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INCLUSION OF ETHYLENE CONTROL TECHNOLOGY ON EXISTING MULTI TEMPERATURE REFRIGERATED CONTAINER SYSTEM

September 2021

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**INCLUSION OF ETHYLENE CONTROL TECHNOLOGY ON EXISTING
MULTI TEMPERATURE REFRIGERATED CONTAINER SYSTEM**

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Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN PROGRAM MANAGEMENT

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ABSTRACT

The natural process of ripening for fresh fruits and vegetables (FF&V) releases ethylene gas and as the concentration of ethylene increases in an enclosed environment, the ripening and spoilage process accelerates. Annually, the deterioration of produce arriving to our different Main Operating Bases (MOB) increases the burden on waste, cost, and logistics to the Army's budget.

This study focuses on the viability of integrating ethylene control devices (ECD) in the Multi-Temperature Refrigerated Container System (MTRCS) to prolong the shelf life of FF&V. MTRCS are currently used by Army units in the field to store the food products they receive from the transportation pipeline.

Although already in production, the Product Manager Force Sustainment Systems (PM FSS) office is considering an equipment modification that would install an ECD to the MTRCS, removing excess ethylene from containers storing FF&V. Prolonging the shelf life of these items has huge cost and morale (possibly even health) implications for our troops downrange. Through a cost benefit analysis methodology and return on investment calculations, we demonstrate that the ECD modification to be affordable and cost effective, which avoids FFV arriving in the field at the tail end of the pipeline, already somewhat degraded.

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LIST OF ACRONYMS AND ABBREVIATIONS

AAO	Army Acquisition Objective
AC	Alternating Current
AE	Active Enlisted
Ah	Amp-hours
AMCOS	Army Military-Civilian Cost System
BY	Base Year
C	Celsius
CMF	Career Management Field
DC	Direct Current
DLA	Defense Logistics Agency
DOD	United States Department of Defense
ECD	Ethylene Control Device
F	Fahrenheit
FF&V	Fresh Fruits and Vegetables
FOB	Forward Operating Base
FSS	Force Sustainment System
FY	Fiscal Year
Hz	Hertz
Kg	Kilograms
kW	Kilowatt
kWh	Kilowatt-hour
lbs	Pounds
M	Million
MAS	Maneuver Ammunition System
MOB	Main Operating Base
MOS	Military Occupational Specialty
MPA	Military Pay Army
MTBF	Mean Time Between Failure
MTRCS	Multi-Temperature Refrigerated Container System
NPS	Naval Postgraduate School

OPA	Other Procurement Army
PA	Pennsylvania
P-Form	Procurement Form
ppm	Parts Per Million
QRF	Quick Reaction Force
ROI	Return on Investment
SBIR	Small Business Innovation Research
SQ	Status Quo
TRL	Technical Readiness Level
TYAD	Tobyhanna Army Depot
UV	Ultra Violet
V	Volts
VAC	Volts Alternating Current
VDC	Volts Direct Current
W	Watt

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—Javier Ramos

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I. INTRODUCTION

Fresh fruits and vegetables (FF&V) are divided in two groups, climacteric or non-climacteric. The climacteric fruits reach a certain point of maturity, and once in that point, they will continue to develop to full maturity even when removed from the plant. Climacteric fruits such as apples, kiwis, bananas, and tomatoes continue to gain flavor and get sweeter by changing starch into sugar. Many also go from firm to soft and juicy (for example, bananas and kiwis). Ethylene gas, which fruits and vegetables self-generate, further accelerates the ripening process. The temperature also affects the shelf life, accelerating the maturation and spoilage. The objective of this project is to study the costs, benefits and affordability of transitioning developmental ethylene control (EC) technology into systems used for the storage and transportation of FF&V.

EC technology provides extended shelf life and improved quality of fresh produce, distributed and stored throughout the military supply chain. The proposed EC technology upgrade initiative provides a potential return on investment (ROI), which we study in this research. A U.S. Transportation Command (TRANSCOM) white paper proposal claimed that a mixed load of produce costing \$17k can be lost (spoiled) due to high levels of ethylene larger than 1 part per million (ppm) in the container, accelerating maturation, and spoilage of more than 20 percent of the load (i.e., spoilage losses exceeding \$3k) (Lavigne, 2018, p. 1).

The ripening process of fruits and vegetables releases ethylene gas. When the concentration of the gas exceeds 0.1 parts per million (ppm), the ripening process accelerates. Be able to control ethylene in storage and processing of fresh fruits and vegetables provides ultimate quality to the consumer. A new device was developed to control the ethylene concentrations in refrigerated containers. This ethylene control device (ECD) is compact, low cost and lightweight. Using ultraviolet (UV) light technology the ECD has demonstrated to reduce ethylene concentrations below 0.1 ppm, eliminating 38% of the ethylene in air at rate of 50 cubic feet per minute (PM FSS, email to author, March 2018). During the elimination process, ethylene is rapidly oxidized to carbon dioxide and water vapor (Lavigne, 2018, p. 1).

During a test performed in 2018 (Lavigne, 2018 p. 1), a 2000 pound mixed FF&V load was located inside a 270 cubic foot refrigerated container. The ethylene concentration reduced from 60 ppm to below 2 ppm and provided extra 7 days of shelf life, with better quality and freshness than the control group of FF&V.

Maintaining ethylene concentrations low in a refrigerated storage can extend the shelf life of FF&V from days to weeks. The proposed study by TRANSCOM supports the accelerated transition to EC technology into ongoing production programs managed by PM-FSS for both the Multi-Temperature Refrigerated Container System (MTRCS) and the TRICON Refrigerated Container System (TRCS) (Lavigne, 2018 p. 1). Furthermore, the EC technology will not only extend the shelf life of FF&V, it maximizes the quality and nutritional value and thereby increases the morale of receiving warfighters.

The technology is currently at technology readiness level (TRL) 5 for the MTRCS/TRCS applications. The proposed initiative leverages the successful development of EC technology initiated in fiscal year (FY) 2006 under the Army Small Business Innovation Research (SBIR) program, which received an Army SBIR Quality Award in 2011 (Small Business Innovative Research [SBIR], 2007). This initiative would facilitate immediate transition of EC technology to the MTRCS as a plug-in enhancement. The EC technology will be configured to provide safe, reliable operation with minimum power draw within the MTRCS/TRCS applications, where an on-board generator or shore power supports the refrigeration system and associated EC enhancement. The EC technology utilizes ultraviolet light to irradiate a catalyst within the device, which converts oxygen to ozone. As ethylene-containing air flows through the device, the ethylene is quickly reduced to carbon dioxide and water vapor. The EC device (ECD) is configured with an ozone sensor that ensures fail-safe operation, which verifies that ozone is not emitted/exhausted from the device. The ECD is also configured to provide diagnostic information in the event of a fault. The possible faults and associated corrective measures are fully detailed in the ECD operation/maintenance manual. The proposed quick reaction force (QRF) will facilitate rapid transition of ethylene control technology for Multi-Temperature Refrigerated Container program of record (POR) SSN M65801, TRICON Refrigerated Container Program Element 0604713A-548, MILVAN, commercial/leased refrigerated container

assets and walk-in refrigerated storerooms. Technology readiness level 7 will be achieved through this initiative, as projected transitions are scheduled for phase-in to ongoing production contracts (MTRCS and TRCS), while implementation to existing fielded assets would be readily facilitated through enhancement kits (Lavigne, 2018, p. 2).

A. MULTI-TEMPERATURE CONTAINER SYSTEM (MTRCS)

In order to support the Army transformation, emerging concepts, Total Army Field Feeding-2010 (TAFF-2010), and the current Army Field Feeding System-Future (AFFS-F) concept, there is a need to provide a flexible, rapidly deployable, and resource-efficient, refrigerated subsistence distribution capability that is capable of supporting meal preparation across the spectrum of military operations. The Army requires the capability to efficiently distribute and store subsistence in order to support maneuver sustainment. Perishable subsistence is required to remain frozen or be retained in a chilled state. Semi-perishable rations can be distributed in either an ambient or chilled state. The MTRCS (as shown in Figure 1) supports emerging objective force and interim brigade combat team (IBCT) doctrine (Office of the Deputy Assistant Secretary of the Army [ODASA], email to author, February 2007).



Figure 1. MTRCS Lifting End View Showing Integrated Bale Bar and Rail System Source: ODASA (email to author, June 2011)

Under the operational and organizational concept for the IBCT, the two major changes are no stocks forward and the requirement for resupply on an every other day basis. This means field sections for feeding must be capable of receiving and holding rations for 2 or more days rather than drawing rations daily for the next day's use.

The MTRCS described replaces the single-temperature/purpose-refrigerated containers (LIN C84541), reduces the known shortfall in refrigerated containers (LIN C84541), and meets the newly identified operational need for multi-day replenishment of subsistence. The MTRCS will have the capability to deploy fully stocked with perishable food and to maintain products in a serviceable condition for 24 hours without power, should power or the refrigeration unit fail to operate. Figure 2 shows the loading side of the MTRCS.



Figure 2. MTRCS Loading End View with Cargo Netting Rolled Up.
Source: ODASA (email to author, June 2011)

The MTRCS is compatible with a self-contained, heavy expanded mobility tactical truck-load handling system (HEMTT-LHS), and the International Organization for Standardization (ISO) compatible, multi-temperature refrigerated container (shown in Figure 3). The MTRCS has the capability to simultaneously keep frozen, chilled, or semi-

perishable ration components at appropriate temperatures for safe food handling. The MTRCS is an integrated system that leverages the current ISO container and potential commercial refrigeration technology (ODASA, email to author, February 2007).

