BrightEye LED Lighting System

After Initiative Report
AMB-06-007
September 2007

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1. MISSION STATEMENT.

1.1. Problem/Situation. The current Air Force FL-1D light-all cart weighs over 1500 pounds, takes up over 145 cubic feet of cargo area, provides only visible spectrum light, generates extreme heat and high decibel levels, and is costly to operate.

1.2. Proposed Solution. Utilize modern solid-state light-emitting diode (LED) technology to supply both infrared (IR) and visible light options. Commercially available LED lighting systems are lightweight, man-portable, enhance blacked out operations utilizing night vision devices (NVD) and directly align with Air Mobility Master Plan, Open the Airbase Mid-Term Milestones.

Figure 1-1.

1.3. System Description. The Air Mobility Battlelab (AMB) assessed the utility of the Cyberlux Corporation's BrightEye LED light system (Figure 1-1) for this demonstration. The BrightEye lighting system utilizes the latest in battery-powered LED technology to provide a lightweight, portable, covert and visible (spot and wide-area) light unit that can be used to support various airbase opening operations to include aircraft loading, maintenance, and force protection (fig 1-2).

1.3.1. Light Head. The control box has 2 rheostat knobs, 1 switch, and 1 button. One knob controls power amplification to both bright white and IR LEDs while the other knob controls gradual transition between full Spot and full Flood modes. The switch applies battery power to the light head and the button turns the light head on and off, and selects between bright white and IR modes. Each kit contains two (2) light heads.

1.3.2. Quad Pod. Four extendable legs provide a sturdy base for the light head which can be extended to a height of six feet. The legs can also be extended outward to provide a lower profile for windy environments. Each kit contains two (2) quad pods.

1.3.3. Li-ion Battery. Each kit contains 4 Mil STD UBI-2590 Li-ion rechargeable batteries (two per light unit).

1.3.4. Wireless System Control Key Fob. Each kit contains two (2) wireless control key fobs which remotely switch visible and covert lighting on and off.

1.3.5. Battery Charger. The 2-bay battery charger supplied with the light kit accepts both AC and DC power for recharge.

1.3.6. Carrying Case. The wheeled, polycarbonate carrying case features temperature and high-impact resistance with foam padded interior for equipment protection. Outer dimensions of the case were 54" x 16.5" x 7" which snuggly fit two light heads, two quad pods, four batteries, two remote control key fobs, and associated connection wiring (figure 1-3).

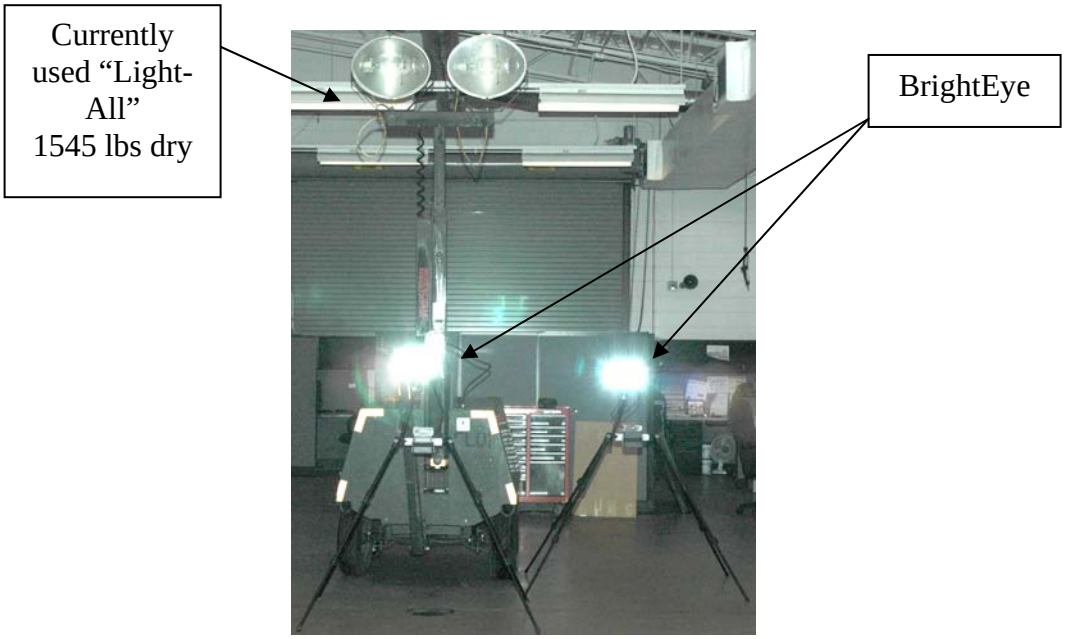


Figure 1-2.

