Night Vision Technology

Night vision technology, by definition, literally allows one to see in the dark. Originally developed for military use, it has provided the United States with a strategic military advantage, the value of which can be measured in lives. Federal and state agencies now routinely utilize the technology for site security, surveillance as well as search and rescue. Night vision equipment has evolved from bulky optical instruments in lightweight goggles through the advancement of image intensification technology.

The first thing you probably think of when you see the words night vision is a spy or action movie you've seen, in which someone straps on a pair of night-vision goggles to find someone else in a dark building on a moonless night. And you may have wondered "Do those things really work? Can you actually see in the dark?"

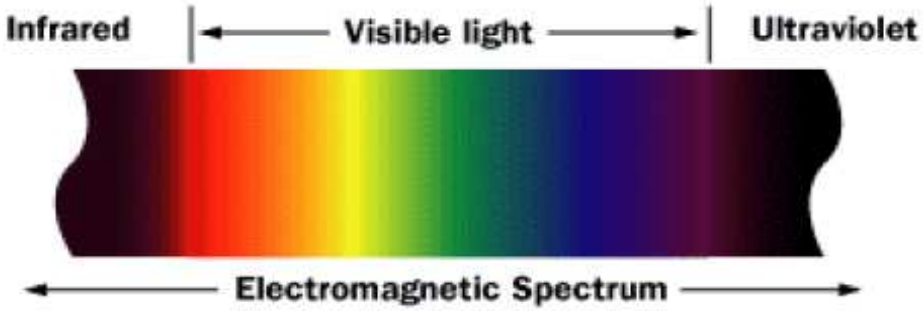
The answer is most definitely yes. With the proper night-vision equipment, you can see a person standing over 200 yards (183 m) away on a moonless, cloudy night! Night vision can work in two very different ways, depending on the technology used.

- **Image enhancement** - This works by collecting the tiny amounts of light, including the lower portion of the infrared light spectrum, that are present but may be imperceptible to our eyes, and amplifying it to the point that we can easily observe the image.
- **Thermal imaging** - This technology operates by capturing the upper portion of the infrared light spectrum, which is emitted as heat by objects instead of simply reflected as light. Hotter objects, such as warm bodies, emit more of this light than cooler objects like trees or buildings.

In this article, you will learn about the two major night-vision technologies. We'll also discuss the various types of night-vision equipment and applications. But first, let's talk about infrared light.

The Basics

In order to understand night vision, it is important to understand something about light. The amount of energy in a light wave is related to its wavelength: Shorter wavelengths have higher energy. Of visible light, violet has the most energy, and red has the least. Just next to the visible light spectrum is the infrared spectrum.



Infrared light can be split into three categories:

- **Near-infrared (near-IR) -** Closest to visible light, near-IR has wavelengths that range from 0.7 to 1.3 microns, or 700 billionths to 1,300 billionths of a meter.
- **Mid-infrared (mid-IR) -** Mid-IR has wavelengths ranging from 1.3 to 3 microns. Both near-IR and mid-IR are used by a variety of electronic devices, including remote controls.
- **Thermal-infrared (thermal-IR) -** Occupying the largest part of the infrared spectrum, thermal-IR has wavelengths ranging from 3 microns to over 30 microns.

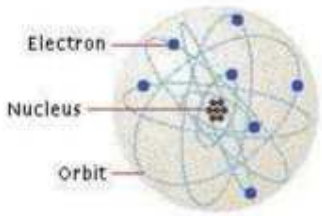
The key difference between thermal-IR and the other two is that thermal-IR is emitted by an object instead of reflected off it. Infrared light is emitted by an object because of what is happening at the atomic level.

Atoms

Atoms are constantly in motion. They continuously vibrate, move and rotate. Even the atoms that make up the chairs that we sit in are moving around. Solids are actually in motion! Atoms can be in different states of excitation. In other words, they can have different energies. If we apply a lot of energy to an atom, it can leave what is called the **ground-state energy level** and move to an **excited level**. The level of excitation depends on the amount of energy applied to the atom via heat, light or electricity.

An atom consists of a **nucleus** (containing the protons and neutrons) and an **electron cloud**. Think of the electrons in this cloud as circling the nucleus in many different **orbits**. Although more modern views of the atom do not depict discrete orbits for the electrons, it can be useful to think of these orbits as the different energy levels of the atom. In other words, if we apply some heat to an atom, we might expect that some of the electrons in the lower energy orbital's would transition to higher energy orbital's, moving farther from the nucleus. Once an electron moves to a higher-energy orbit, it eventually wants to return to the ground state. When it does, it releases its energy as a **photon** -- a particle of light. You see atoms releasing energy as photons all the time. For example, when the heating element in a toaster turns bright red, the red colour is caused by atoms excited by heat,

releasing red photons. An excited electron has more energy than a relaxed electron, and just as the electron absorbed some amount of energy to reach this excited level, it can release this energy to return to the ground state. This emitted energy is in the form of photons (light energy). The photon emitted has a very specific wavelength (colour) that depends on the state of the electron's energy when the photon is released.



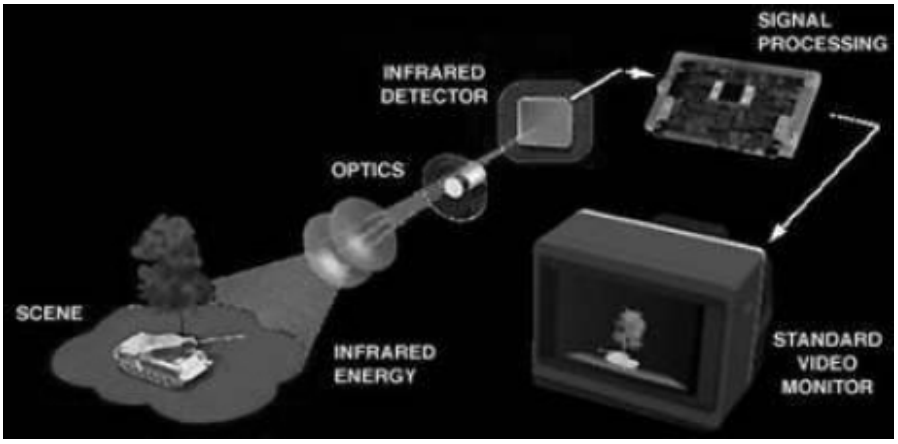
Anything that is alive uses energy, and so do many inanimate items such as **engines** and **rockets**. Energy consumption generates heat. In turn, heat causes the atoms in an object to fire off photons in the thermal-infrared spectrum. The hotter the object, the shorter the wavelength of the infrared photon it releases. An object that is very hot will even begin to emit photons in the visible spectrum, glowing red and then moving up through orange, yellow, blue and eventually white. Be sure to read How Light Bulbs Work, How Lasers Work and How Light Works for more detailed information on light and photon emission.

In night vision, thermal imaging takes advantage of this infrared emission. In the next section, we'll see just how it does this.

Thermal Imaging and Image Enhancement

Here's how thermal imaging works:

- A special lens focuses the infrared light emitted by all of the objects in view.
- The focused light is scanned by a phased array of infrared-detector elements. The detector elements create a very detailed temperature pattern called a **thermogram**. It only takes about one-thirtieth of a second for the detector array to obtain the temperature information to make the thermogram. This information is obtained from several thousand points in the field of view of the detector array.
- The thermogram created by the detector elements is translated into electric impulses.
- The impulses are sent to a signal-processing unit, a circuit board with a dedicated chip that translates the information from the elements into data for the display.
- The signal-processing unit sends the information to the display, where it appears as various colours depending on the intensity of the infrared emission. The combination of all the impulses from all of the elements creates the image.



- The basics components of thermal- imaging system

Types of Thermal Imaging Devices

Most thermal-imaging devices scan at a rate of 30 times per second. They can sense temperatures ranging from -4 degrees Fahrenheit (-20 degrees Celsius) to 3,600 F (2,000 C), and can normally detect changes in temperature of about 0.4 F (0.2 C).

It is quit easy to see everything during the day.....

...but in night you can see very little.

Thermal imaging lets you see again.

