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COMMERCIAL HOLDING COST DIFFERENTIAL BETWEEN
DRY STORAGE AND CONTROLLED COLD STORAGE FOR
MEAL, COMBAT, INDIVIDUAL (MCI)

ARMY TROOP SUPPORT COMMAND
ST. LOUIS, MISSOURI

OCTOBER 1976

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DIFFERENTIAL BETWEEN DRY
STORAGE AND CONTROLLED COLD
STORAGE FOR MEAL, COMBAT, INDIVIDUAL (MCI)

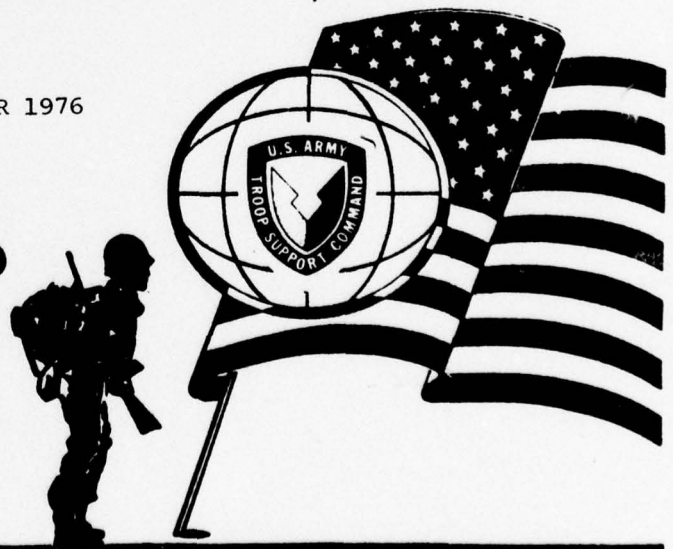
BY

AUBREY A. YAWITZ

OCTOBER 1976

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DIFFERENTIAL BETWEEN DRY
STORAGE AND CONTROLLED COLD
STORAGE FOR MEAL, COMBAT, INDIVIDUAL (MCI)

BY

AUBREY A. YAWITZ

SYSTEMS ANALYSIS OFFICE
US ARMY TROOP SUPPORT COMMAND
ST. LOUIS, MISSOURI

OCTOBER 1976

APPROVED BY:

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ABSTRACT

The US Army maintains war reserve stocks of Meal, Combat, Individual (MCI). These stocks are currently held in commercial cold storage warehouses. Periodically before spoilage occurs these stocks must be sent to the field for consumption. These stocks of MCI's are then replaced by new stocks. This process is called rotation.

Dry storage of MCI's has been considered as an alternative to controlled cold storage. Dry storage requires more frequent rotation than does controlled cold storage, since MCI's deteriorate more rapidly under dry storage conditions. This study compares the costs involved in holding the MCI's under conditions of dry storage and controlled cold storage.

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SUMMARY

In analyzing the comparative costs for holding MCI's in commercial dry storage versus commercial cold storage, the following cost factors are addressed:

- a. Dry storage handling
- b. Monthly dry storage rate
- c. Controlled cold storage handling
- d. Monthly controlled cold storage rate
- e. First destination transportation
- f. Second destination of transportation

The frequency in which MCI's are rotated is a function of the type of storage in which they are held. MCI's in dry storage require rotation with more than twice the frequency of those in cold storage. Since transportation costs associated with rotation are much greater than handling or storage costs, the total cost for holding MCI's in dry storage generally is considerably higher than for holding them in controlled cold storage.

1. DIRECTING AUTHORITY: Commander, US Army Troop Support Command (TROSCOM), St. Louis, Missouri 63120.
2. STUDY AGENCY: The Systems Analysis Office, TROSCOM, St. Louis, Missouri 63120.
3. PURPOSE: To determine the cost differences involved in holding Meal, Combat, Individual (MCI) in commercial dry storage versus commercial controlled cold storage.
4. REFERENCES:
 - a. Long-Term Storage of Military Rations, by S. R. Cecil and J. G. Woodroff, 1962, Department of the Army, Quartermaster Research and Engineering Command, Quartermaster Food and Container Institute for the Armed Forces.
 - b. Technical Manual 743-200, Storage and Materials Handling.
 - c. AR 30-7, 9 June 1971, Food Program, Operational Rations and Authorized and Net Feeding Strengths.
 - d. MIL-M-35048D, 30 June 1975, Military Specification, Meal, Combat, Individual.
5. ACKNOWLEDGEMENTS: Substantial statistical data and valuable background information were provided by:
 - a. Mrs. A. T. Murphy, Chief, Materiel Readiness Branch, Contingency Materiel Management Division, US Army Support Activity, Philadelphia, PA (STSAP-AO) (AV 444-2576).
 - b. Mr. C. J. Becht, Chief, Contingency Materiel Management Division, US Army Support Activity, Philadelphia, PA (STSAP-AO) (AV 444-2506).