Figure 1-3

2. COURSE OF ACTION.

2.1. Strategy to Achieve. AMB purchased a BrightEye kit from the Cyberlux Corporation and conducted a three-phase concept demonstration. During Phase I, the AMB Project Manager (PM) assessed and documented system weight and power characteristics. The goal of Phase II was to evaluate the light kit bright white and IR capabilities in a field demonstration. Phase III deployed the BrightEye to Joint Task Force Port Opening and Eagle Flag exercises for operational feedback from event participants.

For Phase I, the BrightEye kit was weighed on a US Airways baggage scale enroute to the Phase II location. The power characteristics, which consisted of battery discharge and recharge thresholds, were assessed in a controlled environment over a 5 day period. The AMB PM ran the BrightEye light head from full charge to full discharge at multiple power settings and documented battery discharge/recharge times.

The Phase II field demonstration occurred on a dark, open aircraft parking ramp at Ft. Huachuca, Arizona. During the evaluation, an Air Force Research Lab representative from the Night Vision Center of Excellence measured the BrightEye photopic illuminance and night vision imaging system (NVIS) irradiance. Aircraft maintenance and cargo loading assessments were also made utilizing the bright white and IR modes.

Phase III deployed the light kits to exercises for participant feedback, comments and suggestions. By placing the kits in an operationally representative environment, the durability and feasibility of utilizing LED lighting for a variety of tasks was ascertained.

2.2. Objective 1. Assess the BrightEye Lighting System's weight and portability characteristics.

2.2.1. Method. The PM weighed the total system to ensure it was equal to or less than the maximum single male-lifting limit of 87 pounds (ref MIL-STD-1472F). The case was inspected to assess bulkiness and protection for system components.

2.2.2. Results. The protective carrying case with two units weighed 73 pounds. Mating it with the 12-pound battery charger for transport brought the total weight of the kit below the 87-pound requirement.

Figure 2-1 shows a scaled diagram maximizing the useable area of a 463L pallet. Netted and stacked to 91" high, 104 kits and 120 chargers can be accommodated totaling 9387 pounds (including pallet and net). The small physical characteristics of the BrightEye system align directly with fundamental operating characteristics of lighter and leaner Contingency Response Groups (CRG).

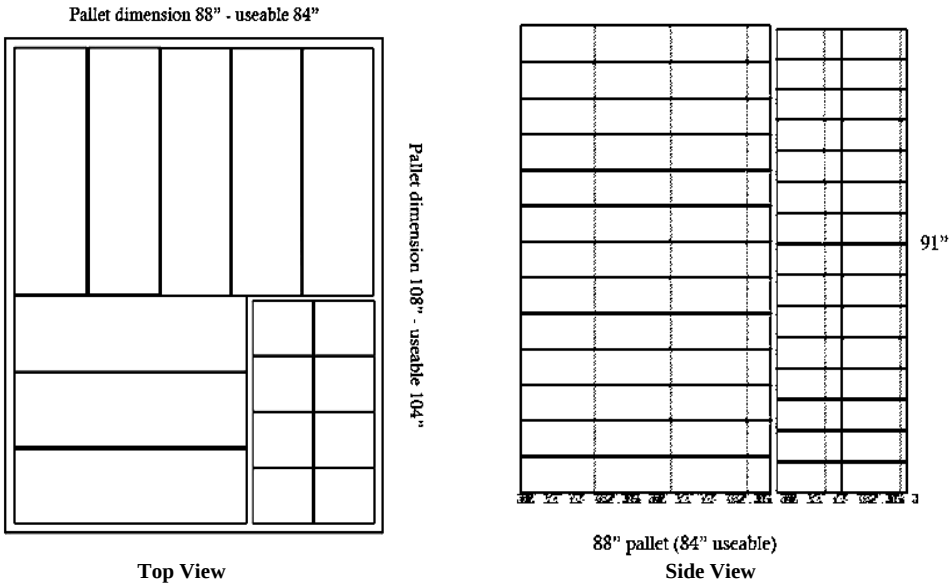


Figure 2-1.

The wheeled polycarbonate case with padded interior provided sufficient protection to all of the light kit components. The case is similar in size to a security forces weapons travel case.

2.3. Objective 2. Determine the BrightEye system's Lithium-ion battery charge and discharge thresholds.

2.3.1. Method. The PM setup and ran the system in a controlled environment. After each use, the batteries were charged on the two-bay charger. The operational battery discharge and recharge times were recorded. Note: Cyberlux Corporation does offer a solar recharge capability for the BrightEye, but it was not assessed during this demonstration because the excessive recharge time (one full day per battery under optimal sun conditions) made it impractical for CRG use.

2.3.2. Results. Figure 2-2 shows light head performance thresholds. Once depleted, the Li-ion batteries were fully recharged in 10 hours utilizing the two-bay ruggedized charger. The charger is compatible with aircraft and ground power sources.