The MTRCS consists of an insulated container (IC) with an electrically driven and/or multi-fuel capable (i.e., diesel and family of jet propulsion (JP) fuels) mechanical refrigeration unit. The IC also contains a partition that allows the interior of the IC to be divided into both frozen and chilled compartments. The MTRCS is consistent with constraints centered on manpower and personnel integration (MANPRINT) requirements for the 5th percentile female through the 95th percentile male soldier (ODASA, email to author, February 2007).



Figure 3. MTRCS and Flatrack on HEMTT-LHS and PLS Trailer. Source: ODASA (email to author, June 2011).

B. ETHYLENE CONTROL DEVICE

The Bluezone Model 2400 (see Figure 4) is an air purification device that eliminates airborne contaminants including microbes (fungi, mold and bacteria), odors and ethylene.



Figure 4. Bluezone Model 2400 Air Purifier.
Source: Bluezone (2021).

As shown in Figure 5, the number of microbes in the air is reduced considerably after 60 minutes of operation. This is one of the best qualities of the Bluezone models. The technology, not only reduces the ethylene in the MTRCS, it also reduces the amount of mold and bacterial growth—lowering the possibility of spoiled FF&V affecting the warfighter in the field.

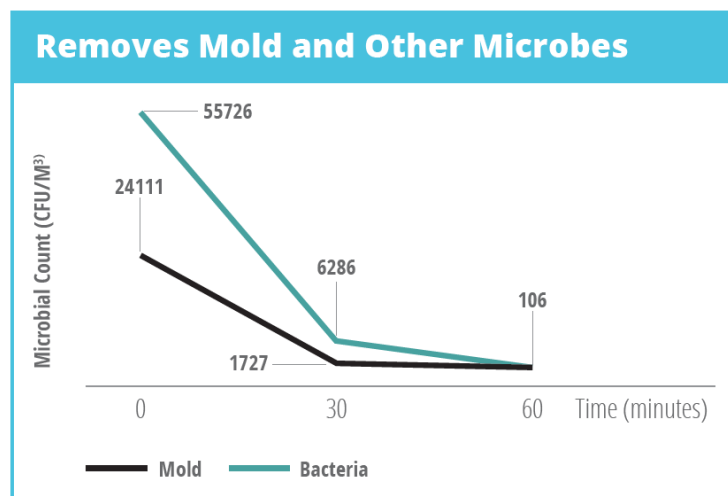


Figure 5. Microbial Removal Performance Bluezone Model 2400. Source: Bluezone (2021).

The Bluezone Model 2400 is designed for use in cold storage and large walk-in coolers as depicted in Figure 6. The Model 2400 can be hung or mounted to the ceiling or wall or located on a shelf. This location inside a container, enhances the usable space of the container and minimizes temperature losses during use.



Figure 6. Bluezone Installed Inside the Container. Adapted from Jamieson et al. (2016, p. 12).

The Bluezone Model 2400 draws in air containing ethylene (see Figure 7) and mold that can lead to early ripening and decay of FF&V, and discharges air with a highly reduced concentration of these impurities. The unit is completely self-contained, meaning the facility, produce, food, and personnel have no contact with the process that is cleaning the air.

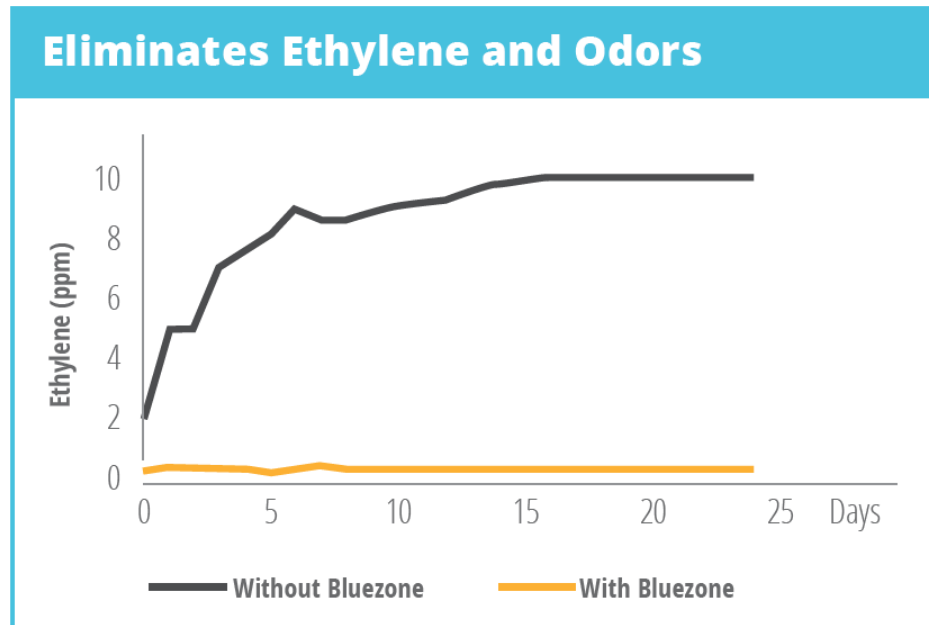


Figure 7. Ethylene Measurements with and without Bluezone. Source: Bluezone (2021)

The ECD device safety features ensures the produce and personnel have no contact with the cleaned air. Per Bluezone’s factsheet, the unit is capable of maintaining ethylene concentrations within refrigerated FF&V storage spaces below 0.5 PPM, thus extending the shelf life of the FF&V (Bluezone, 2018). The Bluezone Unit’s operation is controlled by a microprocessor that maintains safe operation and alerts the user to system faults. The possible fault conditions are described in the operation and maintenance manual, which is provided with each system (Bluezone, 2018). Figure 8 depicts the unit properly mounted inside of the refrigerated container aboard a Mediterranean shipping container (MSC) vessel.



Figure 8. Bluezone Installed in Container. Source: Jamieson et al. (2016, page 12).

C. COMPARISON OF FF&V CONTROL UNIT AND ECD

The Systems Equipment and Engineering Team, Combat Feeding Directorate, U.S. Army Natick Soldier Research, Development and Engineering Center, executed an ECD test and evaluation in 2016. There was a close monitoring of the FF&V over a period of 21 days. The ECD utilized was the Bluezone Model 2400. Figures 9–11 show test samples of the performance of ECD on containers (Jamieson et al., 2016, p. 12). In Figures 9–11 you can see how the different fruits and vegetables are able to remain fresh after 21 days inside an enclose container.

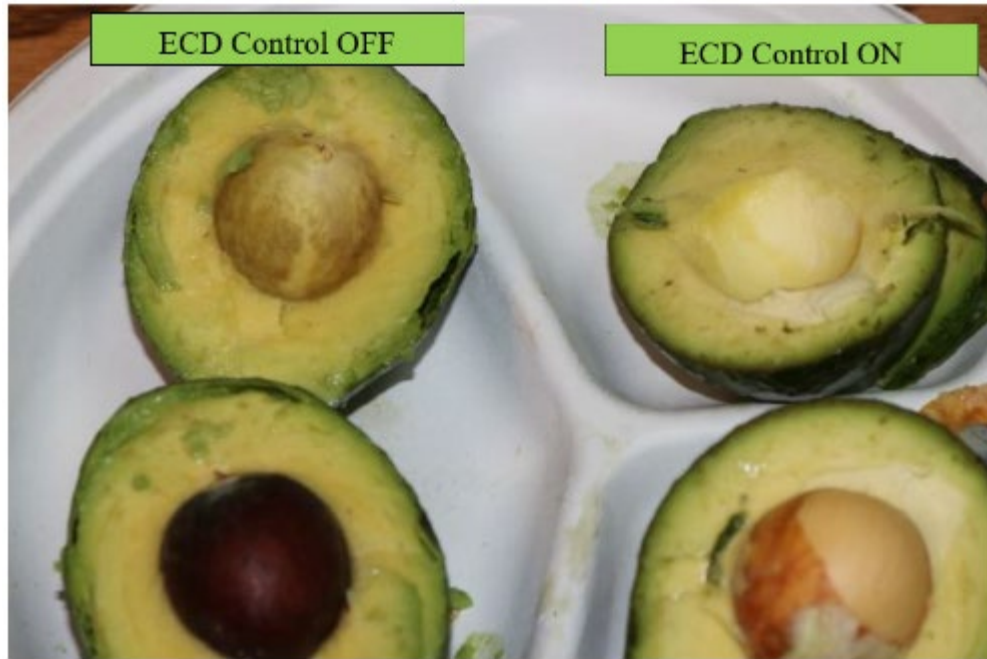


Figure 9. Avocado, Day 21, ECD OFF vs. ECD ON Comparison. Adapted from Jamieson et al. (2016, p. 12).