There are two common types of thermal-imaging devices:

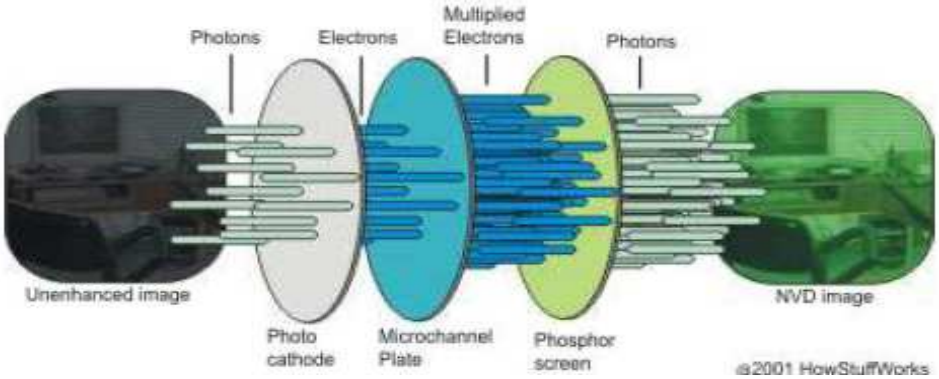
- **Un-cooled -** This is the most common type of thermal-imaging device. The infrared-detector elements are contained in a unit that operates at room temperature. This type of system is completely quiet, activates immediately and has the battery built right in.
- **Cryogenically cooled -** More expensive and more susceptible to damage from rugged use, these systems have the elements sealed inside a container that cools them to below 32 F (zero C). The advantage of such a system is the incredible resolution and sensitivity that result from cooling the elements. Cryogenically-cooled systems can "see" a difference as small as 0.2 F

(0.1 C) from more than 1,000 ft (300 m) away, which is enough to tell if a person is holding a gun at that distance!

While thermal imaging is great for detecting people or working in near-absolute darkness, most night-vision equipment uses image-enhancement technology.

Image Enhancement

Image-enhancement technology is what most people think of when you talk about night vision. In fact, image-enhancement systems are normally called **night-vision devices** (NVDs). NVDs rely on a special tube, called an **image-intensifier tube**, to collect and amplify infrared and visible light.



The image-intensifier tube changes photons to electrons

and back again.

Here's how image enhancement works:

- A conventional lens, called the objective lens, captures ambient light and some near-infrared light.
- The gathered light is sent to the image-intensifier tube. In most NVDs, the power supply for the image-intensifier tube receives power from two N-Cell or two "AA" batteries. The tube outputs a high voltage, about 5,000 volts, to the image-tube components.
- The image-intensifier tube has a photocathode, which is used to convert the photons of light energy into electrons.
- As the electrons pass through the tube, similar electrons are released from atoms in the tube, multiplying the original number of electrons by a factor of thousand through the use of a micro channel plate (MCP) in the tube. An MCP is a tiny glass disc that has millions of microscopic holes (micro channels) in it, made using fibre-optic technology. The MCP is contained in a vacuum and has metal electrodes on either side of the disc. Each channel is about 45 times longer than it is wide, and it works as an electron multiplier.

When the electrons from the photo cathode hit the first electrode of the MCP, they are accelerated into the glass micro channels by the 5,000-V bursts being sent between the electrode pair. As electrons pass through the micro channels, they cause thousands of other electrons to be released in each channel using a process called cascaded secondary emission. Basically, the original electrons collide with the side of the channel, exciting atoms and causing other electrons to be released. These

new electrons also collide with other atoms, creating a chain reaction that results in thousands of electrons leaving the channel where only a few entered. An interesting fact is that the micro channels in the MCP are created at a slight angle (about a 5-degree to 8-degree bias) to encourage electron collisions and reduce both ion and direct-light feedback from the phosphors on the output side.

- At the end of the image-intensifier tube, the electrons hit a screen coated with phosphors. These electrons maintain their position in relation to the channel they passed through, which provides a perfect image since the electrons stay in the same alignment as the original photons. The energy of the electrons causes the phosphors to reach an excited state and release photons. These phosphors create the green image on the screen that has come to characterize night vision.

Night-vision images are known for their eerie green tint.

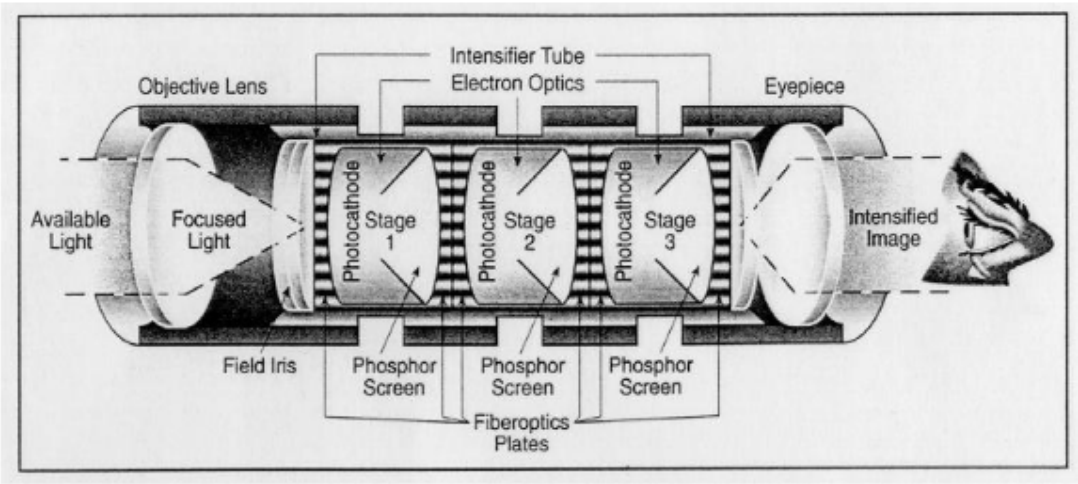
- The green phosphor image is viewed through another lens, called the ocular lens, which allows you to magnify and focus the image. The NVD may be connected to an electronic display, such as a monitor, or the image may be viewed directly through the ocular lens.
- As the electrons pass through the tube, similar electrons are released from atoms in the tube, multiplying the original number of electrons by a factor of thousands through the use of a micro channel plate (MCP) in the tube. An MCP is a tiny glass disc that has millions of microscopic holes (micro channels) in it, made using fibber-optic technology. The MCP is contained in a vacuum and has metal electrodes on either side of the disc. Each channel is about 45 times longer than it is wide, and it works as an electron multiplier.
- At the end of the image-intensifier tube, the electrons hit a screen coated with phosphors. These electrons maintain their position in relation to the channel they passed through, which provides a perfect image since the electrons stay in the same alignment as the original photons. The energy of the electrons causes the phosphors to reach an excited state and release photons. These phosphors create the green image on the screen that has come to characterize night vision.

Generations

Generation 0 :-The earliest (1950's) night vision products were based on image conversion, rather than intensification. They required a source of invisible infrared (IR) light mounted on or near the device to illuminate the target area.

Generation 1 :-The "starlight scopes" of the 1960's (Vietnam Era) have three image intensifier tubes connected in a series. These systems are larger and heavier than Gen 2 and Gen 3. The Gen 1 image is clear at the centre but may be distorted around the edges. (Low-cost Gen 1 imports are often mislabelled as a higher generation.

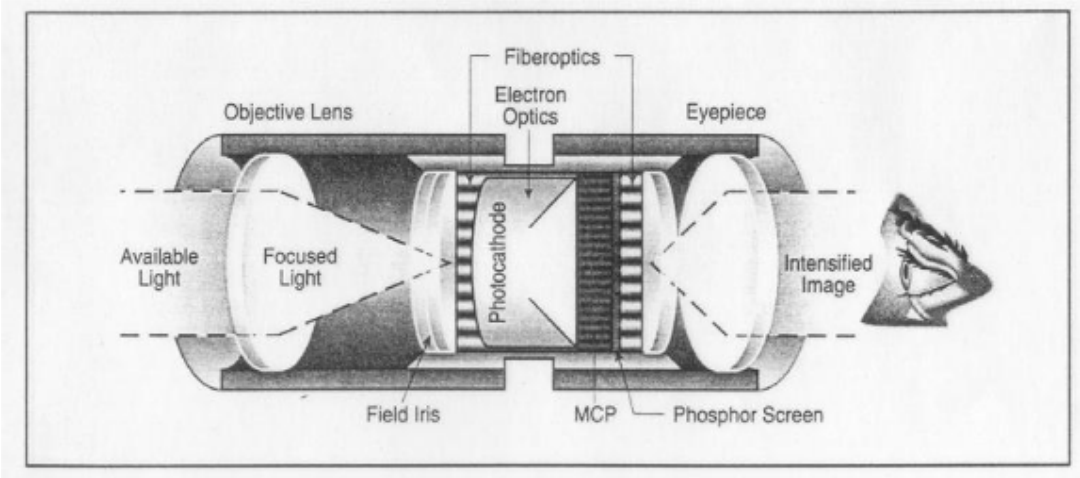
Figure 1 illustrates first-generation night vision. [Not a great topic sentence but it does has the advantage of calling attention to the figure.] Incoming light is collimated by fibre optic plates before impacting a photocathode t which releases electrons, which in turn impact a phosphor screen. The excited screen emits green light into a second fibre optic plate, and the process is repeated. The complete process is repeated three times providing an overall gain of 10,000.



Generation 2 :-The micro channel plate (MCP) electron multiplier prompted Gen 2 development in the 1970s. The "gain" provided by the MCP eliminated the need for back-to-back tubes - thereby improving size and image quality. The MCP enabled development of hand held and helmet mounted goggles.

