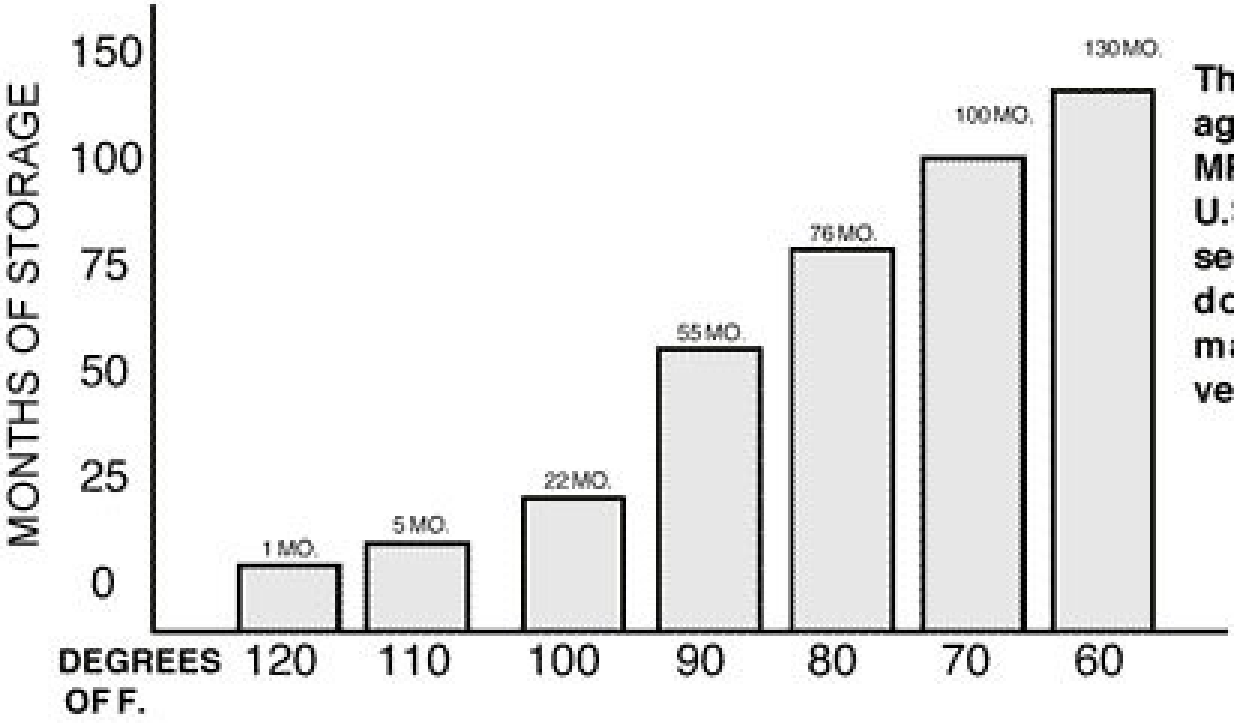

This chart contains storage life projections for MRE rations from the U.S. Army's Natick Research Laboratories and does not reflect a manufacturer's or vendor's guarantee.

BELOW 60°
Not enough data yet collected.
However, projections are the
130 months will be extended.

NOTE: Time and temperature have a cumulative effect. For example, storage at 100° for 11 months moved to 70° would lose one half of the 70° storage.

AVOID FLUCTUATING TEMPERATURES IN AND OUT OF FREEZING LEVEL

MEAL, READY-to-EAT (MRE)
MRE XXVI MENUS*

Menu #1
Chili with Beans
Mexican-style Corn
Jam – 1/
Crackers, plain
Candy I - 2/
Dairy Shake - 1/
Red Pepper
Accessory Packet, A
Spoon
Flameless Heater & Hot Beverage Bag

Menu #2
Pork Rib
Clam Chowder
Cheese Spread, plain
Wheat Snack Bread (2)
Cookies – 4/
Beverage, Carb Electrolyte – 1/
Steak Sauce
Accessory Packet, A
Spoon
Flameless Heater & Hot Beverage Bag

Menu #3
Beef Ravioli
Fruit Pack, Wet – 1/
Fudge Brownie
Cheese Spread, Jalapeno
Crackers, vegetable
Beef Snacks
Beverage Base, Carb Fortified
Hot Sauce
Accessory Packet, A
Spoon
Flameless Heater & Hot Beverage Bag

Menu #4
Cheese & Veggie. Omelet
Hash Browns w/ Bacon
Toaster Pastry – 1/
Jam – 1/
Crackers, plain
Cinnamon Scone
Hot Sauce
Accessory Packet, C
Sugar-free Beverage
Spoon
Flameless Heater & Hot Beverage Bag

Menu #5
Chicken Breast
Mexican Mac & Cheese
Pound Cake – 3/
Cheese Spread, Jalapeno
Wheat Snack Bread
Cappuccino, French Vanilla
Candy II – 2/
Jalapeno Ketchup
Accessory Packet, B
Spoon
Flameless Heater & Hot Beverage Bag

Menu #6
Chicken Fajita
Yellow/Wild Rice Pilaf
Raisin Nut Mix
Cheese Spread, plain
Tortilla
Cappuccino, French Vanilla
Seasoning Blend
Accessory Packet, C
Spoon
Flameless Heater & Hot Beverage Bag

Menu #7
Chicken With Salsa
Mexican Rice
Shortbread Cookies
Cheese Spread, Jalapeno
Cracker, Vegetable
Candy II – 2/
Cappuccino, Mocha Flavored
Hot Sauce
Accessory Packet, B
Spoon
Flameless Heater & Hot Beverage Bag

Menu #8
Beef Patty
Nacho Cheese Pretzels
Western Beans
Cheese Spread w/ Bacon
Wheat Snack Bread (2)
Beverage, Carb Fortified
BBQ Sauce
Hot Sauce
Accessory Packet, B
Spoon
Flameless Heater & Hot Beverage Bag

Menu #9
Beef Stew
HOOAH! Bar – 1/
Peanut Butter
Crackers, plain
Dairy Shake – 1/
Hot Sauce
Accessory Packet, A
Spoon
Flameless Heater & Hot Beverage Bag

Menu #10
Tuna
Tortillas
Cookies – 4/
Pretzels
Dairyshake – 1/
Mayonnaise
Seasoning Packet
Accessory Packet, C
Spoon

Menu #11
Spicy Penne Pasta
Fruit, dried – 1/
Pound Cake – 3/
Peanut Butter
Crackers, plain
Seasoning Blend
Beverage, Carb Fortified
Accessory Packet, C
Spoon
Flameless Heater & Hot Beverage Bag

Menu #12
Veggie Burger w/ BBQ Sauce
Potato Sticks
Fruit, Dried – 1/
Wheat Snack Bread (2)
Chocolate Banana Muffin Top
Beverage, Carb Electrolyte
Hot Sauce
Accessory Packet, B
Spoon
Flameless Heater & Hot Beverage Bag

MEAL, READY-to-EAT (MRE)
MRE XXVI MENUS*

Menu #13
Cheese Tortellini
Spiced Apples
HOOAH! Bar
Peanut Butter
Crackers, plain
Candy I – 2/
Beverage, Sugar Free
Accessory Packet, C & Seasoning
Spoon
Flameless Heater & Hot Beverage Bag

Menu #14
Vegetable Manicotti
Wet Pack Fruit – 1/
Pound Cake – 3/
Peanut Butter
Crackers, plain
Hot Sauce
Cocoa, Hazelnut
Accessory Packet, B
Spoon
Flameless Heater & Hot Beverage Bag

Menu #15
Beef Enchiladas & Refried Beans
Cookies – 4/
Crackers, Vegetable
Cheese Spread, Jalapeno
Beverage, Carb Fortified
Picante Sauce
Red Pepper
Accessory Packet, A
Spoon
Flameless Heater & Hot Beverage Bag

Menu #16
Chicken with Noodles
Wet Pack Fruit – 1/
Cheese Spread, plain
Crackers, plain
Chocolate Covered Sports Bar
Candy II – 2/
Cocoa Beverage
Hot Sauce
Accessory Packet, A
Spoon
Flameless Heater & Hot Beverage Bag

Menu #17
Sloppy Joe
Cheddar Snack Cracker
Shortbread Cookies
Cheese Spread (Jalapeno)
Wheat Snack Bread (2)
Beverage, Carb Electrolyte – 1/
Hot Sauce
Accessory Packet, A
Spoon
Flameless Heater
Flameless Heater & Hot Beverage Bag

Menu #18
Cajun Rice, Beans & Sausage
Cheddar Cheese, plain
Crackers, plain
Nuts – 1/
Cheddar Cheese Pretzels
Beverage, Carb Fortified – 1/
Hot Sauce
Accessory Packet, A
Spoon
Flameless Heater & Hot Beverage Bag

Menu #19
Roast Beef w/ Vegetables
Fruit, Dried – 1/
Ranger Bar, Caramel Apple
Chocolate Peanut Spread
Crackers, plain
Beverage, Carb Fortified – 1/
Hot Sauce
Accessory Packet, A
Spoon
Flameless Heater & Hot Beverage Bag

Menu #20
Spaghetti with Meat Sauce
Cherry Blueberry Cobbler
Cheese Spread, plain
Potato Sticks
Wheat Snack Bread
Beverage, Carb Electrolyte
Hot Sauce
Accessory Packet, A
Spoon
Flameless Heater & Hot Beverage Bag

Menu #21
Chili and Macaroni
Cookies – 4/
Cheese Spread, Jalapeno
Wheat Snack Bread
Candy III – 2/
Beverage, Sugar Free
Accessory Packet, C
Spoon
Flameless Heater & Hot Beverage Bag

Menu #22
Jambalaya
Pound Cake – 3/
Jelly – 1/
Wheat Snack Bread
Dairy Shake – 1/
Hot Sauce
Accessory Packet, A
Spoon
Flameless Heater & Hot Beverage Bag

Menu #23
Chicken with Cavatelli
Raisin Nut Mix / chocolate
Cheese Spread w/ Bacon
Wheat Snack Bread
Fig Bar
Beverage, Carb Fortified
Red Pepper
Accessory Packet, A
Spoon
Flameless Heater & Hot Beverage Bag

Menu #24
Meatloaf With Gravy
Mashed Potato
Shortbread Cookies
Jelly – 1/ & Crackers, plain
Hot Sauce
Candy I – 2/
Cocoa Beverage
Accessory Packet, B
Spoon
Flameless Heater & Hot Beverage Bag

*MRE XXVI Menus are the current production year menus. Please note that availability to the "end user" is dependent upon distribution, the two and one-half to three-year stock rotation process, and exhaustion of current menu stock.

