1. E/T Lights

Principal Investigator

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Capability Area of Interest

Deployable Lighting Technologies

Capability Description

The E/T Light combines four colors (IR/R/G/B or R/Y/G/B) into one compact, durable, long lasting signaling device. Originally designed for JSOC medics (PJ's) to lessen the weight and volume they carried in chemical lights for the purpose of triaging patients. The E/T Lights reduce the weight and volume for this type of equipment by over 60% and will reduce the chemical light stick budget by over 90%. The E/T Lights also reduce the need for constant resupply of chemical lights and contribute towards the reduction of chemical and plastics waste. According to a DLA webpage printout in the years between 2010, to 2013 we purchased close to $180,000,000 in chemical lights, that's close to $60,000,000 per year. This translates to close to 54,000,000 chemical lights in the ground or in the water every year. The E/T Lights also function in all austere environments while chemical lights perform poorly in high humidity and freezing weather.

This study proposes to explore the cost savings, weight & volume reduction for the capability, plastics/chemical waste reductions if the military moves to chemical lights for truly crack and forget tasks, and utilizes a four color in one, re-usable E/T Light instead for common repetitive signaling tasks

Experiment Hypothesis and Objectives

The objective of the experiment is to determine if E/T Lights will be a good augmentation to chemical lights for common repetitive tasks performed by our war fighters in all austere environments. It is important to be properly equipped, as not all wars will be fought in desert environments. The current dependency on chemical lights will be a hindrance during winter warfare since they will freeze and function at a much poorer level if at all. The hope is to prove utilizing a re-usable chemical light augmentation will save money, improve capabilities, reduce plastics waste, and reduce the weight & volume carried by our war fighters for this capability.

Experiment Plan / Data Collection Plan

Determining acceptable light output in both room temperature and freezer conditions:

1. Crack 5 colored chemical lights (IR. Red, yellow, green, blue) in a dark room, in each setting and have a series of viewers state at what time period does the diminishing light become of no use. We all know the chemical light labels say 12 hours but how many of those 12 hours are actually bright enough to be of value. Measure the Lumens output from the peak to the point of being useless to get an average output per chemical light color.
2. Turn on 5 E/T Lights in each setting, one to each available color and have a series of viewers state at what time period does the diminishing light become of no use. US Army Aberdeen Proving grounds found the E/T Lights lasted an average of 4.5 days to 9.5 days but did not state at what lumen output they were considered of no real world value. Measure the lumens output per E/T Light color from the peak to the point of being considered useless to get an average output per E/T Light color.
3. Once we know the average output over X time for each product we can establish which product provides a more acceptable level of output light per X hours in each setting.

Measures of Performance/Effectiveness

The information gathered in the Experiment plan will determine how many chemical lights it takes to match the same average hours/lumens to match one E/T Light.

Determining weight/volume savings for the capability - Once we know the number of chemical lights it takes to match the same average lumens of the E/T Light we know how much weight and volume we save for the capability.

Determining cost savings for the capability - Once we know the number of chemical lights it takes to match the average lumens of the E/T Light we can easily calculate the cost per performance of the capability.

Determining plastics waste and chemical waste - Once we know the number of chemical lights it takes to match the average lumens of the E/T Light we can easily determine the volumes and determine how much plastic is not wasted for the capability. This also goes for the chemicals which have been found are toxic to marine organisms.

What new capability does this represent?

By combing four color capability into one compact, durable, long lasting, dependable illuminated general purpose light we have reduced the need to carry four individually colored lights. This reduces weight and volume requirements for a capability. The E/T Lights also turn off, a feature the chemical lights don't have. The E/T Lights can convey more than just solid colors, E/T Lights can flash and alternate colors giving more signaling options. The E/T Lights function in all austere environments while chemical lights will freeze. By moving to a reusable, multi-colored illuminate marker for use during common repetitive tasks we will save money, improve capabilities, reduce plastics/chemical waste and lighten the load for the capability for our warfighters, weight equals pain. Resupply barrels of chemical lights or small boxes of batteries?

What capability gap does this address?

Deploy-able Lighting Technologies, warfighter performance enhancements are both areas of interest. The E/T Light if proven more long lasting, cost efficient, more capable, reusable, plastics waste reducing, and is less weight & volume to carry for the capability it is an improved deploy-able lighting technology which enhances warfighter performance and capability over chemcial lights. Aberdeen Proving Grounds MIL-STD 810 lab tested and combat proven since 2008 the E/T Light has already been found easy to use, durable, and reliable with 1,001 applications in the field, in training's, and at home.

Two methods of measuring light output were utilized. The first method used the same type of detector as used in the Commodity Item Descriptions (CID) for the chemical lights. In 1992, CID A-A-55134 measured the light output using a Tektronix, model J16 digital Photometer in conjunction with the J6501 sensor probe (used for measuring Yellow & Green LED's). The J6501 sensor probe was used to measure the light output for the 6" (12 hour) chemical lights in the colors green, yellow, red, and orange. The probe was placed 1.5" from the chemical light stick to take the readings. Readings were reported at 15 minutes, 1 hour and then every hour for a 12 hour time period. It is important to note that during this test that at the 8 hour mark the probe was moved to 0”, touching the green chemical light in order to report a reading. The J6501 sensor probe reads in foot candles but the CID reports the numbers in “Lumens per square meter”. Foot candles is a measurement of illuminance.

The following is taken from a Konica Minolta webpage (http://sensing.konicaminolta.us/2015/08/luminance-vs-illuminance/), that distinguishes between Luminance vs. Illuminance readings. It reads, “Illuminance is a term that describes the measurement of the amount of light falling onto (illuminating) and spreading over a given surface area. Illuminance also correlates with how humans perceive the brightness of an illuminated area. As a result, most people use the terms illuminance and brightness interchangeably which leads to confusion, as brightness can also be used to describe luminance. To clarify the difference, illuminance refers to a specific kind of light measurement, while brightness refers to the visual perceptions and physiological sensations of light. Brightness is not a term used for quantitative purposes at all.

The SI unit for illuminance is lux (lx). In the U.S. people sometimes use the non SI term foot-candle when referencing illuminance. The term "foot-candle" means "the illuminance on a surface by a candela source one foot away". One foot-candle is equivalent to one lumen per square foot which is approximately 10.764 lux.

Illuminance (lux) is quantified using a chroma meter, an illuminance (lux) meter, or an illuminance spectrophotometer.”

Foot candles can be converted to LUX, and “1 lux equals 1 Lumen/m2, in other words - light intensity in a specific area. Lux is used to measure the amount of light output in a given area - one lux is equal to one lumen per square meter. It enables us to measure the total "amount" of visible light present and the intensity of the illumination on a surface.” The relationship described between “LUX”, and “Lumens per square meter” in this paragraph was taken from a Google search using the terms, “lux to lumens”.

