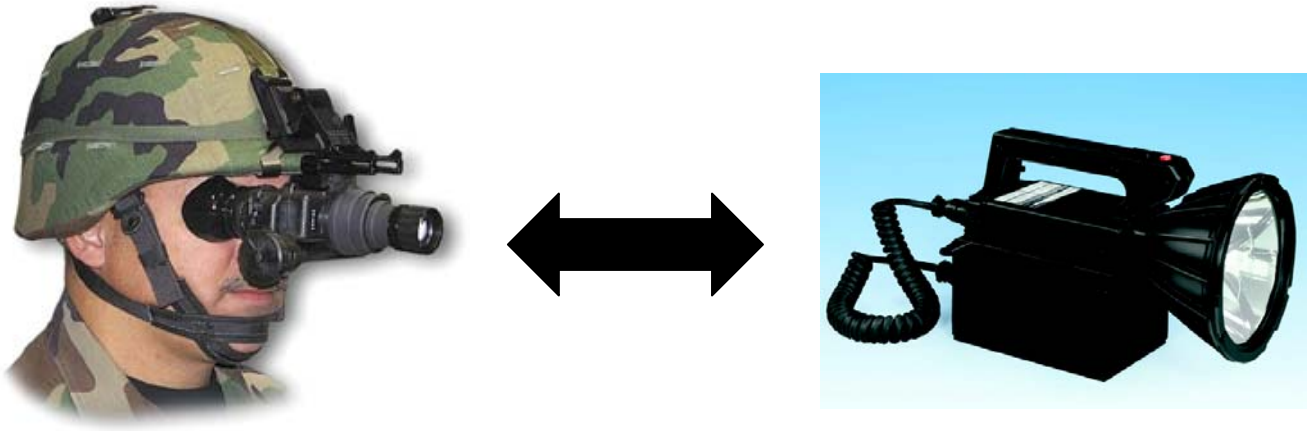
REPORT ON
EXTENDED RANGE PERFORMANCE

USING THE

MAXA BEAM™
INFRARED ILLUMINATOR



Summary and Conclusions:

- **The Maxa Beam™ IR Illuminator, operating at medium power, provides twenty five percent (25%) increase in the range performance of today's Gen2 and Gen3 night vision devices under starlight illumination.**

- **Whereas the same night vision devices may be ineffective inside large buildings, under tree canopy, or in dark alleyways, the Maxa Beam™ IR Illuminator provides the needed supplemental illumination.**

- **The Maxa Beam™ IR Illuminator has an additional "High Intensity" setting which provides an additional twelve percent (12%) resolution and range performance.**

Introduction

Infrared Illuminators, have a unique ability to improve the resolution of objects being observed as well as increasing the distance at which these objects can first be detected and identified. On very dark nights, the illuminator becomes the force multiplier by providing target detection at extended ranges.

In certain law enforcement applications, this can be extremely useful, especially when the humans being observed do not have the equipment to detect near-infrared illuminators. Law enforcement officers encounter many situations where there is not enough illumination for their night vision systems. Examples would be inside large buildings, under tree canopy, or in dark alleyways. In these situations, an infrared illuminator becomes an essential accessory to the night vision devices.

Standard issue night vision goggles and pocketscopes have afocal optical magnifiers available as an option. Afocal means you can attach the magnifier over the 1X (unity magnification) front lens without having to first remove it. The afocal magnifiers typically are 3X and 5X magnification. Much like daylight cameras, the attached afocal lens reduces the amount of illumination reaching the image intensifier tube, thereby, decreasing resolution under low light conditions.

There are performance models developed by the US Army Night Vision and Electronic Sensors Directorate (NVESD) located at Ft. Belvoir, Virginia, which predict performance of these devices. There is also a standard, referred to as the “Johnson Criteria”, which defines how much resolution is needed to detect and recognize personnel and vehicle targets. The standard resolution target for measurement of system resolution is the USAF-1951 Resolution Target. We will use the USAF-1951 target and take resolution measurements with and without the use of a powerful near-infrared illuminator. Then, we will apply the “Johnson Criteria” to show the performance improvement against personnel and vehicle targets. At 50% Probability, the criteria for detection of a man, or vehicle, target is 0.75 cycles on the target. For recognition, at 50% probability, the criteria is 2.0 cycles for a man target and 3.0 cycles for a vehicle target.

