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HAND HELD SEARCHLIGHT
TEST REPORT

NAVAL SURFACE WARFARE CENTER CRANE DIVISION
DEFENSE SECURITY SYSTEMS DEPARTMENT (CODE 404)
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CRANE, INDIANA 47522-5001

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1.0 PURPOSE

The purpose of this report is to provide the results of a comparative test of two models of hand held searchlights; the Maxa Beam from Peak Beam Systems Inc., and the Xenonics NightHunter. The test was conducted in accordance with NSWC Crane 4042-TP-050201, Hand Held Searchlight Test and Evaluation Procedure for the technical assessment of hand-held searchlights and support accessories. The procedure is based on the mandatory minimum requirements established in the CCNO (OPNAV N34), "Force Protection Hand Held Searchlight Performance Requirements" document of April 15, 2001, and the evaluation criteria of the "Abbreviated Source Selection Plan (ASSP)" for searchlights established by COMNAVSEASYSCOM (Code 04L).

1.0 APPLICABLE DOCUMENTS

References:

a. Firm Fixed Price Abbreviated Source Selection Plan (GAMMA)
b. OPNAV N34 Force Protection Hand-Held Searchlight Performance Requirements
c. NSWC Crane 4042-TR-050201, Hand Held Searchlight Test and Evaluation Procedure

3.0 RATING CRITERIA

Items under test shall be assessed one of four ratings for each evaluation factor as detailed in the SSP. Other product enhancements or performance elements that exceed the solicitation requirements and are beneficial to the government will be noted.
Ratings:

- Exceeds performance requirements, where excess performance would be beneficial to the Navy. (3)
- Meets performance requirements. (2)
- Meets most of the requirements. (1)
- Fails to meet requirements. (0)

4.0 TEST PERSONNEL

All testing was performed or coordinated by Naval Surface Warfare Center (NSWC) Crane, Shipboard Physical Security Branch, Code 4042 personnel. The Crane Night Vision and Chem/Bio sensors Department, Code 805, provided assistance and test equipment for the infrared portions of the test.

5.0 TEST CONDITIONS

Battery duration and light intensity testing were conducted indoors. Ambient temperature range for indoor testing was between 68 and 74 degrees F. Lighting consisted of indirect

fluorescent office light fixtures with ambient levels of 60 foot candles (ft-cd) or less. Outdoor tests, including the IR illumination and long range (1.5 mile) illumination tests, were performed the night of June 25, 2001 between 2100 and 2400 hrs. Conditions in the region were clear, temperatures ranged from 59 to 65 degrees F during the hours of the test. The Bloomington, IN airport listed visibility between 8 and 10 miles. The moon was less than a quarter full, between the last quarter (6/14) and first quarter (6/28) phases.

6.0 UNITS UNDER TEST

See Appendix 1, "Test Unit Configurations'

7.0 REQUIREMENTS

Requirements for searchlights and accessories are as specified in Reference (b). For the purpose of this report requirements are separated into General requirements and Performance requirements.

General requirements establish basic product or component characteristics and features considered necessary in any searchlight for the intended application. General requirements are listed in Section 7.2, test results are found in Section 9.1.

Performance requirements consider features where different products may exhibit significantly different operational characteristics and where testing may be useful in establishing baselines for the purpose of product comparison. Performance requirements are listed in Section 7.3, test procedures for requirement verification are in Section 8, test results are found in section 9.2

7.1 Kit Contents Requirements

Hand-held Xenon Searchlight
Rechargeable Battery Pack
Battery Carry Strap
Power Cord
Battery Charger
Protective Lens Cover
Covert Infrared Filter
Filter Pouch (1 per filter)
Maintenance Kit
Instruction Manual/Training Video
Waterproof carrying/storage case
Amber filter
Rechargeable Battery Belt Pack Option

7.2 General Requirements

7.2.1 Hand-held Xenon Searchlight
Requirements include: visible and infrared (IR) operation, Strobe capable, portability of searchlight and accessories using straps or belts, short arc Xenon lamp with 5600 – 6000 degree K color temperature lamp life 500 hrs minimum, mfgr. ID plate with serial/model number, etc., and safety or references shall be indicated with a warning label if applicable.

7.2.2 Rechargeable Battery Pack
Battery must have a high impact weather resistant shell, including quick release mechanism from the light without tools. There can be no external contacts capable of accidental discharge, and the battery must be able to sustain 500 charge/discharge cycles.

7.2.3 Battery Carry Strap
Strap must be adjustable, high strength, weather resistant.

7.2.4 Power Cord
Cord from battery pack to light must have a length of five ft. minimum uncoiled and include self-captivated and polarized connectors.

7.2.5 Battery Charger
A 12VDC output recharging unit must be available. The recharge unit must operate on either AC (110-240V 50-60Hz) or DC (12-32V), connectors must be self captivated and polarized. The charger must provide a maintenance charge to maintain a full battery. It must be capable of vertical/bulkhead mount and be capable of holding a battery or battery and searchlight when mounted.

7.2.6 Protective Lens Cover
Cover must pass 95% light from lamp and snap over lamp/reflector securely without tools for installation or removal.

7.2.7 Covert Infrared Filter
At least one filter in the 800-900 nanometer (nm) range must be included and must be designed to snap over lamp/reflector securely without tools for installation or removal.

7.2.8 Filter Pouch (1 per filter)
Pouch must be attachable to belt or strap and be water resistant. Velcro type preferred.

7.2.9 Amber filter
At least one filter in the 500-600nm range for reduction of backscatter in fog must be included. The filter must snap over the lamp/reflector securely without tools for installation or removal.

7.2.10 Rechargeable Battery Belt Pack Option
Rechargeable battery packs must be capable of carrying batteries sufficient to operate the light with performance stated in Section 7.3.4 and 7.3.5. Battery belt must be adjustable.

7.3 Performance Requirements

7.3.1 Searchlight must provide at least 2,000 foot-candles (ft-cd) of illumination measured 50 feet from the lens.
(Reference Procedure 8.1.1)

7.3.2 Searchlight must illuminate a target at a distance of 1.5 miles minimum with a beam of visible light under clear conditions.
(Reference Procedure 8.1.2)

7.3.3 Searchlight must have capability for spotlight and for continually variable width beam. Beam width spot size at a distance of 100 ft. must be variable from 2 ft. to 17 ft.
(Reference Procedure 8.2)

7.3.4 Integral battery must sustain operation for 60 minutes at normal usage setting, 90 minutes preferred.
(Reference Procedure 8.3.1)

7.3.5 Battery belt must sustain operation for 60 minutes at normal usage, 90 minutes preferred.
(Reference Procedure 8.3.2)

7.3.6 Continuous nighttime operation is required. Kit must contain a sufficient number of chargers and batteries to provide continuous nighttime operation by recharging and exchanging batteries. Full recharge time no greater than 2x discharge time.
(Reference Procedure 8.4)

7.3.7 Hand held portion of searchlight shall be lightweight, with preferred weight of no more than 4 lbs.
(Reference Procedure 8.5)

7.3.8 Multiple intensity settings for battery preservation must be available from the same switch set. Same switch/switch set must be capable of changing mode from steady to strobe. Capability to preset beam width and strobe rate at start-up is preferred. Operation must be possible with gloved hands.
(Reference Procedure 8.6)

7.3.9 IR filter must provide illumination of objects and enable signaling at a distance of 1000m minimum when used with night vision goggles under clear conditions.
(Reference Procedure 8.7)

7.3.10 Searchlight shall be designed for ease of handling.
(Reference Procedure 8.8)

7.3.11 Storage case shall be capable of storing all parts and accessories described herein, cushioned and compartmentalized, ruggedized, and equipped with wheels and handles if total weight exceeds 50 lb.
(Reference Procedure 8.9)