1/ Flavors shall be procured in equal quantities and assembled in a uniform distribution. Wet pack fruit shall include raspberry applesauce, carbo enhanced applesauce, mango/peach applesauce, pineapple, pears, and mixed fruit. Nuts shall include peanuts and almonds.
2/ Candy I (Menus 1, 13, 24): chocolate toffee rolls and toffee with walnuts, Candy II (Menus 5, 7, 16): plain, peanut, and peanut butter chocolate pan coated disks, and Candy III (Menu 21): fruit disks and cinnamon disks; shall be procured in equal quantities and assembled in a uniform distribution. Candy I shall be overwrapped in a barrier pouch as cited in A-A-20177C PKG & QAP.
3/ Pound cakes, Flavors 1, 6, 7, 8, 9 and 10, shall be procured in equal quantities and assembled in a uniform distribution in Menus 5, 11, 14 and 22. Not more than two meals in any shipping container shall contain the same flavor of cake.
4/ Cookies; Type I; Style I, Flavor 1; Style J, Flavor 1; Style J, Flavor 8; Style K; Style L; Style M; Style Q and PCR-C-031 shall be procured in equal quantities and assembled in a uniform distribution within Menus 2, 10, 15 and 21.

MRE ACCESSORY PACKETS

	A	B	C
TEA, INS, W/ SWEETNER & LEMON FLV.		X	
APPLE CIDER			X
COFFEE	X		
SUGAR	X		
CREAMER	X		
SALT	X	X	X
CHEWING GUM, TABLET, SUGAR FREE, PEPPERMINT or CINNAMON	X	X	X
MATCHES	X	X	X
TOILET TISSUE	X	X	X
TOWELETTE	X	X	X
APPLE CIDER			X

1993
Executive Research Project
RS1

Subsistence Meal Ready to Eat (MRE)

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DISCLAIMER

ABSTRACT

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Preservation of the industrial base for the production of MREs (Meal Ready to Eat) is at risk in light of reductions in the budget of the Department of Defense. This paper will discuss the history of rations, current production status, future requirements, and ways to ensure a viable industrial base. The intent of this paper is to describe in detail the past, present, and future field rations. Compare production concepts and address ways by which a healthy industrial base, capable of meeting DOD capacity requirements for the most common ration -MREs- can be obtained.

OUTLINE

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- Introduction
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- World War I through the Vietnam War
- Conclusions

Chapter II - DOD Standards and Current Production Capabilities
- General
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- Production - Current DOD Requirements for MREs
- New Technology
- Alternative To MREs
- Conclusions

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- Totally Within DOD Authority
  - Contract For Production Capability
  - Increase Unit Basic Load - UBL
  - Increase Use By DOD
  - Pre-positioned War Reserves (PWRS)
- Internal U.S. Governmental Programs
  - U.S. Social Programs
  - Disaster Relief - Federal Emergency Management Agency
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FORWARD - GENERAL STATEMENT.

President George Bush in the 1993 National Security Strategy of the United States on page 15 indicated the need for maintaining the Defense Industrial base as follows;

> In peacetime, the industrial base must provide an advanced research and development capability, ready access to civilian technology, and a continuous design and prototyping capability. Increased focus must be placed on innovative manufacturing techniques that provide the capability to incorporate rapidly and cost effectively the most advanced technological improvements into our armed forces.
>
> In conflict, the industrial base must be capable of surging production of essential warfighting items prior to and during a contingency operation. In addition, the industrial base must have the capacity to restore, in a reasonable period, the war reserve stockpiles of items that were consumed. Finally, the industrial base must be able to reconstitute forces in order to respond to the reemergence of a global threat.
>
> As the national defense budget declines over the near-to mid-term, we must ensure that the industrial base providers of unique, critical peacetime, conflict and reconstitution related capabilities are available when needed.

The goal of DOD is to maintain the field ration portion of the defense industrial base at a minimum operating level during peace and obtain maximum production to meet requirements during mobilization, war or other emergency situations. If defense industrial production is not maintained, the ability to support national crises maybe limited. The end result could be unfavorable and/or unacceptable to the United States.

CHAPTER I

HISTORY OF MREs

INTRODUCTION

It has been said many times that the outcome of a conflict is determined by the logistian before the first round is fired. The ability of a nation to provide the resources needed by its forces is paramount; for without adequate resources, the goals of the nation may not be attainable. Industrial base preparedness is vital in order to provide suitable resources to our forces.

I will focus on only a small portion of the resources required to field a military force: that being the field feeding of the individuals that comprise the force. I will also address the most important aspects of the industrial base that produces MREs.

My interest in field feeding was perked several years ago as I worked on a generic design of a regimental training complex for Southwest Asia. One of the facilities in the training complex was a dining facility of sorts. The uniqueness of this facility, compared to U.S. standards, highlighted the differences between our culture and that of the Middle East. In addition, it depicted the differences in procurement methods and preparation of individual rations. The kitchen area allowed for the use of wood as a fuel source. Large black pots on top of a masonry stove were used for cooking. The animal slaughter pad and racks

were on the outside of the building next to the kitchen. The location of the slaughter area allowed for easy access of the meat to the cooking pots. How many of our soldiers have the ability to process live animals, cattle or goats, in order to produce the food stuff- subsistence - an deliver it to the individual for consumption?

REVOLUTIONARY WAR PERIOD

Ever since the days of the American Revolution, feeding the force has been of great concern to the leaders of our nation.

> The Continental Congress first established a formal program for field feeding in 1775. They attempted to standardize rations and the ways units prepared them. The basic ration included 1 pound of beef, or 3/4 pounds of pork or 1 pound of salt fish; 1 pound of bread or flour; 1 pint of milk or payment of 1/72 dollars, and 1 quart of cider, or spruce beer; 3 pints of peas or beans per man per week.[1]

The rations were issued to individual soldiers for individual or group preparations.

Company level food service was first introduced in 1777. The major concerns were on cleanliness and freeing the individual combat soldier from the task of food preparation. The concept of " eat on the go " was developed and is still the basis for food service doctrine today.

WORLD WAR I THROUGH THE VIETNAM WAR

Food preparation during this period still focused around the

company level mess facility. In a field environment the typical company level kitchen consisted of a tent, gas fired stoves, ice chest, immersion heaters and several 32 gallon trash cans. A-rations (fresh) or B-rations (dehydrated or semi-perishable) subsistence were used when tactically feasible.

The U.S. Army introduced the first prepacked operational ration in 1934, and it was officially known as the Combat (C) ration, consisting essentially of a meat hash, vegetables and bread.[2] The C-ration left much to be desired but due to funding constraints after World War II, was not replaced until after the out break of the Korean conflict. The new ration was called the Meal Combat Individual (MCI); not to be confused with the C-ration as most of us do. The MCI was the main field ration used during the Vietnam War and was still in service until the 1980s.

CURRENT FEEDING METHODS

In the 1980s, a new family of rations was developed because of the desire to provide the highest quality ration possible. The new rations were the Meal Ready to Eat (MRE) and the Tray ration (T- ration) and with the Mobile Kitchen Trailer (MKT) are the basis for the current doctrine for field feeding today.

The Department of the Army (D.A.) requirement is to feed one hot meal per day. The meal may be either a Tray ration or an

A ration. The change was approved by the Chief of Staff U.S. Army in August 1992; the previous standard was one hot meal every three days. The U. S. Army consumes between 70% to 75% of all field rations used by DOD annually.

CONCLUSIONS

The evolution of substitute rations has been a complex issue paved with problems, and at times a drastic lack of funding. The preparation of field rations has changed dramatically over the past 200 years and will continue to evolve as technology allows. The result of the changes have been a higher quality ration than the original rations of the Revolutionary War period.

CHAPTER II
DEPARTMENT OF DEFENSE STANDARDS AND CURRENT PRODUCTION CAPABILITIES

GENERAL

The U.S. industrial base for the production of MREs currently has excess capacity to meet mobilization requirements. However, there are projected availability problems with certain types of packaging material. The largest problem though will be in maintaining an adequate capability to meet mobilization requirements with a smaller Department of Defense (DOD) which requires less volume during peacetime. It will be impossible and unnecessary to sustain all of the current vendors with the projected requirements that have been identified by the services to the Defense Logistics Agency (DLA).

The following is quoted from the 1990-1991 ICAF Agriculture Defense study; it reinforces current MRE producer problems.

> The companies currently in the MRE industry find that profits are only marginal. The drastic reduction in the number of contractors bidding also verifies this claim. The only way to improve profitability in the near term would be to open up new civilian and foreign markets. Foreign military forces rely heavily on commercial items for their combat rations, avoiding the problem of being too unique to be profitable to industry. France relies on commercial items; changing to its current policy in 1987 as a result of its major producer going out of business. We should learn from that example and reduce our dependence on military unique food products.[3]

With decreased dollars, maintaining an expandable production base will be more difficult. Where there is an excess production capability today, unless DOD provides funding to maintain

capability, some producers will stop producing and seek alternative uses for their facilities; this change could be permanent or temporary. If too many producers cease production, the long term effect could be an inadequate production base to meet mobilization requirements.