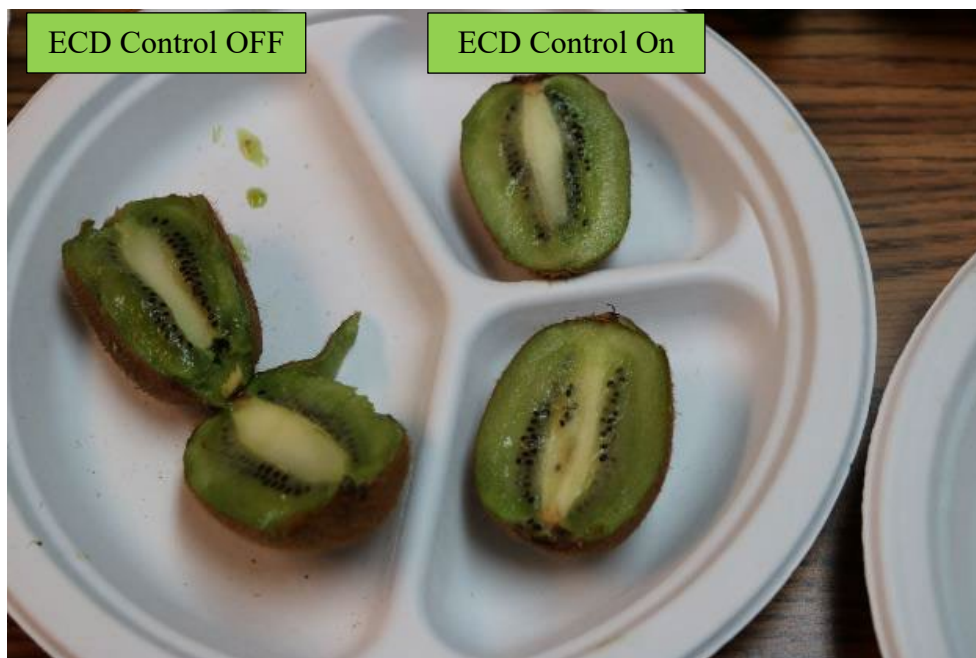


Figure 10. Kiwi, Day 21, ECD OFF vs. ECD ON Comparison. Adapted from Jamieson et al. (2016, p. 12).

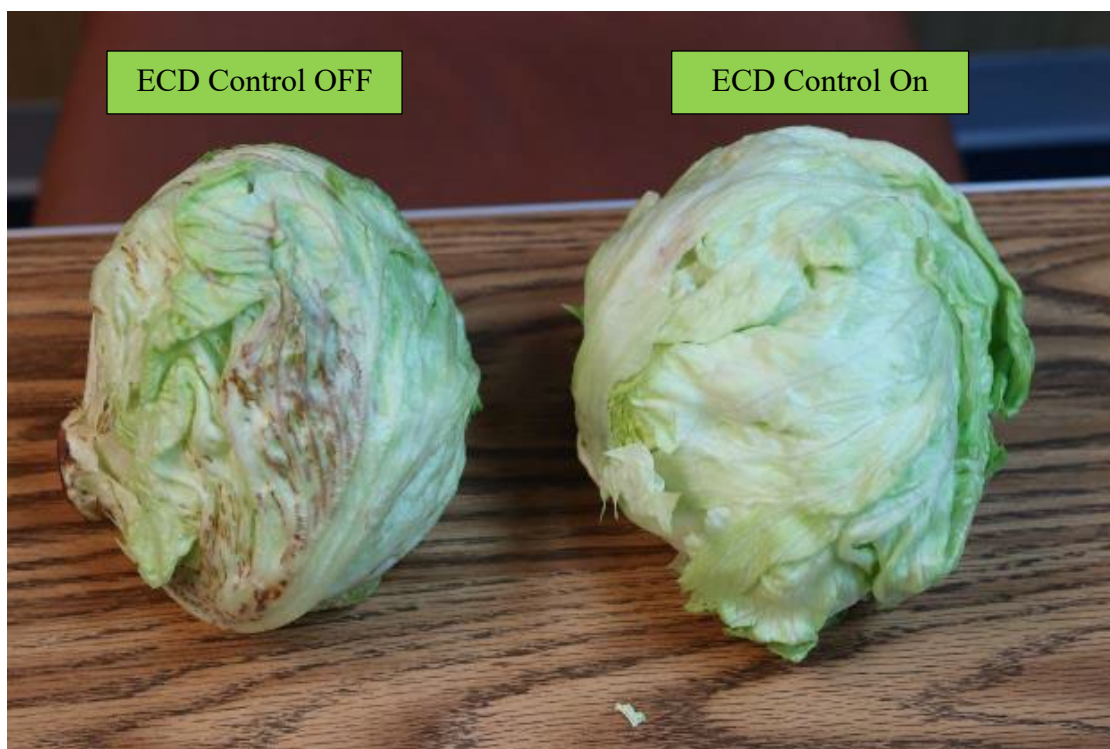


Figure 11. Lettuce, Day 21, ECD OFF vs. ECD ON Comparison. Adapted from Jamieson et al. (2016, p. 12).

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II. RESEARCH METHODOLOGY

The overall research of this thesis follows the cost benefit analysis (CBA) eight (8) step process as listed in Figure 12.

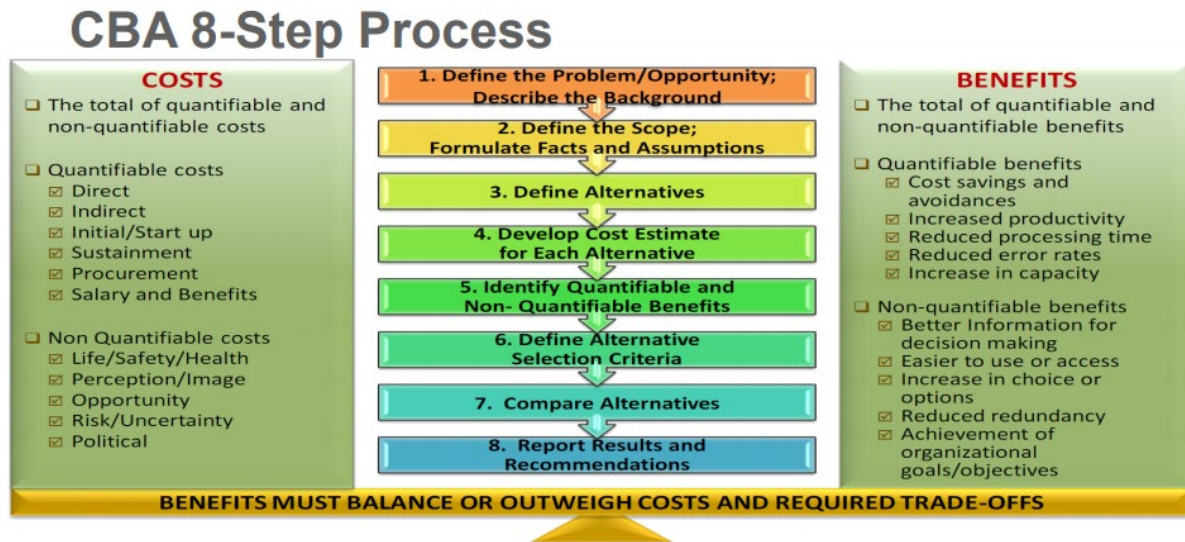


Figure 12. Cost Benefit Analysis Process. Source: ASAFMC (2018).

The steps are followed and outlined throughout this thesis. The first step is to define the problem and background, which was covered in Chapter I. This section focuses on step number two of the CBA Process, namely define the scope and formulate facts and assumptions and the third step of defining the alternatives (ASAFMC, 2018).

The preliminary assessment of this analysis investigates the condition of the FF&V arriving in country. If the FF&V have a high rejection rate at the arriving depot, there will be no need to install an ECD on a MTRCS as the FF&V are not in condition for consumption. Rejection of FF&V would include unusable, spoiled, or damaged FF&V. To examine if FF&V arrive in country in a desirable state of low rejections, the Defense Logistics Agency (DLA) provided data in Table 1.

Table 1. Dubai to Bagram Air Field

ANHAM FZCO - FFV Rejections and Inbound IFFV Flights (12 Months Trend)							
Year	Month	Value Total Shipped	Customer Rejection	ANHAM QA Rejection	Total Rejection	% of Total Value Shipped	Inbound IFFV Flights
2018	Sep	\$ 3,382,335.10	\$ 6,336.97	\$ 102.64	\$ 6,439.61	0.19%	17
2018	Oct	\$ 3,092,754.98	\$ 8,733.13		\$ 8,733.13	0.28%	18
2018	Nov	\$ 2,881,102.24	\$ 2,545.36		\$ 2,545.36	0.09%	17
2018	Dec	\$ 2,671,434.49	\$ 1,447.60		\$ 1,447.60	0.05%	18
2019	Jan	\$ 2,700,938.74	\$ 7,772.12		\$ 7,772.12	0.29%	17
2019	Feb	\$ 2,632,698.33	\$ 456.45	\$ 20.53	\$ 476.98	0.02%	16
2019	Mar	\$ 2,988,030.84	\$ 10,701.54		\$ 10,701.54	0.36%	18
2019	Apr	\$ 3,099,946.36	\$ 1,190.85		\$ 1,190.85	0.04%	17
2019	May	\$ 3,180,954.94	\$ 5,140.02	\$ 20,854.55	\$ 25,994.57	0.82%	18
2019	Jun	\$ 3,051,197.98	\$ 10,852.04		\$ 10,852.04	0.36%	15
2019	Jul	\$ 3,447,650.71	\$ 3,471.43	\$ 1,425.18	\$ 4,896.61	0.14%	18
2019	Aug	\$ 3,293,163.03	\$ 6,150.58	\$ 941.55	\$ 7,092.13	0.22%	16
Grand Total		\$ 36,422,207.74	\$ 64,798.09	\$ 23,344.44	\$ 88,142.53	0.24%	205

12 month trend showing rejections and inbound FF&V Flights from Dubai to Bagram Air Field

Source: Defense Logistics Agency (email to author, September 2019).

Table 1 lists the shipments of FF&V from the prime vendor, ANHAM, to Bagram Air Field. The FF&V rejections percentages are based on the dollar value of inbound flights from the prime vendor on a current contract over a 12-month period from Sept 2018 through August 2019 occurring on a total of 205 flights.

