FM 10-13

DEPARTMENT OF THE ARMY FIELD MANUAL

SUPPLY AND SERVICE REFERENCE DATA

HEADQUARTERS, DEPARTMENT OF THE ARMY

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FIELD MANUAL
No. 10–13

HEADQUARTERS
DEPARTMENT OF THE ARMY
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*This manual supersedes FM 10–13, 24 September 1957, including all changes.

CHAPTER 1
INTRODUCTION

1–1. Purpose and Scope.

This manual is designed to assist staff and unit officers in planning supply and service operations. It provides logistics reference data from a variety of sources not readily available to staff and unit officers. As a digest of supply and service data, it contains information on subsistence, general supplies and equipment, petroleum, storage, packaging and packing, transportation, and cemeteries and burials. Measurements, conversions and equivalents, and miscellaneous data pertinent to supply and service operations are also provided. In addition, current automatic data processing systems are outlined in chapter 11.

1–2. Relation to Other Manuals

Appendix A lists the publications used as source material for much of the data presented in this manual. Pertinent information has been summarized from these publications and other sources. However, to avoid unnecessary duplication the appropriate publication is merely cited in some instances. Users of this manual are encouraged to consult the referenced sources for additional information. DA Pamphlets in the 310-series give publications in related fields.

1–3. Recommended Change

Users of this manual are encouraged to submit recommended changes and comments to improve the manual. Comments should be keyed to the specific page, paragraph, and line of text in which the change is recommended. Reasons will be provided for each comment to insure understanding and complete evaluation. Comments should be prepared using DA Form 2028 (Recommended Changes to Publications) and forwarded direct to the Commandant, U.S. Army Quartermaster School, ATTN: AHBFQS–AR–T, Fort Lee, Virginia 23801.

1–4. Classes of Supply and Estimated Consumption Factors

The 10 classes of supply and estimated consumption factors for each are listed in table 1–1. Alpha codes for the subclassifications of classes I, II, III, V, VII, and IX are indicated. Classes IV, VI, VIII, and X are not subdivided; however, additional subclassifications may be established to meet service requirements. AR 11–8 gives the relationship of supply class to Federal Supply Classification Groups and lists the commodity manager responsible for supplies by subclass. AR 11–8 also indicates the units and activities responsible for storage, distribution, maintenance, and transportation of supplies by subclass.

Table 1–1. Classes of Supply and Estimated Consumption Factors [1]

Major class	Subclass	Pounds per man per day	Percent of total
Class I. Subsistence.	A—Air (in-flight rations).	.14	2
	R—Refrigerated subsistence.	1.21 [2]	18
	S—Nonrefrigerated subsistence (less combat rations).	4.01 [2]	60
	C—Combat rations.	1.34	20
	Total	6.70	100
Class II. Clothing, individual equipment, tentage, organizational tool sets and toolkits, handtools, administrative and housekeeping supplies and equipment.	B—Ground support materiel.[3]	3.00	42.61
	E—General supplies.	.25	3.55
	F—Clothing and textiles.	.42	5.97
	M—Weapons.	.01	.14
	O—General equipment.	3.13	44.46
	T—Industrial supplies.[4]	.23	3.27
	Total	7.04	100

See footnotes at end of table.

Table 1–1—Continued

Major class	Subclass	Pounds per man per day	Percent of total
Class III. Petroleum products: petroleum fuels, lubricants, hydraulic and insulating oils, preservatives, liquid and compressed gases, bulk chemical products, coolants, deicing and antifreeze compounds, together with components and additives of such products, and coal.	A—Air. W—Ground.	1.28 34.61	3.6 96.4
	Total	35.89	100
Class IV. Construction materials: installed equipment and all fortification and barrier materials.		4.06	100
	Total	4.06	100
Class V. Ammunition: Ammunition of all types including chemical, biological, radiological, and special weapons; explosives; mines; fuzes; detonators; pyrotechnics; missiles; rockets; propellants and other associated items.	A—Air. W—Ground.	.96 23.04	54 46
	Total	24.00	100
Class VI. Personal Demand Items (includes all Army exchange items).		9.00 [5]	100
	Total	9.00	100
Class VII. Major End Items: A final combination of components which is ready for its intended use such as tanks, launchers, mobile machine shops and vehicles.	A—Air. B—Ground support materiel.[3] D—Administrative vehicles.[6] G—Electronics. K—Tactical vehicles. L—Missiles. M—Weapons. N—Special weapons. O—General equipment.	.16 .40 .10 .10 .80 .40 .40 .42 .04	5.68 14.18 3.55 3.55 28.37 14.18 14.18 14.89 1.42
	Total	2.82	100
Class VIII. Medical materiel (including medical peculiar repair parts).		.30	100
	Total	.30	100
Class IX. Repair parts: (less medical peculiar repair parts) Repair parts and components including kits, assemblies, and subassemblies required for maintenance support of all equipment. Both reparable and nonreparable components are included.	A—Air. B—Ground support materiel.[3] D—Administrative vehicles.[6] G—Electronics. K—Tactical vehicles. L—Missiles. M—Weapons. N—Special weapons. O—General equipment. T—Industrial supplies.[4]	.31 .15 .16 .31 1.55 .15 .25 .03 .16 .03	10 5 5 10 50 5 8 1 5 1
	Total	3.10	100

See footnotes at end of table.

Table 1–1—Continued

Major class	Subclass	Pounds per man per day	Percent of total
Class X. Material to support nonmilitary programs (such as agricultural and economic development) not included in classes I through IX.		5.90	100
	Total	5.90	100

[1] The force structure used for these estimates is based on TASTA–70. It consists of a troop strength of 580,000 for a theater under normal combat conditions.

[2] Figures for refrigerated and nonrefrigerated storage are based primarily on experience in Word War II and Korea. Pounds per man per day currently issued for the 28 Day Master Menu and for the full A ration are approximately as follows:

	Perishables	*Nonperishables*
28 Day Menu	3.7	2.5
Full A Ration	5.0	1.5

[3] Includes power generators and construction, barrier, bridging, fire fighting, petroleum, and mapping equipment.

[4] Includes block and tackle, cable, chain, wire rope, bearings, screws, bolts, studs, steel rods, plates, and bars.

[5] Based on Vietnam experience.

[6] Commercial vehicles used in administrative motor pools.

1–5. Federal Supply Classification System

The Federal Supply Classification (FSC) system divides items of supply into broad commodity groups. Each commodity group is subdivided into classes which cover similar commodities. For example, Group 84, Clothing, Individual Equipment, and Insiginia contains Class 8405, Men's Outerwear; Class 8410, Women's Outerwear; Class 8415, Special Purpose Clothing; and Class 8420, Men's Underwear and Nightwear. A complete listing of FSC groups and classes is found in SB 708–21. SB 708–22 and SB 708–23 are numeric and alphabetic indexes of items in each group and class.

1–6. Supply Catalogs and Supply Manuals

Department of the Army supply manuals, supply catalogs, and components lists furnish supply classification codes, identification numbers, category numbers, stock numbers, item names and identifications, units of issue, expendability, illustrations, prices, parts allowances, stockage guide data, cross-references, and other supply operational information required by Army activities to carry out their assigned responsibilities. Supply catalogs and supply manuals are listed in DA Pamphlets 310–4 and 310–6.

1–7. Serviceability Criteria

The following criteria may be used in classifying personal property as to serviceability.

Condition Code	Definition
N–1 (New-Excellent)	New or unused property in excellent condition and ready for use. This property is identical to or interchangeable with new items.
N–2 (New-Good)	New or unused property in good condition but not of N–1 quality because it is slightly shopworn or soiled. Condition does not impair utility.
N–3 (New-Fair)	New or unused property in fair condition but soiled, shopworn, rusted, deteriorated, damaged, or broken. Condition slightly impairs utility.
N–4 (New-Poor)	New or unused property so badly broken, soiled, rusted, mildewed, deteriorated, damaged, or broken that utility is seriously impaired.
E–1 (Used-Reconditioned-Excellent)	Used property which has been repaired or renovated. Condition is excellent.
E–2 (Used-Reconditioned-Good)	Used property which has been repaired or renovated. This property is in good, usable condition, but it has become worn from further use and cannot qualify for excellent condition.
E–3 (Used-Reconditioned-Fair)	Used property which has been repaired or renovated but has deteriorated since reconditioning. Condition is fair. Further repairs or renovations are required or are expected to be needed in the near future.
E–4 (Used-Reconditioned-Poor)	Used property which has been repaired or renovated but is in poor condition because of major wear and tear, corrosion, exposure to weather, or mildew.
O–1 (Used-Usable without Repairs-Excellent)	Slightly or moderately used property which is in excellent condition and requires no repairs.

Condition Code	Definition
O–2 (Used-Usable without Repairs-Good)	Used property which is more worn than O–1 but is still in good condition and may be used considerably before requiring any important repairs.
O–3 (Used-Usable without Repairs-Fair)	Used property in fair condition and usable without making repairs. This property is somewhat deteriorated, however, and worn parts should be replaced.
O–4 (Used-Usable without Repairs-Poor)	Used property which is still usable without repairs but in poor condition and undependable or unecomonical in use. Parts are badly worn and deteriorated.
R–1 (Used-Repairs Required-Excellent)	Used property in excellent condition but requiring minor repairs. Repairs would not cost more than 10 percent of standard price.
R–2 (Used-Repairs Required-Good)	Used property in good condition but requiring extensive repairs. Estimated cost of repairs would be from 11 percent to 25 percent of standard price.
R–3 (Used-Repairs Required-Fair)	Used property in fair condition but requiring extensive repairs. Estimated cost of repairs would be from 26 percent to 40 percent of standard price.
R–4 (Used-Repairs Required-Poor)	Used property in poor condition. This property is badly worn and requires major repairs. If repaired, it would be of doubtful condition and dependability and it would be uneconomical in use. Estimated cost of repairs would be from 41 percent to 65 percent of standard price.
X (No further value for use as originally intended but of possible value other than scrap)	Personal property which has some value in excess of the basic material content. There is no reasonable prospect for use of this property as a unit by either the holding agency or any other Federal agency for any purpose. Repair or rehabilitation of the property for use as a unit by either the holding agency or any other Federal agency is clearly impractical because the estimated cost would be in excess of 65 percent of standard price.
Scrap	Material that has no value except for its basic material content.

CHAPTER 2
SUBSISTENCE

2–1. Ration Data

Table 2–1 provides information on rations.

Table 2–1. Characteristics of Standard Rations

Item	Packaging information			Average wt. per unit, including packing (lb.)	Average calories per ration or unit
	Contents per package or case	Gross weight per package or case (pounds)	Volume per package or case (cubic ft)		
1 Field ration A [1]				7.390	4,000+ per ration
2 Standard B ration for Armed Forces [2]			.1106 per ration	3.963	3,950 per ration
3 Meal, combat individual [3]	12 meals	25.0	0.79	1.77	1,200 per meal
4 Food packet, long-range patrol [4]	24 packets	21	1.1	.69	1,100+ per packet
5 Food packet, survival, general purpose [5]	24 packets	20	.43	.75	870 per packet
6 Ration trail, frigid individual [6]	8 rations	34.0	1.28	4.0	4,400 per ration
7 Ration supplement, sundries pack (1 pack per 100 men) [7]	1	39.0	1.57		
8 Ration supplement, aid station (makes 100 8-oz drinks) [8]	1	16.0	1.01		

[1] This is the basic field ration. It consists of such perishables as fresh and frozen meats, vegetables, and fruit. It is intended for use primarily under stable conditions and during static phases of military operations when normal cooking and refrigeration facilities are available. It should be issued in preference to any other type of ration whenever it is available and circumstances permit its use.

[2] Same as the field ration, with nonperishables substituted for perishables. It is designed to be used where refrigeration facilities are lacking or impracticable but where kitchen and cooking facilities are available. (See SB 10–495).

[3] Designed for use as individual meal packets or in multiples of three for a complete ration. This packet is not to be used over extended periods.

[4] Issued to troops under combat conditions where resupply may be uncertain for as much as 10 days. Because the packet is designed for individual use, it is suitable for tactical messing, which requires dispersion. The principal menu component is dehydrated and may be eaten as is with drinking water or may be rehydrated rapidly with hot or cold water. Eight different menus are available.

[5] Contains 4 food bars, sugar, instant coffee, and soup and gravy base packed in a rectangular can with a key opener taped to it. Minimal recommended issue is one-half packet per man per day in hot climates and one packet per man per day in cold climates.

[6] Designed for use in extremely cold climates by small patrols or trail teams for short periods of time (1–3 days) under conditions where resupply is impossible.

[7] Composed of items necessary to the health and comfort of troops; e.g., essential toilet articles, tobacco, and confections that usually are obtained at an exchange. This packet is made available in theaters of operation for issue, pending establishment of adequate service facilities.

[8] Designed for use at forward medical aid stations to provide combat casualties with hot, stimulating beverages which alleviate shock and contribute to patient comfort.

2–2. Time Element in Class I Supply

Table 2–2 may be used as a guide in estimating the time required to distribute and process 1 day's class I supplies from the distributing point to the using unit. Estimates are based on full TOE strength working under normal conditions using organic equipment. Time elements vary, depending on supply capabilities and type of ration issued.

Table 2–2. Time elements in Class I Supply

1 Work	2 Daylight (min)	3 Dark (min)
(Division, Brigade, Battalion)		
1. Unloading rations for one division at a Class I distribution point and preparing for distribution to brigades, battalions or units of similar size	100	125
2. Issuing Class I supplies by supply point distribution to brigades or units of similar size by higher echelon	30	30

Table 2–2—Continued

1 Work	2 Daylight (min)	3 Dark (min)
3. Issuing Class I supplies by supply point distribution to separate battalions or units of similar size by higher echelon	15	15
4. Preparing Class I supplies for issue at brigades or battalion distributing point	30	60
(*Kitchen Activities*)		
1. Issuing Class I supplies (transfer of loads) to kitchens (excluding transport time)	20	25
2. Unloading kitchen equipment from trucks, setting up, and being prepared to begin cooking or reloading equipment on trucks	20	20
3. Dividing subsistence into three meals at kitchen (accomplished by mess personnel)	15	20
4. Preparing, cooking, and being ready to serve a hot meal (starting with a hot kitchen)	120	150
5. Preparing a cold meal	60	90
6. Serving a hot meal to troops from a kitchen truck with majority of men being served at the truck	45	60
7. Serving a hot meal to troops by means of carrying parties (when kitchen is within 900 meters of the company)	90	120

2–3. Ration Breakdown Chart

The ration breakdown chart (table 2–3) is useful for making accurate computations for issue. To use the chart on a sample problem, assume a ration strength of 2,187 men. One of the items to be issued is evaporated milk at 32 cans per 100 men. Place a straightedge along the line marked 32 on the left. Now take the amount at the intersection of the 2,000 strength column, which is 640; next at the intersection of 100, which is 32; next at the intersection of 80, which is 25.6; and then at the intersection of 7, which is 2.24. The total is 699.84 cans, allowance for 2,187 men. A ration breakdown card calculator (FSN 7520–286–5462), available through supply channels, may also be used to compute class I requirements.

Table 2–3. Ration Breakdown Chart

(Located in back of manual)

2–4. Storage of Class I Supplies

a. Nonperishables. Nonperishable subsistence is food which is canned, dried, dehydrated, or otherwise processed so that it can be stored without refrigeration. Nonperishables are not immune from decay or deterioration, however, and they require care and protection in storage. Mishandling or improper or excessively long storage will result in spoilage. Cereals or condiments, for example, must be stored in covered storage, and evaporated milk and items in jars must not be stored in open storage under freezing conditions. Table 2–4 gives the period of time which nonperishable subsistence items may be kept without loss of quality. Storage time should be calculated from the date of packing, not from the date of receipt. The period indicated for each item in table 2–4 is not necessarily its maximum storage life and should be used as a guide only. The actual maximum storage time for nonperishables varies greatly depending on such factors as temperature, humidity, care in handling, protection from the weather, condition of the food when received, and adequacy of packing. Safekeeping time is especially uncertain at extreme temperatures and under combat conditions. Keeping subsistence beyond the indicated storage period does not necessarily require survey action, but it does call for careful inspection and prompt issue.

Table 2–4. Storage Data for Nonperishable Subsistence [1]

Item	Unit	Keeping time (months) 70° F.	90° F.
Apple butter	Can/Jar	18	10
Apples, dehydrated	Can	24	12
Applesauce	Can	36	24
Apricots	Can	33	12

See footnotes at end of table.

Table 2–4—Continued

Item	Unit	Keeping time (months)	
		70° F.	90° F.
Apricots, dried	Carton	3	1
Asparagus	Can	36	12
Bacon, sliced	Can	18	12
Baking powder	Can	12	6
Baking soda	Carton	Indefinite	Indefinite
Beans:			
Dried [2]	Bag/Carton	12	9
Kidney	Can	48	24
Lima	Can	48	24
Wax	Can	36	18
White, dry	Sack	36 to 42	12 to 24
Beef:			
Chunks with natural gravy	Can	42	30
Corned	Can	42	30
With gravy	Can	42	30
Patties, dehydrated	Can	36	18
Steak, raw, dehydrated	Can	36	18
With vegetables	Can	42	30
Beets	Can	24	10
Beverage base	Can	24	12
Bouillon cubes	Can	24	10 to 12
Bread, white	Can	24	18
Cabbage:			
Cooked, dehydrated	Can	36	18
Raw, dehydrated	Can	24	12
Cake	Can	24 to 36	12 to 18
Fruit Cake	Box	6	1
Pound Cake	Can	48	24 to 36
Candy:			
Hard	Can	24	12
Starch jelly	Carton	12	6
Carrots	Can	42	24
Catsup, Tomato	Can	18	9
	Bottle	24	12
Cereals:			
Prepared	Carton	12	6
Wheat, farina	Can	24	12
Cheese, Cheddar, processed	Can	36	12
Cherries, red, sour, pitted	Can	18	9
Chicken:			
Boned	Can	36	18
Boned, solid packed	Can	36	24
With noodles	Can	36	18
With vegetables	Can	36	18
Chili con carne, without beans	Can	36	24
Chili sauce	Glass	24	12
Chocolate, cooking:			
Semisweet chips [3]	Package	18	6
Unsweetened [1,2]	Carton	24	12
Cocoa:			
Powder	Carton	18	9
Syrup	Can	24	18
Coconut, prepared, sweet	Can	18	6
Coffee:			
Green	Sack	48 to 60	24
Instant	Can	36	24
Roasted and ground	Bulk	2	1
Roasted and ground	Can/Carton	12	5
Cookies	Carton	4	2

See footnotes at end of table.

Table 2–4—Continued

Item	Unit	Keeping time (months)	
		70° F.	90° F.
Corn:			
Cream style	Can	42	24
Whole grain style	Can	42	24
Cornmeal	Can	24	18
	Package	12	6
Cornstarch	Carton	36	24
Crackers, graham	Package	2	1
Crackers, soda, salted	Package	4	2
Cranberry sauce	Can	24	12
Dessert powder (all favors): [4]			
Gelatin base	Can	36	12
Starch base	Can	18	6
Instant	Can	18	6
Eggs, whole, dry	Can	36	18
Figs	Can	24	12
Flavoring, imitation:			
Maple or vanilla	Bottle	Indefinite	Indefinite
Tablets	Bottle	Indefinite	Indefinite
Flour, wheat, hard or soft [5]	Bag	12	3
Frankfurters	Can	48	30
Frankfurters and beans	Can	48	24
Fruit cocktail	Can	33	12
Garlic:			
Dehydrated	Can	24	12
Dry	Container	4	3
Gelatin, plain, edible	Container	36	24
Grapefruit, segments	Can	30	12
Grits, hominy	Cloth/paper bag	12	6
Ham:			
Chunks	Can	48	30
Fried	Can	48	30
With eggs, chopped	Can	24	12
With potatoes and gravy	Can	48	30
Hamburgers	Can	42	30
Honey, extracted	Jar	24	12
Horseradish, dehydrated	Jar	24	6
Ice cream, mix	Can	15	6
Inhibitor, mold, bread, and rolls [4]	Bag	9	3
Jam, fruit	Can/Jar	18	10
Jelly, fruit	Can/Jar	18	10
Juices:			
Apple	Can	36	12
Grape	Can	18	9
Grapefruit and orange, unsweetened	Can	36	18
Orange, sweetened	Can	36	18
Pineapple	Can	36	12
Tomato	Can	24	15
Vegetable, single strength	Can	24	15
Juice, dehydrated [6]	Can	36	18
Luncheon meat	Can	36	24
Macaroni [4]	Carton	36	24
Margarine	Can	24	9
Marmalade	Can	18	12
Mayonnaise [7]	Can/Jar	6	4
Meal combat individual	Can	24	12
Meringue powder	Can	24	1
Milk:			
Chocolate (cocoa flavored)	Envelope	24	12

See footnotes at end of table.

Table 2-4—Continued

Item	Unit	Keeping time (months)	
		70° F.	90° F.
Condensed and sweetened condensed	Can	12	6
Evaporated [8]	Can	12	6
Dry, malted	Can	24	9
Whole, dry	Can	24	9
Solids, dry, nonfat	Drum	24	9
Whole, sterilized [9]	Can	6	3
Mincemeat	Can	24	9
Molasses	Can	18	12
Monosodium glutamate	Package	Indefinite	Indefinite
Mustard, prepared	Can/Jar	18	9
Noodles:			
Egg [4]	Carton	24	9
Chow mein	Can	2	1
Onions, dehydrated	Can	24	12
Packet, long-range patrol	Case	24	12
Parsley, dehydrated	Can	9	6
Peaches	Can	36	18
Peaches, dried	Can	12	6
Peanuts, roasted, shelled	Can	24	12
Peanut butter	Can	36	12
Pears	Can	40	15
Pears, dried	Can	12	9
Peas:	Can	42	18
Dehydrated, cooked/uncooked, dried [2]	Bag/Carton	12	9
Pepper, black, ground	Box	36	12
Pie filling, fruit [10]	Can	12	6
Pickles:			
Cucumber, cured	Jar	24	12
	Can	12	6
Cucumber, fresh packed	Jar	18	9
	Can	9	4
Mixed	Jar	24	12
	Can	12	6
Pineapple, regular packed	Can	33	12
Plums, regular packed	Can	30	12
Pork sausage, links	Can	36	24
Pork chops, raw, dehydrated	Can	36	18
Potatoes:			
Sweet	Can	30	12
Sweet, dehydrated	Can	24	12
White	Can	30	11
White, dehydrated	Can	30	18
Prunes:			
Dehydrated, pitted (low moisture)	Can	12	9
Dried	Can	18	9
Pumpkin	Can	27	11
Raisins, seedless	Can	18	9
Relish	Jar	24	12
	Can	12	6
Ready to serve	Can	36	12
Tomato-vegetable w/noodle, dehydrated	Can	24	9
Vegetable, dehydrated	Package	12	6
Soup and gravy base	Envelope/Can/Jar	24	12
Spaghetti: [4]			
With ground meat	Can	24 to 30	18
With meat balls	Can	24 to 30	18
Spices, seasonings, and herbs [13]	Can	36	12
	Container	18	3
Spinach, dehydrated, regular packed	Can	30	12

See footnotes at end of table.

Table 2–4—Continued

Item	Unit	Keeping time (months)	
		70° F.	90° F.
Sugar:			
Brown [14]	Carton	18	4
Refined, granulated [14]	Envelop/Can/Bag	Indefinite	Indefinite
Powdered [14]	Carton/Bag	18	6
Sugar substitute	Envelope	Indefinite	Indefinite
Tablets, salt	Can	Indefinite	Indefiinte
Tea:			
Regular	Can/Carton	18	12
Instant	Envelope	18	9
Tomatoes	Can	30	12
Tomato paste	Can	18	9
Tuna:			
Dehydrated	Can	36	18
Oil packed	Can	30	12
Water packed	Can	24	12
Turkey	Can	36	18
Boned, solid packed	Can	36	18
Vinegar	Bottle	30	18
Vinegar, synthetic, dry	Flexible bag	12	6
Water	Can	Indefinite	Indefinite
Wheat base [4]	Bag	36	12
Rice: [4]			
Instant	Carton	18	6
Milled	Bag	24	9
Parboiled	Container/Bag	12	6
Sage, rubbed	Package	24	6 to 9
Salad dressing [7]	Can/Jar	5	3
Salad oil	Can	12	6
Salmon	Can	30	12
Salt, table [11]	Bag	Indefinite	Indefinite
Sauces, hot, kitchen, meat, soy, or worcestershire	Bottle	24	12
Sauerkraut	Can	18	9
Sardines	Can	18	9
Shortening compound:			
Regular	Can/Cube	24	12
High stability	Can/Cube	30	18
Shrimp	Can	18	9
Shrimp, dehydrated	Can	36	18
Syrup:			
Blended	Can	24	12
Maple, imitation	Bottle/Can	24	12
Soup:			
Beef noodle, dehydrated	Package	18	9
Chicken, chunk, dehydrated	Can	36	18
Chicken noodle, dehydrated	Can	24	12
Condensed	Can	36	12
Cream of onion, instant, dehydrated [12]	Flexible package	12	6
Cream of potato, instant, dehydrated [12]	Flexible package	12	6
Green pea, instant and simmer, dehydrated	Package/Can	12	6
Lima bean, instant, dehydrated	Can	30	12
Onion, dehydrated	Package	12	6
	Can	30	12
Yeast, bakers, active, dry	Can	1	1/4
Yeast food	Bag	24	6

[1] In general, the relative humidity is 50–55 percent. Metal cans are susceptible to rust, and most boxed or bagged food is susceptible to mustiness or molding above 60 percent relative humidity.

[2] High temperatures harden these items, and high humidity causes molding.

[3] Do not store chocolate near items capable of imparting odor.

[4] These items are highly susceptible to damage by moisture.

[5] Flour should be stored under cool, dry conditions. The major problem is protection against dampness, insects, and rodents. Low temperatures, 32°–40° F., protect against insects. Humidity greater than 70 percent leads to mustiness. Temperatures ranging from 52° to 55° F. and relative humidity from 50 to 65 percent provide the best storage conditions.

[6] Store dehydrated juice at cool temperatures below 75° F. during first 3 months.
[7] Contents of these items separate at high temperatures or after freezing.
[8] Cases of milk should be turned every 30 to 60 days to prevent separation of butterfat. Separated or grainy milk can be used for cooking.
[9] This item should be stored at temperatures below 72° F., for long holding, chill storage is recommended. Do not freeze.
[10] Freezing pie filling changes the appearance of starch thickening. Baking restores desirable appearance.
[11] Humidity above 90 percent causes salt to "cake." Caked salt is usable.
[12] When frozen, cream style soups break down, but they are not spoiled.
[13] In temperatures above 100° F., there is a complete loss of flavor in less than 6 months. Whole spices keep longer than group spices.
[14] Keeping time for sugar is based on relative humidity of not more than 60 percent for storage longer than one month. This item should be covered with tarpaulins and should not be stored on damp or concrete floors or near cold walls.

b. Perishables.

(1) *Storage temperatures.* Table 2–5 may be used as a guide for determining the proper storage temperatures for items of perishable subsistence and the approximate safe storage life of items at the temperatures given.

Table 2–5. Storage Data for Perishable Subsistence

Item	Best storage temperature (degrees F.)	Approximate storage life
Apples [1]	32	4 months
Apricots	32	1–2 weeks
Artichokes, globe	32	30 days
Asparagus [2]	32	10 days
Avocados:		
cold tolerant	40–45	28 days
cold intolerant	55	14 days
Bacon [3]	32–35	2–6 weeks
Bananas:		
Green	56–58	7–10 days
Ripe	56–58	2–4 days
Beans:		
Green or wax	45–50	8–10 days
Lima	32	2–3 weeks
Beef:		
Carcass and wholesale cuts	32–35	10–14 days
Corned	32–35	9–11 days
Dried, sliced	32–35	4–6 weeks
Ground	32–35	4 days
Tongue	32–35	5–6 weeks
Beets, topped [4]	32	1–3 months
Berries:		
Blackberries	32	5–7 days
Raspberries	32	5–7 days
Strawberries	32	5–7 days
Blueberries	32	2–3 weeks
Bologna: [3]		
Lebanon	32–35	2 months
50% beef	32–35	12 days
Broccoli	32	7–10 days
Brussels sprouts	32	3–4 weeks
Butter:		
Frozen	−5 or below	12 months
Fresh	32–35	1 month
Cabbage:		
Red and summer types	32	3–6 weeks
Winter types	32	3–4 months
Cake, fresh:		
Layer	35	7 days
Loaf	35	10 days
Coffee	60	5 days
Carrots: [4,6]		
Mature, topped	32	120–150 days
Immature, topped	32	28–42 days

See footnotes at end of table.

Table 2–5—Continued

Item	Best storage temperature (degrees F.)	Approximate storage life
Catsup:		
Boat, envelopes	50	6 months
Cup, foil punch	50	1 year
Cauliflower [4]	32	2–4 weeks
Celery:		
Northern grown [4]	32	2–3 months
California or Florida [7]	32	35–42 days
Cheese:		
Cheddar	32–35	1 year
Cottage	32–35	2 weeks
Cherries	32	10–14 days
Clams	32–35	4 days
Corn, on the cob	32	4–8 days
Cranberries:		
Fresh	36–40	1–3 months
Sauce	50	6 months
Cucumbers [5]	45–50	2–3 weeks
Dates, pitted, cured:		
Cane sugar types	32	1 year
Invert sugar types	32	6 months
Duck, frozen, cut up	0–below	8–10 months
Eggs, shell:		
Fresh	32	4 months
Frozen	0	9 months
Oil processed	32	6 months
Eggplaint [5]	45–50	10 days
Endive (escarole), kale, and romaine [4]	32	2–3 weeks
Fish, frozen	−10–0	3–9 months
Frankfurters, 50% beef and 50% pork: [3]		
Type I, Carton	32–35	10 days
Type I, Flexible package	32–35	3 weeks
Type II, Carton	32–35	2 weeks
Type II, Flexible package	32–35	35 days
French dressing	50	3 months
Fruitcake, fresh	40	10 months
Frozen juice concentrates:		
Apple	0	2½ years
Grape	0	2 years
Grapefruit	0	2 years
Lemon	0	1½ years
Lime	0	1½ years
Orange	0	2 years
Garlic:		
Dehydrated	32	6–9 months
Granulated	32	6–8 months
Grapefruit	50	4 weeks
Grapefruit (Sept. to Feb. harvest)	60	4 weeks
Grapes:		
American type	32	3–4 weeks
European type	30	3–6 months
Greens—(Collards, parsley, mustard greens, turnip greens)	32	7–10 days
Ham: [3]		
Cured, canned, type 1	32–35	6 months
Cured, canned, type 2	32–35	9 months
Boneless, cooked	32–35	28 days
Smoked [8]	32–35	28 days
Horseradish, prepared	32	3 months
Jams, jellies, and preserves:		
Boat, envelope	50	6 months

See footnotes at end of table.

Table 2–5—Continued

Item	Best storage temperature (degrees F.)	Approximate storage life
Cup, foil pouch	50	1 year
Lamb, carcass, wholesale cuts [3]	32–35	7–10 days
Ice cream	− 10 or below	9 months
Lard, service style	32–35	4 months
Lemons	55	1–4 months
Lettuce [9]	32–35	2–3 weeks
Limes	48–50	6–8 weeks
Lobster, live, in water	33–50	1 week
Luncheon loaf	32–35	2 weeks
Margarine: [10]		
Fresh	32–35	2 months
Frozen	0 or below	1 year
Meal, combat, individual	32	7 years
Melon:		
Cantaloupes:		
Hard ripe [5]	36	15 days
Fullslip	32–34	5–14 days
Casaba	45–50	3–6 weeks
Honeyball and honeydew	45–50	3–4 weeks
Persian	45–50	1–2 weeks
Watermelon	36–40	2–3 weeks
Milk:		
Buttermilk	32–35	2 weeks
Chocolate flavored, sterilized	32–35	1 year
Concentrated	32–35	6 days
Fluid, pasteurized, all types	32–35	1 week
Fat, anhydrous	32–35	6 months
Mustard:		
Boat, envelope	50	3 months
Cup, foil pouch	50	9 months
Nectarines	32	2 weeks
Okra	45–50	7–10 days
Onions: [11]		
Bermuda, dry	32	6–8 weeks
Globe, dry	32	6–8 months
Green, top-iced	32	10–14 days
Spanish	32	1–2 months
Oranges:		
California	40–44	7–8 weeks
Florida	30–32	2–3 months
Temple	38	10 days
Oysters, shucked, iced	32–35	4 days
Parsnips	32	2–4 months
Peaches	32	2–3 weeks
Pears [12]	29–31	2–3 months
Peas, unshelled	32	1–2 weeks
Peppers, sweet	45–50	8–10 days
Pies, fruit, fresh	35	3 days
Pineapples:		
Mature, green [5]	50–55	2–3 weeks
Ripe	45	2–2½ weeks
Plums	32	3–4 weeks
Pork, wholesale cuts [3]	32–35	5 days
Potatoes, sweet, cured at 85° F [5]	55–60	4–6 months
Potatoes, white:		
Early crop, uncured	50	2–3 months
Early crop, cured before storage	40	4–5 months
Late crop	40	8 months

See footnotes at end of table.

Table 2–5—Continued

Item	Best storage temperature (degrees F.)	Approximate storage life
Irradiated	40–45	1 year
Poultry:		
Fresh	32–35	5 days
Frozen	−10–0	8–10 months
Prunes	32	3–8 weeks
Pumpkins	50–55	2–6 months
Radishes:		
Spring, topped	32	3–4 weeks
Winter, topped	32	2–6 months
Rabbit, frozen	0	5–6 months
Rhubarb	32	2–3 weeks
Rolls, brown and serve	32	3 weeks
Rutabagas, topped	32	2–4 months
Salad dressing, cup, boat, and envelope	50	3 months
Salmon steaks	32–35	4 weeks
Salami: [3]		
Dry	32–35	2 months
Cooked	32–35	2 weeks
Sausage: [3]		
Liver	32–35	2 weeks
New England style	32–35	10 days
Pork links:		
Type I	32–35	2 weeks
Types II and III	32–35	3 weeks
Pork bulk	32–35	2 weeks
Scallops	32–35	4 days
Shallots	32	10–14 days
Shortening compound, can, carton, or cube	32–35	5 years
Shrimp, unpeeled, iced	32–35	2 weeks
Sirup, imitation maple, cup, boat, or envelope	50	1 year
Spinach	32	10–14 days
Squash:		
Summer	32	10–14 days
Winter and fall	50–55	4–6 months
Swiss chard	32	10–14 days
Tangerines	31–38	2–4 weeks
Tomatoes:		
Mature, green [5]	55	2–6 weeks
Ripe	50	8–12 days
Turnips	32	4–5 months
Veal and calf sides, wholesale cuts [3]	32–35	6 days
Yeast, bakers:		
Active, dry	32	6 months
Compressed cake	32	1 week

[1] The length of time apples can be held successfully in cold storage depends upon the variety, the district where they were grown, and the condition of the apples when harvested. Safe storage periods vary from 2 to 8 months.

[2] Asparagus held too long at 32° F is subject to chill injury. The butts of asparagus should be placed in absorbent material during storage.

[3] Carcasses and cuts: Quarters, carcasses, and cuts of beef, of lamb, and of veal should be hung or placed on racks when in chill space. If these items are in a solid frozen condition when they are received, stow them compactly as possible in the freezer space. Frozen, boneless beef should be stacked compactly. Veal carcasses or cuts, particularly of the lighter weights and lower grades, are subject to rapid deterioration. Holding time of these items in the chill space should be held to a minimum. Fresh chilled pork cuts should be treated as highly perishable.

Variety meats and sausage: These items are highly perishable. Hold storage time to a minimum.

Cured and smoked meat: The keeping qualities of cured and smoked meats depend upon the type of cure, the length of the smoking period, and the method of packaging. The storage life of these items is further influenced by the condition of the storeroom with regard to humidity, temperature, and sanitation. The growth of mold and the development of rancidity in hams and bacon can be retarded by stowing these items in the chill space for current consumption and in the freezer space for seasonal stocks. Because condensed water causes the growth of mold on cured and smoked meats, excessive humidity should be avoided. If the relative humidity is higher than recommended, it is essential that good circulation of air be maintained. Hams and bacon which have been individually wrapped with one or more layers of paper have a tendency to retain surface moisture which may have seeped from the product after wrapping. This moisture, in a measure, stimulates mold and bacterial growth. If wrapped hams are held at temperatures of 45° F, or above, for a considerable length of time, mold and slime will form on the surface of the meat. Surface slime and mold make the ham unattractive and unpleasant to handle, but this condition does not necessarily indicate spoilage. Accordingly, these products should be carefully inspected to determine how far the mold has penetrated. In most cases where only the surface is affected, the mold

can be removed by brushing the meat with a stiff-bristled brush, wiping it with a clean cloth moistened with a vinegar or salt-water solution, and allowing it to air dry. When the mold growth is heavy, it may be trimed away. If the ham does not have deep cracks or abrasions, the meat underneath the surface usually is found to be perfectly sound and wholesome. Mold growth or spoilage deep between the muscles and around the bone usually warrants survey action.

[4] This item keeps better unwashed.

[5] Damage will result if these items are stored at lower temperatures than indicated.

[6] Carrots may become bitter if they are stored with fruits, such as apples and pears, which give off ethylene.

[7] Polyethylene liners will extend storage life an additional 7–14 days.

[8] These items are very susceptible to surface mold growth. They should be inspected and wiped off often.

[9] Ice-packed lettuce will encourage the growth of mold on other commodities. The storage life shown for lettuce is lengthened substantially by trimming the heads closely and wrapping them individually in polystyrene film.

[10] Soybean oil margarine is considered by some authorities to be less stable than cottonseed oil margarine.

[11] Because onions transmit their flavor, they should not be stored with commodities which absorb flavor and odor, such as apples and grapefruit. Storage compartments should be kept dark.

[12] For best ripening, pears should be held at about 65° F for 2 to 3 days prior to serving. Storage time varies from 1 to 7 months according to the variety of the pears.

(2) *Refrigerated storage rooms.* Refrigerated storage at oversea depots and installations usually consists of a freezer room for frozen items, chill temperature rooms for fruits and vegetables, and a room for eggs and dairy products. In oversea operations, particularly at depots, the lowest temperature of the range indicated in table 2–5 should be maintained if within the capability of the cold storage facility. Table 2–6 lists items that are stored in refrigerated rooms at installations in CONUS.

Table 2–6. Items Stored in CONUS Refrigerated Storage Rooms

Fruit and vegetable chillroom		Egg and dairy chillroom	Frozen food room	Meat chillroom
35° F.	50° F.	35° F.	0° F. or below	32° F.
Apricots	Apples [1]	Butter	Fish and water foods	Chilled meats and meat products. Frozen meat, meat products, and poultry to be processed in the central meat processing facility are tempered in this room.
Asparagus	Avocados	Cheese	Fruits and vegetables	
Beets	Cantaloupes	Eggs, shell	Fruit juices	
Broccoli	Cranberries	Oleomargarine	Meat and meat products	
Brussel sprouts	Cucumbers	Shortening and lard	Poultry	
Cabbage	Eggplant	Yeast, baker's, active, dry		
Carrots	Fruits:			
Cauliflower	Citrus [2]			
Celery	Dried			
Cherries	Melons			
Collards	Onions, dry [4]			
Corn on the cob	Peppers, sweet			
Endive	Pineapples			
Escarole	Potatoes:			
Garlic	sweet			
Grapes	white [4]			
Kale	Squash			
Lettuce	Tomatoes [3]			
Nectarines				
Onions, green				
Parsley				
Parsnips				
Peaches				
Pears				
Plumbs				
Radishes				
Romaine				
Rhubarb				
Rutabagas				
Spinach				
Turnips, topped				

[1] Apples, in general, may be stored satisfactorily for several days in 50° F. space because they are naturally a hardy fruit with good keeping qualities. When long term storage is required, apples maintain their quality best when held between 30° and 32° F. although some varieties are cold-sensitive at this lower temperature and have to be held at 35° to 40° F.

[2] Oranges may be successfully stored for a few days at 50° F. For longer periods, however, they should be stored at a lower temperature, preferably 32° F.

[3] Tomatoes belong to the cold-sensitive class of vegetables. Mature, green tomatoes should not be stored in temperatures below 55° F. Ripening of pink tomatoes can be retarded by storing them in temperatures of 50° to 55° F., and firm, ripe tomatoes can be held for 1 or 2 days at

45° to 50° F. Temperatures below 50° F. induce chilling injury. The development of extensive *Alternaria Rot* is characteristic of low-temperature injury in mature, green tomatoes. Firm, ripe tomatoes held at a low temperature become soft and eventually decay.

[4] These items may be stored in a general purpose warehouse. The storage room should be dark, ventilated, and sufficiently warm in winter to prevent freezing.

2–5. Can Data

Data on dimensions and capacities of the most commonly used cans and the number of cans per case are shown in table 2–7. The "can equivalent" column of table 2–8 indicates the number of cans needed to equal each of the cans listed in the "type of can" column. Table 2–8 also gives the case equivalents of the commonly used can sizes. Case equivalents for No. 303 and No. 2½ size cans may be obtained by dividing the number of cans per case of the can size to be converted by 24 and multiplying the result by the can equivalent. Case equivalents for No. 10 size cans may be obtained by dividing the number of cans per case of the can size to be converted by 6 and multiplying the result by the can equivalent.