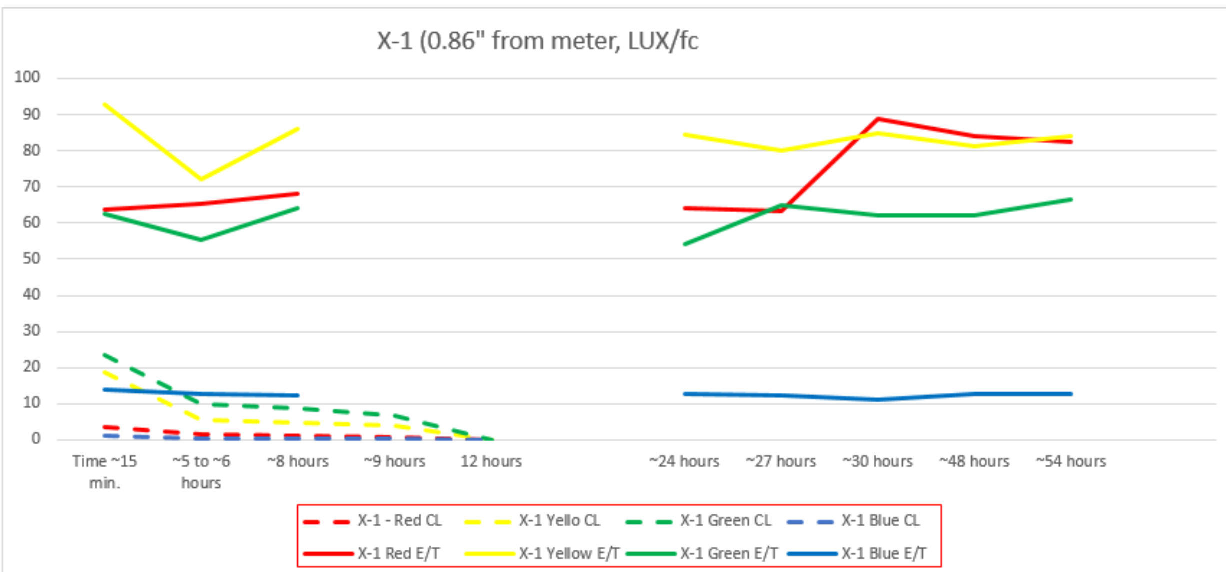
CID A-A-55134 was superseded by September 16ths 2013 CID A-A-55134A. It is important to note that CID A-A-55134A used a different illuminance measuring device. The International Light model IL1700 radiometer was used in conjunction with sensor probe SED 033Y. The 2013 CID does not specify which SED 033Y probe was used, there are many versions. Interesting to note is that for this CID the chemical lights tested were tested at a shorter distance of 0.866” from the chemical light sticks. In effect the reported numbers in the 2013 CID seem higher but it is due to the distance at which the readings were taken. The other odd thing in both CID’s is that the chemical lights were shaken just prior to each reading and this is not a real world scenario.

For the purposes of this experiment, a Sper Scientific, model number 840020C light meters (LUX/fc, certified (N.I.S.T. traceable certificate of calibration)) were used to take both a side measurement and top measurement of the chemical light and E/T Light output. X1 measurements are side measurements taken at ~0.866” from the light sources (chemical lights & E/T Lights).

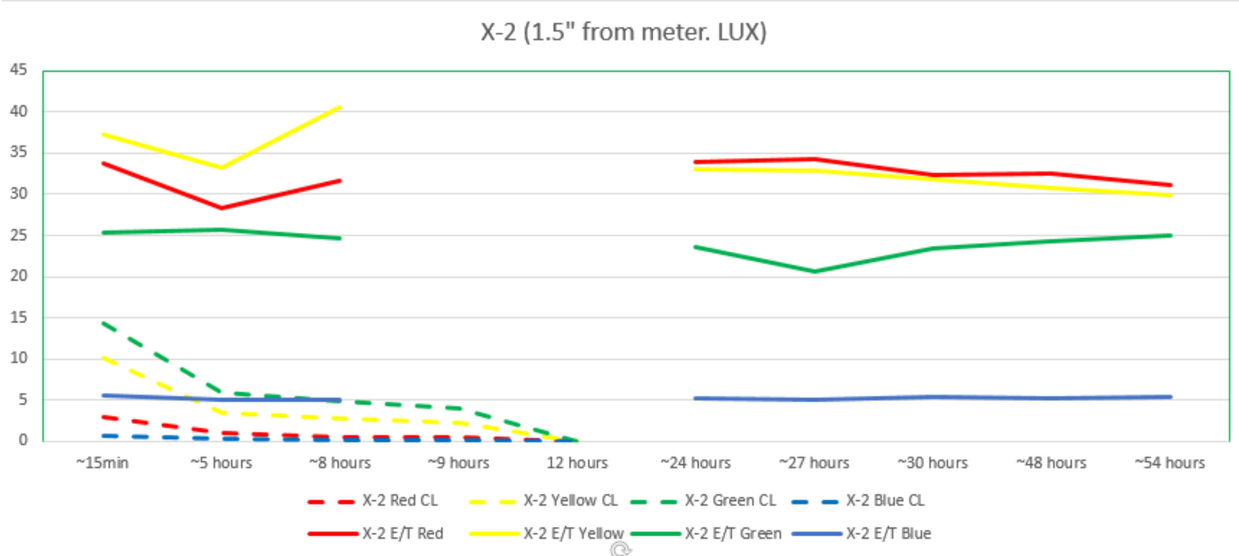
This is to closely duplicate the measurement conditions mentioned in CID A-A-55134A. The X2 measurements are side measurements taken at ~1.5" from the light sources. This is to closely duplicate the measurement conditions mentioned in CID A-A-55134. Y measurements are top side measurements taken at ~0.86" from the light sources. The purpose of this is with drones being depended on more and more for improved situational awareness I thought it would be important to know how well the light sources may be seen from the sky if the user is wearing the light sources in a vertical position.

Unfortunately, due to a shortage of manpower and the conditions in which experiments are conducted during JIFX I was not able to take light measurements every hour on the hour for the 12 hour period, maintain a certain temperature/humidity in the rooms, verify measurement exact angles and exact distances, basically maintain a laboratory atmosphere, so the data that was collected is limited but still informative. Included are an Excel spread sheet with all the light measurements recorded and copies of the original documents on which they were recorded on.

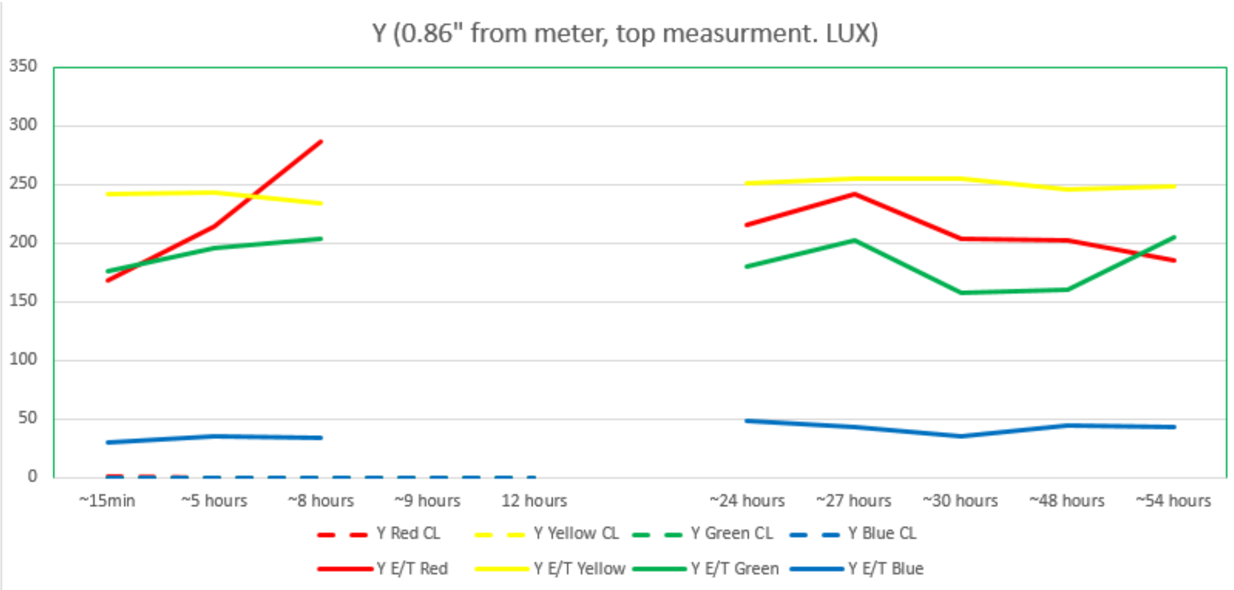
To illustrate the findings for illuminance readings see the following charts:



	X-1 - Red CL	X-1 Yello CL	X-1 Green CL	X-1 Blue CL	X-1 Red E/T	X-1 Yellow E/T	X-1 Green E/T	X-1 Blue E/T
Time ~15 min.	3.68	18.58	23.65	1.27	63.8	92.7	62.5	13.92
~5 to ~6 hours	1.57	5.53	10.09	0.53	65.4	72.2	55.3	12.81
~8 hours	1.14	4.77	8.66	0.36	68	85.9	64.2	12.14
~9 hours	0.96	3.76	6.57	0.3				
12 hours	0	0	0	0				