Second-generation image intensification significantly increased gain and resolution by employing a micro channel plate. Figure 2 depicts the basic configuration. [These two sentences could have been combined: "Figure2 depicts how second-generation image ... plate."] The micro channel plate is composed of several million microscopic hollow glass channels fused into a disk. Each channel, approximately 0.0125 mm in diameter, is coated with a special semiconductor which easily liberates electrons. A single electron entering a channel initiates an avalanche process of secondary emission, under influence of an applied voltage, freeing hundreds of electrons. These electrons, effectively collimated by the channel, increase the resolution of the device. With additional electron optics, details as fine as 0.025 mm can be realized (half the diameter of a human hair).

Current image intensifiers incorporate their predecessor's resolution with additional light amplification. The multialkali photocathode is replaced with a gallium arsenide photocathode; this extends the wavelength sensitivity of the detector into the near infrared. The moon and stars provide light in these wavelengths, which boosts the effectively available light by approximately 30%, bringing the total gain of the system to around 30,000.

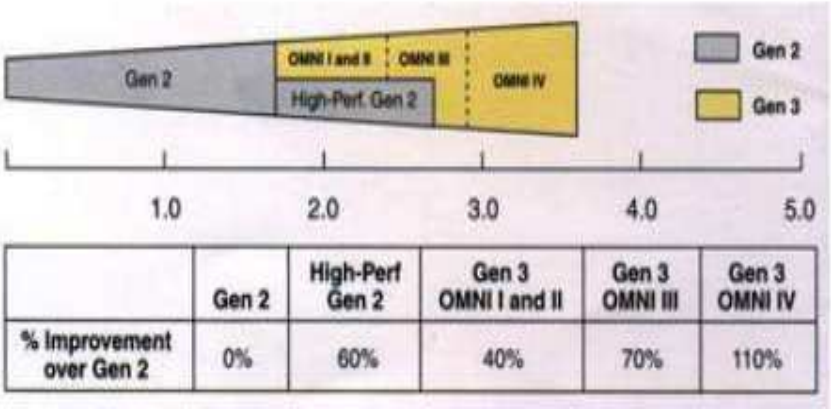


[No topic sentence. Indeed one might have moved this material to the front in a more dramatic way, perhaps by calling attention to the movie `Silence of the Lambs.'] slight green tint similar to some sunglasses. The apparent lighting of the landscape on a dark night is comparable to what the unaided eye would see on a clear winter night with fresh snow on the ground and a full moon.

Generation 3: - Two major advancements characterized development of Gen 3 in the late 1970s and early 1980s: the gallium arsenide (Gash) photocathode and the ion-barrier film on the MCP. The Gash photocathode enabled detection of objects at greater distances under much darker conditions. The ion-barrier film increased the operational life of the tube from 2000 hours (Gen 2) to 10,000 (Gen 3), as demonstrated by actual testing and not extrapolation.

Generation 4: - for a good explanation of this commonly misunderstood advancement in night vision technology.

When discussing night vision technology, you also may hear the term "Omnibus" or "OMNI". The U.S. Army procures night vision devices through multi-year/multi-product contracts referred to as "Omnibus" - abbreviated as "OMNI". For each successive OMNI contract, ITT has provided Gen 3 devices with increasingly higher performance. (See range detection chart directly below) Therefore, Gen 3 devices may be further defined as OMNI 3, 4, 5, etc. Current Omnibus contract as of 2006 is OMNI 7.



	Gen 2	High-Perf Gen 2	Gen 3 OMNI I and II	Gen 3 OMNI III	Gen 3 OMNI IV
% Improvement over Gen 2	0%	60%	40%	70%	110%

If you're using night vision to find a lost person in the woods, to locate boats or buoys on the water, or to stargaze into the wilderness, you need Generation 3 because it creates the best images when there is very little ambient light. Generation 2 may be the choice in situations with higher levels of ambient light.

KEY GENERATION DEVELOPMENTS:

GENERATION 1 (Developed in 1960's);

- Vacuum Tube Technology
- Full Moon Operation
- Amplification: 1,000
- Operating Life: 2,000 Hours

GENERATION 2 (Developed in 1970's);

- First Micro channel Plate (MCP) Application
- One-Quarter Moon Operation
- Amplification: 20,000
- Operating Life: 2,500 Hours

GENERATION 2+ (1970s)

- Development increased image tube bias voltage to improve gain.
- Additionally, a glass faceplate was added to improve resolution.

GENERATION 3 (Developed in 1990's);

- Improved MCP & Photocathode
- Starlight Operation
- Amplification: 40,000
- Operating Life: 10,000 Hour

GENERATION 3 Enhanced (2000's);

- Improvements in the photocathode and MCP resulted in increased gain and resolution.

Characteristics of Night Vision

Using intensified night vision is different from using regular binoculars and/or your own eyes. Below are some of the aspects of night vision that you should be aware of when you are using an image intensified night vision system.

Textures, Light and Dark:-

Objects that appear light during the day but have a dull surface may appear darker, through the night vision unit, than objects that are dark during the day but have a highly reflective surface. For example, a shinny dark coloured jacket may appear brighter than a light coloured jacket with a dull surface.

Depth Perception:-

Night vision does not present normal depth perception.

Fog and Rain:-

Night vision is very responsive to reflective ambient light; therefore, the light reflecting off of fog or heavy rain causes much more light to go toward the night vision unit and may degrade its performance.

Honeycomb:-

This is a faint hexagonal pattern which is the result of the manufacturing process.

Black Spots:-

A few black spots throughout the image area are also inherent characteristics of all night vision technology. These spots will remain constant and should not increase in size or number. See example below of an image with black spots.

- Do not be concerned if you see this feature-it is an inherent characteristic found in light amplification night vision systems that incorporate a micro channel plate in the intensifier.

Equipment and Applications

Night-vision equipment can be split into three broad categories:

- **Scopes: -** Normally handheld or mounted on a weapon, scopes are monocular (one eye-piece). Since scopes are handheld, not worn like goggles, they are good for when you want to get a better look at a specific object and then return to normal viewing conditions.

- **Goggles: -** While goggles can be handheld, they are most often worn on the head. Goggles are binocular (two eye-pieces) and may have a single lens or stereo lens, depending on the model. Goggles are excellent for constant viewing, such as moving around in a dark building.

- **Cameras: -** Cameras with night-vision technology can send the image to a monitor for display or to a VCR for recording. When night-vision capability is desired in a permanent location, such as on a building or as part of the equipment in a helicopter, cameras are used. Many of the newer camcorders have night vision built right in

Applications:-

Common applications for night vision include:

- Military
- Law enforcement
- Hunting
- Wildlife observation
- Surveillance
- Security
- Navigation
- Hidden-object detection
- Entertainment

The original purpose of night vision was to locate enemy targets at night. It is still used extensively by the military for that purpose, as well as for navigation, surveillance and targeting. Police and security often use both thermal-imaging and image-enhancement technology, particularly for surveillance. Hunters and nature enthusiasts use NVDs to manoeuvre through the woods at night.

- This soldier is using DARK INVADER night-vision goggles.

Detectives and private investigators use night vision to watch people they are assigned to track. Many businesses have permanently-mounted cameras equipped with night vision to monitor the surroundings.

A really amazing ability of thermal imaging is that it reveals whether an area has been disturbed -- it can show that the ground has been dug up to bury something, even if there is no obvious sign to the naked eye. Law enforcement has used this to discover items that have been hidden by criminals, including money, drugs and bodies. Also, recent changes to areas such as walls can be seen using thermal imaging, which has provided important clues in several cases.

Many people are beginning to discover the unique world that can be found after darkness falls. If you're out camping or hunting a lot, chances are that night-vision devices can be useful to you -- just be sure to get the right type for your needs.

NIGH VISION APPROACHES

SPECTRAL RANGE:- Night-useful spectral range techniques make the viewer sensitive to types of light that would be invisible to a human observer. Human vision is confined to a small portion of the electromagnetic spectrum called visible light. Enhanced spectral range allows the viewer to take advantage of non-visible sources of electromagnetic radiation (such as near-infrared or ultraviolet radiation). Some animals can see well into the infrared and/or ultraviolet compared to humans, enough to help them see in conditions humans cannot.

