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## Defence Innovation Hub Exemplar

## Call for Submission (CFS) – Phase 1

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## Disclaimer

*The document provides an example of suitable content to be provided within a CFS submission using an existing technology as an example. The sample is for general information only and every submission will vary depending on the type, maturity and complexity of the innovation proposed.*

*The example should be read in conjunction with the guidance notes, which take precedence. The questions posed within each of the sections are intended to provoke thought and promote an understanding about the type of information that is required to support a well-considered proposal. This example should not be used as a template as every innovation is different.*

*Trademarks, copyrights, brand names, product and company names related to the sample information provided are used for demonstration purposes only and are fictitious. The depiction of products or images is for demonstration purposes only and in no way indicates that the Defence has sponsored, approved, or are otherwise affiliated with, the owner of any such rights.*

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## Section D. What is the proposal?

### D.1. Solicitation Number

*Solicitation Number*
*HUB-16-PIN-SIF-001*

*Title*
*Priority Innovation Notice*

### D.2. Proposal title and description

*Short title for your proposal*
*Gallium Arsenide Photocathode for Night Vision Goggles*

*Provide an executive summary of the proposal (max 5,000 characters)*
*This is to be a summary of the overall proposal. You'll be asked for more specific details about the innovation phase relevant to your proposal at D.3.*

Night Owl Vision Systems Pty Ltd is proposing to develop a Generation III Gallium Arsenide Photocathode (GAP) for Night Vision Goggles (NVG) to increase visibility during low-light operations. The design is intended for use across Army, Navy and Air Force, with the initial development focusing on use by Army and Navy helicopter pilots. When mature, the system will allow for increased light sensitivity, better image quality, lower image distortion and greater reliability. These improvements will provide pilots with greater viewing power that they need for safe and effective night-time operations, which is not offered by any systems currently available.

During daylight hours, pilots rely heavily on the windshield view for situational awareness. Thus, visual referencing for pilots is essential for safe and effective flight operations. During night hours, the pilot's vision is often limited and they must rely on avionics such as flight control, monitoring, navigation, collision avoidance and communication systems. Situational awareness becomes critical for night flying and this technology seeks to increase visual referencing.

Night Owl Vision Systems Pty Ltd is proposing to use its unique photocathode made from Gallium Arsenide to significantly improve image quality. In addition, it is proposed that the Microchannel Plates (MCP) is to be coated with an ion barrier film for increased tube life. Once the tube has been developed, we aim to integrate these components into a head-unit that can be worn by pilots during day and night operations.

*Describe the background and current status of the technology underpinning this proposal (max 5,000 characters)*

The underlying mechanism of NVG operation uses light from the stars, moon or an available artificial source that reflects off the terrain. Light then enters through a lens, which inverts the picture and directs the light towards the photocathode. This light then converts the light (photons) into electrons, with the number of electrons released being proportional to the number of photons striking the element.

The MCP then amplifies the image. It achieves this through the interactions of electrons with millions of glass tubes. As an electron from the photocathode enters the tube and strikes the glass wall, several electrons are freed from the glass. This process is repeated and effectively multiplies the number of electrons by thousands of times, with electrons in the glass being replaced by a voltage across the device (allowing this process to recur). The electrons then strike a phosphor screen that converts them back to visible light which is then perceived through the eyepiece lens. This process is shown in Figure 1, below.

