Detection Ranges Table for IIT-Based Night Vision Systems

Generations of tubes are one way to classify Night Vision Devices, however individual units should be evaluated by their specific performance attributes.
There are numerous factors that affect the distance for Night Vision Devices. Detection range is when you are able to see if something is there, or you are able to determine that there is movement but not the details of the activity. **Size does matter** - the larger the object is, the easier it is to see. Another contributing factor is the amount of **ambient light** you have (starlight, moonlight, infrared light), the more light, the further you will be able to see.

The detection range of a good Gen 3 can be several times farther than a Gen 1 device. Even the type of device will have a big impact on its detection range; where binoculars are inherently more capable at longer distances. Many clients immediately opt for larger focal lenses to see farther, but other factors must be taken into account, such as the sacrifice to overall field of view, portability, and hands-free operation. Even more important to consider is the quality of the larger focal lenses – the difference between a low cost F/1.8 and a high end F/1.0 lens is night and day.

The data given in this document is approximated and based off an average of collected data of night vision devices with 1X magnification, in green phosphor with a diversity of the type of devices (monoculars, binoculars, goggles) with a number of varying factors such as FOM (resolution, signal-to-noise), F-number and overall quality of lenses, rain, snow, hail, wind, fog/mist/haze, temperature, surrounding landscape, presence/absence of external sources of light and light pollution. The data is an estimation only and used for the purpose of demonstrating a general relationship ONLY.

The factors (and their definitions) provided below are not exhaustive, other factors may also affect low-light performance of a night vision device.

Image Intensifier Tube

- *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 microamperes per lumen (or μA/lm).
- *Resolution* → is the unit's ability to resolve detail in the image. Measured in lp/mm (line pairs per millimeter). Some units give the option of higher magnification, but it is not necessary for effective function of the system. The highest possible resolution is required for accurate target discrimination.
- *Signal-to-Noise* → plays a key role in night vision performance. It is the unit's ability to transfer a strong signal from input to output and is usually referenced as a ratio.

Device's Optics →

The main component being the objective lens, with the main requirement being high light transmittance in visible and near IR spectrum, and hence a low F-Number. Of course the cost of "light power" optic of high quality has an influence on final cost of night vision devices. Some manufacturers equip their NVDs with objective lenses of larger focus distance and low "light power" to get a bigger magnification (3.5 X to 5 X). If you prefer to choose between two devices, all else the same other than magnification, the distance and image you get in a device with just a large focus distance is going to be worse than in items with lesser magnification and greater "light power". This aspect is very important especially for aiming/shooting devices.

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Ambient light and Infrared Illuminator → when image intensifier is used in really dark conditions the quality of the picture on the phosphor screen drops dramatically. The use of IR illuminators is the most cost effective way of getting big increases in intensifier performance.

Fog and Rain → night vision is very responsive to reflective ambient light, therefore the light reflecting off fog and heave rain causes much more light to go toward the night vision device and may degrade performance.

Depth Perception → The information collected from both naked eyes creates an accurate awareness of object distances in three dimensions, known as depth perception. Night vision goggles use a single source to collect light information for both eyes, representing just two dimensions and eliminating depth perception. This is why it is often recommended to use dual tube binoculars for operations that require the highest observational awareness - separate sources collecting light for each eye means depth perception is retained.

Visual comparison is presented in the graph and calculated data are given in the tables below.

Generation/Type	Generation 2+					Generation 3				
Photocathode Sensitivity, µA/lm	500-800+; sensitive to light in infrared spectrum					1300-2400				
Resolution, lp/mm	45-56					57-64				
Signal-to-Noise	18-23					18-25				
Amplification	20,000					40,000				
Type of technology	Multi-Alkali, Micro-channel plate (MCP)					Gallium Arsenide, MCP				
Light Conditions (Lux)	Full Moon (0.1)	1/2 Moon (0.05)	1/4 Moon (0.01)	Starlight (0.001)	Overcast (0.0001)	Full Moon (0.1)	1/2 Moon (0.05)	1/4 Moon (0.01)	Starlight (0.001)	Overcast (0.0001)
Detection of Human (1.8x0.8m), m	630	630	590	390	145	810	810	770	530	200

Generation/Type	XR-5, 4G				
Photocathode Sensitivity, µA/lm	700-800				
Resolution, lp/mm	64-72				
Signal-to-Noise	25-30				
Amplification	30,000-55,000				
Type of technology	Photonis® Technology				
Light Conditions (Lux)	Full Moon (0.1)	1/2 Moon (0.05)	1/4 Moon (0.01)	Starlight (0.001)	Overcast (0.0001)
Detection of Human (1.8x0.8m), m	810	810	770	530	200

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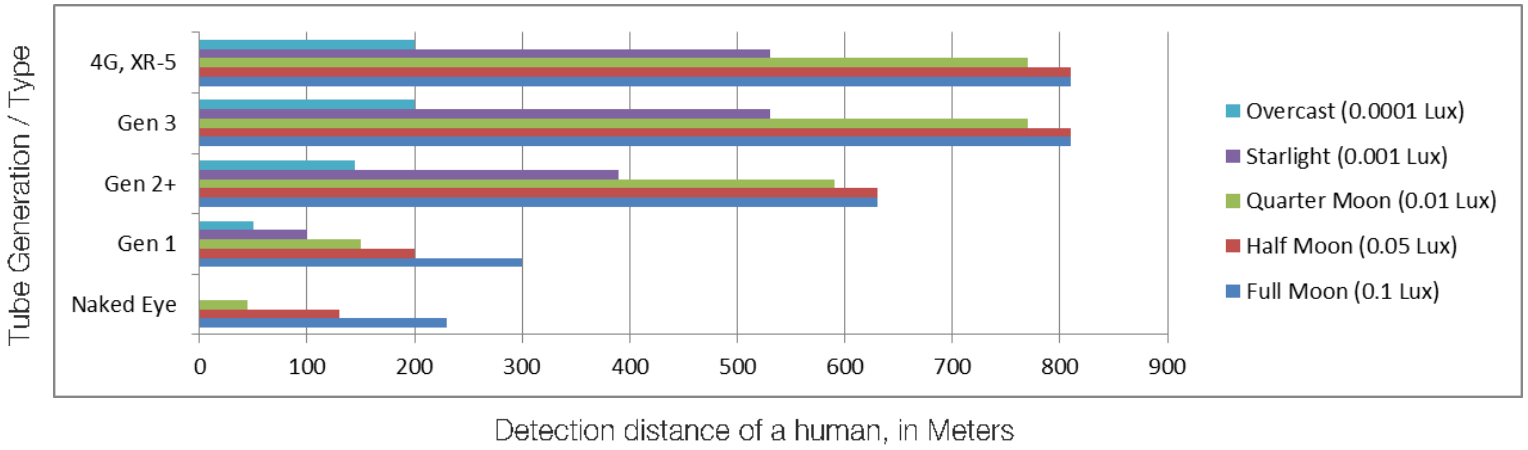

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