Table 2–7. Dimensions and Capacities of Cans and Cans Per Case

Type of can	Dimensions*	Water capacity at 68° F (oz)	Cans per case
8 Z Short	211 × 300	7.90	48, 72
8 Z Tall	211 × 304	8.65	36, 48, 72
No. 1 Picnic	211 × 400	10.90	48
211 Cylinder	211 × 414	13.55	24
No. 300	300 × 407	15.20	24, 36, 48
No. 1 Tall	301 × 411	16.60	24
No. 303	303 × 406	16.85	24, 36
No. 95	307 × 400	17.80	24
No. 2	307 × 409	20.50	24
Jumbo	307 × 510	25.70	24
Quart-Olive	307 × 704	33.70	12
32 Z–Quart	307 × 710	35.50	12
No. 2½	401 × 411	29.75	24
No. 3 Vac	404 × 307	23.85	24
No. 3	404 × 414	35.10	24
No. 3 Cyl–46 Z	404 × 700	51.70	12
No. 5	502 × 510	59.10	6
No. 5 Squat	603 × 408	68.15	6
No. 10	603 × 700	109.45	6
No. 12–Gal	603 × 812	138.30	6

*The first group of digits in this column represents the outside diameter of the can; the second group, the height of the sealed can. The first digit of each group represents inches; the second and third digits of each group represents sixteenths of an inch. For example the 8Z short is 2 11/16 inches in diameter and 3 inches in height.

Table 2–8. Can and Case Equivalents

Type of can*	Can equivalents			Case equivalents		
	#303	#2½	#10	#303	#2½	#10
8 Z Short (72)	.469	.266	.072	1.41	.80	.86
8 Z Tall (48)	.513	.291	.079	1.03	.58	.63
No. 1 Picnic (48)	.647	.366	.100	1.29	.73	.80
211 Cylinder (48)	.804	.455	.124	1.61	.91	.99
No. 300 (24)	.902	.511	.139	.90	.51	.56
No. 1 Tall (48)	.985	.558	.152	1.97	1.12	1.22
No. 303 (24)	1.000	.566	.154	1.00	.57	.62
No. 95 (24)	1.056	.598	.163	1.06	.60	.65
No. 2 (24)	1.217	.689	.187	1.22	.69	.75
Jumbo (24)	1.525	.864	.235	1.53	.86	.94
Quart-Olive (12)	2.000	1.133	.308	1.00	.57	.62
32 Z–Quart (12)	2.107	1.193	.324	1.05	.60	.65
No. 2½ (24)	1.766	1.000	.272	1.77	1.00	1.09
No. 3 Vac (24)	1.415	.802	.218	1.42	.80	.87
No. 3 (24)	2.083	1.180	.321	2.08	1.18	1.28

Table 2–8—Continued

Type of can*	Can equivalents			Case equivalents		
	#303	#2½	#10	#303	#2½	#10
No. 3 Cyl–46Z (12)	3.068	1.738	.472	1.53	.87	.94
No. 5 (6)	3.507	1.987	.540	.88	.50	.54
No. 5-Squat (6)	4.045	2.291	.623	1.01	.57	.62
No. 10 (6)	6.496	3.679	1.000	1.62	.92	1.00
No. 12-Gal (6)	8.208	4.649	1.264	2.05	1.16	1.26

*Number of cans per case used in this table are in parenthesis.

2–6 Perishable Component Buildup

Following the establishment of a theater of operations, perishable components are phased in to replace items in the nonperishable ration. The subsistence officer selects perishables to be introduced and determines their rate of buildup, based on the number of troops to be supported and the storage facilities available. The amount of refrigerated storage space is a major consideration in his decision. The initial phase normally introduces such highly desirable perishables as fresh frozen boneless beef, shell eggs, and apples. Table 2–9 provides issue rates, ration factors, weights, and cubes of perishable subsistence items. This data may be used in planning the orderly introduction of perishable components into newly established theaters of operations. Information in the table is based on SB 10–261, 28 Day Master Menu, and SB 10–261–1, Recapitulation of 28 Day Master Menu Issues, both published in May of 1968. The 28 Day Master Menu is designed to be used when refrigeration facilities are limited. Meals prescribed by the menu can be prepared using field equipment.

a. Ration Factor. The ration factor (column 5, table 2–9) is the average issue of a subsistence item per 1000 troops. It is expressed in pounds per 1000 rations. The ration factor is determined by multiplying the issue rate per 100 men (colum 2) by the frequency of issue (column 3) to get the total issue per 100 troops (column 4). This figure is multiplied by 10 to yeild the total issue for 1000 troops. When the 28 day menu is used, the total issue per 1000 troops is divided by 28 to yield the ration factor. For example, the total quantity of boneless beef in the 28 Day Master Menu is 811 pounds per 100 men or if multiplied by 10 is 8,110 pounds per 1000 men for a 28 day-period. 8,110 pounds divided by 28 equals 289.64 pounds per 1000 men per day Therefore, the ration factor for boneless beef is 289.64.

b. Cold Storage Space Requirements. Gross cubic feet figures shown in tables 2–9 and 2–10 are for perishable subsistence and packaging material only. All refrigerated space cannot be occupied by the items being stored. Allowances must be made for aisles, reciving and issuing, and other factors which affect space utilization. For planning purposes, a space utilization factor of 50 percent for supply points and 60 percent for depots using prefabricated refrigerators should be used to determine gross space requirements. For example, if 20,000 cubic feet of perishables are to be stored, the gross space required would be:

$$\frac{20{,}000}{.50} = 40{,}000 \text{ cubic feet for a supply point}$$

$$\frac{20{,}000}{.60} = 33{,}333 \text{ cubic feet for a depot}$$

For fixed or permanent type facilities the percent of gross space that can be occupied by items to be stored should be determined as follows:

a = gross square footage of storage space.

b = aisles, air circulation space between walls and merchandise, and other nonstorage space in square feet.

c = net stacking height of perishables.

d = gross interior cubic feet of the refrigerated storage space.

$\frac{(a - b) \times c}{d}$ = percent of gross storage space that can be occupied by perishables.

Table 2–9. Data on Perishable Components of the 28 Day Master Menu

1	2	3	4	5	6	7
				1000 Rations		
Item	Issue rate per 100 men (lbs)	Frequency of issue (28 day period)	Total issue per 100 men (28 day period)	Net weight lbs. (ration factor)	Gross wt. (lbs,)[1]	Gross cubic feet[1]
FREEZE:						
Bacon, Sliced	15	19	2850	107.14[2]	133.93	4.11
Beef, Boneless	--	(See table 2–12)	811	289.64	312.81	6.72

Table 2–9—Continued

1	2	3	4	5	6	7
				1000 Rations		
Item	Issue rate per 100 men (lbs)	Frequency of issue (28 day period)	Total issue per 100 men (28 day period)	Net weight lbs. (ration factor)	Gross wt. (lbs.)[1]	Gross cubic feet[1]
Beef, Corned	45	1	45	16.07	17.41	.45
Beef, Dried	7	1	7	2.50	2.78	.07
Beef, Patties	37.5	1	37.5	13.39	15.63	.89
Beef, Liver	25	1	25	8.93	10.40	.39
Bologna	7	1	7	2.50	2.78	.07
Cervelat, Soft	7	1	7	2.50	2.78	.07
Chicken, Broiler	50	5	250	89.29	96.80	2.75
Frankfurters	25	2	50	17.86	19.20	.50
Ham, Cooked, Smoked	30	1	30	17.14	18.17	.43
Liver, Sausage	7	1	7	2.50	2.78	.07
Pork, Slices, Boned	35	2	70	25.0	26.50	.63
Pork Loin, Boned	39.30[2]	3	117	38.57	40.89	.96
Pork & Beef Saug. Ck	12	4	48	17.14	18.57	.48
Salami, Cooked	7	1	7	2.50	2.78	.07
Turkey, Boneless, can	39	2	78	27.86	31.57	.73
Veal, Boneless				61.07	65.96	1.42
Slices	35	2	70	25		
Roasts	39	1	39	13.93		
Ground	31	2	62	22.14		
Ice Cream	16.45 (3.5 gal)	14	230.30	82.14	90.48	2.47
Butter	3			125.60	146.50	2.36
Vegetables, Mixed	12	3	36	12.86	14.46	.57
Strawberries	20	2	40	14.29	16.19	.38
Potatoes, White, Fr. Fried	35	2	70	25.00	29.13	.98
TOTAL						
M/Ratons (1000 men 1 day)				1001.49	1118.50	27.57
Per Man Per 28 Days				28.04	31.32	.772
CHILL:						
Ham, canned	30	3	90	37.50[3]	41.17	.65
Luncheon Meat, canned	2	2	4	8.57	10.05	.18
Cheese, Cheddar, Proc.				15.98	17.03	.31
Cheese, Cottage	12	5	60	21.43	32.11	1.31
Eggs, Shell	25 (16.67 doz)		25	193.87[3]	215.41	10.21
Milk	53.75 (6.25 gal)	.84	53.75	1612.50	1674.58	26.05
Cabbage	--	(See note 3)		19.52	22.40	.94
Carrots	--	(See note 4)		30.00	30.63	1.09
Lettuce	--	(See note 4)		81.43	93.00	4.98
Peppers	--	(See note 4)		6.21	6.63	.36
Tomatoes	25		25	96.25	105.91	6.79
Grapefruit	24	1	24	8.57	9.64	.39
Lemons	--	(See note 4)		33.13	37.86	1.19
Oranges	40		40	143.21	154.86	4.55
Celery	--	(See note 4)		38.18	41.57	1.57
Cucumbers	--	(See note 4)		27.86	30.64	.90
Onions, Green	--	(See note 4)		6.25	8.36	.51
Radishes	--	(See note 4)		3.93	5.36	.22
Apples	35	10	350	132.68	135.89	3.36
Grapes	--	(See note 4)		.54	.61	.02
Pineapple	35	1	35	1.25	1.40	.64
Bananas	40	8	320	120.71	150.89	11.50
Yeast, Bakers, Active, Dry	--	(See note 4)		2.55	3.48	.10
TOTAL						
M/Rations (1000 men 1 day)				2642.12	2829.48	77.82
Per Man Per 28 Days				73.98	79.23	2.17

Table 2-9—Continued

1	2	3	4	5	6	7
				1000 Rations		
Item	Issue rate per 100 men (lbs)	Frequency of issue (28 day period)	Total issue per 100 men (28 day period)	Net weight lbs. (ration factor)	Gross wt. (lbs.)[1]	Gross cubic feet[1]
VENT:						
Potatoes, White, Fr.	45	1	45	50.36	54.39	1.48
Potatoes, White, Bk.	55	1	55	39.64	40.07	1.41
Onions, Dry				8.57	8.74	.28
TOTAL						
M/Rations (1000 men 1 day)				98.57	103.20	3.17
Per Man Per 28 Days				2.76	2.89	.09
TOTAL: FREEZE AND CHILL						
M/Rations (1000 men 1 day)				3643.61	3947.98	105.39
Per Man Per 28 Days				102.02	110.54	2.951
TOTAL FREEZE, CHILL AND VENT						
M/Rations (1000 men 1 day)				3742.18	4051.18	108.56
Per Man Per 28 Days				104.78	113.43	3.04

[1] Based on Part II, C8900—SL FSC Group Subsistence.

[2] Includes 5.35 pounds of bacon issued for use in omelettes and seasoning.

[3] Will vary depending on how the item is to be served.

[4] Issued in combination with other items to provide 100 servings (salads, baked goods, etc.)

*Table 2-10. Data on Perishable Components of the Full A Ration**

		Net weight (pounds)	Gross weight (pounds)	Gross cubic feet
Freeze	1,000 men per day	1308.56	1446.01	37.93
	1 man per month	39.26	43.38	1.14
Chill	1,000 men per day	3025.04	3162.51	74.34
	1 man per month	90.75	94.88	2.23
Vent	1,000 men per day	675.72	724.85	20.23
	1 man per month	20.27	21.75	.61
Total Freeze and Chill	1,000 men per day	4333.60	4608.52	112.27
	1 man per month	130.01	138.26	3.27
Total Freeze, Chill, & Vent	1,000 men per day	5009.32	5333.37	132.50
	1 man per month	150.28	160.01	3.98

*Breakdown between freeze, chill, and vent will vary according to specific "A" ration.

2-7. Boneless Beef

In oversea commands and at CONUS installations without central meat-processing facilities, the beef component of the menu is frozen boneless beef. Boneless beef is procured by the Armed Forces as six-way beef; that is, beef that is cut into six different categories according to the recommended method of preparation. The more tender cuts are ordinarily prepared using dry heat, and the less tender cuts are cooked with moist heat. The issue factors and the frequency of serving cuts of boneless beef are based on the yield of the various categories. The relative percentage of each category of boneless beef in a lot is determined by the proportion of beef carcass which is suitable for preparing cuts of a given category.

Table 2–11 gives the percentage of cuts in each category for six-way boneless beef and boneless veal. Table 2–12 gives issue rates, frequency of issue, and ration factors for the six cuts of boneless beef. Estimates of the actual issue for 1000 men are also given. Pounds of ground beef received are 532.6 pounds less than requirements of 3,290 pounds. However, the difference is offset by increases in grill and swiss steak and oven and pot roasts. The substitutions are made to compensate for variations in attendance at different types of beef meals and are based on experience factors. Issuance of cuts tends to balance over a series of 28 day cycles.

Table 2–11. Relative Percentages of Each Category for Boneless Beef and Veal

Category	Minimum	Maximum
Boneless Beef	Relative percentages	
Grill Steak	13.5	
Oven Roast	16.5	
Swiss Steak	10.0	
Pot Roast	15.0	
Diced	9.0	10.0
Ground	24.0	34.0
Boneless Veal		
Slices	37.0	
Roasts	25.0	
Ground	----	38.0

*Table 2–12. Issue Data on Boneless Beef**

Item	Issue rate per 100 men (pounds)	Frequency of issue (28 day period)	Total issue per 100 men	Requirement per 1000 men	Estimated pounds issued per 1000 men	Actual frequency of issue
Grill Steaks	50	2	100	1000	1,114.7	2.11
Oven Roast	40	3	120	1200	1,362.5	3.13
Swiss Steak	40	2	80	800	825.7	2.03
Pot Roast	40	3	120	1200	1,238.7	3.03
Diced	31	2	62	620	811.0	2.31
Ground	31	7	217	2170	2,757.4	6.00
Ground	24	3	72	720		2.50
Ground	20	2	40	400		2.00
Total		24	811	8110	8,110.0	

* Based on 28 Day Master Menu.

2–8. United States Department of Agriculture Grades

a. Meat. Grades for the various types of meat are as follows:

(1) *Beef.* The United States Department of Agriculture (USDA) has established eight grades of beef. In descending order these grades are prime, choice, good, standard, commercial, utility, cutter, and canner. The Department of Defense (DOD) procures meat in the first four grades, depending on price and availability. Carcass beef and boneless beef are purchased in two grades, good and choice. Beef in grades below standard usually is used for sausage or canned beef stew. The grades of beef are determined by three factors: conformation, finish, and quality. Conformation describes the general shape and fullness or meatiness of the carcass. Finish refers to the amount of fat covering. Quality is associated with the fat distribution within the muscle tissue and is also called marbling. Generally, the higher grades show superior conformation, heavier finish or fat covering, and greater marbling. Choice or good beef is often preferred over prime because of the excessive waste associated with the heavy fat covering on prime beef.

(2) *Poultry.* The USDA has established A, B, and C grades for dressed poultry. Major grading factors are fat covering, condition of skin, soundness of bone structure, and workmanship in dressing and evisceration. Only graded poultry is procured by the DOD.

(3) *Veal.* Veal is the meat of bovines that are under 3 months old. The six grades of live vealers listed by the USDA are prime, choice, good, standard, utility, and cull. Veal has very little protective fat covering, it is high in moisture content, and does not lend itself to aging or ripening. The meat-to-bone ratio is an important factor in grading veal. Because all veal is immature, high and low grades do not differ greatly in taste.

(4) *Sheep.* The grades of sheep are based upon conformation, quality, and finish. The grades used for lamb and yearling mutton are prime, choice, good, utility, and cull Mutton has darker flesh, more fat, and a heavier carcass than lamb. In the prime grade, the requirements for quantities of interior fats and for firmness of

lean and fat change with the maturity of the meat. In lower grades the flesh is dark red and may be soft and watery, the external finish tends to be soft, and marbling usually is absent.

b. Eggs. Eggs for U.S. consumer use are graded AA, A, B, and C according to quality. The low grades have thin whites, offcenter and imperfect yolks, and large air cells between the egg and the shell. Eggs are also classified by weight: extra large, large, medium, and small. Soiled and cracked eggs are classified as dirty, check (cracked but not leaking) and leaker. Eggs for Government use are purchased in lots made up of one or more cases of 30 dozen eggs each and in U.S. procurement grades I and II.

c. Fruits and Vegetables. Table 2–13 indicates the USDA grades for fruits and vegetables. DOD usually procures U.S. No. 1; however, because the classifications differ for each fruit and vegetable, procurement cannot be based on the same grade for all produce.

Table 2–13. U.S. Grades in Descending Order

Item	Grade
Fruits:	
Apples	Extra fancy, fancy, No. 1, No. 1 (cookers) No. 1 (early), utility, combination fancy and extra fancy, combination fancy and No. 1, combination No. 1 and utility, No. 1 hail
Avocados	None
Bananas	None
Berries	No. 1, No. 2, combination grades
Cantaloupes	No. 1, commercial
Cherries	Grade A
Cranberries	Grade A
Grapefruit:	
Florida	Fancy, No. 1, No. 1 bright, No. 1 golden, No. 1 bronze, No. 1 russet, No. 2, No. 2 bright, No. 2 russet, No 3
Texas	Fancy, No. 1, No. 1 bright, No. 1 golden, No. 1 bronze, No. 1 russet, No. 2, No. 2 bright, No. 2 russet, combination, combination russet
California	Fancy, No. 1, No. 2, combination, No. 3
Arizona	Fancy, No. 1, No. 2, combination, No. 3
Grapes, European type	Fancy, extra No. 1, No. 1
Lemons	No. 1, No. 2, combination No. 1, combination No. 2, No. 3
Limes	No. 1, combination, No. 2, No. 1 mixed color, No. 1 turning, No. 2 mixed color
Oranges:	
Florida	Fancy, No. 1, No. 1 bright, No. 1 golden, No. 1 bronze, No. 1 russet, No. 2, No. 2 bright, No. 2 russet, No. 3
California	Fancy, No. 1, No. 2, combination, No. 3
Arizona	Fancy, No. 1, No. 2, combination, No. 3
Melons:	
Honeydew	No. 1, commercial, No. 2
Watermelon	No. 1, commercial, No. 2
Pears:	
Winter	Extra No. 1, No. 1, No. 2, combination grade
Summer and fall	No. 1, No. 2, combination grade
Plums and prunes	Fancy, No. 1, No. 2, combination
Vegetables:	
Asparagus	No. 1, No. 2
Beets	Bunched No. 1, topped No. 1
Cabbage	No. 1, commercial
Carrots:	
With short, trimmed tops	No. 1, commercial
Bunched	No. 1, commercial
Topped	Extra No. 1, No. 1, No. 2
Celery	Extra No. 1, No. 1, No. 2
Corn	Fancy, No. 1, No. 2
Cucumbers:	
Slicing	Fancy, No. 1, No. 2, No. 1 small
Pickling	No. 1, No. 2, No. 3

Table 2–13—Continued

Item	Grade
Eggplant	No. 1, No. 2
Onions:	
Green and Bermuda	No. 1, No. 2
Dry, non-Bermuda	No. 1, commercial, No. 1 boilers, No. 1 picklers, No. 2
Peppers, sweet	No. 1, No. 2
Potatoes:	
Sweet	Extra No. 1, No. 1, commercial, No. 2
White	Fancy, No. 1, commercial, No. 2
Radishes	No. 1, commercial
Romaine	No. 1
Squash	No. 1, No. 2
Tomatoes:	
Field grown	No. 1, combination, No. 2, No. 3
Greenhouse	Fancy, No. 1, No. 2

CHAPTER 3

TENTAGE AND SPECIAL-PURPOSE EQUIPMENT

3–1. Tentage

Data on standard tents are given in table 3–1.

3–2. Refrigeration

a. Requirements. The requirement for refrigerated storage space is approximately 3.37 cubic feet per man per month of supply. When ice is used, approximately 2 pounds are required per man per day.

b. Equipment. Table 3–2 gives information on refrigeration equipment.

Table 3–1. Data on Standard Tents

Type of tent	Size: Floor dimensions and area	Size: Height of ridge	Size: Height of side wall	No. of men accommodated	Wt. (lb.): Tent	Wt. (lb.): Pins and poles	Bulk in storage (cu. ft.): Tent	Bulk in storage (cu. ft.): Pins and poles	Authorized heating equipment	Remarks
Tent, arctic, w/cover, o.d., V47071, fire, mildew, water, and weather-resistant (FMWWR)	6-sided Each side 8'6" 200 sq. ft.	8' 6"	3' 0"	10	68	8	7.10	0.20	Heater, space, radiant-type, portable, coal or oil, 45,000-B.t.u., (1)	A six-sided pyramidal tent supported by a telescopic center pole, this tent provides shelter for operating in extremely cold and cold-wet areas. The tent has a stovepipe opening and a fire-resistant liner for insulation purposes. Erection: 6 men, 27 min. Striking: 6 men, 18 min.
Tent, assembly, M–1942, w/cover, o.d., V47345, FMWWR	40' x 80' 2,856.6 sq. ft.	18'	8'	80 (quarters) 500 (seated)	1,100	655	23.3	16.9	Heater, space, radiant-type, portable, coal or oil, 45,000-B.t.u., (4)	This is a large circus-type tent. It has a rectangular center section and hipped-roof ends. The top is made in four sections that lace together. The side walls also have four sections which may be rolled up or removed when weather conditions permit. This tent is authorized for chaplains in the field or for other purposes such as lectures or the showing of motion pictures. The tent may also be used for storage, truck maintenance, quartering personnel, housing the M–1945 mobile bakery unit, and other authorized uses. Erection: 6 men, 5 hrs. Striking: 6 men, 2 hrs.
Tent, command post, M–1945, w/cover, liner, and screen o.d., V47482,	10' x 20' 7" 172 sq. ft. (48 sq. ft.	9'	5' 6"	8	165	92	6.8	3.6	Heater, space, radiant-type, portable, coal or oil, 45,000-B.t.u., (1)	The central part of this tent is A-shaped. The ends have hipped-roofs, and converging side walls. A liner for insul-

FMWWR	vestibule space)									ation and wall screens for insect protection are provided. The tent can be completely blackedout. It is used in theaters of operations, to provide office shelter for staff sections of the echelons. When necessary, the tent may be used for quartering three persons. It also may be used as a battalion aid station since the blackout vestibule is long enough to accommodate a litter and bearers. Erection: 5 men, 20 min. Striking: 5 men, 15 min.
Tent, frame-type, insulated, sectional, with floor, M–1948, V48030	Basic size, 16′ x 16′; extendible in length by 4′ intermediate 256 sq. ft.	8′	Semicircular in cross section	4–6	556 (canvas components)	1,696 (wood and metal components)	Total 250		Heater, space, radiant-type, portable, coal or oil, 45,000-B.t.u., (1)	This is a general-purpose, vehicle-portable, frame-type tent designed for use in cold climates. It is constructed of insulated blankets supported on laminated wooden arches. The floor units are insulated boxes which, when locked together in pairs, also serve as packing cases for other components of the tent. Erection: 6 men, 45 min. Striking: 6 men, 30 min.
Tent, general-purpose, large, w/cover, o.d., V48578, FMWWR	18′ x 52′ 936 sq. ft.	12′ 3″	5′ 6″	24	Tent: 420 Liner: 155	245	60.2	8.8	Heater, space, radiant-type, portable, coal or oil, 45,000-B.t.u., (3)	The tent has a hipped-roof and square ends, and it is rectangular. It is used when a large tent is needed for storage or shelter. It also may be used as a small bakery or hospital ward. The tent has two entrances, one at each end. Two curtains, attached to each end and near the door entrances, slide along a double wire cable at

Table 3-1—Continued

Type of tent	Size: Floor dimensions and area	Size: Height of ridge	Size: Height of side wall	No. of men accommodated	Wt. (lb.): Tent	Wt. (lb.): Pins and poles	Bulk in storage (cu. ft.): Tent	Bulk in storage (cu. ft.): Pins and poles	Authorized heating equipment	Remarks
										the eave to open or shut the door. Four screened vinyl plastic windows equipped with blackout flaps are located on each side of the tent below the eave. The tent deck has ventilators at each end. Further ventilation can be obtained by leaving the door curtains open. The canvas is suspended on a webbing framework, which carries the stress and supports the canvas. The tent is pitched with the center pole placed 2 feet off center to create an unobstructed aisle extending the length of the tent. The tent is equipped with a liner with sidewalls made of both fabric and screen. The liner provides additional insulation in cold climates, and ventilation and insect protection when the tent and fabric liner side walls are rolled up in hot climates. Erection: 6 men, 1 hr. and 15 min. Striking: 6 men, 50 min.
Tent, general purpose, medium, o.d., V48921 FMWWR	16 x 32'8" 512 sq. ft.	10'	5' 6"	12	Tent: 334 Liner: 100	200	Tent: 18.7 Liner: 8.0	6.3	Heater, space, radiant-type, portable, coal or oil, 45,000-B.t.u., (2)	A hipped-roof tent similar in size to the limited standard squad tent M-1945 which it replaces. The tent is designed to

										satisfy general-purpose requirements such as storage, personnel housing, fire direction centers, and mess tents. Each end is provided with a 4-foot wide door, formed by two curtains which are opened and closed by sliding along a double wire at the eave line. Screened vinyl plastic windows equipped with blackout flaps are located on each side. The tent deck has ventilators at each end and insulated stovepipe openings near the ridge. The guy stress is carried by a webbing frame sewed in the tent. The tent is equipped with a liner with side walls made of both fabric and screen. The liner provides additional insulation in cold climates, and ventilation and insect protection when tent and fabric liner side walls are rolled up in hot climates. Erection: 4 men, 40 min. Striking: 4 men, 30 min.
Tent, hexagonal, lightweight, M–1950, o.d., FMWWR	6-sided each side 6′7″ long 113.2 sq. ft.	Peak 8′ 6″	2′	5–7	40	8.0	3.6	.2	Heater, space, radiant-type, portable, coal or oil, 45,000-B.t.u.	A 6-sided pyramidal tent supported by a telescopic pole, this tent provides shelter for troops operating in extremely cold and cold-wet areas. The tent has a stovepipe opening and a fire-resistant liner for insulation purposes. It may be manpacked. Erection: 5 men, 20 min. Striking: 5 men, 15 min.

Table 3–1—Continued

Type of tent	Size: Floor dimensions and area	Size: Height of ridge	Size: Height of side wall	No. of men accommodated	Wt. (lb.): Tent	Wt. (lb.): Pins and poles	Bulk in storage (cu. ft.): Tent	Bulk in storage (cu. ft.): Pins and poles	Authorized heating equipment	Remarks
Tent, kitchen, fly-proof, M1948, o.d., FMWWR	18′ x 12′ 216 sq. ft.	9′ Stack 12′	6′ Stack 9′		202	218	14.2	11.8		This tent is used as a shelter during the cooking and serving of food in the tropics. It is a rectangular A-type, square-end tent. The back portion of the tent forms a stack higher than the rest of the tent. The side and front walls may be guyed out, forming awnings. A wall screen, which snaps to the tent, provides an insect proof closure on sides and front when the walls are raised. The tent may be completely blacked out. Erection: 5 men, 60 min. Striking: 5 men, 40 min.
Tent, maintenance shelter, o.d., FMWWR	18′ x 26′ 9½″ 468 sq. ft.	13′ 8″	5′ 6″		500	Frame 755	26.3	58	Heater, duct-type, portable 250,000 B.t.u., (1 external)	This tent is used in theaters of operations for the repair of tanks and trucks. It looks like a wall tent but can be erected over a steel frame, which eliminates the use of interior poles and permits entrance of vehicles. A section of the roof may be lowered by means of slide fasteners operated by ropes to give a 10- by 10-foot opening, through which heavy equipment may be moved by a crane outside the tent. Six ground cloths are provided with each tent to form a floor for men working under vehicles.

										Erection: 4 men, 2 hrs. Striking: 4 men, 1 hr.
Tent, mountain, o.d., and white, FMWWR	6'10" x 4'6" 26.25 sq. ft.	3' 7"	Triangular in cross section	2	6		0.5	0.2		A man-packed, lightweight housing designed to be used in cold-climate operations, particularly in mountainous areas when ordinary means of transportation are not available for bringing in heavier types of tentage. Erection: 2 men, 15 min. Striking: 2 men, 10 min.
Shelter half, tent, MWWR	64" x 84" (Approximately, for two shelter halves joined) 30 sq. ft.	43"	Triangular in cross section	2	3	1	0.3	0.1		This shelter half is one-half of a small tent. Two shelter halves joined together form a tent, providing shelter for two men. The shelter half is carried by each man as part of the field pack. Erection: 2 men, 10 min. Striking: 2 men, 5 min.
Tent, general purpose, small, o.d., FMWWR	8'9" x 17'6" 198 sq. ft.	10' 6"	5' 0"		Tent: 116 Liner: 28		8.0 w/pins and poles		Heater, space, radiant-type, portable, coal or oil, 45,000-B.t.u., (1)	This tent is designed to be used as a command post, fire direction center, battalion aid station, or for any general purpose use. The tent is intended to be used in temperate and tropical climates; however, with the liner, it can be used effectively in cold climates. The tent is a six-sided pyramidal tent supported by a telescopic center pole and eight telescopic eave poles. A front and rear entrance is provided, each with a flag arrangement to permit vestibule attachment or the erection of tents in tandem. Erection: 4 men, 30 min. Striking: 4 men, 15 min.

Table 3–1—Continued

Type of tent	Size: Floor dimensions and area	Size: Height of ridge	Size: Height of side wall	No. of men accommodated	Wt. (lb.): Tent	Wt. (lb.): Pins and poles	Bulk in storage (cu. ft.): Tent	Bulk in storage (cu. ft.): Pins and poles	Authorized heating equipment	Remarks
Tent, frame-type, maintenance, medium light metal, o.d., FMWWR	20′ x 32′ (640 sq. ft. basic tent) Additional 8-foot intermediate sections can be added as required up to a maximum tent length of 64 feet	14′ 0″	Arch top		Basic tent: outer fabric, 540; tent liner, 475; intermediate section, outer fabric, 100; intermediate sections, tent liner, 95	Basic tent frame, 1042; intermediate frame section, 116	Basic tent outer fabric, 52; basic tent liner, 185; intermediate section outer fabric, 10; intermediate section tent liner, 37		Heater, duct-type, portable, 250,000-B.t.u., (1-external)	This tent, complete with frame and tent liner, is designed to be used as a medium-sized maintenance tent for repair of wheeled and tracked vehicles in temperate or cold climates. It is also designed to be used as a maintenance shelter for personnel performing maintenance and assembly operations for the Hawk or Corporal missiles. The tent is rectangular with an arched top consisting of a sectionalized magnesium frame, a sectionalized outer fabric or skin, and a sectionalized tent liner. The tent has a personnel and vehicle door at each end with four windows in each side. Erection: 8 men, 4 hrs. Striking: 4 men, 3 hrs.

Table 3–2. Refrigeration Equipment Data

Item	Manufacturer & model No.	FSN	Storage cap	Weight (lb.) net shipped		Max dimensions	Type of power	Remarks
1. Refrigerator, mechanical, self-contained, reach-in and pass-through Specification AA–R–200	Koch Ref. Co. Warren Ref. Co.	4110–194–1572	65 cu. ft.			90″ L x 36″ W x 75″ W*	Elec.	This refrigerator is designed for storing perishable foods at 38° F. in ambient temperatures up to 110° F. Refrigerator is self-contained with the condensing unit located in compartment below one door or mounted on top of cabinet.

*Without legs.

2. Refrigerator, mechanical, commercial, portable, reach-in (less mechanical unit) Specification MIL–R–43024	S&S Vending Machine Erickson Industries	4110–965–1222	70 cu. ft.	630		75 11/16″ L x 41 15/16″ W x 65 7/32″ H	This refrigerator is designed to store temperature-sensitive food items at temperatures from 0° F. to 35° F. under adverse climatic and operational conditions when mated with a 3,000 B.t.u./hr. refrigeration unit. Refrigerator is equipped with lifting attachments for transport by helicopter. It may also be transported on a 1 1/2 ton trailer. A half door is provided on each of the two sides and one full length door on end. Refrigerator is skid-mounted for use in severe weather.
3. Refrigerator, mechanical, commercial, field, portable, walk-in, plug-in, Specification MIL–R–12571	Esco Cabinet Co. Model 150AL	4110–274–6342	150 cu. ft.	900		73 1/8″ W x 83 1/8″ L x 77 3/8″ H	This refrigerator is a completely assembled structure. It is intended for worldwide field use under adverse climatic and operational conditions. The refrigerator is skid-mounted and designed with openings to accommodate the blades of a forklift vehicle for ease of handling. An opening is provided for a panel-type, plug-in refrigeration unit having a 5,000-B.t.u./hr. capacity. The refrigerator may be transported by a 2 1/2-ton vehicle.
4. Refrigerator, prefabricated, panel-type without refrigeration equipment Specification MIL–R–10932	Various	4110–926–9544	600 cu. ft.	3,750	6,300	107″ L x 153 5/8″ W x 89 3/4″ H	This refrigerator is designed to provide suitable storage space in the field for bulk perishable subsistence and other temperature-sensitive items. It is of panel construction and can be easily and quickly assembled and disassembled. It has one walk-in door and one plug panel to accommodate a 10,000 B.t.u./hr. refrigeration unit. It is capable of maintaining an interior temperature of 0° F. with an outside ambient temperature of 110° F. Conveyor door may be provided to facilitate in-and-out loading to reduce the loss of refrigeration.

Table 3–2—Continued

Item	Manufacturer & model No.	FSN	Storage cap	Weight (lb.) net shipped		Max dimensions	Type of power	Remarks
5. Refrigerator, prefabricated, panel-type without refrigeration equipment Specification MIL–R–10932	Various	4110–926–4159	1,200	5,600		199″ L x 153 5/8″ W x 89 3/4″ H		Same as item 4, except for size. It has greater storage capacity and two plug panels to accommodate two 10,000-B.t.u./hr. refrigeration units.
6. Refrigeration, prefabricated, panel-type, without refrigeration equipment Specification MIL–R–10932	Various	4110–287–3161	1,800	8,180		291″ L x 153 5/8″ W x 89 3/4″ H		Same as item 4, except for size. It has greater storage capacity and two plug panels to accommodate two 10,000 B.t.u./hr. refrigeration units. A partition panel to divide the box into two sections and two walk-in doors are provided.
7. Refrigerator, prefabricated, panel-type, without refrigeration equipment Specification MIL–R–10932	Various	4110–269–5071	4,000	17,380	29,182	658 5/8″ L x 153 5/8″ W x 89 3/4″ H		Same as item 4, except for size. It has greater storage capacity and four plug panels to accommodate four 10,000 B.t.u./hr. refrigeration units. Three partition panels are provided to divide box into four sections. Four walk-in doors are provided.
8. Refrigeration unit, mechanical, panel-type Specification MIL–R–43031	Thermo-King Various	4110–941–3045				32″ L x 33″ W x 52″ H	Elec.	This refrigeration unit which is mounted on a 70-cubic foot refrigerator, is intended for field use. The unit is designed for a 208-volt, 60-cycle, 3-phase power source. It operates in ambient temperatures of 110° F. and has a 3,000-B.t.u./hr. capacity while maintaining to a 0° to 35° F. box temperature.
9. Refrigeration unit, mechanical, panel-type Specification MIL–R–43031	Thermo-King	4110–941–3040				32″ L x 33″ W x 52″ H	Gas	Same as item 8, except this unit is powered by Military Standard Engine Model No. 2A016.
10. Refrigeration unit, mechanical, panel-type, 6,000-B.t.u./hr. capacity Specification MIL–R–12574	Various	4110–082–5832				36″ L x 36″ W x 54″ H	Elec.	This refrigeration unit is intended for field use and is designed to operate on 208-volt, 60-cycle, 3-phase, power source. The unit is designed to operate in ambient temperatures ranging from 0° to 110° F, and it is capable of main-

								taining temperatures at 0° to 35° F. The unit is designed for use with the 150-cubic foot refrigerator and may also be used on the 70-cubic foot refrigerator.
11. Refrigeration unit, mechanical, panel-type, 5,000-B.t.u./hr. capacity Specification MIL–R–12574	Dixie-Marco, Inc. Model D.N. 5,000-IV	4110–933–6114		575		36″ L x 36″ W x 54″ H	Gas	Same as item 10, except this unit is driven by Military Standard Engine Model No. 2A016.
12. Refrigeration unit, mechanical, panel-type 9,000-B.t.u./hr. capacity Specification MIL–R–10735	Dunham-Bush Model PTG9 Thermo-King Model QL9–M1	4110–987–8578 4110–967–9762		1,000		44″ L x 42″ W x 60″ H	Gas	This refrigeration unit is designed for use with semi-trailer refrigerator to preserve sensitive products. It can maintain a temperature of 0° F. with an ambient temperature of 110° F.
13. Refrigeration unit, mechanical, panel-mounted for refrigerator, prefabricated, panel-type, 10,000-B.t.u./hr. capacity Specification MIL–R–13312	Various	4110–287–3184				45″ L x 43″ W x 74″ H	Elec.	This unit is designed to provide subfreezing or chill temperatures in prefabricated warehouses used for the preservation of perishable subsistence and other temperature-sensitive items. The unit is completely automatic and is designed to operate on a 208-volt, 60-cycle, 3-phase current.
14. Refrigeration unit, mechanical, panel-mounted for refrigerator, prefabricated, panel-type, 10,000-B.t.u./hr. capacity Specification MIL–R–13312	Victor Products	4110–993–8034				45″ L x 43″ W x 74″ H	Gas	This unit, designed to run continuously, is powered by Military Standard Engine Model 4A032. The unit is provided with modulating control to maintain above-freezing temperatures, when desired. It is used with prefabricated refrigerators described in item 4, 5, 6, 7. Unit requirements same as in item 13.
15. Ice cream plant, portable, 2½-gallon freezer, 40-gallon hardening cabinet Specification MIL–R–20564	Emery-Thompson Bastian & Blessing Model DF–1966–254	4110–926–4126	40 gal.	1,050	1,650	79 3/16″ L x 33″ W x 67″ H	Elec.	The ice cream plant is a unit having a single refrigeration system which supports both the freezer and hardening cabinet. The unit is designed to operate on a 208-volt, 60-cycle, 3-phase, power source. The unit is also designed to produce 2 1/2 gallons of ice cream per batch and to have a storage capacity for 40 gallons of ice cream.

3–3. Special-Purpose Equipment

Data on special-purpose equipment are given in table 3–3.

Table 3–3. Special-Purpose Vehicles and Equipment Data

Name	Wt. (lb.)	Dimensions (in.)			Cubage (cu. ft.)	Remarks
		Lgth.	Wdth.	Hgt.		
Bath: Bath unit, portable, 8-shower head, M–1958	1,260	78	49	40	88.5	The bath unit is made up of a 20-gallon water heater, a 3/4-horsepower water pump, and two shower stands with four nozzles each. It is equipped with a 3-k.w. generator set, a 55-gallon fuel drum, and a carbon dioxide fire extinguisher. The unit uses approximately 960 gallons of water per hour. It is capable of providing continuing support for 3,000 troops.
Laundry: Laundry, mobile, two-trailer type: Washer trailer	4,300	168	78	84	637	This mobile laundry unit consists of a washer trailer with water heater, washer, and extractor; and a tumbler trailer with a tumbler dryer, engine, and generator.
Tumbler trailer	4,300	168	78	90	682.5	A laundry section made up of two washers and three driers is capable of producing 205 pounds of laundry per hour. A section is capable of supporting 4,200 troops.
Laundry unit, unit, single, trailer-mounted.	9,300	200	96	96	1066.8	The unit consists of a single, 2½-ton capacity, 2-wheel trailer; a washer-extractor; drying tumbler; hot water heater; electric generator; air compressor; and water pump. The unit will furnish complete (wash and dry) laundering service at a capacity of 120 pounds per hour. It can support 2,100 troops.
Clothing repair shop, trailer-mounted.	5,350	165	83	98	863	The trailer-mounted clothing repair shop is equipped with one button sewing machine, six clothing sewing machines, one darning machine, one grommet press, one tack-button attaching machine, a fire extinguisher, and a self-contained portable generator set. When in a stationary position, it rests on wheels and leveling jacks. During travel, it is towed by and vehicle equipped with standard Army-type pintle. The clothing repair shop is capable of supporting 8,200 troops.