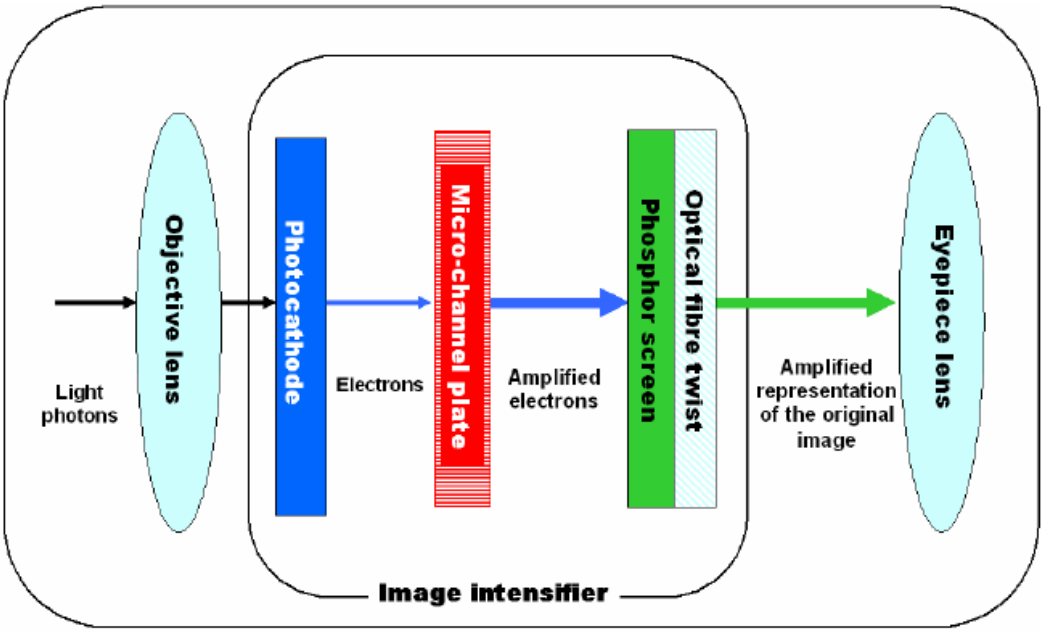


*Figure 1 - Image Intensifier (Ref: Aviation Research Report, B2004/0152, Australian Government Transport Safety Bureau)*

The development of NVG systems has been an iterative process with the production of the first generation image intensifier (I2) tubes, occurring in the early 1960s. These tubes were not suitable for head mounts, as their three-stage construction makes them too heavy. In the late 1960's, a breakthrough in NVG technology occurred primarily through the production of MCP and second-generation wafers. These two advances in technology allowed for a compact and lightweight design that became suitable for head-units. The visibility provided in these units, however, has had limited use in aircraft operations. This is due to the poor performance in low-light-environments, high weight, visual facemask obstruction and the need for repeatedly re-focusing (caused by cockpit lighting).

Initial R&D on GAP based on literature research and theoretical analysis has been completed. Night Owl Vision Systems Pty Ltd's research studies (attached) in collaboration with the University of Albury, have shown that GAP has substantial benefits over Gen II models as discussed below. As a result of that work, the innovation is currently at TRL 2.

Night Owl Vision Systems Pty Ltd has conducted trials indicating that our Gen III photocathode increased sensitivity with the sensitivity band extended near to the infrared spectrum, which is highly compatible with the night sky light spectrum, improving the effectiveness of NVGs for night operations. However, the initial research conducted in our R&D Laboratories (in Albury, NSW) has also indicated that these photocathodes can be degraded by positive ions, thus, reducing the sensitivity of the device. To protect the photocathode from positive ions and gases from the MCP, the addition of an aluminium oxide layer (ion barrier film) to the MCP will be included to aid in protecting the photocathode and extend the tube life.

## D.3. Capability Streams and the Technology

*You should select a capability stream to provide the context to the specific innovation you are proposing. Your selection should align with the benefits to Defence outlined in your response to D.2.*

*It is important that you select the correct capability stream to support a rapid evaluation of your submission by Defence.*

*Select the most applicable Defence capability stream that your proposed innovation would improve when mature*

Land Combat, Amphibious Warfare and Special Operations

*When mature, which (if any) Defence platforms, capabilities, networks or processes will the proposed innovation need to be integrated to or interface with? (max 5,000 characters)*

*Where applicable, describe specific Defence platforms/systems the innovation this proposal relates to will be integrated to or interface with.*