7.3.12 Searchlights, compartmentalized cases, and accessories intended for field use shall be capable of satisfying all operational requirements during and after exposure to rain, spray or splash. All controls shall be water-resistant and show no evidence of being adversely effected by moisture or exposure to adverse weather conditions.
(Reference Procedure 8.10.1)

7.3.13 Searchlights and accessories shall be designed so that under rough use there is no damage to the lamp reflector or any internal parts.
(Reference Procedure 8.10.2)

7.3.14 Materials used in the fabrication of the searchlights and compartmentalized cases shall be corrosion resistant or treated to resist corrosion. All parts shall be clean, free from rust, tool marks, pits and other injurious defects. External edges shall be free of burrs, sharp edges and corners.
(Reference Procedure 8.11)

7.3.15 Searchlights must be eye safe for normal use. An independent safety report certifying the eye safety of the units shall be provided. In addition this documentation shall describe conditions of use and disclose any potential hazards associated with the operation of the searchlights.
(Reference Procedure 8.12.1)

7.3.16 An instructional manual, written in English, detailing the proper operation and routine maintenance of the searchlight system shall be provided with each kit. Inclusion of an instructional video is desired.
(Reference Procedure 8.12.2)

7.3.17 A maintenance kit must be available and must contain at a minimum: a replacement lamp, replacement primary lens, and replacement power connector if applicable. Maintenance instructions, parts, supplies, safety equipment and specialized tools for field repairable parts shall be included.
(Reference Procedure 8.13)

8.0 TEST PROCEDURES

Test procedures originally developed in Reference (c) are restated here. The intent of the procedures is to verify the requirements as set forth in References (a) and (b) and outlined in Section 7.3 above.

8.1 Beam intensity

8.1.1 Maximum intensity
Turn on lamp and operate at rated wattage. Focus lamp to smallest beam on a calibrated detector located 50 feet from the optic. Move the detector around within the beam until the highest reading can be achieved. Measure the value in foot-candles and record. If the light has a switch for multiple beam intensities, measure and record intensity at each setting.

8.1.2 Long range capability
Establish a target structure or area approximately 1.5 miles away from light source. Turn on lamp and focus to smallest beam, switch to high power beam. Verify visibility of target and record.

8.2 Beam spread
Focus lamp to smallest beam on a flat surface perpendicular to the beam, located 100 feet from the optic. Measure diameter of light spot and record. Increase beam width to maximum. Measure diameter of light spot and record. Record clarity and uniformity of beam, note any edge effects at each setting.

8.3 Battery duration and configuration
8.3.1 Integral Battery
Use a fully charged battery attached directly to hand held unit, not an unattached battery pack. Operate light at normal intensity with battery attached. Measure peak intensity at a distance of 50ft as described in procedure 8.1a and record. Repeat measurement every 10 minutes until battery is discharged. Record time to discharge.

8.3.2 Battery Belt
Remove battery and attach light to a fully charged battery belt pack, if available, with a power cord of 5 feet minimum length. Operate light at normal intensity with battery attached. Measure peak intensity at distance of 50ft as described in procedure 8.1a and record. Repeat measurement every 10 minutes until battery is discharged. Record time to discharge.

8.4 Battery charging system
Configure light for continuous portable night operation, as by a night watch stander. Record configuration. Based on manufacturers' data on charge/discharge time, establish the number of chargers and batteries that are required for continuous operation. Visibly number the batteries or establish other unique means of identification, plug in chargers and verify operation. Attach light to the first fully charged battery/battery pack, operate light at normal intensity until the battery is discharged, record time to discharge. Disconnect light from discharged battery and connect light to a second battery that is fully charged. Place first battery in battery charger and record time required to fully recharge. Repeat sequence as required to keep light continuously operational by replacing discharged batteries with ones that are freshly charged. Record discharge time for each battery. Re-install first battery after it has been fully charged and the last battery has been fully discharged. Test is

complete when first battery has been discharged in the light under normal operation for a second time. Record the number of battery exchanges and total time of the test.

8.5 Weight
Weigh hand held portion of light in normal operating configuration, including clear protective lens. Removable battery and cord should not be included unless required for normal operation. Place on a commercial quality scale with at least 0.1 lb gradations. Record results. Record weight of alternate portable configurations, including light with attachable battery and battery belt if applicable.

8.6 One-hand operation of controls
Verify that all controls are operable using one hand only. Controls should include at least: On/Off, switching to preset beam intensities, beam width adjustment, and strobe function. Testing shall be performed both with and without work gloves.

8.7 Infrared operations
Establish a man sized target approximately 1000 meters away from light source. Install infrared filter in the 800nm to 900nm wavelength range. Turn on lamp and focus to smallest beam. Switch to high power beam momentarily and illuminate target. Verify visibility of target using night vision goggles and record. If target is visible at 1000m, move target further away in 100m increments, illuminate and record results. Repeat to a distance of 1600m, or until target is no longer detectable.

8.8 Ease of use
Test shall consist of performing tasks required for normal use of light features and establishing ease of use to the operator. Judgement regarding ease of use should consider basic ergonomic features and the time required to change or adjust the light to alternate configurations or operating modes. Items to be considered shall include a minimum of: switch/control operation, programming of controls or settings if applicable, battery installation/replacement, battery charger use, installation of lens covers and alternate lenses, identification/readability of control settings, indicator lights, cord connections, and adjustability of belts and straps.

8.9 Storage system
Record weight, type and number of latches, thickness and type of exterior case and inside cushioning material. The case shall be water resistant and shock resistant and shall be tested in accordance with Section 8.10.

8.10 Environmental ruggedness
8.10.1 Water Resistance
Water tightness test shall consist of spraying the unit with water from all directions from a low pressure/volume source. Testing should be performed in all operational battery configurations. The light should be operational during and following the conclusion of the test. The storage case and contents shall also be protected against windblown dust and rain,

and splashing water. Spray test the case from all angles as described above. Open case and inspect interior upon completion, record results and extent of any water intrusion.

8.10.2 Shock Resistance
The light shall be drop tested both with and without attachable battery packs. The light, including clear protective lens cover, if applicable, shall be dropped from a height of 30 inches on each face and results recorded. Broken lens covers may be replaced if necessary. Verify the condition of the light after each drop and record. The light must be operable at the conclusion of the test.
The storage case and contents shall be drop tested from a height of 48 inches on each face. The case shall be opened after each drop and the condition of the case and contents inspected and recorded. The light must be operable at the conclusion of the test.

8.11 Materials and Workmanship
Record material types used in external light construction that will be exposed to weather conditions. Note use of corrosion resistant fasteners, materials and coatings. Inspect light and accessories to verify that no corrosion, dirt, sharp edges, burrs, pits, tool marks, etc, are visible.

8.12 Documentation
8.12.1 Eye Safety
Verify that the proper safety documentation is included and that it meets the stated requirements.

8.12.2 Operating Manual
Verify that a manual is included and that it meets the stated requirements.
Note whether or not an instructional video is included.

8.13 Maintenance kit
Verify that a maintenance kit is available and that it meets the stated requirements.

8.14 Other product enhancements beneficial to the government
Special features of the unit under test that are beneficial to the government not tested for in Section 8.0 or listed in the requirement criteria of Section 7.0 shall be noted and recorded.

9.0 RESULTS

This section provides the narrative results of the inspections and tests used to verify the requirements established in Section 7. Numerical and other data collected for the tests is included in the Appendices and referenced when applicable.

9.1 General Test Results
General requirements are typically verified by visual inspection rather than a special test procedure. Manufacturer claims regarding the existence of features that are less critical or

that reflect common industry standards are reported as being available but not tested. The verification of general requirements is summarized in Appendix 8 and product features are rated in accordance with the criteria of Section 3. Testing of some features is beyond the scope of this report. Items not provided by the manufacturer for testing are also indicated.