Power Setting	Spot/Flood	White/IR	Duration
Full	Flood	White	8.5 hrs
Half	Flood	White	16 hrs
Full	Flood	IR	24+ hrs
Half	Flood	IR	24+hrs
Full	Spot	White	8 hrs
Half	Spot	White	16 hrs
Full	Spot	IR	24+ hrs
Half	Spot	IR	24+ hrs
Battery recharge	N/A	N/A	~10 hrs

Figure 2-2.

2.4. Objective 3. Assess BrightEye bright white and IR lighting capabilities.

2.4.1. Method. AFRL measured the BrightEye, FL-1D and NF-2 light cart systems' light intensities. The BrightEye demonstration team then assessed the feasibility of performing aircraft maintenance and cargo loading operations in overt and covert lighting environments.

2.4.2. Results. The BrightEye visible and NVD B (compatible with properly filtered red lights) intensities were measured by an AFRL Night Vision Center of Excellence team member. For comparison purposes, illuminance (visible surface energy) and irradiance (visible IR surface energy) measurements of the NF-2 and FL-1D lighting carts were also measured. Data measured indicated that two BrightEye light heads in balanced bright white mode (mixed spot and flood) created more than 50% the illumination of the diesel powered light carts. The two BrightEye light heads, while in bright white spot mode, created almost 90% the illumination of the light carts. The complete AFRL memo of recorded data is provided as Attachment 1. Comments on the AFRL memo were provided by Cyberlux in the form of amended, italicized paragraphs (Attachment 2). The height of the BrightEye light head presented some problems. At about the same height as the average person, it can be blinding when shone horizontal to the ground. In addition, because the BrightEye light head can only be raised to 6 feet above the ground, it wasn't able to illuminate as large an area as current lighting carts that can be elevated up to 15 feet. A higher mast would create an umbrella of more useable flood lighting that would not be at eye level.

Following the lighting measurements, BrightEye was used to assess lighting sufficiency for aircraft maintenance utilizing both IR and bright white settings. The BrightEye was placed on the ground beside a B-5 maintenance stand and was aimed directly onto the area where a simulated maintenance task was to be performed. An aerospace ground equipment (AGE) team member on the B-5 stand simulating the maintenance task concluded that enough bright white lighting was present on the job surface to perform procedures. The visible light was ideal as the light intensity could be increased or decreased and the unit could be placed virtually anywhere necessary. While wearing NVGs, the direct beam of IR proved too much for the NVGs to compensate. The

BrightEye IR lighting had to be reflected off of the airplane surface to provide useable work lighting.

For blacked out cargo loading operations, the BrightEye IR light was strategically aimed into the cargo loading path to prevent NVG blinding of the forklift driver or the loading crew. According to the loading driver, utilizing BrightEye's IR lighting greatly enhanced visibility of the entire aircraft loading area.

Feedback forms (Attachment 4) were distributed to the initiative participants at Ft. Huachuca, the Eagle Flag Exercises, and the JTFPO. The thirteen forms collected revealed that the BrightEye was favorably received. Results from the feedback forms are provided as Attachment 5 along with the following key comments:

- Brighter than FL-1D but not as much flood coverage
- Easy deployment – setup and operating in under 10 minutes
- Higher elevation of light head would increase illumination area
- Light can be taken anywhere needed
- Small footprint perfect for Mobile C2 Unit Type Codes

3. RESOURCES.

3.1. Schedule.

Table 1. Initiative Schedule

EVENT	START	FINISH
Initiative Approval Date	22 Jun 06	22 Jun 06
Demonstration Plan	23 Jun 06	3 Aug 06
Phase I	18 Jan 07	5 Mar 07
Phase II	5 Mar 07	8 Mar 07
Phase III	5 Feb 07	26 Apr 07
After Initiative Report	27 Apr 07	1 Oct 07

3.2. Funding.

Table 2. Resources

RESOURCE	QUANTITY	SOURCE	TIMEFRAME	COST
Cyberlux contract - included Light Kit/charger	1	Cyberlux	Duration	$51,000
Additional charger	1	McDowell Research	Feb 07	$1,296.65
Additional batteries	2	McDowell Research	Feb 07	$628.20
AMB Travel/Per Diem	1	AMB	Mar 07	$1329.89
EC/MOS Travel/Per Diem	1	AMB	Mar 07	$ 956.07
			Total	$55,210.81

3.3. Organizational Support. The Advanced Airlift Tactical Training Center provided the ground equipment and C-130 aircraft required to complete the objectives for Phase II at Ft. Huachuca. For Phase III, the 621 CRW and 421 CTS deployed the light kit to one Joint Task Force Port Opening and three Eagle Flag exercises.