Table 3–3—Continued

Name	Wt. (lb.)	Dimensions (in.)			Cubage (cu. ft.)	Remarks
		Lgth.	Wdth.	Hgt.		
Trailer-mounted textile repair shop.	5,360 (gross)	165	83	98	863	The trailer-mounted textile repair shop is equipped with one clothing sewing machine, one darning machine, one overedge sewing machine, one textile sewing machine, two heavy-duty sewing machines, one grommet press, one tack-button attaching machine, a fire extinguisher, and a self-contained portable generator set.
Bakery plant, trailer-mounted, M–1945:						The plant is capable of baking 1,296 pounds of bread at one time and may be operated 20 hours a day in frigid, temperate, or tropical areas. It is equipped with skid-mounted, electrically powered water pump, molding tables, baking pans, bread racks, scales, conveyors, space heaters, and immersion water heaters. An air compressor is furnished and is used to clean the equipment on the makeup outfit trailer. A lighting set is provided for night operations. When operated in two 10-hour shifts a day, the plant can support 30,000 troops.
Dough-mixing and makeup outfit, trailer-mounted (1 per plant).	11,000	241	141	111	2,182.81	
Bakery ovens, trailer-mounted (3 per plant).	6,500	193	88	84	825.61	
Electric flour sifter.	210	42	42	67	68	
Dough-proofing cabinets (36-pan) (3 per plant).	386	70	28	70	79.40	
Generator sets (2 per plant).	3,600	144	70	76	443.33	
Fuel system supply point						Fuel enters the system through the fuel manifold assembly and is moved into the six 10,000-gallon collapsible tanks by the first of two 350-g.p.m. centrifugal pumps or by the fuel transporter or pipeline pumps. The second 350-g.p.m. pump moves the fuel from the collapsible tank through two parallel filter separators to the loading standards.
Loading standards.	170 (uncrated) 257 (crated)	120 (extended) 84 (retracted)		120	35.76	
Fuel manifold assembly.	220 (uncrated) 400 (crated)	46	40	30	33	
Centrifugal pump.	1,539 (crated)	75 (tow bar retracted)	56	56	143.4	
Filter separator.	1,130 (crated)	73	36	66	165.6	
Collapsible fabric tank.	600 (empty) 1,850 (tank and manifold crated)	480	132	48	88	
Semitrailer refrigerator 7½ ton military (M349A4).	8,810	287.3	98.3	130.?	2129.6	Refrigerating unit maintains 10° F. inside temperature at 120° F. outside temperature.

Table 3–3—Continued

Name	Wt. (lb.)	Dimensions (in.)			Cubage (cu. ft.)	Remarks
		Lgth.	Wdth.	Hgt.		
Decontaminating apparatus, power-driven, truck-mounted M3A2.	13,420	261.5	95	89	1,320	Decontaminating solution tank has capacity of 400 gallons.
Decontaminating apparatus, power-driven, truck-mounted, M3A3.	14,430	261.5	95	89	1,320	Decontaminating solution tank has capacity of 400 gallons.
Decontaminating apparatus, power-driven, truck-mounted, 400-gallon, M9.	16,005	261.5	95	96.5	1,387	Decontaminating solution tank has capacity of 400 gallons.
Heater, water, liquid fuel, M1 (crated).	1,365	-------	-----	-----	79.7	Used with decontaminating apparatus; capable of heating 600 gallons of water per hour through 100° F.
Heater, water, liquid fuel, skid-mounted, 600 g.p.h, M2 (crated).	950	-------	-----	-----	32	Used with decontaminating apparatus; capable of heating 600 gallons of water per hour through 100° F.

CHAPTER 4

PETROLEUM

4–1. Petroleum Products Commonly Used In Theaters Of Operations

A tabulation of standardized fuels and lubricants that have been approved for procurement and use in Army equipment may be found in Federal Supply Catalog C9100–IL. AR 700–60 provides guidance on authorized grades of automotive gasoline and their use. Table 4–1 provides data on commonly used petroleum products.

Table 4–1. Physical Properties of Commonly Used Petroleum Products

Product	Symbol	API gravity (Degrees) Range From	To	Average	Average specific gravity	Density (pounds per U.S. gallon)	Minimum flash point degrees F.
Aviation gasoline Grade 115/145	115/145	66.0	75.0	69.2	0.7050	5.868	Below 0° F.
Motor gasoline Combat	91A	55.1	61.4	58.4	0.7451	6,203	Below 0° F.
Jet Fuels Grade JP–4	JP–4	45.0	57.0	53.5	0.7657	6.375	Below 10° F.
Grade JP–5	JP–5	36.8	48.0	41.0	0.8203	6.830	140° F.
Kerosene	K	40.0	50.0	48.0	0.7883	6.563	115° F.
Solvent, Dry Cleaning Grade 1	SD 1	45.0	55.0	48.0	0.7883	6.563	100° F.
Grade 2	SD 2	45.0	55.0	50.0	0.7796	6.490	138° F.
Diesel Fuel Grade DF–2	DF 2	30.0	38.0	35.0	0.8498	7.076	125° F.
Lube Oil Internal Combustion Engine SAE 30	OE 30	20.0	30.0	26.0	0.8984	7.481	390° F.
Gear oil, Grade 90	GO 90	20.0	25.0	23.0	0.9159	7.627	350° F.

4–2. Petroleum Conversion Factors

Table 4–2 may be used for the conversion of weights and measures in handling petroleum products.

Table 4–2. Petroleum Conversion Factors

Multiply—	By	To obtain—
Barrels	42.0	U.S. gallons
Barrels	9,702.0	Cubic inches
Barrels	5.61	Cubic feet
Barrels	34.97	Imperial gallons
Barrels 5	158.98	Liters
Barrels 5	0.1589	Cubic meters
Cubic feet	7.48	Gallons
Cubic feet	0.1782	Barrel
Cubic feet	0.025	Ton, measurement
Cubic feet	0.01	Ton, register
Cubic feet	28.32	Liters
Cubic inches	0.0043	Gallon
Cubic meters	264.2	Gallon
Cubic meters	6.29	Barrels
Gallons	231.0	Cubic inches
Gallons	0.1337	Cubic foot
Gallons	3.7854	Liters
Gallons	0.0238	Barrel
Gallons (gasoline)	6.103	Pounds
Gallons (gasoline)	0.0031	Ton, short
Gallons (gasoline)	0.0033	Ton, measurement
Gallons (gasoline)	0.0027	Ton, long
Gallons (gasoline)	0.0026	Ton, metric
Gallons (oil)	7.434	Pounds
Kiloliters	0.159	Barrel
Liters	0.2642	Gallon
Liters	0.001	Cubic meters
Pounds	0.1639	Gallons (gasoline)
Pounds	0.1345	Gallon (oil)
Tons, long	367.21	Gallons (gasoline)
Tons, measurement	303.03	Gallons (gasoline)
Tons, measurement	1.0	Ton, short (grease)

Table 4–2—Continued

Multiply—	By	To obtain—
Tons, measurement	1.1086	Ton, short (gasoline)
Tons, measurement	1.4285	Tons, short (gasoline in drums)
Tons, measurement	1.2048	Tons, short (oil in drums)
Tons, measurement	40.0	Cubic feet (gasoline)
Tons, metric	373.10	Gallons (gasoline)
Tons, short	327.8	Gallons (gasoline)
Tons, short (gasoline)	0.9195	Ton, measurement
Tons, short (gasoline in drums)	0.7	Ton, measurement
Tons, short (grease)	1.0	Ton, measurement
Tons, short (oil in drums)	0.83	Ton, measurement
Bbl/day	1.75	g.p.h.
Bbl/day	0.0292	g.p.m.
Bbl/hr.	0.0936	cu ft/min
Bbl/hr.	0.7	g.p.m.
Gal./hr.	0.1337	cu ft/hr
Gal/hr.	0.002228	cu ft/min
Gal/hr.	0.016667	g.p.m.
G.p.m.	34.2857	bbl/day
G.p.m.	1.4286	bbl/hr
G.p.m.	0.02381	bbl/min
G.p.m.	192.50	cu ft/day
G.p.m.	0.1337	cu ft/min
G.p.m.	1,440.0	gal/day
G.p.m.	0.6308	liters/sec
G.p.m.	0.002228	cu ft/sec
Cu ft/min	0.1247	gal/sec
Cu ft/min	0.4720	liters/sec
Cu ft/min	472.0	cubic centimeters/sec
Cu ft/sec	0.646317	million gals/day
Cu ft/sec	448.831	gals/min
Cu yards/min	0.45	cu ft/sec
Cu yards/min	3.367	gals/sec
Cu yards/min	12.74	liters/sec

4–3. Expansion and Contraction of Petroleum Products

Because volumes of petrolem products increase or decrease in direct proportion to temperature increase or decrease, accurate temperature of a product must be taken at the time of gaging and the measured quantity corrected to the standard temperature of 60° F. When gaging bulk product, it is often necessary to taken several temperature readings at various levels and average these readings to determine the true average temperature of the product. Table 4–3 specifies the number of readings necessary and the points at which readings should be taken for various depths of product.

Table 4–3. Procedural data for Petroleum Product Temperature Measurements

Depth of product	Minimum number of temperature measurements	Measurement levels
More than 15 feet	3	3 feet below top surface of product, middle of product, and 3 feet above bottom surface of product.
10 feet to 15 feet	2	3 feet below top surface of product, and 3 feet above bottom surface of product.
Less than 10 feet	1	Middle of product.

4–4. Volume Correction for Petroleum Products

To correct a measured volume of product at observed temperature to corresponding volume at 60° F, it is first necessary to determine the API gravity group number corresponding to the product. TM 10–1101 gives API groups and lists the products normally found in each. Correction factors for the various API groups at observed temperatures are also given in TM 10–1101. Multiply the volume at observed temperature by the appropriate correction factor to obtain corresponding volume at 60° F. For example, 10,000 gallons of automotive combat gasoline (group 3) at an observed temperature of 80° F is corrected to corresponding volume at 60° F. by multiplying by the factor 0.9879. The result is 9,879.0 gallons at 60° F. Table 4–4 shows 5,000 gallons of various products measured at temperatures from 0° to 135° F. Figures listed represent the volume of the product when corrected to 60° F.

Table 4–4. Corrections Based on 5,000 Gallons

Temp	Jet fuels diesel fuels kerosene	Mogas	Avgas
F°	(.0005)	(.0006)	(.0007)
0	5,150	5,180	5,210
1	5,147	5,177	5,206
2	5,145	5,174	5,203
3	5,143	5,171	5,199
4	5,140	5,168	5,196
5	5,137	5,165	5,193
6	5,135	5,162	5,189
7	5,133	5,159	5,185
8	5,130	5,156	5,182
9	5,127	5,153	5,179
10	5,125	5,150	5,175

Table 4-4—Continued

Temp F°	Jet fuels diesel fuels kerosene (.0005)	Mogas (.0006)	Avgas (.0007)
11	5,122	5,147	5,171
12	5,120	5,144	5,168
13	5,118	5,141	5,164
14	5,115	5,138	5,161
15	5,112	5,135	5,158
16	5,110	5,132	5,154
17	5,108	5,129	5,150
18	5,105	5,126	5,147
19	5,102	5,123	5,144
20	5,100	5,120	5,140
21	5,097	5,117	5,136
22	5,095	5,114	5,133
23	5,093	5,111	5,129
24	5,090	5,108	5,126
25	5,087	5,105	5,123
26	5,085	5,102	5,119
27	5,083	5,099	5,115
28	5,080	5,096	5,112
29	5,077	5,093	5,109
30	5,075	5,090	5,105
31	5,072	5,087	5,101
32	5,070	5,084	5,098
33	5,068	5,081	5,094
34	5,065	5,078	5,091
35	5,062	5,075	5,088
36	5,060	5,072	5,084
37	5,058	5,069	5,080
38	5,055	5,066	5,077
39	5,052	5,063	5,074
40	5,050	5,060	5,070
41	5,047	5,057	5,066
42	5,045	5,054	5,063
43	5,043	5,051	5,059
44	5,040	5,048	5,056
45	5,037	5,045	5,053
46	5,035	5,042	5,049
47	5,033	5,039	5,045
48	5,030	5,036	5,042
49	5,027	5,033	5,039
50	5,025	5,030	5,035
51	5,022	5,027	5,031
52	5,020	5,024	5,028
53	5,018	5,021	5,024
54	5,015	5,018	5,021
55	5,012	5,015	5,018
56	5,010	5,012	5,014
57	5,008	5,009	5,010
58	5,005	5,006	5,007
59	5,002	5,003	5,004
60	5,000	5,000	5,000
61	4,998	4,997	4,996
62	4,995	4,994	4,993
63	4,993	4,991	4,990
64	4,990	4,988	4,986
65	4,987	4,985	4,982
66	4,985	4,982	4,979
67	4,983	4,979	4,976
68	4,980	4,976	4,972
69	4,977	4,973	4,969
70	4,975	4,970	4,965
71	4,972	4,967	4,961
72	4,970	4,964	4,958
73	4,968	4,961	4,954
74	4,965	4,958	4,951
75	4,962	4,955	4,948
76	4,960	4,952	4,944
77	4,958	4,949	4,940
78	4,955	4,946	4,937
79	4,952	4,943	4,934
80	4,950	4,940	4,930
81	4,947	4,937	4,926
82	4,945	4,934	4,923
83	4,943	4,931	4,919
84	4,940	4,928	4,916
85	4,937	4,925	4,913
86	4,935	4,922	4,909
87	4,933	4,919	4,905
88	4,930	4,916	4,902
89	4,927	4,913	4,899
90	4,925	4,910	4,895
91	4,923	4,906	4,890
92	4,920	4,903	4,886
93	4,918	4,899	4,883
94	4,915	4,896	4,879
95	4,913	4,893	4,876
96	4,910	4,890	4,872
97	4,908	4,887	4,869
98	4,905	4,884	4,865
99	4,903	4,881	4,861
100	4,900	4,878	4,858
101	4,898	4,875	4,854
102	4,895	4,872	4,851
103	4,893	4,869	4,847
104	4,890	4,866	4,844
105	4,888	4,863	4,840
106	4,885	4,860	4,836
107	4,883	4,857	4,833
108	4,880	4,854	4,829
109	4,878	4,851	4,826
110	4,875	4,848	4,822
111	4,873	4,845	4,819
112	4,870	4,841	4,815
113	4,868	4,838	4,811
114	4,865	4,835	4,808
115	4,863	4,832	4,804
116	4,860	4,829	4,801
117	4,858	4,826	4,797
118	4,856	4,823	4,793
119	4,853	4,820	4,790
120	4,851	4,817	4,786
121	4,848	4,814	4,783
122	4,846	4,811	4,779
123	4,843	4,808	4,776
124	4,841	4,805	4,772
125	4,838	4,802	4,768
126	4,836	4,799	4,765
127	4,833	4,796	4,761
128	4,831	4,792	4,758

Table 4–4—Continued

Temp	Jet fuels diesel fuels kerosene	Mogas	Avgas
F°	(.0005)	(.0006)	(.0007)
129	4,828	4,789	4,754
130	4,826	4,786	4,750
131	4,823	4,783	4,747
132	4,821	4,780	4,743
133	4,818	4,777	4,740
134	4,816	4,774	4,736
135	4,813	4,771	4,732

4–5. Factors Influencing Petroleum Requirements

The factors influencing petroleum consumption are as follows:

a. Displacement. The average distance vehicles of an organization will travel can be determined by measuring the route on a map from the old location to the new location. The distance should be measured from the approximate center of the old area to the approximate center of the new area. Cross-country battle consumption is estimated at two and one-half times the consumption of movements over roads.

b. Vehicle-Per-Mile Consumption. Gasoline consumption per mile varies with the type of vehicle employed. Hence, it will be necessary to determine the number of each type of vehicle used for the movement. Table 4–5 provides fuel consumption data for various vehicles.

c. Supply. During a displacement, certain vehicles of an organization must make round trip supply hauls. Since these hauls generally are made to supply points located at varying distances from the organization, an average round trip supply distance must be determined. The amount of fuel required daily for supply hauls may be estimated by multiplying the average round trip supply distance by 10 percent of the amount of fuel required to move the total organization one kilometer. When the organization is not on the move, supply haul requirements are included in the composite requirement and are not computed separately.

d. Service. Supplemental daily requirements must be considered for the movement of vehicles within bivouac areas and on reconnaissance, for the warming up of engines, and for abnormal periods of low-gear operation. Under average conditions of operation, weather, road, and terrain, the requirements can be estimated by using the consumption necessary to move all vehicles 16 kilometers over roads.

e. Loss Factor. When operating in a combat zone, an additional 10 percent of the total consumption figure should be included in the estimate to cover evaporation, spillage, and small combat losses.

f. Housekeeping. Additional daily petroleum requirements exist for administrative vehicles, kitchens, gasoline-powered equipment, and for the maintenance and testing of engines. When the organization is not on the march, these requirements are grouped in a composite daily requirement for the organization. When the organization is on the move, these factors, with the exception of kitchen requirements, are included in displacement and service factors. The kitchen requirement is figured on a daily consumption of 15 gallons per kitchen.

4–6. Petroleum Consumption Factors

Tables 4–5, 4–6, and 4–7 may be used as guides for estimating petroleum requirements of Army vehicles, equipment, and aircraft.

Table 4–5. Vehicle Fuel and Lubrication Data

Line item number	Vehicle	Type of fuel	Fuel tk cap.	Fuel consumption gal./km.	Oil/ 100 km (gal.)	Gear/lub. 100 km. (lb.)	Misc. grease 100 km. (lb.)
B04578	Automobile, sedan, hv	Gas	20.0	.044	0.1	0.1	0.1
B04578	Automobile, sedan, mdm	Gas	19.0	.045	0.1	0.1	0.1
B04715	Automobile, sedan, lt	Gas	16.0	.036	0.1	0.1	0.1
D11048	Carrier, cgo, tracked, 6-ton	Diesel	105.0	.220	------	------	------
D11401	Carrier, comd and recon, M114	Gas	110.0	.227	------	------	------
D11538	Carrier, CP, lt-tracked, M577A1	Diesel	120.0	.248	------	------	------
D12086	Carrier, pers, full-tracked, armd, M113	Gas	80.0	.250	------	------	------
D12086	Carrier, pers, full-tracked, armd, M113A1	Diesel	95.0	.197	------	------	------
E56577	Combat, engine vehicle, full-tracked, M728	Diesel	375.0	.555	------	------	------

Table 4-5—Continued

Line item number	Vehicle	Type of fuel	Fuel tk cap.	Fuel consumption gal./km.	Oil/ 100 km (gal.)	Gear/lub. 100 km. (lb.)	Misc. grease 100 km. (lb.)
H56391	Firefighting equipment set, trk-mtd, 2½-ton	Gas	78.0	.091	0.3	0.5	0.3
J96819	Gun, aircraft, SP, 40-mm, M42	Gas	144.0	1.130	------	------	------
J96956	Gun, at, SP, 90-mm, M56	Gas	55.0	.310	------	------	------
J97230	Gun, FA, SP, 175-mm	Diesel	300.0	.420	------	------	------
K56981	Howitzer, 8-in, SP, full-tracked, M110	Diesel	300.0	.416	2.5	1.1	1.8
K57666	Howitzer, 155-mm, SP, full-tracked, M44A1	Gas	135.0	1.250	2.4	0.9	1.6
K90188	Inst repair shop, trk-mtd, 2½-ton, 6x6, with equip	Gas	50.0	.125	0.3	0.5	0.3
L45534	Launcher, rkt, 762-mm, M386	Gas	78.0	.227	------	------	------
D10725	Carrier, 81-mm mort, full-tracked	Gas	136.5	.740	1.3	------	1.3
D10740	Carrier, 107-mm mort, SP	Gas	136.5	.740	1.3	------	1.3
R50543	Recov vehicle, full-tracked, lt armed, M578	Diesel	320.0	.416	------	------	------
R50680	Recov vehicle, full-tracked, mdm, M88	Gas	445.0	1.250	------	------	------
T10138	Shop equipment, contract maint, trk-mtd, 2½-ton	Gas	50.0	.069	0.3	0.5	0.3
T13152	Shop equipment organization repair, lt trk-mtd, ¾-ton	Gas	24.0	.069	0.1	0.2	0.2
V12826	Tank, cbt, full-tracked, 76-mm gun, M41A3	Gas	140.0	.910	2.3	0.9	0.9
V12963	Tank cbt, full-tracked, 90-mm gun, M-48A3	Diesel	375.0	.812	------	------	------
V13100	Tank, cbt, full-tracked, 105-mm gun, M60A1	Diesel	375.0	.710	3.2	1.3	0.6
V13100	Tank, cbt, full-tracked, 105-mm gun, M60	Diesel	385.0	.774	3.2	1.3	0.6
X38639	Truck, amb, ¼-ton, 4x4, M718	Gas	20.0	.044	0.2	0.1	0.1
X38776	Truck, amb, ¾-ton, 4x4, M43B1	Gas	24.0	.069	0.1	0.2	0.2
X39735	Truck, cgo, ¾-ton, 4x4, with equip, M38B1	Gas	24.0	.069	0.1	0.2	0.2
X40009	Truck, cgo, 2½-ton, 6x6, with equip, M35A2	multi-fuel	50.0	.055	0.3	0.5	0.3
X40831	Truck, cgo, 5-ton, 6x6, LWB with equip, M54A2	multi-fuel	78.0	.116	0.5	0.3	0.3
X41790	Truck, cgo, 10-ton, 6x6, WWN with equip, M125	Gas	220.0	.207	0.5	0.3	0.3
X43228	Truck, dump, 3/4-ton, 4x4, XM708	Gas	24.0	.069	0.1	0.2	0.2
X43297	Truck, dump, 2 1/2-ton, 6x6, M342A2	Gas	50.0	.104	0.3	0.5	0.3
X43845	Truck, dump, 5-ton, 6x6, WWN, with equip, M51A2	Gas	110.0	.115	0.5	0.3	0.3
X55627	Truck, platform, util, 1/2-ton, 4x4, M274A4	Gas	8.0	.049	0.1	0.1	0.1
X56586	Truck, stake, 5-ton, 6x6, WWN with equip, M54A2	Diesel	78.0	.116	0.5	0.3	0.3
X57271	Truck, tk, fuel svc, 2 1/2-ton, 6x6, with equip	multi-fuel	50.0	.055	0.3	0.5	0.3
X59189	Truck, trac, 2 1/2-ton, 6x6, WWN, with equip	Gas	50.0	.089	0.3	0.5	0.3
X59326	Truck, trac, 5-ton, 6x6, with equip, M52A2	Diesel	110.0	.115	0.4	0.6	0.5
X59600	Truck, trac, 10-ton, 6x6, with equip, M123	Gas	166.0	.625	0.5	0.5	0.6
X60696	Truck, trac, wkr, 5-ton, 6x6, WWN, with equip M246	Gas	78.0	.141	0.3	0.5	0.3
X60833	Truck, util, 1/4-ton, with quip, M151A	Gas	17.0	.044	0.1	0.1	0.1
X61929	Truck, van, expansible, 2 1/2-ton, 6x6, with equip, M292A2	Gas	50.0	.089	0.3	0.5	0.3

Table 4–5—Continued

Line item number	Vehicle	Type of fuel	Fuel tk cap.	Fuel consumption gal./km.	Oil/ 100 km (gal.)	Gear/lub. 100 km. (lb.)	Misc. grease 100 km. (lb.)
X62237	Truck, van, expansible, 5-ton, 6x6, with equip, M291A2	Gas	78.0	.116	0.5	0.3	0.3
X62340	Truck, van, shop, 2 1/2-ton, 6x6, with equip, M109A3	Gas	50.0	.089	0.3	0.5	0.3
X63025	Truck, wkr, crane, 2 1/2-ton, 6x6, M108	Gas	50.0	.089	0.3	0.5	0.3
X63904	Truck, 3/4-ton, wkr kit, mtd, XM711	Gas	24.0	.069	0.1	0.2	0.2
X63162	Truck, wkr, 2 1/2-ton, 6x6, M60A2	Gas	50.0	.104	0.3	0.5	0.3
X63299	Truck, wkr, 5-ton, 6x6, WWN, with equip, M543A2	Gas	78.0	.116	0.5	0.3	0.3
Y35486	Water purif equipment set, trk-mtd, 2 1/2-ton trk	Gas	50.0	.089	0.3	0.5	0.3

Table 4–6. Equipment Fuel Consumption

Line item number	Type	Type of fuel	Est. avg. rate of consumption in gal./hr.
F43414	Crane-shovel, trk-mtd, 20-ton, ¾ cu yd	Gas	4.0
F39241	Crane, wheel-mtd, 5-ton, ⅜ cu yd	Gas	4.3
W86269	Tractor, full-tracked, low-speed, 8,600–12,000 lb. drawer pull	Diesel	9.0
X48846	Truck, lift, fork, Air Mobile, 4,000 lb. Rough Terrain	Gas	3.5
X48914	Truck, lift, fork, 6,000 lb. Rough Terrain	Diesel	8.0
X49051	Truck, lift, fork, 10,000 lb. Rough Terrain	Diesel	8.0
X51106	Truck, lift, fork, 2,000-lb, solid rubber tires	Gas	3.3
X51380	Truck, lift, fork, 4,000-lb, solid rubber tires	Gas	3.3
X51928	Truck, lift fork, 6,000-lb, pneumatic tires	Gas	3.5
X52476	Truck, lift, fork, 10,000-lb, pneumatic tires	Gas	3.2
X52750	Truck, lift, fork, 15,000-lb, pneumatic tires	Gas	4.7

Table 4–7. Army Aircraft Petroleum Requirements

Line item number	Model	Grade of fuel	Internal fuel capacity (gal.)	Fuel consumption/ cruise hr. (gal.)	Type of engine oil	Engine oil consumption hr. (gal.)
A30071	O–1A	115/145	42	8.5	GD1100	.29
A30111	O–1D	115/145	42	--	GD1100	--
A30132	O–1G	115/145	41	--	GD1100	--
A30171	OV–1A	JP–4	297	170.0	23699	.04
A30221	OV1B	JP–4	297	170.0	23699	.04
A30271	OV1C	JP–4	297	170.0	23699	.04
A30371	TO–1D		41	8.6	GD1100	.29
A30596	T42A		142	27.62	22851	--
A30621	U–1A	115/145	213.5	30.0	GD1100	2.19
A30671	U–6A	115/145	95	23.0	GD1100	.70
A30721	U–8D	115/145	230	40.0	GD1100	1.22
A30821	U–8F	115/145	230	40.0	GD1100	1.22
A30871	U–9B/G	115/145	233	29.7	GD1100	.60
A30946	U21A	JP–4	378	83.0	23699	--
A30961	OH–23G	115/145	46	21.9	GD1100	.48
A30971	U–10A	100/130	60	14.0	1080	--
K29660	AH–1G	JP–4/5	251	83.6	23699	--
K29728	AH–56A	JP–4	438	140.0	23699	--
K29797	TH–13T		57	21.2	22851	1.00
K30234	CH–34A	115/145	262	71.3	GD1100	5.17
K30254	CH–34C	115/145	262	115.0	GD1100	5.17

Table 4–7—Continued

Line item number	Model	Grade of fuel	Internal fuel capacity (gal.)	Fuel consumption/ cruise hr. (gal.)	Type of engine oil	Engine oil consumption hr. (gal.)
K30291	CH–37B	115/145	398	233.0	GD1100	27.20
K30378	CH–47A	JP–4	621	342.0	23699	.28
K30383	CH–47B	JP–4	621	427.0	23699	.37
--	CH47C	JP–4	1,131	467.0	23699	--
K50515	CH–54A	JP–4/5	914	532.0	23699	--
K30596	T42A		142	27.62	22851	--
K30645	OH–6A	JP–4	59	22.0	7808	.05
K30682	OH–13E	91/96	29	16.2	22851	.05
K30702	OH–130	91/96	42	10.4	GD1100	.27
K30719	OH–13H		42	13.6	GD1100	.27
K30746	OH–13S	115/145	43	21.0	GD1100	.27
K30900	OH–23C	115/145	28	15.0	GD1100	.48
K30917	OH–23D	115/145	46	16.1	GD1100	.48
K31042	DH–58A	JP–4	70	29.0	7808	--
K31749	UH–1B	JP–4	165	75.0	23699	.02
K31786	UH–1D	JP–4/5	224	85.0	23699	.02

4–7. Per-Man-Per-Day Method of Estimating Petroleum Requirements

The per-man-per-day method of estimating petroleum requirements is used in the early planning stages when definite information is not available on the number and types of vehicles. Because organizations vary in composition, this method is seldom used below field army level and never below corps level; however, once the estimated requirements are established for a given theater, the figure may be used for requisitioning purposes by smaller units. It is emphasized that the gallons-per-man-per-day is to be used as a guide only and not as a substitute for more exact computation. The consumption in gallons per man per day in various theaters will vary with the terrain, the climate, the ratio between land and amphibious operations, and the employment of units using special vehicles and equipment. The figures given in table 4–8 should be adjusted to fit each area as soon as experience shows any variance between these planning factors and actual usage. To compute estimated petroleum requirements, multiply troop strength by factors listed in table 4–8.

Table 4–8. Per-Man-Per-Day Method of Estimating Petroleum requirements [1]

Product	Pounds per man per day	Gal per man per day
Army ground bulk petroleum fuels	50.77	8.05
Mogas	38.19	6.25 [2]
Diesel	12.58	1.80 [2,3]
Engine oil	1.00	0.10 [2]
Gear lubricants	.80	0.08 [2]
Grease	.06	----

[1] Class IIIA requirements must be computed for individual aircraft. See table 4–7.
[2] Based on SB 710–2, (data for France and Germany).
[3] M–60 tanks in Europe.

4–8. Per-Vehicle-Per-Mile Method of Estimating Petroleum Requirements

The per-vehicle-per-mile method of estimating petroleum requirements is a more accurate method than the per-man-per-day method. It is used in operational stages when numbers and types of vehicles are known. To estimate requirements by this method, multiply the total number of each type of vehicle by its known "per-mile" factor.

4–9. Unit Method of Estimating Petroleum Requirements

The unit method of estimating petroleum requirements is used when a number of units are to make a mass movement over roads. For example, table 4–9 gives average consumption figures for moving units of the division support command of the armored division one kilomenter. To obtain lubricating oil requirements in gallons, multiply vehicular fuel requirements by a factor of 0.02.

Table 4-9. Unit Method of Estimating Petroleum Requirements (Example)

Unit	Fuel to move 1 km. (gal.)*		Fuel cap. (gal.)								organic kitchens
			Vehicle tanks		Gas cans		Bulk fuel		Total fuel cap.		
	Diesel	Gas	Diesel	Gas	Diesel	Gas	Diesel	Gas	Diesel	Gas	
Armored Division	20.07	28.03	18,560	11,652	3,590	2,740	160,200	35,348	182,350	49,740	19
DISCOM (TOE 17G)											
HHC and Band	(.28)	(.56)	(250)	(208)	(50)	(70)	------	------	(300)	(278)	(1)
Admin Co.	(.33)	(1.04)	(300)	(424)	(60)	(130)	------	------	(360)	(554)	(3)
Med Bn	(2.37)	(5.22)	(2,150)	(1,862)	(430)	(730)	------	------	(2,580)	(2,592)	(4)
HQ and Spt Co.	(1.05)	(1.60)	(950)	(578)	(190)	(220)	------	------	(1,140)	(798)	(1)
3 Med Co. (ea)	(.44)	(.71)	(400)	(428)	(80)	(170)	------	------	(480)	(598)	(1)
Maint Bn	(8.19)	(17.59)	(7,600)	(7,719)	(1,460)	(1,305)	(2,628)	(2,620)	(11,688)	(11,644)	(7)
HQ and Main Spt Co.	(2.87)	(7.25)	(2,670)	(3,260)	(510)	(555)	(540)	(660)	(3,720)	(4,475)	(3)
3 Fwd Spt Co. (ea)	(1.34)	(3.07)	(1,240)	(1,308)	(240)	(205)	(584)	(616)	(2,064)	(2,129)	(1)
Trans Acft Maint Co.	(1.30)	(1.13)	(1,210)	(535)	(230)	(135)	(336)	(112)	(1,776)	(782)	(1)
S&T Bn	(8.9)	(3.62)	(8,260)	(1,439)	(1,590)	(505)	(157,572)	(32,728)	(167,422)	(34,672)	(4)
HHC	(.17)	(.77)	(150)	(280)	(30)	(100)	------	------	(180)	(380)	(1)
S&S Co.	(1.16)	(1.58)	(1,060)	(592)	(210)	(230)	(47,500)	(30,000)	(48,770)	(30,822)	(1)
TMT Co.	(7.25)	(.57)	(6,750)	(282)	(1,290)	(80)	(107,200)	------	(115,240)	(362)	(2)
Div Avn Spt Det.	(.32)	.70	300	285	60	95	2,872	2,728	3,232	3,108	--

*Multiply by 2.5 for cross-country battle conditions.

4–10. Experience Tables for Estimating Petroleum Requirements

The most accurate method of estimating petroleum requirements is based upon weekly experience tables, which more exactly reflect the variables of weather, terrain, organizational strength, and operational vehicles and equipment. These tables, when submitted weekly by each unit and compiled at the next higher headquarters, may be used for all levels of petroleum planning, and the figures used the man-per-day, vehicle-per-mile, or unit methods can be adjusted accordingly. An allowance of 5 percent in tonnage usually is added for auxiliary equipment, such as ranges and generators. Lubricants are estimated as a percentage, based on experience, of total gasoline requirements.

4–11. Petroleum Storage

a. Bulk. Bulk petroleum products are stored in permanent and temporary tanks.

(1) *Permanent tanks.*

(*a*) *Description.* Bulk petroleun usually is stored at bulk storage facilities in welded- or bolted-steel tanks ranging in capacity from 100 to 100,000 barrels or more (42 U.S. gallons equal 1 barrel). Pressure- and vacuum-release valves are supplied with all sizes of tanks. Table 4–10 gives information on the gallon and barrel capacity, and the dimensions of various tanks. Detailed information is contained in MIL–HDBK–210.

(*b*) *Measurement of liquid in vertical cylinder.* The contents in U.S. gallons of a vertical cylindrical tank, such as a steel storage tank, may be calculated by use of equation

$$V = \pi r^2 h \quad (7.481).$$

Note. V = Volume (U.S. gallons).
π = 3.1416.
r = Radius in feet.
h = Height of liquid level (innage) in feet.
7.481 = Conversion factor to U.S. gallons.

(2) *Temoporary tanks.* Temporary tanks are used to store petroleum products for relatively short periods. They are generally used at forward petroleum supply points, but they can also be used wherever required in the petroleum supply system (table 4–11).

(*a*) *Collapsible tanks.* The 3,000- and 10,000-gallon collapsible liquid fuel tanks are constructed of heavy fabric impregnated with petroleum-resistant rubber. Each tank is equipped with a manifold assembly through which it is filled and emptied. The lightweight and compactness of the tanks facilitate their transportation to forward areas for petroleum storage. Collapsible tanks ranging in capacity from 1,200 to 2,500 barrels are presently under development.

*Table 4–10. Data on Bolted-Steel Tanks**

Approximate inside diameter (ft)	Height (ft)	Capacity (gals.)	Capacity (barrels)	Approximate net weight (lbs)	Cubic feet (packed)	Approximate gross weight crated (lbs)	Approximate volume displacement (cu ft)
9′2″	8	4,200	100	2,750	80	3,196	210
15′4″	8	10,500	250	5,600	----	6,510	260
21′6″	8	21,000	500	9,760	144	11,712	350
29′8″	8	42,000	1,000	17,080	218	20,496	470
29′8″	24	126,000	3,000	27,840	----	33,408	850
38′8″	24	210,000	5,000	39,000	890	44,000	1,064
54′11″	24	420,000	10,000	77,300	2,015	92,100	1,600

*Tank with capacity greater than 10,000 barrels are welded steel.

Table 4–11. Skid-Mounted and Collapsible Tanks for Petroleum Products

Item Description	Dimensions of filled tanks (ft.)			Weight (lb.)			Cubci feet [1]		Number that can be carried on a 2½-ton truck	Number that can be carried on a 5-ton truck
	Lgth.	Wdth.	Hgt.	Empty	Filled [2]	Crated	Crated	Rolled up		
Tank, metal, skid-mounted, 600-gallon capacity.	6	6	4	497	4,190	797	223	--	2 [3]	2
Tank, fabric, collapsible, 3,000-gallon capacity.	20	6½	3	228	18,500	265	--	22	--	--

Table 4–11—Continued

Item Description	Dimensions of filled tanks (ft.)			Weight (lb.)			Cubci feet [1]		Number that can be carried on a 2½-ton truck	Number that can be carried on a 5-ton truck
	Lgth.	Wdth.	Hgt.	Empty	Filled [2]	Crated	Crated	Rolled up		
Tank, fabric, collapsible, 10,000-gallon capacity.[4]	42	12	4	800	61,800	950	--	30	--	--
Drum, fabric, collapsible, 500-gallon capacity. (Model 4C)	6'8"	3'10" [5]		250	3,200	330	--	--	2	3
(Model 5)	5'2"	4' 5" ⅛"		250	3,200	330	28.4	--	2	3

[1] Average.
[2] Filled with gasoline weights increase when filled with heavier petroleum products.
[3] Only one tank can be carried on a 2½-ton truck for off-highway transportation.
[4] Tank assembly contains a 4-inch hose manifold, which weighs 660 pounds and has a storage volume of 49 cubic feet.
[5] Diameter.

(*b*) *Skid-mounted tanks.* There are two types of skid-mounted fuel tanks: the one-compartment, 600-gallon tank; and the one and two-compartment, 750-gallon tank (limited standard). The tanks are of welded steel construction and are equipped with inlet and outlet fittings and pressure vent. Two 600-gallon tanks can be carried in the bed of a standard 2 ½-ton, 6 x 6 cargo truck.

b. Packaged.

(1) *Dimensions of containers.* Table 4–12 gives weights, dimensions, and planning factors of standard petroleum containers. For storage and pipeline computations, bulk petroleum is usually measured in barrels of 42 gallons each or in long tons. For packaged petroleum products, ocean shipping is based on the measurement ton (40 cubic feet). The capacity of vehicles for carrying filled containers is based upon authorized loads. When overloads are authorized, these quantities may be increased to the cubic capacity of each vehicle or to 100 percent overload, whichever limit is reached first.

Table 4–12. Data on Standard Petroleum Containers

Container	Empty Wt. (lb.)	Average wt. when filled (lb.)					Dimensions (in.)				Packages [1] per		Number of full containers carried on a 2½-ton truck
		Gasoline, automotive, combat [2]	Kerosene	Diesel fuel	Lubricating oil, engine	Grease	Length	Width or diameter	Height	Cubic feet (including planning factor)	Long ton	Measurement ton	
Drum, 55-gallon, 16-gage [2]	70	411	443	457	479	----	----	23 7/16	35	12	5.93	3.33	14
Drum, 55-gallon, 18-gage [2]	50	391	423	437	459	----	----	23 7/16	35	12	---	---	14
Can, 5-gallon, gasoline	10.5	41	---	---	---	----	13 3/4	6 3/4	18 1/2	1	53.5	40	120
Drum, 5-gallon cylindrical	11	---	45.2	46.2	49.2	66	----	11 1/2	13 9/16	1	40.7	40	101
Case, twenty-four 1-quart cans	7.5	---	---	---	59.6	----	16 3/8	12 3/16	11 5/8	1.5	37.3	20.0	90
Case, six 5-quart cans	8.43	---	---	---	75.7	----	22	14	10	1.9	29.1	20.0	65
Pail, 35-pound [3]	5.0	---	---	---	43.1	40.25	----	11 1/2	13 9/16	1.1	49.6	40	125
Drum, 120-pound	16	---	---	---	139.7	136	----	14 7/8	26 3/4	3.4	14.7	11.76	36

[1] Data for 55-gallon drums and 5-gallon gasoline cans are based on average weight of automotive combat gasoline; data on 35-pound pail and 120-pound drum are based on average weight of grease; data on all other containers are based on average weight of lubricating oil, engine.

[2] The standard 55-gallon drum (specification PPP–D–729, amendment No. 1) has an authorized capacity of 54 gallons for products with flash point of less than 80° F, or 55-gallons over 80° F. The specification shows maximum capacity of 57.75 gallons. The drum is identified by the letter "O" embossed on the head of the drum.

[3] Data based on average empty weight of class 1 pail. The average empty weight of the class 2 pail is 5.75 pounds.

(2) *Layout of stacking areas.* It is extremely important that petroleum products be identified correctly. One of the most effective means of accomplishing this is to provide exclusive stacking areas for each product and type of package. This also aids in taking inventory. The exact layout and size of the stacking area must be determined by evaluating local conditions and normal safety requirements. So that the entire stock of one product will not be lost by attack or fire, stocks should be adequately dispersed. This is best accomplished by using a "block" system of segregation (TM 10–1101).

(*a*) *Aisles and firebreaks.* Adequate space should be provided for aisles and firebreaks within the stacking area. Between units of stacked 55-gallon drums, 4 to 9 feet for aisles should be provided. Wider aisles should be planned when heavy-handling equipment is to be used in stacking the drums. Aisles, between sections of containers should be 15 to 50 feet wide; and firebreaks, 50 to 150 feet wide, should be provided around blocks of several sections.

(*b*) *Typical layouts.* In a typical layout of a stacking area for 5-gallon cans, each block might be composed of nine 50-foot square sections with 30-foot aisles between sections. In a typical block layout of a stacking area for 55-gallon drums, blocks are composed of 55-foot square sections rather than 50-foot square sections, and each section is divided into six parallel units with 9-foot aisles between units.

4–12. Transportation

a. Tanker. Ship tankers range in capacity from 12,000 to 900,000 barrels and in speed from 10 to 16.5 knots. The T–2 class, with an average capacity of 138,000 barrels (5,796,000 gallons), is a commonly used military tanker. Table 4–13 gives cargo data for tankers.

b. Pipeline. Pipelines should be used whenever possible, to transfer bulk liquids from one storage dispensing point to another because they are the most efficient overland means for this task. Information on pipeline systems is given in TM 5–343; scheduling and dispatching are detailed in TM 10–1112.

(1) *Pipeline sizes and capacities.*

(*a*) *4-inch.* This line has a normal design capacity of 355 barrels (14,910 gallons) per hour.

(*b*) *6-inch.* This line has a normal design capacity of 785 barrels (32,970 gallons) per hour.

(*c*) *8-inch.* This line has a normal design capacity of 1,355 barrels (56,910 gallons) per hour.