9.2 Performance Test Results

Results of performance tests outlined in Section 8 are discussed in this section and summarized in Appendix 9.

9.2.1 Beam Intensity

9.2.1.1 Maximum intensity

Beam intensity results are recorded in Appendix 2. As Maxa Beam is equipped with 'X and Y' beam adjustment screws to optimize beam focus, two sets of data were obtained, one before beam adjustment and one after. Loss of XY adjustment is predicted by the manufacturers literature if the unit is subject to rough handling. The post adjustment intensities are about 20% higher at 2310 foot candles (ft-cd). Testing for both units was done indoors in the code 4042 Bunker B-368. Measurements were taken with a digital light meter (Test unit 8, Appendix 3) for both Maxa Beam and NightHunter units. As seen in Appendix 1, the intensity for the Xenonics unit was far lower than that for the Maxa Beam and failed to meet the minimum intensity requirement of 2000 ft-cd at 50 ft. A second light meter (Test unit 9, Appendix 3) was used to verify the results. The scale of the analog meter is not as fine as that for the original unit and requires interpolation, but results were consistent regardless of meter type. Both NightHunter units #1 and #2 were tested with both meters and the results were roughly the same with maximum readings in the 800 ft-cd range. The results are shown graphically in Figure 1. Visible beam intensity was also tested in conjunction with the Infrared test of 9.2.7. Test setup and results are discussed in that section.

9.2.1.2 Long range capability

Field testing of long range visible intensities was accomplished in conjunction with the IR testing of Section 9.2.7. Testing was performed in the NSWC Crane Night Vision Department test tower, a facility constructed for testing Infrared (IR) and Night Vision (NV) devices. Using the range finder (Test unit 7, Appendix 3), a water tower at a distance of 2400m (approx. 1.5 miles) was targeted and illuminated with the searchlights. Each light was switched to high power and focused to its smallest beam and a video camera (Test unit 3, Appendix 3) was set up and focused on the water tower. The camera signal was fed to a Hi8 video tape cassette recorder (Test unit 6, Appendix 3) to capture the images. The video was transferred from the tape to a Compact Disk in MPEG format and individual Bitmap images were extracted with 'Power DVD' software. The Bitmaps were converted to JPEG format using Microsoft Word. The results are shown in Figure 3 of Appendix 4. Both units can illuminate the tower. The Maxa Beam unit is judged to provide greater illumination in this test.

9.2.2 Beam Spread

Beam spread was tested inside a warehouse by projecting a beam onto a wall at 100'. Readings were difficult to obtain with accuracy on the narrow portion of the test, as beams for both searchlights lose edge definition as they approach minimum width. The Maxa Beam is reported to have a 1˚ minimum and 40˚ maximum beam width. At 100' this would be a variation of 1'-9" to about 70'. The NightHunter reports a 1˚ to 15˚ spread or 1'-9" to about 26'. In test, the narrowest beam with a discernable round border for the Maxa Beam was about 2'. The NightHunter was measured to be about 4'. Maximum spreads were about 60' and 30' respectively. Beam clarity and uniformity were similar for both lights, the Maxa Beam does exhibit a dark spot in the center of the beam pattern, most noticeable at wide beam but not significant at minimum width.

9.2.3 Battery duration and configuration

Searchlights were tested to verify that batteries in all configurations will support normal light operation for a minimum of 60 minutes. One Maxa Beam and both NightHunter units, one with the internal battery and one without, were tested and compared. The Maxa Beam attached battery module and battery belt both use the same capacity NiCd battery. The NightHunter batteries for both internal and battery belt application are lead acid, although of a different style. Intensity was measured every 10 minutes to ensure that the quality of light remained constant over the test period. Testing was performed only after batteries were fully charged. For both searchlights, the light shuts off automatically when battery voltage drops to a pre-determined level. Results of this test are recorded in Appendix 5; Figure 2 shows a graph of the results.

9.2.3.1 Integral Battery

Maxa Beam –

The battery that integrates with the searchlight is an external module that locks onto the bottom of the unit and can be released and removed using a lever on the searchlight handle. A short cord is required to attach the battery to the searchlight unit. The NiCd technology is known to exhibit 'memory set' that reduces recharge capacity with each successive use. All batteries were reconditioned one time prior to testing to reduce memory set, a process taking about 24hrs for each battery. The amount and rate of memory development depends on how the light is used, and was not evaluated in this test. As seen in Appendix 5 the Maxa Beam using integral battery lasted 91 minutes, meeting the 60 minute requirement and slightly exceeding the preferred 90 minute threshold.

NightHunter –

The NightHunter is equipped with a battery and recharger that is internal to the unit. The battery can be replaced by unscrewing 3 screws in the back of the unit, removing the back panel and replacing the old battery with the new one. The manufacturer recommends removal and replacement of the internal battery only after its usage lifetime expires and the battery will no longer hold sufficient charge. The NightHunter operated on the internal battery for the required 60 minutes. The intensity of the NightHunter, while significantly lower than that of the Maxa Beam, is more constant over the discharge period dropping 27% vs. 40% for the Maxa Beam.

9.2.3.2 Battery Belt

Maxa Beam –

The batteries in the Maxa Beam belt are the same as those used in the attachable battery module on the searchlight, and use the same charger. The battery module is unplugged removed and the searchlight unit is plugged into the battery belt with a separate cable. As anticipated the performance of these batteries are similar. The battery belt tested has a longer life and showed a higher intensity than the chosen integral battery module. Such intensity and discharge time variations are expected based on battery history. The battery belt lasted 118 minutes, 27 minutes longer than the integral battery. The intensity dropped a significant 45% over the test period.

NightHunter –

The battery belt for the NightHunter also outlasted its internal battery, although by a more significant margin of 55 minutes. The belt life was about the same as that of the Maxa Beam. As with the internal batteries the intensity of the NightHunter operating on battery belt, while significantly lower than that of the Maxa Beam, is more constant over the discharge period dropping only 30%.

9.2.4 Battery Charging System

Batteries were marked, discharged and recharged as described in Section 8.4, keeping the searchlight continuously operational. The times were recorded and are shown in Appendix 6. To keep the searchlights operating continuously the following equipment is required:

Maxa Beam –

Batteries (integral or belt) (3), Multi Chargers (2), 100-240 VAC adapters with cord (2).

NightHunter –

Battery belts (2), 100-240 VAC adapters with cord (1), Power cord/Vehicular adapter (1).

Because the NightHunter battery belt recharge time (average 56 minutes) is less than that of its discharge time (average 101 minutes), considerably less equipment is required to keep the NightHunter operational than the Maxa Beam. The NightHunter configured with the internal battery however takes 160 minutes to recharge making it unsuitable for continuous use, and battery belts must be employed when continuous usage is required. The Maxa Beam average discharge time using the integral batteries was found to be 105 minutes, slightly more than that for the NightHunter. The Maxa Beam recharge average time is 130 minutes using the rapid recharge mode, more than twice that of the NightHunter. Maxa Beam has 3 charging modes: 1) Quick charge mode, which requires the connection of a pigtail cord between the searchlight and the battery. This mode is required for continuous searchlight usage. 2) Reconditioning mode (24 hrs) for the NiCd batteries and a trickle charge mode (14 hrs) are also available.

Some difficulty was encountered while testing the NightHunter because the recharge unit exhibited erratic behavior necessitating an interruption in recharging time data collection.

Once full recharge was indicated however, the batteries appeared to perform normally during subsequent discharge.