Table 3. Required Organizational Support

NAME	AGENCY	PHONE	EMAIL
MSgt Michael Harris	Air Mobility Battlelab	DSN 650-7604	michael.harris03@mcguire.af.mil
MSgt Gordon Mossman	HQ AMC/A3MMM	DSN 576-2315	gordon.mossman@scott.af.mil
SMSgt Tim Jones	HQ AMC/A4MJS	DSN 779-2629	timothy.jones6@scott.af.mil
Mr. Mark Horning	AFRL/HEA	DSN 474-6446	mark.horning@mesa.afmc.af.mil
SSgt Bill Hutchinson	621 CRW/819 GSS	DSN 650-6046	billy.hutchinson@mcguire.af.mil
Capt Barb Denny	139 AATTC/NGPC	DSN 356-3662	barbara.denny@mostjo.ang.af.mil
MSgt Jim Puente	621 CRW/818 GSM	DSN 650-6046	james.puente@mcguire.af.mil
Mr. Mark Schmidt	Cyberlux Corp.	(919) 474-9700	mschmidt@cyberlux.com
Mr. Don Evans	Cyberlux Corp.	(919) 474-9700	dfevans@cyberlux.com

3.4. Equipment Disposition. The AMB-purchased BrightEye kit will be turned over to the 621 CRW for further durability and capability assessments during exercises and deployment.

4. POTENTIAL RETURN ON INVESTMENT (ROI). Objectives 1 and 3 assessed two major sources of potential ROI offered by LED-based lighting: footprint reduction and IR capability. An additional source that was not specifically addressed by an objective is the potential for reduced operating cost. The purchase price of a Bright Eye kit is 23% higher than that of the existing FL-1D light cart ($18,333 vs $14,073), but AMB performed a rough order cost analysis (Attachment 3) that indicated Bright Eye's annual operating and maintenance costs would be approximately 54% less ($613 vs $1,669) if commercial power is available for battery recharging.

5. CONCLUSION. The Bright Eye Battlelab initiative demonstrated the feasibility and advantages of a lightweight battery-powered, LED -based lighting technology for deployed and home-based (garrison) operations. Advantages include greatly-reduced deployment footprint, man-portability, IR capability, reduced operating costs, and the elimination of the heat and noise signatures inherent in diesel generators. The specific light kit demonstrated for this initiative is not an across-the-board replacement for the current lighting carts because of its lower light output. Even with this limitation, however, the Bright Eye kit as-is proved to be effective in many expeditionary applications, and an improved version (PNs 2CP0170 and 2CP0182) are available for government purchase on GSA Advantage. Furthermore, AMB's market research indicates industry has the capability to quickly develop an LED-based across-the-board light cart replacement should the Air Force issue such a requirement.

6. <u>RECOMMENDATION</u>. AMB recommended transition of this concept to HQ AMC, with AMC/A3MMM serving as transition OPR and A4MJS and A7 serving as OCRs. AMC/CV approved these recommendations at the 17 July 07 Battlelab Quarterly Update briefing.

//SIGNED//
JEFFREY R. LATHROP, Lt Col, USAF
Commander, USAF Air Mobility Battlelab

Attachments:
(1) AFRL/ Night Operations Center of Excellence Report
(2) AFRL Report With Cyberlux Simplification In *Italics*
(3) FL-1D Floodlight vs. BrightEye Portable Lighting System Cost Analysis
(4) User Feedback Questionnaire Form
(5) User Feedback Questionnaire Results
(6) Distribution List

ATTACHMENT 1
AFRL/ Night Operations Center of Excellence Report

Night Operations Center of Excellence
Air Force Research Laboratory

28 March 2007

Re: Brighteye Portable Illumination System

COE#: 0953-07-AMC

Representatives from the AMC Battlelab, Missouri ANG, Cyberlux Corporation, and the Night Operations Center of Excellence at the Warfighter Readiness Research Division of the Air Force Research Laboratory met at Ft. Huachuca to evaluate the Brightye Portable Illumination system developed by Cyberlux Corporation. The evaluation commenced 45 minutes after local sundown and before local moonrise on the night of 6 March 2007.

During the evaluation, measurements of the Brighteye photopic illuminance, and night vision imaging system (NVIS) irradiance were measured from a Lambertian surface placed on a tripod 50 feet from a pair of Brighteye illuminators. For comparison purposes, measurements of the illuminance and irradiance of the same surface lit by both new and old style "light all" lighting carts were also recorded. A Photo-Research PR-1530 Spot Radiometer fitted with both photopic and NVIS Class B filters was used for all measurements. Measurements were recorded for two Brighteye illumination heads to match the two illumination spotlights per lighting cart. The target luminance (visible) and NVIS B radiance (and corresponding source intensities) measured for the BrightEye and Legacy systems are listed in Table I.

Table I: Visible and NVIS B Intensities for Brighteye and Legacy Illumination Systems

Test Condition	Target Luminance (fL)	Target NR_B ($W/cm^2/Sr$)	Source Intensity (Cd)	Source NVIS B Intensity (W/Sr)
Old Style Lighting Cart	36.2	9.81E-06	91,000	71.6
New Style Lighting Cart	37.0	6.00E-06	93,000	43.8
Brighteye Visible Balanced mode	20.1	1.84E-06	50,600	13.4
Brighteye Covert Balanced mode	N/A	7.08E-07	N/A	5.2
Brighteye Visible Spotlight mode	32.2	3.06E-06	80,900	22.3
Brighteye Covert Spotlight mode	N/A	7.70E-07	N/A	5.6

For the purposes of the evaluation, the Brighteye system was configured by representatives from Cyberlux in both a spotlight and a balanced, or mixed spot/floodlight mode. Although the brightness

of the visible portion of the system was notably brighter in the spot mode (compared to the mixed mode) the energy produced by the infrared portion of the system did not appear to be significantly affected by the focus setting.