Table 4–13. Tankers (Cargo Data)

Class (U.S. Maritime Commission designation)	D.w.t. (1,000 tons)	Draft [1] (fully loaded)	Cargo capacity (bbl.) [2]	Cargo tanks	Cargo pumps	Cargo pumps hourly capacity per pump (bbl.)	Hourly cap., all pumps (bbl.)	Size of hose connections (in.)	Discharge [3] pressure (p.s.i.)
AO–22 [4]	16.5	32′-0″	138,000	9	4	2,000	8,000	8	125
AO–143 [4]	22.2	35′-0″	187,100	9	4	4,285	17,000	8	125
T–1:	4			7				8	
M–A1		12′-11″	11,840		2	857	1,700		100
M–A2		13′-0″	12,460		2	857	1,700		100
M–BT–1		19′-4″	30,800		3	1,043	3,100		80
M–BT–2		19′-3″	31,300		3	1,043	3,100		80
T–2:	16.5			9				8 to 10	
SE–A1		30′-2″	138,335		3	2,857	8,500		125
SE–A2		30′-2″	138,335		3	2,857	8,500		125
SE–A3		30′-2″	138,335		3	2,857	8,500		125
T–3:	18.5	30′-0″	131,000	10	2	4,000	8,000	8 to 10	125
Super	25 to 37.5	32′-0″ to 35′-9″	200,000	10	3 or 4		20,000 to 28,000	10 to 12	125
Giant [5]	37.5 to 65	35′-9″ to 49′-3″	300,000 000	10+	4+		20,000 to 30,000	10 to 12	125
Mammoth [5]	65 to 106	42′-3″ to 49′-0″	520,000 to 864, 000	10+	4+		25,000 to 50,000	10 to 12	125

[1] There are minor variations in each class of vessels from the data shown above. The values indicated for "Draft" in the tabulation are maximum for each class.

[2] U.S. Navy tankers 95 percent loaded to provide for expansion. All others 98 percent loaded.

[3] Use 100 p.s.i. for planning purposes.

[4] U.S. Navy designation.

[5] Giant and mammoth tankers are used primarily for movement of crude oil.

(*d*) *12-inch.* This line has a normal design capacity of 7,150 barrels (300,000 gallons) per hour.

(2) *Pump units.*

(*a*) *Four-inch, four-stage pump unit.* The 4-inch, 4-stage pump unit consists of a gasoline-engine power unit and a 4-stage centrifugal pump. It is used with 4- and 6-inch pipelines. At 1,800 revolutions per minute, the unit will pump 785 barrels per hour against 463 feet of head of 0.725 specific gravity gasoline. The maximum working pressure to which the pump may be subjected is 750 pounds per square inch or 2,390 feet of head of 0.725 specific gravity gasoline (63.7° API).

(*b*) *Six-inch, two-stage pump unit.* The 6-inch, 2-stage pump unit consists of a gasoline-engine power unit and a 2-stage centrifugal pump which may be connected either in series or parallel. It is used with pipelines of 8-inch nominal diameter and larger, or in booster pump stations. The unit can pump 1,730 barrels per hour at 380 feet of head of 0.725 specific gravity gasoline when operated with stages in series. When operating with stages in parallel, the unit has a capacity ranging from 2,860 barrels per hour at 160 feet of head to 3,570 barrels per hour at 170 feet of head. The maximum working pressure to which the pump may be subjected is 700 pounds per square inch or 2,230 feet of head of 0.725 specific gravity gasoline (63.7° API).

(*c*) *Six-inch, single-stage, self-priming pump unit.* The 6-inch, single-stage, self-priming pump unit consists of a gasoline-engine power unit and a single-stage, self-priming centrifugal pump. The unit has two main uses: It serves as a *feeder pump* to supply the required suction pressure at the No. 1 pump station on the pipeline; and it serves as a *transfer pump* at tank farms and loading, unloading, and dispensing installations. It can pump 715 barrels per hour at 200 feet of head of 0.725 specific gravity gasoline. It provides a suction lift of approximately 30 feet at 50° F, and 3 feet at 135° F. The maximum working pressure to which the pump may be subjected is 207 pounds per square inch, or 660 feet of head of 0.725 specific gravity gasoline (63.7° API).

c. Roadway. Packaged petroleum products, such as drums, cans, and pails, are transported by standard military vehicles. Bulk petroleum products are transported over roadways in 5,000-gallon semitrailers and in 1200-gallon tank trucks. Table 4–14 outlines cleaning procedures required when the product carried in the tanker is changed.

Table 4–14. Conversion Chart for Tank Cars and Tank Trucks

Last product carried	Product to be loaded									
	Avgas MIL–G–5572	Mogas MIL–G–3056	Jet fuel MIL–T–5624 JP–4	Jet fuel MIL–T–5624 JP–5	Petrl solvent or paint thinner	Kerosene VV–K–211	Diesel fuels MIL–F–16884 VV–F–800	Burner fuel oil VV–F–815 Gr 1 & 2	Burner fuel oil VV–F–815 Gr 4, 5&6	Lubricating oils [1]
Avgas MIL–G–5572		[2]	[2]	[2]	[2]	[2]	[2]	[2]	[2]	[2]
Mogas MIL–G–3056 VV–G–76	3		3	3	3	3	3	3	3	3
Jet fuel MIL–T–5624 JP–4	3	2		3	3	3	3	3	3	3
Jet fuel MIL–T–5624 JP–5	3	2	2		3	2	2	2	2	3
Petrl solvent or paint thinner	3	2	3	3		3	3	3	3	3
Kerosene VV–K–211	3	2	2	2	3		2	2	2	3
Diesel fuels MIL–F–16884 VV–F–800	4	3	4	4	5	5		2	2	3

Table 4–14—Continued

Last product carried	Product to be loaded									
	Avgas MIL–G–5572	Mogas MIL–G–3056	Jet fuel MIL–T–5624 JP–4	Jet fuel MIL–T–5624 JP–5	Petrl solvent or paint thinner	Kerosene VV–K–211	Diesel fuels MIL–F–16884 VV–F–800	Burner fuel oil VV–F–815 Gr 1 & 2	Burner fuel oil VV–F–815 Gr 4, 5&6	Lubricating oils [1]
Burner fuel oil VV–F–815, Gr 1 & 2	5	3	5	5	5	5	2		2	3
Burner fuel oil VV–F–815, Gr 4, 5 & 6	5	5	5	5	5	5	5	2		5
Lubricating oils	[5]	[4]	[5]	[5]	[5]	[5]	[3]	[2]	[2]	

[1] Equipment carrying lubricating oil must be dry and free from loose rust, scale, and dirt.
[2] Drain tank and manifold and empty filter separator.
[3] Drain tank and manifold, empty filter separator, and flush with product to be loaded.
[4] Steam clean, dry, and change filter elements. If the equipment has a coated interior, do not steam clean; wash tank and change filter elements.
[5] Do not load.

d. Rail. Tank cars, when available, are used to move bulk petroleum. The cars are metal cylindrical tanks, varying in capacity from 6,000 to 13,000 gallons. The U.S. Army 40-ton tank car has a nominal capacity of 9,900 gallons. Boxcars are used to transport packaged petroleum products. The dimensions of an average U.S. railway boxcar are 40 ½ feet long, 9 feet high, and 8 ½ feet wide. With an average capacity of 20 to 50 short tons, this boxcar can transport 1,300 filled or 2,500 empty 5-gallon containers, or 135 filled or 235 empty 55-gallon drums. Temporary storage tanks may be mounted on flatcars and gondolas and used to transport bulk petroleum products. Use of collapsible tanks for this purpose, however, should be limited to emergency situations (table 4–15).

Table 4–15. Transporting Filled Temporary Storage Tanks by Rail and Motor [1]

Type of transport	600-gallon skid-mounted tank		3,000-gallon collapsible tank [2]	
	No. tanks	Total gal.	No. tanks	Total gal.
Motor:				
Truck:				
2 1/2-ton, 6 x 6	2	1,200	0	0
5-ton, 6 x 6	2	1,200	0	0
Semitrailer, stake and platform:				
5-ton, 2-wheel	1 [3]	750 [3]	0	0
10-ton, 2-wheel	3 [3]	2,250 [3]	1	3,000
Rail:				
Gondola, 40-ton, low side	6	4,500	1	3,000
Flatcar, 80-ton	7	5,250	2	6,000

[1] Based upon average cargo limits of typical military motor and rail carriers, and weight of tanks when filled with gasoline. Information pertains to on-or-off highway use, except that only one 600-gallon, skid-mounted tank can be carried off the highway.
[2] Collapsible tanks are used to transport petroleum products in emergencies only.
[3] When overloads are authorized, one filled tank, may be added to the load.

4–13. Handling and Testing Equipment

Details on petroleum handling and testing equipment are given in TM 10–1101.

a. Engine-Driven Pumps. The 50-g.p.m. gasoline dispensers and the 350-g.p.m. pumping assembly are used to package bulk petroleum products in the field for issue to using units. They can also be used to transfer bulk petroleum products from one storage tank into another.

(1) *50-g.p.m. dispenser.* The 50-g.p.m. dispenser consists of a single-cylinder, 4-cycle, air-cooled gasoline engine, a self-priming, nonrecirculatory centrifugal pump, suction and discharge hose, two 1 ½-inch dispensing nozzles, and a carrying case. One unit is issued as a component with the fuel-can-and-drum cleaning machine. A hose and fitting kit, consisting basically of two Y-fittings, four discharge hoses, and four 1-inch dispensing nozzles, is used when operating the 50-g.p.m. dispenser to fill 5-gallon cans.

(2) *350-g.p.m. pumping assembly.* Each

pumping assembly consists of a pump and engine assembly mounted on a two-wheel, pneumatic-tired trailer equipped with a telescoping tow bar for towing the pump assembly behind a ¼- or ¾-ton truck. Ground rods are supplied for added safety because of the insulating tires.

(*a*) *Pump.* The self-priming centrifugal pump is rated at 350-g.p.m. at about 80 p.s.i. or 275-feet of head of 0.725 specific gravity gasoline (63.7 API). It has double inlets and outlets. All ports are controlled by gate valves. An integral Y-strainer on the suction manifold provides gross filtration. An air eliminator vent with hose aids priming and prevents spraying fuel on the hot engine.

(*b*) *Engine.* The pump is driven by a 4-cylinder, 4-cycle, air cooled, hand cranked gasoline engine, model MVG4D. An instrument panel shows engine vacuum, oil pressure, revolutions per minute, hours of operation, and suction and discharge pressures. A centrifugal flyball governor controls engine speed by varying throttle openings to suit pump loads. The engine is designed to operate on 80 octane fuel and to deliver 34.5 horsepower at 2,200 r.p.m.

b. Vehicle-Mounted Dispensers.

(1) The 2 ½-ton gasoline tank truck (6 x 6, 1,200-gallon capacity) truck is equipped with a rotary, positive displacement pump. The pumps on the M49 and M49C tank trucks have a capacity of 80 gallons per minute; those on the M217 and M217C have a capacity of 60 gallons per minute. The pump is operated from power takeoff through front, intermediate, and rear drive shafts mounted under the tank body. A strainer body with strainer is incorporated in the pump for filtering fuel loaded or discharged through the pump. Discharge is through the delivery gate valve located under the pump compartment.

(2) The 12-ton gasoline-tank, semitrailer (4-wheel, M131, 5,000-gallon capacity is equipped with a self-priming, centrifugal pump with a 7 ⅞-inch impeller. The pump has a capacity of 250 gallons per minute. The pump is mounted on the right end of the platform in the rear cabinet. It is driven by the auxiliary engine through a flexible coupling and a bearing-mounted shaft. This shaft is inclosed in a shaft housing. The pump is connected by a cutoff gate valve and piping to the rear manifold. The pump discharge outlet is located at the top of the pump.

c. Hand-Operated Pumps. The three hand-operated petroleum products pumps are used primarily at the organizational level to dispense petroleum products from 55-gallon drums into 5-gallon cans or into vehicle fuel tanks, and to disperse lubricating oil into smaller containers. Each pump is equipped with dispensing hose and nozzle or discharge outlet.

d. Cleaning Machine. The fuel-can-and-drum cleaning machine consists of two sedimentation tanks equipped with 5-gallon-can-cleaning equipment, two 55-gallon-drums-cleaning assemblies, suction hose, pressure hose, and 50-g.p.m. dispenser. The machine is capable of cleaning about 4,000 5-gallon cans or 800 55-gallon drums in an 8-hour operating day.

e. Testing Equipment. Petroleum testing equipment is used by specially trained personnel to maintain quality control of petroleum products used by the Army.

(1) *Testing kit.* The portable petroleum testing kit is used to perform a limited number of quality surveillance tests in the field. It is designed to be carried in any organizational vehicle, and for short distances by two men. In addition to the test apparatus, the testing kit contains sampling and gaging equipment.

(2) *Mobile laboratory.* The mobile petroleum laboratory is housed in a van-type, 8 ½-ton, two-wheeled semitrailer. It contains the testing equipment and apparatus necessary for making all prescribed quality surveillance tests on petroleum products. Some of the units are equipped with a specially designed knock engine for determining octane ratings of gasoline-type fuels. The utility equipment includes a space heater, air compressor, vacuum pump, and water pump. An air conditioning unit may be provided for use in tropical and desert climates. A 4- to 5-ton tractor truck is used to pull the trailer on land. For air transport aboard a C–119 cargo aircraft, the front and rear dollies must be removed. The laboratory is designed to operate with an auxiliary, trailer-mounted, 30-kilovolt ampere, 125- to 250-volt, alternating-current, 3-phase, 60-cycle, M7A1 generator unit. The generator weighs 4,500 pounds, and it is 130 inches long, 62 inches wide, and 84 inches high.

f. Supply Point Fuel System. The supply point fuel system is made up of a bulk fuel manifold; two 350-g.p.m. pumping assemblies; two 350-g.p.m. filter separators; six 10,000-gallon collapsible tanks; six liquid transfer loading standards for loading tank trucks and semitrailers; a hose

header that provides two filling points for 500-gallon collapsible drums; and six refueling points for filling vehicle fuel tanks, 5-gallon cans, and 55-gallon drums. Components of the fuel system are connected by approximately 1,400 feet of hose with numerous valves and fittings (see table 3–3). A complete listing of assemblies is given in TM 10–4930–203–13. The product from highway transporters, railway tank cars, pipeline, or a combination of these, enters the system through the fuel transfer manifold; it may move under positive pressure from transporters, pipeline, or hoseline, but usually the product moves under suction from one of the pumping assemblies used as a receiving pump. The receiving pump also distributes the product to the collapsible tanks through one side of the hoseline manifold. The pumping assembly is used as a delivery pump to draw fuel from the tanks through the other side of the hoseline manifold and discharge it through the filter separators into a line to the truck loading standards and into the hose header of the can and drum filling and refueling points. Fuel can also be drawn from the source of supply for direct discharge through the loading standards or those of hose header nozzles, bypassing storage entirely.

CHAPTER 5

STORAGE

5–1. Warehousing

TM 743–200 prescribes policies, procedures, and methods for the receipt, storage, issue, and care of supplies.

a. Organizing Warehouse Space.

(1) The shipping area and the receiving area should be located near the storekeeper's office. Both areas should be as small as the efficient handling of average workloads will permit. Unusually large workloads may be handled using vacant storage areas on a temporary basis.

(2) Factors which influence the storage location of items in a warehouse are as follows:

(*a*) *Popularity.* The rate of turnover is the first factor to be considered in determining the storage location of material. Stocks which move daily are located nearest the shipping area. Classes of items with the slowest movement are located farthest from the working areas. This policy creates activity areas in the warehouse—areas for fast, medium, and slow moving stock.

(*b*) *Similarity.* Similar items are generally grouped together. Items are stored by class as far as possible, and within classes items may be stored in categorical groups to facilitate storage and issue.

(*c*) *Size.* The cubic size [illegible] influences not only how much space is alloted to its class but also the location of the class within the storage area. Supplies are classified as large lots, medium lots, small lots, and retail bin stock depending upon the amount of storage space they require. Cubic size, rather than numerical sequence, is the basis for positioning classes of supply. Whenever practical, supplies requiring large capacity materials handling equipment are grouped in a separate location from those requiring smaller capacity materials handling equipment. Moreover, large, heavy items which are difficult to move are stored as near as possible to the shipping area. A 5-ton dynamo, for example, would be stored close to the working area to keep to a minimum the distance it must be moved to complete the cycle of receipt, storage, and issue. Items usually are stored by lot size to insure the efficient use of space. However, in the case of very heavy items, weight may be the determining factor. Since high-density items can be stacked to only a limited height, they should be stored in areas with low clearances unless overhead cranes are to be used.

(*d*) *Characteristics of material.* Certain materials require special handling. Hard fuels, for example, require special storage areas and handling equipment; and liquids handled in bulk require pumps, pipelines, and special storage tanks. Solid bulk items require special handling, materials which constitute a fire hazard must be stored in specially protected areas, and sensitive items must be stored in secure areas and rigidly controlled. For perishable items, the conditions most favorable to preservation must be made available.

b. Determining Maximum Stacking Height. The height of stacks in warehouses is limited by the clearance required below sprinklers and the floorload capacity. To determine the floorload capacity, assume that certain supplies (40 tons) consist of 50-pound boxes and that each box occupies 3.5 square feet of floorspace, 250 pounds per square foot being the allowable floorload. Then the load per square foot is approximately 14.3 pounds (50 ÷ 3.5). The approximate number of boxes to be stored in one column would be 17 (250 ÷ 14.3). This formula can be used only for commodities having density of 45 pounds or more per cubic foot. In the field, where box pallets are not available, the height of the stack may be limited by the weight-bearing capabilities of the containers used in the stack.

c. Determining Safe Floorloads.

(1) Safe warehouse floorloads may be determined by referring to the building plans on which the floor capacities in pounds per square foot usually are designated. In all cases where building plans are not avaiable or where the plans do not indicate safe floorloads or where the accuracy of the stated floorloads is doubtful, the

installation engineer must be brought in to establish floorload capacity.

(2) Loading on floors should be distributed so that the weight bearing on any single square foot does not exceed the load capacity of that square foot. For instance, a 16- by 16-foot warehouse bay, with a safe load capacity of 250 pounds per square foot, may be evenly loaded to a total of 64,000 pounds (16 x 16 x 250).

(3) In certain instances, overloading portions of a floor area to compensate for adjacent vacant or underloaded portions is permissible and is recommended whenever space is limited. The following may be used as a guide to safe overloading:

(*a*) In wood frame construction, where the normal storage space of a floor area is reduced by narrow aisles, the remaining storage space may be overloaded by an amount equal to the capacity of the aisles provided that the aisle runs at right angle to the floor support and that the excess load is uniformly distributed over the remaining portion of the bay. For example, a 16- by 16-foot bay which has a safe floor capacity of 250 pounds per square foot can be loaded to a total of 64,000 pounds. A 2-foot wide fire aisle running the full length of the bay would reduce the storage space by 32 square feet, leaving a remaining area of 224 square feet for storage. Provided that this aisle runs at right angle to the floor supports, the remaining area could safely be loaded at the uniform rate (64,000 divided by 224), or approximately 285 pounds per square foot. When the aisle runs parallel to the floor supports or is used for the transportation of supplies or the movement of mechanical equipment, compensation will not be made and the remaining space in the bay will not be loaded beyond the rated space capacity.

(*b*) In wood frame construction, when a bay is to be loaded unequally, it usually can be loaded to its full capacity provided that no part is overloaded in excess of 20 percent and that the dividing line of the unequal loading is at right angle to the floor support; that is, the floor joists run out from the underloaded portion and through the overloaded portion. For example, a 16- by 16-foot bay with a total safe load capacity of 64,000 pounds may be loaded on the side of a line at right angle to the floor joists with 38,400 pounds of supplies and on the other side with 25,600 pounds. If the dividing line of unequal loading runs parallel to the floor support, the maximum load per square foot may not exceed the rated safe load.

(*c*) In reinforced concrete flat slab construction, where a portion of the floor is left unloaded in order to provide aisle space or for other reasons, the remaining portion of the floor can sustain an overload; however, the overload should not exceed ⅓ of the allowable load on any appreciable portion of the floor, and the allowable load for the total floor must not be exceeded.

(4) The maximum capacity of forklift trucks which may be safely operated on a warehouse floor of a given live load can be determined as follows:

(*a*) Load forklift trucks whose capacity does not exceed 4,000 pounds can in general be operated safely on floors having a safe live load capacity of 250 pounds per square foot. The floorspace adjacent to aisles through which the trucks travel will not be loaded beyond the rated safety load and no other concentrated loads will be permitted in aisles when the trucks are operating.

(*b*) Forklift trucks with capacities at 4,000 to 6,000 pounds are divided into two classes. Trucks having a width of 3 feet or greater and a wheelbase of 5 feet or greater may operate safely in reinforced concrete buildings or steel frame buildings with reinforced concrete floor slabs, on floors designed for 350 pounds per square foot.

(*c*) An allowance for impact of 15 percent of the total truckload should be added in all computations for determining safe loads on floors.

d. Computing Space Requirements by Number of Troops Supported.

(1) For guidance in computing cold storage space requirements see paragraph 2–6*b*.

(2) In the theater of operations, the average height of stacks is 8 feet for supplies in covered storage and 6 feet for supplies in open storage. For the continental United States these averages are increased by 25 percent. The information given in table 5–1 is based on 8-foot stacks. The figures are used to compute gross space requirements including aisles and fire aisles. To determine the amount of covered and refrigerated storage space required to maintain a 10-day level of supply of field ration A for 15,000 men, refer to *a* in table 5–1, from which the figure .0820 is obtained. Multiply .0820 by 15,000 and the result is 1,230 square feet for 1 day. For a 10-day level of supply, 1,230 square feet multiplied by 10 equals 12,300 square feet. The same procedure is

applied to determine the amount of open space required. In determining the amount of open storage space, a dispersion factor should be applied to the open storage space computed from table 5–1. A dispersion factor of 40 square feet per 1 square foot storage space usually is required for protection against aircraft. For example, assume that three stacks are being set up in open storage and that the number of square feet of storage space in the stacks is as follows: 200, 250, and 300, a total of 750 square feet. To disperse the stacks properly, 40 square feet of space is allowed for each foot of storage space. Multiplying, 750 square feet by 40 square feet yields 30,000 square feet of area required for open storage.

(3) In the theater of operations, the average height of stacks is 8 feet for supplies in covered storage and 6 feet for supplies in open storage. For the continental United States these averages are increased by 25 percent. The information given in table 5–3 is based on 8-foot stacks. The figures are used to compute gross space requirements including aisles and fire aisles. To determine the amount of covered storage space required to maintain a 10-day level of supply of field ration A for 15,000 men, refer to *a* in table 5–4 from which the figure .0556 is obtained. Multiply .0556 by 15,000 and the result is 834 square feet for 1 day. For a 10-day level of supply, 834 square feet multiplied by 10 equals 8,340 square feet. The same procedure is applied to determine the amount of open space required. In determining the amount of open storage space, a dispersion factor should be applied to the open storage space computed from table 5–3. A dispersion factor of 40 square feet per 1 square foot storage space usually is required for protection against aircraft. For example, assume that three stacks are being set up in open storage and that the number of square feet of storage space in the stacks is as follows: 200, 250, and 300, a total of 750 square feet. To disperse the stacks properly, 40 square feet of space is allowed for each foot of storage space. Multiplying, 750 square feet by 40 square feet yields 30,000 square feet of area required for open storage. Local conditions, terrain features, and natural camouflage may alter the dispersion factor considerably. In many instances, a greater or smaller dispersion factor may be applied, depending upon the conditions prevailing at a given site. SB 38–8–1 lists specific items designated for controlled humidity storage and items which may be stored in open storage.

*Table 5–1. Storage Space Requirements (sq. ft.)**

Type of supply	Covered and refrigerated	Open	Total
a. Per man per day.			
Field ration A	.0820	.0415	.1235
Standard B ration for Armed Forces	.0329	.0493	.0822
Clothing and equipage	.0146	.0019	.0165
Regulated items	.0014	.0007	.0021
Total	.1309	.0934	.2243
b. Per man per 30 days.			
Field ration A	2.460	1.245	3.705
Standard B ration for Armed Forces	.987	1.479	2.466
Clothing and equipage	.438	.057	.495
Regulated items	.042	.021	.063
Total	3.927	2.802	6.729
c. Per 20,000 men per day.			
Field ration A	1,640	830	2,470
Standard B ration for Armed Forces	658	986	1,644
Clothing and equipage	292	38	330
Regulated items	28	14	42
Total	2,618	1,868	4,486
d. Per 20,000 men per 30 days.			
Field ration A	49,200	24,900	74,100
Standard B ration for Armed Forces	19,740	29,580	49,320
Clothing and equipage	8,760	1,140	9,900
Regulated items	840	420	1,260
Total	78,540	56,040	134,580

*Temperate zone.

5–2. Storage Data for Decontaminants

Storage data for several decontaminants for chemical and bioliogical agents are shown in table 5–2. See applicable TM's for decontaminants not listed.

Table 5–2. Storage Data for Decontaminants

Decontaminant	Storage characteristics	Surveillance requirements
Acetylene tetrachloride	Stable, attacks metals in the presence of moisture.	Mean shade temperature in hottest months: Frequency of inspections: Over 90° F ..... Every 6 months. 70° to 90° F ..... Every 9 months. Under 70° F ..... Every 12 months.
STB (supertropical bleach)	Stable for 6 weeks at temperatures up to 158° F. Stable for 10 years in airtight containers.	Routine surveillance to detect defects in drums.
RH 195	Decomposes gradually; should be stored in cool, dry place.	Routine surveillance to detect defects in drums.
Sodium Hydroxide	Stable in tightly sealed drums; absorbs moisture and carbon dioxide.	Routine surveillance to detect defects in drums.
DS2	Serviceable after 4 years storage in bulk containers or after 6 months storage in spray containers. Can be stored in all climatic conditions for at least 9 weeks.	Inspect after 9 weeks when stored in desert or tropic areas.
BPL (Beta-propiolactone)	Polymerizes at ambient temperatures (70° F) in about 3 months, producing an undesirable residue. Stable for long periods when refrigerated (40° F).	Inspect as follows: Monthly when stored at temperatures above 70° F; every 3 months when stored at 70° F; every 6 months when stored at 40° F. or lower.

5–3. Paulins

Paulins or tarpaulins are canvas coverings used to protect materials in open storage. Paulins used in supply and service units and in depots are commonly provided in two sizes, 12 x 17 and 20 x 40. When tarpaulins are used to cover materials in open storage, care must be taken to provide adequate ventilation to permit the evaporation of condensed moisture. For this purpose, locally constructed A-frames may be placed on top of stacks to increase air circulation and improve the drainage of water. To increase air circulation in and around the stored material, an opening should be provided in the upper area of the stack covering. It must be arranged, however, so that rain and snow cannot reach the stack. A space of 12 to 15 inches should be left between the bottom of the paulin and the ground, where possible. When used to cover machinery or other uncrated materials, paulins should extend *only* to the top of the dunnage on which the material is stored. Two crossed paulins are used on each stack to insure adequate coverage of the sides of the stack and to facilitate tiedown.

5–4. Materials Handling Equipment

Battery powered materials handling equipment must be recharged after 8 hours of intermittent operation or after 6 hours of continuous operation. Only direct current can be used for charging. If alternating current is available, it must be converted to direct current by means of approved rectifiers. The standard storage battery charger (Federal Specification W–C–260) is the conversion type that can be used with either 18 cell lead-acid or 30 cell nickel-iron-alkaline storage batteries. A 160-ampere battery charger (FSN 6130–500–0069) is used to charge storage batteries of materials handling equipment with 2,000 to 4,000 pounds lift capacity. Storage batteries used in materials handling equipment of 6,000 pounds lift capacity require a 175-ampere battery charger (FSN 6130–823–3090). Commercial chargers, procured through local purchase, are also widely used. TM 10–1690A gives maintenance procedures for storage batteries, including charging principles, methods, and equipment.

a. Forklift Trucks. A forklift truck is a materials handling vehicle designed to load, unload, transport, and stack unit loads of supplies either indoors or outdoors. Most forklift trucks are front-wheel drive, rear-wheel steer; however, rough terrain forklifts may be four-wheel drive, four-wheel steer. Forklift trucks equipped with

cushion (solid rubber) tires generally are used for work inside a warehouse, whereas forklift trucks equipped with pneumatic tires, including all rough-terrain forklifts, are used for outdoor storage. The load is carried on the front of the truck on a two-tined fork and lift carriage assembly that is raised and lowered by a hydraulic lifting mechanism. The forks and the upright assembly on which they are mounted can be tilted forward or backward from the vertical to assist in picking up loads and balancing them in transit.

(1) *Capacity.* The capacity of forklift trucks is rated on the weight of the load they can carry and the height to which they can lift the load. Lifting heights range from 100 to 210 inches. Forklift trucks used for interior warehouse duty have lifting capacities ranging from 2,000 to 10,000 pounds and those used for outdoor storage have lifting capacities of 4,000 to 15,000 pounds.

(2) *Power.* A forklift truck may be powered by a gasoline engine, a diesel engine, or a battery-driven electric motor. A truck equipped with a gasoline or diesel engine may be used for either indoor or outdoor storage, whereas a truck equipped with an electric motor is designed exclusively for indoor operation. In a gasoline-engine-driven froklift truck, power developed by the engine may be transmitted to the drive axle and wheels by means of a conventional clutch and transmission, a torque converter transmission, an electromagnetic drive unit, or a hydraulic drive system. On models identified by the letters RS, the engines have been modified by the use of radio-suppression devices.

(3) *Hydraulic mechanism.* The fork-and-lift-carriage assembly on both gasoline- and battery-powered forklift trucks is lifted by a hydraulic mechanism. On trucks designed primarily for indoor warehousing operations, the hydraulic mechanism usually allows a free lift of several feet. Free lift is the distance the forks may be moved upward before the inner slides extend beyond the top of the mast and increase the overall height of the truck. This design permits more effective use of available storage space and allows loads to be tiered in closed-top trucks and boxcars as well as under balconies and other low-ceilinged areas. Hydraulic mechanisms are also used to provide trucks designed for outdoor operation with power sterring and power brakes.

(4) *Application.* The primary advantage of the forklift truck is its extreme flexibility. The most successful and efficient use of the truck is in handling palletized unit loads of 2,000 pounds or more. It is often used, however, to move items that cannot be palletized because of their size or shape. The forklift truck enables maximum use of cubic space, simplifies inventories and inspections, and permits rapid relocation of supplies. If the distance a load is to be carried exceeds 400 feet, but is less than one mile, the tractor-trailer train should be used for transporting the load, and the forklift truck used only for placing and stacking. For distances of a mile or more, cargo vehicles should be used for transport and forklift trucks used for loading and unloading.

(5) Table 5–3 includes the most common forklifts found in supply and service unit TOE and gives examples of forklifts of each lift capacity. The load center for all forklifters listed is 24 inches.

Table 5–3. Forklift Data

a. Gasoline-Powered Forklifts.

Federal stock no.	Length (in.)	Width (in.)	Height (in.)	Weight (lbs.)	Lift height capacity	Free lift	Capacity (lbs.)	Type of tires S—solid rubber P—pneumatic	Model No.
3930–271–1833	63¾	32	83	4,304	130	12	2,000	S	FB 20–24(131)
3930–271–1449	70	32½	83	4,134	130	66	2,000	S	KC 51T20H–RS53(156)
3930–271–1836	115	79	107	7,035	144	10	3,500	P	Planeloader 52RS(141)
3930–290–1070	115	79	107	7,000	144	10	3,500	P	Planeloader 53RS(149)
3930–214–1024	113¼	68	92	7,170	144	17	3,500	P	KGP51AT–35RS(157)
3930–724–3568	97½	60½	90½	8,500	144	57	4,000	P	MY4ORS(170)
3930–724–3570	94½	60½	90½	8,500	144	57	4,000	P	MY40(170)
3930–678–9913	92¾	63½	91	8,420	144	57	4,000	P	G54P–4024RS(166)
3930–554–2318	89¾	44	83	10,500	127	57	6,000	S	540 RS(160)VI
3930–266–8963	113	68	115	9,705	168	6¾	6,000	P	Yardlift 60 RS(115)
3930–724–3569	110¼	70	110½	9,720	168	18½	6,000	P	MY 60RS(171)
3930–679–4457	110¼	53	68	13,200	100	43	10,000	S	GLF 100–(163)

Table 5–3—Continued

Federal stock no.	Length (in.)	Width (in.)	Height (in.)	Weight (lbs.)	Lift height capacity	Free lift	Capacity (lbs.)	Type of tires S—solid rubber P—pneumatic	Model No.
3930–351–9946	136	77	150	14,890	210	5	10,000	P	Yardlift 100RS(146)
3930–038–4412	152	96	150	22,000	210	2½	15,000	P	Yardlift 150–53RS(151)
3930–897–4632	145	81	152	19,050	210	2	15,000	P	H 150C(178)

b. Rough-Terrain Forklifts.

Federal stock no.	Length (in.)	Width (in.)	Height (mast collapsed) (in.)	Weight (lbs.)	Lift height capacity	Power	Capacity (lbs.)	Type of tires S—solid rubber P—pneumatic	Model No.
3930–900–8565	204 160	84	96	8,000	78	Gasoline	4,000 RT	P	
3960–679–4458	229¼	86	94	16,800	144	Gasoline	6,000	P	Baker RPF060M02(164)
3930–903–0900	228 183LF	102	W/G 124	23,800	144	Diesel	6,000 RT	P	Anthony MLT6
3930–799–9956	244	103	100	30,000	144	Gasoline	10,000	P	MR 100 (173)
3930–903–0899	252 203 LF	106	W/G 133	34,500	142	Diesel	10,000 RT	P	Millicin Pettybone RTLN RTL–10

c. Electric-Powered Forklifts.

Federal stock no.	Length (in.)	Width (in.)	Height (mast collapsed) (in.)	Weight (lbs.)	Lift height capacity	Free lift	Capacity (lbs.)	Type of tires S—solid rubber P—pneumatic	Model No.
3930–273–8219	69½	34¼	83	3,808	130	5	2,000	S	FSHEYG20/48
3930–271–1902	64⅞	34½	83	3,900	130	64	2,000	S	Clipper ECE2024SE
3930–474–0546	37¼	13	31¼	5,130	144	44	3,000	S	RAT 30 Type E
3930–272–9972	81	41½	91	6,950	144	7½	4,000	S	FTHEG 40/48
3930–266–8965	77¼	41	91	6,613	144	70	4,000	S	Carloader SE ELL 4024
3930–038–3162	88	47½	83	8,000	127	61	6,000	S	FT 60/48
3930–266–8967	92¼	43	113	8,550	168	6	6,000	S	EUT 6024 SE 50

b. Warehouse Tractors. A warehouse tractor is a front-wheel steer, rear-wheel drive, self-propelled vehicle. Warehouse tractors are available in two distinct types: the threepoint suspension model, employing a single front-wheel suspension point and two rear-wheel suspension points, and the four-point suspension model, with 2 front-wheel and 2 rear-wheel suspension points. Either type may be equipped with solid rubber or pneumatic tires.

(1) *Power.* Warehouse tractors may be powered by gasoline engines or battery-driven electric motors. Those powered by gasoline engines may be equipped with solid rubber or pneumatic tires for indoor and outdoor operation. Those powered by battery-driven electric motors usually are equipped with solid rubber tires for indoor operation exclusively. Gasoline-powered models vary in capacity from 2,600 to 7,500-pound drawbar pull; electric-powered models vary in capacity from 2,000- to 4,000-pound drawbar pull. It should be noted that drawbar pull is the force the tractor can exert in pushing or pulling a load and that the actual weight of the load which can be towed usually far exceeds the drawbar pull rating.

(2) *Use.* The warehouse tractor has sufficient power to pull loads of a practical size, yet it is small and maneuverable enough to move in the limited space of warehouses and storage areas. This tractor may be used for direct drag-towing of materials along the floor on skids, for pulling one or two trailers, or for towing a train of 6 to 25 trailers. Where the volume of materials and the regularity of schedules warrant its use, the trailer train is the most practical and economical method of moving materials with a warehouse tractor. In this system the tractor acts as a locomotive for a trackless train of trailers. The train moves through the storage area, spotting trailers at intervals where they are to be used and picking up trailers that are to be moved.

(3) *Types, capabilities, and capacities.* Types, capabilities, and capacities of warehouse tractors are given in table 5–4.

Table 5–4. Wheeled Warehouse Tractors

Item	Federal stock no.	Lgth. (in.)	Wdth. (in.)	Hgt. (in.)	Shipping wt. (lb.)	Number of wheels	Drawbar pull	Tires S—solid rubber P—pneumatic	Model no.
Electric-powered	3930–038–3164	89½	41⅞	62	2,740	3	2,000	S	TSSA
warehouse	3930–265–6854	79	42	48½	3,500	4	3,500	S	MTT–W
tractor	3930–265–6853	86	42	59	3,545	4	4,000	S	MW–4–SE
Gasoline-powered	3930–271–1842	110	65½	56	4,700	4	4,000	P	Clarktor-40–RS
warehouse	3930–038–3166	116	66	62	5,800	4	4,000	P	J–217–E
tractor	3930–214–1027	119	69	56½	9,940	4	7,500	P	Clarktor-75

c. Warehouse Crane Trucks.

(1) *Description.* A warehouse crane truck is a power-driven, self-propelled unit consisting of a boom mounted on a mobile wheeled chassis. The boom and hoisting unit are so mounted that they may be swung without moving the chassis. Power is supplied by a gasoline engine or by electric motors. Engine driven units, equipped with pneumatic tires for outdoor operation, normally have a capacity of 10,000 pounds. Battery driven electric motor units, equipped with solid-rubber tires for indoor operation, normally have a capacity of 6,000 pounds.

(2) *Use.* The warehouse crane is used to lift, swing, and lower loads that cannot be handled by other types of materials-handling equipment. If overhead clearance is sufficient, the crane may be used to transport loads for short distances, not in excess of 400 feet.

d. Straddle Trucks.

(1) *Description.* The straddle truck is a gasoline-engine-driven, materials-handling vehicle with a high, inverted framework that enables it to pass over and straddle the load to be picked up and transported. The motor and the operator's compartment are located at the top of the vehicle. The four wheels, equipped with pneumatic tires, are located at the extreme corners of the truck and bear the frame on four vertical shafts, or masts. Because all four wheels can be steered, the straddle truck is highly maneuverable. It is capable of speeds up to 35 miles per hour and may be used on highways as well as in storage areas. The truck has a capacity of 30,000 pounds.

(2) *Use.* The straddle truck was originally designed to handle lumber, and while this remains a principal use, the truck may be used to carry such items as girders, rods, and pipes. It may also be used for carrying containers of bulk materials, awkward-shaped packages, and heavy materials which other industrial trucks would have difficulty moving.

e. Sideloading Trucks. The sideload truck is a rear-wheel drive, front-wheel steer, lift-transport vehicle with a capacity of 10,000 pounds or more. Except for a narrow driver's cab at the extreme left front, the top of the truck is a flat load platform divided by the lift mechanism. Mechanically, the lift assembly is like that of a forklift truck, except that the sideloader's forks move out from a retracted position within the center of the truck body. The forks move up and down and sideways so that they can place palletized loads on either the front or rear platforms of the truck.

f. Electric Tiering Truck. The electric tiering truck is designed to perform lifting operations similar to those of the forklift truck. It is designed with forks that rest between two outriggers, or straddle arms, which support the load so that no counterweight is required. The overall weight of the tiering truck usually is less than the weight of a forklift truck of equal capacity. Electric tiering trucks are available with a lifting height of 144 inches and a capacity of 3,000 pounds.

g. Pallet Handlift Truck. The pallet handlift truck is available in two distinct designs, the hand-operated, hand-propelled model; and the electric-powered, hand-operated model. The truck is equipped with two load-carrying forks that can be raised about 4 inches to carry palletized loads. It is used to move pallet loads that do not have to be tiered, and it is used when short hauls are required. The pallet handlift truck may be used for the movement of pallet loads in boxcars or into trucks, as well as for in-process movements during shipping and receiving operations. It works well in conjunction with forklift trucks and can be operated where a forklift cannot because of space limitations.

h. Fixed Platform Truck.

(1) *Description.* The platform truck is a nonelevating electric- or gasoline-powered vehicle.

This standard gasoline-powered model, equipped with pneumatic tires, has a load capacity of 4,000 pounds. The electric-powered model, usually equiped with solid-rubber tires, has a load capacity of 2,000 pounds.

(2) *Use.* The fixed platform truck is used as a load carrier, often to supplement a forklift truck. When equipped with spare parts and tools or with gasoline and oil dispensing facilities, the fixed platform truck may be used as a portable servicing unit.

i. Powered Conveyors.

(1) *Description.* A power-belt conveyor is a continuous motor-driven belt supported in a frame and designed to move materials horizontally or up an incline. In the frame, the belt is supported either by idling rollers or steel plates spaced between the driving rollers. The conveyor consists of a driving section with the power unit, usually an electric motor, built into the frame and as many driven sections as may be required. The power-belt conveyor is a portable unit, the frame being supported by casters or wheels. The belt may move at a speed of 200 feet per minute, but the most common speed for practical package handling is approximately 100 feet per minute. This type of conveyor is capable of moving packages up an incline of about 25 percent. If materials are to be moved up a steeper incline, supporting cleats must be added to the belt.

(2) *Use.* Power-belt conveyors may be used to load and unload trucks and freight cars, to move packages from one level to another, and to help stack and pile supplies in warehouses. They may be inserted as sections in gravity-type conveyors to act as pushers. They can handle cartons and boxes as well as bags. When both the upper and lower sections of the belt are used, the same conveyor can move materials in opposite directions simultaneously.

j. Gravity Conveyors. Gravity roller conveyors are available in 10-foot sections and in 45° and 90° curved sections. There are accordion-type collapsible conveyors, and there are hinged sections that fold back to allow traffic to move through or across the path of the conveyor. Nonpowered conveyors consist of either rollers or wheels which turn freely within a frame. Materials are moved along gravity conveyors in several different ways. If the conveyor line is level, materials are pushed along by hand. Gravity conveyors have adjustable supports, and these can be set to raise one end of the conveyor so that gravity will provide the motive power. If the conveyor line is made up of several sections, one powered section may be inserted to act as a pusher.

k. Warehouse Trailers.