9.2.5 Weight

The weight of the searchlights, batteries and carrying cases were measured using calibrated scales (Test units 10, Appendix 3). Results are recorded in Appendix 7. The NightHunter, with and without the integral battery weighs 10.9 and 6.1 lbs., respectively. The desired weight for the searchlight without battery is 4 lbs or less, the NightHunter therefore exceeds the weight guideline by approximately 35%. It exceeds the weight of the Maxa Beam by 46%. The Maxa Beam, with and without the integral battery, weighs 8.8 and 3.3 lbs., respectively. Confirgured with searchlight and battery belt only, the Maxa Beam and NightHunter weight totals about the same at 9.9 and 10.2 lbs., respectively. The Maxa Beam total kit weight of 52.5 lbs however far exceeds that of either NightHunter kit, and is considerably larger in size. See Appendix 7 and Figure 4 of Appendix 4

9.2.6 One Hand Operation of Controls

The Maxa Beam searchlight has two buttons that control operation; an on/off button and a four position rocker switch (conditioning switch) that allows automatic adjustment of beam width and intensity. The conditioning switch in conjunction with the on/off switch provides a means of programming/accessing other features such as: strobe, strobe rate, stream and beam width presets. All primary functions are accessible with one hand. The NightHunter has a two position push button. The default for the first push of this button is on/off, which turns the unit on in high intensity mode. Subsequent push and hold actions toggle the switch between high and low power. A quick push and release turns the unit off. No user programmable functions are available on the NightHunter. A fixed strobe mode can be programmed at the factory to replace the low power setting so the unit is ordered either with strobe or without. Beam width is not automatically adjustable from the switch set. The front bezel of the unit must be turned with one hand while the other holds the searchlight. One hand operation is therefore not possible for this function. Both units are operable while wearing gloves.

9.2.7 Infrared Operations

A procedure to test the IR capabilities of the searchlights is outlined in Section 8.7. To perform this procedure, a target consisting of a 2-1/2’ x 3-1/2’ piece of flat white poster board attached to a 6’ step ladder was placed at the end of a straight stretch of road formerly used as an emergency landing strip at NSWC Crane. The rangefinder (Test unit 7, Appendix 3) was used to establish a distance of 1000m, the searchlights were fitted with the IR filters and directed at the target. It was found that while reflective road signs were detectable and the background trees were clearly illuminated, the 1 x hand held scope (Test unit 2, Appendix 3) was unable to resolve the poster board or ladder using either searchlight. Essentially, it was established that a stationary man sized target was not distinguishable at 1000 meters using the 1 x hand held NV scope when illuminated by either searchlight configured with an IR filter. IR Filter documentation shows nearly identical response for both searchlights, with a steep cutoff of visible light between 800 and 900 nm wavelengths

(not tested). The filters are identified as being 850 nm. A larger target was then selected to perform an IR illumination test that would better quantify the relative intensities of the searchlights operating in the IR mode. Testing was moved to the Crane Night Vision Department test tower where a test target at 1000m was already in place for testing IR cameras. Test conditions are described in Section 5.0. The searchlights were fitted with the IR filters and directed at the target. Three NV sights and a visible light camera (Test units 1-4, Appendix 3) were set up and their signals fed into the video multiplexer (Test unit 5, Appendix 3) and recorded on Hi8 tape on a video recorder (Test unit 6, Appendix 3). As described in Section 9.2.1.2 the video was transferred to CD and pictures of the test were extracted. Figure 5 of Appendix 4 shows the results. The Maxa Beam IR output is judged to be higher than that of the NightHunter for this test.

The same equipment setup was used to test the visible light reflected from the target for both searchlights. The results are shown in Figure 6 of Appendix 4 where again the Maxa Beam output is judged to be higher relative to that of NightHunter in the visible light range.

To further examine searchlight IR capabilities, testing was moved to lake Greenwood at NSWC Crane. Standing on one shore, trees and background vegetation on the far shore were ranged at approximately 1600 meters, or about one mile, with the rangefinder. The trees were easily visible with the handheld scope when illuminated by either searchlight with the IR filters installed. The Maxa Beam is again judged to be brighter relative to the NightHunter for this test but either spotlight could be used for IR signaling up to at least one mile.

9.2.8 Ease of Use

Several features were considered as related to their ease of use and impact on operator efficiency:

-Time required to change or adjust the light to alternate configurations or operating modes and switch/control operation:

Changing operations is straightforward with the NightHunter. There is one control button, two intensities, and no external battery or cords when used without the battery pack. To use the battery belt, fasten it around the waist and plug the cord from the belt into the back of the searchlight. The Maxa Beam is relatively feature rich with more components and possible modes of operation than the NightHunter. For basic operation, the operator needs to be familiar with 4 positions on the toggle switch (fwd., back, left, rt.) to control beam spread and three light intensities. The battery must be affixed to the unit, and a cord must be attached between the battery and the light. To use the unit with the battery belt, the battery and cord must be removed, the battery belt fastened around the waist and a separate cord run between the light and belt.

-Programming of controls or settings:

The NightHunter has no user programmable features. The Maxa Beam has 10 programmable features/modes. Programming is accomplished by the sequential pressing of the on/off switch and conditioning switch in predetermined patterns. Instructions on

reprogramming are included in the operators manual. The instructions are reasonably easy to follow but are too numerous to easily remember more than a few.

-Battery installation/replacement:
The NightHunter internal battery is reported by the manufacturer to last 500 discharge/recharge cycles (not tested) before replacement is required. Replacement should therefore be relatively rare depending on usage. Replacement is not difficult although wires attached to the back plate connectors need to be guided, somewhat precariously, back into the light at reassembly to prevent them from being crushed when the plate is retightened. At disassembly, the wiring exhibited a scrape and other signs of stress. An Allen type wrench is provided for back plate removal.
The Maxa Beam has no internal battery and batteries are easily locked in and removed. At end of battery life, also reported by the manufacturer to be 500 discharge/recharge cycles (not tested), batteries are disposed of and replaced.

-Battery charger use:
Battery charger use is outlined in Section 9.2.4. As indicated, two recharge units and two AC to DC converters are required to keep Maxa Beam continuously operational. While the charger itself has bulkhead mount mounting capabilities, the converter units do not. The searchlight and battery snaps easily into the wall mounted charger and can be held in place with an adjustable strap. The NightHunter recharging scheme is simpler and requires only one re-charger when used with the battery belt. The NightHunter is not provided with bulkhead mount capability.

-Installation of lens covers and alternate lenses:
The alternate lenses of the Maxa Beam can be attached and removed quickly over the front lens with about a 1/8 turn. No problems were encountered with the lenses coming loose, although this was not specifically addressed in this test. The NightHunter lenses are threaded, and screw onto the front of the searchlight with between 2 and 3 turns making their application slightly more difficult. No light leakage was apparent around the lenses for any of the units. The Maxa Beam lenses provided for the test were marked by hand with the part number for identification, those for NightHunter were not.

-Identification/readability of control settings:
Neither unit offers an indication to the user of beam intensity or other programmable feature settings. Neither the on/off switches nor the Maxa Beam conditioning switch are marked.

-Indicator lights:
The Maxa Beam is provided with a small indicator light on the unit to show the user that the light is turned on. This is useful when the IR filter is in place and no visible light is emitted. The NightHunter has no such indicator. The NightHunter is equipped with a small light near the charging connector. Flashing or solid green indicates charging status. The NightHunter battery belt charger has a graduated indicator system showing 50, 80 and 100% charge as the battery is recharged. The lights flash if a problem occurs but this is not

explained in the provided documentation. Charging status for Maxa Beam is indicated by a light on the charger that has multi-color capability in red, yellow and green (solid and flashing in each case) to handle the three different charging modes. The failure mode, flashing red, is described as such in the manual and Quick Reference card.