INTENSITY RANGE:- Sufficient intensity range is simply the ability to see with very small quantities of light. Although the human visual system can, in theory, detect single photons under ideal conditions, the neurological noise filters limit sensitivity to a few tens of photons, even in ideal conditions. Many animals have better night vision than humans do,the result of one or more differences in the morphology and anatomy of their eyes. These include having a larger eyeball, a larger lens, a larger optical aperture (the pupils may expand to the physical limit of the eyelids), more rods than cones (or rods exclusively) in the retina, a tapetum lucidum, and improved neurological filtering. Enhanced intensity range is achieved via technological means through the use of an

image intensifier gain multiplication CCD, or other very low-noise and high-sensitivity array of photo detectors

NIGHT VISION DEVICE:-

A night vision device (NVD) is an optical instalment that allows images to be produced in levels of light approaching total darkness. They are most often used by the military and law enforcement agencies, but are available to civilian users. The term usually refers to a complete unit, including an image intensifier tube, a protective and generally water-resistant housing, and some type of mounting system. Many NVDs also include sacrificial lenses, IR illuminators, and telescopic lenses. NVDs are mounted appropriately for their specific purpose, with more general-purpose devices having more mounting options. For instance, the AN/PVS-14 is a monocular night vision device in use with the US military as well as by civilians. It may be mounted on the user's head for hands free use with a harness or helmet attachment, either as a monocular device, or in aligned pairs for binocular "night vision goggles" which provide a degree of depth perception as do optical binoculars. The AN/PVS-14 may also be attached to a rifle using a Pica tinny rail, in front of an existing telescopic or red dot sight, or attached to a single-lens reflex camera. Other systems, such as the AN/PVS-22 or Universal Night Sight, are designed for a specific purpose, integrating an image intensifier into, for example, a telescopic sight, resulting in a smaller and lighter but less versatile system. Night vision devices were first used in World War II, and came into wide use during the Vietnam War The technology has evolved greatly since their introduction, leading to several "generations" of night vision equipment with performance increasing and [censored] decreasing.

Working of night vision devices :

Night Vision technology consists of two major types: image intensification (light amplification) and thermal imaging (infrared).

I. **Image Intensification** (light amplification):- Most consumer night vision products are light amplifying devices. Light amplification is less expensive than thermal, however, higher-end and more effective night vision tubes can become more expensive. Light amplification technology takes the small amount of light, such as moonlight or starlight, that is in the surrounding area, and converts the light energy (scientists call it photons), into electrical energy (electrons). These electrons pass through a thin disk that's about the size of a quarter

and contains over 10 million channels. As the electrons travel through and strike the walls of the channels, thousands more electrons are released. These multiplied electrons then bounce off of a phosphor screen which converts the electrons back into photons and lets you see an impressive night time view even when it's really dark. All image intensified night vision products on the market today have one thing in common: they produce a green output image. Like the one your see to your right . But that's where the similarities end.

II. **Thermal Imaging :** In order to understand thermal imaging, it is important to understand something about light. The amount of energy in a light wave is related to its wavelength: Shorter wavelengths have higher energy. Of visible light, violet has the most energy, and red has the least. Just next to the visible light spectrum is the infrared spectrum. Infrared Ultraviolet Spectrum of light.

Infrared light can be split into three categories:

a. Near-infrared (near-IR) - Closest to visible light, near-IR has wavelengths that range from 0.7 to 1.3 microns, or 700 billionths to 1,300 billionths of a meter.
b. Mid-infrared (mid-IR) - Mid-IR has wavelengths ranging fire Both near-IR and mid-IR are used by a variety of eh remote controls.
c. Thermal-infrared (thermal-IR) – Occupying spectrum, thermal-IR has wavelengths rangi microns.

III. **Thermal-infrared** (thermal-IR):- Occupying spectrum, thermal-IR has wavelengths range microns. The key difference between thermal-IR and the other two is that thermal-IR is emitted by an object instead of reflected off it. Infrared light is emitted by an object because of what is happening at the atomic level.

A special lens focuses the infrared light emitted by all of the objects in view. The focused light is scanned by a phased array of infrared-detector elements. The detector elements create a very detailed temperature pattern called a thermogram. It only takes about one-thirtieth of a second for the detector array to obtain the temperature information to make the thermogram. This information is obtained from several thousand points in the field of view of the detector array. The thermogram created by the detector elements is translated into electric impulses. The impulses are sent to a signal-processing unit, a circuit board with a dedicated chip that translates the information from the elements into data for the display. The signal-processing unit sends the information to the display, where it appears as various colours depending on the intensity of the infrared emission. The combination of all the impulses from all of the elements creates the image. There are two common types of thermal-imaging devices:

IV. **Un-cooled :-** This is the most common type of thermal-imaging device. The infrared-detector elements are contained in a unit that operates at room temperature. This type of system is completely quiet, activates immediately and has the battery built right in.

V. **Cryogenically cooled:-** More expensive and more susceptible to damage from rugged use, these systems have the elements sealed inside a container that coolá.

Range of different generations :

There are many different variables that can effect the distance that you can see with a Night Vision device. First, what are you trying to see? Are you looking for another boat on the water or are you looking for a rabbit in the woods? The larger the object the easier it is too see. Plus, are you trying to see details (what we call recognition range) or are you just trying to see if something is there or maybe you will just see movement but won't be able to 100% determine who or what it is. This is called detection range. Second. Another variable is lighting conditions. The more ambient light you have (starlight, moonlight, infrared light) the better and further you will be able to see You can always see further on a night where the moon and stars are out then if it is cloudy and overcast. We typically state that you can tell the difference between a male and a female or a dog and a deer at about 75 to 100 yards. However, if you were looking across an open field and there was a half moon out you could see a barn or a house 500 yards away. Remember, that the purpose of an NVD is to see in the dark not necessarily a long Way slike a binocular

NEW NIGHT VISION PRODUCT

ATN Night Vision Weapon sights - the world's most complete line of professional night vision sights is proud to introduce a new flagship product line - the ATN MARS Series. Mars, the Roman God of War inspired the fabled legions to overcome any obstacle in their path on the road to success. The ATN MARS Series will do the same for modern warriors. Inspired by ATN's quest for technical perfection, the MARS Series represents the latest in night vision technology combined with rugged reliability. ATN Night Vision rifle scopes - the world's most complete line of professional night vision scopes is proud to introduce a new flagship product line - the ATN MARS Series. Mars, the Roman God of War inspired the fabled legions to overcome any obstacle in their path on the road to success. The ATN MARS night vision series will do the same for modern warriors. Inspired by ATN's quest for technical perfection, the MARS night vision series represents the latest in night vision technology combined with rugged reliability.

ATN NIGHT VISION:-

The ATN MARS night vision riflescopes are versatile coming equipped with two magnification options; a fast 4x lens or a powerful 6x lens. Both units feature specially designed night vision optics using only the purest grades of heavy glass and computer enhanced optical designs to create multi-element, high-speed, multi-coated lenses for ultra-fast light transmission and resolution beyond current military standards. All optical lenses used in the MARS night vision rifle scopes are individually hand fitted. The ATN MARS night vision rifle scopes utilize the highest quality MX10160 type hand-selected image intensifier tubes (IIT) taking advantage of the latest night vision technology. The ATN MARS night vision scopes are available with a wide array of UT configurations to satisfy any requirements and specifications. All image tubes used in the MARS night vision series are of new manufacture.

Some of the tube configurations available are:

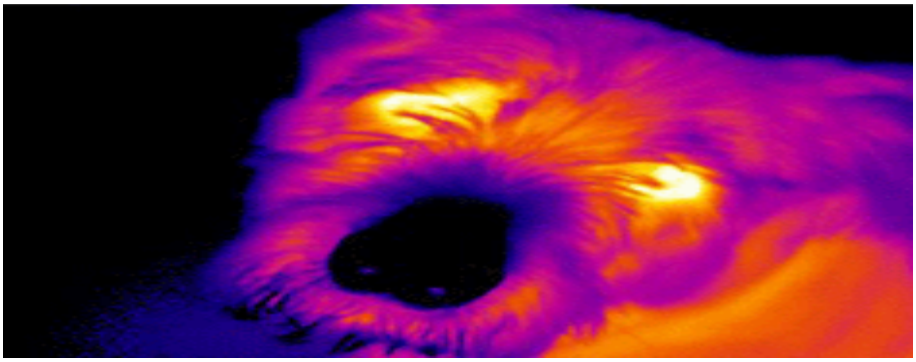
- New ITT Pinnacle™ Image Intensifier tubes with data record sheet.
- 3rd generation configurations are available with Figure of Merit (FOM) image tubes in 1600 and 1250 FOMs.

- G4 Filmless, auto gated tubes which maximize functionality in all lightning conditions, ensuring superb performance, outstanding clarity and combat reliability.

The MARS night vision riflescopes feature rugged one-piece CNC milled construction from solid aerospace-quality aluminium billet and titanium inserts. The ATN MARS night vision scopes give the weapon operator 50% more (45mm!) eye relief and offers superior performance over other manufacturer's models in regards to wind age and elevation adjustment. The MARS is the only night vision scope in the A illuminated two-colour, variable intensity reticule that ca: in all lighting condition. This proprietary ATN feature amber) of the projected reticule depending on operate and is one of many things setting the MARS nigh competition. Hunting With Night Vision Devices Hunting at night and/or in the dark never seemed easy until Night Vision Devices were made available in the market. With these devices, hunters can now get a better and clearer view of what lurks in the dark.
How Night Vision Devices Make You an Invisible Hunter Basically, night vision devices or NVD aids you in hunting by gathering light from the stars, the moon, and other light sources and focusing it on the front lens so as to give you a clearer image of what lurks in the dark. In its simplest form, the night vision devices gather light and then directs this light into the photocathode tube which converts the photons to electrons. After the electron conversion, a host of chemical and electrical process multiplies the number of electrons present. After magnification, the electrons are hurled on a phosphorus screen and the electrons are then converted into light. This process allows you to see the image that is shown in a green-hue scene.