(1) *Description.* A warehouse trailer is a load-carrying platform mounted on coasters or wheels. Standard trailers are available in a wide variety of sizes and capacities and may be equipped with solid-rubber or pneumatic tires. On the caster-steering type, the rear wheels, which carry about two-thirds of the load, are fixed. The caster wheel at the front are used to steer the trailer. The caster-steering type trailer is produced in 4,000- and 6,000-pound capacities. The five-wheel-steering type has rear wheels mounted on a rigid axle and front wheels mounted on a center-pivoted steering axle with a drawbar attachment. This type of trailer is available in capacities of 6,000 and 20,000 pounds.

(2) *Use.* Because warehouse trailers are not self-propelled, they must be used with some other form of materials-handling equipment. Usually warehouse trailers are used with tractors to form the tractor-trailer system of warehouse work. When loads cannot be permanently palletized or easily moved with forklift trucks, the tractor-trailer combination is used.

l. Handtrucks. Handtrucks are of various types, and they are designed to move small amounts of supplies for short distances. They are also used in operations where powered equipment cannot be used because of space limitations.

CHAPTER 6

PACKAGING AND PACKING

6–1. Processing

a. Cleaning. Articles subject to corrosion and deterioration must be cleaned before they are packaged. Cleaning must be thorough for preservatives to be effective. All fingerprints and perspiration should be removed from critical surfaces. Disassembly, however, should be held to a minimum, and care must be taken that the item is not damaged by the cleaning process. Items must pass prescribed cleanliness tests to insure that they have been adequately cleaned. The code numbers listed in (1) through (13) below are used to identify currently recognized classifications of cleaning. The former classifications have been redefined and some code numbers eliminated.

(1) *C–1. Any applicable process.* This classification is not a process, but rather a general heading encompassing any process or combination of processes which will effectively and safely clean the item. This code may include processes other than those listed here.

(2) *C–3. Petroleum solvent cleaning.* The item is cleaned in petroleum solvent and drained. Unless pressure spray is used for this first cleaning, the item is given a second cleaning in clean petroleum solvent. Complete immersion and agitation or scrubbing, scrubbing with a clean brush, or wiping with a cloth soaked in solvent are usual methods for the first cleaning. When possible, complete immersion is used for the second cleaning.

(3) *C–5. Petroleum solvent cleaning followed by fingerprint remover.* This is simply process C–3, (2 above), followed by C–8, (5 below).

(4) *C–7. Vapor degreasing.* The item is subjected to vapors from a degreasing fluid or solvent (trichloroethylene or perchloroethylene) until solvent condensation stops. This process is used for items of simple construction which are contaminated by oil, grease, or some other soluble substance. Vapor degreasing cannot be used on items which are sensitive to heat.

(5) *C–8. Perspiration and fingerprint removal.* Items are immersed and agitated in fingerprint remover for at least 2 minutes. Critical surface of large equipment which cannot be immersed are wiped with a cloth saturated with fingerprint remover. When a petroleum base fingerprint remover is used, the item must be rinsed in clean petroleum solvent.

(6) *C–9. Alkaline cleaning.* Items are immersed or soaked in alkaline cleaner or subjected to a pressurized spray, and rinsed in clean water above 180° F.

(7) *C–11. Electrocleaning.* The item is immersed in a solution and made an element of an electrochemical cell. The electrocleaning process is followed by a rinse in clean water above 180° F.

(8) *C–12. Emulsion cleaning.* Items are subjected to a pressure spray of emulsion cleaner or immersed in a room-temperature solution of solvent emulsion. A rinse of clean water above 180° F follows.

(9) *C–14. Steam cleaning.* Items are subjected to a stream of pure steam or steam with cleaning compound. Steam with cleaning compound must be followed by steam alone.

(10) *C–15. Dry abrasive blast.* The item is subjected to a high-velocity stream of abrasive.

(11) *C–16. Wet abrasive blast(honing process).* The item is subjected to a high-velocity stream of atomized water containing fine abrasive particles and corrosion inhibitor.

(12) *C–17. Soft grit blast.* The item is subjected to a high-velocity stream of water containing a relatively soft abrasive. A corrosion inhibitor may be included if required.

(13) *C–18. Vapor-degreasing followed by fingerprint removal.* This is a combination of process C–7, (4 above), and process C–8, (5 above).

b. Removing Rust. Rust can be removed with abrasive cloth, crocus cloth, or corrosion-removing compound (metal cleaner, conditioner, and rust remover), as applicable. All surfaces to which the rust remover has been applied must be

thoroughly rinsed with a solvent to remove all of the cleaning agent. This is important because rust remover contain chemicals which can harm metals if allowed to remain for an extended period of time.

c. Drying. Immediately after cleaning, the item should be thoroughly dried to evaporate cleaning solutions and to remove any residue mositure. The following are acceptable drying methods with their code designations:

(1) Prepared compressed air—D–1.

(2) Oven—D–2.

(3) Infrared lamps—D–3.

(4) Wiping—D–4.

(5) Draining—D–5.

d. Preservation.

(1) *Preservatives.* Preservatives are selected whose application, use and removal will not damage the item. Application of the preservative may be by a variety of procedures, including dipping, slushing, brushing, filling or flushing, and spraying. Specific types of preservatives and methods of application are described in MIL–P–116E. In general, preservatives are applied to metal surfaces if corrosion on the surface would impair the usefulness of the part or assembly. Preservatives need not be applied to the following:

(*a*) Surfaces which are painted or covered with solid film lubricants, plastic, or vitreous coating.

(*b*) Noncritical metal surfaces of copper, nickel, chromium, brass, bronze, silver, cadmium, zinc, or tin, which are inherently resistant to corrosion.

(*c*) Items made of textile, plastic, mica, rubber, paper, felt, leather, or any other material which would be damaged by contact preservatives.

(*d*) Prelubricated bushings and certain types of electrical and electronic parts and equipment such as condensers, electrical connectors, distributor rotors, circuit breakers, fuses, switches, resistors, and rectifiers.

(2) *Methods of preservation (unit protection).* Unit protection should be a continuous operation. The procedure for unit protection is determined by the type of material used in the item and the degree of protection required. The six basic methods of preservation discussed below are not independent of each other but may be used in combination to meet specific requirements.

(*a*) *Method I—preservative coating (with greaseproof wrap when required).* The preservative-coated article is inclosed in a bag or loosely wrapped in flexible carrier material. Projections and sharp edges are padded to protect the wrap. If the part is attached to a larger item and cannot be wholly inclosed, it should be wrapped in such a way that the coated surface is protected. Items coated with hard-drying preservatives need not be wrapped.

(*b*) *Method IA—water-vaporproof inclosure (with preservative when required).* This method has seven submethods based upon the type of container used.

(*c*) *Method IB—strippable compound coating (hot dip).* This method contains two submethods, direct application and strippable compound on aluminum foil wrap.

(*d*) *Method IC—Waterproof barrier (with preservative when required).* This method has six submethods.

(*e*) *Method II—water-vaporproof barrier with desiccant (with contact preservative when required).* There are six submethods for method II. The desiccant is in bags of standard size positioned in the package for maximum dehydration. Bags must be tied, stored in specially provided baskets, taped, or otherwise secured so that they do not move, rupture, or damage the item. Formulas for finding the quantity of desiccant for use per package are contained in MIL–P–116E.

(*f*) *Method III—packaged for mechanical and physical protection only.* This method is intended only for items not susceptible to damage or deterioration from corrosion. Unpreserved items are tied together or inclosed in containers to protect them from contamination and damage. If a flexible wrapping or bag is used, cushioning material is placed around the item to protect the wrapping. Items packaged in rigid containers are supported by rigid or resilient dunnage to prevent movement within the container. Any material that comes in contact with metal surfaces must be as dry as possible.

(3) *Protection procedures.*

(*a*) Rust-inhibiting synthetic primer is applied to surfaces before they are painted.

(*b*) If painting is not required, rust-preventive film is applied to surfaces.

(*c*) Items on which a soft-drying preservative is used are wrapped in a greaseproof paper,

and the wrapping is secured. If a hard-drying preservative is used, wrapping is not mandatory.

(*d*) When a shipping container is selected, consideration is given to the maximum allowable size of the container, the weight of the contents, and practicability of the container for the prescribed level of packaging or packing—that is, its suitability for immediate use, domestic storage, or oversea shipment.

(*e*) Cushioning materials such as wood, excelsior, crepe cellulose wadding, hair felt, and flexible corrugated paper are used to protect finished surfaces against abrasion, to protect small projections on articles, to fill voids, and so on. Materials used directly against finished surfaces must be chemically neutral and free from abrasive qualities.

(*f*) Articles that do not fill their shipping containers are blocked, braced, or otherwise secured to prevent their moving in the container. Blocks and braces should not be secured to the outer container by end-grain nailing, and blocks and braces coming in direct contact with unpainted or preserved surfaces should be covered with a greaseproof, waterproof material. Wood or steel members are fastened to the shipping box in one direction, crosswise, or portions of braces or supports are cut out to fit around a part of the machine. Bracing makes the article virtually a part of the box itself. Bracing is applied to a part or parts of the article that will not be damaged by impact or by a blow sufficient to distort the box.

(*g*) When possible, articles such as machines or subassemblies should be bolted to the container. In bolting, the article is attached rigidly to the base of the container with the bolts running through the skid and container base.

(*h*) Linings should be used in textile bags, barrels, and drums to protect against sifting, contamination, and entrance or loss of water.

(*i*) When necessary, linings are used to waterproof boxes, crates, and other containers. Lining should be in bag form unless panel linings are required because of interior bracing and blocking.

e. Levels of Packaging and Packing. To provide uniform, efficient, and economical protection to supplies and equipment, the military departments have established three levels of protection based on the performance expected of the package or pack. The following definitions are based on AR 700–15:

(1) *Packaging.* Packaging is the use of appropriate wrappings, cushioning, interior containers, and complete identification markings within, but not including, the exterior shipping container. The levels of packaging are as follows:

(*a*) *Level A—military package.* Level A is preservation and packaging which provides protection against corrosion, deterioration, and physical damage during worldwide shipment, handling, and open storage.

(*b*) *Level B—limited military package.* The level B package affords less protection than the level A package but more protection than the level C package. The design of level B is based on firmly established knowledge of the shipment, handling, and storage conditions to be incountered and on the determination that the costs of preparation are less than costs for level A packaging.

(*c*) *Level C—minimum military package.* Level C provides adequate protection against corrosion and physical damage during shipment from the supply source to the first receiving activity which will put the property to immediate use or provide controlled humidity storage. The supplier's commercial practices may meet the requirements of this level.

(2) *Packing.* Packing is the use of an exterior shipping container and the assembly of items within the container. It includes blocking, bracing or cushioning, weatherproofing, exterior strapping, and markings of the shipping container.

(*a*) *Level A—military pack.* Level A is packing which will protect goods against damage during worldwide shipment, handling, and open storage.

(*b*) *Level B—limited military pack.* Level B is packing which will afford adequate protection against damage during multiple shipments, when shipping and handling will be under cover and storage will be in warehouses or other structures providing equivalent protection from the weather.

(*c*) *Level C—minimum military pack.* Level C is packing which protects against damage during shipment from the supply source to the user. Generally this level conforms to the carrier's rules and regulations and may be the supplier's commercial practice.

6–2. Selecting Containers

a. General. The factors governing the selection of shipping containers are type of load, kinds of

corrosion, preventive and inner packaging used, and method of transportation to be employed.

b. Types of loads. The type of load is determined by the weight, size, fragility, and shape of the contents. There are three types of loads: easy, average, and difficult.

(1) *Type 1, easy load.* The load is a single item or single interior container which provides complete and uniform support to all faces of the shipping container. The contents are relatively sturdy and of moderate density. Some examples are wood or metal chests, toolkits, and canned and boxed items packed in a fiberboard box which completely fills the shipping container.

(2) *Type 2, average load.* The load is composed of several items or interior containers which give some support to all faces of the shipping container. The contents are of moderate density, and they are relatively sturdy. Some examples are goods in metal cans which are not packed in an interior container, bottles individually cushioned, and hardware in cartons.

(3) *Type 3, difficult load.* The load gives little or no support to the shipping container. The contents are extremely heavy, very fragile, or very irregular in shape. They may be bulk materials which are free to shift and flow or items which combine several of these characteristics. Some examples are rivets, nuts, bolts, delicate instruments, machined parts and assemblies, and typewriters.

6–3. Types of Containers

Currently used containers are listed below.

a. Interior Containers.
(1) Fiberboard interior boxes.
(2) Folding cartons.
(3) Setup boxes.
(4) Fiberboard cans and tubes.
(5) Greaseproof, waterproof bags.
(6) Metal interior containers.
(7) Glass containers, plastic containers, and collapsible metal tubes.
(8) Kraft paper bags.
(9) Linings for textile bags, barrels, and drums.

b. Exterior Containers.
(1) Sheathed nailed wood crates.
(2) Open and covered wood crates.
(3) Wood-cleated plywood boxes.
(4) Nailed wood shipping boxes (styles 1, 2, 2 ½, 3, 4, 5, 6, and 7. Styles 1 and 6 are for domestic use only).
(5) Wirebound shipping boxes.
(6) Fiberboard shipping boxes.
(7) Wood-cleated solid fiberboard boxes.
(8) Tight barrels.
(9) Slack barrels.
(10) Slack kegs.
(11) Metal drums.
(12) Metal cans and pails.
(13) Plywood drums.
(14) Fiberboard drums.
(15) Laminated shipping bags.
(16) Multiwall paper shipping sacks.
(17) Textile shipping bags.
(18) Bales and bundles.
(19) Pallets.
(20) Skids.
(21) Reusable metal shipping boxes (CONEX containers).

6–4. Strapping

a. Strapping is used not only as reinforcement for blocking and bracing but also as reinforcement for exterior containers. Only tempered high-tensile strapping and wire may be used for container reinforcement.

b. Each military container specification has a section or appendix devoted to closure and strapping. These instructions must be carefully observed.

c. Unless otherwise specified, style 1 and 6 boxes, regardless of weight, and styles 2, 2 ½, 3, 4, 4½, and 5 boxes, with contents weighing more than 100 pounds, are strapped. All class 2 boxes usually are strapped.

d. All straps should be applied at right angle to the edges of the box over which they pass and should be drawn tight so as to sink into the wood at the edges. Straps should be applied just prior to shipment whenever practicable.

e. The distance between the end of the box and the strap should equal 1/6 the length of the box but not exceed 9 inches. The intermediate straps should be spaced equally between the end straps.

f. When style 2, 2 ½, 3, 4, 4 ½, or 5 boxes are used, two or more straps should be applied girthwise. When the outside length of the box exceeds 36 inches, three or more straps should be applied girthwise so that the distance between straps is not more than 24 inches. When the weight is less

than 35 pounds and the length does not exceed 12 inches, only one strap is applied girthwise.

g. When style 1 and 6 boxes are used, one strap should be applied lengthwise, or around the top, bottom, and end. After this strap has been applied, two additional straps should be applied girthwise.

h. For style 7 boxes, one is applied parallel to and immediately adjoining the inner edges of each skid.

i. When straps and exterior diagonals intersect, the diagonals must be notched slightly (before attachment) to permit treading of strapping under each diagonal after closing the box.

j. When battens are used inside reinforced boxes, straps are placed over batten center lines.

k. Table 6–1 gives the dimensions of flat metal bands, and table 6–2 gives the size of round wire for boxes of various weights.

Table 6–1. Minimum Sizes of Flat Metal Bands for Various Weights of Boxes

Net wt. of contents of box (lb.)	Dimensions of flat metal bands when different numbers of bands are used	
	One or two bands (in.)	Three or more bands (in.)
Less than 70	⅜ x 0.015	⅜ x 0.015
70 to 125	⅜ x 0.020	⅜ x 0.020
126 to 175	½ x 0.020	½ x 0.020
176 to 250	⅝ x 0.020	⅝ x 0.020
251 to 400	¾ x 0.020	¾ x 0.020
401 to 1000		¾ x 0.023

Table 6–2. Minimum Sizes of Round Wire for Various Weights of Boxes

Net wt. of contents of box (lb.)	Size of wire when wires are used in—			
	One or two bands		Three bands	
	100,000 p.s.i. tensile strength (diam. in in. and gage)	140,000 p.s.i tensile strength (diam. in in. and gage)	100,000 p.s.i. tensile strength (diam. in in. and gage)	140,000 p.s.i tensile strength (diam. in in. and gage)
Less than 70	0.0720 (15 gage)	0.0625 (16 gage)	0.0720 (15 gage)	0.0625 (16 gage)
70 to 125	0.0800 (14 gage)	0.0720 (15 gage)	0.0800 (14 gage)	0.720 (15 gage)
126 to 175	0.0915 (13 gage)	0.0800 (14 gage)	0.0915 (13 gage)	0.0800 (14 gage)
176 to 250	0.0915 (13 gage)	0.0915 (13 gage)	0.0915 (13 gage)	0.0915 (13 gage)
251 to 400	0.1055 (12 gage)	0.0990 (12½ gage)	0.0915 (13 gage)	0.0915 (13 gage)
401 to 1,000			0.1055 (12 gage)	0.0990 (12½ gage)

6–5. Woods

a. Species. The species of wood that may be used for lumber for nailed wood boxes are classified in groups as indicated in table 6–3. When a group is specified, any species in that group may be used. Species of groups 1 and 2 may be used in combination. Species of groups 3 and 4 may also be used in combination. However, species of groups 1 and 2 must not be used in combination with species of groups 3 and 4.

Table 6–3. Species of Wood

	Group 1	
Alder, red	Fir, California red	Pine, ponderosa (western yellow)
Aspen (popple)	Fir, grand	Pine, red (Norway)
Basswood	Fir, noble	Pine, sugar
Buckeye	Fir, silver	Pine, white
Cedar	Fir, white	Poplar, yellow
Chestnut	Magnolia	Redwood
Cottonwood	Pine, eastern white	Spruce
Cypress	Pine, jack	Willow
Fir, alpine	Pine, lodgepole	
Fir, balsam		
	Group 2	
Douglas fir	Larch, western	Tamarac
Hemlock	Pine, southern	
	Group 3	
Ash, black	Elm, soft	Sycamore
Ash, cabinet	Maple, soft	Tupelo, water
texture	Sweet gum (red	
Black gum	gum)	
	Group 4	
Ash, white	Elm, rock	Maple, hard
(rough	Hackberry	Oak
texture)	Hickory	Pecan
Beech	Locust	
Birch		

b. Group Characteristics. The groups in this table are set up so that each one is limited to woods with similar characteristics of importance to box design. These characteristics include den-

sity, strength, stiffness, shock absorption, and nail-holding power. Variations of the characteristics of woods within any one group are not great enough to interfere with their use in box design. Box designs should be based on the characteristics of each group of woods.

c. Use of Groups. In general, the density of woods increases in order from group 1 to group 4. There is the same progressive increase from group 1 to group 4 in strength, nail-holding power, and the other characteristics indicated above. Therefore, for a box of the same dimensions designed to carry a stated load under given conditions, the required thickness of boards is greatest when woods of group 1 are used and least when woods of group 4 are used. Likewise, to provide the total nail-holding power required for a box, more nails, longer nails, nails of a larger diameter, or a combination of these must be used if woods of group 3 are used instead of woods of group 4, or of group 2 instead of group 3.

d. Lumber Standards. The lumber used in the manufacture of nailed wooden boxes must meet the following standards:

(1) Lumber must be seasoned to a moisture content not more than 19 percent nor less than 12 percent of its oven-dry weight.

(2) Pieces must be cut to length and dressed on at least one side.

(3) Wood must be free from all defects that materially weaken it, expose the contents of the box to damage, or interfere with the prescribed fabrication or nailing.

(4) No knot should have a diameter exceeding one-third of the width of the piece of lumber.

6–6. Nails

a. Types of Nails. In the manufacture of wooden boxes, three types of cement-coated nails generally are used. They are the standard box nail, the cooler, and the sinker. The cooler and the sinker are identical except for the head. The head of a cooler is flat on the underside, while the head of a sinker is slightly smaller and cone-shaped on the underside. The standard box nail is the same length as the cooler or the sinker nail but is smaller in diameter. Table 6–4 provides the dimensions of cement-coated steel wire nails.

b. Nailing.

(1) *Size of nails.* The size of nails for fastening sides, top and bottoms to ends and cleats, as determined by the groups of wood used and the thickness of parts being fastened together, should conform to the requirements of table 6–5. If the required nail is not available, or splitting is encountered, one size smaller nail should be used and the nails spaced ¼ ineh closer.

(2) *Spacing of nails.* The average spacing of nails holding the sides, top or bottom to the ends and cleats or bottoms should not be greater than the values shown in table 6–6. The size of nails and spacing for nailing top and bottom to sides of boxes are shown in table 6–7. Attachment of skids, if required, should be done by nailing from the inside through the bottom pieces using the spacing shown in table 6–6. Cement-coated or uncoated (bright) nails may be used. The dimensions of uncoated nails appear in table 6–8.

Table 6–4. Dimensions of Cement-Coated Steel Wire Nails

Size of nail	Length (inches)	Cooler and sinker nails standard box nails			
		Steel wire gage No.	Diameter (inches)	Steel wire gage No.	Diameter (inches)
Twopenny	1	16	0.063	16½	0.056
Threepenny	1⅛	15½	.067	16	.065
Fourpenny	1¼	14	.080	15½	.067
Fivepenny	1⅝	13½	.086	15	.072
Sixpenny	1⅞	13	.092	13½	.086
Sevenpenny	2⅛	12½	.099	13½	.086
Eightpenny	2⅜	11½	.113	12½	.099
Ninepenny	2⅝	11½	.113	12½	.099
Tenpenny	2⅞	11	.120	11½	.113
Twelvepenny*	3⅛	10	.135	10½	.128

*Cooler nails are not listed in manufacturer's catalogs in sizes greater than tenpenny.

*Table 6–5. Size of Cement-Coated or Chemically Etched Nails**

Thickness of ends or cleats to which sides, tops, bottoms are nailed.		Size of nail (penny)			
Min. (in.)	Max. (in.)	Group I wood	Group II wood	Group III wood	Group IV wood
—	7/16	4	4	3	3
7/16	1/2	5	4	4	3
1/2	9/16	5	5	4	4
9/16	5/8	6	5	5	4
5/8	11/16	7	6	5	4
11/16	13/16	8	7	6	5
13/16	7/8	8	7	7	6
7/8	1	9	8	7	7
1	1 1/8	9	9	8	8
1 1/8	1 1/4	10	9	9	8
1 1/4	Up	12	12	10	9

*For nailing sides, tops, and bottoms to ends or cleats.

Table 6–6. Spacing of Cement-Coated or Chemically Etched Nails for Boxes[1]

Size of nails	Spacing when driven into side grain[2] (inches)	Spacing when driven into end grain[2] (inches)
Sixpenny or smaller	2	1 3/4
Sevenpenny	2 1/4	2
Eightpenny	2 1/2	2 1/4
Tenpenny	3	2 3/4
Twelvepenny	3 1/2	3
Sixteenpenny	4	3 1/2
Twentypenny	4 1/2	4

[1] Except the nailing of top and bottom of sides. (see table 6–7)

[2] Use end grain spacing when nails are alternately driven into the end and the side grain of the cleat.

Table 6–7. Size of Nails and Spacing for Nailing Top and Bottom to Sides of Boxes

Thickness of side (in.)	Group I wood	Group II wood	Group III wood	Spacing (in).	
				Min.	Max.
Under 3/4	No nailing permitted	No nailing permitted	No nailing permitted	---	---
3/4 to 7/8	7d	6d	5d	6	8
15/16 to 1 1/16	8d	7d	6d	6	8
Over 1 1/16	10d	9d	8d	8	10

Table 6–8. Dimensions of Bright (Uncoated) Standard Box and Common Nails

Size	Length (inches)	Diameter (inches)	Approximate no. per pound
Standard:			
Fourpenny	1 1/2	0.080	473
Fivepenny	1 3/4	.080	406
Sixpenny	2	.099	236
Sevenpenny	2 1/4	.099	210
Eightpenny	2 1/2	.113	145
Ninepenny	2 3/4	.113	132
Tenpenny	3	.128	94
Twelvepenny	3 1/4	.128	88
Common:			
Fourpenny	1 1/2	.099	316
Fivepenny	1 3/4	.099	271
Sixpenny	2	.113	181
Sevenpenny	2 1/4	.113	161
Eightpenny	2 1/2	.131	106
Ninepenny	2 3/4	.131	96
Tenpenny	3	.148	69
Twelvepenny	3 1/4	.148	63

6–7. Thickness of Lumber For Boxes

Information on lumber for boxes for different types of load and groups of woods is given in table 6–9. The information in the table pertains to oversea shipment. For domestic shipment data see Federal Specification PPP–B–621a.

Table 6–9. Lumber for Different Types of Loads and Groups of Woods

Weight of contents of box (lb.)	Style of box[1]	Minimum thickness of sides, tops, and bottoms of box[2] (in.)	Groups I and II woods		Groups III and IV woods		
			Minimum thickness of ends of box[2] (in.)	Minimum thickness[2] of width[3] of cleats (in.)	Thickness of sides, tops, and bottoms[2]	Thickness of ends[2]	Thickness[2] and width[3] of cleats
a. Type 1 (easy) and type 2 (average) loads							
To 50	4, 4 1/2, 5	3/8	5/8	5/8 x 1 3/4	3/8	5/8	5/8 x 1 3/4
51 to 100	4, 4 1/2, 5, 7	1/2	3/4	3/4 x 2 1/4	3/8	5/8	5/8 x 1 3/4
101 to 250	4, 4 1/2, 5	5/8	3/4	3/4 x 2 1/4	1/2	3/4	3/4 x 2 1/4
101 to 250	2, 2 1/2, 3, 7	5/8	5/8	5/8 x 2 1/4	1/2	5/8	5/8 x 2 1/4

Table 6–9—Continued

Weight of contents of box (lb.)	Style of box [1]	Minimum thickness of sides, tops, and bottoms of box [2] (in.)	Groups I and II woods		Groups III and IV woods		
			Minimum thickness of ends of box [2] (in.)	Minimum thickness [2] of width [3] of cleats (in.)	Thickness of sides, tops, and bottoms [2]	Thickness of ends [2]	Thickness [2] and width [3] of cleats
251 to 400	4, 4½, 5	¾	¾	¾ x 2⅝	⅝	¾	¾ x 2¼
251 to 400	2, 2½, 3, 7	¾	13/16	¾ x 2⅝	⅝	¾	¾ x 2¼
401 to 600	2, 2½, 3, 7	13/16	13/16	13/16 x 2⅝	⅝	¾	¾ x 2¼
b. Type 3 (difficult) loads							
To 100	4, 4½, 5	½	¾	¾ x 2¼	½	⅝	⅝ x 1¾
To 100	2, 2½, 3, 7	½	⅝	⅝ x 2¼	½	⅝	⅝ x 1¾
101 to 250	4, 4½, 5	⅝	¾	¾ x 2⅝	½	¾	¾ x 2¼
101 to 250	2, 2½, 3, 7	⅝	¾	¾ x 2¼	½	⅝	⅝ x 2¼
251 to 400	4, 4½, 5	¾	1/16	1 1/16 x 3¼	⅝	13/16	13/16 x 2¾
251 to 400	2, 2½, 3, 7	¾	¾	1 1/16 x 3¼	⅝	¾	¾ x 2¾
401 to 600	2, 2½, 3, 7	13/16	13/16	1 1/16 x 3¼	¾	13/16	13/16 x 2¾
601 to 800	2, 2½, 3, 7	13/16	1 1/16	1 1/16 x 3¼	¾	13/16	13/16 x 2¾
801 to 1000	2, 2½, 3, 7	1 1/16	1 5/16	1 5/16 x 4⅛	⅞	1 1/16	1 1/16 x 3⅜

[1] For style 2, 2½, 3, 4 and 4½ boxes, end cleats are not used when the inside depth of the box is 5 inches or less. The end of these boxes should be equal to the combined thickness of cleats and ends as shown above. Sides and ends are usually made from one piece; however, square ends may be made from two pieces of equal thickness with the grain running opposite. Two end pieces must be nailed together with no less than two nails clinched.

[2] Thickness may vary plus or minus 1/16 inch for pieces ⅜ inch thick or greater. For pieces thinner than ⅜ inch, the allowable deviation is plus 1/16 inch and minus 1/32 inch.

[3] Width tolerance is plus or minus 1/16 inch except that 10 percent of cleats and patterns may vary plus or minus ⅛ inch.

CHAPTER 7

TRANSPORTATION

7-1. Motor Transportation

a. Vehicle Loading. The driver is responsible for the proper loading of his vehicle. The following rules may be used for guidance.

(1) Heavy supplies should be placed at the bottom of the load to avoid damaging lighter cargo and to insure that the load is not top-heavy.

(2) The weight of the load should be evenly distributed over the vehicle cargo bed to avoid damage to the frame, tires, axles, and other components. Improper distribution may result in individual tires, axles, or springs being overloaded, even though the total load does not exceed the rated capacity of the vehicle. In addition, uneven loads may cause improper braking. (Tires with less load tend to skid when brakes are applied.)

(3) The load should not be distributed too loosely or built up too high. High, loosely distributed loads cause the vehicle to sway and possibly overturn.

(4) If possible, barrels and drums should be placed on their sides—parallel with the length of the truck—braced, and stacked in a pyramid. If the possibility of leakage does not permit this placement, drums may be set upright. Upright drums, however, require more space.

(5) Boxed, crated, and packaged cargo should be combined, as far as possible, with like items or items which fit efficiently into the remaining space.

(6) Sacked cargo should be loaded separately, or so that it is not punctured by sharp-edged items. Sacks should be stacked in overlapping layers to prevent shifting.

(7) The vehicle used must be appropriate for the cargo to be loaded. Cargo should not extend more than 12 inches beyond the rear of the vehicles. When overhanging cargo cannot be avoided, cargo should be blocked to prevent excessive weight on the tailgate. A red flag should be displayed at the end of the cargo to warn vehicles approaching from the rear.

(8) Sides, tailgate, tarpaulins, and end curtains should be used to protect the load from the elements.

(9) Detonators and fuses should be loaded separately when artillery shells are transported.

(10) Protective masks and protective ointment should be carried when chemical ammunition is hauled.

b. Vehicle Capacities and Loading Times. Table 7-1 gives maximum capacities and loading times for vehicles of the specified sizes. The figures cited are averages based on field experience and are given for planning purposes only.

Table 7-1. Vehicle Capacities and Loading Times

Type of equipment	Cargo load		Men with individual equip.[1]	Cargo bed		Loading and unloading time
	Off Road	Highway		Lgth. (in.)	Wdth. (in.)	
Trk Cargo 2½T 6x6	2½ tons	4 tons	20	147	80	2½ hrs.
Trk Cargo 5T 6x6	5 tons	6 tons	20	168	88	2½ hrs.
Semitlr 12T S and P	12 tons[2]	18 tons	50[3]	355	88	2½ hrs.
Semitlr Gas Tank 4W	3,000 gal.	5,000	---	---	---	2½ hrs.
Semitlr Refrg 7½T 2W	6 tons[2]	7½ tons	---	244	85	2½ hrs.
Semitlr Low-bed 12T 4W	NA	50 tons	---	300 to 480	96	2½ hrs.
Semitlr Tank Trans 50T	40 tons	50 tons	---	292	131	2½ hrs.
Tlr 1½T 2W	1½ tons	2¼ tons	---	110	74	1 hr.

[1] Does not include driver. For line hauls, passenger capacities are figured at 16 per 2½ ton truck and 18 per 5 ton vehicle.
[2] Not generally used for this type of operation.
[3] Recommended for emergency use only.

c. Capacities of Cargo Vehicles for Palletized and Containerized Loads. Table 7–2 gives the number of pallets and CONEX containers that can be loaded on 2½-ton cargo trucks and 12-ton stake and platform semitrailers.

Table 7–2. Capacities of Cargo Vehicles for Palletized and Containerized Loads

	2½-ton cargo truck [1]		12-ton stake & platform semitrailer	
	Sides in place, crane-loaded	Sides removed, forklift loaded	Sides in place, crane-loaded	Sides removed, forklift loaded
Cargo Transporter, Type 2 (CONEX)	1 lengthwise	1 lengthwise	3 lengthwise	4 [2] crosswise
Standard Pallet (40″ x 48″)	3	3	7 crosswise	14 crosswise
Warehouse Pallet (48″ x 48″)	3	3	6	2 rows of 7 12 crosswise 2 rows of 6

[1] Some 2½-ton 6 x 6 cargo trucks have fender walls which project into the cargo space. In such cases, a level platform for the storage of unitized cargo can be obtained by fitting a frame of 2 x 4 or 4 x 4 timbers flat in the cargo bed between the fender wells.
[2] Loaded by crane.

d. Cargo Bed Capacities and Average Loads. Table 7–3 gives cargo bed sizes and average loads. To estimate the number of vehicles required to carry boxed, crated, or packaged cargo, the following two formulas may be used. Determine which formula yields the higher quotient. This figure is the number of vehicles required to carry the cargo in one haul. (Package weight and cube are given in SB 700–20.)

$$\frac{\text{package cube X number of packages}}{\text{cargo bed capacity}} = \text{number of vehicles required}$$

$$\frac{\text{package weight X number of packages}}{\text{average cargo load}} = \text{number of vehicles required}$$

Table 7–3. Cargo Bed Capacities and Average Loads

Type of equipment	Average usable cargo bed capacity	Average cargo load (tons)
Trk Cargo 2½T 6 x 6	450 cu. ft.	4
Trk Cargo 5T 6 x 6	515 cu. ft.	6
Stlr 12T S & P	830 cu. ft.	12
Stlr Refrg 7½T 2W	600 cu. ft.	6
Tlr 1½T 2W	283 cu. ft.	2¼
Stlr Low-bed 12T 4W	200 sq. ft.*	16

*This figure must be multiplied by the desired stacking height in feet before it can be used in the formula described in paragraph 7–1*d*.

e. Bracing and Tiedown of Cargo. Loose cargo on the bed of a vehicle is a potential danger, especially if the cargo is heavy or if its center of gravity is much higher than that of the truck. The cargo should be blocked in position by bracing with other cargo or lumber, or tied down to the bed of the vehicle to prevent its shifting or falling off the truck. Figures 7–1 and 7–2 illustrate tiedown of CONEX transporters on M127 semitrailers.

(1) The sizes of lumber most commonly used for bracing are 2 x 4 and 4 x 4. Detailed instructions and patterns of blocking and bracing are illustrated in TM 55–601 and FM 55–15. These manuals describe blocking and bracing equipment on rail cars, but the principles apply for loading cargo trucks and semitrailers as well.

(2) The type of rope and tiedown equipment used depends on the probable thrust of the cargo if the driver should stop suddenly or turn sharply. Manila rope with a ½-inch diameter has a safe working capacity of 660 pounds, which is strong enough for stabilizing most loads. For very large loads a number of ropes can be lashed between the cargo and the tiedown points. Two strands will withstand a thrust of 1,320 pounds; three strands, 1,980 pounds, etc. For heavy equipment, the diameter of the manila rope required depends on the amount of expected thrust. The square root of the thrust in pounds equals the diameter of the rope in inches. If the equipment is to be tied down at two points, the thrust should be divided by two before finding the square root; four points, divided by four, etc. Figure 7–3 shows methods of tying knots.

f. Vehicle and Trailer Data. Tables 7–4 and 7–5 provide data on specific vehicles and trailers of each type.

TIEDOWN SYSTEMS:

A. 5/16" X 14' CHAIN WITH BINDER.
B. 47', #9 ANNEALED WIRE 2 TWISTED LOOPS 4 STRANDS.
C. 14' X 1 1/4" X .035" STEEL BANDS.
(1) 2" X 8" X 8' CLEAT, 24 EA. 12d COMMON NAIL TWO ROWS NAILED TO FLOOR OF TRAILER IN STAGGERED PATTERN.
(2) 2" X 6" X 8' CLEAT, 40d COMMON NAIL, 11 EA, NAILED TO BOTTOM CLEAT '1' IN OPPOSITE STAGGERED PATTERN OF PIECE '1'.
(3) 2" X 4" X 8' CLEAT, 12 EA. 12d COMMON NAIL NAILED TO SECOND CLEAT '2' IN STAGGERED PATTERN.

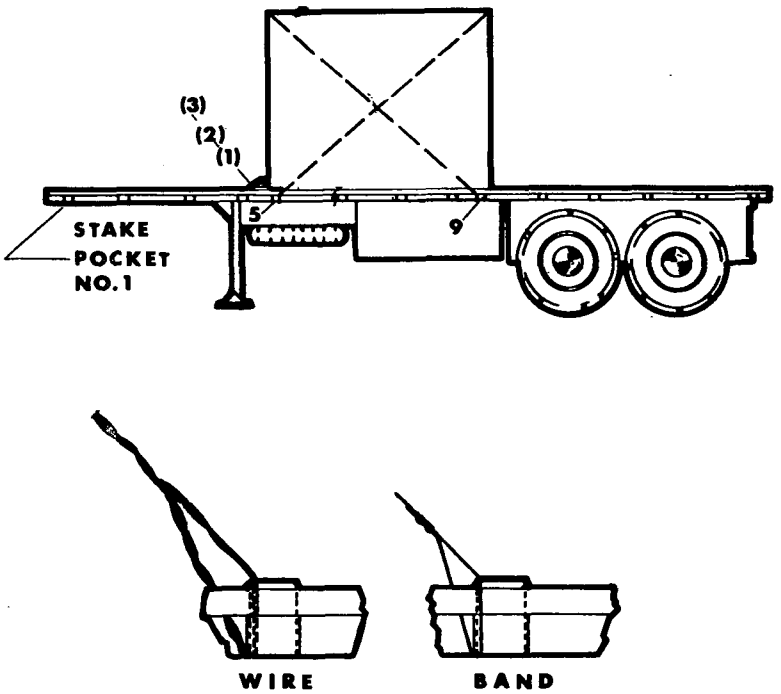


Figure 7-1. Recommended tiedown for one CONEX transporter on M127 semitrailer.

TIEDOWN SYSTEMS:

A. 5/16" X 14' CHAIN WITH BINDER.
B. 47' #9 ANNEALED WIRE 2 TWISTED LOOPS 4 STRANDS.
C. 14' X 1 1/4" X .035" STEEL BANDS.
(1) 2" X 8" X 8' CLEAT, 24 EA. 12d COMMON NAIL IN TWO ROWS NAILED TO FLOOR OF TRAILER.
(2) 2" X 6" X 8' CLEAT, 11 EA. 40d COMMON NAIL NAILED TO BOTTOM CLEAT '1' IN STAGGERED PATTERN.
(3) 2" X 4" X 8' CLEAT, 12 EA. 12d COMMON NAIL NAILED TO SECOND CLEAT '2' IN STAGGERED PATTERN.

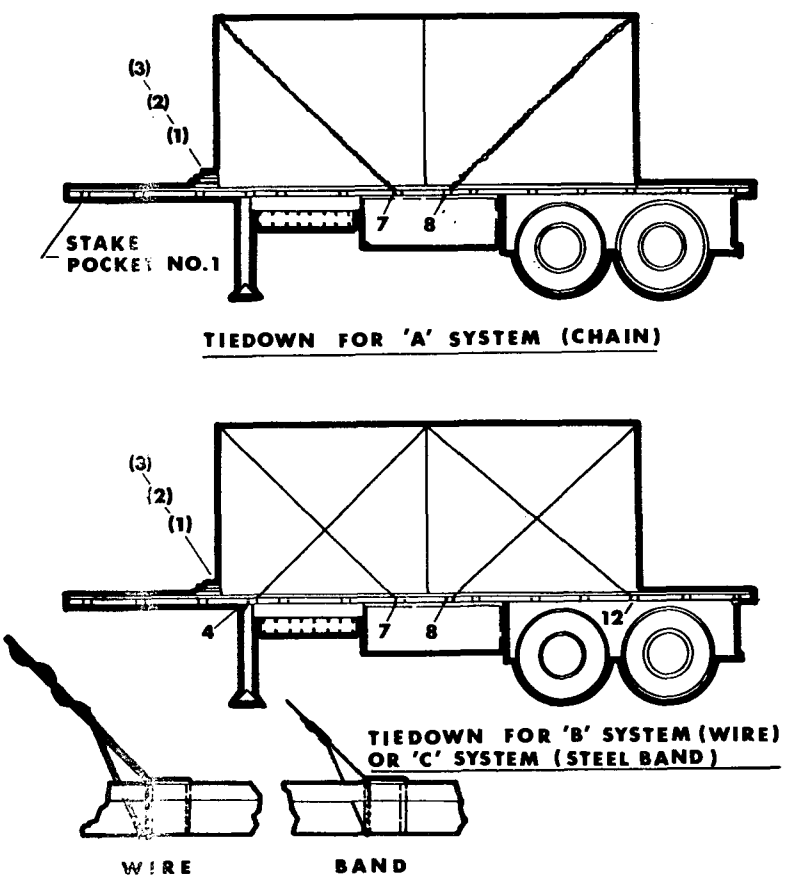
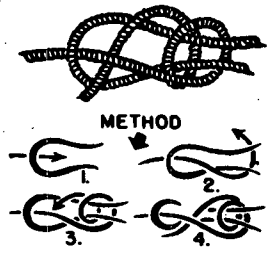
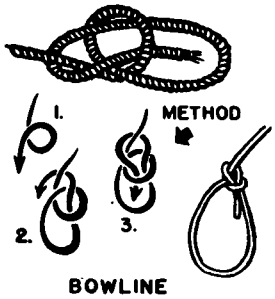


Figure 7-2. Recommended tiedown for two CONEX transporters on M127 semitrailer.