The Buy American Act of March 3, 1933 requires that all food items purchased by the Department of Defense with appropriated funds be of U.S. origin. Exceptions to this policy must be approved by the Commander of the Defense Personnel Services Center (DPSC) or Headquarters Defense Logistics Agency (DLA). The intent of Congress is that each step of the food process be domestic with a preference to American producers. This concept covers all phases of production to include packaging.

TECHNICAL SPECIFICATIONS AND STANDARDS

Meals Ready to Eat (MRE) - DOD requirements significantly differ from that of commercial items which creates challenges for industry. The following identifies major characteristics for MREs:

1. 3-5 year shelf life at 70 degrees, 6 months at 100 degrees.
2. Calories - 2800 to 3200
3. Carbohydrates 50 to 54 %
4. Protein - 16 to 17 %
5. Packaging - 75 % must withstand a 150 feet airdrop with no parachute.
6. Weight - No more than one (1) pound
7. Size - No larger than a MCI
8. Camouflage packaging

The MRE is comprised of 12 menus consisting of 39 component

items. These components are bought under a modified systems approach whereby certain component items are supplied by the Government as Government Furnished Material (GFM); other components, classified as Contractor Furnished Material (CFM), are produced by assemblers or subcontracted out.[4] The future MRE configuration is shown in MRE - 13 (Enclosure I).

Differences exist between DOD and commercial standards which may appear small but complicate the production process such as: the requirement for 4 gram packages of sugar instead of the industry standard which is 3 grams per package. Another example is the military standard of coffee which is powdered instead of the industry standard freeze dried. Use of commercial off the shelf items that are readily available would provide industry greater flexibility in meeting DOD field feeding needs and reduce the per unit cost of each meal.

MRE PRODUCTION CAPABILITY

A reduction in both mobilization and peace time requirements, indicates that the current three MRE assemblers and seven retorters (food processors) are no longer required. The following chart identifies industry capacity, mobilizations requirements, and projected peace time useage.

CURRENT MRE REQUIREMENT and MAXIMUM CAPACITY

ASSEMBLY (MONTHLY)

PEACETIME	MOBILIZATION	MAXIMUM CAPACITY
FY 93		(Three Assemblers)
.103m cases	1.8 million cases	* 3.5m cases

RETORT PROCESSING (MONTHLY)

Peacetime	Mobilization	Maximum Capacity
FY 93		(Seven Retorters)
1.75 m pouches	30.6 m pouches	** 51.4 m pouches

* Assemblers can only assemble 2.5 million cases / month because assembly capacity is restricted by component items.

** Equates to 2.5 million cases / month.[5]

PACKAGING MATERIALS

The current suppliers of packaging materials can meet the preliminary requirement for mobilization of 1.8 million cases per month provided raw materials are available.

MAXIMUM CAPACITIES

PACKAGING MATERIALS (MONTHLY)

MOBILIZATION	* MAX CAPACITY
21.6 m Meal Bags	38.0 m Meal Bags
30.6 m Pouches	** 42.5 m Pouches

* 3-8-7 Shift Basis

** Supports assembly of 2.5 m cases/month

Long leadtimes and /or the nonavailability of either the raw materials used to produce trilaminated rollstock or preformed pouches for retort items could be the " showstopper" in the event of a surge/ national emergency. HIMONT U.S.A., Inc. and EXXON Chemical Company who are suppliers of SD 753 grade polypropylene resin and polypropylene film, respectively, have stated they are no longer interested in supporting the MRE Program. The laminators would be forced to rely on foreign sources unless domestic sources are identified or a different grade of polypropylene resin is approved for use.[5]

The major problem at present is the availability and cost of polypropylene resin used in food pouches. Resin requires a unique polymer in order to meet DOD standards of impact resistance, heat seal strength and extratables. The shelf life requirement and impact standards are of the greatest concern to industry. If these standards could be modified, then production materials could be adjusted which are more readily available; hence a reduction in cost of production and possibly a product that would be more acceptable for commercial use.

ASSEMBLERS AND RETORTERS MINIMUM SUSTAINING RATES(MSR)

MSR is based on a 1-8-5 work schedule (1 shift-8 hours-5 days) and maximum crisis production capacity is based on a 2-10-7 shift; contractor's profile follows. The data is based on current information considering the cost and return on investment.

CONTRACTOR'S MSR AND MAXIMUM CAPACITIES PROFILE

ASSEMBLERS	MIN SUSTAINING RATE		MAX CAPACITIES	
	Assembled Cases	Retort Pouches	Assembled Cases	Retort Pouches
	Annual/Monthly	Annual/Monthly	Monthly	Monthly
Cinpac Inc.	*.52m/ .043m	2.175m/ .181m	.663m	3.19m
Right Away	1.10m/ .092m		1.34m	** 2.23m
SO-PAK-CO	*1.40m/ .117m	*9.000m/ .750m	1.50m	12.70m
RETORTERS				
Ameriqual		8.000m/ .667m		3.78m
Land O'Frost		2.000m/ .167m		5.22m
Pillsbury		1.750m/ .146m		2.29m
Shelf Stable	***	8.750m/ .729m		14.15m
Star Food's		6.000m/ .500m		7.85m
Totals	3.02m/ .252m	37.675m/ 3.14m	3.50m	****51.41m

*Assumes Contractor would receive both assembly and GFM awards.

**Right Away Foods only processes CFM applesauce

***Assumes Right Away Foods receives an assembly award and Shelf provides CFM in addition to GFM.

****Assemblers can only assemble 2.5 m cases / month because assembly capacity is restricted by component items.[7]

MRE INDUSTRY COMPARISON

	PEACETIME	MOBILIZATION
	Year/Month	Year/Month
FY93 Requirements	1.23m/.103m	21.6m/1.8m
FY94 Requirements	1.5m /.125m to 2.0m/ to .166m	21.6m/1.8m

Three assemblers and 7 Retorters

Minimum Sustaining Rate(MSR)	3.02m/.252m	
Assemblers Capacity		42.0m/3.5m
Maximum Capacity		*30.0m/2.5m

*(Limited by availability of packaging material)

The FY 93 peacetime requirement of 1.23 m cases corresponds to an average of .103 m cases and 1.75 m retort pouches per month based on a 12 month delivery schedule. The acquisition quantity of 1.23 m cases can sustain one or possibly two assemblers and three or more retorters depending upon the combination of awards if contractors will accept an award for less than their MSR VALUE.

The preliminary FY 94 annual peacetime acquisition quantity is forecast to be between 1.5 m to 2.0 m cases which equates to an average of .125 m to .167 m cases per month based on a 12 month delivery schedule. This acquisition quantity can sustain one or two assemblers depending upon the final purchase request quantity. The above requirement equates to an average of 2.125m

to 2.839m retort pouches per month based on a 12 month delivery schedule. This quantity can sustain three or more retorters depending upon the combination of awards.

Any unforeseen reduction in peacetime usage by the Services will put the above assumptions regarding how many firms can be sustained during peacetime in jeopardy. Scenarios to market MREs to alternate customers may be problematic due to the past minimal usage by non-DOD sources. Outreach programs of this nature are still in their infancy.[8]

NEW TECHNOLOGY- UHT, Radiation, Electric Shock.

Much has changed since the Continental Congress first standardized the allocation of food for the military. New techniques are available which were unheard of 200 years ago. In the early days of our history, meat was preserved by drying, salting or smoking. There were many advantages to these processes and they were effective, but new technology has allowed for major changes in the methods used to preserve food. One of the earliest known methods was refrigeration. This method is not practical for use by an individual on the battlefield but is used to store, transport and preserve food throughout the world during all types of activities.

Just as refrigeration technology changed the way food is preserved; changes in technology will affect the way military

personnel are fed in the future. Many changes have already been incorporated into the field feeding system. One such change is the use of Ultra-High Temperature (UHT) milk which requires no refrigeration. Granted warm UHT milk is not very palatable but it remains useable without constant cooling.

Technology such as UHT(Ultra High Temp), radiation processing and electric shock methods of production are being investigated by NATICK for possible use in preserving food. Any process that increases shelf life, decreases packaging requirements and provides for commercial use would benefit producers and lower per unit cost to the military. Commonalty of items with the civilian sector is desirable and should be the ultimate strategy that is adapted by the Department of Defense.

ALTERNATIVE TO MREs

Even prior to Desert Storm, the Quartermaster School was considering alternate items that could be used to replace MREs. One concept that was developed - Meal Operational Ready to Eat (MORE)- allowed for use of off the shelf items. This concept was used to some extent during Desert Storm and provided great flexibility to industry. Items such as Top Shelf meat products were used in conjunction with other commercially available products. When they were put together, they provided the necessary nutrients required to maintain an individual. The MORE however did not meet DOD standards. They were not air

dropable nor camouflaged and the high salt content was unacceptable to the Surgeon General.

The MORE concept does, however, highlight the possibility of obtaining off the shelf items that would meet most of the DOD requirements. Just as we have different types of units, we need different types of rations; operational rations to meet normal requirements and a limited amount that can survive the unusual requirements such as a 150 feet free fall.

A complete evaluation of the standards would be beneficial. Just as the services have all gone to readily available commercial items for certain missions; the packaging requirements and other standards for MREs should also be evaluated. It may be as simple as shopping at the commissary to find the on shelf items that meet operational requirements.

Nothing we do helps sustain the individual unless it is consumed. The eating habits and desires of the consumer must be considered and every effort taken to meet their expectations. A wide variety of products that are pleasing in appearance and taste good will best support these expectations. Ease of production and use of off the shelf items are desirable.