Night Vision Device options for Night Hunting:-

There are many units of night vision devices that hunters can opt to use. A Night Vision Device may belong to its 1st, 2nd, 3rd or 4th generation type. Note that each generation only varies according to the type of light intensifier tube that is used for the device. First generation Night Vision Devices are the most prominent these days. They are relatively cheaper than the other units and are thus the most recommended types for conventional use. Note that first generation Night Vision Devices makes use of the process and the lighting equipment described above.



Night Vision Device Sight Range:-

Note that Night Vision Devices were made to allow you to see in the dark, not to let you see in far and wide sight ranges. When using NVDs, there are many factors to consider when assessing the distance that the device allows you to view. First, consider the available lighting. Note that the Night Vision Devices amplifies existing light so you can see things. If the moon or the stars provide ambient lighting, then you can probably see farther than what you can if there are no stars for the night. Also, take note of the size of the object you are trying to see. The larger the object, the greater you have of seeing it. Also, consider what are you trying to see about the object- is it its details (requires recognition range) or just its movement (shown through a detection range).

USAGE:-

Night vision devices were originally developed for military use, but have since spread into other areas, such as security and police work, rescue outfits and various amateur uses (for example animal watching or hunting)Night vision goggles have been especially praised by the pilots of rescue helicopters, as they eliminate the need for a 'sterile light environment' (i.e. a dark cabin to allow the pilot to let his eyes naturally adjust to night-flying conditions). This will for example allow a medic in the cabin to work on a patient under bright lights while retaining the pilot's ability to fly safely under night conditions .There are mainly three devices used in night vision via monocular, binocular , and night vision goggles . The monocular device was first used by USA militry in world war II. The second one binocular was used first in Vietnam war.

Biological Night Vision

In biological night vision, molecules of rhodopsin in the rods of the eye undergo a change in shape as light is absorbed by them. The peak rhodopsin build-up time for optimal night vision in humans is 30 minutes, but most of the adaptation occurs within the first five or ten minutes in the dark. Rhodopsin in the human rods is insensitive to the longer red wavelengths of light, so many people use red light to preserve night vision as it will not deplete the eye's rhodopsin stores in the rods and instead is viewed by the cones.

Some animals, such as cats, dogs, and deer, have a structure called tapetum lucidum in the back of the eye that reflects light back towards the retina, increasing the amount of light it captures. In humans, only 10% of the light that enters the eye falls on photosensitive parts of the retina. Their ability to see in low light levels may be similar to what humans see when using first or perhaps second generation image intensifiers.

Early Attempts at Night Vision Technology

Military tacticians throughout history have seen the advantages of being able to manoeuvre effectively under the cover of darkness. Historically, maneuvering large armies at night carried such risks that it was rarely attempted.

During WW II, the United States, Britain, and Germany worked to develop rudimentary night vision technology. For example, a useful infrared sniper scope that used near-infrared cathodes coupled to visible phosphors to provide a near-infrared image converter was fielded. A small number, perhaps 300 Sniper scopes, were shipped to the Pacific sometime in 1945, but received very little use. Their range was less than 100 yards, and they were used mainly for perimeter defence. However this device had several disadvantages. The infrared sniper scope required an active IR searchlight that was so large it had to be mounted on a flatbed truck. This active IR searchlight could be detected by any enemy soldier equipped with similar equipment. The rifle-mounted scope also required cumbersome batteries and provided limited range.

However, the infrared sniper scope showed that night vision technology was on the horizon. Military leaders immediately saw many uses for this technology beyond sniping at the enemy under cover of darkness. An army equipped with night vision goggles, helmets, and weapons sights would be able to operate 24 hours a day. The Army Corps of Engineers, for example, would be able to build bridges and repair roads at night providing a measure of safety from airborne attack. The next challenge in night vision technology would be the development of passive systems that did not require IR searchlights that might give away a soldier's position to the enemy.

Application of Night Vision:-

Automatic Brightness Control (ABC) :- An electronic feature that automatically reduces voltages to the micro channel plate to keep the image intensifier's brightness within optimal limits and protect the tube. The effect of this can be seen when rapidly changing from low-light to high-light conditions; the image gets brighter and then, after a momentary delay, suddenly dims to a constant level.

Auto-Gated Power Supply:- When the power supply is "auto-gated," it means the system is turning itself on and off at a very rapid rate. This, combined with a thin film attached to the micro channel plate (an ion barrier) reduces blooming. While "blooming" can be noticeably less on systems with a thin film layer, systems with thicker film layers can be perfectly acceptable depending on the end

user's application. Deciding which night vision goggle is better should not be based solely on blooming.

Black Spots:- These are common blemishes in the image intensifier of the NVD or can be dirt or debris between the lenses of the NVG. Black spots that are in the image intensifier do not affect the performance or reliability of a night vision device and are inherent in the manufacturing processes. Every night vision image intensifier tube is different. They are like diamonds. See image to the right.

Binocular:- Viewing a single image source with both eyes (example: watching a television set).

Binocular:- Viewing a scene through two channels; i.e. one channel per eye.

Blooming:- Loss of the entire night vision image, parts of it, or small parts of it, due to intensifier tube overloading by a bright light source. Also, known as a "halo" effect, when the viewer sees a "halo" effect around visible light sources. When such a bright light source comes into the night vision device's view, the entire night vision scene, or parts of it, become much brighter, "whiting out" objects within the field of view. Blooming is common in Generation 0 and 1 devices. The lights in the image to the right would be considered to be "blooming".

Bright-Source Protection (BSP) - High-Light Cut-Off:- An electronic function that reduces the voltage to the photocathode when the night vision device is exposed to bright light sources such as room lights or car lights. BSP protects the image tube from damage and enhances its life; however, it also has the effect of lowering resolution when functioning.

Bore sighting:- The alignment of a weapon aiming device to the bore of the weapon. See also Zeroing.

C-Mount:- A standard still and video camera lens thread size for mounting to the body of a camera. Usually 1/2" or 3/4" in diameter..

COMSPEC (Commercial Specification):- A term used to describe image tube quality, testing and inspection done by the original equipment manufacturer (OEM).

Chicken Wire:- An irregular pattern of dark thin lines in the field of view either throughout the image area or in parts of the image area. Under the worst-case condition, these lines will form hexagonal or square wave-shape lines.

Daylight Lens Cover:- Usually made of soft plastic or rubber with a pinhole that allows a small amount of light to enter the objective lens of a night vision device. This should be used for training purposes only, and is not recommended for an extended period of time.

Daylight Training Filter:- A glass filter assembly designed to fit over the objective lens of a night vision device. The filter reduces light input to a safe (night-time) level, allowing safe extended daytime use of the night vision device.

Dioptre:- The unit of measure used to define eye correction or the refractive power of a lens. Usually adjustments to an optical eyepiece accommodate for differences in individual eyesight. Most ITT systems provide a +2 to -6 dioptre range.

Distortion:- There are two types of distortion found in night vision systems. One type is caused by the design of the optics, or image intensifier tube, and is classical optical distortion. The other type is associated with manufacturing flaws in the fibres optics used in the image intensifier tube.

Classical Optical Distortion:- Classical optical distortion occurs when the design of the optics or image intensifier tube causes straight lines at the edge of the field of view to curve inward or outward. This curving of straight lines at the edge will cause a square grid pattern to start to look like a pincushion or barrel. This distortion is the same for all systems with the same model number. Good optical design normally makes this distortion so low that the typical user will not see the curving of the lines.

Fibre Optics Manufacturing Distortions:- Two types of fibre optics distortions are most significant to night vision devices: S-distortion and shear distortion:

- **S-Distortion:-** Results from the twisting operation in manufacturing fibre-optic inverters. Usually S-distortion is very small and is difficult to detect with the unaided eye.
- **Shear Distortion:-** Can occur in any image tube that use fibre-optic bundles for the phosphor screen. It appears as a cleavage or dislocation in a straight line viewed in the image area, as though the line was "sheared".

Equivalent Background Illumination (EBI):- This is the amount of light you see through a night vision device when an image tube is turned on but no light is on the photocathode. EBI is affected by temperature; the warmer the night vision device, the brighter the background illumination. EBI is measured in lumens per square centimetre (lm/cm2). The lower the value the better. The EBI level determines the lowest light level at which an image can be detected. Below this light level, objects will be masked by the EBI.

Emission Point:- A steady or fluctuating pinpoint of bright light in the image area that does not go away when all light is blocked from the objective lens. The position of an emission point within the field of view will not move. If an emission point disappears or is only faintly visible when viewing under brighter nighttimes conditions, it is not indicative of a problem. If the emission point remains bright under all lighting conditions, the system needs to be repaired. Do not confuse an emission point with a point of light source in the scene being viewed.

Eye Relief:- The distance a person's eyes must be from the last element of an eyepiece in order to achieve the optimal image area.