c. Mr. J. Aruffo, Chief, Financial Management Branch, Program and Management Division, US Army Support Activity, Philadelphia, PA (STSAP-APC) (AV 444-2541).

d. Miss Shirley McCarthy, Chief, Dietary Programs Division, Directorate of Food Service, US Army Troop Support Agency, Fort Lee, VA (DALO-TAD-D) (AV 687-3951/4709/2506).

6. INTRODUCTION:

a. The US Army maintains war reserve stocks of Meal, Combat, Individual (MCI), NSN 8970-00-577-4513 . Although officially described as a meal, one MCI consists, in fact, of 12 meals, each of a different menu, packed in a single case. MCI's provide individual meals/rations when organized kitchens are not available.

b. Since MCI's are subsistence, they eventually deteriorate after having been stored for long periods. The time frames, after which deterioration accelerates, depend on the type of storage in which they are held. In order to avoid spoilage, the MCI's must be periodically shipped to the field (rotated) for consumption by the troops. Rotated MCI's are normally consumed in travel and training operations; and replacement MCI's are shipped from the assemblers. Assemblers package the components of MCI's.

c. At the present time, Army war reserve stocks are held in controlled cold storage at several commercial locations throughout CONUS. Storage contracts specify temperatures of 31-1/2 - 34-1/2° F and relative humidity of 55% or less. This controlled cold storage is more expensive than ordinary dry storage, but MCI's held under it deteriorate at a rate much slower than the dry storage rate. This study endeavors to compare the relevant

costs involved in handling MCI's in commercial controlled cold storage versus holding them in commercial dry storage.

7. DEFINITIONS: The following definitions for expressions used in this study are presented to facilitate understanding (symbols for indicated costs are shown in parentheses):

- a. First destination transportation (T_1) - Transportation from assembler to the storage location.
- b. Second destination transportation (T_2) - Transportation from storage location to posts, camps, and stations.
- c. Controlled cold storage (S_C) - Warehouse storage under specified conditions of controlled temperature and humidity.
- d. Dry storage (S_d) - Warehouse storage without temperature or humidity controls.
- e. Handling for controlled cold storage (H_C) - The operations involved in placing commodities in a controlled cold storage location, maintaining them, and preparing them for shipment from the storage location.
- f. Handling for dry storage (H_d) - The operations involved in placing commodities in a dry storage location, maintaining them, and preparing them for shipment from the storage location.
- g. Meal, Combat, Individual (MCI) - NSN 8970-00-577-4513, one box of 12 separate and different meals as specified in MIL-M-35048D.
- h. Rotation - The shipment of MCI's from storage locations to posts, camps, and stations for consumption before significant deterioration occurs, and their replacement with fresh MCI's from the assembler.

8. ASSUMPTIONS: The following assumptions have been made in connection with this study:

a. The cost associated with warehousing of MCI's (to include storage, handling, and transportation) are static.

b. Losses for spoilage, fire, theft, etc., of MCI's in war reserve is negligible.

c. The unit cost of one MCI, \$15.77, including first destination transportation remains constant.

d. The MCI operational requirements for travel and training exceed the quantities of MCI's requiring rotation.

e. Average costs for first and second destination transportation for dry storage and controlled cold storage, and for handling for dry storage and controlled cold storage respectively are representative of all costs so described.

f. Average maximum time frames estimated for dry storage and controlled cold storage for MCI's in warehouse represent the maximum warehouse storage time frame of all MCI's according to their storage status.

g. Second destination transportation costs are incurred on receipt of the MCI's at the storage location.

h. All handling costs (including costs for placing MCI's in storage and costs for taking them out of storage for shipment) are incurred at the time they are placed into storage.