Test Objective

To scientifically evaluate the improvement in detection range of human and vehicle targets when using the Maxa Beam™ Searchlight from Peak Beam Systems, Inc. and attached Near-Infrared Filter (850 nanometers) in conjunction with handheld intensified night vision devices with attached afocal magnifiers

Description of the Test Items

The night vision devices used in this test are shown and described in this section. The 3X and 5X magnifiers fit on the NVG and on the MNVD devices. All devices are 1X magnification and nominally 40 degree FOV without the 3X or 5X magnifiers. The 3X magnifier reduces the 40 degree FOV to 13.3 degrees, while increasing magnification to 3X. The 5X magnifier reduces the 40 degree FOV to 8 degrees, while increasing magnification to 5X.

AN/PVS-7D, Night Vision Goggles (NVG)

This NVG is widely used by military and law enforcement agencies. Over 200,000 units have been produced. The early versions were designated as the AN/PVS-7B (Bravo), with the –C (Charlie) and –D (Delta) versions in later production. All versions accept the 3X and 5X magnifier lenses.

AN/PVS-14, Monocular Night Vision Device (MNVD)

The MNVD provides leaders of combat infantry units with a lightweight night vision device. The MNVD is used in observation and command and control missions. It may be used by the soldier in several modes: hand held, head mounted, helmet mounted or affixed and boresighted to a rifle with aiming light. For longer range observation missions, a 3x magnifier or 5X magnifier is available.

ITT Model 6015, Monocular Night Vision Device (MNVD)

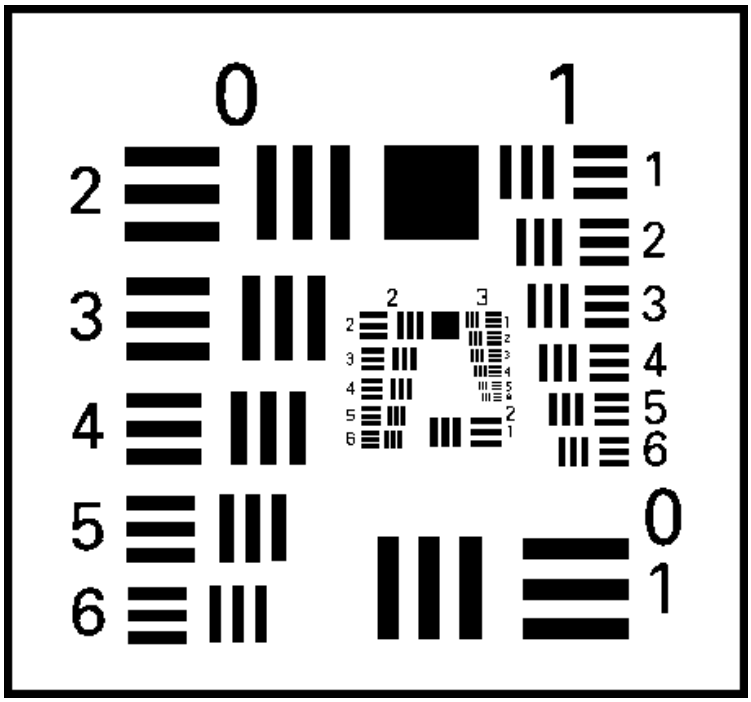
This monocular is a commercial device, which uses a military style image intensifier tube. This unit can be handheld, as well as helmet, head, or weapon mounted.

3X Afocal Magnifier Lens Assembly (Shown on AN/PVS-7D)

5X Afocal Magnifier Lens Assembly (Shown on AN/PVS-7D)

USAF-1951 Test Target and the "Johnson Criteria"

The test target and range analysis tools are discussed here. These tools will be used in data analysis later in this report. The USAF-1951 Test Target is often referred to as a 3-Bar target. The target consists of multiple "elements", each of which is a pattern of three horizontal and three vertical bars. The "elements" are arranged into "groups" of six elements each. Each subsequent element is larger, or smaller, by a factor of the square root of two (1.41421). The "groups" and "elements" are numbered. A sample target is shown below:



In the target shown above, the width of one dark bar and one white space is defined as a "Line Pair". When resolution measurements are made at an outdoor range, the distance from the observer to the USAF-1951 target must be a measured distance. The measurements are then reported as angular resolution, where the units are Line Pairs per milli-radian (LP/mr). Note that a Line Pair is also called a "cycle", such that we could use the units cycles per milli-radian (cy/mr).

The "Johnson Criteria" was developed by NVESD to enable resolution measurements to be converted directly to target detection and recognition ranges. This simplified calculation does not take into account losses due to atmospheric conditions and should not be used for extended ranges. The chart is based on probability of detection or recognition of targets. At 50% probability, one half of a group of observers would detect or recognize the target, but the other half would not. The 50% point is used for most calculations of range, since it represents the average observer. At 50% probability, the target must subtend 0.75 Line Pairs (or cycles) for detection of a single person or a vehicle. Target size is defined as the average of the target height and width. A man target is therefore 0.8 meters (2m tall x 0.4m wide) and a vehicle target is 2.3 meters (2.3m tall x 2.3m wide) in size.