CONCLUSIONS

The 1993 industrial base for the production of MREs has the

capacity to meet both peacetime and mobilization requirements. Due to reduced requirements and the minimum sustaining rate (MSR), only one or possible two assemblers and three or four retorters will be sustainable. Future reductions will affect producers and the resulting loss of production capability could adversely affect the ability to field a military force. Expanded use of the MREs by non-DOD consumers and modification of DOD standards to allow more commercial procurement would benefit industry and the military by reducing cost of the items. The next chapter identifies several ways to expand usage of MREs.

CHAPTER III
MAINTAINING THE INDUSTRIAL BASE

GENERAL

DLA's intent is to maintain the production base at a minimum operational level during normal conditions in order to meet requirements during a crisis, whether it is an all out global war or a limited conflict. To keep the base warm and producing requires careful management of limited resources - dollars - on a continuing basis. With the expenditure of the right amount of dollars, the production base will be maintained. There are many ways of increasing consumption. I will address several of them and make observations and general comments concerning each.

TOTALLY WITHIN DOD AUTHORITY

1. CONTRACT FOR PRODUCTION CAPABILITY

We must understand contractor minimum and maximum production capability and the profit margin required to maintain each element involved in the production process. One approach to maintaining production capability is a direct capabilities contract. Simply pay a contractor to maintain the capability. A vendor will be paid to maintain equipment, people and sources of raw materials under certain conditions and standards. When and if the need arises, we issue an order to proceed. The LOGCAP (Logistic Civil Augmentation Program) concept has been used

before in areas such as pipeline construction and tug boat support for Southwest Asia (SWA). LOGCAP is a process where the government pays a contractor to maintain capabilities or be able to provide certain services for use by the military in support of contingency operations. On the shelf contracts that maintain the ability to meet our national needs in time of crisis may be the best method to retain the needed capability.

2. INCREASE UNIT BASIC LOAD (UBL)

Maintaining the industrial base depends on increasing the volume of production and use. Another method of increasing demand - even with the decrease in the number of units - is to increase the requirement of the units basic load. The UBL at present is 3 days for the Army. If every unit is required to maintain 10 days instead of 3 days then the on hand quantity has been more than tripled. The normal rotation of MREs and accountability will still be required but the one time increase in demand will assist in maintaining the production base.

Some disadvantages exist, such as unit movement of the additional items, but they must be moved to the area of responsibility (AOR) any way. By having the MREs in the hands of the unit, commanders have an additional 7 days of supply available. In the case of heavy units, 30 meals issued to an individual soldier would hardly be noticed. Heavy units are better prepared for such a plus up than light units, such as airborne or air assault

units. The additional days of supply gives units and individuals greater flexibility of operations.

3. INCREASE USE BY DOD UNITS

There is a great tendency on the part of leaders at every level to feed A - rations (normal rations) whenever possible; its called taking care of people. This desire is so strong that unless directed by DOD, the requirement to feed MREs or Tray rations will not be done unless operational requirements dictate their use.

In order to keep the demand as high as possible every effort must be taken to use the field rations. Volume consumed will be increased if all units in a field environment are required to subsist on at least one MRE per day. In addition, the system for managing the logistical distribution will be exercised.

All units in a field environment must adhere to the feeding cycle; whether they are national guard, reserve, or active. All must consume field rations. We must train units as they will fight or support and this must include all spectrums of the system. Only by using MREs will the system be exercised. Users need to provide feedback on food quality and recommended changes in order to allow DLA and other supporting agencies to improve the quality. If it is substandard then identification of the problem is the first step on the road to improvement

in the rations.

4. PREPOSITION WAR RESERVES (PWRS)

The U.S. has a greater challenge in projecting its will worldwide because of the draw down of U.S. forces from around the world and their return to the U.S. The need for prepositioned war stocks- including food- is greater than it has been in many years. Having PWRS in adequate quantities to sustain the planned force structure serves DOD in two ways: first by having readily available resources and second by increasing the required amount needed therefore increased production. The Department of Defense must be very careful not to deplete the PWRs to a level that constrains our national ability to accomplish established goals. The U.S. must retain maximum flexibility during this period of limited resources.

There are some who may determine that DOD no longer needs War Reserves and may even feel that "Just in Time" deliveries are the best methods of supplying a deployed force. War reserves are still required in order to meet support requirements of deploying forces. Increasing the prepositioned War Reserves provides an increased volume and a readily available source for deploying units or national emergencies.

5. U.S. SOCIAL PROGRAMS

There is much need for food within our nation and supporting this need has been answered in many ways; one of them being food stamps which allows recipients to buy food products - subsistence from the corner store. I remember some years ago - before food stamps - commodities were distributed monthly to those in need. Staples of life were given to the needy such as cheese, powdered milk, flour, corn meal, peanut butter etc. This method of providing food directly, prevented the direct purchase of luxury items like alcohol and tobacco products. The intent was to provide food to those who needed it most and had no means of paying for even these basic items. The commodities, in many cases, were items which the federal government had paid farmers to over produce in order to maintain a production base.

MREs could be used in the same type of program. Individual meals (MREs) could be purchased and given to those with the greatest need. Nursing homes, schools, individuals are all possible users of this type of program. The key is maintaining the base through production and use of the items. If we are going to aid the needy, then make it work for the good of the system as a whole. Providing the basic needs of life to the elderly, sick, homeless and deprived of our nation can be accomplished by the federal

government in such a way as to maintain systems which are needed for national defense; this is not a new concept. Protection of our industrial base for national defense reasons is common place. The U.S. sells weapons worldwide partly for strategic reasons and partly for maintaining jobs and a base of production. There will be those against such a process; but what is the difference between providing subsistence in this form verses the food stamps which are used now as commodities were used in the 1950s and 1960s. Let's help our needy and at the same time maintain production systems.

It is estimated that 30 million Americans go to bed hungry each day. In a nation of plenty that uses its military power to provide food and assistance to other nations, should we not do the same for our own citizens? I'm not proposing that the military open food kitchens or have the homeless in the dining facilities for Thanksgiving Dinner. But at the national level a strategy should be instituted that provides for the needs of maintaining the production base and at the same time cares for the needy of our nation.

6. DISASTER RELIEF - FEDERAL EMERGENCY MANAGEMENT AGENCY(FEMA)

The Department of Defense over the last five years has taken a larger responsibility in aiding local governments in recovery operations after natural disasters. The military's role has ranged from fighting fires to assisting in area recovery after

hurricanes and tornadoes, to helping those stranded by floods or earthquakes. The assistance has been provided by active, reserve and national guard units.

In any type of natural disaster, the help needed initially is food, clothing and shelter. Everyone wants to help but may cause more problems because of lack of standardization of items sent to a disaster area. After Hurricane Andrew hit the southern part of the U.S. in 1992, truck loads of everything one can imagine arrived in the devastated areas; many times not the items needed initially to maintain an individual.

The military has a wide range of capabilities to support such missions and a part of that can be found in the ability to provide the basic needs especially food. MREs located in storage facilities worldwide could be used initially to provide food to those in need. When expedient feeding is required, time can be saved in food preparation by using MREs. Federal money is usually available to support such operations and again any increase in usage increases demand on the system and in turn volume produced; thereby maintaining a production base.

PROGRAMS WHICH INVOLVE OTHER SOVEREIGN NATIONS

7. FOREIGN MILITARY SALES(FMS) CREDITS FOR FOOD

Foreign Military Sales is normally connected with weapons systems

such as tanks and planes. A country concerned uses FMS credits to purchase these items from a company where by the U.S. federal government pays for the item or items. Requiring a country that is getting military aid from the U.S. to use some of their FMS credits to purchase subsistence is one way of increasing the volume of items produced. The possibilities are limitless in this area. All countries have a need for subsistence- some greater than others - but the need is real and use of FMS is one option that would meet the requirement of maintaining the industrial base.

Authorities in many of the Third World countries may hesitate to use their FMS credits on the purchase of food but the needs of our nation must also be considered. Sustaining forces by providing adequate resources takes many forms. Without people who are also well maintained combat capability will be reduced. Certain adjustments for cultural differences will be required but could easily be accomplished. The advantage of this program is an increase in the awareness of operational capabilities of our industrial preparedness.

8. UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT (USAID)

Those who have should help those who have not. This assistance may take many forms but the U.S. is constantly involved somewhere in the world with providing food to the hungry and displaced. Providing readily available emergency assistance is extremely

important. How much simpler can one get than by providing a highly nutritious meal- although not always the most palatable - to meet the minimum requirements. Again cultural differences will need to be addressed but where keeping a production line open and operational are concerned how better than providing meals to the hungry of the world.

The MRE is a ideal item to provide in areas where ground transportation is unavailable. The MRE could be air dropped with a large percentage - 75% or more surviving such a drop. Cargo aircraft can accomplish distribution from a central air strip, logistics base, or anywhere in the general vicinity.

The MRE allows for an easy and fast method to supplement the diets of thousands who are in need around the world. With the shelf life and transportability the U.S. could respond to critical locations and provide life sustaining food in a relatively short period of time.

9. EX-WARSAW PACT COUNTRIES - FOOD FOR WEAPONS

There are many needs in the countries of the ex-Warsaw Pact. Providing improvements in the standards of living is paramount in order to curb civil unrest and possibly a return to some form of the cold war era. Feeding the populace of these countries is extremely important; special consideration must be given to just this basic need. It will be hard for democratic reformers

to succeed unless they are able to provide the basic necessities to their people.

The U.S. and other developed countries must aid the struggling democracies wherever possible. One method is to trade food (MREs) for weapons systems or raw materials. The key to sustaining our base is production, demand for the end product. By trading food for "existing" weapons and weapons systems, using the barter system, we can maintain our industrial base. Once such weapons are in U.S. possession they should be destroyed immediately. This is one method of helping feed the people of the former Soviet Union(FSU) and at the same time rid the world of the means to make violent wars of mass destruction.