-Cord connections:
The NightHunter is provided with connectors that easily push on and snap in place; they are removed by turning a quarter turn and pulling. Cords from the charger and battery belts have the same male end that plug into the searchlight. There are several Maxa Beam cables. One attached to the AC to DC converter that plugs into the charger, another attached to the charger that plugs into the searchlight during rapid charging, one to connect the battery belt to the searchlight, and another that connects the searchlight to the battery in normal operation. The cords push into keyed receptacles and are captured with threaded rings. The connectors are keyed to prevent accidental misuse. Sorting out the male and female ends however, and matching up the connector keys is considerably more cumbersome in the Maxa Beam than the simple arrangement of the NightHunter. Vehicular adaptors are included in both searchlight kits.

-Adjustability of belts and straps:
Several issues were apparent with the application of the carrying straps and battery belts on both units. One of the battery belts supplied with NightHunter when adjusted to its smallest size, was too large for a person with a waist of 34 inches or less. The other belt adjusted down to only a slightly smaller size. The Maxa Beam belt had a wider adjustment range. A different problem was encountered with the shoulder straps. The strap provided with the Maxa Beam connects only to the battery making it unusable when the integral battery is removed and the searchlight is configured with the battery belt only. Also, the strap hooks onto the lugs at the corner of the batteries making the unit unbalanced when the strap is attached. The NightHunter strap connects directly to the searchlight and has quick release ends making it easier to attach to the unit. It is noted that the NightHunter unit without the internal battery (battery belt operation) is unbalanced and awkward to hold for very long without the use of the strap.

9.2.9 Storage System
The cases for the two NightHunter units provided are identical. At 20 and 13 pounds for the units with and without internal battery respectively, and roughly 7” x 13” x 16” (H,W,D) in size, they are easily transported and hand carried. Cases are high impact black plastic with 2 front latches and a watertight gasket for the lid. The inside is lined with a tough closed cell foam with cutouts for the equipment. The cases could be slightly larger to adequately store the equipment. The Maxa Beam case is nearly identical in construction, material, and type of latches, handles and lid gasket. There are a total of four latches and three handles. Transportability is somewhat more difficult for the Maxa Beam. The loaded case weighs about 54 pounds and is roughly 14” x 20” x 24” (H, W, D) in size. The case is provided with wheels and a retractable handle for pulling. The interior is lined with an open cell foam that is not quite as durable as that used in the NightHunter case. The lining is torn fairly

easily and some of the cutouts are a bit small for the equipment.

9.2.10 Environmental ruggedness

9.2.10.1 Water resistance

Both the Maxa Beam and NightHunter were sprayed with water from all directions from a low pressure sink type sprayer. These units were turned on and sprayed from all sides. No adverse effects on operation were detected. The lights were cycled on and off several times and worked normally. The storage cases were latched and sprayed on all sides. The cases were all completely dry on the inside when opened.

9.7.10.2 Shock Resistance

Nighthunter-

The NightHunter storage case and contents (Unit 1 of Appendix 1), were dropped onto a linoleum covered concrete floor on each face from a height of 48". The case suffered no visible damage and no physical damage was evident on the searchlight. The light was turned on after the first drop and it worked properly. When turned on after the last drop however the light did not respond. The back plate was removed and a wire lead connected to the remote push button connector had broken off. When the wire was reattached, the unit functioned properly.

The second part of the test consisted of dropping the searchlight to the floor from 30". Upon hitting the floor the light split into two pieces just behind the aluminum bezel. The body suffered additional small splits and some fragmentation, but the lamp and front lens remained intact. The test was considered completed and no additional drops were made. Figure 7 of Appendix 4 illustrates the resulting damage.

Maxa Beam-

The Maxa Beam case and searchlight were subjected to the same procedure. The case and all contents were dropped 48" onto the floor. After the first drop no physical damage was evident on the searchlight, however, when turned on the beam was set in a wide focus pattern. Attempts to refocus the beam were unsuccessful as the automatic focus mechanism failed to respond to the switch. After drops all sides of the case the searchlight would turn on but the focus mechanism remained disabled. The plastic box containing the maintenance kit was also found to be broken after the last drop. Externally, the case suffered no visible damage. The only physical damage to the case was some tearing of the internal foam partitions.

The 30" drop test was also conducted on the Maxa Beam. A battery was attached to the bottom of the unit and it was dropped onto the floor. The body of the searchlight and the case of the battery remained intact. The red on/off button came off and the Xenon lamp broke off at the base rendering the unit inoperable. The test was considered completed and no additional drops were made. Figure 8 of Appendix 4 illustrates the resulting damage.

9.2.11 Materials and Workmanship

The Maxa Beam searchlight body is made from pressure cast aluminum, with a handle of plastic. Most fasteners are stainless steel. The body of the NightHunter is primarily plastic, with a finned aluminum lamp housing/heat sink. The rear plate is aluminum, attached with stainless screws. Both of the units and their accessories exhibit high quality workmanship externally. No sharp edges, burrs or other safety hazards were observed. The units were not disassembled for an examination of internal workmanship. It is noted that the battery belts for the NightHunter were not uniform in size, nor were the lengths of their attaching cables.

9.2.12 Documentation

9.2.12.1 Eye Safety

Maxa Beam offers an Ultraviolet safety testing report intended to address eye safety but it was not included in the proposal received by Crane. A list of warnings on page four of the Maxa Beam manual states 'Do not look directly into the light at close distances'. The warning does not appear on the searchlight or the quick reference card. The NightHunter proposal includes a hazard analysis of the World Wide Technologies LR-100 searchlight, (not the NightHunter itself) whose optics are reportedly similar to those of the NightHunter. This report indicates potential eye hazard up to 10 meters. This warning is repeated on the quick reference card inside the cover of the stowage box, but not on the searchlight.

9.2.12.2 Operating Manual

An instruction manual, written in English is provided with both units. Both also contain a 'Quick Reference' card detailing proper operating procedures. Both manuals provide adequate information on maintenance, troubleshooting, operation, part numbers, and return or technical assistance. A training video is available for Maxa Beam but wasn't provided for the test. No video is offered for the NightHunter.

9.2.13 Maintenance Kit

A maintenance kit was provided for the Maxa Beam that included; a replacement lamp, replacement primary lens, replacement power connector, maintenance instructions, parts, supplies, safety equipment and specialized tools for field repair. The kit is included in the stowage case. A maintenance kit was not provided for test with the NightHunter unit but is available as a separate item.

9.3 Test Results Summary

Numerical results displayed in Appendices 8 (General Test Results) and 9 (Performance Test Results) should not be added and averaged, as not all categories have the same weight.

9.3.1 General Test Results Summary

In the area of General Requirements Maxa Beam 'met all requirements' in every category. While meeting requirements in some areas, NightHunter was noted as 'meeting most requirements' in others. Deficiencies for NightHunter were noted in the following areas:

Power Cord – Length shorter than 5ft. minimum.

Battery Charger – No bulkhead mounting.
Filters – Screw on instead of snap/quick release.
Filter Pouch – Filters are provided in a plastic box instead of a belt attachable pouch.
Strobe Function – Strobe is available only as a permanent factory programmed function on NightHunter. Strobe in Maxa Beam can be programmed in, or removed from, the searchlight function set by the user.

The amber filter, protective lens cover, and filter storage device for NightHunter were not provided by the manufacturer for testing.

9.3.2 Performance Test Results Summary
The Maxa Beam and NightHunter were rated the same in all categories except the following in which Maxa Beam outperformed the NightHunter:

Maximum Intensity – Maxa Beam intensity measured roughly 2300 foot-candles at a distance of 50 feet vs. about 800 foot-candles for NightHunter. The Maxa Beam is capable of a sharper focus than the NightHunter which partly contributes to the disparity in intensity values. Impact of focus on intensity values is shown by the difference in the Pre and Post 'XY' adjustment values for the Maxa Beam (roughly 1800 vs. 2300 ft-cd). Both lights are capable of illuminating a target at 1.5 miles but the Maxa Beam outperforms NightHunter nearly 3:1 in this category.