*For example, the innovation may be a new sensor to be integrated to the Anzac Class Frigate Helicopter combat system, new lightweight long lasting battery to interface with Land 125 soldier modernisation program, Simulation Software module to be integrated to the Defence Simulation Environment, welding process for new armour alloy in M1 Abrahams Tank.*

The Gen III night vision goggles are primarily targeted toward helicopter pilots under the AIR 15 project, with integration into the UH-1D helicopter. To support this, several integration activities are anticipated to be required before they are fully adopted. These integration activities include:

1. Cockpit lighting – Night Vision Imaging System (NVIS) compatible lighting must not decrease the quality of the NVG image but remain bright enough to enable the pilot to clearly see helicopter instruments. Modifications to the current lighting may be required;
2. External lighting – Strobe lighting may cause the NVG image to rapidly modify its gain, which could be distracting to the pilot. Modifications to the current lighting may be required; and
3. Training – Visual perception will vary based on the operating conditions. Additionally, using the goggles in conjunction with the avionics will require training for aviators.

*Explain why the proposed innovation is unique, and how it would provide a new or enhanced capability or improve Defence's effectiveness and efficiency (max 5,000 characters)*

*Describe how the proposed idea, technology or innovation in this proposal addresses a relevant problem in a unique way, and how this is relevant to the capability stream. What special aspects of your idea make it valuable to Defence? In providing a response you should describe why Defence would want to pursue your proposal and the contribution it delivers to the identified capability stream.*

There are two main shortfalls with existing Gen II NVG systems, which are:

1. The spectral range from 350 to 900nm is different to the human vision, which is 380 to 760nm, meaning that not all images created by the GEN II will be visible to the human eye; and
2. The characteristics (i.e. sensitivity, image quality, reliability, image distortion and weight) make them unfavourable for flight operations.

The characteristics of existing NVG systems (Sb-K-Na-Cs (Gen II) cathodes) are:

1. Gain of 3,500 to 10,000 times baseline;
2. Resolution of 28 to 36 lp/mm; and
3. Signal to noise (S/N) ratio of 10 to 12.

A GAP has never been used before and will provide increased sensitivity in the 800nm-900nm range, particularly near the infra-red (IR) spectrum which is highly compatible with the night sky light spectrum. The increase in sensitivity and performance under low light

conditions will enable the Gen III NVG goggles to detect light at far greater distances than previously experienced. Initial R&D efforts have demonstrated the following improved performance characteristics (GaAs-O-Cs (Night Owl Vision Systems Pty Ltd Gen III) cathode):

1. Gains to 80,000 times baseline;
2. Resolution of 45 to 72 lp/mm;
3. Increased performance of radiant sensitivity (as seen in Figure 2); and
4. Signal to noise ratio of 19 to 26.5.

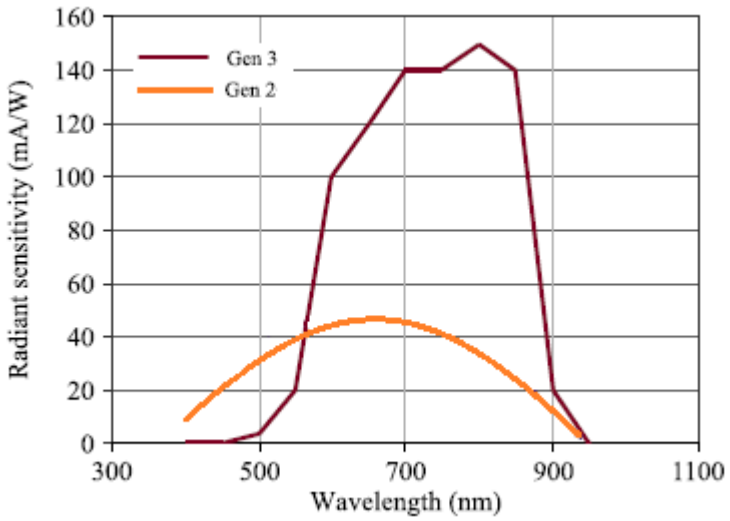


Figure 2 - Gen 3 Radiant Sensitivity

Existing Gen II units do not have the resolution to allow clear distinction between landing hazards, such as low-rise buildings or distressed vehicles, and the surrounding terrain. The current visible distance is less than 200m under a typical non-moonlight scenario and the lighting gain is approximately 10,000 times baseline.