Table 1 lists two rejection dollar values, one from the prime vendor and the second from the customer. The prime vendor rejections consist of FF&V from the supplier. The customer is the depot or FOB that receives the shipment of FF&V from the prime contractor. The FF&V will then be shipped from the depot to the individual unit.

The data in Table 1 demonstrate that there is a very low rejection rate by the time FF&V are ready to be shipped from the depot to the individual units. During this 12 month period, the overall rejection rate is 0.24% of total value shipped. The highest rejection rate is experienced in May 2019 was 0.82% and the lowest rejection rate of 0.02% occurred in Feb 2019.

The general trend in shipping FF&V to the warfighter is that every step along the way the probability of rejections of FF&V increases. As shown in Table 1, with the exception of one month, May 2019, the higher amount of all the rejections occurred at the

depot. Although most of the rejections of the shipment of FF&V occur at the depot, it is still a low percentage base on values shipped. Examining the data, there were 7 months where no FF&V were rejected at the prime vendor. Rejections of the overall 0.24% rejection rate value, 74% occur at the depot while 26% occur at the Prime Vendor. The overall trend indicates that the rejection rate increases at every step of the delivery of FF&V to the warfighter.

The conclusion can be reached that the FF&V have a low rejection rate when they reach the destination country and furthermore, there is a low FF&V rejection rate with the prime vendor at the depot. With that said, there is an increase probability of rejection in FF&V during the delivery process, so it is valuable to add an ECD at the depot level because the FF&V are not in a degraded form and can be received by the warfighter in a much better state than without an ECD.

With the establishment that the FF&V arrive in a desirable condition with a very low rejection rate, the research can proceed with Step 3 of the CBA process, defining alternatives. The alternative discussed is installing an ECD at the depot level before shipment to individual units.

The ECD unit to be installed on the MTRCS should require no more than 500 watts (W) of power and weigh no more than 75 pounds (lbs) (PM Force Sustainment Systems, email to author, March 28, 2018). The ECD considered in this study is the Bluezone Model 2400 that requires 250 watts to power and weighs 25 lbs. Refer the Appendix A for the product specifications. For this thesis, it is assumed that one ECD will be installed on each fielded MTRCS. The total 2,424 fielded MTRCS Systems currently deployed are displayed in Appendix B.

The quantities of ECD to purchase are estimated to be 1 per procured MTRCS. The total number of MTRCSs are found using current procurement forms (P-Forms) from PM MAS. The acquisition objective (AO) quantity of the 2,424 MTRCS (Army Budget Material, May 2021) could be retrofitted to incorporate the ECD. The replacement kits as listed in Appendix A, will also be replaced at the rate of 1 per ECD. Two cycles for replacement kits were estimated for this analysis.

In addition to the procurement of the ECD hardware, personnel costs for the program office were estimated using a historical percentage based on manufacturing costs. The PM MAS percentage for program management, 2.5% and the program executive office (PEO), or 1%, was added to the manufacturing costs for procurement oversight. The backup for the PM MAS rate is displayed in Appendix C.

Sustainment costs for the fielded program will include operation personnel, program office personnel and replacement kits. The replacement kits were estimated one per fielded ECD. Two cycles of replacements were considered as a conservative estimate.

In this chapter, we discussed the first three steps of the CBA process, namely defining the problem and background. In the next chapter we intend to complete the next steps in the CBA process outlined in Figure 12.

III. ANALYSIS

A. COST ANALYSIS ON MTRCS

The quantifiable and non-quantifiable benefits of the ECD installation will be discussed in detail and presented in this section. The installation of the ECD will benefit the delivery of the FF&V from the depot or forward operating base (FOB) to the individual unit.

The cost benefits of installing the ECD will be shown after the first year. The savings of installing the ECD will be calculated and a return on investment (ROI) will be calculated based on Step 2 of the CBA process, using the following assumptions:

- Multi-Temperature Refrigerated Container System (MTRCS) procurement and sustainment costs are not considered part of this study.
- The 25% extension of the FF&V life due to the ECD, will be sufficient time to deliver to the warfighter 100% of the container load with no loss.
- Used the research and development (R&D), other procurements, Army (OPA), operation and maintenance, Army (OMA), and military personnel, Army (MPA) office of the secretary of defense (OSD) inflation indices. (ASAFMC 2021)
- The cost comparison are shown in uninflated 2021 dollars to discount the cost of year over year inflation.
- Costs in this cost study are captured for a six year period form FY22 through FY29. FY22-FY23 cover the investment period and FY24-FY29 cover the cost savings period.
- Mean time between failure (MTBF) of the unit is 1600 hours of use with a lower confidence limit of 80%.
- In regard to depot maintenance, it is assumed that the ECD will be serviced when the MTRCS is serviced.

- The management of the ECD program will be incorporated into ongoing production programs managed by PM-Force Sustainment Systems (FSS) for both the Multi-Temperature Refrigerated Container System (MTRCS) and the TRICON Refrigerated Container System (TRCS).
- The ECD device estimated is the 250W Bluezone Model 2400.
- The ECD will be retrofitted on the existing 2400 MTRCS fielded through FY 2016.
- The loss of a mixed load between the depot and the unit is estimated at 20% of the total value of the FF&V in the MTRCS.

B. EQUIPMENT

The equipment recommended to execute this analysis is produced by Bluezone consisting of the following elements (Bluezone Products Inc. (2021)

1. Bluezone Model 2400
2. Bluezone –Ozone Generating UV Bulb Replacement Kit for Model 2400 (4 Bulbs)

C. RESEARCH AND DEVELOPMENT (R&D)

The R&D dollars are inflated requirements from FY15 and FY16 spend plans that included leveraging existing EC development, bringing the ECD from a TRL5 to a TRL7 and included testing, contract and associated government costs.

The total costs, in uninflated in Base Year (BY) 2021 dollars, are listed in Table 2.

Table 2. ECD Development Costs (\$K) (Summary)

ECD Development		\$BY21
FY15	\$ 910.0	\$ 979.10
FY16	\$ 315.0	\$ 335.58
Total	\$ 1,225.0	\$1,314.7

Adapted from PM FSS (email to author, March 2018).

A detailed breakout of the R&D costs in Table 3 include BY2021 dollars for FY2022 and FY2023.

Table 3. ECD Development Costs (\$K) (Detail)

FY 2022 R&D Projections													
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Total
In-House	\$ 10.8	\$ 10.8	\$ 10.8	\$ 10.8	\$ 10.8	\$ 10.8	\$ 10.8	\$ 10.8	\$ 10.8	\$ 10.8	\$ 10.8	\$ 10.8	\$ 129.1
Contract	\$ -	\$ -	\$ -	\$ -	\$ 37.7	\$ 37.7	\$ 37.7	\$ 37.7	\$ 37.7	\$ 37.7	\$ 37.7	\$ 37.7	\$ 301.3
Testing/Supplies/Travel	\$ 5.4	\$ -	\$ -	\$ -	\$ 511.1	\$ 5.4	\$ -	\$ -	\$ 26.9	\$ -	\$ -	\$ -	\$ 548.7
Total	\$ 16.1	\$ 10.8	\$ 10.8	\$ 10.8	\$ 559.5	\$ 53.8	\$ 48.4	\$ 48.4	\$ 75.3	\$ 48.4	\$ 48.4	\$ 48.4	\$ 979.1
FY 2023 R&D Projections													
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Total
In-House	\$ 10.7	\$ 10.7	\$ 10.7	\$ 10.7	\$ 10.7	\$ 10.7							\$ 63.9
Contract	\$ 37.3	\$ 37.3	\$ 37.3	\$ 37.3	\$ 37.3	\$ 37.3							\$ 223.7
Testing/Supplies/Travel	\$ 5.3	\$ -	\$ -	\$ 5.3	\$ -	\$ 37.3							\$ 47.9
Total	\$ 53.3	\$ 47.9	\$ 47.9	\$ 53.3	\$ 47.9	\$ 85.2	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 335.6

Adapted from PM FSS (email to author, March 2018).

D. PRODUCTION

The production cost for the ECD is broken down into hardware, installation, and government oversight.

1. Hardware

The hardware used the procurement of the Bluezone Model 2400 with the unit cost of \$4,789.95 or \$4,638.62 in BY 2021 uninflated dollars.

2. Installation

The installation cost is derived from the procurement and install price of the ECD Model 300 (PM Force Sustainment Systems. March 8, 2018). The ECD has an install price of \$2,500 but the list price of the unit itself is \$2,089.95. The percent difference in uninflated dollars is 20.78% and is used to burden the price of the Bluezone model 2400 as depicted in Table 4.

Table 4. ECD Burden Percentage

ECD Model 300 Install Percentage		
	\$FY21	\$BY21
ECD Installed	\$ 2,500.00	\$ 2,554.67
ECD Model 300	\$ 2,089.95	\$ 2,023.92
Contractor Installation Burden		20.78%

Adapted from PM (FSS), email to author (March 2018) and VizoCare (2021a).

The install price of the Bluezone 2400 or \$963.71 is found by taking 20.78% of the list price or \$4,638.62. The install price is assumed to be inclusive of all contractor costs. The total cost to procure and install the Bluezone Model 2400 is \$5,602.31 as shown in Table 5.

Table 5. Bluezone Model 2400 Burdened Cost (\$). Adapted from VizoCare. (2021b).