This type program must include assistance for converting the ex-Warsaw Pact countries industrial base for weapons production to industries that produce consumer goods. Civil unrest will continue unless consumer goods are made readily available to the people. The use of force to maintain power has been the trend in most of the third world countries of the world and will be common place without democratic consumer oriented governments.

10. CONCLUSIONS

I have discussed nine methods by which an increase in demand may be achieved, thereby increasing demand on the logistical

system and in turn the production base. Each one of the methods has advantages and disadvantages and must be evaluated according to its own merits.

PROGRAMS TOTALLY WITHIN DOD AUTHORITY

The four concepts within DOD authority are:

1. Contract for Production Capability
2. Increase unit basic Load- UBL
3. Increase use by DOD
4. Pre-positioned War Reserves

These concepts must be funded by DOD and are within the authority of the Department of Defense to control according to funding constraints. Evaluation of contracting production capacity must be accomplished in order to determine the most cost effective way to maintain vendors. The final analysis may determine that it is cheaper to buy additional MREs to a level that maintains vendors than it is to pay for maintaining capability with no product output. Any additional purchases could then be used to fill UBLs, consumption during exercises or increased levels of War Reserves. The end result of this program must be procurement adequate to maintain vendors at a level capable of meeting mobilization requirements. DOD cannot depend on the concepts or wishful thinking to maintain the MRE industrial base.

INTERNAL U. S. GOVERNMENTAL PROGRAMS

The two concepts covered in this area are:

1. U.S. Social Programs
2. Disaster Relief - Federal Emergency Management Agency

The probability of obtaining funding to purchase MREs for the homeless and poor of our nation is very unlikely. Even receiving funding from FEMA or other U.S. Governmental agencies has little chance of succeeding. Emergencies will occur that require feeding of large numbers of people and the military will be called upon to provide support. DOD will use whatever means available to accomplish the task. MREs will be sent initially just as they were during recovery operations after Hurricane Andrew. Adequate War Reserve stocks must be maintained in order to meet normal operational requirements, expected mobilization needs and natural disasters.

PROGRAMS WHICH INVOLVE OTHER SOVEREIGN NATIONS

The three concepts are:

1. Foreign Military Sales (FMS)
2. U.S Agency for International Development
3. Ex-Warsaw Pact Countries- Weapons For Food

Each of these concepts present challenges and opportunities that would benefit all parties concerned but unless totally funded by the U.S. they probably would not even be given serious

consideration by other nations. Many would gladly accept food handouts as long as they did not have to pay for them. The U.S. has given food aid to many nations and should considerate providing a modified MRE.

In the case of the Ex-Warsaw Pact countries, any assistance that helps maintain the stability of the democratic governments while removing weapons systems would be in the best interest of the U.S. and the world as a whole. The U.S. provides loan guarantees for many of these countries which allows them to purchase grain. A similar program for MREs would provide food to the people of these countries while maintaining our production base.

SUMMARY AND RECOMMENDATIONS

The evolution of field feeding has changed dramatically over the last 200 years and more changes will occur in the future. The Department of Defense must maintain industrial production capability in order to feed any deployed force.

FINDINGS

1. FY 93 and FY 94 requirements will not sustain adequate vendors in order to meet mobilization requirements.

2. Technical standards complicate production and increase cost

of MREs to the government.

3. Alternate methods of packaging could solve some of the concerns of industry about the MRE and decrease the cost of production.

RECOMMENDATIONS

1. DOD through DLA purchase enough MREs annually to maintain sufficient assemblers and retorters capable of meeting surge requirements during mobilization.

2. Change the technical standards of the MREs in order to reduce the differences between DOD and normal industry standards wherever possible.

3. DOD should explore in coordination with the State Department the possibility of trading MREs to Russia for weapons.

4. DOD should obtain additional funding for MREs that could be used for domestic programs and disaster relief.

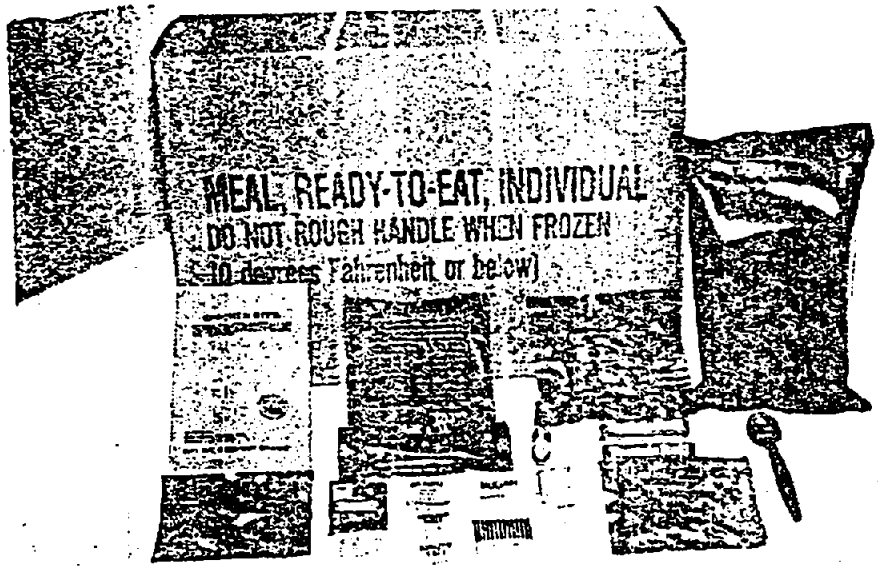
ENCLOSURE 1 - MRE13

COMPONENTS OF IMPROVED MRE - MRE XIII

MENU 1	MENU 2	MENU 3	MENU 4	MENU 5	MENU 6	MENU 7	MENU 8	MENU 9	MENU 10	MENU 11	MENU 12
Pork w/Rice TS-8 oz	Corned BF Hsh TS-8 oz	Chicken Stew TS-8 oz	Omlet w/ Hm TS-6 oz	Spagh w/ Meat Sce TS-8 oz	Smoky Franks TS-3.75oz	Beef Stew TS-8 oz	Ham Slice TS-4.3 oz	Pork Chow Mein TS-8 oz	Tuna w/ Noodles TS-8 oz	Chicken w/Rice TS-8 oz	Esc Pot w/Ham TS-8 oz
Apple Sauce TS	Fruit FD	Fruit TS	Potatoe Au Grat TS-5 oz		Fruit FD		Potato Au Grat, TS-5 oz	Fruit FD			Apple Sauce TS
	Oatmeal Cookie Bar		Oatmeal Cookie Bar	Pound Cake	Potato Sticks	Pound Cake	Brownie Choc Cvd	Cookie Choc Cvd	Pound Cake	Cookie Choc Cvd	Brownie Choc Cvd
Jelly	Jelly	Peanut Butter	Jelly	Cheese Spread	Peanut Butter	Peanut Butter	Cheese Spread	Peanut Butter	Jelly	Cheese Spread	Cheese Spread
Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker
		Candy*	Candy*	Candy*	Candy*			Chow Mein Noodles	Candy*	Candy*	
Cocoa	Cocoa	Cocoa	Cocoa		Cocoa		Cocoa				Cocoa
Sugar Free Bev	Sugar Free Bev	Bev Base w/Sugar	Sugar Free Bev	Sugar Free Bev	Sugar Free Bev	Bev Base w/Sugar	Bev Base w/Sugar	Bev Base w/sugar	Bev Base w/Sugar	Bev Base w/Sugar	Sugar Free Bev
Hot Sce	Hot Sce	Hot Sce	Hot Sce	Hot Sce	Hot Sce	Hot Sce	Hot Sce	Hot Sce	Hot Sce	Hot Sce	Hot Sce
Spoon	Spoon	Spoon	Spoon	Spoon	Spoon	Spoon	Spoon	Spoon	Spoon	Spoon	Spoon
Acc Pkt B	Acc Pkt B	Acc Pkt A	Acc Pkt A	Acc Pkt A	Acc Pkt A	Acc Pkt A	Acc Pkt A	Acc Pkt A	Acc Pkt A	Acc Pkt A	Acc Pkt A
FRH	FRH	FRH	FRH	FRH	FRH	FRH	FRH	FRH	FRH	FRH	FRH

Accessory Packet A: Coffee, Cream Sub, Sugar, Salt, Gum, Matches, Tissue Towelette
Accessory Packet B: Coffee, Cream Sub, Sugar, Salt, Gum, Matches, Tissue, Towelette, Candy (Vanilla Caramels Tootsie Rolls,)

FRH - Flameless Ration Heater FD - Freeze Dried TS - Thermostabilized
* - Charms, Heat Stable M&Ms, Heat Stable Choc Bar



Shipping Container, Menu 3 Meal Bag and Components

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technical note technical

The Fire Safety Hazard of the Use of Flameless Ration Heaters Onboard Commercial Aircraft

Steven M. Summer

June 2006

DOT/FAA/AR-TN06/18

U.S. Department of Transportation
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15. Supplementary Notes

16. Abstract

While it is well established that the shipment of a large quantity of flameless ration heaters poses a significant fire safety risk, this report examines the potential hazard associated with the use of these flameless ration heaters in an aircraft cabin and with the accidental activation of them in a confined area aboard an aircraft, such as in overhead storage bins or a cargo compartment.

Tests were performed both with individual Meals, Ready-to-Eat containing flameless heaters in an open environment and multiple Meals, Ready-to-Eat in a confined space to examine their potential hazard. Temperatures in excess of 215°F and violent ignition events were observed. It is evident from the tests performed that the release of hydrogen gas from these flameless ration heaters is of a sufficient quantity to pose a potential hazard on board a passenger aircraft.

17. Key Words	18. Distribution Statement
FRH, MRE, Flameless ration heater, Flameless meal, Flameless heater	This document is available to the public through the National Technical Information Service (NTIS), Springfield, Virginia 22161.