Because the Brighteye illumination head is small in comparison to the working distance, it can be treated as a point source for purposes of calculating the illuminance and irradiance it will provide at various working distances using the inverse-square law. The calculated equivalent working distances are for aviator NVGs or ground systems fitted with screw in Class A or Class B filters and are listed in Table II. The equivalent working distance for unfiltered ground systems (which are more sensitive to natural illumination) will be somewhat shorter. Natural illumination present in the working environment will extend these ranges.

Table II: Equivalent working distances for the Brighteye IR Spot Mode

Illumination Condition	NRA	NRB	Equivalent Distance (ft)
89% Lunar disc	2.35E-08	2.12E-08	290
50% Lunar disc	1.02E-08	9.18E-09	430
25% Lunar disc	3.88E-09	3.49E-09	700

Furthermore, it should be noted that the IR output of the full-bright setting of the Brighteye system is likely to be too great for maintenance tasks using NVGs. Since NVGs will automatically reduce their gain to compensate for illumination conditions greater than approximately 25% lunar disc conditions, the system should be adjusted to produce between full and 25% moon equivalent illumination (at the working surface) for optimal NVG performance. For a working distance of 50 feet, this is a small percentage of the maximum IR output power of the Brighteye illumination head. As such, the manufacturer should verify that the Brighteye system allows for smooth dimming in this operating range, or provide a switch to place the unit into a lower output maintenance mode and a higher power observation mode.

Mark E. Horning
Physicist

L-3 Communications, Link Simulation and Training
Night Operations Center of Excellence
Air Force Research Lab; AFRL/HEA

ATTACHMENT 2

AFRL Report With Cyberlux Simplification In I*talics*

Re: Brighteye Portable Illumination System

During the evaluation, measurements of the Brighteye photopic illuminance, and night vision imaging system (NVIS) irradiance were measured from a Lambertian surface placed on a tripod 50 feet from a pair of Brighteye illuminators. For comparison purposes, measurements of the illuminance and irradiance of the same surface lit by both new and old style "FL-1D light all" lighting carts were also recorded. A Photo-Research PR-1530 Spot Radiometer fitted with both photopic and NVIS Class B filters was used for all measurements. Measurements were recorded for two Brighteye illumination heads to match the two illumination spotlights per lighting cart. The target luminance (visible) and NVIS B radiance (and corresponding source intensities) measured for the BrightEye and Legacy systems are listed in Table I.

Table I is important for the Visible results that compare the BrightEye in spotlight mode or balanced mode to the FL-1D legacy illumination systems. Most importantly, the 'Target Luminance' (how much light hits the target area) data shows that the two BrightEye units in balanced mode created more than half (20 vs. 36/37) the illumination of the Old or New Style FL-1D, and the two BrightEye units in spotlight mode created almost 90% (32 vs. 36/37) the illumination of the Old or New Style FL-1D. Additionally, the 'Source Intensity' (how bright the light source is perceived) data shows that the two BrightEye units produced almost 90% the brightness (80.9 vs. 91/93) in spotlight mode and over 50% the brightness in balanced mode (50.6 vs. 91/93) as the Old or New Style FL-1D.

Table I: Visible and NVIS B Intensities for Brighteye and Legacy Illumination Systems

Test Condition	Target Luminance (fL)	Target NR_B ($W/cm^2/Sr$)	Source Intensity (Cd)	Source NVIS B Intensity (W/Sr)
Old Style Lighting Cart	36.2	9.81E-06	91,000	71.6
New Style Lighting Cart	37.0	6.00E-06	93,000	43.8
Brighteye Visible Balanced mode	20.1	1.84E-06	50,600	13.4
Brighteye Covert Balanced mode	N/A	7.08E-07	N/A	5.2
Brighteye Visible Spotlight mode	32.2	3.06E-06	80,900	22.3
Brighteye Covert Spotlight mode	N/A	7.70E-07	N/A	5.6

For the purposes of the evaluation, the Brighteye system was configured by representatives from Cyberlux in both a spotlight and a balanced, or mixed spot/floodlight mode. Although the brightness of the visible portion of the system was notably brighter in the spot mode (compared to the mixed mode) the energy produced by the infrared portion of the system did not appear to be significantly affected by the focus setting.

