demonstration must be performed by the Contractor with DRDC TA witnessing the demonstration.

The test “**internally actuated NUC**” will be accepted as a “**SUCCESS**” when successfully demonstrated by the Contractor and meeting the evaluation grid.

#### **8.1.2 Center wavelengths “blue shift” with a 45 degrees angle of incidence – (DRDC responsibility)**

At the bid evaluation, the Contractor proposed a solution for this feature (YES/NO).

The 2C-IR center wavelength "blue shift" with the angle of incidence must be measured at ambient temperature. For this test, the 2C-IR imager must be installed on a rotary table, providing a horizontal  $45 \pm 2$  degrees angle of incidence, and mounted with the objective #2 from Table 5. A monochromator will stimulate the 2C-IR imager at B1 and B2 center wavelengths.

The test "center wavelength "blue shift" with at 45 degrees angle of incidence" will be accepted as a "SUCCESS" if the "blue shift" for B1 and B2 center wavelengths is less than or equal to the evaluation grid.

#### **8.1.3 Tunable bandwidths – (Contractor responsibility)**

At the bid evaluation, the Contractor proposed a solution for this feature (YES/NO).

The 2C-IR imager has tunable bandwidths capability that can be modified by an experienced optical engineer using the optical component(s) required. This demonstration must be performed by the Contractor with DRDC TA witnessing the demonstration.

The test "tunable bandwidths" will be accepted as a "SUCCESS" when successfully demonstrated by the Contractor.

#### **8.1.4 Internal optical density filtering – (Contractor responsibility)**

At the bid evaluation, the Contractor proposed a solution for this feature (YES/NO).

The 2C-IR imager has internal OD filtering capability in the optical path to move its dynamic range. This demonstration must be performed by the Contractor with DRDC TA witnessing the demonstration.

The test "internal optical density filtering" will be accepted as a "SUCCESS" when successfully demonstrated by the Contractor.

#### **8.1.5 Optical compensation – (Contractor responsibility)**

At the bid evaluation, the Contractor proposed a solution for this feature (YES/NO).

The 2C-IR imager has internal opto-mechanical adjustment(s) in the optical path(s) to compensate for drifts and aging. This demonstration must be performed by the Contractor with DRDC TA witnessing the demonstration.

The test "optical compensation" will be accepted as a "SUCCESS" when successfully demonstrated by the Contractor.

#### **8.1.6 Maximum volume excluding the objective (Contractor responsibility)**

At the bid evaluation, the Contractor proposed to design the 2C-IR imager with a smaller form-factor (YES/NO).

The 2C-IR imager maximum volume is equal to or less than 420 cubic inches.

The test "Maximum volume excluding the objective" will be accepted as a "SUCCESS" when successfully demonstrated by the Contractor.

#### **8.1.7 Temperature sensors – (Contractor responsibility)**

At the bid evaluation, the Contractor proposed to design the 2C-IR imager with Ethernet communication for all the temperature sensors (YES/NO).

The Contractor has provided the 2C-IR imager temperature read-out capability via the data connector (Ethernet) instead of the "Power/Control/Configuration" connector (I2C communication).

The test "**temperature sensors**" will be accepted as a "**SUCCESS**" when successfully demonstrated by the Contractor and meeting the evaluation grid.

#### **8.2.1 Additional MWIR objectives – (Contractor responsibility)**

At the bid evaluation, the Contractor proposed to design and deliver an additional MWIR objective(s) (YES/NO).

The Contractor has provided an additional objective(s) for the 2C-IR imager meeting the requirements of Subsection 6.2. This demonstration must be performed by the Contractor with DRDC TA witnessing the demonstration.

The test "**additional MWIR objectives**" will be accepted as a "**SUCCESS**" when the Contractor install the objective developed to the 2C-IR imager and demonstrate its FOV as per the evaluation grid.

### **9. DOCUMENTATION**

The following documentation must be provided by the Contractor to complete the 2C-IR imager contract:  
**User/Operating manual:**

The User/Operating manual must be produced by the Contractor to support the user in operating and understanding the 2C-IR camera technical capabilities and limitations. It must also include the 2C-IR technical specifications, connectivity, how to operate, software description and features.

#### **Acceptance test document:**

The acceptance test document must include all the mandatory and the additional features signed by DRDC and blank signature spaces for the acceptance tests to be performed by DRDC after the delivery of the 2C-IR imager. A copy of this document must be provided to the Contractor when all the acceptance tests are completed and signed by DRDC.

### **10. DELIVERABLES**

Number	Description of deliverable	Quantity and Format
1	Demonstrate the detector used for the development of the 2C-IR imager. The detector must meet the Statement of Requirement (SOR) document.  Provide the SRR (mechanical, optical, electrical) meeting the requirements of the SOR document for the 2C-IR imager.	Cooled MWIR detector  All the SRR design files / DVD
2	Provide the design files of the 2C-IR imager at the PDR stage (mechanical, optical, electrical) meeting the SOR document.	All the PDR design files / DVD
3	Provide the design files of the 2C-IR imager at the CDR stage (mechanical, optical, electrical) meeting the SOR document.	All the CDR design files / DVD
4	Demonstrate the MWIR objectives FOVs and protection covers meeting the SOR document.	(2 to 4) MWIR objectives

N° de l'invitation - Solicitation No.  
W7701-166079/A  
N° de réf. du client - Client Ref. No.  
W7701-166079

N° de la modif - Amd. No.  
003  
File No. - N° du dossier  
QCL-5-38151

Id de l'acheteur - Buyer ID  
qcl029  
N° CCC / CCC No./ N° VME - FMS

5	Provide a 2C-IR imager meeting the SOR document, the Control software and its SDK, the User/Operating manual and the Acceptance test document.	2C-IR imager Control software and SDK / DVD User/Operating manual / DVD Acceptance test document / DVD
6	All the cabling that is required to operate and to perform "DRDC responsibility" acceptance tests for the 2C-IR imager. The cables must have a length of 10 feet.	All the cabling
7	Two ruggedized "Pelican-type" transport cases.	Transport cases

For the deliverables #2 (PDR) and #3 (CDR), the 2C-IR imager design files (mechanical, optical, electrical) are expected to be 80 % and 99 % completed, respectively. For the acceptance of these deliverables, the Contractor must provide all the design files related to the 2C-IR imager conception for this contract.

**\*\*\*ALL THE OTHER TERMS AND CONDITIONS REMAIN UNCHANGED\*\*\***