i. The starting point of this study is the occasion of the receipt of the MCI's at the storage location. At that instant, the MCI's have been received at the warehouse for either dry storage or controlled cold

storage; they have incurred the second destination transportation cost, but have not been placed into storage, and therefore have not incurred handling costs.

j. First destination transportation costs to controlled cold storage locations and dry storage locations are equal.

k. Second destination transportation costs from dry storage locations equal those from controlled cold storage locations.

l. Costs terminate on the completion of transportation to second destination.

m. A 50-month time frame is a suitable period over which to make the cost comparison.

n. Commercial dry storage and commercial controlled cold storage are the two types of storage suitable for holding MCI's in war reserve.

o. On rotation, new stocks of MCI's are received at the storage location in the same month as those that are shipped to the field.

9. DISCUSSION:

a. The methodology for this study requires that costs relating to one MCI for the following functions be determined:

(1) Transportation:

(a) First destination (T_1)

(b) Second destination (T_2)

(2) Commercial warehouse handling for:

(a) Dry storage (H_d)

(b) Controlled cold storage (H_c)

(3) Commercial warehouse storage:

(a) Dry (S_d)

(b) Controlled cold (S_c)

b. In addition, it is necessary to establish the average length of time that MCI's can be safely held under conditions of:

(1) Dry storage

(2) Controlled cold storage

c. Once the above costs and time frames have been established, the accrued costs of dry and controlled cold storage are then computed and plotted on a chart.

d. The beginning point for cost and time is on receipt of the MCI's at the warehouse, either for dry storage or controlled cold storage. At that point, the MCI's theoretically could be immediately reshipped, incurring only the cost of second destination transportation.

e. If shipment to second destination were to be made within the first month of storage, in addition to the cost of second destination transportation, the costs of handling and one month's storage accrue.

f. If shipment is made during the second month, in addition to the above costs, another month's storage cost accrues.

g. In each succeeding month, another month's storage cost accrues.

h. At the point where the MCI's must be shipped to the field for consumption before spoilage, normally new MCI's are received and placed in storage. During the month in which that situation occurs, costs for the following are added to those already accrued:

- (1) First destination transportation
- (2) Second destination transportation
- (3) Handling
- (4) Monthly storage

(Since it is assumed that the field MCI requirements for operational purposes exceed those rotated, the unit cost of an MCI is not considered).

i. This process continues with each month's costs being added to those costs that had previously accrued.

j. Since MCI's in dry storage require rotation after a shorter period than those in controlled cold storage, the dry storage MCI's incur handling and transportation costs at shorter intervals than those stored otherwise.

10. PROCEDURE:

a. The Army Support Activity, Philadelphia, PA provided most of the numerical data used in this study. Included in these data are the following:

- (1) The present published unit cost of an MCI is \$15.77.
- (2) The average first destination transportation cost of one MCI (T_1) is estimated at 7.5% of the unit cost or \$1.18275 ($.075 \times \15.77).
- (3) One MCI weighs 25 pounds.
- (4) An estimated average rate for second destination transportation for MCI's is \$1.793 per hundred weight (100 pounds). Based on a weight of 25 pounds, the cost of second destination transportation (T_2) is estimated at \$.44825 ($\$1.793 \times .25$).
- (5) MCI's currently are stored at five commercial controlled cold storage locations. Data relating to handling and storage costs at those locations are itemized in Appendix A.

(6) Average rotational storage periods for MCI's are:

(a) Dry storage - Approximately 21 months

(b) Controlled cold storage - Approximately 48 months

b. Essentially, all Army war reserve stocks of MCI's are held in commercial controlled cold storage; there is no available current contract information on commercial dry storage. However, reference 4a (page 209) provides a means for calculating dry handling and storage costs if corresponding cold storage costs are known. The following is extracted from reference 4a: "It was found that charges for handling food in refrigerated storage were about twice those for non-refrigerated space. It appeared that the overall cost of storage under refrigeration (32° to 36° F) was about 30% higher than storage at room temperature (70° F),". Therefore, the cost of handling for dry storage is calculated to be 1/2 (or .50) of the handling cost for cold storage. Accordingly, the dry storage rate is .76923 (or 100%/130%) of the cold storage rate.