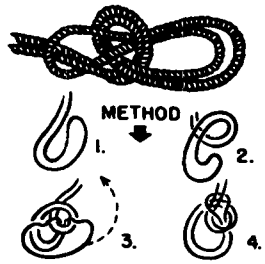
DOUBLE-SHEET BEND

To join two wet ropes of different diameters.



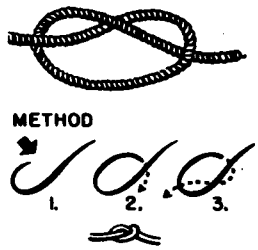
BOWLINE

To form a loop of any desired size that will not slip.



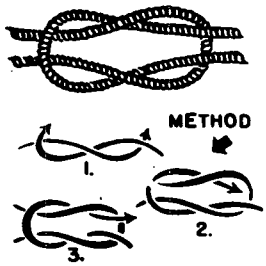
BOWLINE ON A BIGHT

To form a loop with a double purchase. To form a loop in a rope when the ends are not available.



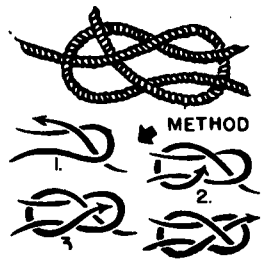
OVERHAND KNOT

To prevent the end of a rope from unravelling. To prevent the end from passing back through the sheave of a block.



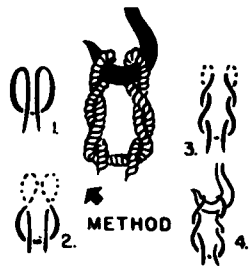
SQUARE KNOT

To join ends of the same rope. To tie together two ropes of equal diameter.



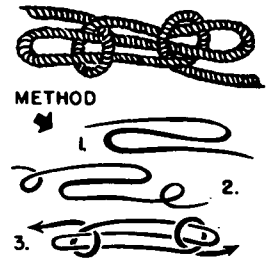
SINGLE-SHEET BEND

To join two ropes of different diameters.



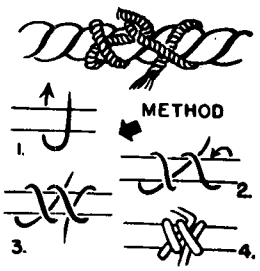
CAT'S PAW

To obtain a double bearing surface on a hook.



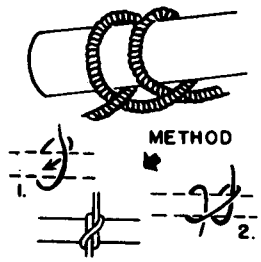
SHEEPSHANK

To shorten a rope when ends are not available. To bypass a weak section of a rope when ends are not available.



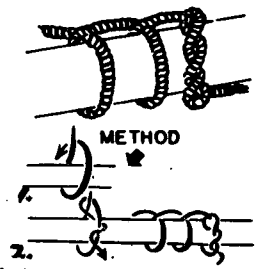
ROLLING HITCH

To form a hitch which will hold on a spar or rope yet will slide readily upon a slight adjustment.



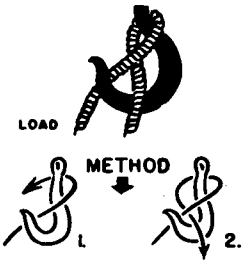
CLOVE HITCH

To fasten guy lines to anchorages and spars.



TIMBER HITCH WITH TWO HALF HITCHES

To haul a log, spar, gun tube, or any long cylindrical object with the pull line parallel to the object drawn.



BLACKWALL HITCH

To secure a rope to a hook rapidly.

Figure 7–3. Knots, bends, and hitches.

Table 7–4. Vehicle Data

	Vehicle	Vehicle dimensions			Net Wt.	Miles per gal.	Fuel tank cap., gal.	Loading hgt. from ground	Max. grade ability (percent)	Tire size	Max. recommended speed
		Lgth	Wdth.	Hgt.							
1	Trk Utility ¼ T 4 x 4 M151	132	63	71	2,140	17.3	17	--	65	7.10 x 15	66
2	Trk Cargo ¾ T 4 x 4 M37B1	190	74	90	5,917	9	24	30	65	9.0 x 16	55
3	Trk Cargo 1½ T 4 x 4 G7127	296	86	106	8,150	6	30	47	65	7.5 x 20	48
4	Trk Cargo LWB 2½ T M35	262	96	111	12,465	5	50	51	64	9.0 x 20	58
5	Trk Cargo SWB 2½ T 6 x 6 CCKW 352	245	88	93	10,350	5	40	48	65	7.5 x 20	45
6	Trk Tank Gasoline 1200 gal. 2½ T 6 x 6 M49C	262	96	98	13,955	7	50	89	62	9.0 x 20	58
7	Trk Van Shop 2½ T 6 x 6 M220	267	96	131	15,085	5.4	56	51	66	9.0 x 20	55
8	Trk Tractor 2½ T 6 x 6 M48	254	94	98	11,430	6	50	52	40	9.0 x 20	58
9	Trk Tractor 5 T 6 x 6 M52	258	97	102	18,813	4.4	110	--	77	11.0 x 20	52
10	Trk Wrecker Med 5 T 6 x 6 M62	310	97	103	33,675	2.7	78	--	36	11.0 x 20	52
11	Trk Cargo 5 T 6 x 6 M41	310	96	112	19,119	4.4	78	55	68	14.0 x 20	59
12	Trk Cargo 10 T 6 x 6 M125	332	114	112	31,600	3	110	66	60	14.0 x 24	42

Table 7–5. Trailer Data

Trailer	Combination*	Dimensions			Net Wt
		Lgth.	Wdth.	Hgt.	
Stlr Cargo Stake 6 T 2W M118A1	8	276	93	133	7,140
Stlr Tanker 6 T 2 W M30	9	240	96	93	6,750
Stlr Refrig Van 7½ T 2W M349A1	8, 9	284	97	130	7,000
Stlr Cargo Stake 10 T 2W SKD2361	9	307	96	108	9,430
Stlr Low-bed Wrecker 12 T 4W M269A1	9	410	97	121	14,695
Stlr Cargo Stake 12 T 4W M127A1	9	344	97	109	13,500
Stlr Tanker Gasoline 12 T 4W M131	9	361	96	111	14,850
Stlr Cargo Van 12 T 4W M128A1	9	350	97	143	14,695
Stlr Low-bed 15 T 4W M172	9	404	116	64	15,500
Tlr Cargo Amph ¼ T 2W M100	1	109	57	42	565
Tlr Cargo ¾ T 2W M101	2	147	74	83	1,340
Tlr Cargo 1T 2W T6	2	146	72	73	1,300
Tlr Cargo 1½ T 2W M104A1	3, 4, 6, 7	166	83	100	2,730
Tlr Tank Water 400 Gal. 1½ T 2W M106A1	3, 4, 6, 7	167	93	80	2,360
Tlr Flat-bed 10 T 4W M345	10	330	76	55	11,260

*Number of the vehicle or vehicles in table 7–4 which can be used to tow the trailer.

7–2. Rail Transportation

a. Characteristics of Railcars. Information on U.S. railcars is given in tables 7–6 through 7–8.

Table 7–6. Characteristics of U.S. Military Freight Cars

Type of car	Gage (in.)	Capacity		Inside dimensions			Tare wt. empty tons
		Lb.	Cargo space	Lgth.	Wdth.	Hgt.	
FOREIGN SERVICE							
Box (30 ton)	36, 39⅜, 42	60,000	1,588 cu. ft.	34′ 5½″	7′ ¾″	6′ 4″	13.6
Box (40 ton)	56½, 60, 63, 66	80,000	2,520 cu. ft.	40′ 6″	8′ 6″	6′ 5⅝″	18.5
Flat (30 ton)	36, 39⅜, 42	60,000	247 sq. ft.	34′ 8½″	7′ 2″	----	10.9
Flat (40 ton)	56½, 60, 63, 66	80,000	351 sq. ft.	40′ 9″	8′ 7¼″	----	14.5
Flat (80 tons)	56½, 60, 63, 66	160,000	447 sq. ft.	46′ 4″	9′ 8″	----	35.3
Flat Depressed Center (70 tons)	56½, 60, 63, 66	140,000	193 sq. ft.	50′ 7″	9′ 8″	----	41.5
Gondola, high side (30 tons)	36, 39⅜, 42	60,000	940 cu. ft.	34′ 5″	6′ 10½″	4′ 0″	13.0
Gondola, high side (40 tons)	56½	80,000	1,680 cu. ft.	40′ 0″	8′ 8¾″	4′ 0″	18.0
Gondola, low side (30 tons)	36, 39⅜, 42	60,000	356 cu. ft.	34′ 6″	6′ 10½″	1′ 6″	12.1
Gondola, low side (40 tons)	56½, 60, 63, 66	80,000	500 cu. ft.	40′ 4½″	8′ 8¾″	1′ 6″	16.0
Tank, POL (6,000 gal.)	36, 38⅜, 42	------	6,000 gal.	---------	------	----	16.0
Tank, POL (10,000 gal.)	56½, 60, 63	------	10,000 gal.	---------	------	----	19.0
DOMESTIC SERVICE							
Box (50 ton)	56½	100,000	3,975 cu. ft.	40′ 6″	9′ 2″	10′ 6″	23.0
Flat (50 ton)	56½	100,000	454 sq. ft.	43′ 3″	10′ 6″	----	25.5
Flat (70 ton)	56½	140,000	513 sq. ft.	49′ 11½″	10′ 3¼″	----	27.0
Flat (100 ton)	56½	200,000	562 sq. ft.	54′ 0″	10′ 6¼″	----	35.0
Gondola, high side (50 ton)	56½	100,000	1,770 cu. ft.	41′ 6″	9′ 6″	4′ 6″	25.0
Gondola, low side (50 tons)	56½	100,000	1,184 cu. ft.	41′ 6″	9′ 6½″	3′ 0″	23.0
Tank POL (10,000 gal.)	56½	------	10,000 gal	---------	------	----	23.0

Table 7–7. Dimensions, Weight, and Capacities of Typical U.S. Commercial Cars [1]

Type	Capacity			Wt. empty (tons)	Inside dimensions (ft.)		
	Tons	Men (8 sq. ft. per man and equip.)	Cu. ft.		Lgth.	Wdth.	Hgt.
Automobile	40	45	3,100	20	40.5	8.5	9.0
	50	58	4,702	25	50.6	9.2	10.1
Baggage	--	--	-----	45	60.0	9.1	8.0
Box	30	38	2,750	18	36.0	8.5	9.0
	40	43	3,100	20	40.5	8.5	9.0
	50	43	3,100	24	40.5	8.5	9.0
Caboose	--	--	-----	20	27.5	8.2	7.0
Diner	--	--	-----	90	78.5	8.5	8.5
Flat	40	--	-----	18	40.0	9.0	---
	50	--	-----	20	45.0	9.0	---
	70	--	-----	25	50.0	9.0	---
Gondola	50	--	1,570	22	40.0	9.9	4.0
	70	--	1,920	25	48.0	10.0	4.0
Refrigerator	30 [2]	--	2,570	28	40.5	8.2	7.2
	40 [3]	--	2,570	30	40.5	8.2	7.5
Stock	30	--	2,625	20	36.0	8.5	8.5
	40	--	3,003	22	40.6	8.6	8.6
Tank	40 [4]	--	-----	20	33.0	6.6 [6]	---
	50 [5]	--	-----	24	33.0	7.2 [6]	---

[1] There are no standard dimensions for commercial cars. The figures given are for types in common use. The 40-ton stock car comes in many lengths, varying from 35′ 7″ to 41′ 10″. All types have similar variations in capacity and dimensions.

[2] Ice capacity, 4 tons.

[3] Ice capacity, 5 tons.

[4] 8,000 gal.

[5] 10,000 gal.

[6] Diameter.

Table 7-8. Data Pertaining to Standard U.S. Railway Passenger Cars

Dimensions/capacity	Day coach	Tourist Sleeper	Standard[2] sleeper
Length in feet	65–75	65–75	65–80
Number of sections	None	13–16	12–16
Maximum seating:			
2 men to each dbl. seat[1]	60–70	52–64	53–64
3 men to each 2 dbl. seats[1]	45–52	39–48	40–48
Sleeping Capacity:			
2 men per berth (max.)	None	52–64	53–64
3 men per section	None	39–48	36–48
1 man per berth	None	26–32	27–32

[1] Seat having capacity of two men.

[2] Twelve sections and drawing room or 16 sections and no drawing room.

b. Maximum Bulk Loading of Freight Cars. The rated weight capacities of freight cars shown in tables 7–6 and 7–7 do not pertain to all items. Light, bulky items fill the car before its rated weight capacity is reached. Table 7–9 gives actual capacities of freight cars for specific low-density items.

Table 7–9. Maximum Loads of Low-Density Items

Item to be loaded	Actual capacity in tons of freight car		
	With 30-ton rating	With 40-ton rating	With 50-ton rating
Blankets, baled	27	32	40
Bread	19	24	30
Canned goods in boxes	30	36	45
Clothing, baled	27	32	40
Hay, baled	15	20	25
Meat	15	24	35
Motor vehicle parts	24	28	40
Sandbags	21	24	30
Tentage	15	20	30
Ties, railroad	19	26	32

7–3. Water Transportation

Table 7–10 contains an explanation of the Maritime Administration vessel classification system. Data on landing craft, landing ships, Navy transport vessels, and United States cargo ships as well as hatch and boom data and load capacities for vehicles are also provided.

Table 7–10. Vessel Classification System

a. Maritime Administration Vessel Classification System

1. Method. The classification of vessels is based upon three groups of letters and numbers. The first group (prefix) indicates the type vessel and its length at waterline when loaded. The second group (intermediate) indicates the type of machinery, number of screws (propellers), and passenger accomodation. The third group (suffix) indicates the particular design of the type vessel and modifications.

2. Prefix Designations.

Single Letter	*Class of Vessel*	*Length Designation (load waterline in ft)* 1	2	3	4	5	6	7
C	Cargo, unlimited service, under 100 passengers.	Under 400	400–450	450–500	500–550			
P	Passenger, unlimited service, over 100 passengers.	Under 500	500–600	600–700	700–800	800–900	900–1000	Over 1000
B	Barge	Under 100	100–150	150–200	200–250	250–300		
L	Great Lakes tankers (ore, grain)	Under 400	400–450	450–500	500–550	550–600	600–650	
N	Coastwise cargo	Under 200	200–250	250–300	300–350	350–400	400–450	450–500
R	Refrigerator	Under 400	400–450	450–500	500–550			
S	Special	Under 200	200–300	300–400	400–500	500–600	600–700	
T	Tanker	Under 450	450–500	500–550				
V	Towing vessels	Under 50	50–100	100–150	150–200			
Z	Conversion							

Double Letter

Table 7–10—Continued

Single Letter	*Class of Vessel*	*Length Designation (load waterline in ft)* 1	2	3	4	5	6	7
EC	Emergency cargo (Liberty Ship)	Under 400	400–450	450–500	500–550			
ET	Emergency tanker	450						
VC	Victory cargo	Under 400	400–450	450–500	500–550			

3. Intermediate Letter or Group

Type of machinery	*Type of propeller*	*Under 12 passengers*	*Over 12 passengers*
Steam	Single	S	S1
Motor	Single	M	M1
Turboelectric	Single	SE	SE1
Diesel-electric	Single	ME	ME1
Gas turbine	Single	G	G1
Gas turboelectric	Single	GE	GE1
Steam	Twin	ST	S2
Motor	Twin	MT	M2
Turboelectric	Twin	SET	SE2
Diesel-electric	Twin	MET	ME2
Gas turbine	Twin	GT	G2
Gas turboelectric	Twin	GET	GE2
Steam	Stern wheel	SW	SO
Motor	Stern wheel	MW	MO

4. Suffix. The third group identifies the particular design and indicates the approximate time the design originated. The alphabetical letters are assigned in series. Therefore, if there is only one letter, this indicates that the design originated earlier than one having two letters. The figure following the letter or letters in the suffix indicates that it is either the original design of that particular alphabetical designation or a modification thereof. The original design is always numbered 1.

5. Older Designs. The following older designs have prefixes similar to those in 2 above, but do not follow the same system for the intermediate and suffix portions. The letters or words after the hyphen are simply distinguishing characters.

C1–A	CT–Seas shipping	C3–IN(P&C)
C1–B	C2–SU Reefers	C3–M
C2-Diesel	C2–T	C3 (P&C) Diesel
C2–F	C2-Turbine	C3 (P&C) Turbine
C2–G	C3–A (P&C)	C3–P (P&C)
C2-Modified	C3-Diesel	C3 Turbine
C2–S	C3–E	

Table 7–10—Continued

b. Landing Craft

Nomenclature	Designation	Length (overall)	Beam	Draft, Fwd	Draft, Loaded[2] Aft	Operating (Nautical Mi.)	Speed (Knots)	Capacity Cargo (LTON)	Cargo Space Dimensions: Length	Cargo Space Dimensions: Width	Ramp Openings
Landing Craft, Utility 501 class	LCU	119′	32′	3′4″	4′	700	6.5	161	101′	12′–26′	12′6″
Landing Craft, Utility 1466 class	LCU	115′1″	34′	3′1″	4′	700	7	150	52′;	29′6″;	14′4″
Landing Craft, Utility 1610 class	LCU	135′3″	29′	3′6″	6′	1,200	9	170	22′	[1]	14′
Landing Craft, Mechanized LCM (6)	LCM	56′	14′1″	3′	4′8″	124	8	32	37′6″	11′	11′
Landing Craft, Mechanized LCM(8)	LCM	73′8″	21′	3′	5′	303	9	53.5	42′9″	14′6″	14′6″
Landing Craft, Vehicle, Personnel (LCVP)	LCVP	35′9″	10′11″	2′	3′	102	7	3.6	17′3″	7′5″	7′5″

[1] Information not available.
[2] Will differ for salt and fresh water and vary with temperature.

C. Landing Ships

Nomenclature	Designation	Length (overall)	Beam	Draft, Fwd	Draft, Loaded[1] Aft	Operating (Nautical Mi.)	Speed (Knots)	Capacity Cargo (LTON)	Deck	Length	Width	Area (Sq. Ft.)
Dock, Landing Ship, LSD–1 class	LSD	457′9″	72′2″	18′ dry 30′4″ flood	18′ dry 30′4″ flood	10,000	15	1233	Well	394′	42′10″	16,776
									Half	125′	42′	5,250
									Super	141′	44′10″	6,353
Dock, Landing Ship, LSD–28 class	LSD	510′1″	84′2″	19′ dry 32′6″ flood	19′ dry 34′1″ flood	9,500	16.5	2400	Well	396′	48′9″ — 24′	18,400
									Mezzanine	144′	48′7″ — 30′	6,500
									Cargo	71′2″	48′6″	3,143
									Helicopter	71′	43′5″	3,100
				Beaching				Beaching				
Tank, Landing Ship,[2] LST–542 class	LST	328′	50′	4′4″ Norm. 9′3″ 5′3″ Max. 10′2″ Full: no beaching		17,800	8.5	Norm. 500 Max. 900 Full 1,358	Tank Main	226′6″ 100′	24″ 45′	4,556 4,432
Tank, Landing Ship,[3] LST–1153 class	LST	382′	54′	3′4″ Norm. 11′3″ 3′11″ Max. 11′11″ Full: no beaching		7,706	10.4	Norm. 500 Max. 900 Full 2,200	Tank Main	280′ 160′	30′5″ 46′	8,972 6,268
Tank, Landing Ship,[4] LST–1156 class	LST	384′	55′7″	4′2″ Norm. 9′11″ 4′11″ Max. 10′8″ Full: no beaching		6,000	12	Norm. 500 Max. 900 Full 1,563	Tank Main	275′9″ 187′	32′9″ 47′8″	7,500 6,400
Tank, Landing Ship,[5] LST–1171 class	LST	442′	62′1″	4′ Norm. 13′ 5′8″ Max. 13′11″ Full: no beaching		6,048	14	Norm. 500 Max. 900 Full 2,400	Tank Main	320′ 208′	30′ 60′	9,800 7,686

[1] Will differ for salt and fresh water and vary with temperature.
[2] The LST–542 class has a bow ramp capacity of 100 T supported and 50 T unsupported, inside width of 12′6″, and overhead clearance of 13′9″.
[3] The LST–1153 class has a bow ramp capacity of 100 T supported and 50 T unsupported, inside width of 14′2″, width between bulkheads of 16′5″, and overhead clearance of 16′6″.
[4] The LST–1156 class has a bow ramp capacity of 75 T supported and 5 T unsupported, inside width of 14′2″, width between bulkheads of 16′5″, and overhead clearance of 17′.
[5] The LST–1171 class has a bow ramp capacity of 75 T supported, inside width of 15′5″, width between bulkheads of 17′, and overhead clearance of 17′8″.

Table 7–10—Continued

d. Navy Transport Vessels

Nomenclature	*Designation*	*Maritime Type*	*Length (overall)*	*Beam*	*Draft [1] Loaded*	*Operating Range (Nautical mi)*	*Speed (knots)*	*Capacity Cargo (LTON)*	*Cargo Space*
Attack Transport	APA	VC2–S–AP5	455′3″	62′2″	28′6″	20,500	18	446–714	13,788 sq ft 123,198 cu ft
Attack Transport	APA	C3–S–A2	491′7″	69′6″	26′6″	11,630	17.2	446–714	15,892 sq ft 154,238 cu ft
Attack Transport	APA	C4–S–1	536′6″	76′	27′	12,000	20	1,500	10,487 sq ft 138,974 cu ft
Attack Cargo Ship	AKA	C4–S–1B	536′6″	76′	28′	12,000	20	4,375	33,363 sq ft 330,984 cu ft
Attack Cargo Ship	AKA	C2–S–B1	459′3″	62′1″	28′	14,280	16	1,335–1,600	40,949 sq ft 299,797 sq ft
Attack Cargo Ship	AKA	C2–S–AJ3	459′1″	63′	27′7″	16,200	15	[2]	27,304 sq ft 316,823 cu ft
Tanker	AO	T2E	524′	68′	30′	12,600	14.5	141,000 barrels	NA
Tanker (converted liberty ship).	AO	ZET1	442′	57′	28′	17,000	11	65,000 barrels	NA
Emergency Cargo (Liberty Ship).	-----	EC2	442′	57′	28′	9,000	11.9	8,000	475,440 cu ft
Victory Cargo (Victory).	-----	VC2	455′	62′	29′	23,000	15.5	7,500	456,520 cu ft

[1] Will differ for salt and fresh water and vary with temperature.
[2] Information not available.

e. United States Cargo Ships [1]

Type	*Length (Overall)*	*Beam*	*Draft [2] Loaded*	*Operating Range (Nautical mi)*	*Speed (knots)*	*Capacity [3] Cargo (LTON)*	*Cargo Space [4] (MTON)*	*Hatches*
C1B	418′	60′	28′	24,000	14	7,200	11,300	5
C1–M–AV1	339′	50′	21′	25,000	11	6,900	5,699	4
C4–S–1A (mariner)	564′	76′	30′	23,000	20	9,300	18,418	7
C2–S–AJ	459′	63′	26′	16,000	15	7,000	11,823	5
C3–S–A2	492′	70′	29′	11,700	16.5	9,200	18,425	5
C4–S–A4	520′	71′	33′	9,000	17	10,000	17,790	7
FS (Freighter) [5]	176′	32′	12′	4,000	12	390	483	2

[1] Ships listed are representative of the cargo vessel classes, and not a complete listing of U.S. cargo ships.
[2] Will differ for salt and fresh water and vary with temperature.
[3] Payload cargo; exclusive of ships stores and supplies. Payload will vary with voyage requirements. Figures are approximate and are intended for planning purposes only.
[4] One measurement top equals forty cubic feet.
[5] Designed for U.S. Army. Seagoing, but due to size, used primarily for interisland transport.

f. Hatch and Boom Data

Vessel	*Hatch No.*	*Hatch Dimension*	*Number of booms per ship*	*Capacity per boom (LTONS)*
C1B	1	25′3″ x 20′6″	15	5
	2	31′6″ x 20′0″	1	30
	3	31′6″ x 20′0″		
	4	31′6″ x 20′0″		
	5	31′6″ x 20′0″		
C1–M–AV1	1	19′11″ x 20′2″	2	3
	2	19′11″ x 40′5″	10	5
	3	19′11″ x 40′5″	2	30
	4	8′0″ x 8′0″		

Table 7–10—Continued

Vessel	*Hatch No.*	*Hatch Dimension*	*Number of booms per ship*	*Capacity per boom (LTONS)*
C2–S–AJ	1	26'10" x 19'10"	4	5
	2	32'4" x 19'10"	2	10
	3	34'10" x 19'10"	4	35
	4	29'10" x 19'10"		
	5	29'10" x 19'10"		
C3–S–A2	1	35'9" x 19'9"	6	10
	2	29'9" x 23'9"	2	30
	3	37'3" x 23'9"		
	4	29'9" x 23'9"		
	5	39'9" x 23'9"		
C4–S–A4	1	17'9" x 16'8"	24	5
	2	26'10" x 17'9"	2	50
	3	26'10" x 17'9"		
	4	26'10" x 17'9"		
	5	26'10" x 17'9"		
	6	26'10" x 17'9"		
	7	17'9" x 17'1"		
FS (Freighter)	1	20'0" x 16'0"	5	5
	2	28'0" x 16'0"	1	15
C4–S–1A (Mariner)	1	19'6" x 17'9"	18	5
	2	29'10" x 23'10"	8	10
	3	39'10" x 29'10"	2	60
	4	39'10" x 29'10"		
	5	39'10" x 29'10"		
	6	39'10" x 29'10"		
	7	29'10" x 24'10"		
Liberty Ship	1	33'7" x 19'10"	12	5
	2	34'10" x 19'10"	1	15 or 30
	3	19'10" x 19'10"	1	30 or 50
	4	34'10" x 19'10"		
	5	34'10" x 19'10"		
Victory Ship	1	24'11" x 22'3"	16	5
	2	23'11" x 22'3"	1	30
	3	35'11" x 22'3"	1	50
	4	35'11" x 22'3"		
	5	23'11" x 22'3"		

g. Load capacities for vehicles.[1]

Vessel	Truck, utility ¼-ton, 4x4		Trailers, cargo, 1 ½-ton, 2-wheel		Truck cargo, ½-ton, 4x4		Trucks, cargo, 2 ½-tons, 6x6, LWB		Trucks, cargo, 5-ton, 6x6, LWB [2]
	On wheels	Crated [3]	On Wheel [4]	Crated [5]	On wheel [6]	Crated [3]	On wheels	Crated [3]	On wheels
Liberty [7]	498	2,078	404	4,493	312	744	185 [8]	357	102
Victory	512	1,983	512	4,287	331	710	193	340	114
C1–B	511	1,912	491	4,133	337	684	182	328	145
C1–M–AV1	314	645	261	456	167	280	111	114	61
Mariner	1,181	1,740	891	1,732	665	966	364	328	229

[1] The figures contained in this and the following section reflect general loading conditions and are not the maximum vehicle capacities of the vessels. With the exception of crated vehicles, no allowance has been made for stacking or doubledecking. All below-deck stowage is fore and aft, except in the case of ¼-ton trucks and 1 ½-ton trailers, which are stowed both fore and aft and athwartship.

[2] Not crated for shipment.

[3] Boxed as single units.

[4] It is estimated that at least 35 percent more 1 ½-ton trailers can be loaded if stowed in tandem with drawbar nested inside the body of the preceding trailer.

[5] Boxed as twin units.

[6] Twice the number of ½-ton trucks can be stowed if they are stacked.

[7] Capacity can be increased by double-decking.

[8] One hundred fifty-three ¼-ton trucks may be loaded in the bodies of 153 of these trucks. The other 32 trucks will not hold jeeps because of the limiting height of the compartments in which they are stowed. As an alternative, a total of 215 trucks can be stowed by double-decking in Nos. 2 and 3 holds.

Table 7–10—Continued

h. Detailed load capacities by individual ship (vehicles slowed on wheels).

Hatch No.	LIBERTY SHIP [2] Location	Trucks, utility ¼-ton 4 x 4	Trailers, cargo 1 ½-ton, 2-wheel	Trucks, cargo ¾-ton, 4 x 4	Trucks, cargo 2 ½-ton, 6 x 6, LWB	Trucks, cargo 5-ton, 6 x 6 LWB
1	Tween deck	28	27	23	12	8
	Lower hold	28	24	18	10	5
	On deck	41	36	20	13	8
2	Tween deck	54	44	30	21	12
	Lower hold	48	42	30 [1]	18 [1]	12
	On deck	22	14	10	6	4
3	Tween deck	36	28	25	14	6
	Lower hold	32	28	22 [1]	12 [1]	6
	On deck	31	20	16	11	8
4	Tween deck	41	37	27	16	8
	Lower hold	20	15	18	10	2
	On deck	31	22	14	11	6
5	Tween deck	44	34	25	16	9
	Lower hold	20	11	20	6	2
	On deck	14	12	6	5	4

[1] Based on *no* centerline bulkhead, which may not be standard equipment.
[2] Holds are not adaptable to plane stowage.

Hatch No.	VICTORY SHIP [1]	Trucks, utility ¼-ton 4 x 4	Trailers, cargo 1 ½-ton, 2-wheel	Trucks, cargo ¾-ton, 4 x 4	Trucks, cargo 2 ½-ton, 6 x 6, LWB	Trucks, cargo 5-ton, 6 x 6 LWB
1	Upper tween deck	15	16	9	5	0
	Lower tween deck	16	18	9	6	3
	Hold	15	13	8	4	3
	On deck	18	16	12	7	4
2	Upper tween deck	29	26	17	10	4
	Lower tween deck	25	24	17	10	5
	Hold	21	21	14	8	3
	On deck	25	29	18	13	8
3	Upper tween deck	48	48	29	17	12
	Lower tween deck	46	46	30	18	12
	Hold	44	46	30	18	8
	On deck	23	25	18	13	8
4	Tween deck	49	48	34	16	14
	Hold	49	49	31	18	13
	On deck	25	25	17	6	4
5	Tween deck	30	31	20	12	6
	Hold	20	19	12	7	3
	On deck	20	14	13	7	4

[1] Holds are not adaptable to plane stowage.

Hatch No.	C1–B [1] location	Trucks, utility ¼-ton 4 x 4	Trailers, cargo 1 ½-ton, 2-wheel	Trucks, cargo ¾-ton, 4 x 4	Trucks, cargo 2 ½-ton, 6 x 6, LWB	Trucks, cargo 5-ton, 6 x 6 LWB
1	On deck	14	14	12	5	7
	Upper tween deck	21	18	12	6	4
	Lower tween deck	21	18	12	6	5
	Lower hold	14	13	9	4	4
	On deck	25	21	18	12	7
2	Upper tween deck	46	37	25	13	12
	Lower tween deck	42	37	25	15	12
	Lower hold	34	36	21	13	11
	On deck	23	21	14	10	5
3	Upper tween deck	44	42	30	17	12
	Lower tween deck	41	42	28	13	12
	Lower hold	41	42	28	13	9
	On deck	21	21	14	10	7

Table 7–10—Continued

Hatch No.	C1–B[1] location	Trucks, utility ¼-ton 4 x 4	Trailers, cargo 1 ½-ton, 2-wheel	Trucks, cargo ¾-ton, 4 x 4	Trucks, cargo 2 ½-ton, 6 x 6, LWB	Trucks, cargo 5-ton, 6 x 6 LWB
4	Upper tween deck	39	41	26	14	12
	Lower tween deck	36	37	24	12	10
	On deck	16	18	12	7	5
5	Tween deck	23	23	15	7	5
	Hold	10	10	12	6	6
	On deck	22	22	14	9	6

[1] Twice as many vehicles (except 5-ton, 6 x 6) can be stowed in lower holds of Nos. 2 and 3 hatches by double-decking. Holds are not adaptable to plane stowage.

Hatch No.	C1–M–AV1 location	Trucks, utility ¼-ton, 4 x 4	Trailers, cargo 1 ½-ton, 2-wheel	Trucks, cargo ¾-ton, 4 x 4	Trucks, cargo 2 ½-ton, 6 x 6, LWB	Trucks, cargo 5-ton, 6 x 6 LWB
1	Tween deck	30	23	16	10	3
	Hold	16	13	7	4	2
	On deck	30	24	18	10	8
2	Tween deck	51	46	28	19	10
	Hold	51	45	28	19	10
	On deck	28	22	14	10	6
3	Tween deck	44	37	27	17	9
	Hold	44	37	26	15	9
	On deck	20	20	11	7	4

Hatch No.	MARINER Location	Trucks, utility ¼-ton, 4 x 4	Trailers, cargo 1 ½-ton, 2-wheel	Trucks, cargo ¾-ton, 4 x 4	Trucks, cargo 2 ½-ton, 6 x 6, LWB	Trucks, cargo 5-ton, 6 x 6 LWB
1	Upper tween deck	20	16	12	6	4
	Lower tween deck	14	10	9	4	0
	Hold	9	5	6	3	0
	On deck	33	23	20	10	7
2	Upper tween deck	37	23	22	11	7
	Lower tween deck	26	21	15	9	7
	Hold	15	11	9	5	2
	On deck	52	42	30	20	10
3	Upper tween deck	61	48	38	25	13
	Lower tween deck	52	44	32	21	13
	Hold	36	32	22	14	9
	On deck	52	36	26	18	10
4	Upper tween deck	69	46	38	20	14
	Lower tween deck	69	46	38	20	14
	Hold	56	44	30	16	12
	On deck	54	36	28	20	12
5	Upper tween deck	72	56	42	18	14
	Lower tween deck	74	58	44	18[1]	14[1]
	Hold	72	56	42	16[1]	12[1]
	Deep tank	36	28	14	6	2
	On deck	54	40	30	20	12
6	Tween deck	65	47	36	18	14
	Hold	34	30	20	12	9
	Deep tank	10	4	0	0	0
	On deck	37	27	22	12	7
7	Tween deck	42	33	23	11	7
	Hold	10	9	6	4	0

[1] On nonrefrigerated type only. Approximately three 5-tons or four 2½-tons can be loaded in these decks on refrigerated-type vessels.

7–4. Air Transportation

a. Aircraft Requirements. There are three ways of determining aircraft requirements—the weight, space, and load-type methods. The weight method is used primarily for bulk-cargo or logistics shipments when unit integrity of tactical loading is not a consideration. To compute the number of aircraft required, the gross weight of the cargo is divided by the allowable cargo load of the aircraft to be used. The space method of determining aircraft requirements is used for Army aircraft. A space is 240 pounds, the weight of a fully combat-equipped soldier. Heavy equipment is converted into spaces by dividing its weight by 240. The type-load method may be used for both airmobile and joint airborne operations. The type-load method takes into consideration the weight and dimensions of the cargo, the size of cargo compartments, and any special restrictions of the aircraft. The use of scale-down templates of loads and floor diagrams is recommended for type-load planning. All three methods of determining aircraft requirements are explained in TM 55–450–15.

b. Airlift of Troops. Troop movements by air are of two types—tactical and administrative. A tactical move is made under real or simulated combat conditions. The loading plans are influenced by the type of movement. They will vary depending on the mission, the aircraft available, the distance to be flown, the conditions of the flight, the security of the landing area, the time available for disassembly and assembly of equipment, the number of supplies to be transported with the troops, the size of the engineer tools needed in the terrain to be encountered, and other factors. Troop movement orders involving Air Force aircraft usually are issued by the headquarters in command of both the transporting and transported units and are issued to both units simultaneously. The airlifting of a large body of troops usually involves concurrent departures from several airfields and concurrent landings at different locations in the objective area. The availability of transport aircraft and base facilities, the urgency of the situation, and the likelihood of hostile interference are major factors in determining the number of installations to be used and the number of sorties to be made. For load planning, loading procedures, and air movement planning forms see TM 55–450–15.

c. Air Delivery of Supplies. Supplies may be airlanded or airdropped. For external-transport procedures, see TM 55–450–8; for internal-transport procedures, see TM 55–450–8; for internal-transport procedures, see TM 55–450–15. Any of the methods of airdrop—high velocity, low velocity, or free drop—may be employed. In high velocity drops, the parachute limits the rate of descent to about 60–90 feet per second. In low-velocity drops, parachutes limit the rate of descent to about 20–25 feet per second and the load is packed in air delivery containers or rigged on platforms. The amount of supplies that can be delivered by this method depends on the number and types of containers that can be carried on the aircraft and the container ejection means that can be employed. The most commonly used means of extraction is gravity drop. The other common airdrop method, free drop, is the delivery of supplies or equipment without the use of a parachute. Airdrop characteristics of various aircraft are given in TM 55–450–15 and TM 10–500-series manuals.

d. Army Aircraft.

(1) *Performance standards.* Performance standards are affected by many variables, such as fuel load, cargo load, weather, airfield characteristics, and individual aircraft charcteristics. The weight-carrying capabilities of all aircraft are particularly dependent on air density, which is affected by altitude, temperature, and humidity. As air density decreases, lift capacity decreases. In operations requiring long ranges or maximum lift capabilities, wind may become a critical factor. Thus payloads may have to be increased or decreased because of variations in flying conditions. The characteristics and capabilities of Army aircraft shown in table 7–11 are based on normal flying conditions. The Army aviation staff officer should be consulted for accurate, detailed computations to meet specific requirements.

Table 7–11. Army Aircraft Characteristics
(Located in back of manual)

(2) *Rotary-wing aircraft.*

(*a*) *General.* Army rotary-wing aircraft (helicopters) are more limited in speed and range than are fixed-wing aircraft. However, their ability to land and take off vertically permits their use in areas of operations inaccessible to fixed-wing aircraft. Likewise, their capability for flight at relatively slow speeds permits continued operations under weather conditions of low ceiling and restricted visibility.

(*b*) *Planning factors (rotary-wing).*

1. Availability. The number of helicopters available for a mission at any one time will depend on the status of maintenance and inspections on the heilcopters in the unit. Experience indicates that about two-thirds of the helicopters assigned to a unit are available for flying during continuous operations. Usually a higher percentage of assigned aircraft will be operational for missions of short duration. The state of aircraft readiness depends on variables such as previous operational commitments, status of maintenance and inspections, type of aircraft, availability of repair parts, and operational environment.

2. Cargo. The dimensions of cargo are restricted only by the size of the cargo compartment doors and the system used to carry the cargo externally—assuming, of course, that the weight of the load does not exceed the weight limitations or center of gravity limits for the aircraft under prevailing conditions. Typical items of cargo for internal loading are boxes of rations, ammunition, signal equipment, vehicle and aircraft parts, and supplies. Loads which are too large to fit into the cargo compartment but under the maximum weight permissible for external loads may be carried slung under the helicopter.

3. Landing facilities. Provisions must be made for adequate landing sites when planning helicopter movements. The minimum requirements for landing sites are as follows; however, larger areas with cleared approaches are highly desirable.

OH–23, OH–13	18 m x 18 m
UH–1A	28 m x 28 m
CH–34	28 m x 46 m
CH–37, CH–47	46 m x 64 m

4. Maintenance. Primary landing areas should have maintenance facilities or, as a minimum, a sheltered area where organizational maintenance can be performed. For planning purposes, organizational maintenance requires 10.8 hours for the CH–34C; 15.6 hours for the CH–37B, CH–47A, and CH–54A; and 6 hours for the UH–1B and UH–1D aircraft.

5. Hours of operation. The average number of hours of operation per day for extended periods should not exceed daily equivalents of the monthly flying hour program contained in FM 101–20, for the type of helicopter employed.

6. Loading and unloading time. The factors given here are for planning purposes and presume the aircraft has been properly prepared for the personnel or cargo that it is to transport. The times do not include palletizing general cargo for internal loading or rigging slings on cargo for external transport.

Personnel:	
Troops	3 minutes
Casualties	10 minutes
Cargo internal in fuselage:	
Single vehicles	5 minutes
Vehicles with trailers	15 minutes
Palletized cargo (by hand)	20 minutes
Cargo suspended beneath helicopter:	
Hookup or release time only	30 seconds

7. Payload guidance. Data on payload guidance for rotary-wing aircraft is furnished in table 7–11. For effective payload, subtract the number of door gunners from the troop capacity. Density altitude will have a decided effect on helicopter payloads; therefore, the command's aviation staff officer should be consulted on a daily basis.

8. Determination of transport helicopter requirements. Most helicopter operations will be of the short-haul type and may require that more than one round trip (sortie) be flown in support of the movement. If service and fuel are available at both pickup and delivery points, one-half sortie can be computed as a lift. (A lift is the movement of a load from origin to destination.) This would require the helicopters to remain in the delivery point area for service, which usually is undesirable. The following formulas may be used to determine the number of helicopters or units required to accomplish a given mission or the capabilities of helicopters on a specific mission:

$N = \frac{HS}{D}$ when

N = Number of sorties per aircraft per day. This figure must be the next lower whole number if a fraction is involved.

S = Average sortie speed of aircraft in knots. For planning purposes, use cruising speed unless some other speed is specified.

D = Round trip distance in nautical miles. This distance must be the actual distance flown rather than airline distance from origin to destination. If airline distance is used, add 15 percent to the airline distance to obtain estimated flight distance.

H = The number of operational hours available.

$O = \frac{T}{N \times P}$ when

O = Number of operational aircraft required or available daily.

T = Tonnage to be moved or tonnage that can be moved.

P = Payload of type aircraft used.

$A = 1.5 \times O$, when

A = The number of aircraft required or available to carry out a sustained operation. This formula ap-

plies a planning factor of 67 percent. (For sustained operations, only 67 percent of the assigned aircraft can be considered available for use at any given time.)