Field-of-View:- The diameter of the imaged area when viewed through an optic

Figure of Merit (FOM):- Image Intensification tube specification designation, calculated on line pair per mm x signal to noise.

Fixed-Pattern Noise (FPN):- A faint hexagonal (honeycomb) pattern throughout the image area that most often occurs under high-light conditions. This pattern is inherent in the structure of the micro channel plate and can be seen in virtually all Gen 2 and Gen 3 systems if the light level is high enough.

Foot-lambert (fL):- A unit of brightness equal to one foot-candle at a distance of one foot.

Gain:- Also called brightness gain or luminance gain. This is the number of times a night vision device amplifies light input. It is usually measured as tube gain and system gain. Tube gain is measured as the light output (in fL) divided by the light input (in fc). This figure is usually expressed in values of tens of thousands. If tube gain is pushed too high, the tube will be "nosier" and the signal-to-noise ration many go down. U.S. military Gen 3 image tubes operate at gains of between 20,000 and 45,000. On the other hand, system gain is measured as the light output (fL) divided by the light input (also fL) and is what the user actually sees. System gain is usually seen in the thousands. U.S. military systems operate at 2,000 to 3,000. In any night vision system, the tube gain is reduced by the system's lenses and is affected by the quality of the optics or any filters. Therefore, system gain is a more important measurement to the user.

Gallium Arsenide (GaAs):- The semiconductor material used in manufacturing the Gen 3 photocathode. GaAs photocathode have a very high photosensitivity in the spectral region of about 450 to 950 nanometres (visible and near-infrared region).

Highlight Shutoff:-

An image intensifier protection feature incorporating a sensor, microprocessor and circuit breaker. This feature will turn the system off during periods of extreme bright light conditions.

Interpupillary Adjustment:- The distance between the user's eyes (pupils) and the adjustment of binocular optics to adjust for differences in individuals. Improperly adjusted binoculars will display a scene that appears egg-shaped or as a reclining figure-8.

Interpupillary Distance:- The distance between the user's pupils (eyeball centres). The 95th percentile of US military personnel falls within the 55 to 72mm range of IPD.

IR Illuminator:- Many night vision devices incorporate a built-in infrared (IR) diode that emits invisible light or the illuminator can be mounted on to it as a separate component. IR light cannot be seen by the unaided eye; therefore, a night vision device is necessary to see this light. IR Illuminators provide supplemental infrared illumination of an appropriate wavelength, typically in a range of wavelengths (e.g. 730nm, 830nm, 920nm), and eliminate the variability of available ambient light, but also allow the observer to illuminate only specific areas of interest while eliminating shadows and enhancing image contrast.

IR Laser:- High-power devices providing long-range illumination capability. Ranges of several thousand meters are common. Most are not eye-safe and are restricted in use. Each IR laser should be marked with a warning label like the one shown here. Consult FDA CFR Title 21 for specific details and restrictions.

I2 (Image Intensification):- Collects and intensifies the available light in the visible and near-infrared spectrum. Offers a clear , distinguishable image under low-light conditions.

IR (Infrared):- Area outside the visible spectrum that cannot be seen by the human eye (between 700 nanometres and 1 millimetre). The visible spectrum is between 400 and 700 nanometres.

Ip/mm (Line Pairs per Millimetre)**:-** Units used to measure image intensifier resolution. Usually determined from a 1951 U.S. Air Force Resolving Power Test Target. The target is a series of

different-sized patterns composed of three horizontal and three vertical lines. A user must be able to distinguish all the horizontal and vertical lines and the spaces between them. Typically, the higher the line pair, the better the image resolution. Generation 3 tubes generally have a range of 64 - 72 lp/mm, although line pair measurement does not indicate the generation of the tube. Some Generation 2+ tubes measure 28-38 lp/mm, while a Generation 1+ tube may have measure at 40 lp/mm.

Lumen:- Denotes the photons perceptible by the human eye in one second.

Monocular:- A single channel op-Tikal device. The American Eagle in this catalogue is an example of a monocular.

Nato-Stanag:- Term for the North Atlantic Treaty Organization Standard Agreement. This can be described as an international MILSPEC

mA/W (Milliamps per Watt):-The measure of electrical current (mA) produced by a photocathode when exposed to a specified wavelength of light at a given radiant power (watt).

MCP (Micro-channel Plate):- A metal-coated glass disk that multiplies the electrons produced by the photocathode. An MCP is found only in Gen 2 or Gen 3 systems. MCPs eliminate the distortion characteristic of Gen 0 and Gen 1 systems. The number of holes (channels) in an MCP is a major factor in determining resolution. ITT Industries' MCPs have 10.6 million holes or channels compared to the previous standard of 3.14 million.

Near-Infrared:- The shortest wavelengths of the infrared region, nominally 750 to 2,500 nanometres. Also see IR (infrared).

Photocathode:- The input surface of an image intensifier tube that absorbs light energy (photons) and in turn releases electrical energy (electrons) in the form of an image. The type of material used is a distinguishing characteristic of the different generations.

Photocathode Sensitivity:- Photocathode sensitivity is a measure of how well the image intensifier tube converts light into an electronic signal so it can be amplified. The measuring units of photocathode sensitivity are micro-amps/lumen (µA/lm) or microamperes per lumen. This criterion specifies the number of electrons released by the Photocathode (PC). PC response is always measured in isolation with no amplification stage or ion barrier (film). Therefore, tube data sheets (which always carry this “raw” figure) do not reflect the fact that over 50% of those electrons are lost in the ion barrier. While for most latest 3rd generation image intensifiers the photo response is in the 1800 µA/lm (2000 µA/lm for the latest Omni VI Pinnacle tubes), the actual number is more like 900 µA/lm. The 4th generation DOES NOT use ion barrier and while its “raw” photo response is the same as 3rd, the actual number is actually 100% higher.

Resolution:- The ability of an image intensifier or night vision system to distinguish between objects close together. Image intensifier resolution is measured in line pairs per millimetre (lp/mm) while system resolution is measured in cycles per miliradian. For any particular night vision system, the image intensifier resolution will remain constant while the system resolution can be affected by altering the objective or eyepiece optics by adding magnification or relay lenses. Often the resolution

in the same night vision device is very different when measured at the centre of the image and at the periphery of the image.

This is especially important for devices selected for photograph or video where the entire image resolution is important. Measured in line pairs per millimetre (lp/mm).

Reticule (Reticule Pattern)**:-** An adjustable aiming point or pattern (i.e. crosshair) located within an optical weapon sight

Signal-to-Noise Ratio (SNR):- A measure of the light signal reaching the eye divided by the perceived noise as seen by the eye. A tube's SNR determines the low-light-resolution of the image tube; therefore, the higher the SNR, the better the ability of the tube to resolve objects with good contrast under low-light conditions. Because SNR is directly related to the photocathode's sensitivity and also accounts for phosphor efficiency and MCP operating voltage, it is the best single indicator of an image intensifier's performance.

Scintillation:- Also known as electronic noise. A faint, random, sparkling effect throughout the image area . Scintillation is a normal characteristic of micro channel plate image intensifiers and is more pronounced under low-light-level conditions

Screen:- The image tube output that produces the viewable image. Phosphor (P) is used on the inside surface of the screen to produce the glow, thus producing the picture. Different phosphors are used in image intensifier tubes, depending on manufacturer and tube generation. P-20 phosphor is used in the systems offered in this catalogue

Stereoscopic Night Vision:- When two views or photographs are taken through one device. One view/photograph represents the left eye, and the other the right eye. When the two photographs are viewed in a stereoscopic apparatus, they combine to create a single image with depth and relief. Sometimes this gives two perspectives. However, it is usually not an issue because the object of focus is far enough away for the perspectives to blend into one.

System Gain:- Equal to tube gain minus losses induced by system components such as lenses, beam splitters and filters.

Variable Gain Control:- Allows the user to manually adjust the gain control (basically like a dim control) in varying light conditions. This feature sets the PVS-14 apart from other popular monocular that do not offer this feature.

Weaver Mounting System:- A US weapon mounting system used for attaching sighting devices to weapons. A Weaver Rail is a weapon-unique notched metal rail designed to receive a mating throw-lever or Weaver Squeezer attached to the sighting device

Zeroing:- A method of bore sighting an aiming device to a weapon and adjusting to compensate for projectile characteristics at known distances.

Weapons Suppression in Night Operations

Much has been written about the need for our army to be able to operate 24 hours a day. Of the key elements being studied, friend or foe identification and weapons signature reduction should be given serious thought. The most reliable means of identifying our own forces at night is to have active IR emitters or reflective IR patches placed on or near our personnel and equipment. But what of the enemy identifying us? When we fire our weapons at night, the muzzle flash gives our position away at ranges well beyond 1000 metres.

Some thought has to be given to the weapons signature our small arms produce and how to mask it. The fitting of suppressors to our small arms would be the answer. The benefits would be numerous; firstly, the flash effect produced at the muzzle is reduced to the point where it would not be observable either with the naked eye or with night vision much past 100 metres. (5.56) This would allow the firer to engage targets and remain undetected at much closer distances than are currently possible.