Beam Spread – Maxa Beam is capable of a sharper focus than NightHunter. Maxa Beam is capable of projecting a beam of just under 2' diameter at a distance of 100', NightHunter beam diameter is about twice this at about 4'.

Battery Duration – Both lights met the 60 minute battery life requirement in all configurations. Maxa Beam meets the preferred requirement of 90 minute battery duration for both the battery belt and battery integral to searchlight configurations. NightHunter battery belt average depletion time of 101 minutes is just slightly below the 105 average for Maxa Beam. The NightHunter's integral battery however showed 33% less operating life than that of the Maxa Beam.

Weight – Weight of the Maxa Beam both with and without integral battery is less than NightHunter. Without battery the Maxa Beam searchlight weighs 3.3 lbs. vs. 6 lbs for the NightHunter.

One Hand Control – NightHunter beam width is adjusted by manually turning the lens housing, making one hand control impossible for this function. All Maxa Beam functions are controllable with one hand using a multi-positional 'conditioning' switch.

9.3.3 Overall Summary

Both units tested for this report exhibited good to outstanding results for most features tested. In many performance categories, such as: IR capability, ease of handling, stowage container, environmental ruggedness, materials and workmanship and documentation, the units are equally scored. Maxa Beam however outperformed NightHunter to varying degrees in several important areas including: light intensity, beam spread, battery duration, weight, and one hand control. Maxa Beam also outperformed NightHunter in the general requirement categories of: programmability of strobe function, power cord length, battery charger bulkhead mounting, lens/filter attachment method and filter container configuration. Neither searchlight could sustain a 30 inch drop onto a hard surface and remain operational.

Both units tested have strengths and weaknesses. Maxa Beam is more feature rich and offers greater performance in several key areas. While not excessively complex, operation is somewhat more demanding on the user and the unit requires more parts for operation. NightHunter is very simple to operate and the searchlight comes as a single self contained unit without an external battery or cord. The unit comes in a relatively smaller case which enhances portability, and continuous operation can be attained with little additional equipment. The NightHunter however lacks some of the performance characteristics and features required in a shipboard environment. Based on the requirements established for this test the Maxa Beam consistently outperformed the NightHunter in a number of requirement categories. Conversely, in no single category did the NightHunter outperform the Maxa Beam.

Appendix 1
Test Unit Configurations

SEARCHLIGHTS
AND ACCESSORIES

DESCRIPTION	QTY.	MODEL or PART NO.	SERIAL NO.
XENONICS*			
Unit 1			
Searchlight with internal battery	**1**	**70-6000**	**1462**
100 – 240 VAC Adapter and cord	**1**	**23-1001**	**004 X1**
Shoulder strap	**1**	**13-1043**	
Remote control button	**1**	**70-6218**	
Power cord/Vehicular adapter	**1**	**70-6001**	
Filter – 850nm near Infrared (IR)	**1**	**70-6103**	
Screw with locking knob	**1**	**70-6116**	
Storage Case	**1**	**12-1007**	
Operation Manual	**1**		
Quick Reference card	**1**		
Unit 2			
Searchlight (provided without battery)	**1**	**70-6000**	**1478**
Battery belt charger	**1**	**1210A**	
Shoulder strap	**1**	**13-1043**	
Power cord/Vehicular adapter	**1**	**70-6001**	
Infrared filter	**1**	**70-6103**	
Storage case	**1**	**12-1007**	
Operation manual	**1**		
Quick Reference card	**1**		
Battery belt	**2**		

*** Two searchlight kits were provided for test, designated here Unit 1 and Unit 2**
Unit 1 includes the searchlight with internal battery installed
Unit 2 searchlight has no internal battery and is intended for use with the battery belt
Two battery belts provided for testing. Belts are not integral with kits.

Appendix 1
Test Unit Configurations

MAXA BEAM**			
Force Protection Package	**1**	**MBPKG-F**	
Includes:			
Searchlight	**1**	**MBS-410**	**M8608 G2-20**
100-240 VAC Adapter and cord	**2**	**SW-243A**	
#1			**84621**
#2			**84735**
Vehicular adapter	**2**	**MBP-5230**	
Multi Charger	**2**	**MBP-5200**	
#1			**M-1299**
#2			**M-1298**
NICAD Battery	**3**	**MBP-1207-FV**	
#1			**BN7-M9439**
#2			**BN7-M9441**
#3			**BN7-M9440**
Vertical mount kit	**2**	**MBP-5200-VMK**	
5' Coil power cord	**3**	**MBA-8105**	
Battery Shoulder Strap	**3**	**MBA-6005**	
850nm IR filter	**1**	**MBA-1850**	
Amber smoke/fog filter	**1**	**MBA-1500**	
Sacrificial Lens		**1** **MBA-2005**	
Filter Pouch	**2**	**MBA-6100**	
Maintenance kit		**1** **MBA-2400N**	
Adjustment tool		**1**	
Operation Manual	**1**		
Quick Reference card	**1**		
Large wheeled storage case	**1**	**MBA-6400**	
Battery belt pack	**1**	**MBP-1217**	
Battery back pack (demo)	**1**		

**** One searchlight kit was provided for test.**
A battery belt and a battery back pack were provided for testing. Belts/Packs are not integral with kit.

Appendix 2
Maximum Intensity

MAXIMUM BEAM INTENSITY
AT 50FT.

Maxa Beam

Pre adjust	**Digital meter reading**
Max	**824 ft-cd**
Mid	**1442 ft-cd**
Min	**1114 ft-cd**

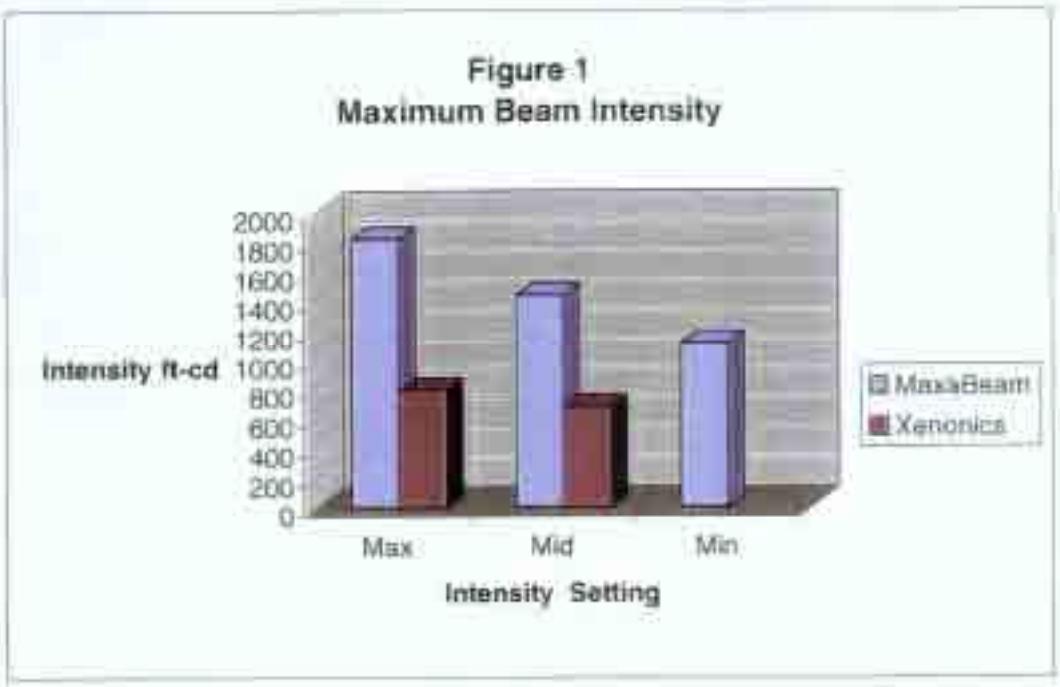
Post adjust	
Max	**2310 ft-cd**
Mid	**1853 ft-cd**
Min	**1519 ft-cd**