A newly developed NVG system would improve spatial awareness allowing the pilots to:

1. Define the horizon and terrain detail with increased clarity (over 300m with gains of up to 80,000 times baseline);
2. The ability to continually monitor and identify landing sites from increased gain and resolution;
3. Avoid obstacles (collision avoidance); and
4. Improve the search and rescue effectiveness of pilots through identification of target areas.

This is achieved through (please refer to section 4 for a detailed quantification of these value):

1. Higher sensitivity to light;

2. Better Image quality;
3. Lower Image distortion; and
4. Greater reliability.

*How will the proposal contribute to Australia's Defence industry capability and/or capacity? (max 5,000 characters)*

*Describe what activities in this proposal will be performed in Australia and will contribute to the ongoing development of Australia's Defence industry.*

*You may wish to consider, where relevant, impacts to employment, supply chains, and regional development; up-skilling; increased collaboration between businesses and/or businesses and research institutions.*

All prior research on Gallium Arsenide cathodes has been performed in Australia by Night Owl Vision Systems Pty Ltd. Future manufacturing and development will occur in Night Owl Vision Systems' manufacturing facilities in Albury, NSW.

Concept development, design and prototype development will all be performed in Australia. Support will be provided by US Optics Headsets Pty Ltd, in the United States, for the development of the head mount unit. Night Owl Vision Systems has an established partnership with US Optics Headsets Pty Ltd. All remaining work (including the design and manufacture of the binocular units) will be performed in Australia.

Additionally, the use and operation of NVG headsets for helicopter pilots will generate a unique training requirement, resulting in the upskilling and training of a large group of Defence personnel.

## D.4. Technology Readiness Levels

*What is the current Technology Readiness Level (TRL) of the technology underpinning this proposal?*

*In selecting your Technology Readiness Level (TRL) you should be realistic about your current level. Your selection of TRL should be supported by other responses provided in this proposal.*

*2*

*Given the current TRL of the innovation this proposal relates to, what innovation phase do you believe the innovation is currently most appropriate for?*

*Phase 1: Concept Exploration*

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*What are the intended objectives, outcomes, activities and schedule to be undertaken as part of the phase as identified above? (max 5,000 characters)*

*Detail and describe the high level objectives and outcomes to be accomplished within the phase and how this will contribute to the overall development of the innovation as it matures. Your response should be specific to the phase you have selected above, rather than the overall proposed project you described at D2.*

High level objectives and outcomes to be accomplished:

This Phase 1 will have three stages. The objective of this phase is to advance the innovation from TRL 2 to TRL 3 by initiating concept exploration work and, building on our prior research. The three different stages and their objectives are:

Stage 1 – Stakeholder engagement and needs definition. The objective of this stage is to engage the stakeholder so that stakeholder needs can be defined. The outcomes of this stage are:

- Documentation of shortfalls in existing systems and capability;
- Documentation of the different types of missions to be performed by the aviator;
- Development of system operational needs;
- Documentation of use cases and operational environments for the NVG system; and
- Documentation of the preliminary requirements.

Stage 2 – Conceptual design. The objective of this stage is to develop conceptual designs so they can be progressed to prototype designs. The outcomes of this stage are:

- Conceptual (paper based) design of the following:
  - Mounting interfaces;
  - Power modules; and
  - Binocular image component including GAP.
- Conceptual design for subsystem integration into user mounted headset;
- Laboratory (physical) validation of the innovative GAP for improved image quality.