	X-2 Red CL	X-2 Yellow CL	X-2 Green CL	X-2 Blue CL	X-2 E/T Red	X-2 E/T Yellow	X-2 E/T Green	X-2 E/T Blue
~15min	2.96	10.14	14.27	0.69	33.7	37.2	25.41	5.53
~5 hours	0.9	3.48	5.83	0.22	28.35	33.31	25.67	5.09
~8 hours	0.52	2.66	4.92	0.07	31.75	40.6	24.72	4.95
~9 hours	0.44	2.18	3.91	0.05				
12 hours	0	0	0	0				
~24 hours					33.92	33.04	23.56	5.18
~27 hours					34.28	32.96	20.56	5.03
~30 hours					32.42	31.86	23.36	5.36
~48 hours					32.51	30.71	24.24	5.25
~54 hours					31.07	29.85	25.02	5.33



	Y Red CL	Y Yellow CL	Y Green CL	Y Blue CL	Y E/T Red	Y E/T Yellow	Y E/T Green	Y E/T Blue
~15min	1.55	0.16	0.25	0	168.5	241.2	175.5	30.07
~5 hours	0	0	0	0	213.6	243.2	196.2	35.22
~8 hours	0	0	0	0	286.1	234.5	203.6	33.67
~9 hours	0	0	0	0				
12 hours	0	0	0	0				
~24 hours					215.8	251.4	179.7	48.7
~27 hours					242	255.4	201.8	43.04
~30 hours					203.1	254.7	157.6	35.15
~48 hours					202.3	246.3	159.8	45.3
~54 hours					185	247.9	204.4	43.9

To summarize the above data, the E/T Lights emit more light and last much longer than chemical lights. You will note that the E/T Light readings moved up and down over the time period, whereas the chemical light measurements drop in a linear fashion. The reason for the non-linear readings over time for the E/T Lights is that due to the LED place within the silicon nosecone enclosure and the conical shape of the silicon nosecone, the light emitted from any given point will change. Here is a link to a short video taken after noticing that the readings increased even though time had passed, https://www.youtube.com/watch?v=walTZDWHBBE . Suggest for more exact results, that one of the military labs do a controlled experiment utilizing a integrating sphere to keep track of the lumen output over the life of the light emitting tool. This would be the best way to gather the data and compare the Lumen output over time, say every 5 to 15 minutes.

Following are the high and low (X1 – 0.86" from meter) outputs for each light over the initial ~8 to ~9 hours:

Red chemical light H = 3.68, L = 0.96 Red E/T Light H = 68, L = 63.8

Yellow chemical light H = 18.58, L = 3.76 Yellow E/T Light H = 92.7, L = 72.2

Green chemical light H = 23.65, L = 6.57 Green E/T Light H = 62.5, L = 55.3

Blue chemical light H = 1.27, L = 0.30 Blue E/T Light H= 13.929, L = 12.14

Following are the high and low (X2 – 1.5" from meter) outputs for each light over the initial ~8 to ~9 hours:

Red chemical light H = 2.96, L = 0.44 Red E/T Light H = 33.7, L = 28.35

Yellow chemical light H = 10.14, L = 2.18 Yellow E/T Light H = 40.6, L = 33.1

Green chemical light H = 14.27, L = 3.91 Green E/T Light H = 25.67, L = 24.72

Blue chemical light H = 0.69, L = 0.05 Blue E/T Light H= 5.53, L = 4.95

Following are the high and low (Y (top view)– 0.86" from meter) outputs for each light over the initial ~8 to ~9 hours:

Red chemical light H = 1.55, L = 0 Red E/T Light H = 286.1, L = 168.5

Yellow chemical light H = 0.16, L = 0 Yellow E/T Light H = 243.2, L = 234.5

Green chemical light H = 0.25, L = 0 Green E/T Light H = 203.6, L = 175.5

Blue chemical light H = 0, L = 0 Blue E/T Light H= 35.22, L = 30.07

The chemical light were no longer measured past the initial ~8 to~9 hours. The E/T Light continued to be measured for approximately 3.5 days in total. Following are the highest and lowest readings over the ~3.5 day period:

E/T Light set to red X1 reading H= 88.8, L = 63.2
X2 reading H = 34.28, L = 28.35
Y reading H = 286.1, L = 168.5

E/T Light set to yellow X1 reading H= 92.7, L = 72.2
X2 reading H = 40.6, L = 29.85
Y reading H = 255.4, L = 234.5

E/T Light set to green X1 reading H= 66.6, L =54.2
X2 reading H = 25.67, L = 20.56
Y reading H = 204.4, L = 157.6

E/T Light set to blue X1 reading H=13.925, L = 11
X2 reading H = 5.53, L = 4.95
Y reading H = 48.7, L = 30.07

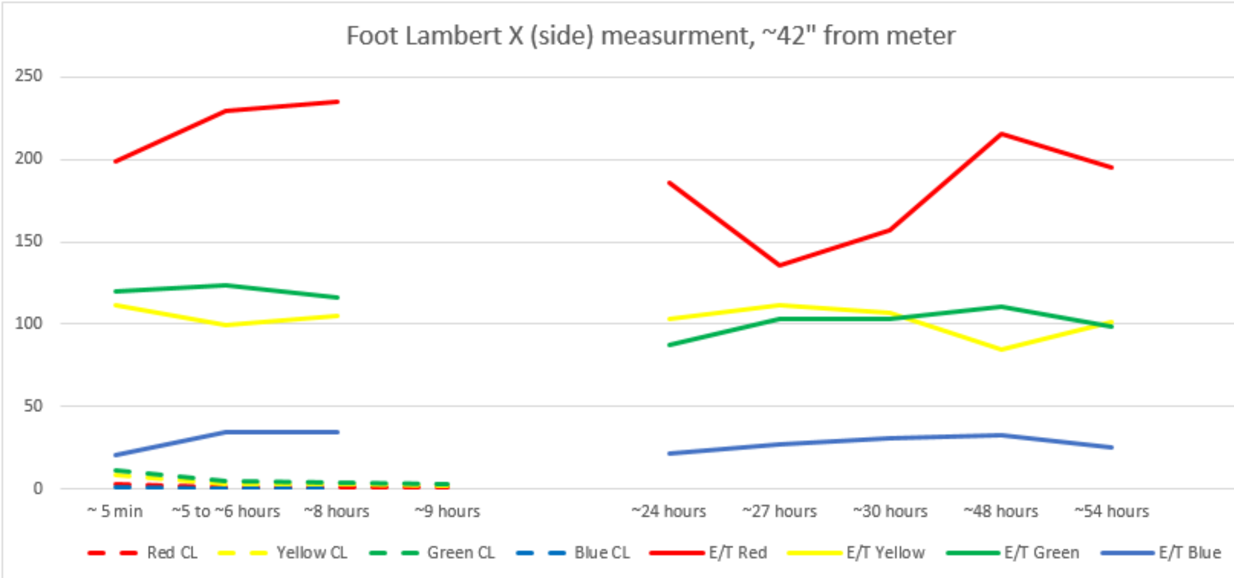
Included is the US Army Aberdeen Proving Grounds MIL-STD 810 testing document to prove the APG lab report, reported an average longevity life for the E/T light set to red of 4.5 days, and if set to blue, an average of 9.5 days. The green averaged 9.2 days, and yellow averaged 5.2 days regarding longevity times.

The second method used to take light readings measures luminance. The Konica Minolta webpage mentioned above explains luminance in the following manner, “Luminance describes the measurement of the amount of light emitting, passing through or reflected from a particular surface from a solid angle. It also indicates how much luminous power can be perceived by the human eye. This means that luminance indicates the brightness of light emitted or reflected off of a surface. In the display industry, luminance is used to quantify the brightness of displays.