ECD Model 2400 Install Price		
	\$FY21	BY21(\$)
ECD Model 2400	\$ 4,789.95	\$ 4,638.61
ECD Model 2400 (Installed)		\$ 5,602.31

3. Government Oversight

Government personnel costs for program execution and management is estimated by taking a historical percentage of the manufacturing costs. The historical rate of PM

Maneuver Ammunition Systems was used for PM and PEO personnel. The historical rate was outlined in the previous chapter.

The costs of procurement can be summarized in the Table 6 in uninflated BY 2021 dollars.

Table 6. ECD Procurement Cost (\$K) (By Year).

ECD Procurement										
Description	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
MTRCS/ECD Qty		360	516	516	516	516	0	0		2424
ECD Cost (\$BY21)		\$ 2,016.8	\$ 2,890.8	\$ 2,890.8	\$ 2,890.8	\$ 2,890.8	\$ -	\$ -		\$ 13,580.0
PM (2.5%) \$BY21		\$ 50.42	\$ 72.27	\$ 72.27	\$ 72.27	\$ 72.27	\$ -	\$ -		\$ 339.5
PEO (1.0%) \$BY21		\$ 20.17	\$ 28.91	\$ 28.91	\$ 28.91	\$ 28.91	\$ -	\$ -	\$ -	\$ 135.8
Total (\$BY21)		\$ 2,067.3	\$ 2,963.1	\$ 2,963.1	\$ 2,963.1	\$ 2,963.1	\$ -	\$ -		\$ 13,919.5

E. SUSTAINMENT

The sustainment of the ECD system once fielded consists of a replacement kit, two military occupational specialty (MOS) codes for maintenance, and government personnel. The 91C, Utilities Equipment Repairer, and 91J, Quartermaster and Chemical Equipment Repairer, MOSs were used as a conservative estimate as these were the objective in the performance metrics (PM Force Sustainment Systems. March 8, 2018).

As listed in Appendix D, the AMCOS Lite system was used to obtain the average salary using two conditions. The first condition is the rank used and the second condition is the geographical location. AMCOS lists the all the ranks per MOS listed at a selected location. The ranks listed for the 91C MOS range from enlisted rank 1 (E1) through enlisted rank 6 (E6). AMCOS lists the 91J MOS ranks from E1 to E5. The E3 salary was used since it was the median of ranks listed. The location selected was Tobyhanna Army Depot (TYAD) due to its geographical location and competency in logistics and sustainment.

For government personnel, the ARDEC labor rate was used. This rate is developed at Picatinny Arsenal and used for estimates where a government labor rate is utilized.

The summary of the labor categories and rates are listed in Table 7.

Table 7. Sustainment Unit Cost (\$)

Sustainment Unit Costs	\$FY2021	Appropriation	\$BY21 (\$)
91C (E3, TYAD)	\$ 104,484.24	MPA	\$ 104,456.00
91J (E3, TYAD)	\$101,259.17	MPA	\$ 101,231.80
Logistician*	\$ 222,690.28	OMA	\$ 219,012.47
PM*	\$ 222,690.28	OMA	\$ 219,012.47
Replacement Kit	293.95	OMA	\$ 289.10
* Used the Government ARDEC Labor Rate (FY2021)			

Adapted from Operating and Support Management System (OSMIS), (2021).

The quantity of personnel was estimated at one full year for the 91C and 91J MOSs and one quarter of one man year for the government personnel as listed in Table 8.

Table 8. ECD Sustainment Level of Effort

Sustainment Labor	Appropriation	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
91C (E3, TYAD)	MPA	1	1	1	1	1	1	1	1		8
91J (E3, TYAD)	MPA	1	1	1	1	1	1	1	1		8
Logistician	OMA	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25		2
PM	OMA	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25		2

The replacement bulbs are estimated at one per fielded ECD. For this estimate, two replenishment cycles were used. The unit cost of the replacement bulb can be seen in Appendix A. The quantity of replacement bulbs in FY24 are prorated based on a one year lag of the requirement of R&D to show technological maturity and readiness to field. The replacement schedule is shown in Table 9.

Table 9. Replacement Kit Schedule.

	Description	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
Replacement Kit	First Pass			360	516	516	516	516			2424
Replacement Kit	Second Pass				360	516	516	516	516		2424
											0
											0
Total		0	0	360	876	1032	1032	1032	516	0	4848

Adapted from Army Budget Material, (2021).

The total cost of the personnel and kits in sustainment are found by multiplying the unit cost times the quantity. The results are shown in Table 10.

Table 10. ECD Sustainment Cost (\$) (By Year)

Sustainment Cost (\$)	Appropriation	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total (\$K)
91C (E3, TYAD)	MPA	\$ -	\$ 77,793	\$ 104,456	\$104,456	\$104,456	\$104,456	\$104,456	\$104,456	\$ -	\$ 704,529
91J (E3, TYAD)	MPA	\$ -	\$ 75,392	\$ 101,232	\$101,232	\$101,232	\$101,232	\$101,232	\$101,232	\$ -	\$ 682,783
Logistician	OMA	\$ -	\$ 40,777	\$ 54,753	\$ 54,753	\$ 54,753	\$ 54,753	\$ 54,753	\$ 54,753	\$ -	\$ 369,296
PM	OMA	\$ -	\$ 40,777	\$ 54,753	\$ 54,753	\$ 54,753	\$ 54,753	\$ 54,753	\$ 54,753	\$ -	\$ 369,296
Replacement Kit	OMA	\$ -	\$ -	\$ 104,074	\$253,247	\$298,346	\$298,346	\$298,346	\$149,173	\$ -	\$1,401,534
Total		\$ -	\$ 234,739	\$ 419,268	\$568,442	\$613,540	\$613,540	\$613,540	\$464,367	\$ -	\$3,527,437

Table 11 summarizes the total cost by appropriation to include research and development, productions, and sustainment. The total cost in Table 11 represents the total money used towards the investment of installing and sustaining the ECD on the MTRCS. This total cost will be used to calculate the Return on Investment in Section F, Savings.

Table 11. Total ECD Cost by Appropriation (\$K)

	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
Research and Development	\$ 979.1	\$ 335.6								\$ 1,315
Procurement	\$ 2,067.3	\$ 2,963.1	\$ 2,963.1	\$ 2,963.1	\$ 2,963.1	\$ -	\$ -	\$ -		\$ 13,920
Sustainment Investment	\$ -	\$ 234.7	\$ 419.3	\$ 568.4	\$ 613.5	\$ 613.5	\$ 613.5	\$ 464.4	\$ -	\$ 3,527
Total	\$ 3,046.4	\$ 3,533.4	\$ 3,382.3	\$ 3,531.5	\$ 3,576.6	\$ 613.5	\$ 613.5	\$ 464.4	\$ -	\$ 18,762

F. SAVINGS

As outlined in Step 5 of the CBA process, this section analyses the quantifiable benefits of installing the ECD. The benefit of installing the ECD device is that it will recover the existing 20% loss of FF&V as delivered to the warfighter. The 20% is calculated by the \$3,400 lost on a shipment worth \$17,000. These values were translated to uninflated dollars as shown in the Table 12.

Table 12. FF&V Loss Percentage

	FY15	BY21
FF&V Typical loss	\$ 3,400	\$ 3,653.29
FF&V Typical Load	\$ 17,000	\$ 18,266.47
FF&V Typical Loss %		20%

Adapted from Adapted from PM FSS, email to author (March 2018).

The cost savings for installing the MTRCS is calculated by multiplying the ECDs operating in a year times the FF&V typical lost value of \$3,653.29 in uninflated 2021 dollars. The total is then multiplied by the average number of flights in one year. The average number of flights over a 12 month period is seen in Table 1.

The total savings of \$150.545M is broken down by year in Table 13 in BY 2021 uninflated dollars.

Table 13. ECD Cost Savings (\$K) (By Year)

	2022	2023	2024	2025	2026	2027	2028	2029	Total
Units operating		360	516	516	516	516	0	0	2424
FF&V Cost Savings (\$K)	\$ -	\$ 22,358	\$ 32,047	\$ 32,047	\$ 32,047	\$ 32,047	\$ -	\$ -	\$ 150,545

G. RESULTS

1. Quantifiable

a. Cost Benefit Analysis Criteria Chart

In line with the CBA process, Step 6 defines alternative selection criteria, this section discusses the criteria in detail and suggested weighting factors. Section 7 of the CBA, to compare alternatives, is also discussed. The ECD was compared to the status quo (SQ) option based on various criteria. The SQ option is the existing MTRCS with no improvements. The ECD Alternative captures all activities and costs related to installing an ECD on an existing MTRCS. Rank values are assessed by the analyst with a lower number representing better performance or value. The score for each criteria is found by multiplying the weight for each

criteria by the rank for each criteria. Table 14 describes the results of the table followed by a description of the rank and weight for each criteria.

Table 14. Cost Benefit Analysis Criteria Table.

Criteria	Weight	Alternative 1 (SQ)			Alternative 2 (ECD)		
		Data	Rank	Score	Data	Rank	Score
Total LC Cost Difference with SQ (BY21 \$K)	10%	0	1	0.10	\$ 3,542.7	2	0.20
Break-Even (Years)	15%	0	1	0.15	<1	2	0.30
Extended Life	25%	0%	2	0.50	25%	1	0.25
Spoiled Inventory loss (Value)	25%	20%	2	0.50	0%	1	0.25
Ethylene Levels (PPM) of mixed load of FF&V	25%	10	2	0.50	0.6	1	0.25
Total Score				1.75			1.25

Adapted from ASAFMC (2018)

Rank values are assessed by the analyst with a lower number representing better performance or value. The overall ranking places the alternative for the ECD install as the preferred alternative.

