



TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Ethylene Control
For Extended
Preservation of Fresh
Fruits and Vegetables

Peter Lavigne
Equipment & Energy Tech Team
DoD Combat Feeding Directorate
US Army Natick Soldier RD&E Center

UNCLASSIFIED



Background/Historical Information



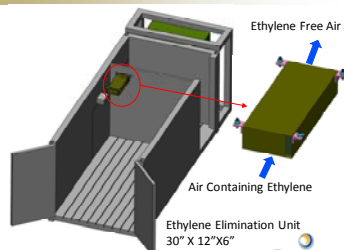
- As the harvested produce respire, a number of gaseous by-products are released, to include water vapor, carbon dioxide, ethylene, and potentially other volatile organic compounds
- Temperature imparts the greatest impact on the ripening, yet the produce continues to respire after being harvested and some produce generates a large amount of ethylene
- Controlled ethylene storage has been demonstrated to extend the shelf life of fresh produce from days to weeks

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

UNCLASSIFIED



Ethylene Control for Extended Preservation of FF&V



Schedule & Cost

Milestones	FY07	FY08	FY09	FY10
Evaluate commercial alternatives				
Execute SBIR Phase II Contract				
Transition to 6.3				
Prototype / Technical Testing				
Execute SBIR Enhancement				
Procure Mil./Comm. RCS units				
Optimize modular RCS Enh. Kit				
Complete User Evaluations				
Transition to 6.4 (PM FSS, Force Provider, and DSCP)				

Purpose:

Develop low-cost technology to control ethylene produced by fresh fruits and vegetables (FF&V) transported and stored in refrigerated containers

Results/Products:

- Control ethylene concentration to <0.1 ppm
- Require no more than 100 watts of power
- Require less than 3 cubic feet of space
- Low maintenance design (12+ month reliability)
- Cost less than \$500 per unit

ROI/Payoff:

- Extend fresh produce shelf life to 3 weeks
- Reduce produce losses (\$3M reported FY06)
- Transition technology to 6.3 (JSN 07-01) in FY10 for application to Defense Logistics Agency-managed commercial transport of fresh produce to theater support area, Army Single Temp 8x8x20, MTRCS, Navy Shipboard Refrigeration Systems, Marine Corps QuadCon RCS

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

UNCLASSIFIED



Need



- Fresh Fruits and Vegetables are an essential dietary supplement to operational rations and are typically packed, transported and stored in refrigerated containers to extend their shelf life
- Ethylene is naturally released by fresh produce in storage, accelerating ripening and spoilage and ethylene gas levels as low as 1ppm can destroy an entire shipment in one day
- Logistics of stocking, maintaining and disposing of commercial sorbent materials is not feasible
- A non-consumable device is need for refrigerated containers to control ethylene to maintain the quality of fresh fruits and vegetables as it is delivered to field units

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

UNCLASSIFIED



Technical Approach



- Year 1:
 - Evaluate commercial sorbent/filtration alternatives
 - Establish baseline of performance for achieving extended preservation of fresh produce
- Year 2:
 - Award Phase I contracts to develop system for operational effectiveness and long term reliability
- Year 3:
 - Award Phase II contract for photo-catalytic ozone device to control ethylene for extended preservation of fresh produce
- Year 4:
 - Fabricate / test full-scale system within cost/weight/cube/power parameters
 - Transition to Army Product Manager Force Sustainment Systems for implementation in Army refrigerated container applications, to the Systems Equipment and Engineering Team for Navy, Marine Corps and Air Force applications, and to Defense Supply Center – Philadelphia for specification in commercial contracts

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

UNCLASSIFIED



Accomplishments



- FY08:
 - Evaluated commercial sorbent/filtration alternatives
 - UV-based commercial air purifier
 - Potassium permanganate-based filters and sachets
 - Carbonate/Silicate-based sorbents
 - Established baseline of performance for achieving extended preservation of fresh produce
 - Initiated Phase II Small Business Innovation Research contract to complete development and fabrication of a full-scale, low cost UV-enhanced ozone ethylene control system

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

UNCLASSIFIED



Planned Accomplishments



- FY09:
 - Complete assessment of commercial alternatives and determine maximum attainable shelf-life extension for primary produce examples
 - Complete development and fabrication of the full-scale ethylene control system for extended preservation of Fresh Fruits and Vegetables
 - Continue technical testing to verify performance, safety, maintainability, and cost factors have been achieved

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

UNCLASSIFIED



Commercial Alternatives for Extended Preservation of FF&V



Commercial UV Filtration Unit in 56°F Container



Premium quality (Left)

Spoilage and mold (Right)

UV Test (Left)

Control (Right)

Day 1



Day 16



TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

UNCLASSIFIED



Sorbent-Media Filter and Sachet Alternatives

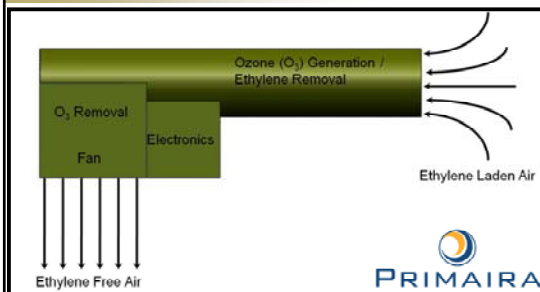


Challenges:

- Monthly filter replacement/regeneration
- Excess humidity can degrade performance
- Potential disposal challenges

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

UNCLASSIFIED

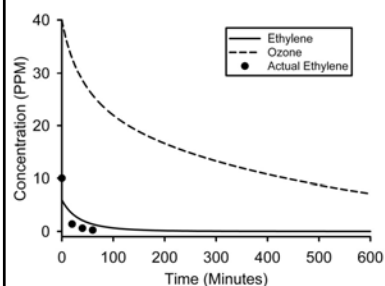


With UV / O₃ Control



7-day storage of lettuce

With O₃ Control



Comparison of actual and theoretical ethylene concentration as a function of time

UNCLASSIFIED



Transition Plan/Acquisition Strategy:

- Develop technology and define conceptual configuration
- Establish feasibility of system concept and perform small-scale technical testing
- Optimize system design and transition to Army Product Manager Force Sustainment Systems, the Systems Equipment and Engineering Team, and Force Provider for development validation and user testing in target refrigerated container applications

Deliverable(s):

A non-consumable device for refrigerated containers that autonomously control ethylene to maintain the quality of fresh fruits and vegetables as it is delivered to field units

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

UNCLASSIFIED

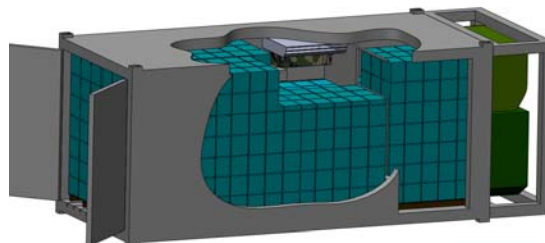


APPLICATIONS

- Army Multi-Temperature Refrigerated Container System (MTRCS)
- Army 8 x 8 x 20 Refrigerated Container System (RCS)
- Air Force Advanced Design Refrigerator (ADR 300)
- Force Provider / Marine Corps TRICON Refrigerated Containers
- Navy Refrigeration Program; Marine Corps QuadCon RCS
- Commercial refrigerated containers and trailers (20 - 40 foot)

CONFIGURATION

- Modular design
- Enhancement kit for RCS applications
- Tolerates intermittent power availability for on-board generators
- Long life



PRIMAIRA

UNCLASSIFIED