Because the Brighteye illumination head is small in comparison to the working distance, it can be treated as a point source for purposes of calculating the illuminance and irradiance it will provide at

various working distances using the inverse-square law. The calculated equivalent working distances are for aviator NVGs or ground systems fitted with screw in Class A or Class B filters and are listed in Table II. The equivalent working distance for unfiltered ground systems (which are more sensitive to natural illumination) will be somewhat shorter. Natural illumination present in the working environment will extend these ranges.

Table II: Equivalent working distances for the Brighteye IR Spot Mode

Illumination Condition	NRA	NRB	Equivalent Distance (ft)
89% Lunar disc	2.35E-08	2.12E-08	290
50% Lunar disc	1.02E-08	9.18E-09	430
25% Lunar disc	3.88E-09	3.49E-09	700

Table II is important for the NVG-compatible IR lighting results that measure the BrightEye in IR mode. Most importantly, the 'Equivalent Distance' data shows the distance and target illumination percentage create by the BrightEye with IR lighting. At 290 ft, the BrightEye can almost fully illuminate the target (89%), at 430 ft, 50% of the target was illuminated, and at 700 feet the BrightEye was able to illuminate 25% of the target, more than enough illumination to either conduct security or maintenance operations. By extrapolation, the BrightEye in IR mode will illuminate more than 10% of a target at over 1400 feet. Also, there was a 10% difference (2.35E-08 vs. 2.12E-08, 1.02E-08 vs. 9.18E-09, 3.88E-09 vs. 3.49E-09) observed between the Class A and Class B filters, which is consistent with next generation NVG performance.

Furthermore, it should be noted that the IR output of the full-bright setting of the Brighteye system is likely to be too great for maintenance tasks using NVGs. Since NVGs will automatically reduce their gain to compensate for illumination conditions greater than approximately 25% lunar disc conditions, the system should be adjusted to produce between full and 25% moon equivalent illumination (at the working surface) for optimal NVG performance. For a working distance of 50 feet, this is a small percentage of the maximum IR output power of the Brighteye illumination head. As such, the manufacturer should verify that the Brighteye system allows for smooth dimming in this operating range, or provide a switch to place the unit into a lower output maintenance mode and a higher power observation mode.

ATTACHMENT 3

FL-1D Floodlight vs. BrightEye Portable Lighting System Cost Analysis

Based on the **FL-1D Floodlights** now used by the USAF, the following is a projected fuel savings over a year in comparison to the BrightEye Portable Lighting System:

- Cost Efficiency
    - Based on information obtained from the internet and MXS sources, the yearly cost to own and operate a FL-1D Floodlight is broken down as follows.
        - Initial cost: $14,073 (Average cost per unit from 1999-2001) (http://www.unicor.gov/electronics/floodlights.cfm, http://www.fas.org/man/docs/fy01/usaf/afotherproc.pdf)
        - Daily operating cost: $13.91
            - Each FL-1D, under lamp load only, operates continuously for 36 hours on 13.5 gallons of diesel (ref TO 35 F5-5-20-1, Table 1-1).
            - Estimate 120 days/year of operation @ 9hrs use/day = 4 days use on 13.5 gallons
            - The current cost of diesel fuel is $2.889 per gallon. (http://tonto.eia.doe.gov/oog/info/gdu/gasdiesel.asp)
            - 13.5 gallons/4 days * $2.889/gallon = **$9.75/day**
            - Assuming an E-5 over 6 years of service performs the semi-annual Periodic Examination (PE) and each PE is 14hrs
                - 14hrs * 2/year * E-5 hourly wage of $14.52 = **$406.56**
                - Oil filter replace/ PE - $30/ filter * 2 = **$60**
                - Oil change/ PE = **$13.21**
            - Average 1 bulb replacement/ year = **$19.42**
            - **($406.56 + $60 + $13.21 + $19.42)/120 + $9.75 = $13.91**
        - **Daily operating cost**
            - $9.75 (fuel) + $1.114 (manpower) + $.16 (2 * filter) + $.036 (oil) + $.053 (bulb) = $13.91
        - **Annual operating cost (120 days)**
            - $1170 (fuel) + $406.56 (manpower) + $60 (2 * filter) + $13.21 (oil) + $19.42 (bulb) = $1669.19
    - The **BrightEye Portable Lighting System's** yearly cost to own and operate in an environment where commercial power is available for battery charging is as follows.
        - Initial cost: $18,333 (**GSA Contract: GS-07F-9409S**)
        - Yearly operating costs = $613.36
            - Commercial electricity costs Kilowatt-hour rate: (http://www.eia.doe.gov/emeu/international/elecprii.html)
                - Each of the 4 batteries requires 0.1875 Kilowatt-hours for a daily charge.