Stage 3 – Technology Maturation Plan. The objective of this stage is to plan out the approach to mature the technology. The outcomes of this stage are:

- Design options for the progression into prototype development;
- Documentation of the identified technical risks that may impede the design;
- Documentation of the anticipated cost and schedule requirements for future design phases;
- Documentation of design impacts with respect to integration of the NVG into the helicopter; and
- Documentation of the requirements for airworthiness certification.

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*Select the timeliness with respect to the proposed activities.*

| |
|---|
| *0-1 year* |

*Select your estimated timeframe for your whole program i.e. how long it would take to progress to the end of a Phase 4 project.*

| |
|---|
| *4-6 years* |

*Describe your schedule for the proposed activities and outcomes, and their alignment to any known Defence programs. (max 2,000 characters)*

*A high level work breakdown structure should be provided, detailing anticipated tasks, their outcomes and timescales for completion against your anticipated delivery schedule. With respect to the overall Defence program, provide details of how your innovation aligns itself to programs ongoing in Defence, if known.*

This Phase 1 will have three stages. The three different stages, timeframes and their activities are:

Stage 1 – Stakeholder engagement and needs definition (1-month). The objective of this stage is to engage the stakeholder so that stakeholder needs can be defined. This stage will consist of the following activities:

- Analysis of the existing system and capability shortfalls;
- Identify the missions to be performed by the pilot;
- System operational needs;
- Use cases and operational environments for the NVG system; and
- Preliminary requirements definition development including:
  - Survivability;
  - Ruggedness;
  - Human Machine Interface;
  - Modularity / Functionality;
  - Reliability (Mean-Time Between Failure);
  - Interoperability; and
  - Integration.

Stage 2 – Conceptual design (4 – months). The objective of this stage is to develop conceptual designs so they can be progressed to prototype designs. This stage will consist of the following activities:

- Conceptual (paper based) design of the following:
  - Mounting interfaces;
  - Power modules; and
  - Binocular image component including GAP.
- Conceptual design for subsystem integration into user mounted headset;
- Laboratory (physical) validation of the innovative GAP.

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Stage 3 – Technology Maturation Plan (1 month). This stage will consist of the following activities:

- Articulation of potential design options for the progression into prototype development;
- Identification of any technical risks that may impede the design;
- Identification of anticipated cost and schedule requirements for future design phases.
- Design impacts including the potential impacts for:
  - Modifications of cockpit lighting;
  - Modifications of interior lighting; and
  - Updates required for training programs.
- Certification Requirements (airworthiness).

*What is the anticipated TRL of the technology underpinning this proposal at the completion of your nominated project phase?*

*In selecting your TRL you should be realistic about the proposed level at the completion of the activities you are proposing to undertake in the phase. Your selection of TRL should be supported by other responses provided in this proposal.*

*3*

## D.5. Location of work

*Will the majority of project work described in D.4. be done in Australia?*

*Yes*

*Where will the project work be done? (max 5,000 characters)*

*Albury, NSW*

## D.6. Funding

*What is the estimated budget range (GST exclusive) that is being sought from the Department of Defence for the activities included in the project phase (as selected in D.4)?*

*The amount should be relative to the identified project phase and the activities outlined in the phase summary (D.4) rather than this proposal as a whole.*

*You should consider all the costs likely to be associated with the nominated phase, including staffing costs, engineering and testing costs, contract and intellectual property costs, travel and transport.*

*Please respond on a GST exclusive basis.*

$250,000 to $999,999

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*Have you previously received, or are you currently receiving, funding from the Commonwealth of Australia, Government of New Zealand, Australian State or Territory governments, or third party funding or contributions in relation to the technology underpinning this proposal?*

☒ *No* ☐ *Yes*

*What amount was or is being provided (GST exclusive), what was the purpose of the funding and who received the funding? (max 500 characters)*

*N/A*

*Have you previously, or are you currently undertaking another Defence Innovation Hub initiative?*

☒ *No* ☐ *Yes*

*Please state the HUB proposal reference numbers*

*N/A*

*Have you discussed this proposal with Department of Defence staff (excluding staff of the Office of Defence Industry Support)?*