This method of determining helicopter requirements is particularly applicable to movement of supplies or troops when combat loading is not a factor to be considered. Aircraft for air-landed assault operations should be determined by the preparation of a planning worksheet. The planning worksheet develops loads to provide for tactical integrity of the combat units and combat loading of each aircraft. The method of determining aircraft requirements described here can be used to *estimate* requirements for assault operations by adding 10 percent to the unit personnel and equipment tonnage to allow for combat loading.

(3) *Fixed-wing aircraft.*

(*a*) *General.* Army fixed-wing aircraft have less speed and range than larger transport aircraft. However, the ability of Army fixed-wing aircraft to land and take off from selected small, unprepared areas permit their use in areas of operations inaccessible to larger aircraft. The ability of Army fixed-wing aircraft to fly slow and maintain a high degree of maneuverabilitiy further enhances their value in forward areas under combat conditions.

(*b*) *Planning factors (fixed-wing).*

1. Availability. The operation plan should be based on the availability of 75 percent of the assigned aircraft for sustained operations. A higher availability ratio of approximately 95 percent may be obtained for operations of short duration (less than 6 days). This higher availability ratio will depend on the status of maintenance and inspections, repair parts, time available for maintenance, and degree of skill of maintenance personnel.

2. Cargo. The size and amount of cargo which may be loaded internally will be governed by the size of compartment door, compartment door location with respect to the cargo compartment, size of cargo compartment, aircraft center of gravity, and lifting capability of the aircraft used.

3. Landing facilities. When aircraft movements are planned, provisions must be made for an adequate landing area. Moreover, the development of a landing area adequate for prolonged operations or for accommodation of frequent traffic is a continuous operation. The minimum requirements for landing areas are shown in table 7–12. See TM 5–330 for a detailed discussion.

Table 7–12. Minimum Requirements for Landing Areas

Aircraft at max. gross wt.	Minimum landing area [1]	
	Length (meters)	Width (meters)
O–1A	250	15
U–6A	370	20
U–8D	760	20
U–1A	460	20
OV–1A	900 [2]	20

[1] With no wind, at sea level, over 15-meter obstacle.
[2] Most critical configuration.

4. Maintenance. Under normal climatic conditions, direct support maintenance units are equipped for field operations, and no extensive facilities are required for organizational maintenance. Under extreme climatic conditions, however, special facilities and equipment may be required.

5. Hours of operation. Based on a sustained operation, average flying hours per airplane should not exceed the daily equivalent of the monthly flying hour program contained in FM 101–20.

6. Loading and unloading time. The factors given here are for planning purposes and presume that the aircraft has been properly prepared for the personnel or cargo to be transported. The times do not include palletizing general cargo for internal loading or rigging slings on cargo for external transport.

Personnel:

Troops	3 minutes
Casualties	10 minutes

Loading internal cargo in fuselage 10 to 30 minutes
Unloading internal cargo in fuselage 5 to 15 minutes
External loads:

Loading	10 minutes
Air landed	10 minutes
Dropped by parachute	30 seconds
Off loaded for free fall	10 seconds

7. Payload guidance. Table 7–10 can be used as a guide for determining the approximate aircraft requirements for transporting cargo or personnel. Crewmen should not be counted against payload weight or troop capacity. The recommended weight of payload and fuel is for extended operation at 60° F at sea level with no wind. For one-time emergency flight this figure may be increased to the design limit of the aircraft. Technical manuals of the 55–1510–10 series for the

respective aircraft give the lift capability at temperature other than 50° F and at higher elevations.

8. Refueling time. Time requirements to refuel from a pump delivering 50 gallons per minute are as follows:

Light observation aircraft (O–1)	5 minutes
Utility aircraft (U–6)	8 minutes
Transports (U–1A)	15 minutes
Staff transports	10 minutes

e. Air Force Transport Aircraft.

(1) For general consideration and procedures governing the employment of Air Force transport aircraft in joint operations, see FM 100–5; FM 101–5; and FM 57–100.

(2) The following terms are useful in planning for joint airborne operations.

(*a*) *Allowable cargo load.* The allowable cargo load is the weight of cargo which can be loaded into an aircraft for a specific mission. In an airborne operation, the Air Force commander will announce the allowable cargo load for each type of aircraft. The allowable cargo load of an aircraft varies according to the distance and conditions of the flight. Because longer flights require that more fuel be carried, the allowable cargo load is reduced for long flights. In radius operations, the allowable cargo load for the distance traveled may be greater for parachute operations than that for air landed operations because of weight restrictions on landing aircraft.

(*b*) *Radius of action.* The radius of action is the maximum distance to which an airplane can safely travel and return without refueling. Operations under radius conditions are those in which aircraft deliver troops or material at a destination and return without refueling.

(*c*) *Range.* Range is the distance from the takeoff point to the point where an airplane delivers its cargo load (safety margin of reserve fuel included). The plane must refuel to return to the original takeoff point.

(3) TM 55–450–15 contains general descriptions of the various types of military aircraft, technical characteristics, and performance data, including cargo compartment dimensions, troop and litter capacities, and aerial delivery capacities.

(4) Planning data for determining Air Force transport aircraft requirements for movement of units of a type field army are contained in FM 101–10–1.

(5) The following data are included for use as a guide in computing type load requirements for airlifting Army aircraft in Air Force transport aircraft. Total requirements of Air Force transport aircraft necessary to lift complete TOE units may be determined by combining aircraft requirements based on the data below with the tabulated requirements for the aviation unit shown in FM 101–10–1. The allowable cargo loads for Air Force aircraft used in determining the number of Army aircraft each can transport are those shown in table 7–13. Space, however, rather than weight is the critical factor.

Table 7–13. Type Loads for Airlifting Army Aircraft

Air Force transport aircraft	Type of Army aircraft	No. of Army aircraft	Degree of disassembly	Total load*	
				Pounds	Short tons
C–119	O–1	2	Wings, elevators, and vertical fin	3,718	1.9
C–123	O–1	1	Wings, elevators, and vertical fin	3,718	1.9
C–124	O–1	2	Wings	5,577	2.8
C–124	O–1	4	Wings, elevators, and vertical fin	7,437	3.7
C–130	O–1	2	Wings, elevators, and vertical fin	3,718	1.9
C–133	O–1	3	Wings	5,577	2.8
C–133	O–1	4	Wings and elevators	9,296	4.7
C–119	U–6	1	Wings, elevators, main and tail landing gear, propeller, and all antennas.	3,527	1.8
C–123	U–6	1	Wings, elevators, main and tail landing gear, propeller, and all antennas.	3,527	1.8
C–124	U–6	2	Wings, elevators. Reduce landing gear width to 118"	7,056	3.5
C–130	U–6	1	Wings, elevators. Reduce landing gear width to 113"	3,527	1.8
C–133	U–6	4	Wings, elevators, and fuselage-to-leg fairings	14,112	7.1
C–119	U–1A	--	Degree of disassembly required to transport in this aircraft is uneconomical.	------	----

Table 7–13—Continued

Air Force transport aircraft	Type of Army aircraft	No. of Army aircraft	Degree of disassembly	Total load*	
				Pounds	Short tons
C–123	U–1A	--	Degree of disassembly required to transport in this aircraft is uneconomical.	------	----
C–124	U–1A	--	Wings, elevators, propellers, and landing gear	10,752	5.4
C–130	U–1A	1	Wings, elevators, propellers, and landing gear	5,876	2.7
C–133	U–1A	2	Wings, elevators, propellers, and landing gear	10,752	5.4
C–119	OH–13	1	Blades and main rotor mast assembly	1,893	0.9
C–123	OH–13	1	Blades and main rotor mast assembly	1,893	0.9
C–124	OH–13	2	Main rotor blade on one aircraft	3,786	1.9
C–130	OH–13	2	Main rotor blade and mast on one aircraft and main rotor blade only on the other aircraft.	3,786	1.9
C–133	OH–13	2	One main rotor blade and whip antenna (two)	3,786	1.9
C–133	OH–13	5	One main rotor blade and whip antenna	9,465	4.7
C–119	UH–19	1	Head, blades, landing gear, and tail cone	6,382	3.2
C–123	UH–19	1	Head, blades, landing gear, and tail cone	6,382	3.2
C–124	UH–19	2	Head, blades, and tail cone	12,764	6.4
C–130	UH–19	2	Head, blades, landing gear, and tail cone	12,764	6.4
C–133	UH–19	2	Head and blades	12,764	6.4
C–133	UH–19	4	Head, blades, and tail cone	25,528	12.8
C–119	CH–21	--	Degree of disassembly required to transport in this aircraft is uneconomical.	------	----
C–123	CH–21	--	Degree of disassembly required to transport in this aircraft is uneconomical.	------	----
C–124	CH–21	1	Blades and landing gear; body in two sections	10,416	5.2
C–130	CH–21	--	Degree of disassembly required to transport in this aircraft is uneconomical.	------	----
C–133	CH–21	1	Head, blades, and landing gear	10,416	5.2
C–119	OH–23	1	Blades and mast	2,016	1.0
C–123	OH–23	1	Blades and mast	2,016	1.0
C–124	OH–23	2	One main rotor blade, both control blades, and antennas	4,032	2.0
C–130	OH–23	2	Head and blades	4,032	2.0
C–133	OH–23	2	One main rotor blade and antenna	4,032	2.0
C–133	OH–23	4	One main rotor blade (four) and antennas	8,064	4.0
C–133	OH–23	5	One main rotor blade (five) and antennas	10,080	5.0
C–119	CH–34	--	Degree of disassembly required to transport in this aircraft is uneconomical.	------	----
C–123	CH–34	--	Degree of disassembly required to transport in this aircraft is uneconomical.	------	----
C–124	CH–34	2	Heads, blades, landing gear, tail pylon and canopy assembly.	17,987	9.0
C–130	CH–34	--	Degree of disassembly required to transport in this aircraft is uneconomical.	------	----
C–133	CH–34	2	Heads, blades, landing gear, tail pylon and canopy assembly.	17,987	9.0
C–119	UH–1	--	Degree of disassembly required to transport in this aircraft is uneconomical.	------	----
C–123	UH–1	1	Blades, landing gear, pylon stabilizers, main rotor mast, tailpipe fairing, transmission cowling (2 halves), tail rotor blade, tail cone, and all antennas.	4,333	2.2
C–124	UH–1	2	For UH–1A: (from each helicopter) one main rotor blade, stabilizer bar from main rotor head; synchronized elevator, one tail rotor, antennas. For UH–1B and UH–1D; antennas, stabilizer bar assembly, hub assembly, main rotor blades, mast and swashplate assembly, one tail rotor blade, and synchronized elevators.	8,666	4.3
C–130	UH–1	1	For UH–1A: main rotor blades, head and mast, one tail rotor, synchronized elevator, and all antennas. For UH–1B and UH–1D: antennas, main blades, tail rotor blade, mast and swashplate assembly, synchronized elevators, exhaust cowling, and exterior mirror.	4,333	2.2

Table 7–13—Continued

Air Force transport aircraft	Type of Army aircraft	No. of Army aircraft	Degree of disassembly	Total load*	
				Pounds	Short tons
C–133	UH–1	3	For UH–1A: one main rotor blade, one tail rotor blade, all antennas, and synchronized elevator. For UH–1B and UH–1D: all antennas, leading main rotor blade, synchronized elevators, and exterior mirror, additionally, for helicopters loaded forward of the wing spar, remove both main rotor blades, and mast and swashplate assembly.	12,999	6.5

* Includes an estimated 240 pounds per ton of aircraft for crating and cradling materials.

CHAPTER 8

CEMETERIES AND BURIALS

8–1. Military Cemeteries

The size of temporary military cemeteries, established as required during military operations, is not fixed but is dependent on requirements. An acre of average land (43,560 square feet) will accommodate approximately 6 standard plots (5,772 square feet per plot), providing space for 864 grave sites, including aisle and border requirements. Layout of the cemetery by plot, row, and grave is described in FM 10–63.

8–2. Mass Burials

Responsibility for and layout of the grave site for mass burials is described in FM 10–63.

CHAPTER 9

MEASUREMENTS, CONVERSIONS, AND EQUIVALENTS

9–1. Measurement Tables

Tables 9–1 through 9–9 give information on measurements.

Table 9–1. Linear Measure

12	inches	= 1 foot
3	feet	= 1 yard
16½	feet	= 1 rod
5½	yards	= 1 rod
320	rods	= 1 mile
1,760	yards	= 1 mile
5,280	feet	= 1 mile

Table 9–2. Square Measure

144	square inches	= 1 square foot
9	square feet	= 1 square yard
4,840	square yards	= 1 acre
70	yards square	= 1 acre (approximately)
43,560	square feet	= 1 acre
640	acres	= 1 square mile
272¼	square feet	= 1 square rod

Table 9–3. Cubic Measure

1,728	cubic inches	= 1 cubic foot
27	cubic feet	= 1 cubic yard

Table 9–4. Nautical Measure

6	feet	= 1 fathom
100	fathoms	= 1 cable length (ordinary)
120	fathoms	= 1 cable length (U.S. Navy)
6,080.2	feet	= 1 nautical mile

Table 9–5. Dry Measure

1	pint	= 33.6 cubic inches
2	pints	= 1 quart
1	quart	= 67.2 cubic inches
8	quarts	= 1 peck
1	peck	= 537.6 cubic inches
4	pecks	= 1 bushel
1	bushel	= 2,150.42 cubic inches

Table 9–6. Fluid Measure

16	fluid ounces (U.S.A.)	= 1 pint
20	fluid ounces (Britain)	= 1 pint
2	pints	= 1 quart
4	quarts	= 1 gallon
1	gallon	= 8½ pounds (approximate)
1	pint	= 4 gills
31½	gallons	= 1 barrel

Table 9–7. Angular and Circular Measure

60	seconds	= 1 minute
60	minutes	= 1 degree
90	degrees	= 1 right angle
180	degrees	= 1 straight angle
360	degrees	= 1 circle

Table 9–8. Measurement of Surfaces and Solids

Circumference of a circle	= Diameter x 3.1416
Area of a triangle	= Base times altitude ÷ 2
Area of a square or an oblong	= Length x breadth
Area of a circle	= Square of the diameter x .7854 or Square of the radius x 3.1416
Area of the sector of a circle	= Length of the arc x the radius divided by 2
Area of any right-lined figure of four or more unequal sides	= Division of the figure into triangles, finding of the area of each triangle, and adding of the areas
Area of an ellipse	= Long axis x the short axis x .7854 (length x perimeter)
Surface of a cone or a pyramid	= One-half of slant height x perimeter of base + area of base
Surface of a cube	= Sum of areas of all the sides
Surface of a sphere	= Square of the diameter x 3.1416
Cubic content of a prism or cylinder	= Area of the base x the height
Cubic content of a cone or a pyramid	= 1/3 (area of base x altitude)
Surface of a prism or a cylinder	= Area of 2 ends + (length x perimeter)
Cubic content of a cube	= Length x breadth x depth
Cubic content of a sphere	= Cube of the diameter x .5236

Table 9–9. Weights and Measures of Various Nations

Country	Weight or measure	American equivalent
Argentina	Arroba	25.32 lb.
	Baril	20.077 gal.
	Cuadra	4.2 acres
	Frasco (liq.)	2.509 qt. (liq.)
	Libra	1.013 lb.
	Pie	0.947 ft.
	Vara	34.01 in.
Australia	Weights and measures of Great Britain	

Table 9–9—Continued

Country	Weight or measure	American equivalent
Austria	Joch	1.422 acres
	Klafter	2.074 yd.
Belgium	Last	85.134 bu.
Bolivia	Marc	0.507 lb.
Borneo	Picul	135.64 lb.
Brazil	Arroba	32.379 lb.
	Quintal	120.54 lb.
Canada	Weights and measures of Great Britain	
Celebes	Picul	135.64 lb.
Central America	Centore	4.263 gal.
	Fanega	1.574 bu.
	Libra	1.014 lb.
	Manzana	1.727 acres
	Vara	32.913 in.
Chile	Fanega	2.753 bu.
	Libra	1.014 lb.
	Quintal	101.41 lb.
	Vara	32.913 in.
China	Catty	1.333 lb.
	Ch'ih	12.6 in.
	Li	1,890 feet
	Picul	133.333 lb.
	Tael Kuping	575.64 grains (troy)
	Tsun	1.26 in.
Cuba	Libra	1.014 lb.
	Vara	33.386 in.
Denmark	Pund	1.102 lb.
	Tønde (grain)	4.491 bu.
	Tøndeland	1.36 acres
Dutch Guiana	Livre	1.089 lb.
Ecuador	Fanega	1.574 bu.
Egypt	Ardeb	5.619 bu.
	Cantar	99.05 lb.
	Feddan	1.04 acres
	Oke	2.805 lb.
	Pic	22.83 in.
France	Tonne	2,204.62 lb.
Federated Malay States	Bongkal	832.0 grains
Germany	Klafter	2.074 yd.
	Last	4,409 + lb.
Great Britain	Comb	4.128 bu.
	Gallon	1.2 U.S. gal.
	Last	82.56 bu.
	Load (timber)	50 cu. ft.
	Cwt. (hundred weight)	112.0 lb.
	Quart (liq.)	1.2 U.S. qt. (liq.)
	Quart (dry)	1.03 U.S. qt. (liq.)
	Quarter	8.256 bu.
	Sack (flour)	280 lb.
	Stone	14 lb.
	Wey	41.282 bu.

Table 9–9—Continued

Country	Weight or measure	American equivalent
Greece	Drachma (new)	1 metric gr.
	Livre	1.1 lb.
	Mina (old)	2.202 lb.
	Oke	2.82 lb.
Guatemala	Fanega	1.53 bu.
	Libra	1.014 lb.
	Vara	32.909 in.
Honduras	Milla	1.149 mi.
	Vara	32.953 in.
Hongkong	Catty	1.333 lb.
	Picul	133.333 lb.
Hungary	Joch	1.067 acres
India		
(Bombay)	Candy	569 lb.
(Madras)	Candy	500 lb.
	Maund	82.285 lb.
	Ser	2.204 lb.
Iran (Persia)	Jarib	2.471 acres
Iraq	Hogga	2.8 lb.
	Man	56 lb.
	Wazna	224 lb.
	Tughar	4,480 lb.
	Dhar	29.38 in.
	Meshara	.62 acres
Israel	Rottle	6.35 lb.
Japan	Bu	0.12 in.
	Catty	1.32 lb.
	Cho	2.451 acres
	Ken	5.97 ft.
	Koku	5.119 bu.
	Kwamme	8.267 lb.
	Se	.024 acres
	Shaku	11.93 in.
	Sho (liq.)	1.91 qt. (liq.)
	Sun	1.193 in.
	Tan	.25 acres
	To	2.05 pk.
	Tsubo	35.58 sq. ft.
Java	Catty	1.36 lb.
	Picul	136.16 lb.
Luxemburg	Fuder	264.18 gal.
Malacca	Catty	1.36 lb.
Malta	Barrel (customs)	11.2 gal.
	Caffisco	5.4 gal.
	Cantaro	175 lb.
	Salm	8.2 bu.
Mexico	Baril	20.078 gal.
	Fanega	2.577 bu.
	Frasco (liq.)	2.5 qt. (liq.)
	Libra	1.014 lb.
	Quintal	101.47 lb.
	Vara	32.99 in.
Morocco	Artel	1.12 lb.
	Cantar	112 lb.
Nicaraugua	Manzana	1.742 acres
	Milla	1.159 mi.
	Vara	33.057 in.

Table 9–9—Continued

Country	Weight or measure	American equivalent
Norway	Centner	110.23 lb.
Paraguay	Arroba	25.32 lb.
	Cuadra (lin.)	94.7 yd.
	Cuadra (sq.)	1.85 acres
	League	4.633 acres
Peru	Libra	1.014 lb.
	Quintal	101.43 lb.
	Vara	31.913 in.
Philippines	Picul	139.44 lb.
Poland	Garnice	1.056 gal.
	Vloka	41.5 acres
Portugal	Almude	4.422 gal.
	Li'ra	1.012 lb.
Russia	Arshin (lin.)	28 in.
	Arshin (sq.)	5.44 sq. ft.
	Berkovets	361.128 lb.
	Chetyert	5.957 bu.
	Dessiatine	2.699 acres
	Food	36.113 bl.
	Funt	0.9 lb.
	Sajene	7 ft.
	Vedro	2.707 gal.
	Verst	0.633 mile
Spain	Arroba	4.263 gal.
	Fanega	16 gal.
	Frail (rais's)	50 lb.
	Pie	0.914 ft.
	Quintal	101.43 lb.
Sumatra	Bouw	7,096.5 $m.^2$
	Catty	2.12 lb.
Sweden	Centner	93.7 lb.
	Skalpund	0.937 lb.
	Tunna	4.5 bu.
	Tunnland	1.22 acres
Thailand	Catty (standard)	1.333 lb.
	Catty	2.667 lb.
	Coyan	2,645.5 lb.
Turkey	Cantar	124.45 lb.
	Oke	2.828 lb.
	Pik	27.9 in.
Uruguay	Cuadra	1.82 acres
	Fanega	3.888 bu.
	Libra	1.014 lb.
Venezuela	Fanega (double)	3.334 bu.
	Fanega (single)	7.776 bu.
	Libra	1.014 lb.
Zanzibar	Frasila	35 lb.

9–2. Miscellaneous Units of Measure

a. Bale. A large, closely pressed bundle of goods. When the amount is fixed for a certain commodity, the term is sometimes used as a unit of measure; for example, a bale of cotton weighs 500 pounds.

b. Board foot. A unit of quantity for lumber equal to the volume of a board 12 inches by 12 inches by 1 inch.

c. British Thermal Unit (B.t.u.). A measure of heat equal to 252 calories or 0.00029 kilowatt-hours.

d. Calorie. A unit of heat equal to the quantity of heat required to raise one gram of water from 14.5° C to 15.5° C.

e. Decibel. A unit for measuring the relative loudness of sounds. It is equal to the smallest degree of sound detectable by the human ear. The human auditory range is about 130 decibels on a scale beginning at one.

f. Foot-pound. A unit of work equal to raising one pound a distance of 1 foot against the force of gravity.

g. Freight Ton. Cargo measuring less than 40 cubic feet per long ton or weighing less than 56 pounds per cubic foot.

h. Great Gross. A unit of quantity equal to 12 gross or 1,728.

i. Gross. A unit of quantity equal to 12 dozen or 144.

j. Hand. A unit of measure equal to 4 inches used especially for stating the height of horses.

k. Hogshead. A large cask or barrel, especially one containing 63 to 140 gallons.

l. Horsepower. A unit of power equal in the United States to 746 watts and nearly equivalent to the English gravitational unit of the same name that equals 550 foot-pounds of work per second.

m. Knot. One nautical mile per hour. Used as a unit of measurement in expressing the rate of speed of ships and airplanes and in expressing the strength of air and water currents.

n. League. An English unit of about 3 miles.

o. Mil. A unit of length equal to 1/1000 inch or 0.0254 millimeter. Used especially for measuring the diameter of wire.

p. Quire. A collection of 24 or 25 sheets of paper of the same size and quality. May be unfolded or a single fold.

q. Ream. Twenty quires or 480 sheets of paper. (500 sheets for newsprint or book paper.)

r. Span. The distance from the end of the thumb to the end of the little finger of the spread hand or 9 inches.

s. Watt. A unit of electrical power equal to the voltage multiplied by the amperage.

9–3. Conversions

Tables 9–10 through 9–19 give information on conversions.

Table 9–10. Conversions of Volume

Unit	Cubic feet	Imperial gallon	U.S. gallon	Liters	U.S. quarts
One cubic foot.	=	6.229	7.481	23.32	29.92
One imperial gallon.	= .16054		1.2010	4.546	4,804
One U.S. gallon.	= .13368	.8327		3.7854	4.000
One liter	= .03532	.2201	.2642		1.0567

Table 9–11. Conversions of Weight

a. Metric to United States.

Metric	United States
Millier (tonneau, metric ton)	2,204.6 pounds
Quintal	220.46 pounds
Myriagram	22.046 pounds
Kilogram	2.2046 pounds
Hectogram	3.5274 ounces
Decagram	.3527 ounces
Gram	15.432 grains
Decigram	1.5432 grains
Centigram	.1543 grains
Milligram	.0154 grains

b. Tons and kilograms.

Unit	Long tons	Metric tons	Short tons	Kilograms	Pounds	Cu. ft.
One long ton.		1.0160	1.1200	1,016.0	2,240.0	
One metric ton.	0.9842		1.1023	1,000.0	2,204.6	
One short ton.	.8929	.9072		907.2	2,000.0	
One kilogram.					2.2	
One measurement ton.						40.0

Table 9–12. Conversions of Length

Metric	United States
Myriameter	6.2137 miles
Kilometer	.62137 mile
Hectometer	328 feet 1 inch
Decameter	393.7 inches
Meter	39.37 inches
Decimeter	3.937 inches
Centimeter	.3937 inch
Millimeter	.03937 inch

Table 9–13. Conversions of United States Measures to Metric Measures

United States or imperial measures	Conversion factor	Metric measures
Acres	0.4047	Hectares
Cubic feet	.0283	Cubic meters
Cubic inches	16.3872	Cubic centimeters
Cubic inches	.0164	Liters
Cubic yards	.7646	Cubic meters
Feet	.3048	Meters
Feet per second	18.288	Meters per minute
Gallons (U.S.)	3.7854	Liters
Gallons (imp.)	4.543	Liters
Grains	.0648	Grams
Hundredweights	.508	Quintals
Inches	2.54	Centimeters
Inches	.0254	Meters
Inches	25.4001	Millimeters
Miles	1.6093	Kilometers
Miles per hour	.447	Meters per second
Ounces (avdp.)	28.349	Grams
Ounces (avdp.)	.92835	Kilograms
Pints (U.S.)	.4732	Liters
Pints (imp.)	.568	Liters
Pounds (avdp.)	.45359	Kilograms
Square feet	.0929	Square meters
Square inches	6.4516	Square centimeters
Square miles	2.590	Square kilometers
Square yards	.8361	Square meters
Yards	.914	Meters

Table 9–14. Conversions of Metric Measures to United States Measures

Metric Measures	Conversion factor	United States or imperial measures
Acres	119.6	Square yards
Centimeters	0.3937	Inches
Cubic centimeters	.0610	Cubic inches
Cubic meters	35.3144	Cubic feet
Cubic meters	1.3079	Cubic yards
Grams	15.4324	Grains
Grams	.03527	Ounces (avdp.)
Hectares	2.4710	Acres
Kilogram	2.2046	Pounds (avdp.)
Kilograms	35.2739	Ounces (avdp.)
Kilometers	.62137	Miles
Liters	61.025	Cubic inches
Liters	.2642	Gallons (U.S.)
Liters	.220	Gallons (imp.)
Liters	2.1134	Pints (U.S.)
Liters	1.76	Pints (imp.)
Meters	3.2808	Feet
Meters	39.37	Inches
Meters	1.0936	Yards
Meters per minute	.0547	Feet per second
Meters per second	2.237	Miles per hour
Metric ton	2,204.6	Pounds
Millimeters	.0393	Inches
Quintals	1.97	Hundredweights
Square centimeters	.155	Square inches
Square kilometers	.3861	Square miles
Square meters	1.1960	Square yards
Square meters	10.764	Square feet

Table 9-15. Prefixes of Metric Units of Measure

Prefix	Multiply by
Giga	1,000,000,000
Mega	1,000,000
Kilo	1,000
Hecto	100
Deca	10
Deci	.1
Centi	.01
Milli	.001
Micro	.000001

Table 9-16. Conversions of Temperature

Centigrade	=	5/9 (F − 32)
Fahrenheit	=	9/5C + 32
Centigrade	=	5/4R
Reaumur	=	4/5C
Fahrenheit	=	9/4R + 32
Reaumur	=	4/9 (F − 32)

Table 9-17. Cloth Conversions

(To find square yards, multiply the length of the cloth in yards by the conversion factor of its width.)

Width of cloth (inches)	Conversion factor	Width of cloth (inches)	Conversion factor
21½	.5972	38½	1.0694
22	.6111	39	1.0833
22½	.6250	39½	1.0972
23	.6339	40	1.1111
23½	.6528	40½	1.1250
24	.6667	41	1.1389
24½	.6806	41½	1.1528
25	.6944	42	1.1667
25½	.7083	42½	1.1806
26	.7222	43	1.1944
26½	.7361	43½	1.2083
27	.7500	44	1.2222
27½	.7639	44½	1.2361
28	.7778	45	1.2500

Table 9-17—Continued

Width of cloth (inches)	Conversion factor	Width of cloth (inches)	Conversion factor
28½	.7917	45½	1.2639
29	.8056	46	1.2778
29½	.8194	46½	1.2917
30	.8333	47	1.3056
30½	.8472	47½	1.3194
31	.8611	48	1.3333
31½	.8750	48½	1.3472
32	.8889	49	1.3611
32½	.9028	49½	1.3750
33	.9167	50	1.3889
33½	.9306	50½	1.4028
34	.9444	51	1.4167
34½	.9583	51½	1.4306
35	.9722	52	1.4444
35½	.9861	52½	1.4583
36	1.0000	53	1.4722
36½	1.0139	53½	1.4861
37	1.0278	54	1.5000
37½	1.0418	54½	1.5139
38	1.0556	55	1.5278
55½	1.5417	69	1.9167
56	1.5556	70	1.9444
56½	1.5694	71	1.9722
57	1.5833	72	2.0000
57½	1.5972	73	2.0278
58	1.6111	74	2.0556
58½	1.6250	75	2.0833
59	1.6389	76	2.1111
59½	1.6528	78	2.1667
60	1.6667	80	2.2222
61	1.6944	82	2.2778
62	1.7222	84	2.3333
63	1.7500	88	2.4444
64	1.7778	90	2.5000
65	1.8056	96	2.6667
66	1.8333	100	2.7778
67	1.8611	108	3.0000
68	1.8889		

Table 9-18. Rope Conversions

a. Standard lay, tent lay, and cotton.

Diameter (inches)	Standard lay		Tent lay								Cotton			
	Manila, Sisal, Jute		Manila, Sisal		Manila		Cotton		Jute		Twisted		Braided	
	Lb/Ft	Ft/Lb	Lb/Ft	Ft/Lb	Lb/Ft	Ft/Lb	Lb/Ft	Ft/Lb	Lb/Ft	Ft/Lb	Lb/Ft	Ft/Lb	Lb/Ft	Ft/Lb
1/8											.005	200.0	.005	200.0
5/32													.011	90.0
3/16	.015	66.6					.014	71.4			.011	90.0	.017	58.8
7/32													.021	47.6
1/4	.020	50.0	.018	55.6			.023	43.5	.020	50.0	.019	52.0	.025	40.0
5/16	.029	34.5	.026	38.5			.036	27.8	.029	34.5			.040	25.0
3/8	.041	24.4	.037	27.0			.053	18.9	.041	24.4	.043	23.5	.053	18.9
7/16	.053	19.0												
1/2	.075	13.3	.068	14.7			.087	11.5	.075	13.3	.074	13.5	.091	11.0
9/16	.104	9.61												
5/8	.133	7.50	.120	8.33			.154	6.49	.133	7.5				
3/4	.167	6.00	.150	6.67			.196	5.10	.167	6.0	.167	6.0		
13/16	.195	5.13												
7/8	.225	4.45												

Table 9–18. Continued

Diameter (inches)	Standard lay		Tent lay								Cotton			
	Manila, Sisal, Jute		Manila, Sisal		Manila		Cotton		Jute		Twisted		Braided	
	Lb/Ft	Ft/Lb	Lb/Ft	Ft/Lb	Lb/Ft	Ft/Lb	Lb/Ft	Ft/Lb	Lb/Ft	Ft/Lb	Lb/Ft	Ft/Lb	Lb/Ft	Ft/Lb
1	.270	3.71			.243	4.12					.285	3.5		
1 1/16	.313	3.20												
1 1/8	.360	2.78												
1 1/4	.418	2.40			.377	2.65								
1 5/16	.480	2.09												
1 1/2	.600	1.67												
1 5/8	.744	1.34												
1 3/4	.895	1.12												
2	1.08	.926												
2 1/4	1.46	.685												
2 5/8	1.91	.524												
3	2.42	.414												
3 1/4	2.99	.335												
3 5/8	3.67	.273												
4	4.36	.230												

b. Plied yarn construction.

Diameter (inches)	Filament nylon MIL–R–17343C		Filament polyester MIL–R–30500A		Monofilament & multifilament polypropylene MIL–R–24049A	
	Lb. Per Ft.	Ft. Per Lb.	Lb. Per Ft.	Ft. Per Lb.	Lb. Per Ft.	Ft. Per Lb.
3/16	.009*	113.00	.01*	100.00	.0065*	155.00
1/4	.015	67.67	.018*	55.00	.011*	92.00
5/16	.025*	40.00	.029*	35.00	.018*	55.00
3/8	.036	27.78	.041	24.10	.025*	40.00
7/16	.050	20.00	.057	17.50	.033*	30.00
1/2	.066	15.04	.074	13.60	.044	22.50
9/16	.082	12.12	.093	10.70	.059	17.00
5/8	.100	10.00	.115	8.70	.071	14.00
3/4	.145	6.90	.167	6.00	.100	10.00
3/16	.168	5.95	.196	5.10	.121	8.25
7/8	.200	5.00	.227	4.40	.135	7.40
1	.258	3.88	.294	3.40	.172	5.80
1 1/16	.285	3.51	.331	3.02	.198	5.05
1 1/8	.320	3.13	.375	2.67	.213	4.70
1 1/4	.395	2.53	.461	2.17	.260	3.85
1 5/16	.460	2.17	.505	1.98	.294	3.40
1 1/2	.565	1.77	.662	1.51	.364	2.75
1 5/8	.700	1.43	.781	1.28	.444	2.25
1 3/4	.830	1.20	.885	1.13	.518	1.93
2	.980	1.02	1.21	.83	.625	1.60
2 1/8	1.120	.89	1.34	.74	.730	1.37
2 1/4	1.310	.76	1.42	.66	.800	1.25
2 1/2	1.500	.67	1.89	.53	.971	1.03
2 5/8	1.700	.59	2.08	.48	1.08	.93
2 7/8	1.900	.53	2.47	.405	1.20	.83
3	2.130	.47	2.72	.368	1.41	.71
3 1/8	2.33	.435	2.94	.34	1.49	.67
3 1/4	2.480	.40	3.23	.31	1.64	.61
3 1/2	3.03	.33	3.70	.27	1.96	.51
3 3/4	3.57	.28	4.26	.235	2.22	.45

* Regular construction, not plied yarns

c. Spun nylon regular construction (MIL–R–43161)

Diameter (inches)	Lb/Ft	Ft/Lb
1/4	.014	73.0
5/16	.023	43.0
3/8	.033	30.4
7/16	.048	21.0
1/2	.058	17.4
9/16	.077	13.0
5/8	.096	10.4
3/4	.135	7.4
13/16	.156	6.4
7/8	.185	5.4
1	.263	3.8

Table 9–18—Continued

d. Spun polyester regular construction

Diameter (inches)	Lb/Ft	Ft/Lb
1/4	.016	62.5
5/16	.026	37.9
3/8	.038	26.5
7/16	.054	18.6
1/2	.065	15.4
9/16	.087	11.5
5/8	.108	9.3
3/4	.154	6.5
13/16	.176	5.7
7/8	.208	4.8
1	.294	3.4

Table 9–19. Miscellaneous Conversions

Multiply	By	To Obtain
Acres	43,560	Square feet
Acres	4,047	Square meters
B.t.u.	778	Foot-pounds
Cubic feet	7.481	Gallons (U.S.)
Feet per minute	.01137	Miles per hour
Feet per second	.6818	Miles per hour
Gallons (U.S.)	.1337	Cubic feet
Gallons (imp.)	.1605	Cubic feet
Gallons (U.S.)	.8327	Gallons (imp.)
Gallons (imp.)	1.201	Gallons (U.S.)
Inches	.02778	Yards
Knots	1.1516	Miles per hour
Miles per hour	88	Feet per minute
Miles per hour	1.467	Feet per second
Miles per hour	.8684	Knots
Quires	25	Sheets
Reams	500	Sheets
Square yards	.0002066	Acres
Stones	14	Pounds
Tons, long	2,240	Pounds
Tons, short	2,000	Pounds
Tons, long	1.12	Tons, short

Table 9–19—Continued

Multiply	By	To Obtain
Tons, short	.893	Tons, long
Tons, long	2.464	Tons. ship
Tons, ship	40	Cubic feet
Tons, register	100	Cubic feet

9–4. Shipping Equivalents

Table 9–20 gives information on shipping equivalents of fractions.

Table 9–20. Shipping Equivalents

Weight	Equivalent
Average short ton of military supplies with stowage	2.2 ship (measurement) tons
Average short ton of military supplies without stowage	1.9 ship (measurement) tons
Average long ton of military supplies with stowage	2.464 ship (measurement) tons.
Ship (measurement) tonnage	$\frac{\text{Bale cubic capacity}}{40}$
Deadweight tonnage	.85 ship (measurement) tonnage.
Effective deadweight tonage	.80 deadweight tonnage
Deadweight tonnage	1.5 gross registered tonnage
Gross tonnage	.6 deadweight tonnage*
Net tonnage	.4 deadweight tonnage*

* Approximate relation of freight ships of 10,000 dead-weight tons.

9–5. Decimal Equivalents of Fractions

Table 9–21 contains information on decimal equivalents of fractions.

Table 9–21. Decimal Equivalents of Fractions

Inches (fractions)	Inches (decimals)	Millimeters	Inches (fractions)	Inches (decimals)	Millimeters
1/64	.015625	.397	33/64	.515625	13.097
1/32	.03125	.794	17/32	.53125	13.494
3/64	.046875	1.191	35/64	.546875	13.890
1/16	.0625	1.587	9/16	.5625	14.287
5/64	.078125	1.984	37/64	.578125	14.684
3/32	.09375	2.381	19/32	.59375	15.081
7/64	.109375	2.778	39/64	.609375	15.478
1/8	.125	3.175	5/8	.625	15.875
9/64	.140625	3.572	41/64	.640625	16.272
5/32	.15625	3.969	21/32	.65625	16.669
11/64	.171875	4.366	43/64	.671875	17.065
3/16	.1875	4.762	11/16	.6875	17.462
13/64	.203125	5.159	45/64	.703125	17.859
7/32	.21875	5.556	23/32	.71875	18.256
15/64	.234375	5.953	47/64	.734375	18.653
1/4	.25	6.350	3/4	.75	19.050
17/64	.265625	6.747	49/64	.765625	19.447

Table 9–21—Continued

Inches (fractions)	Inches (decimals)	Millimeters	Inches (fractions)	Inches (decimals)	Millimeters
9/32	.28125	7.144	25/32	.78125	19.844
19/64	.296875	7.541	51/64	.796875	20.240
5/16	.3125	7.937	13/16	.8125	20.637
21/64	.328125	8.334	53/64	.828125	21.034
11/32	.34375	8.731	27/32	.84375	21.431
23/64	.359375	9.128	55/64	.859375	21.828
3/8	.375	9.525	7/8	.875	22.225
25/64	.390625	9.922	57/64	.890625	22.622
13/32	.40625	10.319	29/32	.90625	23.019
27/64	.421875	10.716	59/64	.921875	23.415
7/16	.4375	11.113	15/16	.9375	23.812
29/64	.453125	11.509	61/64	.953125	24.209
15/32	.46875	11.906	31/32	.96875	24.606
31/64	.484375	12.303	63/64	.984375	25.003
1/2	.5	12.700	1	1.	25.400

Inches in decimals of a foot

1/16	3/32	1/8	3/16	1/4	5/16	3/8	1/2	5/8	3/4	7/8
.0052	.0078	.0104	.0156	.0208	.0260	.0313	.0417	.0521	.0625	.0729

1	2	3	4	5	6	7	8	9	10	11
.0833	.1667	.2500	.3333	.4167	.5000	.5833	.6667	.7500	.8333	.9167

9–6. Functions of Numbers

Table 9–22 gives information on function of numbers.