- 0.1875 kilowatt-hour/battery * $.085/kilowatt-hour * 4 batteries * 120 days = $7.65
- Battery replacement cost = $1,514.28
    - Each battery will be replaced @ ~300 charges at a cost of $1,514.28 for 4 batteries
    - 300 charges/ 120 operating days = 2.5 years per 4 battery replacement
    - $1,514.28 (4 batteries)/ 2.5 years = $605.71 per year

(https://www.gsaadvantage.gov/advgsa/advantage/catalog/product_detail.do?contractNumber=GS-07F-0389J&BV_UseBVCookie=Yes&itemNumber=UBI-2590)

- Operating costs: $7.65 + $605.71= $613.36

- **Daily operating cost**
    - $.0633 (daily power) + $5.05 = $5.11

- **Annual operating cost (120 days)**
    - $7.65 (daily power) + $605.71 (battery replacement) = $613.36

- Light Efficiency & Product Features

    - The FL-1D Floodlight
        - Provides 120 lumens/watt
        - Telescopic 144” mast with 360 degree rotational capability
        - Fossil fuel dependent
        - 87.6 decibel diesel generator
        - Weight: 1620 lbs.
            - Requires prime mover for transport
        - Requires 2 to 4 minute warm-up time/ 10 to 15 minute restart time

    - BrightEye Portable Lighting System
        - Provides 70 lumens/watt
        - Telescopic 63” mast with 360 degree rotational capability
            - Fixed-position mounting also available
        - Multiple AC/DC recharge options
        - Runs silently
        - Weight: 85 lbs (73 lb kit + 12 lb charger)
            - Man-portable unit, easy for transport
        - User-defined spot or flood illumination power
        - Wireless system control and operation
        - No warm-up or restart times

Conclusion

Based on the cost analysis comparison, the following conclusions can be made:

- Because the light output of the BrightEye kit demonstrated for this initiative is less than that of an FL-1D, it cannot be used as a one-for-one replacement in all cases. In applications where a single BrightEye kit will suffice, however, its operating and maintenance costs would be $1,055.38 less per year than an FL-1D.

- FL-1D operating cost for five 120 day years: $8,345.95
- BrightEye operating cost for five 120 day years: $3,066.80
- FL-1D five year cost – BrightEye five year cost = $8,345.95 - $3,066.80= $5,279.40
- BrightEye reduces daily operating cost by 63%
  - $13.91 - $5.11/ $13.91 = .63 = 63%
- Initial BrightEye purchase price is 23% more than the FL-1D
  - $18,333 - $14,073 = $4,260/$18,333 = .23 = 23%
- FL-1D is **2.72X** more expensive to operate than the BrightEye System over a five year period
- FL-1D cost / BrightEye cost = $8,345.95/$3,066.80 = 2.72
- Time to recoup differences in purchase price: 4.03 years
  - $4,260/$1,055.83 per year = 4.03 years

ATTACHMENT 4

USER FEEDBACK QUESTIONAIRE
Bright Eye LED Lighting System

Name (optional): _____ Unit (optional): _____

Rank: _____ AFSC: _____ Years of Service:_____

Please comment on any items you find Unacceptable.

1. Rate the acceptability of the lighting coverage provided by the system (ability to perform task without difficulty)

☐	☐	☐	☐	☐	☐	☐
Completely Unacceptable	Largely Unacceptable	Somewhat Unacceptable	Somewhat Acceptable	Largely Acceptable	Completely Acceptable	N/A

Comments:

2. Rate the acceptability of the system's rechargeable batteries to provide useable quality light coverage. (how long the light lasted)

☐	☐	☐	☐	☐	☐	☐
Completely Unacceptable	Largely Unacceptable	Somewhat Unacceptable	Somewhat Acceptable	Largely Acceptable	Completely Acceptable	N/A

Comments:

3. Rate the acceptability of the system's re-charge capability.

☐	☐	☐	☐	☐	☐	☐
Completely Unacceptable	Largely Unacceptable	Somewhat Unacceptable	Somewhat Acceptable	Largely Acceptable	Completely Acceptable	N/A

Comments:

4. Rate the acceptability of time required to deploy the lighting system.

☐	☐	☐	☐	☐	☐	☐
Completely Unacceptable	Largely Unacceptable	Somewhat Unacceptable	Somewhat Acceptable	Largely Acceptable	Completely Acceptable	N/A

Comments:

5. Rate the acceptability of the procedures to deploy the system.

☐	☐	☐	☐	☐	☐	☐
Completely Unacceptable	Largely Unacceptable	Somewhat Unacceptable	Somewhat Acceptable	Largely Acceptable	Completely Acceptable	N/A

Comments:

6. Rate the acceptability of the lighting system's packaging.

☐	☐	☐	☐	☐	☐	☐
Completely Unacceptable	Largely Unacceptable	Somewhat Unacceptable	Somewhat Acceptable	Largely Acceptable	Completely Acceptable	N/A

Comments:

7. The light quality of the LED light system is preferable to that of the standard TF-1 light cart.

☐	☐	☐	☐	☐	☐	☐
Completely Disagree	Largely Disagree	Somewhat Disagree	Somewhat Agree	Largely Agree	Completely Agree	N/A

Comments:

8. The portability of the LED light system is preferable to that of the standard TF-1 light cart.

☐	☐	☐	☐	☐	☐	☐
Completely Disagree	Largely Disagree	Somewhat Disagree	Somewhat Agree	Largely Agree	Completely Agree	N/A

Comments:

9. Rate the acceptability of the general durability of the lighting system and its components.

☐	☐	☐	☐	☐	☐	☐
Completely Unacceptable	Largely Unacceptable	Somewhat Unacceptable	Somewhat Acceptable	Largely Acceptable	Completely Acceptable	N/A

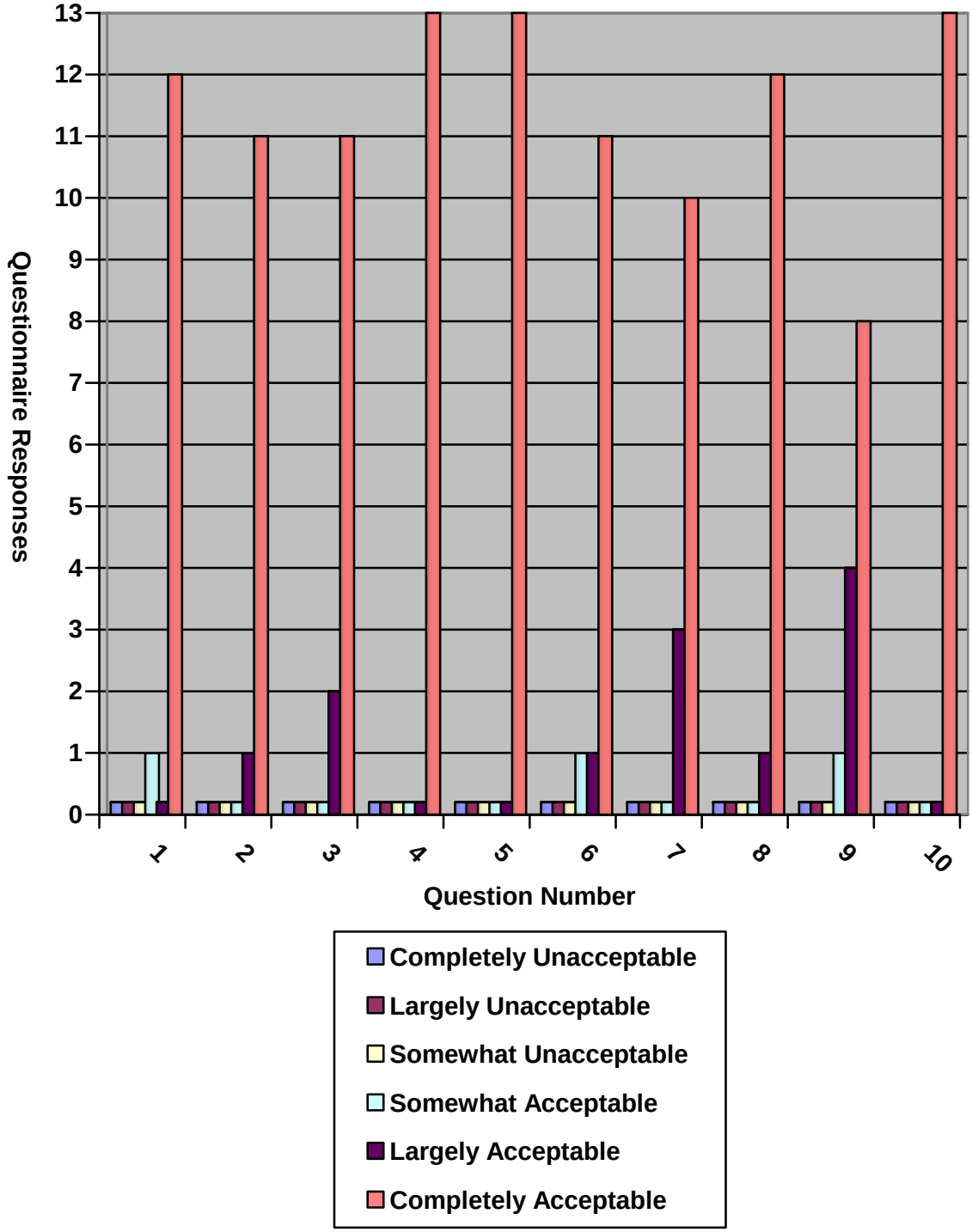
Comments:

10. Rate the acceptability of this system's ability to enhance mission requirements. ***Please provide comments on this question regardless of the rating.***

☐	☐	☐	☐	☐	☐	☐
Completely Unacceptable	Largely Unacceptable	Somewhat Unacceptable	Somewhat Acceptable	Largely Acceptable	Completely Acceptable	N/A

Comments:

Attachment 5
USER FEEDBACK QUESTIONAIRE RESULTS



ATTACHMENT 6

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