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LIST OF ACRONYMS

FRH	Flameless ration heaters
MRE	Meal, Ready-to-Eat

EXECUTIVE SUMMARY

Flameless ration heaters are devices used for the flameless heating of a meal known as Meals, Ready-to-Eat. The technology behind flameless ration heaters is based on a combination of food grade iron and magnesium. When salt water is added to the iron-magnesium combination, the mixture results in an exothermic reaction, reaching temperatures of up to 100°F in a relatively short amount of time. This rapid rise in temperature is then used to cook the Meal, Ready-to-Eat. Meals, Ready-to-Eat are used extensively in the military as a method of providing meals to soldiers while in the field. They are also finding their way into use by others, such as campers, boaters, and disaster response teams.

While it is well established that the shipment of a large quantity of these flameless heaters poses a significant fire safety risk, this report examines the potential hazard associated with the use of these Meals, Ready-to-Eat in an aircraft cabin, or the accidental activation of flameless ration heaters in a confined area aboard the aircraft, such as in overhead storage bins or a cargo compartment.

INTRODUCTION

Flameless ration heaters (FRH) are devices used for the flameless cooking of a self-heating meal known as a Meal, Ready-to-Eat (MRE). The technology behind FRH is based on a combination of food grade iron and magnesium. When salt water is added to the iron-magnesium combination, the mixture results in an exothermic reaction, reaching temperatures of up to 100°F in a relatively short amount of time. This rapid rise in temperature is then used to cook the MRE. MREs are used extensively in the military as a method of providing meals to soldiers in the field. FRH MREs are also finding their way into use by others, such as campers, boaters, and disaster response teams.

FRH MREs are well known to pose certain fire, explosion, and health-related safety issues while in shipment where typically hundreds of these meals are packaged together in a single shipping container. They are also considered to be a hazardous material under the United Nations publication "Recommendations on the Transport of Dangerous Goods" and in that publication are listed as "dangerous when wet." The 2004 Emergency Response Guidebook published by the United States Department of Transportation covers FRHs under guide 138: "Substances—Water-Reactive (Emitting Flammable Gases)" and lists the potential fire and/or explosion hazards. Some of the hazards listed include:

- Produces flammable gases on contact with water
- May ignite on contact with water or moist air
- Some react vigorously or explosively on contact with water
- May be ignited by heat, sparks, or flames
- May reignite after fire is extinguished

In fact, a major product of the reaction of the salt water and iron-magnesium mixture is hydrogen gas. The release of hydrogen is the primary cause of any fire safety concern surrounding FRHs and has resulted in at least one cargo fire during shipment. In March 2001, a container filled with FRHs was loaded onto a container ship at a naval station in Guam. The ship's crew detected leaking hydrogen from the container and removed it from the ship. Fire fighters decided to attempt to move the contents and spread them among three separate containers. While performing this operation, the contents burst into flames as can be seen in figure 1.

While it is well established that the shipment of a large quantity of these flameless heaters poses a significant fire safety risk, this report examines the potential hazard associated with the use of these MREs in an aircraft cabin, or the accidental activation of FRHs in a confined area aboard an aircraft, such as in overhead storage bins or a cargo compartment.

FIGURE 1. RESULTS OF A CARGO FIRE OCCURRING DURING THE SHIPMENT OF MREs IN MARCH OF 2001 [1]

PACKAGING AND USE OF MEALS, READY-TO-EAT

For the purposes of these experiments, several MREs manufactured by La Briute were acquired. The La Briute MREs use an FRH manufactured by ZestoTherm, Inc. Along with the meal itself, the MRE comes packaged with a Styrofoam™ tray, an FRH packet consisting of the iron-magnesium mixture, and a 2-ounce salt water packet. Photographs of these contents and of the MRE packaging are shown in figure 2. The packaging contains a caution not to use the MRE near fire or flame and that the activated FRH will produce heat and steam. No other fire safety warnings are noted on the package. The following are the directions supplied with the MREs:

1. Open carton at side with tab. Save carton. Remove cutlery pack and sodium water pouch. Keep food heater in foam tray. Use on flat, heat-safe surface.

2. Open sodium water pouch at notch. Lift entrée. Pour all water on food heater. Water activates food heater. Replace meal, film cover down on food heater in foam tray.

3. Slide foam tray back into carton. Close carton with tab. After 14 minutes, meal is hot and ready to eat. Slowly remove meal film cover. Stir contents.

FIGURE 2. CONTENTS OF MRE USED IN TESTING

DESCRIPTION OF EXPERIMENTS

INDIVIDUAL MRE TESTS.

Initial tests were performed with individual MREs under varying conditions. Temperatures within the MRE box were taken with a standard K-type thermocouple attached to a digital multimeter. The MRE was activated as specified in the directions in an attempt to determine the maximum temperature occurring within the box as well as the typical temperature rise seen under normal operating conditions. In addition, tests were performed in which the FRH was activated and the MRE container was surrounded by shredded paper to determine if the heat generated had the potential to ignite the surrounding paper. Also, a small flame was held to the vapors emanating from the activated container to determine the vapor's ignition potential. A description of each test performed with the individual MRE is shown in table 1.

TABLE 1. CONDITIONS FOR THE INDIVIDUAL MRE TESTS

Test	Condition
1	MRE heated according to provided directions. Internal temperature of MRE container monitored.
2	Nonactivated FRH placed on supplied Styrofoam and both were lit with a match.
3	FRH activated by salt water and surrounded by shredded paper.
4	FRH activated by salt water and placed on supplied Styrofoam. FRH and Styrofoam surrounded by shredded paper.
5 and 6	MRE heated according to provided directions. Ignition source held to vapors emanating from packaging.

IGNITION TESTING OF MULTIPLE MREs IN A CONFINED AREA.

In addition to the individual MRE tests, experiments were performed with multiple FRH MREs inside a small, vented tank. In each of these cases, the FRHs were activated and ignition was attempted by initiating a high-power spark within the tank.

The test article was constructed of 1/4-in. aluminum with internal dimensions of 3′ by 3′ by 1′ in height for a total internal volume of 9 ft^3. A 10″ by 10″ opening in the test article's roof was fitted with a foil diaphragm pressure relief mechanism, which for the purposes of these tests was not fully sealed. Three K-type thermocouples monitored air temperatures within the tank throughout testing.

A spark/arc gap was located in the front left corner of the tank. This gap consisted of two 1/16-in.-diameter tungsten electrodes that used a micrometer for gap width control and adjustment springs for electrode alignment. The gap width was set at approximately 7 mm throughout testing. Power was supplied to the spark gap via an oil burner transformer, shown in previous experiments to provide a spark energy of approximately 0.5-0.8 Joules/second [2].

A total of four tests were conducted in this apparatus with a varying number of FRHs MREs located inside in several different configurations. More details of these tests and results are discussed in the section Results of Ignition Testing of Multiple MREs in a Contained Area.

DISCUSSION OF RESULTS

INDIVIDUAL MRE TEST RESULTS.

Test 1 consisted of the MRE being heated under normal operation according to the supplied directions. The temperature within the box was monitored and a peak reading of 150°F was observed. For test 2, a nonactivated FRH was placed on its Styrofoam tray and out in the open (not placed back in the box). A match was used to light both the Styrofoam tray and the FRH. It was observed that the Styrofoam burned significantly more than the FRH did.

Tests 3 and 4 consisted of placing an activated FRH by itself (test 3) and with the enclosed Styrofoam (test 4) in a container of shredded paper. Both tests resulted in no visible burning of the surrounding shredded paper.

In tests 5 and 6, an MRE was heated under normal conditions, as in test 1, but an ignition source in the form of a match was used to ignite the vapors emanating from the MRE box. Temperatures in excess of 215°F were recorded inside the box. When lit with the match, the vapors produced an ignition event. The side of the box was blown open, and flames emitted from the box, which can be seen in figure 3.

FIGURE 3. PHOTOGRAPH TAKEN FROM A VIDEO OF IGNITION EVENT OCCURING IN AN MRE UNDER NORMAL OPERATION

RESULTS OF IGNITION TESTING OF MULTIPLE MREs IN A CONFINED AREA.

The first of these tests was conducted with three MREs placed inside the small, vented tank as shown in figure 4. The FRH of each MRE was activated and the MRE was placed back into the box as described in the MRE directions. The top of the tank was sealed and the igniter was activated to provide a continuous high-energy arc inside the tank. The meals were allowed to cook for 15 minutes and throughout that time no reaction was observed. The monitored temperature within the tank peaked at approximately 90°F, up from an initial starting temperature of approximately 72°F. The temperature profile from this test is shown in figure 5.