	Digital meter reading
Xenonics Max	**797 ft-cd**
Min	**679 ft-cd**

	Analog meter readings (Interpolation required)
Max	**1675**
Min	**1625**

	Cubic Spline Interpolation of analog meter reading
Max	**841 ft-cd**
Min	**593 ft-cd**

Appendix 2
Maximum Intensity



Appendix 3
Test Equipment

TEST EQUIPMENT

	DESCRIPTION	NOMENCLATURE	REMARKS
1	**Night Vision Sight**	**SU-88/TVS-5**	**Camera 1**
2	**Submersible Monocular Night Vision System**	**AN/PVS-18**	**Camera 2**
3	**Camcorder (visible)**	**Sony NPF960**	**Camera 3**
4	**Long Range Night Vision Sight**	**AN/PVS-8**	**Camera 4**
5	**Video Multiplexer DQ441**	**GYYR**	
6	**Hi MP Video Recorder**	**Sony Video Walkman**	
7	**Laser Rangefinder Class 1 10m 1054 nm**	**Leica Vector 7x42 SFR2**	
8	**Foot Candle/Lux Light Meter, Digital**	**Extech 407026 200-5000 Fc**	
9	**Light Meter Analog**	**Gossen Luna Pro**	
10	**Toledo Scales**		
	0-50 lb	**Lb./Oz Increments**	**+/- 1 oz**
	0-500 lb	**1/2 lb Increments**	**+/- 2 lb.**