c. To determine average MCI handling and storage costs in a commercial controlled cold storage warehouse, the data from Appendix A was processed to provide cost averages weighted according to the quantity in warehouse. Appendix B displays the process by which these costs were derived. Total costs developed are:

(1) Handling = \$77,688.10

(2) Monthly Storage = \$35,909.15

d. Appendix B indicates a total of 360,151.5 hundred-weight of MCI in controlled cold storage. At 25 pounds each, there are four MCI's per hundred-weight. Therefore, the number of MCI's in controlled cold storage is $360,151.5 \times 4$ or 1,440,606. Dividing the handling cost and monthly

storage cost each by the number of MCI's stored, the following average controlled cold storage rates per MCI are determined:

$$(1) \text{ Handling rate } (H_c): \frac{\$ 77,688.10}{1,440,606} = \$.05393$$

$$(2) \text{ Monthly storage rate } (S_c): \frac{\$ 35,909.15}{1,440,606} = \$.02493$$

e. The dry storage rates are determined by applying the factors established in paragraph 10b to the controlled cold storage rates developed in paragraph 10d. These average dry storage rates for one MCI are:

$$(1) \text{ Handling rate } (H_d): \$.05393 \times .50 = \$.02696$$

$$(2) \text{ Monthly storage rate } (S_d): \$.02493 \times .76923 = \$.01917$$

f. Appendix C displays the monthly costs applicable to controlled cold storage. Accrued costs through 50 months are also indicated.

g. Likewise, Appendix D displays the corresponding data for dry storage.

h. Appendix E graphically illustrates the cumulative costs for dry storage and controlled cold storage.

11. CAVEAT: In order to acquire information for this study within allowable resources, certain elements of data produced primarily from the judgements of knowledgeable sources have been utilized. There is no reason to question these judgements, and although they may contain some inaccuracies, these inaccuracies can influence the conclusions only to a minor degree.

12. FINDINGS:

a. That during the first 21 months of storage, cumulative costs for dry storage are slightly lower than those for controlled cold storage.

b. That after 21 months the dry storage cumulative costs are considerably higher than those for controlled cold storage.

c. That in general after 21 months the cumulative dry storage costs increase more rapidly than the corresponding controlled cold storage costs.

d. That transportation influences the cumulative cost to a much greater degree than do handling and storage.

13. CONCLUSIONS:

a. That during the first 21 months, dry storage is slightly less expensive than controlled cold storage. However, under present policy, storage for less than 21 months is an unlikely requirement.

b. That after 21 months, it is considerably less expensive to utilize controlled cold storage. Therefore, this means of MCI storage is in the best interests of the government.

14. RECOMMENDATION: For anticipated storage beyond 21 months, that controlled cold storage be utilized for war reserve MCI's.

APPENDIX A

MCI STORAGE LOCATIONS AND COSTS

<u>CONTRACT NO.</u>	<u>CONTRACTOR</u>	<u>HANDLING COST PER 100 LBS</u>	<u>POUNDS ACTIVELY STORED (ON HAND)</u>	<u>MONTHLY STORAGE COST PER 100 LBS</u>
DSA-13H-76-D-0176	A	\$.19	3,497,950	\$.10
DSA-13H-75-D-0190	B	.195	14,323,200	.0975
DSA-13H-76-D-0174	C	.30	7,660,800	.095
DSA-13H-76-D-0175	D	.24	6,854,400	.12
DSA-13H-74-D-0231	E	.10	3,678,800	.08

APPENDIX B

WAREHOUSING COSTS FOR MCI'S IN COMMERCIAL CONTROLLED STORAGE LOCATIONS AS OF 30 JUNE 1976

CONTRACTOR	HUNDRED- WEIGHT STOPE (a)	HANDLING RATE PER HUNDRED- WEIGHT (b)	TOTAL HANDLING COST (c=ab)	MONTHLY STORAGE RATE PER HUNDRED- WEIGHT (d)	TOTAL MONTHLY STORAGE COST (e=ad)
A	34,979.5	\$.19	\$ 6,646.10	\$.10	\$ 3,497.95
B	143,232	.195	27,930.24	.0975	13,965.12
C	76,608	.30	22,982.40	.095	7,277.76
D	68,544	.24	16,450.56	.12	8,225.28
E	36,788	.10	3,678.80	.08	2,943.04
TOTAL	360,151.5		\$77,688.10		\$35,909.15