The first criteria is the total life cycle cost. This criteria is not as important as delivering a usable product so only a 10% weight was place on this criteria. The SQ does not require more funding and the ECD Alternative requires \$3.5M and advantage of the lower rank to this criteria is given to the SQ.

The second criteria considered was a break-even years and carries a 15% weight factor. The ECD alternative has a breakeven of less than 1 year. Since the SQ has no breakeven, as no additional costs was required, advantage to this criteria with a lower rank was given to the SQ.

The third criteria considered was the percentage of extended life 25% weight factor. This weight was attributed because it is one of the desirable result of this study. The ECD alternative extends the life of the FF&V by 25% (PM Force Sustainment Systems. (March 8, 2018). The advantage and the lower rank for this criteria was given to the ECD Alternative.

The fourth criteria considered was the percent of spoiled inventory loss and carries a 25% weight factor. With no controls on ethylene levels, the SQ loose about 20% of the containers inventory based on monetary value (PM Force Sustainment Systems. March 8,

2018). It is assumed that the ECD will recover the full loss and deliver a full container of desirable FF&V. The lower rank for this criteria is given to the ECD Alternative.

The fifth criteria considered was the ethylene levels measured in parts per million (ppm) and carries a 25% weight factor. The amount of ethylene in the container without the ECD is 10ppm. Test results of the ethylene levels with the ECD device are 0.6ppm. Ethylene levels of less than 1 ppm are desirable to extend the life of the FF&V, the desirable alternative with the lower rank is the ECD Alternative.

As outlined in Step 7 of the CBA process, the consolidated comparison of alternatives is listed in Table 14. The total score for the SQ alternative, after multiplying the weight by the rank, results in 1.75. By applying the same methodology to the ECD alternative, the total score results in 1.25. Being that the lower score is the more desirable alternative, the ECD quantified as the desirable alternative.

b. Return on Investment Calculation

The ROI was calculated for installing the ECD device on the fielded 2424 MTRCS containers in the field. A ROI of greater than one (1) is desirable. The ROI calculation is found by Equation 1.

$$ROI = \frac{\text{Net Return on Investment}}{\text{Cost of Investment}} \quad (1)$$

Reviewing Equation 1, the first step is to calculate the net return on investment and then divide by the cost of the investment. The net return on investment equals the savings realized minus the cost of the investment. Equation 1 now becomes:

$$ROI = \frac{\text{Savings} - \text{Cost of Investment}}{\text{Cost of Investment}} \quad (2)$$

To go through a sample calculation, FY2023 will be considered. The savings are listed in Table 13 and the cost of total cost of the investment is summed in Table 11.

Equation 2 now becomes:

$$ROI (FY2023) = \frac{\$ 22.358 - \$ 3,533}{\$ 3,533} \quad (3)$$

$$ROI (FY2023) = 5.3 \quad (4)$$

Following the same calculation method, Table 15 shows the yearly calculated ROIs based on the phased investment from Table 11 and the phased savings from Table 13.

Table 15. Yearly ROI Calculations

ROI Calculation (Yearly)									
	2022	2023	2024	2025	2026	2027	2028	2029	Total
Investment	\$ 3,046.4	\$ 3,533.4	\$ 3,382.3	\$ 3,531.5	\$ 3,576.6	\$ 613.5	\$ 613.5	\$ 464.4	\$ 18,762
Net Savings	\$ -	\$ 22,358	\$ 32,047	\$ 32,047	\$ 32,047	\$ 32,047	\$ -	\$ -	\$ 150,545
ROI	-1.00	5.33	8.47	8.07	7.96	51.23	-1.00	-1.00	

Table 16 shows the overall cumulative ROI calculation based on the cumulative net savings and cumulative investments.

Table 16. ECD Return on Investment Cumulative (\$K) (By Year)

ROI Calculation (Cumulative)									
	2022	2023	2024	2025	2026	2027	2028	2029	Total
Investment	\$ 3,046.4	\$ 6,579.7	\$ 9,962.1	\$ 13,493.6	\$ 17,070.2	\$ 17,683.7	\$ 18,297.3	\$ 18,761.6	\$ 18,762
Net Savings	\$ (3,046.4)	\$ 15,778	\$ 44,443	\$ 72,958	\$ 101,428	\$ 132,861	\$ 132,248	\$ 131,783	\$ 131,783
ROI	-1.00	2.40	4.46	5.41	5.94	7.51	7.23	7.02	

The cumulative ROI for the ECD program is graphically represented by year in Figure 13.

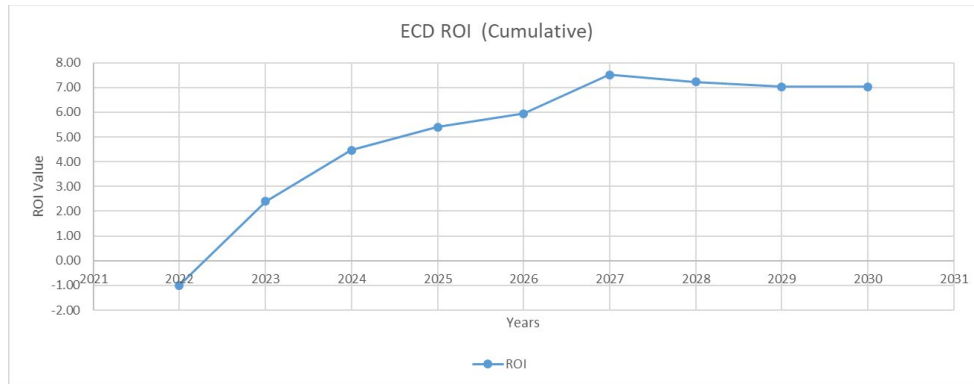


Figure 13. Return on Investment (ROI) Graph

The cumulative net savings from Table 13 and cumulative net investment for the ECD total system cost from Table 11 are represented graphically to depict the breakeven year is represented in Figure 14. The breakeven year occurs within the first year of execution.

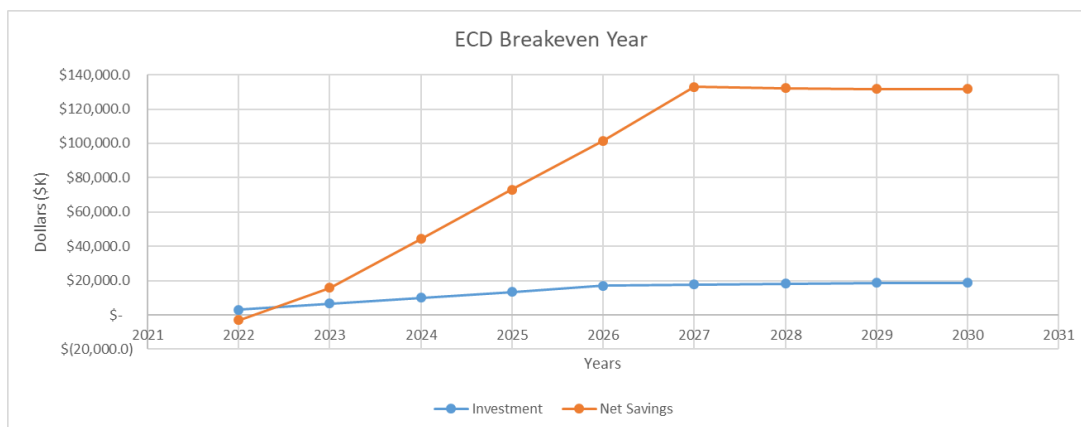


Figure 14. Breakeven Year Graph

2. Non-quantifiable

The non-quantifiable benefits include the satisfaction of delivering a quality product. To know that efforts that go into delivering FF&V are not futile and are delivered successfully with little to no waste. Other non-quantifiable benefits include the increased nourishment and improved morale of the warfighter. The warfighter will be satisfied because they are receiving a quality shipment of FF&V and not a packaged meal.

IV. CONCLUSION

Step 8 of the CBA process is to report results and recommendations. This project examined the benefits of installing an ECD on a MTRCS to extend the life of FF&V. Specifically, the project calculated the ROI for the ECD technology to improve the quality of FF&V to warfighters. The ECD reduces the amount of ethylene in the MTRCS container, prolonging the life of FF&V, thus assuring the warfighter receives produce in a desirable condition.

The first part of the research verified the FF&V received at a depot or FOB were in a desirable state. The process to get FF&V to the warfighter consists of the growers of the FF&V shipping to the prime vendor. The prime vendor will then ship the FF&V to the customer, or depot/FOB. The depot or FOB in turn will then ship the FF&V to the individual units.

We determined that there is a small overall percentage of rejection up to the customer, or depot, at a yearly rate of 0.24% based on the value of the shipment. It is further illustrated that overall more of the rejections occur at the depot than the prime vendor. This is indicative that FF&V are more likely to spoil or be damaged the further along it is in the shipping process. The individual units experience FF&V losses exceeding 20% noting “severe spoilage and instances where the availability of fresh produce is, as a result, limited, delayed, or nonexistent” (PM Force Sustainment Systems. March 8, 2018). Our research suggests that installing an ECD in the shipping process at the depot stage would greatly benefit the warfighter to obtain FF&V in a desirable condition.

The second part of the research examined the benefits of installing an ECD on a MTRCS for shipment of FF&V from the depot to individual units. The ECD, Bluezone model 2400, was estimated to be installed on the existing 2424 MTRCS fielded. The MTRCS were assumed to be on an average of 17 inbound flights per year.