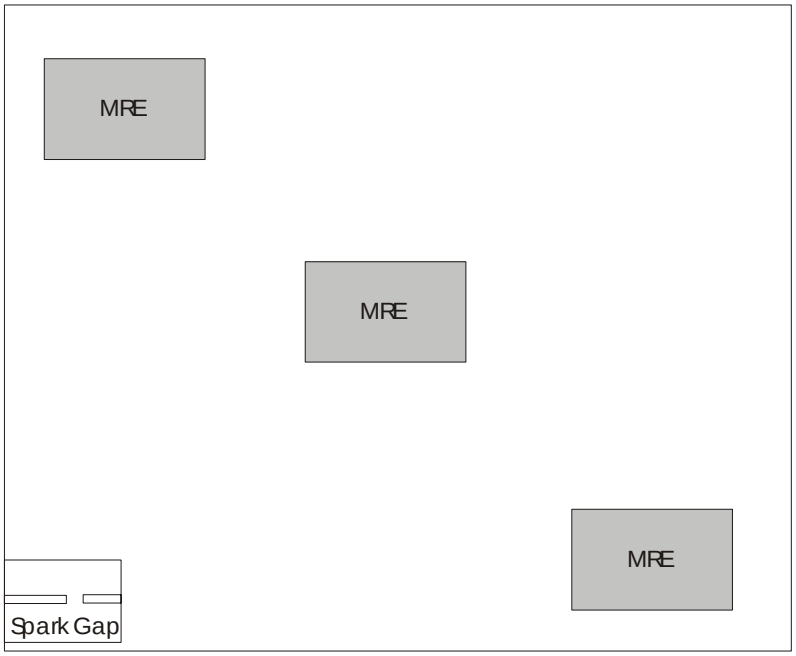

FIGURE 4. CONFIGURATION OF MREs FOR IGNITION TEST 1

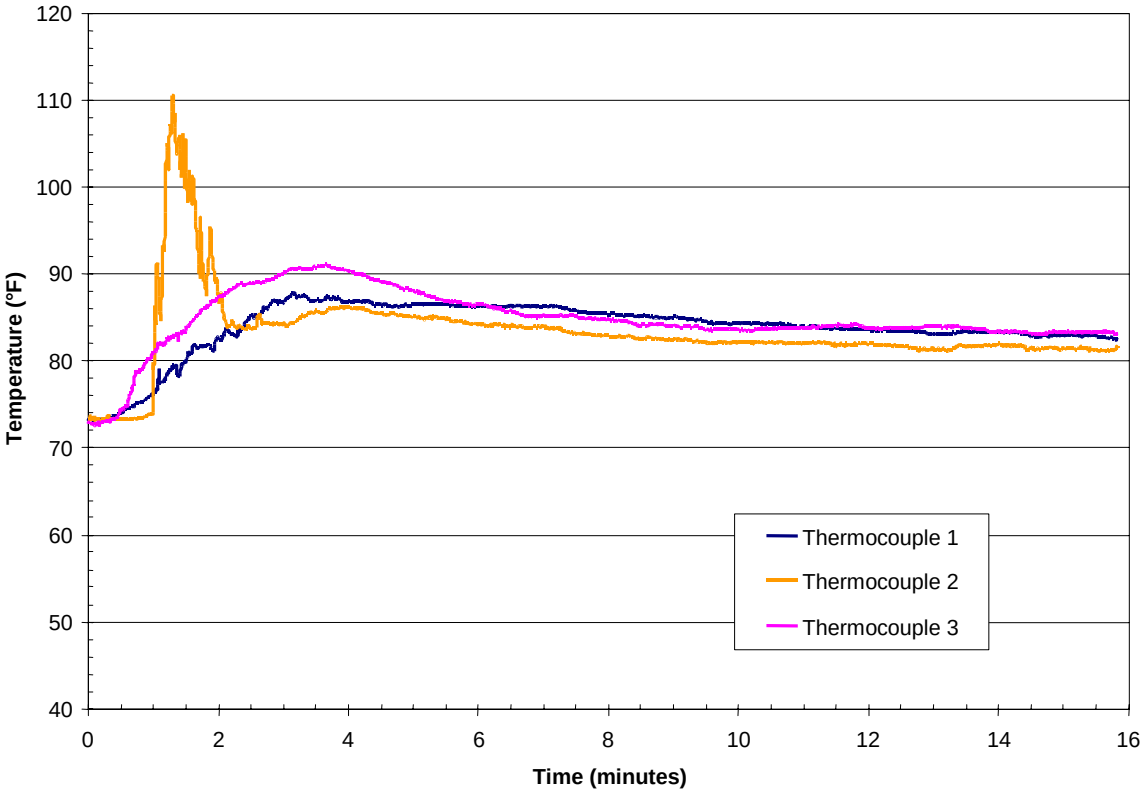

FIGURE 5. TEMPERATURE PROFILES FOR IGNITION TEST 1

The next test was conducted with six FRH packets placed on top of the Styrofoam tray without the meal or box. The trays were arranged as shown in figure 6. As in the first test, the igniter was activated to provide a continuous high-energy arc. In this instance however, a quick puff of smoke was released through the vent hole and through leaks in the tank seals. After this initial surge of smoke, a slow, continuous stream of smoke could be seen emanating from the tank's vent hole. As the igniter was intermittently initiated after this, small surges of smoke could also be seen coming from the tank's vent. Upon completion of the test, two of the six Styrofoam trays were visibly burnt from the reaction that had occurred within the tank. The temperature profile from this test can be seen in figure 7. From this plot, it is observed that the peak temperatures recorded by the three thermocouples range from approximately 140° to 160°F.

Test 3 was conducted identically to the previous test, but with four FRH trays instead of six. The trays were placed near each corner of the tank. Observances in this test were identical to test 2 but with a noticeably smaller volume of smoke. The temperature profile for this test is unavailable due to issues arising in the data acquisition system during this test; however, the observed peak temperature range was approximately 120°-125°F, with an initial tank temperature of approximately 73°F.

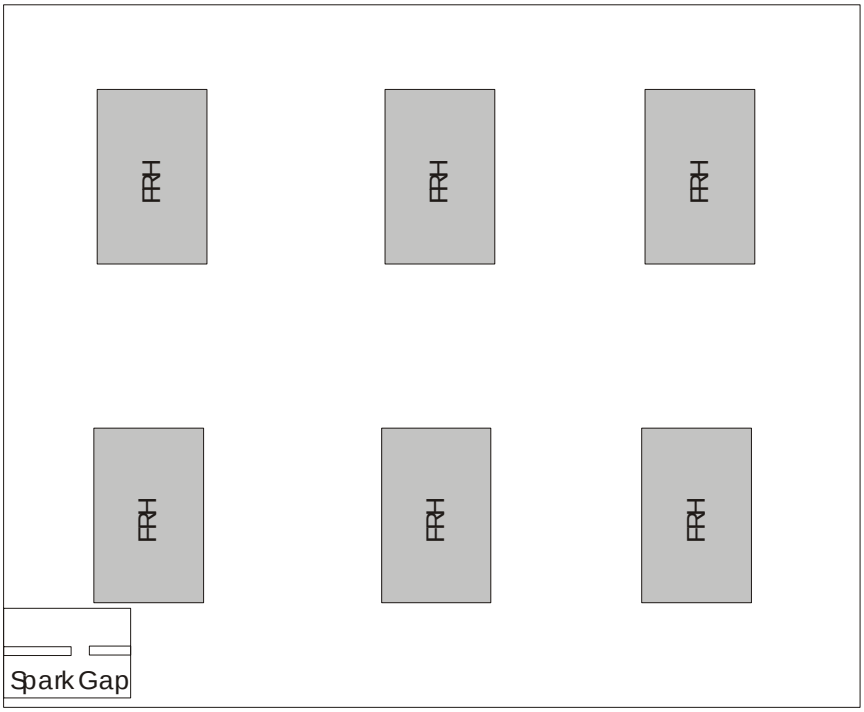

FIGURE 6. CONFIGURATION OF FRHs FOR IGNITION TEST 2

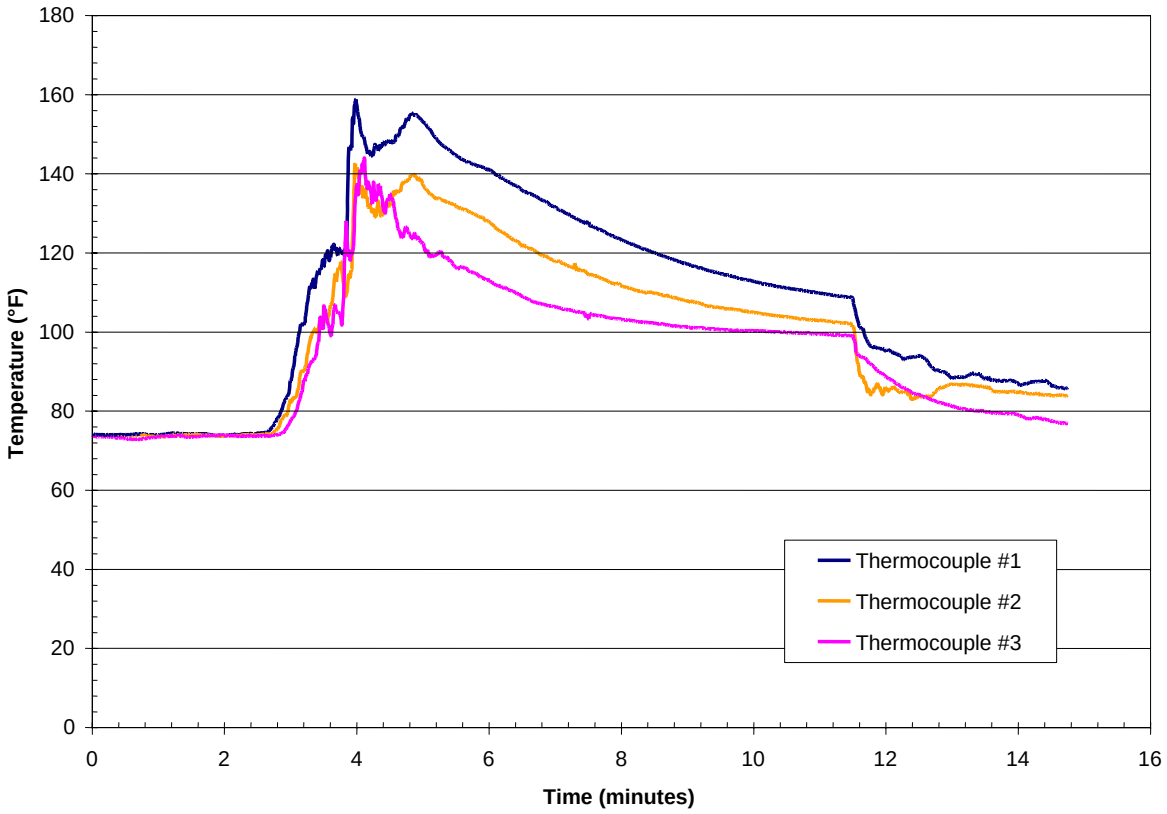

FIGURE 7. TEMPERATURE PROFILES FOR IGNITION TEST 2

The final test of this series was conducted with five FRH packets, again placed on top of the Styrofoam trays with no meal or box. The trays were arranged as shown in figure 8. However, in this test, the igniter was not initiated until approximately 3 minutes after the FRH packets were activated. This provided sufficient time for the tank to achieve its peak temperature, as well as for any flammable vapors emanating from the FRH packets to accumulate. A violent and rapid ignition was achieved in this test, rupturing the tank's pressure relief mechanism. Flames emanated from the tank. A series of still photographs taken from video of the ignition event is shown in figure 9. The temperature profiles from this test can be seen in figure 10. The ignition event can easily be seen in this plot since all three thermocouples display a rapid increase in temperature at a timestamp of approximately 4 minutes. The increase in temperature resulted in a peak tank temperature of 164°F.