APPENDIX C

COSTS OF COMMERCIAL CONTROLLED COLD STORAGE FOR ONE MCI

MONTH	MONTHLY INCREMENTAL COSTS (\$)	ACCRUED COSTS \$
	$T_1 = 1.18275$	
	$T_2 = .44825$	
	$S_C = .02493$	
	$H_C = .05393$	
0	T_2	.44825
1	$H_C + S_C$	.52711
2	S_C	.55204
3	S_C	.57697
4	S_C	.60190
5	S_C	.63683
6	S_C	.65176
7	S_C	.67669
8	S_C	.70162
9	S_C	.72655
10	S_C	.75148
11	S_C	.77641
12	S_C	.80134
13	S_C	.82627
14	S_C	.85120
15	S_C	.87613
16	S_C	.90106
17	S_C	.92599
18	S_C	.95092
19	S_C	.97585

APPENDIX C

MONTH	MONTHLY INCREMENTAL COSTS (\$)	ACCRUED COSTS \$
20	S _C	1.00078
21	S _C	1.02511
22	S _C	1.05064
23	S _C	1.07557
24	S _C	1.10050
25	S _C	1.12543
26	S _C	1.15036
27	S _C	1.17529
28	S _C	1.20022
29	S _C	1.22515
30	S _C	1.25008
31	S _C	1.27501
32	S _C	1.29994
33	S _C	1.32487
34	S _C	1.34980
35	S _C	1.37473
36	S _C	1.39966
37	S _C	1.42459
38	S _C	1.44952
39	S _C	1.47445
40	S _C	1.49938

APPENDIX C

MONTH	MONTHLY INCREMENTAL COSTS (\$)	ACCRUED COSTS \$
41	S_C	1.52431
42	S_C	1.54924
43	S_C	1.57417
44	S_C	1.59910
45	S_C	1.62403
46	S_C	1.64896
47	S_C	1.67389
48	S_C	1.69882
49	$T_1 + T_2 + H_C + S_C$	3.40868
50	S_C	3.43361

APPENDIX D

COSTS OF COMMERCIAL DRY STORAGE FOR ONE MCI

MONTH	MONTHLY INCREMENTAL COSTS (\$)	ACCRUED COST \$
	$T_1 = 1.18275$	
	$T_2 = .44825$	
	$S_d = .01917$	
	$H_d = .02696$	
0	T_2	.44825
1	$H_d + S_d$	.49438
2	S_d	.51355
3	S_d	.53272
4	S_d	.55189
5	S_d	.57106
6	S_d	.59023
7	S_d	.60940
8	S_d	.62857
9	S_d	.64774
10	S_d	.66691
11	S_d	.68608
12	S_d	.70525
13	S_d	.72442
14	S_d	.74359
15	S_d	.76276
16	S_d	.78193
17	S_d	.80110
18	S_d	.82027
19	S_d	.83944

APPENDIX D

MONTH	MONTHLY INCREMENTAL COSTS (\$)	ACCRUED COSTS \$
20	S_d	.85861
21	S_d	.87778
22	$T_1 + T_2 + H_d + S_d$	2.55491
23	S_d	2.57408
24	S_d	2.59325
25	S_d	2.61242
26	S_d	2.63159
27	S_d	2.65076
28	S_d	2.66993
29	S_d	2.68910
30	S_d	2.70827
31	S_d	2.72744
32	S_d	2.74661
33	S_d	2.76578
34	S_d	2.78495
35	S_d	2.80412
36	S_d	2.82329
37	S_d	2.84246
38	S_d	2.86163
39	S_d	2.88080
40	S_d	2.89997

APPENDIX D

MONTH	MONTHLY INCREMENTAL COSTS (\$)	ACCRUED COSTS \$
41	S_d	2.91914
42	S_d	2.93831
43	$T_1 + T_2 + H_d + S_d$	4.61544
44	S_d	4.63461
45	S_d	4.65378
46	S_d	4.67295
47	S_d	4.69212
48	S_d	4.71129
49	S_d	4.73046
50	S_d	4.74963

APPENDIX E

COMMERCIAL WAREHOUSING AND TRANSPORTATION COSTS FOR MEAL, COMBAT, INDIVIDUAL (MCI)