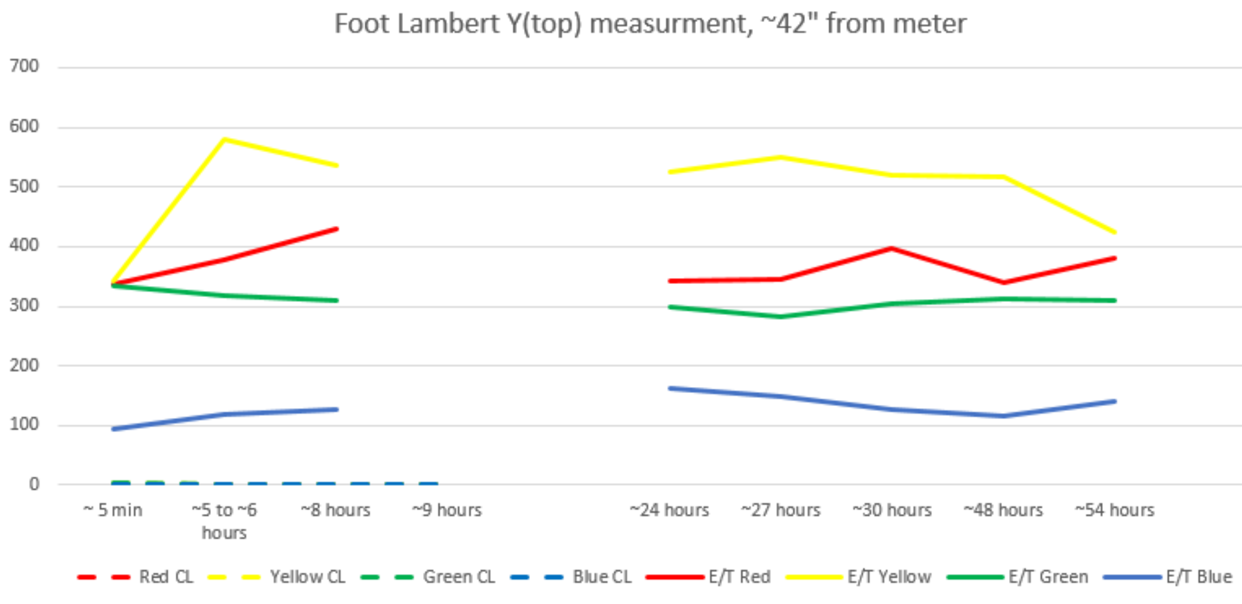
There are a variety of units used for luminance. The SI unit for luminance is candela/square meter (cd/m2). In the U.S. one of the common units is the foot-lambert (fL); 1 foot-lambert (fL) equals 1/π candela/square foot, or 3.426 cd/m2. Professionals in the industry will be familiar with the term nit (nt). Nit is a non SI term used for luminance, and 1 nit is equivalent to 1 cd/m2.

Luminance is quantified using a spectroradiometer, luminance meter or a chroma meter.”

For this experiment a brand new Konica Minolta LS-150 (N.I.S.T traceable) luminance meter was utilized to measure the chemical lights, and E/T Lights output in foot-lamberts. The distance between the meter and the lights was ~42”. Following are the charts showing the data collected.



	Red CL	Yellow CL	Green CL	Blue CL	E/T Red	E/T Yellow	E/T Green	E/T Blue
~ 5 min	3.095	8.49	11.48	0.67	198.7	111.6	120	20.96
~5 to ~6 hours	1.109	2.762	4.97	0.391	229.3	99.39	123.6	34.4
~8 hours	0.793	2.4	4.104	0.366	235.1	105.3	115.8	34.09
~9 hours	0.712	2.188	3.059					
~24 hours					186.2	103.2	87.7	21.6
~27 hours					135.8	111.9	103.6	26.91
~30 hours					156.9	106.7	103.4	30.62
~48 hours					215.5	84.64	111	32.44
~54 hours					195.2	101.2	98.33	25.1



	Red CL	Yellow CL	Green CL	Blue CL	E/T Red	E/T Yellow	E/T Green	E/T Blue
~ 5 min	1.28	2.88	4.7	0.29	335.8	342.8	334	93.56
~5 to ~6 hours	0.498	1.098	2.342	0.173	376.8	580.8	317.7	119.2
~8 hours	0.383	0.969	2.092	0.152	428.6	534.9	309.9	127.3
~9 hours	0.294	0.874	1.663	0				
~24 hours					343.2	526.4	299.5	161.1
~27 hours					344.1	550.5	282	147.5
~30 hours					395.8	520.8	303.2	126.9
~48 hours					340.5	516.9	311.9	115.8
~54 hours					380.5	424.7	308.9	141.7

Once again the E/T Lights prove to be “brighter”, and longer lasting than chemical lights. It’s obvious the E/T Lights are brighter when viewed from the top, like a low level flashlight, but still give off a significant amount of light output to the sides, like chemical lights.

The above mentioned tests also included a set of frozen chemical lights and frozen E/T Lights. Following are the high and low (X1 – 0.86” from meter) outputs for each light over the initial 8 hours in LUX (Illuminance):

Red chemical light H = 1.2, L = 0 Red E/T Light H & L = 62.4 (measured once)

Yellow chemical light H = 1.97, L = 0.46 Yellow E/T Light H & L = 90.4

Green chemical light H = 3.21, L = 1.28 Green E/T Light H & L = 18.3

Blue chemical light H = 0.22, L = 0 Blue E/T Light H& L = 5.67

Following are the high and low (X2 – 1.5” from meter) outputs for each light over the initial 8 hours:

Red chemical light H = 1.1, L = 0 Red E/T Light H & L = 24.86

Yellow chemical light H = 1.65, L = 0.5 Yellow E/T Light H & L = 32.44

Green chemical light H = 2.63, L = 1.34 Green E/T Light H & L = 9.26

Blue chemical light H = 0.22, L = 0 Blue E/T Light H & L = 2.33

Following are the high and low (Y (top view)– 0.86" from meter) outputs for each light over the initial 8 hours:

Red chemical light H = 0.04, L = 0 Red E/T Light H & L = 163.4

Yellow chemical light H = 0.45, L = 0 Yellow E/T Light H & L = 351.7

Green chemical light H = 0.65, L = 0 Green E/T Light H & L = 67.9

Blue chemical light H = 0.74, L = 0 Blue E/T Light H & L = 17.09

The frozen chemical light were no longer measured past the initial ~8 hours. The frozen (~-3 F) E/T Light continued to be measured for approximately 3.5 days in total. Following are the highest and lowest readings over the ~3.5 day period:

E/T Light set to red X1 reading H= 75.6, L = 62.4

X2 reading H = 32.43, L = 24.86

Y reading H = 189.2, L = 163.4

E/T Light set to yellow X1 reading H= 90.4, L = 66.2

X2 reading H = 32.44, L = 24.01

Y reading H = 447, L = 289.9

E/T Light set to green X1 reading H= 20.65, L = 15.66

X2 reading H = 9.41, L = 7.71

Y reading H = 110.9, L = 50.8

E/T Light set to blue X1 reading H=5.67, L = 3.91

X2 reading H = 2.33, L = 1.76

Y reading H = 21.7, L = 15.85

The general observation is that the E/T Light output is lower in colder temperatures than at room temperatures but still very usable. Unfortunately, the numbers for the frozen items are not very accurate. I noticed as the time passed from one test to another that the chemical lights and the E/T Lights got brighter as they started warming up. In order for a proper freeze test/comparison to be done, the measurements need to be taken at the same temperature in which the lights are kept in. Basically, the measurements need to be done in a walk in freezer. Included are copies of the original data entry forms as well as copies of the luminance meter captures.

Qualitative Results (please be as descriptive and detailed as possible):

Part of this experiment included having a questionnaire filled out by observers of the experiment. There was two questionnaires, one for the frozen chemical lights, and frozen E/T Lights, and one for the room temperature chemical lights and room temperature E/T Lights.

Unfortunately, not enough feedback was received to determine at what approximate hour the chemical light output was of no use. The experiment started at 9:47 AM on 5/16/17. One person, a little over an hour from when the experiment started, stated "all the chemical lights were useful for general movement and large object detection, but that they were not useful to read small print." The same person stated the "E/T Lights were more useful for general movement, area scan, searching surfaces and that they could read the small print very easily."