Another benefit is that the washout that occurs in night vision sights or goggles when a weapon is fired would no longer occur. This allows the firer to engage targets rapidly and safely, without having to wait for the 'corona effect' to disappear or for the sight to come on-line again after being blacked out.

When firing within buildings, muzzle flash and noise, especially at night, have a disorienting effect on not only the firer but on his or her teammates as well. If we were to equip our small arms fleet with suppressors, the ear splitting blast and blinding flash from a C9,C7, or GPMG fired within a building would virtually disappear. An enemy unequipped with suppressors would be very easy to ID and at a distinct disadvantage.

For snipers in particular, the muzzle blast produced by our Tac .50 or any rifle equipped with a muzzle brake instantly reveals the position of the weapon to even the most casual observer. In dry conditions in particular, the cloud of dust produced by the diffusion of gasses at the muzzle not only pinpoints where the shot came from, but it also makes the

spotter's job nigh on impossible, as he spits debris from his mouth and tries to clear his eyes. There is another danger as well, anyone in the vicinity of the weapon is actually receiving more energy and noise than if they were near a weapon that had no muzzle brake.

NIGHT OPERATIONS

OUT OF THE DARK:

NIGHT VISION EQUIPMENT FOR THE INFANTRY

The Reality:-

The historically based and hard-earned reputation of Canadian infantrymen being aggressive and effective night fighters is currently being put into question through a reluctance by soldiers to fully employ currently issued night vision devices (NVD's) coupled with an inadequate allotment of the required equipment. Unlike the past where boldness, stamina and skills could win the day or night, modern night operations require up-to-date equipment and procedures. Unfortunately, the equipment acquisition of the Canadian Infantry Corps has not kept pace with the advances in modern technology. The situation has evolved to a point where the dismounted Canadian soldier with limited Gen-2 and NVDs no longer possesses the capability to effectively fight at night; this shortfall is especially clear when comparing our dismounted infantry's ability to that our allies and potential adversaries.

More bluntly stated, we will not be able to see the enemy, so we will not be able to kill him. More critically though, our current disadvantage will mean that our soldiers will be unnecessarily put at risk by allowing them to be seen in situations where they cannot.

The Analysis:-

It will be useful to address this problem by examining the three following combat functions: manoeuvre, fire power and command. All three of these are affected by the shortfalls that exist in our NVD stores. It is important to keep in mind, however, that more equipment alone is not the solution to all of our problems. The correct attitude of individual soldiers about the employment of NVD's must also be guaranteed; it is unacceptable to see night vision goggles (NVG's) dangling around soldiers' necks instead of being mounted to a head harness or helmet. The optimistic news is that one estimate shows an entire battalion could be outfitted with the ability to "own the night" for less than two million dollars (roughly the price of one LAV-3).

The Prescription

1.Manoeuvre:-

In order for infantry sub-units to move and fight at night, every soldier requires some type of NVD. These devices allow the soldier to engage targets at the maximum range of his personal weapon and manoeuvre across the battlefield with good situational awareness.

The infantry needs to replace all of their current Gen-2 and older Gen-3 NVD's with the far superior Gen-3 Omni-5 models. The authors suggest that the minimum number required by dismounted infantry sections is one set of NVG's per fire team. With these, the sect will be able to move at night as it does in the day. However, as noted earlier, in order to take full advantage of the technology,

leaders and soldiers must wear them at all times. While the initial training will be difficult and resisted by some soldiers, the benefits will soon become clear to leaders.

NVG's should have the ability to be mounted to the helmet and flip up in the same manner as an aviator's or the US Army's PVS-7Ds. The LAV crew comd requires NVG's in addition to the gunner's thermal sight to enable him to operate with his head outside of the turret. This would increase his peripheral vision capabilities and assist him in maintaining situational awareness; both of these would be lost if he remained inside the turret and focused on the thermal sight.

A possible alternative to the AN/PVS-7D is the AN/PVS-14. This monocular flexibility is unsurpassed in that it can be used as a hand-held, helmet-mounted or weapon-mounted NVD. It is currently being issued to US Ranger battalions. Its great advantage is that in helmet-mounted mode it leaves one eye unrestricted to allow for increased situational awareness.

An added piece of available equipment to be considered for limited purchase is the a focal magnifier lens that can be attached to PVS-7D Gen-3 Omni-5 NVGs or PVS-14. It would be useful for soldiers who require long-range observation capabilities (such as pl comds) who do not necessarily require a weapon sight. It is especially worthy of consideration because of its relative low procurement cost.

With a PVS-7D (NVG) and one of these a focal lenses, the user gains dual NVD capability; he can move at night using the NVGs and then attach the a focal lens (to be used like conventional hand-held binoculars) upon reaching a fixed position. US sniper teams have found this combination indispensable. Such a pairing would also be useful for OP's

2. Firepower:-

Seeing is not enough; soldiers must also be able to hit and kill a target. Canadian infantry units do not have the ability to effectively engage targets at night without illumination. The only way to gain this capability is by using NVG's coupled with an IR pointing device (such as the PAQ-4C) or by using a weapon night sight such as the British-made Kite sight.

The PAQ-4C (called "Pack – 4" by US forces) is the latest and improved version of the PAQ-4B, and currently in use by Canadians deployed with KFOR/SFOR. The AN/PAQ-4C is an infrared weapon aiming light that allows the soldier to aim his weapon while still using NVG's. The IR light that is projected from this device is invisible to the naked eye; however, the light can easily be seen when using image intensification devices. The light provides a rapid, accurate aiming point from which to engage targets at night.

With their longer ranges, the C-9 LMG and C-6 GPMG require a night sight with a corresponding range capability. One option is to employ a night sight such as the Gen-3 Kite or Maxikite sight (which is also being employed by Canadian Forces in KFOR/SFOR). This will allow the C-9 and C-6 gunners to engage targets out to 600m. With the Kite sight the sect would also gain greater depth in their ability to observe of the battlefield going beyond the range of their NVGs.

FIBUA and certain other operations require special considerations and equipment. For a number of years special and police forces have employed weapon-mounted white light devices in FIBUA-type operations. In addition to allowing rapid target acquisition, white light has the advantage of blinding

image intensification equipment. It can also temporarily dazzle and disorient an enemy with unprotected eyesight – even in daylight or lighted rooms. Sure-fire lights In addition to optical NVD's there are pyrotechnic IR illumination devices. These include Para flares, illumination rounds, pen flares, and trip flares. To the naked eye, these have the same brightness as a burning match; however, through NVD's, they "light up the sky." The US Army employs them and we should too.

All of these equipment choices beg the question "what is the right mix?" The answer is not universal and depends on the operation at hand. However, it is suggested that the scale of issue for the C-9 and C-6 should be Gen-3 Kite/Maxi kite sights. Riflemen should be equipped with NVGs and PAQ-4C's. When it is desirable to mount the Kite sights on the C-7s for pinpoint accuracy, the C-9 gunners would utilize the NVG and PAQ-4C combination (this is not necessarily a compromise for the latter since it would reduce washout from muzzle flash). Thus, comds would allot night vision equipment based on the tasks for his sub-unit. It is clear that other forces similar in size and composition to our, reflect this same concern for adequate NVD's.

3. Command and Control:-

Commanding dismounted infantry during normal daylight operations is an intricate task; to attempt the same during reduced visibility operations is infinitely more challenging. Even after NVD's are obtained, there must be a means for leaders to guarantee control and thus reduce the risk of fratricide. This risk is an important consideration not only for

sub-unit fire, but also for supporting fire, such as provided by attack helicopters and close air support.

The most important infantry night command aid is the Ground Commander's Pointer (GCP). This device is an IR laser with a range of 8 km+. It allows comds to direct soldiers equipped with NVD's by indicating both targets and boundaries. For example, a pl comds could indicate trenches to his sect comds and the OC, subsequently giving his arcs for the consolidation. Recue Pl could then mark depth objectives for attack helicopters.

The GCP-1 comes in two versions: the GCP-1/2A (50mW) and the longer range GCP-1/2B (100mW). The GCP-1's are hand held, and the GCP-2's can be mounted on a weapon. If the GCP-2A/B are employed, the PAQ-4C is not required.

Soldiers and comds must have a means to establish positive combat identification at night in order to prevent fratricide; "Warrior Glotape" is a very inexpensive solution. To the naked eye, it appears as black duct tape in both finish and texture. When illuminated by normal visible light it exhibits no special reflective characteristics. However, when illuminated by an IR source (for example, GCP's, PAQ-4C's, or LAV-3 IR spotlights) the tape glows brightly. "Warrior Glotape" could be placed on the back of a soldier's helmet and on the fore stock of his weapon. An obvious criticism of this system is that NVD equipped enemy forces would also see our forces during IR illumination. This is true; however, illumination by comds would take place only seconds before engagement as a final confirmation of identity. Thus, the safeguard against fratricide far outweighs the risk of detection.