☐ *No* ☒ *Yes*

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*Add details of Department of Defence staff you have discussed this proposal with*

*For each person, summarise the discussions with them including their involvement in the development of the innovation; and the preparation of this submission. What feedback was provided? Have you acted on this feedback? Please outline how you have revised or modified your proposal or innovation following discussions with the person.*

| *Title/Rank* | *Family Name* | *Given Name* | *Defence Group, Division or Branch* | *Email* | *Telephone* | *Mobile Phone* | *Summarise your discussions with Defence Staff* |
|---|---|---|---|---|---|---|---|
| *WGCDR* | *James* | *Clive* | *AIR-15 Project Lead* | *Clive.James@defence.gov.au* | *0457 287 569* | N/A | *Initial discussions held to understand whether a capability need/gap existed.* |

## D.7. Conflict of Interest

*Is there an actual, potential or perceived conflict between Defence's interests and your interests in relation to this proposal?*
*"Your interests" includes the interests of your related bodies corporate, and the interests of the officers or employees of you or your related bodies corporate.*

☒ *No* ☐ *Yes*

*In selecting 'No', you declare that there is no potential or perceived conflict between Defence's interests and your interests in relation to the process. Please note your obligations under clause 8.1h of the CFS Terms that by making a submission, you declare that all actual, potential or perceived conflicts between Defence's interests and your interests in relation to the process (if any) have been identified in your submission, and that you will immediately notify Defence if you become aware of any other actual, potential or perceived conflict between Defence's interest and your interest in relation to the process.*

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### D.8. Details of nominated contact

*The proposal must be signed by an Authorised Representative of the business. An authorised representative can include the Chief Executive Officer, Chief Financial Officer, Managing Director, Director, Chair of the Board, President or an Authorised Manager.*

*If we want to speak to someone about your proposal, are you that person?*

☐ *No* ☒ *Yes s*

## Section E. Image or photo of the technology

If applicable, you can attach a single file (which could be an image, photograph, table, graph or process flow) illustrating the technology underpinning the proposal. This attachment is an opportunity to provide context to the technology and the benefits to Defence. You are able to reference this attachment in describing your technology in previous sections of your submission. You should ensure that your attachment is clear and understandable.

The file size of the attachment cannot exceed 2MB.

The attachment can only be a .PNG, .JPG or .BMP file type.

When you upload the file you will be asked to provide a sort description of the image or photo.

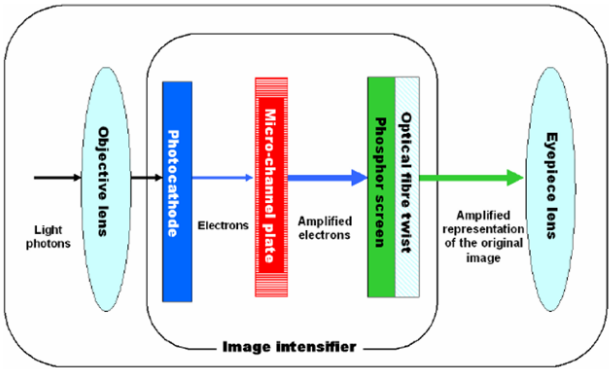


*Figure 1 - Image Intensifier (Ref: Aviation Research Report, B2004/0152, Australian Government Transport Safety Bureau)*

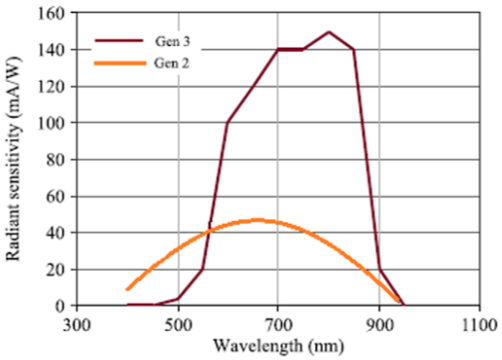


Figure 2 - Gen 3 Radiant Sensitivity