At 11 AM one person wrote the following about the chemical lights (all colors), "Could not read w/chem light positioned at left corner, could read w/all up close over paper. The light was dim & harder to read compared to the E/T." The same person wrote the following about the E/T Light, "(light on left back edge of the table throughout observations for both comments) could not read or make out most letters, could easily read if held over the paper, this applies to all colors. If light were lifted 6" to 12" off left table edge I could make out large letters w/red & yellow, & read the page w/green and blue."

At 9:20 PM, almost twelve hours after the experiment started one person stated the following regarding the chemical lights, "red – usable to read @ 0", yellow @ 2", green @ 1" and blue @0.5"". Same person replied the following regarding the E/T Light, "red - usable to read @ 14", yellow @ 8", green @ 4", and blue @ 6"."

For the next couple of days everyone commented the E/T Light output was usable. Here is a link to a video showing the E/T Light experiment set up and how the chemical lights and E/T Lights looked 24 hours into the experiment, https://www.youtube.com/watch?v=iO8bnaCG6qY . The video includes a shot of the E/T Light and chemical lights in the freezer. You should observe that the E/T Lights in the freezer are just moderately dimmer than the E/T Lights at room temperature.

On 5/17/17 one of the Marines replied that none of the chemical lights were of any use and stated, “While the light output is lower in the frozen E/T’s the frozen E/T shined brighter and lasted significantly longer than the frozen chemlights.” The same Marine wrote the following on 5/18/17 at 10:11 am, “The frozen & unfrozen E/T Lights are still at original brightness. The frozen and unfrozen chemlights are dead. The frozen E/T light are as durable as the unfrozen E/T Lights.”

A second Marine, on the second day stated the chemlights, “no longer works”, and that the E/T Light, “still works great. Good battery life. Very bright.” He stated the following regarding the frozen E/T Lights, “Good durability even when frozen.”

Included are copies of all the original questionnaires with feedback for your review

Observations & Comments:

One of the purposes for the experiment was to determine if the E/T Light is a good augmentation (NOT REPLACEMENT) to one time use chemical lights, for common repetitive tasks performed by all our Military and Federal Agencies. Examples of common repetitive tasks are the nightly marking of personnel, doing buzz saws, using low level lights for reading, marking perimeters, marking equipment, setting up expedited Drop Zones/Landing Zones, or marking hazards, etc... Below is a picture that was taken at Camp Roberts during JIFX 17-3 showing a common repetitive task currently performed by chemical lights. Also observed chemical lights on the ground that should have been in the trash.

For the purposes of being conservative we will state that chemical lights do produce useful light output over the advertised time of 12 hours for the colors red, green, and yellow. The blue chemical light is advertised as an 8 hour item.

For the purposes of determining how long the useful light output for the E/T lights, we will use the reported average number of days in the US Army Aberdeen Proving Grounds MIL-STD 810 lab test report.

Red, green, and yellow chemical lights = 12 hours

Blue chemical lights = 8 hours

Chemical lights weigh 24.8 grams with their protective cover

Chemical light measure approximately 6” X ~0.75” X ~075” = ~ 3.375 cubic inches

E/T Lights have all four colors (R/Y/G/B or IR/R/G/B) in one light.

E/T Light set to constant red = 4.5 days (108 hours)

E/T Light set to constant yellow = 5.2 days (124.8 hours)

E/T Light set to constant green = 9.2 days (220.80 hours)

E/T Light set to constant blue = 9.5 days (228 hours)

E/T Lights weigh 43.2 grams with lanyard

E/T Lights measure approximately 3.125” X 1.125 X ~1.125 = ~3.955 cubic inches

From 2010 to early 2014 we spent approximately $179,536,123.00 in chemical lights just via the DLA alone. I have not been able to find more current numbers so for this analysis we will use the following information that was located back in early 2014. See below:

Chemical light stick contracts since 2010 ($179,536,123.30) and counting:

Green 6” (NSN 6260-01-074-4229) $142,582,353.90

https://www.dibbs.bsm.dla.mil/Awards/AwdRecs.aspx?scope=all&sort=contract&TypeSrch=cq&category=nsn&value=6260010744229

All Awards/Modifications where **NSN/Part Numbers: 6260010744229** sorted by Contract/Delivery Order Ascending
Records Found: **7**

Pages: 1

Click on Contract/Delivery Order number to view contract or MODs/Attachments.

#	Contract/Delivery Order	Awardee CAGE	Total Contract Price	Awarded	Posted	NSN/Part Number	Nomenclature	Purchase Request	Solicitation
1	SPM4A610D0285 » Package View EPROC	1A920	$141,776,630.78	06-10-2010	06-28-2013	6260010744229	LIGHT, CHEMILUMINESC		
2	SPM4A610D028538UD » Package View EPROC	1A920	$90,975.00	08-26-2013	08-26-2013	6260010744229	LIGHT, CHEMILUMINESC	0049988784	
3	SPM4A610D028538UE » Package View EPROC	1A920	$90,975.00	08-26-2013	08-26-2013	6260010744229	LIGHT, CHEMILUMINESC	0050185697	
4	SPM4A610D028539FL » Package View EPROC	1A920	$90,975.00	09-23-2013	09-23-2013	6260010744229	LIGHT, CHEMILUMINESC	0051035024	
5	SPM4A610D028539MV » Package View EPROC	1A920	$42,430.74	10-16-2013	10-16-2013	6260010744229	LIGHT, CHEMILUMINESC	0051173129	
6	SPM4A610D028539MW » Package View EPROC	1A920	$143,291.69	10-16-2013	10-16-2013	6260010744229	LIGHT, CHEMILUMINESC	0051173129	
7	SPM4A610D028539MX » Package View EPROC	1A920	$347,075.69	10-16-2013	10-16-2013	6260010744229	LIGHT, CHEMILUMINESC	0051173129	

Pages: 1

Number of chemical light sticks used in the ~3 year period:

~$179,536,123.00 / $~1.13 per chemical light = ~158,881,524.78 chemical lights

Approximate chemical lights consumed per year:

~158,881,524.78 / ~3 year period = ~52,960,508.26 chemical lights per year

Plastic and chemical waste generated by chemical lights (Note, the chemicals in chemical lights have been found toxic to marine organisms)

Waste in Weight: ~52,960,508.26 chemical lights X 24.8 grams each = ~1,313,420,604.848 grams / 1,000 grams = ~1,313,420.60 Kgs of plastic and chemical waste per year. By moving to a reusable marking/signaling system for common repetitive tasks we would reduce this by ~90+%.

Waste in Volume: ~52,960,508.26 chemical lights X ~3.375 cubic inches each chemical light = ~178,741,715.3775 cubic inches, which equals ~103,438.49 cubic feet of plastic and chemical waste per year. This volume of waste would also be reduced by ~90+%.

Cost savings:

After speaking with many soldiers over the last 13 years and reading the September 2013 PEO Soldier SEP, LUE report, I've learned that only 5% to 10% of the tasks currently performed by chemical lights are truly crack and forget tasks. I've also learned you will never get rid of chemical lights, they serve a purpose. As one war fighter wrote me once, after having read the September 2013 PEO Soldier SEP LUE report, he stated "The testing results were a good read. I'm just as impressed by your diligence to get the product out as I was when I first saw your product.

I recently thought of your triage light after reviewing a report of the humanitarian effort of Operation Damayan in the Philippians.

The Marine Corps Air Traffic Controllers commanded a damaged tower and had issues with expeditious runway lights during humanitarian operations.

They ended up using a tremendous amount of AA batteries to power their devices and some Chemlights to fill the gap. Ironically, procuring a large number of AA batteries comes with significant challenges.

They could have used your LGPs to cut cost & weight. Just an observation.

One interesting note: 60% used LGP as a low level flashlight.

This is true of my personal experience when either in the rear, not actively engaged in operations or in a training environment. Chemlights were also a big part of our training signal plan (improved situational awareness of team members) i.e. placing chemlight in the shoulder pocket to identify 'key leaders'. I also used it heavily as an IR marker during nighttime Air Support and personnel recovery missions in training.