Test Location

On November 20, 2000 an airstrip, located at the decommissioned Philadelphia Naval Yard, was made available for our use. The airstrip provided an unobstructed line-of-sight with minimal light pollution from streetlights, etc. Several locations were surveyed and measured in order to provide a direct line-of-sight between the illuminator and the target scene at well defined distances.

Test Methodology

Independent data collectors, using calibrated measuring devices, were tasked to perform test and collect the data. The data acquisition sequence was as follows:

(1) At each target range the targets were observed with the naked eye.
(2) Each night vision device was tested using only ambient light available.
(3) Each night vision device was tested again with the illuminator aimed at the target.

Personnel and vehicle targets are the primary interest of our customer base. The resolution data will be translated into target ranges using the "Johnson Criteria". The collection of data was performed in a scientific manner, noting temperature, weather/atmospheric conditions, moon phase, etc. The objective is to obtain accurate data which can be employed by users of night vision equipment to assess the need for the Maxa Beam™ product.

1. The test was performed by taking resolution readings from a standard USAF-1951 Resolution Chart. The readings were taken at measured distances, and the target was verified to conform to the USAF-1951 standard.
2. The test data was collected using two observers. If the two observers did not agree, the lower reading from the resolution test target was recorded. Both observers had approximately 20/20 vision and neither wears corrective lenses.
3. The collection of data was witnessed by an independent observer, Mr. Christopher Voth of Solar Light Company, Inc., who testifies that the collected data was based on a fair comparison of the test units.
4. The collected resolution data was converted to a value in cycles/milliradian, which represents angular resolution.
5. The angular resolution values were converted to target detection and recognition ranges for a man target and a vehicle target. This conversion was performed using the "Johnson Criteria", developed by the U.S. Army Night Vision Laboratory.

Resolution Test Data

The following spreadsheet provides tables of the collected test data and range performance calculations using the "Johnson Criteria". The performance of selected night vision devices are documented with and without the Maxa Beam™ Searchlight.

Maxa Beam™ IR Illuminator Evaluation Data

Test Date: 20-21 Nov. 2000	3X Afocal Lens						5X Afocal Lens					
	100m RANGE		Range Performance, Meters				100m RANGE		Range Performance, Meters			
			Detection		Recognition				Detection		Recognition	
SYSTEM DESCRIPTION	**Res.**	**Cy/mr**	**Man**	**Veh**	**Man**	**Veh**	**Res.**	**Cy/mr**	**Man**	**Veh**	**Man**	**Veh**
PVS-7, Gen 3-OMNI IV Tube												
No Maxa Beam	-6, 6	2.78	3996	7993	1599	2131	-5, 1	3.13	4499	8999	1800	2400
Maxa Beam - Normal	-5, 2	3.51	5146	10293	2059	2745	-5, 3	3.94	5664	11328	2266	3021
PVS-7, Gen 2 Tube												
No Maxa Beam	-6, 4	2.21	3171	6354	1271	1694	-6, 6	2.78	3996	7993	1599	2131
Maxa Beam - Normal	-6, 6	2.78	3996	7993	1599	2131	-5, 1	3.13	4499	8999	1800	2400
PVS-14, Gen 3-OMNI IV Tube												
No Maxa Beam	-6, 6	2.78	3996	7993	1599	2131	-5, 2	3.51	5146	10293	2059	2745
Maxa Beam - Normal	-5, 2	3.51	5146	10293	2059	2745	-5, 3	3.94	5664	11328	2266	3021
ITT Model 6015, Gen 3 Tube												
No Maxa Beam	-6, 6	2.78	3996	7993	1599	2131	-5, 1	3.13	4499	8999	1800	2400
Maxa Beam - Normal	-5, 3	3.94	5664	11328	2266	3021	-5, 3	3.94	5664	11328	2266	3021

Comparison of Night Vision Devices With/Without the Maxa Beam™ IR Illuminator

The Maxa Beam IR Illuminator provided significant improvements to resolution and range performance compared to the same device without the aid of the Maxa Beam IR Illuminator. The percentage improvement was as follows:

Night Vision Device	% Improvement at 3X	% Improvement at 5X
AN/PVS-7, Gen 3	+26.3%	+26%
AN/PVS-7, Gen 2	+25.8%	+13%
AN/PVS-14, Gen 3	+26.3%	+12%
ITT Model 6015, Gen 3	+42%	+26%

NOTE: The “High Intensity” setting available only on the Maxa Beam IR Illuminator provides an additional 12 percent increase in resolution and range performance beyond the numbers shown above.