The Phoenix IR beacon is a longer-range device that should be used in addition to glow tape. The IR beacon - when activated - emits a strobe, which can only be detected by NVD's. The programmable

nature of this device means it lends itself to marking different friendly locations during the conduct of patrols, link up operations, and other night operations. It can be also be used to mark vehicles, routes, attack positions, rolling replenishments, and landing zones.

The problem of control and identification remains during the use of thermal sights, so an item to meet this requirement needs investigation. It must be remembered that thermal sights prevent one from seeing visible white light or IR light sources, such as chem lights. Thermal panel markers are a useful and cost-effective solution. They will assist in the marking of a variety of operationally significant locations (such as identifying obstacle breach sites for LAV-3 drivers using thermal viewers) and help to prevent fratricide. The Thermal Identification Panel (TIP - manufactured by NVEC) is a thermal reflective marker designed for use with thermal sights and viewers. TIPs work by showing the contrast between their cold spots and the warmer background temperature.

DEVELOPMENT OF A NIGHT VISION DEVICE

Introduction

1.Statement of the problem:-

The use of night vision devices (NVDs), including image intensification (I2) and thermal devices, in a tactical environment has the potential for enhancing driving operations at night by allowing increased mobility and safer operations.

However, with this increased capability has come the requirement to manage risks and provide suitable training. A review of accidents involving Army drivers using I2 devices and the results of experiments conducted by the military suggest that problems experienced by drivers with NVDs can be largely attributed to a limited understanding of the NVD capabilities and limitations and to perceptual problems.1

2.OBJECTIVES:-

The overall SBIR project objective is to develop a low cost, effective PC-based training aid for training drivers of wheeled and tracked vehicles to drive safely and effectively with I2 devices. During Phase I we explored concepts and design possibilities, developed concepts for each of the relevant design possibilities, and assessed the feasibility for each concept.

We also developed. a Concept Development Tool containing four sample lessons on CD-ROM. Furthermore, we validated the need for and the technical feasibility of an NDTA and identified a preliminary set of training requirements (what knowledge and skills need to be trained) and NDTA functional requirements (what the training aid should be able to do).1,5 We performed the work reported in this paper during the first year of the two-year Phase II SBIR effort. The objectives of Phase II are (1) to validate the functional and training requirements identified in Phase I, (2) to develop a fully functional prototype NDTA, and (3) to assess NDTA user acceptability. In this paper, we provide an interim summary of our work during the first year of the Phase II effort to include validating the requirements, developing instructional materials, and developing techniques to deliver the instruction in a multimedia, interactive PC environment. In addition, we discuss issues and lessons learned for training NVD driving knowledge and skills in a PC environment and the potential

for extending the NDTA to driver training with thermal NVDs. The assessment of NDTA user acceptability will be performed during the second contract year.

FRATRICIDE

Sitrep:-

The battle group was put on the highest alert status, in anticipation of Serb retaliation for the NATO air strikes in another sector. As a precaution, the CO moved his TUAs (TOW Under Armour APCs) to support his companies with either their C-6 MG or the deadly TOW 2A missiles.

Sgt Blogging was waiting in his TUA, Call Sign 74. Although recently posted in to the platoon as a section commander, he was not qualified advanced TOW. He had once spent three years in the anti armour platoon as driver and gunner, but that was before the thermal sight and upgrade to TUA. His section had only two weeks of training on the TUA before deploying.

He received his orders. OP C-29 was under fire, and he was to move to position 102. They pulled off the main road and he ordered the driver to kill the lights as they moved up the winding track. "Fuck, it's dark," he told his driver. Blogging had been here once before, and that was a month ago in the daytime.

The OP reported that they could hear the Serbs moving up tracked vehicles. Suddenly the OP was receiving fire from a M-80. Blogging' gunner was ready. As soon as the TUA stopped the gunner knew he had to be ready to fire, showing those Serbs that we couldn't be pushed around. He just finished the TOW course and was top tracker on the TVIGS (TOW Video Interactive Gunnery Simulator), and PGS (Precision Gunnery Simulator). Unfortunately the gunner had fired only one live missile during his course, and that was by day against a stationary target.

The TUA came to a halt. On his command net, Blogging received orders to engage any hostile force attacking the OP. This must be it, Blogging thought, and ordered the gunner to search for targets - no time to align that CCTAS (Crew Commander's Target Acquisition System) device to Grid North and besides he wasn't sure how to do it. The gunner, using the thermal sight, quickly found a hot spot on wide field of view, and quickly changed the sight to full 12 power magnification. "Target!" he yelled to Sgt Blogging. He didn't know what it was, but he was never any good at that AFV stuff. Blogging gave the order to fire. The missile roared away. The gunner maintained the 5 second track to the target 1000 metres away, then armed the other missile as he looked for a new target.

"Holly Fuck", the MCpl in 62A yelled. Having just finished his advanced recce course and after spending hours on the Target Identification Recognition Training System (TIRTS) mastering both thermal and optical recognition, he knew a TUA had just hit Call Sign 62's M-113 with a missile. He called 60 to report the incident, but before they could figure out what to do another missile slammed into the side of his APC. The MCpl died within a second....

Later on at the Board of Inquiry into the fratricide deaths of five soldiers it was found that poor navigation, the lack of rehearsals by day and night to position 102, the lack of arcs of fire for the gunner, the lack of effective thermal AFV recognition training, and the absence of any SOPs to deal with fratricide incidents led to the deplorable events that took place.

Aim:-

The aim of this article is to bring to light the very serious problem of units being engaged by friendly fire which is commonly known as "FRATRICIDE". Fratricide has been a problem throughout warfare but the Gulf War brought to light some serious problems to the high technology battle field regarding the thermal imagery sight during reduced visibility operations. War Fratricide Casualties UK Gulf War 9 killed, 16 wounded US Gulf War 24 killed, 57 wounded During Operation Desert Storm, direct fire vehicular engagements caused 12 of the 15 U.S. Army friendly fire incidents. Of these 12, all but one occurred at night, 10 of these happened within 1500m.

Observation

Thermal Recognition Training:-.

During the Gulf War, many fratricide incidents were avoided because crews were able identify a target as friendly even though they were told from higher that it was enemy. In Canada, with the exception of ADATS gunners who use the Target Identification Recognition Training System (TIRTS), there is no comprehensive thermal recognition training available for soldiers who are required to use thermal imagery devices.

Recommendation: -

Thermal Recognition Training. While training standards in thermal recognition seem to be evolving, there are no comprehensive training aids available for use. Initial and continuation training is practically non existent at the unit level. Some progress is being made. The Advanced Recue and Anti-Armour Courses at the Infantry School are now taught thermal recognition training (14 periods), using the Air Defence School's TIRTS, but the Advance Mortar Course which trains our FCs (Fire Controllers) does not cover this vital topic. Nevertheless, the major shortcoming is at unit level where there are no effective means to teach thermal recognition. This is particularly critical when in the very near future every Section will be issued a thermal sight fitted to their Eryx anti armour missiles. In addition, the gunnery systems on the new APCs may also have a thermal sight for the 25mm Bushmaster Chain Gun. Thermal imaging sights are excellent passive observation and target acquisition devices, but the sight picture is not as clear as one might assume. It takes training to be able to properly use a TI sight and to ensure that the heat source you see is either friend or foe, and therefore it is essential that thermal recognition training be conducted for all soldiers. Expedient means are possible by taking soldiers to the field and have them observe targets in a wide variety of situations. Unfortunately, the lack of enemy vehicles precludes any hope of high standards. The answer is to purchase the TIRTS system for each Battalion, so that initial, and more importantly, continuation training is conducted by all TI users.

Thermal Recognition Standards-

The AFV (Armoured Fighting Vehicle) recognition standards set out in LFCO 21-13 should also include thermal AFV recognition standards. The following are the proposed Infantry standards for thermal AFV/AC recognition, and have been written into the training plans for the Basic and Advanced Recce and Anti Armour courses

M STAR radar on the LAV Recue vehicle can track targets 24 km distant. Beyond the thermal recognition range, commanders at all levels can only base the decision on whether a target should be engaged and killed, solely on their situation awareness, or more simply stated, are there any friendly units in the area they wish to engage? Poor communications, navigation, misunderstood orders, and so on, create situational awareness problems, and headquarters often believe an area to be clear of for TOW DET/SECT/PL COMD 3 TOW SIGHT/ CCTAS 13X 3500M TOW NIGHT SIGHT 12X 1500M 1.

CONCLUSION

First night vision is specified and then night vision device is mentioned . Few example of night vision device is given . then working has been mentioned . we have seen the four generation of night vision device and the range of four generations has been mentioned . Table chart is provided for this .Finally we have seen usage of night vision devices .We find that night vision device is useful in both the conditions whether in the presence of ambient light or in case of overcast or cloudy whether .There are so many devices available in the market but in all these devices one thing is common : they produce green light . So in overcast and cloudy whether the performance of night vision devices decreased means the detection range is decreased compared to ambient light such as moonlight or starlight.