So I concur with the study's findings with the added caveat that Chemlight use has simply become a habitual preference that can be duplicated by the LGP's.

I think you right on the mark about separating items 2&3, they should be combined to capture the true preference of the LGP standard.

Also, the cost savings is a significant oversight in the report. However, as beneficial as the LGP's could prove in both operational and logistical considerations, there is still a place for the Chemlight as a 'disposable' light source. I personally think there is room for both, and adding the LGP alongside Chemlights reduces the financial burden of unit funds while reducing the weight & logistical burden of the warfighter."

Note he mentions an error on the September PEO Soldier, SEP, LUE report. The report starts by stating the soldiers preferred the chemical lights but in the next page it states less than 40% of soldiers preferred the chemical lights. When you take a look at page 25, you see a pie chart. For some reason the report writer separated two versions (6.8A & 6.8IR) of the E/T Lights into 3 parts of the pie, and kept the IR chemical lights and the visible colored chemical lights as one. It turns out the report writer did not include 25% who preferred both the E/T Light and IR E/T Light in their math. Basically, 63% preferred the E/T Lights to 37% who preferred the chemical lights.

By moving to a reusable, four colors in one, personal signaling device, from a one time use crack and forget chemical light, for use in performing common repetitive tasks, taxpayers could be saving tens of millions of dollars every year, and Federal agencies/Military would significantly reduce the plastics/chemical waste generated every year by chemical lights.

NAVSUP already informally & favorably reviewed the E/T Light technology as a product for the reduction of plastic waste at sea.

Ft Sam Combat Medics School has also taken a look and wrote the following AAR, which in part considered long term cost savings:

"AAR COMMENTS FOR THE EMERGENCY TRIAGE LIGHTS

PROS

1. Durability of the E/T light was good, the ease of being able to switch color coding for PT with one hand played an important part of the ongoing triage of simulated patient.

2. The multi-use function was good for funneling all casualties to centralized point. It prevented a chokepoint and allowed a more organized training event.

3. The ease of use for switching colors allowed for less confusion as compared to utilizing multiple chemlights. With one triage light source there was no need to scramble to grab multiple chemlight and no chance of utilizing the wrong color. Also, there was limited confusion as to the actual casualty triage code, due to only one color light source.

4. The durability of light allowed for no mess with accidental breaking of chemlight.

5. Multiple boxes of chemlights not needed, one light can be utilized over and over for training.

6. Cost would be significantly lower than multiple purchases of chemlights.

CONS

1. Using lanyard around neck to mark casualty opens the potential for choking hazard or damage to the airway.
2. Due to the extreme use for training events, a more durable clasp is needed. After two iterations of training, the light was caught on equipment and the clip was bent out.
3. The need to account for each light after each training event, due to the fact that the Soldiers thought they would be fun to take or "forgot they were in their pocket".

Overall the NCOs at SMTS felt the E/T light would be plus to BAS training operations, both in the schoolhouse and also TOE units. Durability, ease of use, multifunctionality, cost and space availability played a factor into the decision making process.

MSG G "

Please note we will soon be moving to a lanyard with no metal components and a plastic breakaway lanyard. This will address two of the three cons mentioned. Issue E/T Lights to every man on base or in the field and you get rid of con number 3.

The calculation for the number of chemical lights required to match the longevity of an E/T Light follow:

Red – E/T lights last 108 hours. Chemical light lasts 12 hours. 108 hrs/12 hrs = 9 chemical lights

Yellow – E/T lights last 124.8 hours. Chemical light lasts 12 hours. 124.8 hrs/12 hrs = 10.4 chemical lights

Green – E/T lights last 220.8 hours. Chemical light lasts 12 hours. 220.8 hrs/12 hrs = 18.4 chemical lights

Blue – E/T Lights last 228 hours. Chemical lights last 8 hours. 228 hrs/ hrs = 28.5 chemical lights

Cost analysis:

One multi-program version 6.8A (NSN 6230-01-605-9650) is roughly $35 each (includes new improved lanyard and 3" EPDM plastic T-tab to easily attach the E/T Light to helmet straps, MOLLE, or other gear)

One chemical light is roughly $1.39 each. Add a 55o cord, breakaway lanyard it is $1.75 more. ($1.39 + $1.75 = $3.14 w/lanyard)

Red – 9 chemical lights X $1.39 each = $12.51
Yellow – 10.4 chemical lights X $1.39 each = $14.46
Green – 18.4 chemical lights X $1.39 = $25.58
Blue – 28.5 chemical lights X $1.39 = $39.62

You spend the above versus the one-time purchase of ~$35 for the longevity of a four color in one E/T Light, and then spend ~$3 for a replacement battery.

As you read the DLA screenshot above you may have noticed the majority of chemical light expenditure is for the green colored chemical light. See contract SPM4A610D0285, showing $141,776,630.78

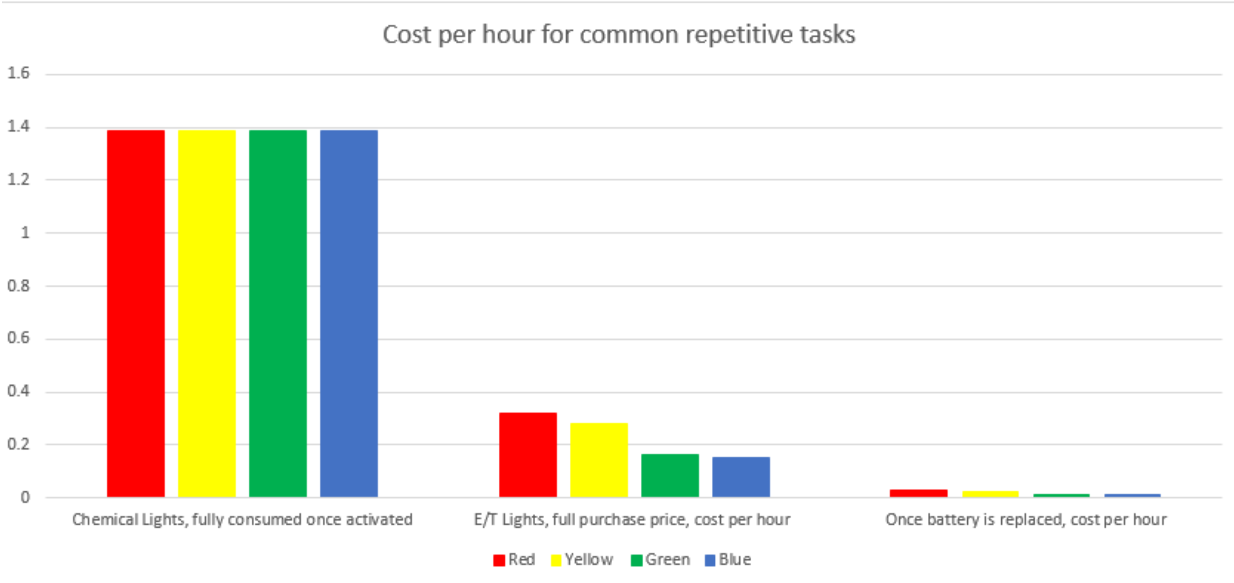
Each E/T Light, set to one color costs:

Red - ~$35.00 / 108 hours = $0.32 / hr.
Yellow - ~$35.00 / 124.8 hours = $0.28 / hr.
Green -~$35.00 / 220.8 hours = $0.16 / hr.
Blue - ~$35.00 / 228 hours = $0.15 / hr.

Each replacement battery costs ~$3.00

Red - ~$3 / 108 hours = $0.03 / hr.
Yellow - ~$3 / 124.8 hours = $0.02 / hr.
Green - ~$3 / 220.8 hours = $0.01 / hr.
Blue - ~$3 / 228 hours = <$0.01 / hr.