Our research suggests an overall cost savings and a ROI ranging from -1 to 7.02 for installing the ECD at the depot level. An initial investment of \$18.8M is needed to bring the ECD technology to TRL7, procure and field the ECD, and sustain it in the field. The

net savings produced from the fielded MTRCS yield \$131.8M for 5 years' worth of procurement. The investment payback period happens within the first year of use.

We conclude that installing the ECD at the depot level has significant benefit to the warfighter. The warfighter would receive FF&V in a desirable condition. Receiving FF&V in a timely and desired state aids in nourishment and overall morale. For little investment, relatively speaking, there many quantifiable and non-quantifiable benefits to install the ECD

V. APPENDIX

A. HARDWARE

Ethylene Glycol Removal Device Cost. Source: VizoCare (2021b)



BLUEZONE 2400 WITH 4 OZONE GENERATING UV BULBS

by Bluezone

\$4,789.95

SKU UV-43

For special discount on bulk orders, email sales@vizocare.com

Bluezone 2400 with 4 Ozone Generating UV Bulbs

Designed for fresh food preservation in walk-in coolers, the model 2400 extends shelf life, maintains quality, eliminates flavor transfer.

Utilizes UV enhanced oxidation to clean the air

<https://www.vizocare.com/collections/bluezone/products/bluezone-2400-with-4-ozone-generating-uv-bulbs?variant=39327718768714>

Ethylene Glycol Removal Device Specifications. Source: Bluezone (2021)

SPECIFICATION CATEGORY	MODEL 2400 AIR PURIFIER
Size	31" X 15" X 14" / 79cm X 36cm x 34cm
Weight	25 lb / 11 kg
Input Voltage & Current	120 VAC 1 Phase, 3 amps
Electrical Connection	IEC 320-C13 120 VAC power cord
Operating Environment	34° F — 104° F or 1° C — 40° C Up to 85% RH
Storage Environment	-40° F — 150°F / -20° C — 65° C Up to 85% RH
Treatment Volume	15,000 cubic feet 430 m3 per Bluezone
Power	Max 250 watts
Certifications	cETLus Listed ARB certified - ozone emissions NSF Listed per request
Mounting Options:	Hung from ceiling, placed on shelf/ rack/cart, or mounted to wall

Replacement Kit Cost. Source: VizoCare (2021c)



All categories ▾ What are you looking for?

Home > Bluezone - Ozone Generating UV Bulb Replacement Kit For Model 2400 (4 Bulbs)





BLUEZONE - OZONE GENERATING UV BULB REPLACEMENT KIT FOR MODEL 2400 (4 BULBS)

by Bluezone

\$293.95

SKU UV-44L

Ozone Generating UV Bulb Replacement Kit For Model 2400 (4 Bulbs)

B. MULTI-TEMPERATURE REFRIGERATED CONTAINER SYSTEM P-FORM

Source: Army Budget Material (2021)

UNCLASSIFIED

Exhibit P-40, Budget Line Item Justification: PB 2022 Army											Date: May 2021	
Appropriation / Budget Activity / Budget Sub Activity: 2035A: Other Procurement, Army / BA 03: Other Support Equipment / BSA 25: Combat Service Support Equipment						P-1 Line Item Number / Title: 9120M65800 / Field Feeding Equipment						
ID Code (A=Service Ready, S=Not Service Ready): A			Program Elements for Code B Items: N/A				Other Related Program Elements: 0604713A					
Line Item MDAP/MAIS Code: N/A												
Resource Summary	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	To Complete	Total
Procurement Quantity (Units in Each)	106	80	12	12	-	12	-	-	-	-	-	-
Gross/Weapon System Cost (\$ in Millions)	247.819	15.973	2.279	2.321	-	2.321	-	-	-	-	-	-
Less FY Advance Procurement (\$ in Millions)	-	-	-	-	-	-	-	-	-	-	-	-
Net Procurement (P-1) (\$ in Millions)	247.819	15.973	2.279	2.321	-	2.321	-	-	-	-	-	-
Plus CY Advance Procurement (\$ in Millions)	-	-	-	-	-	-	-	-	-	-	-	-
Total Obligation Authority (\$ in Millions)	247.819	15.973	2.279	2.321	-	2.321	-	-	-	-	-	-
(The following Resource Summary rows are for informational purposes only. The corresponding budget requests are documented elsewhere.)												
Initial Spares (\$ in Millions)	-	-	-	-	-	-	-	-	-	-	-	-
Flyaway Unit Cost (\$ in Thousands)	-	-	-	-	-	-	-	-	-	-	-	-
Gross/Weapon System Unit Cost (\$ in Thousands)	2,337.915	199.663	189.917	193.417	-	193.417	-	-	-	-	-	-
Description:												
The Field Feeding and Refrigeration program provides equipment to conduct tactical food service operations. Field Feeding is a combat multiplier which improves morale and enhances the Soldier's physical and cognitive capabilities. Associated with food service operations are storage, preparation, serving and cleanup. Equipment items include: field kitchens, food sanitation centers, and refrigerated containers. This program supports production of the Multi Temperature Refrigerated Container System (MTRCS), Assault Kitchen (AK), Containerized Kitchen (CK) and Field Feeding Sanitation Center (FSC). This equipment in conjunction with food service personnel and field rations, comprises the Army Field Feeding System (AFFS) which supports the Army standard of a minimum of one hot prepared meal per day in the field. This program provides a critical capability that supports Army transformation and modularity concept while maintaining readiness through fielding and integration of new equipment. It enhances the field Soldier's well being and reduces requirements for related lift demands, combat zone footprint, and logistical support costs. AAO is as the following:												
1. AK = 2274 2. MTRCS = 2424 3. CK = 972 4. FSC = 2693												
Secondary Distribution		FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026		
Army	Quantity	80	12	12	-	12	-	-	-	-	-	-
	Total Obligation Authority	15.973	2.279	2.321	-	2.321	-	-	-	-	-	-
Total:	Quantity	80	12	12	-	12	-	-	-	-	-	-
Secondary Distribution	Total Obligation Authority	15.973	2.279	2.321	-	2.321	-	-	-	-	-	-
Justification:												
FY 2022 base procurement dollars in the amount of \$2.321 million supports production of 12 Multi-Temperature Refrigerated Container Systems (MTRCS) to replace losses of deployed assets. These funds are to support the Direct War Cost for Operation Freedom's Sentinel.												

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Exhibit P-40, Budget Line Item Justification: PB 2022 Army		Date: May 2021
Appropriation / Budget Activity / Budget Sub Activity: 2035A: Other Procurement, Army / BA 03: Other Support Equipment / BSA 25: Combat Service Support Equipment		P-1 Line Item Number / Title: 9120M65800 / Field Feeding Equipment
ID Code: (A=Service Ready, B=Not Service Ready) C: A	Program Elements for Code B Items: N/A	Other Related Program Elements: 0604713A
Line Item NDAP/MAIS Code: N/A		
In accordance with Section 1816 of the FY2008 National Defense Authorization Act (P.L. 110-181), this item is necessary for use by the active and reserve components of the Armed Forces for homeland defense missions, domestic emergency responses, and providing military support to civil authorities.		

LI 9120M65800 - Field Feeding Equipment
Army

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C. PROGRAM OFFICE PERSONNEL HISTORICAL PERCENTAGE DERIVATION

PM MAS In House Operating Budget				
Co-located Matrix & Travel Expenses:	FY19	FY20	Comments	Questions
Matrix Labor	\$ 10,326,847.50	\$ 12,050,844.55	FY19 & 20 not including FM (seperated below). FY20 Includes additional 10 matrix for new NGCV, NGSW, MPF, etc. requirements.	FY19 Update with Actuals
ARDEC 2363 Fee Matrix	\$ 476,002.60	\$ 546,221.05		
Travel	\$ 600,000.00	\$ 700,000.00	FY19 Travel goal \$590,519.63 (10% reduction)	FY19 Update with Actuals
Contracts:	FY19	FY20	Comments	
SAIC	\$ 2,999,371.80	\$ 4,000,000.00	FY20 Estimated	
Alion Business Case Analysis	\$ -	\$ 1,000,000.00	FY20 Estimated	
Vertex (Large Cal)	\$ 600,528.00	\$ 612,538.56	FY20 Inflated	
Booz Allen (Small / Med Cal)	\$ 3,273,391.00	\$ 4,000,000.00	FY20 Estimated	
Kelley (PEO Spt)	\$ 233,662.77	\$ -	PM MAS funds contract every other year. FY17 PM MAS/CCS funded. FY18 PM CAS/JPEO A&A funded. FY19 PM MAS/CCS funded. PM MAS will fund again in FY21.	Did we fund in FY19?
Bill Melton	\$ 267,072.00	\$ -	SAIC starting in FY20.	
Bob Darcy	\$ 67,511.88	\$ -	SAIC starting in FY20.	
IT Support (ISS)	\$ 783,290.84	\$ 803,290.84	FY20 Estimated. Increases about \$20k/year	
Porter	\$ 25,128.00	\$ 26,000.00	FY20 Estimated	
KMW Germany Configuration Mgt. Support	\$ 9,448.01	\$ 10,000.00	FY20 Estimated	
Mobile Services	\$ 82,167.90	\$ 85,000.00	FY20 Estimated	
In House Bills:	FY19	FY20	Comments	
ACC NJ	\$ 840,000.00	\$ 840,000.00		
Legal	\$ 96,000.00	\$ 100,000.00	No bill received in FY19.	Did we fund in FY19?
ARDEC ITPO	\$ 40,000.00	\$ 40,000.00		Did we fund in FY19?
FM/CA APA (CCDC FM Matrix)	\$ 1,573,217.41	\$ 1,604,681.75	Labor & Non-Labor for MAD/Mantrac/ODC (in addition to co-located FM matrix).	
Ammo Services	\$ 26,293.00	\$ 2,050.00	FY19 Not paid, no justification provided by CCDC on price increase.	
NEC	\$ 13,871.22	\$ 14,148.64		
NETCOM	\$ 35,000.00	\$ 35,000.00		
Garrison	\$ 21,334.00	\$ 22,000.00		Did we fund in FY19?
Building Renovations		\$ 1,450,000.00	\$100k for CR#3 + \$400k for CR#4 + \$750k for North end reno +B355 reno \$200k.	
Building Lease		\$ 120,000.00		
Supplies	\$ 364,140.00	\$ 371,422.80		FY19 Update with Actuals
Shipping	\$ 155,000.00	\$ 158,100.00		FY19 Update with Actuals
Total Expenses, Contracts & In House:	\$ 22,909,277.92	\$ 28,591,298.20	FY20 Estimated	
Presidents Budget (PAA)	\$572,301,000	\$680,633,000		
PM MAS In House Withhold %	3.00%	2.50%	FY20 Proposed %	

D. MILITARY OCCUPATIONAL SPECIALTY (MOS)

MOS 91 C. Source: OSMIS (2021).