Appendix 4
Figures 3.1, 3.2, 3.3
1.5 mile Light Intensity Comparison

Figure 3.1
Tower at 1.5 Miles,
No Illumination

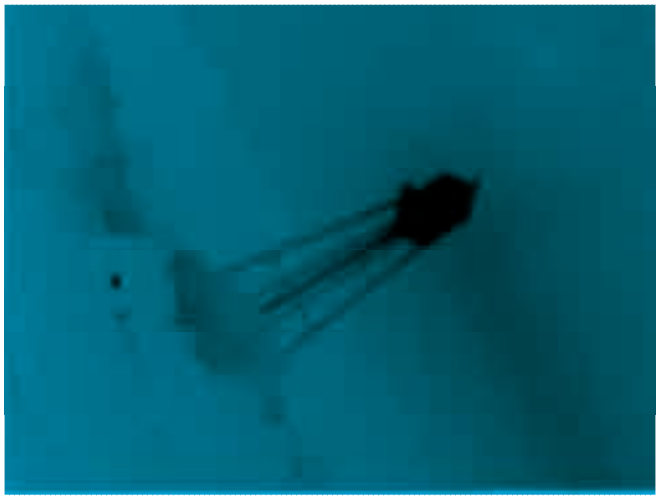


Figure 3.2
Tower at 1.5 Miles,
Maxa Beam
Hi Beam Illumination

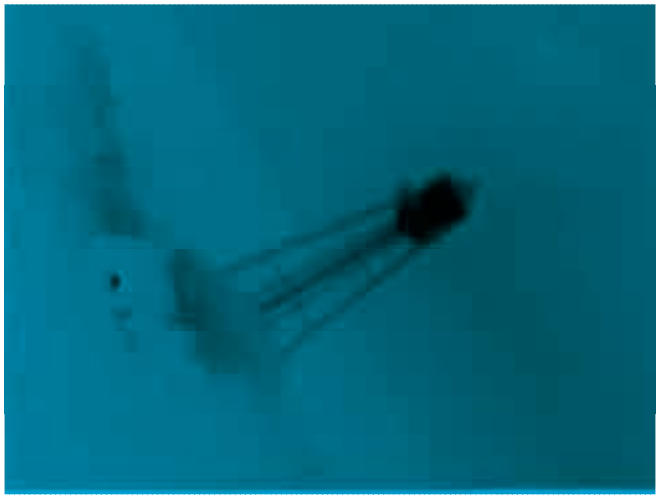


Figure 3.3
Tower at 1.5 Miles,
Nighthunter
Hi Beam Illumination

Appendix 4
Figure 4
Searchlights and Stowage Cases

Figure 4
Searchlights and Stowage Cases

Appendix 4
Figures 5.1, 5.2
Infrared Test Results

Figure 5.1 Nighthunter, Infrared, Hi Beam

Figure 5.2 Maxa Beam Infrared, Hi Beam

Appendix 4
Figures 6.1, 6.2
Visible Test Results

Figure 6.1 Nighthunter Visible, Hi Beam

Figure 6.1 Maxa Beam Visible, Hi Beam

Appendix 4
Figures 7.1, 7.2
NightHunter Shock Test

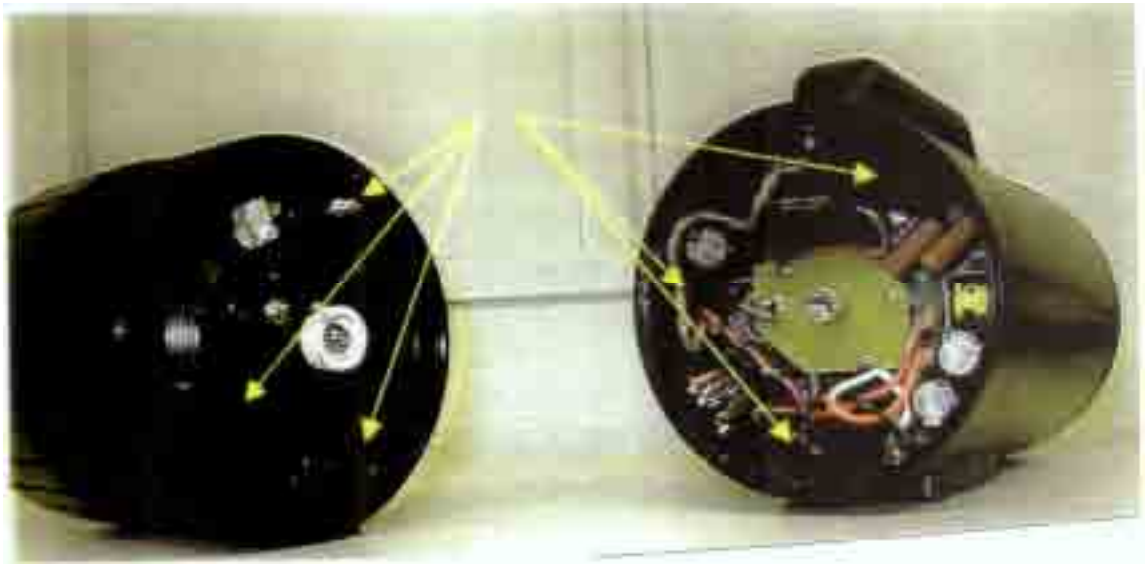


Figure 7.1 NightHunter After 30 inch Drop Test

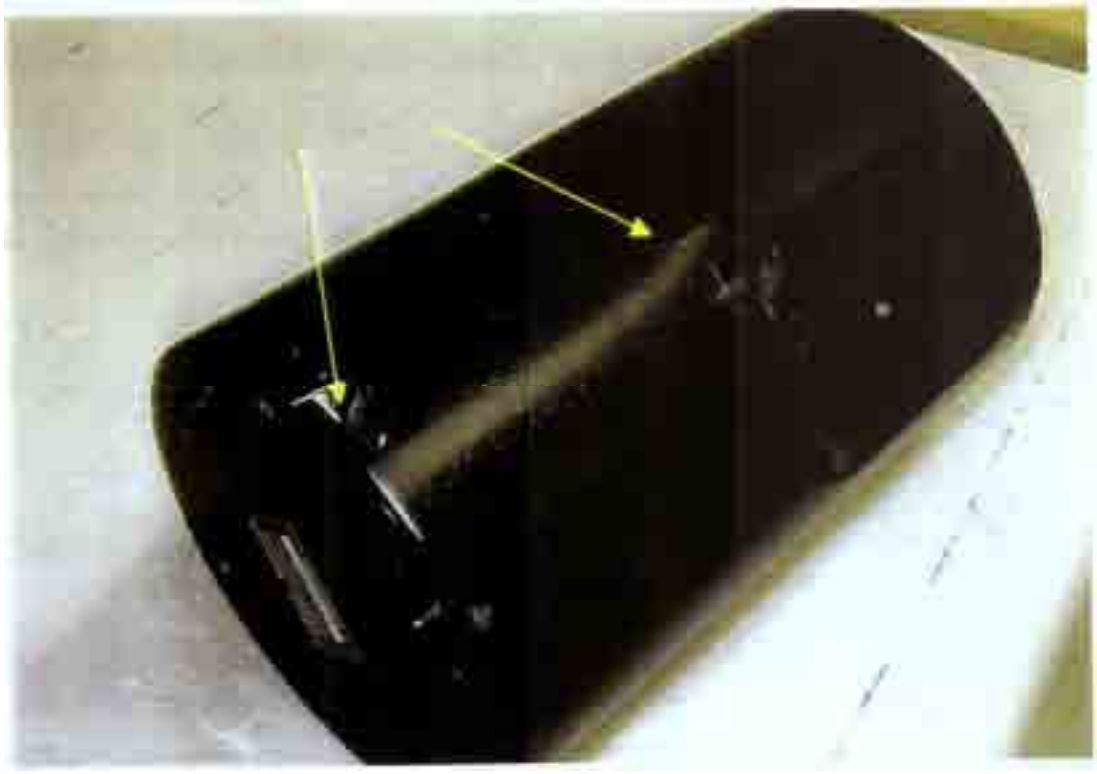


Figure 7.2 NightHunter Case After 30 inch Drop Test

Appendix 4
Figure 8.1, 8.2
Maxa Beam Shock Test

Figure 8.1 Maxa Beam Searchlight
After 30 inch Drop Test

Figure 8.2 Maxa Beam Stowage Case
After 48 inch Drop Test

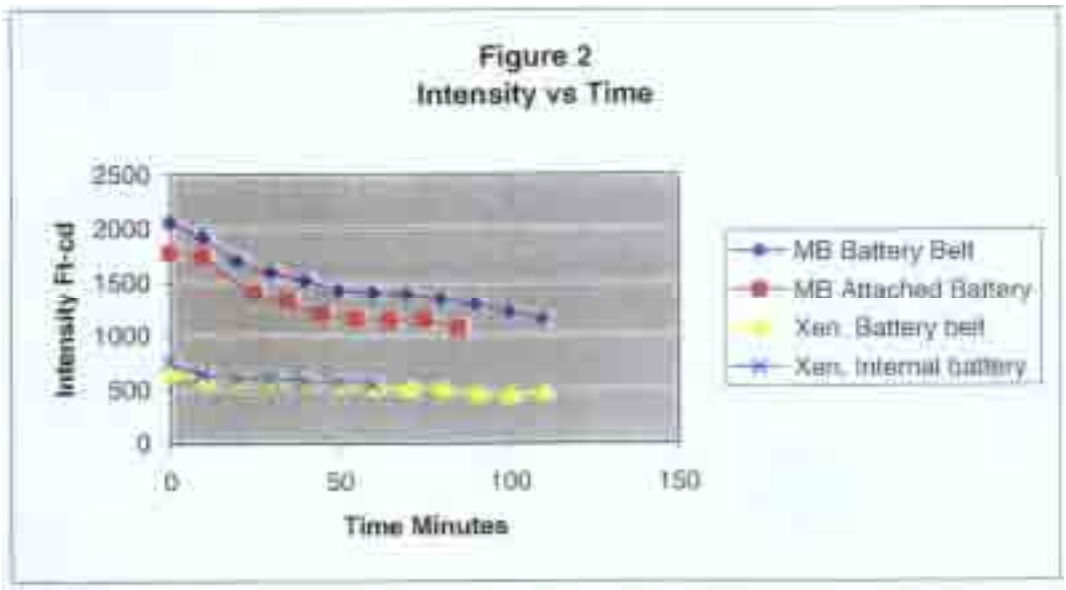
Appendix 5
Intensity vs Discharge Time

BEAM INTENSITY AT 50 FT.
vs TIME DURING DISCHARGE

Xenonics	Mins	Ft-cd		Mins	Ft-cd
Internal Battery	0	755	Battery Belt 1	0	669
1:00	10	645	1:55	10	591
Normal	20	606	Normal	20	591
(min intensity)	30	607	(min intensity)	30	585
	40	584		40	577
27% drop	50	568	30% drop	50	546
	60	550		60	520
				70	508
				80	502
				90	459
				100	442
				110	470

MaxaBeam	Mins	Ft-cd		Mins	Ft-cd
Battery 3	0	1777	Battery Belt	0	2070
1:31	10	1741	1:58	10	1920
Normal	25	1401	Normal	20	1703
(mid intensity)	35	1328	(mid intensity)	30	1598
	45	1192		40	1523
40% drop	55	1152	45% drop	50	1428
	65	1136		60	1407
	75	1146		70	1388
	85	1067		80	1344
				90	1295
				100	1224
				110	1154

Appendix 5
Intensity vs Discharge Time



Appendix 6
Battery Discharge/Recharge

BATTERY DISCHARGE AND RECHARGE TIMES

Maxabeam

Discharge time: Medium intensity setting

Battery 1	100 min.		
Battery 2	128 min.		
Battery 3	98 min.		
Battery 1	95 min.		
Total	421 min.	Average Discharge	105.25 min. 1:45 hr.
Battery Belt	120 min.		

Rapid Recharge

Battery 1	135 min.		
Battery 2	130 min.		
Battery 3	127 min.		
Total	392 min.	Average Recharge	130.67 min. 2:11 hr.
Battery Belt	150 min.		

Xenonics

Discharge time: Medium intensity setting

Belt 1	110 min.		
Belt 2	105 min.		
Belt 1	90 min.		
Total	305 min.	Average Discharge	101.67 min. 1:42 hr.
Internal Battery	60 min.		

Rapid Recharge

Belt 1	58 min.		
Belt 2	*60 min.		
Belt 1	**50 min.		
Total	168 min.	Average Recharge	56.00 min. :56 hr.
Internal Battery	160 min.		

Remarks

*** Charger fault after 15 mins. Retry and charger shows 100% after another 45 min then flashes default again**

**** Charger fault after 25 mins. Retry and charger shows 100% after another 25 min. Suspect charger or cable malfunction**

Appendix 7
Weights

COMPONENT WEIGHTS

DESCRIPTION		WEIGHT LB
XENONICS		
Unit 1	**Searchlight with internal battery**	**10.9**
	Case with Unit 1 and accessories	**20.6**
	Case (empty)	**6.4**
Unit 2	**Searchlight without internal battery**	**6.1**
	Case with Unit 2 and accessories	**13.4**
	Case (empty)	**6.4**
	Battery belt	**4.1**
MAXABEAM		
	Searchlight	**3.3**
	Searchlight with integral battery attached	**8.8**
	Case with searchlight and accessories	**53.5**
	Case (empty)	**22.7**
	Battery belt	**6.3**