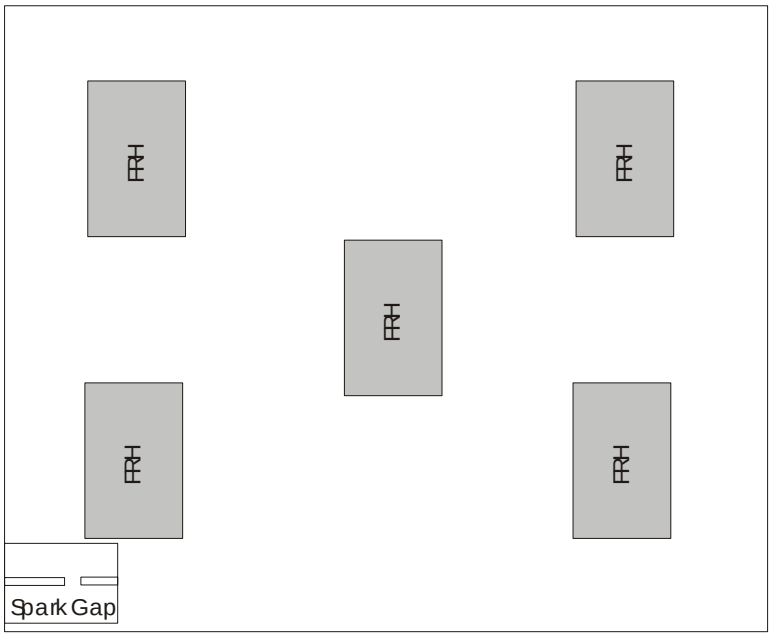

FIGURE 8. CONFIGURATION OF FRHs FOR IGNITION TEST 4

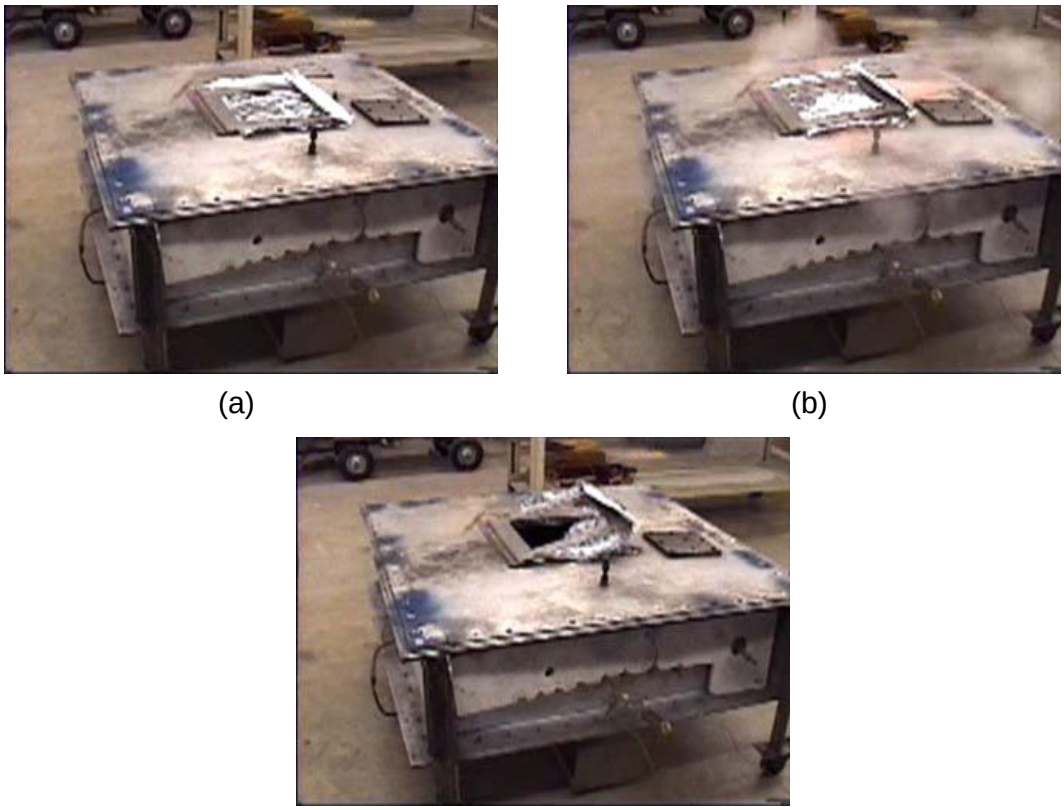

FIGURE 9. STILL PHOTOGRAPHS TAKEN FROM VIDEO OF IGNITION TEST 4 AT (a) TIME = 0.00 s, (b) TIME = 0.47 s, AND (c) TIME = 2.33 s

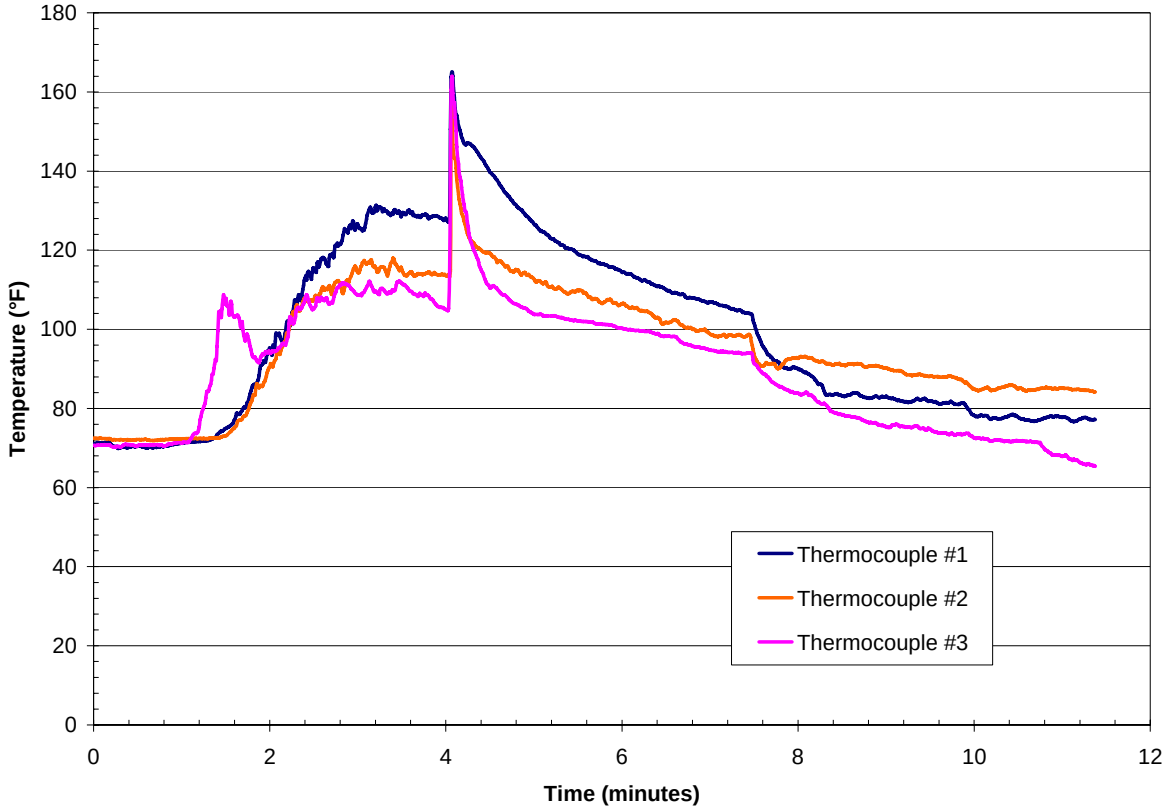

FIGURE 10. TEMPERATURE PROFILES FOR IGNITION TEST 4

SUMMARY

Tests were performed with individual MREs in an open environment and multiple MREs in a confined space to examine the potential hazard associated with their use in an aircraft cabin. The tests also examined accidental activation of FRHs in a confined area aboard the aircraft, such as in overhead storage bins or a cargo compartment. Temperatures in excess of 215°F and violent ignition events were observed. It is evident from the tests that the release of hydrogen gas from these MREs is of a sufficient quantity to pose a potential hazard onboard a passenger aircraft.

REFERENCES

1. http://www.cargolaw.com/2001nightmare_mre2.html.

2. Summer, S., “Limiting Oxygen Concentration Required to Inert Jet Fuel Vapors Existing at Reduced Fuel Tank Pressures—Final Phase,” FAA Report DOT/FAA/AR-04/8, August 2004.

NOTE:

The Military assumes that soldiers using an MRE will be equipped with
a knife (to open the plastic packaging) and
a canteen (to mix the drink powder).

I suggest substituting a pair of scissors, and a plastic water bottle.