AMCOS Lite						
PayPlan	Active Enlisted (AE)					
Career Management Field (CMF)	91 - MECHANICAL MAINTENANCE					
Military Occupational Specialty (MOS)	91C - UTILITIES EQUIPMENT REPAIRER					
Location	TOBYHANNA ARMY DEPOT [ARMY] (PA) - PA254					
Dependent Status	average					
Inflation (Base/Input Year: 2021)	Then Year to Then Year					
Output/Target Year	2021					
Summary	Default					
Appropriation	MPA	MPA Non-Pay	OMA	OMA_1	OMDW	Federal OM
Inflation Rate	100.0000%	100.0000%	100.0000%	100.0000%	100.0000%	100.0000%
Appropriation Group	E1	E2	E3	E4	E5	E6
ARMY	\$67,864.41	\$75,615.50	\$75,570.62	\$85,641.72	\$99,682.76	\$118,274.23
DoD	\$12,730.37	\$12,730.37	\$12,730.37	\$12,730.37	\$12,730.37	\$12,730.37
FEDERAL	\$16,183.25	\$16,183.25	\$16,183.25	\$16,183.25	\$16,183.25	\$16,183.25
Total	\$96,778.03	\$104,529.12	\$104,484.24	\$114,555.34	\$128,596.38	\$147,187.85
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MOS 91J. Source: OSMIS (2021)

AMCOS Lite						
PayPlan	Active Enlisted (AE)					
Career Management Field (CMF)	91 - MECHANICAL MAINTENANCE					
Military Occupational Specialty (MOS)	91C - UTILITIES EQUIPMENT REPAIRER					
Location	TOBYHANNA ARMY DEPOT [ARMY] (PA) - PA254					
Dependent Status	average					
Inflation (Base/Input Year: 2021)	Then Year to Then Year					
Output/Target Year	2021					
Summary	Default					
Appropriation	MPA	MPA Non-Pay	OMA	OMA_1	OMDW	Federal OM
Inflation Rate	100.0000%	100.0000%	100.0000%	100.0000%	100.0000%	100.0000%
Appropriation Group	E1	E2	E3	E4	E5	E6
ARMY	\$67,864.41	\$75,615.50	\$75,570.62	\$85,641.72	\$99,682.76	\$118,274.23
DoD	\$12,730.37	\$12,730.37	\$12,730.37	\$12,730.37	\$12,730.37	\$12,730.37
FEDERAL	\$16,183.25	\$16,183.25	\$16,183.25	\$16,183.25	\$16,183.25	\$16,183.25
Total	\$96,778.03	\$104,529.12	\$104,484.24	\$114,555.34	\$128,596.38	\$147,187.85
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E. INFLATION INDICES

Research, Development, Test and Evaluation – Army Indices

Source: ASAFMC (2021)

Research, Development, Test & Evaluation Army (RDTEA) Appropriation					
Fiscal Year	Inflation Rate %	Raw Index	Weighted Index	Budget Year Index	Budget Year Inflation Rate %
2015	1.10%	0.9047	0.9294	0.9115	1.65%
2016	1.20%	0.9156	0.9387	0.9205	0.99%
2017	1.70%	0.9311	0.9574	0.9389	1.99%
2018	2.20%	0.9516	0.9724	0.9536	1.57%
2019	1.90%	0.9697	0.9847	0.9657	1.27%
2020	1.30%	0.9823	1.0025	0.9831	1.80%
2021	1.80%	1.0000	1.0197	1.0000	1.72%
2022	2.00%	1.0200	1.0426	1.0224	2.24%
2023	2.00%	1.0404	1.0634	1.0429	2.00%
2024	2.00%	1.0612	1.0847	1.0637	2.00%
2025	2.00%	1.0824	1.1064	1.0850	2.00%
2026	2.00%	1.1041	1.1285	1.1067	2.00%
2027	2.00%	1.1262	1.1511	1.1288	2.00%
2028	2.00%	1.1487	1.1741	1.1514	2.00%
2029	2.00%	1.1717	1.1976	1.1744	2.00%
2030	2.00%	1.1951	1.2215	1.1979	2.00%

Other Procurement Army (OPA) Indices
Source: ASAFMC (2021)

Other Procurement Army (OPA) Appropriation					
ARMY	Base Year = 2021				16-Jul-21
Fiscal Year	Inflation Rate %	Raw Index	Weighted Index	Budget Year Index	Budget Year Inflation Rate %
2015	1.10%	0.9047	0.9307	0.9013	1.35%
2016	1.20%	0.9156	0.9434	0.9136	1.37%
2017	1.70%	0.9311	0.9620	0.9316	1.96%
2018	2.20%	0.9516	0.9786	0.9477	1.73%
2019	1.90%	0.9697	0.9946	0.9632	1.64%
2020	1.30%	0.9823	1.0127	0.9807	1.82%
2021	1.80%	1.0000	1.0326	1.0000	1.97%
2022	2.00%	1.0200	1.0533	1.0200	2.00%
2023	2.00%	1.0404	1.0743	1.0404	2.00%
2024	2.00%	1.0612	1.0958	1.0612	2.00%
2025	2.00%	1.0824	1.1177	1.0824	2.00%
2026	2.00%	1.1041	1.1401	1.1041	2.00%
2027	2.00%	1.1262	1.1629	1.1262	2.00%
2028	2.00%	1.1487	1.1862	1.1487	2.00%
2029	2.00%	1.1717	1.2099	1.1717	2.00%
2030	2.00%	1.1951	1.2341	1.1951	2.00%

Other Maintenance Army (OMA) Indices
Source: ASAFMC (2021)

Operations & Maintenance Army (OMA) Appropriation					
ARMY		Base Year = 2021			20-Jul-21
Fiscal Year	Inflation Rate %	Raw Index	Weighted Index	Budget Year Index	Budget Year Inflation Rate %
2015	1.10%	0.9047	0.9148	0.8997	1.00%
2016	1.20%	0.9156	0.9312	0.9158	1.79%
2017	1.70%	0.9311	0.9466	0.9310	1.66%
2018	2.20%	0.9516	0.9646	0.9486	1.89%
2019	1.90%	0.9697	0.9830	0.9668	1.91%
2020	1.30%	0.9823	0.9977	0.9813	1.49%
2021	1.80%	1.0000	1.0168	1.0000	1.91%
2022	2.00%	1.0200	1.0366	1.0195	1.95%
2023	2.00%	1.0404	1.0574	1.0399	2.00%
2024	2.00%	1.0612	1.0785	1.0607	2.00%
2025	2.00%	1.0824	1.1001	1.0819	2.00%
2026	2.00%	1.1041	1.1221	1.1035	2.00%
2027	2.00%	1.1262	1.1445	1.1256	2.00%
2028	2.00%	1.1487	1.1674	1.1481	2.00%
2029	2.00%	1.1717	1.1908	1.1711	2.00%
2030	2.00%	1.1951	1.2146	1.1945	2.00%

Military Pay Army (OPA) Indices
Source: ASAFMC (2021)

Military Pay Army (MPA) Appropriation Composite					
ARMY		Base Year = 2021			21-Jul-21
Fiscal Year	Inflation Rate %	Raw Index	Weighted Index	Budget Year Index	Budget Year Inflation Rate %
2015	1.01%	0.8717	0.8719	0.8717	1.01%
2016	1.22%	0.8824	0.8826	0.8824	1.23%
2017	1.89%	0.8991	0.8994	0.8991	1.90%
2018	2.32%	0.9199	0.9201	0.9199	2.31%
2019	2.51%	0.9430	0.9433	0.9430	2.52%
2020	2.93%	0.9707	0.9710	0.9708	2.94%
2021	3.02%	1.0000	1.0003	1.0000	3.01%
2022	2.72%	1.0272	1.0274	1.0272	2.72%
2023	2.61%	1.0540	1.0543	1.0540	2.61%
2024	2.61%	1.0816	1.0818	1.0815	2.61%
2025	2.61%	1.1098	1.1101	1.1098	2.61%
2026	2.61%	1.1388	1.1391	1.1388	2.61%
2027	2.61%	1.1686	1.1689	1.1686	2.61%
2028	2.61%	1.1992	1.1995	1.1992	2.61%
2029	2.62%	1.2305	1.2309	1.2305	2.62%
2030	2.62%	1.2627	1.2630	1.2627	2.62%

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