Chemical always will cost the purchase price since once cracked they are fully consumed. See cost analysis chart below:



	Red	Yellow	Green	Blue
Chemical Lights, fully consumed once activated	1.39	1.39	1.39	1.39
E/T Lights, full purchase price, cost per hour	0.32	0.28	0.16	0.15
Once battery is replaced, cost per hour	0.03	0.02	0.01	0.01

There are other benefits and savings the E/T Lights offer

Chemical light shortcomings:

1. They cannot be turned off when needed, posing a hazard to our troops.
2. When processed as waste at sea, they leave a glowing trail behind the ships.
3. They function poorly if at all in low temperatures.
4. They can break and expose the warfighter to the glowing chemicals which can pose a risk to that soldier.
5. If used for triage they can break and contaminate the patients wounds not only with the “harmless chemicals”, but also with the shattered vile inside the chemical light
6. Cannot flash.
7. Must be continuously replenished, adding to logistical costs and volume
8. There is a time and cost expense associated with repurchasing, collecting, and disposing of spent chemical lights.

Weight for capability:

1 E/T light weighs 43.2 grams for four color capability.

4 chemical lights weigh (24.8 g X 4 =), 99.2 grams.

The chemical lights weigh more than double for the one time use four color capability.

Weight savings over time for the capability/longevity:

Red – 9 chemical lights X 24.8 grams each = 223.2 g
Yellow – 10.4 chemical lights X 24.8 g = 257.92 g
Green – 18.4 chemical lights X 24.8 g = 456.32 g
Blue – 28.5 chemical lights X 24.8 g= 706.8 g

It takes the above numbers per color to match the longevity of one 43.2 gram E/T Light. Then you replace one 11.2 gram battery to go back to full longevity.

Battery:

I was asked by a Marine at JIFX 17-3 how other battery powered chemical light stick alternatives to chemical lights performed. I mentioned that the E/T Lights had been compared to the Lazerbrites by a US Army Ranger and that he mentioned they used coin cell batteries. In my experience coin cell batteries do not last as long and the light output diminishes quickly when compared to CR2's or CR123's. The E/T Lights utilize a CR2 Lithium Metal battery, a common camera battery that is in the supply chain. Following is the AAR that in part discusses this:

"ATSH-RBE-A

MEMORANDUM FOR RECORD

SUBJECT: Triage Lights vs. Lazer Brite Lights

Issue #1

Battery Life

Discussion:

Both lights were fitted with a new battery and turned on. The Lazer Brite only has red and the Triage light has multiple. So to keep things equal the Triage Light was set to red as well. At approx. the 96 hour mark the Lazer Brite light had lost almost all if it's luminosity. It was still on but it was effectively useless. The Triage light ran at full power for the duration of it's battery life of 162 hours of Operation. A fact to remember is also the red light is the most power draining of the four visible light colors. The Triage Light under different colors would last even longer. The Lazer Brite light did last for an extra 22 hours, but as stated before their effectiveness was essentially non-existent.

Recommendation:

Based on the ability of the Triage Light to operate at full capacity for the duration of the battery makes it a much more feasible light for long durations.

Issue #2:

Versatility

Discussion:

The Lazer Brite lights that were given to be tested were only single color. A set of Red and a set of IR. The Triage Lights contain in one light four visible colors, Red (steady/blink), Blue (steady/blink), Amber (steady/blink) and Green (steady/blink). They also have the IR light built in as well. Giving one light the ability of five separate Lazer Brite Lights. Each Lazer Brite light is approx. $32 making one $35 Triage light as cost effective as $160 of Lazer Brite lights. The fact that the Triage Lights have 5 multiple colors makes it useful for every situation. The Triage lights also have a lockout function that keep the light from being turned off accidentally when used as an actual Triage light. This keeps a patient from changing his light indicating his status to another color.

Recommendation:

A single Triage Light can be used in five times more situations than a single Lazer Brite light. That would cut down on how many lights must be carried. This helps with weight of packing lists and the ability to quickly utilize a single light instead of searching through a bag of lights to find the correct color. The Lazer Brite lights are simply marked with a color coordinated band near the switch. This would be hard to identify under limited visibility.

Issue #3:

Durability

Discussion:

There were multiple tests run on the Triage Light to test its ability to last in the most extreme conditions. One test that was ran here was to freeze the lights to see how they last under extreme cold. The same effectiveness for the luminosity was found for each light. The Triage Light ran at full power for the duration, with the Lazer Brite falling off around day 4. Strangely the frozen lights lasted longer by almost 21 hours vs. the ones at room temperature. I found quite a bit of testing done on the Triage light but could not find any on the Lazer Brite. I was going to conduct a slam test on both light. I repeatedly threw the Triage Light onto the pavement to see if it would stop functioning. It continued to function perfectly. I was not allowed to do this to the Lazer Brite since it would most definitely break due to its plastic shell. A few instructors have used the Lazer Brite lights before and reported that the on/off mechanism breaks often. I found where the Triage Lights have a life of over 30,000 cycles without problem. I attached more evaluations from the Triage Lights. I do not have or could not find equivalent evaluation for the

Lazer Brite. There were such tests as freezing the Triage Light to -109F dropping it, boiling the light, then refreezing to -109F. The Triage Light worked normally in all situations. It can be used as a dive light to 200ft down, and it has been dragged behind cars just to name a few of the tests conducted.

Recommendation:

The durability of the Triage Light has been proven through multiple tests. Some conducted here and some conducted by the manufacturer. The Triage Light is essentially indestructible and the Lazer Brite lights seem to be lacking durability with its plastic components. There are multiple pieces that could easily break on a Lazer Brite light that would need replaced. The triage light has a silicon outer shell with literally no chances of breaking

Issue #4

Visibilty

Discussion:

The lights were used as DZ Marking for an Aerial Resupply via poncho parachute during a Ranger Class. The first pass was conducted used the standard sand bag lights for DZ/LZ use. The next pass was conducted using the Triage Lights set on Red (Lazer Brite only had red so it was done for equality) and the pass was conducted. The third pass utilized the red Lazer Brite lights. An AAR was conducted with the pilots and there was not distinguishable differences between the lights. For Reference the flight was at 100ft @ 30 Kias.

Recommendation:

There seems to be no difference in the light output of the two lights. The only issue I would point to is in issue #1 with the Lazer Brite lights losing their ability to output at max capacity for long periods.

Issue #5

Accessories

Discussion:

The Lazer Brite kit that was provided come with five red lights five IR lights, five stake adapters, five directional adapters and some elastic bands. It also came with replacement batteries and some replacement caps in the event they were broken. The stake adapters made it easy to emplace the lights during the DZ operation. The little elastic bands were similar to girls hair ties. These would make it easy to attach to rucks and MOLLE gear. Although the nature of the on/off switch which is a twisting motion can easily be switched off if the light is rubbed against an outside object. The directional adapters would give the ability to direct light if the situation arose. The Triage Lights test had looped bottoms along with bottoms that were magnetic. The bottoms of the Triage Lights are easy to pop on and off. They did not have a directional attachment. Although the light come in a small clear plastic container. With a piece of Gorilla Tape the small plastic containers were made into a directional adapter. The Triage lights did not have a stake adapter. But a purchase of 5 stakes at $0.49 at a local hardware store easily made such an adapter. The magnetic bottoms held onto the stakes at over 40 mph driving down the road which would be similar to rotor wash of an LZ/PZ. The Triage Lights come with the Lanyard for use as a triage light hanging around the neck of a patient. They also come with an EPDM band that will allow you to quickly attach the light to rucks, helmets, MOLLE gear etc. The nature of the switch and lockout function prevent the light from being accidently turned off like the Lazer Brite light. The Lazer Brite kit was sent specifically for test in a combat environment. The Triage Lights were purchased by an Instructor in a prior unit for use as Triage Lights during his deployment. So the kits were not something that they had available. They used some good 'ol field craft to make it work. The Triage Manufacturer was contacted and stated that similar kits could be constructed and thought that the price would be similar or less than the Lazer Brite kit.

Recommendation:

The Lazer Brite Kit came with many useful attachments. The Triage Lights with minimal field Craft became as bit effective as the Lazer Brite Lights. More contact with the Triage Manufacturer would be needed to get a good comparison. In this situation a $170 worth of Triage Lights and $4 in field craft made the Triage Lights as effective as a $400 kit of Lazer Brite Lights."

Volume calculations:

One E/T Light = ~3.955 cubic inches

One chemical light = ~3.375 cubic inches

4 chemical lights R/Y/G/B) = ~13.5 cubic inches (~3.375 X 4)

Red – 9 chemical lights X ~3.375 ci = 30.375 ci
Yellow – 10.4 chemical lights X ~3.375 ci = 35.1 ci
Green – 18.4 chemical lights X ~3.375 ci = 62.1 ci
Blue – 28.5 chemical lights ~3.375 ci = 96.1875 ci.

The above numbers per color versus the 3.3955 cubic inch E/T Light for the longevity capability.

Logistical cost reductions:

There are unmeasurable cost savings associated with the recovery, management, and constant repurchasing of chemical lights. Simply think of shipping logistics. Would you prefer to be shipping barrels of chemical lights or a small box off replacement batteries? Use the room for more important items. Another benefit is the batteries can be used for a variety of equipment and/or rechargeable batteries are an option.

Additional Questions:

Did you receive constructive end-user feedback on technology?

Yes. One of the Marines was extremely skeptical at the beginning. He mentioned how the crack and forget feature of the chemlights was important. Once I made it clear that the intention was to “augment”, not “replace” the chemical lights for common repetitive tasks he then seemed convinced of the possibilities.

Did you discover additional capabilities with could be included in your technology?

Yes. Combining color coded illumination with the communicator technology could have some interesting possibilities. Also the IR feature may have worked well in conjunction with some of the imagining technology being carried on the drones. I am waiting for feedback on this.

Did you discover additional applications of the technology you produced?

Yes. By maybe adding a recorder of some kind to take the medics notes and have that transmitted and stored along with time and GPS location. It also came to mind that drones could drop the E/T Lights as nighttime cookie trail markers, helping lead responders to patients or responders out of dangerous situations.

Did you perform any on the fly development of your technology during the JIFX week?

No.

Were you provided with additional data necessary to conduct your experiment?

No

Were you provided with support services necessary to conduct your experiment?

Yes. The Marines were invaluable regarding feedback and participating during the length of the experiment. Scott, Ashley, Scott, Dirk and others were all very helpful and did everything possible to make the experiments happen. I am honored to have met them and worked with them.

Did you engage in ad-hoc experimentation or collaboration with other experimenters? If so, include names of those experiments for purposes of identification.

Yes, loaned an IR E/T Light for use in the daytime collaborative experiment on Thursday. Waiting to hear feedback.

Did members of the Joint Vulnerability Assessment Branch (JVAB) look at you experiment? If so, please describe the interaction.

No.

What, if any, are the uniquely valuable aspects of this event?

Great opportunity to interact with other developers and stakeholders. Improve research skills, and think outside of the box.

Photo/Graphics (*please keep the file size to a minimum)*:

<u>Picture of Sailors using chemical lights for a common repetitive task performed on board ships</u>

<u>Chemical lights and E/T Lights after ~24 hours in the freezer at JIFX 17-3</u>

<u>Picture sent by TCMC personnel from Ft Sam Houston during their evaluation</u>

E/T Lights in use by our Nations State Task Forces in an ESF-9 nighttime training exercise to improve situational awareness, performance, and accountability. Teams were broken into the Yellow team, the blue team, the red team. Team leaders set their E/T Lights to flash. Incident command was green and safety officers utilized the multi-color rotating selection to ID themselves. The multi-color rotating selection has been used in Afghanistan as a Mass Casualty Collection point marker.

E/T Light shown with Magnetic base accessory & conveying the four color in one device capability

Stakeholder Evaluation(s):

Do you consider yourself to be a Subject Matter Expert?

1. Yes
2. No
3. Yes
4. No
5. No
6. Yes
7. No

Is this Experiment Relevant?

1. Yes
2. Yes
3. Yes
4. Yes
5. Yes

6. Yes
7. Yes

What Areas of the RFI does this experiment relate to?

1. C3. Small Vessel Cooperative Identification and Tracking (SVCT) and Non-Cooperative Vessel Imaging and Tracking (NVIT), E2. Maritime Domain Awareness
2. No response
3. I2. Deployable Lighting Technologies
4. I2. Deployable Lighting Technologies, I3. Energy efficiencies
5. F1. Non-combatant Evacuation Operations (NEO)
6. D5. Location, Tracking and Communication Technologies F1. Non-combatant Evacuation Operations (NEO) F2. Interoperable Communication Solutions in Network Denied Disaster Response Environments
7. E3. Improved Situational Awareness and Collaborative Tools/Applications for Synchronized Execution F1. Non-combatant Evacuation Operations (NEO) H1. Signature Reductions and Management I2. Deployable Lighting Technologies

Additional areas not listed above?

1. No response
2. No response
3. No response
4. No response
5. No response
6. Rapid visual patient tracking, marking for night operations, friendly troop
7. No response

How much of an improvement is this technology over existing solutions?

1. High
2. Medium
3. High
4. Medium
5. High
6. High
7. High

What are the observable strengths of this technology?

1. Physical Size, Physical Weight, Physical Robustness, Cost of Unit/System, Other
2. No response

3. Physical Size, Physical Weight, Power Requirements, Operating Endurance, Scalability to Multiple Units/Users, Ease of Integration
4. Physical Robustness, Operating Endurance, Usability/Intuitiveness, Complies with Existing Standards
5. Physical Size, Physical Weight, Physical Robustness, Power Requirements, Operating Endurance, Usability/Intuitiveness, Training Requirements
6. Physical Size, Physical Weight, Physical Robustness, Speed of Deployment, Usability/Intuitiveness, Scalability, Ease of Integration
7. Physical Size, Physical Weight, Physical Robustness, Power Requirements, Operating Endurance, Resilience to user during failure conditions, Speed of Deployment, Usability/Intuitiveness, Training Requirements, Scalability, Ease of Integration, Ability to operate in isolation

Additional strengths not listed before?

1. With this unit, the need to use 4-8 chemlights per CRRC per day over a 2 week training package could make a huge difference in money, weight, and overall space used for transportation.
2. Better visibility, longer life, resuable, less waste
3. No response
4. No response
5. No response
6. No response
7. No response

Observable weaknesses of technology?

1. No response
2. No response
3. Cost of Unit/System
4. No response
5. Cost of unit/system
6. Power Requirements, Resilience to user during failure conditions, Cost of Unit/System
7. No response

Weaknesses not Listed Before?

1. Would like to see how well they stay connected during surf passages with CRRCs and how they fare in salt water.
2. One more thing for the warfighter to carry
3. No response
4. None identified
5. No response

6. No response
7. No response

Does this experiment aid in refining RFI elements?

1. Yes
2. No response
3. Yes
4. No
5. No
6. Yes
7. No

Does this experiment represent a new approach to bridging a capability gap?

1. No
2. Yes
3. No
4. No
5. Yes
6. Yes
7. Yes

Did the experimenters modify current technology for a new application?

1. Yes
2. Yes
3. Yes
4. Yes
5. No
6. Yes
7. Yes

Did the experiments collaborate with other experiments on a potential solution?

1. No response
2. No response
3. No
4. Yes
5. No
6. Yes
7. Yes

Did you attend an experiment by the participant at a prior event?

1. No
2. No
3. No
4. No
5. No
6. No
7. No

Additional Comments

1. No response
2. So these comments just apply to the LED lights in general for both G-1 and I-1. Clearly these lights are better quality than the chem lights currently used. The fact that they have long battery life and can be turned on and off makes them a no brainer.
3. Lights can coexist with with chem lights. Cannot replace chemlight but can help supplement the use of chem light would be good for repeated task where you could collect the light at a later time.
4. No response
5. This item wont fully replace chem lights, but there are multiple situations where small reusabld lights would be useful, such as: in amphib ops, marking lines in a FOB, as a buzzsaw for marking an LZ.
6. Great product w a growing listof uses. Would like to bring down to Camp Pendleton for use at 1st Recon Bn for use/integration during a reconnaissance and amphibious package.
7. Very practical improvement over Chem lights in brightness, endurance and form factor. Potentially superior in terms of cost and environmental impact as well.