Table 9–22. Functions of Numbers

Number	Square	Cube	Square root	Logarithm	Number	Square	Cube	Square root	Logarithm
1	1	1	1.0000	0.00000	30	900	27000	5.4772	1.47712
2	4	8	1.4142	.30103	31	961	29791	5.5678	1.49136
3	9	27	1.7321	.47712	32	1024	32768	5.6569	1.50515
4	16	64	2.0000	.60206	33	1089	35937	5.7446	1.51851
5	25	125	2.2361	.69897	34	1156	39304	5.8310	1.53148
6	36	216	2.4495	.77815	35	1225	42875	5.9161	1.54407
7	49	343	2.6458	.84510	36	1296	46656	6.0000	1.55630
8	64	512	2.8284	.90309	37	1369	50653	6.0828	1.56820
9	81	729	3.0000	.95424	38	1444	54872	6.1644	1.57978
10	100	1000	3.1623	1.00000	39	1521	59319	6.2450	1.59106
11	121	1331	3.3166	1.04139	40	1600	64000	6.3246	1.60206
12	144	1728	3.4641	1.07918	41	1681	68921	6.4031	1.61278
13	169	2197	3.6056	1.11394	42	1764	74088	6.4807	1.62325
14	196	2744	3.7417	1.14613	43	1849	79507	6.5574	1.63347
15	225	3375	3.8730	1.17609	44	1936	85184	6.6332	1.64345
16	256	4096	4.0000	1.20412	45	2025	91125	6.7082	1.65321
17	289	4913	4.1231	1.23045	46	2116	97336	6.7823	1.66276
18	324	5832	4.2426	1.25527	47	2209	103823	6.8557	1.67210
19	361	6859	4.3589	1.27875	48	2304	110592	6.9282	1.68124
20	400	8000	4.4721	1.30103	49	2401	117649	7.0000	1.69020
21	441	9261	4.5826	1.32222	50	2500	125000	7.0711	1.69897
22	484	10648	4.6904	1.34242	51	2601	132651	7.1414	1.70757
23	520	12167	4.7958	1.36173	52	2704	140608	7.2111	1.71600
24	576	13824	4.8990	1.38021	53	2809	148877	7.2801	1.72428
25	625	15625	5.0000	1.39794	54	2916	157464	7.3485	1.73239
26	676	17576	5.0990	1.41497	55	3025	166375	7.4162	1.74036
27	729	19683	5.1962	1.43136	56	3136	175616	7.4833	1.74819
28	784	21952	5.2915	1.44716	57	3249	185193	7.5498	1.75587
29	841	24389	5.3852	1.46240	58	3364	195112	7.6158	1.76343

Table 9–22—Continued

Number	Square	Cube	Square root	Logarithm	Number	Square	Cube	Square root	Logarithm
59	3481	205379	7.6811	1.77085	80	6400	512000	8.9443	1.90309
60	3600	216000	7.7460	1.77815	81	6561	531441	9.0000	1.90849
61	3721	226981	7.8102	1.78533	82	6724	551368	9.0554	1.91381
62	3844	238328	7.8740	1.79239	83	6889	571787	9.1104	1.91908
63	3969	250047	7.9373	1.79934	84	7056	592704	9.1652	1.92428
64	4096	262144	8.0000	1.80618	85	7225	614125	9.2195	1.92942
65	4225	274625	8.0623	1.81291	86	7296	636056	9.2736	1.93450
66	4256	287496	8.1240	1.81954	87	7569	658503	9.3274	1.93952
67	4489	300763	8.1854	1.82607	88	7744	681472	9.3808	1.94448
68	4624	314432	8.2462	1.83251	89	7921	704969	9.4340	1.94939
69	4761	328509	8.3066	1.83885	90	8100	729000	9.4868	1.95424
70	4900	343000	8.3666	1.84510	91	8281	753571	9.5394	1.95904
71	5041	357911	8.4261	1.85126	92	8464	778688	9.5917	1.96379
72	5184	373248	8.4853	1.85733	93	8649	804357	9.6437	1.96848
73	5329	389017	8.5440	1.86332	94	8836	830584	9.6954	1.97313
74	5476	405224	8.6023	1.86923	95	9025	857375	9.7468	1.97772
75	5625	421875	8.6603	1.87506	96	9216	884736	9.7980	1.98227
76	5776	438976	8.7178	1.88081	97	9409	912673	9.8489	1.98677
77	5929	456533	8.7750	1.88649	98	9604	941192	9.8995	1.99123
78	6084	474552	8.8318	1.89209	99	9801	970299	9.9499	1.99564
79	6241	493039	8.8882	1.89763	100	10000	1000000	10.0000	2.00000

9–7. Trigonometric Functions

Table 9–23 gives information on natural trigonometric functions.

Table 9–23. Natural Trigonometric Functions

Angle	Sin.	Cosec.	Tan.	Cotan.	Sec.	Cos.	
0°	0.000	-----	0.000	-----	1.000	1.000	90°
1°	.017	57.30	.017	57.29	1.000	1.000	89°
2°	.035	28.65	.035	28.64	1.001	.999	88°
3°	0.52	19.11	.052	19.08	1.001	.999	87°
4°	.070	14.34	.070	14.30	1.002	.998	86°
5°	.087	11.47	.087	11.43	1.004	.996	85°
6°	.105	9.567	.105	9.514	1.006	.995	84°
7°	.122	8.206	.123	8.144	1.008	.993	83°
8°	.139	7.185	.141	7.115	1.010	.990	82°
9°	.156	6.392	.158	6.314	1.012	.988	81°
10°	.174	5.759	.176	5.671	1.015	.985	80°
11°	.191	5.241	.194	5.145	1.019	.982	79°
12°	.208	4.810	.213	4.705	1.022	.978	78°
13°	.225	4.445	.231	4.331	1.026	.974	77°
14°	.242	4.134	.249	4.011	1.031	.970	76°
15°	.259	3.864	.268	3.732	1.035	.966	75°
16°	.276	3.628	.287	3.487	1.040	.961	74°
17°	.292	3.420	.306	3.271	1.046	.956	73°
18°	.309	3.236	.325	3.078	1.051	.951	72°
19°	.326	3.072	.344	2.904	1.058	.946	71°
20°	.342	2.924	.364	2.747	1.064	.940	70°
21°	.358	2.790	.384	2.605	1.071	.934	69°
22°	.375	2.669	.404	2.475	1.079	.927	68°
23°	.391	2.559	.424	2.356	1.086	.921	67°
24°	.407	2.459	.445	2.246	1.095	.914	66°
25°	.423	2.366	.466	2.145	1.103	.906	65°
26°	.438	2.281	.488	2.050	1.113	.899	64°
27°	.454	2.203	.510	1.963	1.122	.891	63°
28°	.469	2.130	.532	1.881	1.133	.883	62°
29°	.485	2.063	.554	1.804	1.143	.875	61°
30°	.500	2.000	.577	1.732	1.155	.866	60°

Table 9–23—Continued

Angle	Sin.	Cosec.	Tan.	Cotan.	Sec.	Cos.	
31°	.515	1.942	.601	1.664	1.167	.857	59°
32°	.530	1.887	.625	1.600	1.179	.848	58°
33°	.545	1.836	.649	1.540	1.192	.839	57°
34°	.559	1.788	.675	1.483	1.206	.829	56°
35°	.574	1.743	.700	1.428	1.221	.819	55°
36°	.588	1.701	.727	1.376	1.236	.809	54°
37°	.602	1.662	.754	1.327	1.252	.799	53°
38°	.616	1.624	.781	1.280	1.269	.788	52°
39°	.629	1.589	.810	1.235	1.287	.777	51°
40°	.643	1.556	.839	1.192	1.305	.766	50°
41°	.656	1.524	.869	1.150	1.325	.755	49°
42°	.669	1.494	.900	1.111	1.346	.743	48°
43°	.682	1.466	.933	1.072	1.367	.731	47°
44°	.695	1.440	.966	1.036	1.390	.719	46°
45°	.707	1.414	1.000	1.000	1.414	.707	45°
	Cos.	Sec.	Cotan.	Tan.	Cosec.	Sin.	Angle

CHAPTER 10

MISCELLANEOUS

10–1. Decontamination

References pertinent to decontamination include FM 21–40, FM 21–41, FM 21–48, TM 3–215, TM 3–200, TM 5–700, TM 750–5–15, TM 8–285, TB CML 40, and TB CML 41.

a. Portable Decontaminating Apparatus. The M11 1 1/2-quart DS2 portable decontaminating apparatus is used to decontaminate a vechilce and its equipment to the minimum extent necessary to allow the vehicle operator to continue his mission. The apparatus produces a spray of decontaminating agent DS2 by means of a nitrogen cylinder which pressurizes the container. The following data are applicable to the M11 Apparatus:

Capacity	1 1/3 quarts.
Filling	DS2 solution.
Weight of empty apparatus	3.0 pounds.
Weight of filling (1 1/3 quarts of DS2 solution)	2.9 pounds.
Weight of filled apparatus	6 pounds.
Effective spray range	6 to 8 feet.
Coverage per filling	15 square meters.

b. Chemical Decontamination. The more common and effective decontaminants for chemcial agents are shown in table 10–1. In addition to those listed in the table, the following decontaminants may be used to destroy or remove toxic chemical agent contamination: lime, bleach, baking soda, ammonia, caustic potash, sodium sulfite, chloramine-T, dichloramine-T, alcoholic caustic soda, and alcoholic caustic potash. The aeration method can be used to decontaminate items exposed to nonpersistent-effect checmical agents and to decontaminate lightly contaminated clothing and fabrics which have been exposed to the vapors of persistent-effect chemical agents. Gentle heating accelerates evaporation and can be used to decontaminate many fragile and complicated items. Hot or cold water alone, or in combination with soaps or detergents, may be used to remove toxic chemical agents from surfaces that can be washed. Various common organic solvents may be used to remove contaminants from equipment that might be damaged by water. These solvents include kerosene and allied petroleum fractions (diesel fuel, naphtha, and drycleaning fluid), and alcohol. Since water and organic solvents only remove contaminants and do not neutralize them, suitable precautions must be taken to dispose of the solvent waste as contaminated material.

Table 10–1. Decontaminants for Chemical Agents

Decontaminant	Chemical agent used against—	Decontaminant container	Remarks
DANC solution	Blister agents, V-agents	3-gal. and 4½-gal. containers.	2.5-lb RH 195 decontaminating agent per 3-gal. acetylene tetrachloride.
Detergent and wetting agent.	Persistent effect agents, G-agents.		
GUNK	Persistent effect agents	55-gal. drum	Water-dispersible solution (1.34-lb GUNK per gal. kerosene).
HTH (high test bleach)	Blister agents, G- and V-agents.		Oxidizing agent; releases chlorine.
M5 protective ointment	Blister agents, V-agents	¾-oz tube	Salve.
Sodium carbonate (washing soda).	G-agents, irritant agents		White, alkaline powder; dissolves easily in water.
Sodium hydroxide (caustic soda or lye).	Persistent effect agents, G-agents.	Steel drum	Water solution (0.5-lb lye per gal. water).
Sodium hypochlorite (household bleach).	Blister agents, G- and V-agents.	Carboy or barrel	Unstable as solid; more stable in solution.
STB (supertropical bleach)	Blister agents, G- and V-agents.	8-gal., 50-lb can	White powder containing 30 percent available chlorine.

Table 10–1—Continued

Decontaminant	Chemical agent used against—	Decontaminant container	Remarks
Steam	Blister agents, G-agents		Hydrolyzes certain chemical agents.
Soap and water	Blister agents, G-agents.		
DS2 Solution	All chemical agents	1 1/3-qt cans or 5-gal. drums	Applied by M11 apparatus or by brushes, brooms, or swabs.
Fullers earth	All liquid agents	Skin pad in M13 decontaminating and reimpregnating kit.	Power which absorbs contamination.
Chloramide powder	Blister, G- and V-agents	Dust bags in M13 decontaminating and reimpregnating kit.	Effective against fine droplets and vapors only.

(1) *Recommended decontaminants for individual chemical agents.* Table 10–2 provides information on decontaminants recommended for specific chemical agents. For additional information, see TM 3–220.

Table 10–2. Recommended Decontaminants for Individual Chemical Agents on Materiel

Chemical Agents	Decontaminants [1]	Remarks
G-agents (GA, GB, GD)	Slurry, hot soapy water, alkaline solution, DS2, or components of M13 kit.	STB in contact with GA produces toxic vapors; in confined areas, steam and ammonia should be used.
V-agents	DS2, slurry, DANC solution, components of M13 kit, M5 protective ointment.	Liquid V-agents do not evaporate rapidly or freeze at normal freezing temperatures. Absorbed V-agents remain toxic for some time.
Mustards (H, HD, HN, HT)	STB, slurry, DS2, DANC solution, components of M13 kit, or M5 protective ointment.	Dry STB on liquid mustard produces flame and toxic vapors.
Lewisite (L), mustard-lewisite mixture (HL), phenyldichloroarsine (PD), ethyldichloroarsine (ED), methyldichloroarsine (MD).	STB, slurry, DS2, DANC solution, water, or caustic soda.	Decontamination products are toxic, fairly stable, nonvolatile, and insoluble in water. Alkaline solutions [2] destroy vesicant properties.
Phosgene oxime (CX)	Large amounts of water or DS2	Liquid above 39° F. Readily soluble in water.
Phosgene (CG)	Water followed by alkaline solution [2] or DS2.	Liquid below 47° F.
Cyanogen chloride (CK), hydrogen cyanide (AC).	Sodium hydroxide solution or DS2	CK liquid below 55° F. AC liquid below 77° F.
Adamsite (DM)	Slurry or DS2	Aeration is sufficient in the field.
Diphenylchloroarsine (DA), diphenylcyanoarsine (DC).	Alkaline solution [2] or DS2	Aeration is sufficient in the field.
CS	Water or 5-percent sodium bisulfite solution.	(See FM 21–48 for further information.)
BZ	Hot soapy water.	
Chloroacetophenone (CN), CN solution (CNB, CNC, CNS [3]).	Hot sodium carbonate solution, hot sodium hydroxide solution, or hot soapy water.	Aeration is sufficient for vapors.
White phosporus (WP) or plasticized white phosphorus (PWP).	Water or copper sulfate solution	Water extinguishes burning WP; copper sulfate prevents further burning.
Sulfur trioxide-chlorosulfonic acid (FS).	Alkaline solution,[2] water followed by alkaline solution,[2] or hot soapy water.	Corrosive to metals when moist; acidic; destroys nylon and paint.
Titanium tetrachloride (FM)	Water or alkaline solution [2]	No decontamination required for vapor. Corrosive to metals.
HC mixture (HC)	Water or alkaline solution [2]	High concentrations toxic.

[1] Decontaminants are listed for chemical agents in liquid or solid state. In addition to decontaminants listed, aeration is effective for most chemical agents (vapors and light contamination) except V-agents. Screening smokes generally require no decontamination except aeration. The decontaminant selected depends on the type of contaminated surface and its intended use.

[2] Ten-percent solution of caustic soda or sodium carbonate; caustic soda is not recommended for fabrics, canvas, and leather.

[3] In closed spaces, sodium sulfite or sodium bisulfite is used for CNS.

(2) *Decontamination of surfaces and materials contaminated with toxic chemical agents.* Table 10–3 contains methods of decontaminating various surfaces contaminated with toxic chemical agents. This table should be used with care as decontamination methods are dependent on many factors, especially the weather and the type of toxic chemical agent. FM 21–40, FM 21–41 and TM 3–220 should be referred to for additional information.

Table 10–3. Decontamination Methods for Chemical Agents [1]

Contaminated surface or object	Recommended methods of decontamination [2]		
Asphalt:			
Roads [6]	Flush with water. Spray with slurry from power-driven decontaminating apparatus.	Cover with STB; when liquid contaminant is visible and personnel are nearby, use dry mix.	Weather. Cover small areas or paths across roads with 10 centimeters (4 inches) of earth.
Roofs	Flush with water. Spray with slurry from power-driven decontaminating apparatus.	Cover with STB or dry mix.	Weather.
Brick and stone:			
Roads [3]	Spray with slurry from power-driven decontaminating apparatus or apply with brushes and brooms. Let remain 24 hours, then flush with water.	Wash with soapy water, preferably hot.	Cover small areas or paths across roads with 10 centimeters (4 inches) of earth. Weather.
Buildings	Spray with slurry from power-driven decontaminating apparatus or apply with brushes and brooms. Let remain 24 hours, then flush with water.	Wash with soapy water, preferably hot. Use STB or dry mix around buildings where waste water runs.	Weather.
Canvas: Tarpaulins, tentage, covers, mask carriers, cartridge belts.	Immerse in boiling soapy water for 1 hour. Use 5-percent solution of washing soda for G-agents.	Immerse in boiling water for 1 hour. Launder by standard methods. Use slurry.	Aerate (except for V-agents). Use chloramide powder from M13 kit or M5 protective ointment.
Concrete:			
Roads [3]	Spray with slurry from power-driven decontaminating apparatus.	Cover with STB or dry mix.	Weather. Cover small areas or paths across roads with 10 centimeters (4 inches) of earth.
Buildings, pill-boxes, gun emplacements, tank obstacles.	Spray with slurry from power-driven decontaminating apparatus or apply with brushes and brooms. Let remain 24 hours, then flush with water.	Wash with soapy water, preferably hot. Apply STB or dry mix on ground surrounding structure where waste water flows.	Cover small areas with 10 centimeters (4 inches) of earth.
Earth: Roads,[3] gun emplacements, bivouac areas, pathways, bomb craters.	Spray with slurry from power-driven decontaminating apparatus.	Cover with STB; when liquid contaminant is visible and personnel are nearby, use dry mix.	Weather. Burn. Cover small areas or paths across roads with 10 centimeters (4 inches) of earth. Scrape layer of contaminated earth to side of road.
Leather: Boots, gloves, and other items.	Scrub with hot soapy water and rinse. Immerse in soapy water at 120° F for 4 hours and rinse.	Use 5-percent washing soda solution for G-agents.	Aerate. Use chloramide powder from M13 kit or M5 protective ointment.

See footnotes at end of table.

Table 10–3—Continued

Contaminated surface or object	Recommended methods of decontamination [2]		
	For cotton items		
Fabrics (cotton or wool [4]): Coveralls, shirts, trousers, field jackets, underwear, socks, gloves, overcoats, ties, hoods, barracks bags.	Immerse in boiling water for 1 hour; stir items; add 454 grams (1 pound) of soap to 10 gallons of water to make water alkaline. Use 5-percent solution of washing soda for G-agents.	Launder by standard methods.	Use chloramide powder from M13 kit. Rub M5 protective ointment on small contaminated area. Aerate except for V-agents.
	For woolen items		
	Immerse in warm (100° F) soapy water for 1 hour or longer with light agitation; dry items slowly.	Use chloramide powder from M13 kit. Rub M5 protective ointment on small contaminated areas.	Aerate.
Glass:			
Windows	Use DS2 or DANC solution.	Wash with hot soapy water. Wash with clear water or organic solvent.	Blot off surface. Aerate. Weather.
Lenses	Use DS2 or DANC solution.	Wash with hot soapy water. Wash with clear water or organic solvent.	Blot off surface. Aerate.
Grass and low vegetation (fields open terrain).[3]	Burn Spray with slurry from power-driven decontaminating apparatus.	Cover with STB or dry mix.	Explode drums of STB. Clear paths through area by use of detonating cord or other detonating devices.
Metals (unpainted):			
Ammunition	Use DS2 or DANC solution, then rinse or wipe with organic solvent and dry.	Wash with *cool* soapy water and rinse.	Aerate.
Machinery	Use DS2 or DANC solution and rinse.	Wash with hot soapy water. Wash with organic solvent.	Weather. Aerate.
Mess gear, canned rations.	Immerse in boiling soapy water for 30 minutes and rinse. Immerse in boiling water for 30 minutes.	Spray with DS2 or apply DANC solution and rinse. Wash in hot soapy water, rinse, and aerate.	
Metals (painted):[5]			
Vehicles, weapons, equipment.	Use DS2 or DANC solution.	Wash with hot soapy water and rinse. (Slurry may be used if it is removed from surface after 1 hour and surface is oiled.)	Weather Aerate.
Plastics (opaque):			
Insulation, telephones, panel boards.	Treat with DANC solution and rinse.	Wash with hot soapy water and rinse.	Weather. Aerate.
Plastics (transparent):			
Eyepieces	Spray with DS2 and rinse.	Wash with warm soapy water.	Aerate.
Airplane canopies	Spray with DS2 and rinse.	Wash with hot soapy water.	Weather.
Rubber (impermeable):	Spray with DS2 and rinse after 30 minutes.	Apply hot soapy water with brushes and rinse.	Aerate. Weather.

See footnotes at end of table.

Table 10–3—Continued

Contaminated surface or object	Recommended methods of decontamination [2]		
Aprons, suits, and other items.	Immerse in hot soapy water (just below boiling point) for 1 hour; do not agitate. Rinse with clear water and hang up to dry. For G-agents, use 10-percent sodium carbonate solution, rinse, and aerate.	Spray with slurry from power-driven decontaminating apparatus. After a few minutes, wash off with clear water.	
Rubber (natural and synthetic):	Spray with DS2 and rinse.	Immerse in boiling soapy [6] water for 2 to 8 hours; do not boil more than four times a year.	Use chloramide powder from M13 kit for emergency decontamination. Apply M5 protective ointment for emergency decontamination. Aerate.
Gloves, boots	Immerse in slurry solution for 4 hours, rinse, and aerate.		
Mask facepieces and other rubber articles coming in direct contact with the skin.	Use skin decontaminating pad or chloramide powder from the M13 kit for emergency decontamination. Apply M5 protective ointment for emergency decontamination.	Wash with warm soapy water.	
Tires, hoses, mats, insulation.	Spray with DS2 and rinse. Apply thick slurry, allow slurry to remain at least 30 minutes, then flush with clear water. (May be left on tires.)	Immerse in boiling soapy [6] water for 2 to 8 hours; do not boil more than four times a year.	Aerate. Weather.
Sand [3] (beaches, deserts).	Flush with water	Spread STB or spray slurry over surface.	Weather Cover paths with roofing paper. Scrape off 5 to 10 centimeters (2 to 4 inches) of contaminated top layer.
Jndergrowth and tall grass (meadows, jungles, forests). [3]	Burn	Spray slurry from power-driven decontaminating apparatus.	Weather. Explode drums of STB. Clear paths with detonating cord, bangalore torpedoes, or demolition snakes.
Wood:			
Building, vehicle bodies.	Apply slurry with power-driven decontaminating apparatus, brooms, or swabs. Let slurry remain 12 to 24 hours; flush and repeat application, then flush again.	Scrub with hot soapy water and rinse.	Weather.
Boxes, crates, gunstocks.	Apply slurry with power-driven decontaminating apparatus, brooms, or swabs. Let slurry remain 12 to 24 hours: flush and repeat application, then flush again. (Scrub slurry off gunstocks with soapy water and rinse.	Scrub with hot soapy water and rinse. Use chloromide powder from M13 kit for gunstocks.	Weather.
Wood (painted surface): [5]			

See footnotes at end of table.

Table 10–3—Continued

Contaminated surface or object	Recommended methods of decontamination [2]		
Buildings, boxes ------	Apply slurry with power-driven decontaminating apparatus, brooms, or swabs. Let slurry remain 12 to 24 hours, then rinse off with water.	Scrub with hot soapy water and rinse. Use DS2 and rinse.	Weather.

[1] DANC solution is not recommended for G-agent decontamination; 10-percent alkaline solutions are recommended for G-agent decontamination on material except fabrics, canvas, and leather.

[2] The best method of decontamination in a given situation could be any of these methods listed for the surface. The order in which the methods are listed does *not* indicate that one is preferred over another.

[3] Applicable to small vital areas only.

[4] DS2 is not recommended for woolen items.

[5] DS2 may soften fresh paint.

[6] Alkaline soaps neutralize G-agent vapors which are driven out of the rubber during boiling, thereby reducing the hazard to personnel performing the decontamination operation. If alkaline soap is not available, rubber articles can still be decontaminated by boiling in water; however, the hazard to personnel is increased.

c. Decontamination of Biological Agents. The decontaminants and decontamination procedures for toxic chemical agents usually are effective against biological agents. Methods of decontamination for biological agents are described in FM 3–8 and TM 3–220.

d. Radiological Decontamination. Radioactive contaminants cannot be made safe by chemical action. They must be removed or shielded if it is impracticable to wait for natural decay. Therefore, radiological decontamination is the process of reducing the hazard of radioactivity to a permissible level by removal and disposal of the contamination or by shielding over the contamination.

(1) *Protection of personnel.* Personnel performing radiological decontamination should wear regular clothing with the openings taped closed. Caps and gloves should also be worn, and dosimeters carried. If a liquid decontaminate is used, clothing should be waterproof. A protective mask or other device is required in smoky or dusty areas. Shower facilities should be available to personnel engaged in monitoring or decontamination.

(2) *Agents.* Radiological decontaminants are listed in table 10–4.

Table 10–4. Agents Used to Remove Radioactive Contaminants

Decontaminant	Type	Remarks
Soapless detergent, soap, wetting agent.	Detergent	Practicable for field use.
Gasoline, kerosene, water.	Solvent	Practicable for field use.
Steam ----------	Solvent	Practicable for field use.
Potassium hydroxide, sodium hydroxide, trisodium phosphate, sodium orthosilicate.	Solvent	Practicable for field use.
Acetone, alcohol, ether, paint remover.	Solvent	Practicable for small-scale operations only.
Citrates, citric acid, sodium versenates, polyphosphates.	Complexing agent.	Practicable for small-scale operations only.
Aqua regia*, hydrochloric acid*, nitric acid.*	Corroding agent.	Practicable for small-scale operations only.

* To be handled by experienced personnel only.

(3) *Radiological decontamination equipment.* Equipment used in radiological decontamination includes the 400-gallon, power-driven, decontaminating apparatus, the portable water heater, and the decontaminating brushes. Some other items useful in radiological decontamination are listed in table 10–5.

Table 10–5. Equipment for Radiological Decontamination

Item	Use
Broom ----------	Brushing dust from personnel, clothing, equipment, and surfaces.
Brush ----------	Scrubbing and brushing dust from personnel, clothing, equipment, and surfaces.
Shovel ----------	Removal, burial, or other disposal of contaminated objects and materials.
Fire or garden hose -----	Hosing and scrubbing operations; also for use with bulldozer or road grader in holding down dust.

Table 10–5—Continued

Item	Use
Bulldozer	Large-scale removal, burial, or other disposal of contaminated objects.
Power-driven decontaminating apparatus.	Large-scale hosing and spraying of vital areas, buildings, vehicles, and machinery.
Long-handled scraper	Scraping paint.
Steam jenny	Cleaning complicated machinery and greasy or hard dirt film surfaces.
Water-carrying or moving equipment.	Moving water.
Containers	Waste movement and control.

(4) *Radiological decontamination methods.* Table 10–6 gives information on methods of radiological decontamination.

(5) *Radioactive waste disposal.* In a peacetime situation, consult AR 55–55, AR 755–15 and Title 10, Code of Federal Regulations, Atomic Energy, Part 20 for instruction on disposal. Disposal, in peacetime, generally is done by specialized installations, not locally. TM 3–260 contains information pertaining to the operation of radioactive material disposal facilities. In a wartime situation, the methods shown in table 10–7 are applicable in the theater of operations.

Table 10–6. Radiological Decontamination Methods

Method	Surfaces	Action	Technique	Advantages	Disadvantages
Water washing	All nonporous surfaces (metal, paint, plastic).	Acts as a solvent and erodes. Action faster if water is hot.	For gross decontamination use water shot from high pressure hose. Work from top to bottom to avoid recontamination and from upwind to avoid spray. Spray from distance of 15 to 20 ft. Use 30° to 45° angle on vertical surfaces.	All water equipment may be utilized. Allows operation to be carried out from a distance. Most readily available agent.	Runoff requires disposal. Carries contaminant into porous materials if permitted to soak in.
Using detergent solution.	Nonporous surfaces	Emulsifying agent. Wetting agent. (Action faster if solution is hot).	Rub surface 1 minute and wipe with dry rag; use clean surface of the rag for each application. (Moist application is all that is desired.) Do not allow solution to drip onto other surfaces.	Dissolves films which hold contamination. Contamination may be reduced by 90 percent. Easily handled. More efficient than water alone.	Requires close contact with surface. Not efficient for long-standing contamination without scrubbing. Runoff requires disposal.
		Solution, erosion, and physical removal.	Solution may be applied with a powered rotary distance by use of pressure sprays.		
Steaming	Nonporous surfaces (especially painted or oiled surfaces).		Work from top to bottom and from upwind. The cleaning efficiency of steam may be greatly increased by use of detergents.	Reduces contamination by about 90 percent on painted surfaces. Corps of Engineers steam jenny can be used.	Runoff requires disposal. Waterproof clothing necessary. Requires special equipment.
Scrubbing	Porous and nonporous surfaces.	Physical removal of contaminant.	Use in conjunction with other processes.	Used on "hot spots" following other processes. May be used on small objects and areas. Aided by detergents.	Slow and laborious. Erosive action on some surfaces.
Using complexing agents	Nonporous surfaces	Forms soluble complexes with contaminant.	Use 3 percent (by weight) solution. Spray solution on surface. Keep surface moist 30 minutes by spraying periodically, then flush with water. Mix equal parts with mechanical foam for use on vertical and overhead surfaces.	Holds contamination in solution. Solution can be prepared in tank of power-driven decontaminating apparatus. Solution easily stored and used.	Requires application for 5 to 30 minutes. Little penetrating power. Little value on weathered surfaces. Difficult to keep in place on nonhorizontal surfaces.

Using caustic solution: Sodium hydroxide (lye), calcium hydroxide, potassium hydroxide.	Painted surfaces	Removes paint	Allow solution to remain on surface until paint softens, then wash off with water; remove remaining paint with long-handled scrapers. 1 lb of caustic in 2½ gal. of water removes about 100 sq ft of paint; the addition of 1½ lb of trisodium phosphate aids in removal; the addition of holds solution to sur- 3 oz of cornstarch face.	Time of contact varies with contaminated surface—15 minutes to 2 hours. Can be prepared in steel tank of power-driven decontaminating apparatus.	Can cause severe burns. Corrosive to aluminum or magnesium surfaces or rubber. Not recommended for vertical or overhead surfaces.
Using trisodium phosphate solution.	Painted surfaces	Removes paint	Apply hot 10-percent solution. When paint softens, flush from surface with water. Repeat as necessary.	Fast acting	Useful on walls and ceilings. Solution harmful to body tissue. Powder harmful if inhaled. Corrosive to aluminum or magnesium surfaces.
Using organic solvents: Kerosene, gasoline, alcohol, turpentine, acetone, ether, commercial paint remover.	Nonporous surfaces (greasy or waxed surfaces, paint or plastic finishes).	Dissolves oil and other organic materials. Also removes paint.	Immerse object in solvent or wipe with solvent. Wash in hot soapy water, then rinse in clear water.	Quick dissolving action Recovery of solvent possible by distillation.	Vapors are toxic. Good ventilation required. Fire precautions required. Vapors are flammable.
Using inorganic acids: Hydrochloric acid, sulfuric acid.	Metal surfaces, especially those with porous deposits (rust or calcareous growth): circulatory pipe systems.	Strong dissolving action on metals and porous deposits.	Use dip-bath technique for movable objects. Keep acid at a concentration of 1 to 2 normal (9 to 18 percent hydrochloric acid, 3 to 6 percent sulfuric acid). (Reaction time on weathered surfaces should be 1 hour; on pipe systems, 2 to 4 hours.) Flush surface with water, neutralize or wash with hot soapy water, and then flush with water again.	Rapid and complete dissolving action.	Vapors are toxic. (Good ventilation required.) Liquid is harmful to the skin. Acid solutions should not be heated. Rust inhibitor required to prevent corrosion. Trained personnel required. Special equipment required.

Table 10–6—Continued

Method	Surfaces	Action	Technique	Advantages	Disadvantages
Using acid mixtures: Hydrochloric acid or sulfuric acid with acetates or citrates.	Nonporous surfaces, especially those having porous deposits: circulatory pipe systems.	Dissolving action	Use same as inorganic acids. Mixture consists of 1/10 gal. of hydrochloric acid, 1/5 lb of sodium acetate, and 1 gal. of water. Keep surface wet for 1 hour, then flush with water.	Dissolving action may reduce contamination of unweathered surfaces by 90 percent in 1 hour. Removes rust.	Weathered surfaces may require prolonged treatment. Harmful to personnel.
Vacuum blasting	Porous and nonporous surfaces.	Physical removal of contaminated surfaces.	Run unit over contaminated surface.	Safe and rapid Contaminant controlled.	Wears away surfaces. Protective mask required.
Sandblasting	Nonporous surfaces	Physical removal of contaminated surfaces.	Wet sand prior to sandblasting. Keep removed material wetted down.	Satisfactory method for nonporous surfaces. Can be used for large-scale operations.	Wears away surfaces. Not feasible for porous surfaces. Spreads contamination. Protective mask and hood required.
Sanding, filing, grinding, planing, chipping.	Porous and nonporous surfaces.	Physical removal of contaminated surfaces.	Remove surface and control residue.	Reduces "hot spots"	Practical for small areas or objects only. Time-consuming. Protective mask and gloves required.
Using earth-moving operations.	Soil and loose rock	Physical removal of top layer of soil, with contaminant.	Remove contamination with bulldozers, road graders, and similar equipment.	Suitable for large areas if equipment is available.	Limited control of contaminated dust. Disposal problem may become acute due to large volumes involved. Equipment may become contaminated. Protective mask should be worn.
Brushing	Porous and nonporous surfaces.	Physical removal of loose contaminated dust.	Brush dust from surface	Work may begin quickly Rapid action. Brushes usually available.	Limited control of contaminated dust. Little or no removal of dust within pores of many porous surfaces. Protective mask should be worn.
Vacuum cleaning	Dry contaminated surfaces.	Removal of contaminated dust by suction.	Use conventional vacuum technique with efficient filter or field expedient. Siphon action.	Rapid Good on dry, porous surfaces. Water not required. Contamination controlled.	All dust must be removed from exhaust system. Machine may become contaminated. Rubber gloves required

Using ion exchange resins.	Fluids	Removes contaminant from solution.	Pass solution through prepared exchange column.	Concentrates contaminant	for disposal of waste and filters. Special equipment required.

Table 10–7. Radioactive Waste Disposal

Method	Technique	Area consideration	Advantages and disadvantages
Dilution into lakes and rivers.	Dump solids and running liquid into the body of water.		Temporary tactical expedient only; continued use in populated areas will produce unfavorable results.
Burial at sea	Place material in reasonably strong leakproof containers, preferably of concrete. Fill completely, seal, and sink in deep water (6,000 feet or more).	Areas close to large bodies of water.	Requires considerable logistic support.
Land burial	Place material in sealed containers, if possible; then emplace in caves, if possible, or in deep trenches; cover with at least 4 feet of soil. Cap with 1 inch of asphalt, if possible; otherwise, keep vegetation from the top of the material. The bottom of the burial site should be lined with 6 inches of gravel to minimize leaching. Mark well and report the location and other pertinent data. Drainage ditches may be dug to bring liquid wastes to the same trench (sump). Do not mix with other types of contamination (e.g., chemical).	Arid clay soils are best. Do not choose sandy or rock soils. Area should have good surface drainage. Avoid areas subject to flooding or near bodies of water. Choose sites well above water table. Sites should be located near collection points, but not in critical terrain. Care must be taken not to disrupt underground facilities.	Most permanent form of deposit; requires least logistic support of all practical methods.

(6) *Radiological decontamination of surfaces and objects.* Methods of radiological decontamination are outlined in table 10–8.

Table 10–8. Radiological Decontamination of Surfaces and Objects

Item	Method (in order of preference	Remarks
Clothing	Brush (wipe); wash; vacuum clean	Brushing satisfactory for tactical use.
Buildings	Flush with water; wash with detergent and water; brush; steam clean.	Roofs and surrounding terrain more important than walls.
Terrain	Remove top 2 inches of surface; cover with 6 inches of uncontaminated earth.	Delay as long as possible before beginning.
Water	Engineer water supply point processes; in emergency, filter through 6 inches of clean sand and boil.	Im–141/PD not adequate for monitoring. Assume contaminated unless obtained at water supply point.
Food:		
Prepared, uncovered	None; treat as waste	Do not use.
In sealed containers	Clean container, monitor, open, and remonitor.	Contamination cannot penetrate.
Heavy-skinned	Clean, monitor, then peel and remonitor.	Contamination cannot penetrate.

Table 10–8—Continued

Item	Method (in order of preference	Remarks
Solid, uncovered	Pare, then monitor. Do not wash before paring or contamination will soak in.	Contamination cannot penetrate.
Personnel	Bathe and scrub; shower; wipe with damp cloth.	Perform as soon as practicable.
Painted or waxed surfaces	Flush with water; wash with water and detergents; use complexing agents; use organic solvents.	
Bare metal or wood surfaces	Flush with water; wash with water and detergents; use complexing agents.	Do not soak; wash rapidly.
Greasy surfaces	Use organic solvent; steam clean	Decontaminate only as absolutely necessary.

e. Personnel Decontamination Stations. Field stations should be established to provide facilities for decontamination of personnel who have become contaminated with CBR agents. FM 21–40 and FM 21–48 contain detailed procedures and a description of the station.

10–2. Gases and Gas Cylinders

a. Characteristics. The characteristics of certain gases which are used in industry and in the Army, and which are stored and shipped in a compressed state, are shown in table 10–9.

b. U.S. and Foreign Cylinders.

(1) In the United States, cylinders for compressed gases are manufactured under various Interstate Commerce Commission (ICC) specifications. For details see AR 700–68.

(2) Table 10–10 shows the color code which is used under U.S. military standards to identify the contents of cylinders. Table 10–11 shows the color codes for certain gases in use in five foreign countries. Table 10–12 shows the characteristics of the cylinders used for certain of the more common gases.

Table 10–9. Characteristics of Gases

Gas	Color	Odor	Wt. when compared to air	Physical state as shipped	Physical effect
Acetylene	None	Garliclike	Lighter	Dissolved	Anesthetic
Ammonia	None	Pungent	Lighter	Liquid	Irritant
Argon	None	None	Slightly heavier	Liquid	None*
Carbon dioxide	None	Faint	Much heavier	Liquid	None*
Chlorine	Greenish yellow	Disagreeable	Much heavier	Liquid	Irritant
Ethylene oxide	None	Pungent	Lighter	Liquid	Irritant
Helium	None	None	Much lighter	Gas	None*
Hydrogen	None	None	Much lighter	Gas	None*
Hydrogen cyanide	None	Peach blossom	Lighter	Liquid	Toxic
Methyl chloride	None	Etherlike	Heavier	Liquid	Anesthetic
Nitrogen	None	None	Slightly lighter	Gas	None*
Oxygen	None	None	Slightly heavier	Gas	None
Petroleum gas—Butane propane.	None	Sewer gas	Heavier	Liquid	Anesthetic
Refrigerant	None	None	Heavier	Liquid	None*
Sulphur dioxide	None	Rotten eggs	Much heavier	Liquid	Irritant

* Excessive amounts cause suffocation.

Table 10–10. Military Standard 101A—Color Code for Compressed Gas Cylinders and Pipelines

Title	Top A	Band B	Band C	Body
Acetylene	Yellow	Yellow	Yellow	Yellow
Acrolein	Yellow	Brown	Black	Brown
Aerosol insecticide	Buff	Buff	Buff	Buff
Air, oil pumped	Black	Green	Green	Black
Air, water pumped	Black	Green	Black	Black
Ammonia	Brown	Yellow	Orange	Orange

Table 10–10—Continued

Title	Top A	Band B	Band C	Body
Argon, oil pumped	Gray	White	White	Gray
Argon, water pumped	Gray	White	Gray	Gray
Boron trichloride	Gray	Brown	Gray	Brown
Boron trifluoride	Gray	Brown	Brown	Brown
Bromoacetone	Brown	Black	Black	Brown
Bromochloromethane	Buff	Gray	Buff	Buff
Bromochloromethane (fire only)	Red	Gray	Red	Red
Bromofluoromethane	Orange	White	Gray	Orange
Bromofluoromethane (fire only)	Red	White	Gray	Red
Butadiene	Yellow	White	Buff	Buff
Carbon dioxide	Gray	Gray	Gray	Gray
Carbon dioxide (fire only)	Red	Red	Red	Red
Carbon monoxide	Yellow	Brown	Brown	Brown
Chloroacetone	Black	Brown	Black	Brown
Chlorine	Brown	Brown	Brown	Brown
Chlorine trifluoride	Brown	Green	Brown	Brown
Chloropicrin	Brown	Orange	Orange	Brown
Cyanogen	Yellow	Brown	Yellow	Brown
Cyclopropane, medical	Orange	Yellow	Blue	Blue
Cyclopropane, medical	Orange	Chromium plated	Chromium plated	Chromium plated
Dibromodifluoromethane	Buff	White	Buff	Buff
Dibromodifluoromethane (fire only)	Red	White	Red	Red
Difluorochloroethane	Gray	Yellow	Yellow	Orange
Difluoroethane	Gray	Yellow	Orange	Orange
Dimethylamine, anhydrous	Yellow	Blue	White	Buff
Dimethylether	Yellow	Brown	Buff	Buff
Dispersant, Dichlorodifluoromethane-Difluoroethane Mix.	Buff	Gray	Gray	Buff
Ethane	Yellow	Blue	Yellow	Yellow
Ethyl chloride	Buff	Blue	Yellow	Buff
Ethyl nitrite	Yellow	Buff	Buff	Buff
Ethylamine, anhydrous	Yellow	Blue	Blue	Buff
Ethylene, industrial	Blue	Yellow	Buff	Buff
Ethylene, medical	Yellow	Blue	Blue	Blue
Ethylene oxide	Yellow	Blue	Buff	Buff
F-11, Trichlorofluoromethane	Orange	Orange	Orange	Orange
F-12, Dichlorodifluoromethane	Orange	Orange	Orange	Orange
F-13, Chlorotrifluoromethane	Orange	Orange	Orange	Orange
F-21, Dichlorofluoromethane	Orange	Orange	Orange	Orange
F-22, Chlorodifluoromethane	Orange	Orange	Orange	Orange
F-113, Trichlorotrifluoroethane	Orange	Orange	Orange	Orange
F-114, Dichlorotetrafluoroethane	Orange	Orange	Orange	Orange
F-124A, Chlorotetrafluoroethane	Orange	Orange	Orange	Orange
Fluorine	Brown	Green	Green	Brown
Fumigant, Carbon dioxide-Ethylene oxide.	Buff	Blue	Buff	Buff
Helium, oil free or medical	Buff	Gray	Gray	Gray
Helium, oil pumped	Gray	Orange	Gray	Gray
Helium-Oxygen	Buff [1]	White [2]	Green	Green
Hydrogen	Yellow	Black	Yellow	Yellow
Hydrogen bromide	Black	Brown	Brown	Brown
Hydrogen chloride, anhydrous	Brown	White	Brown	Brown
Hydrogen cyanide, anhydrous	Yellow	Brown	White	Brown
Hydrogen fluoride, anhydrous	Green	Brown	Brown	Brown
Hydrogen sulfide	Brown	Yellow	Brown	Brown
Krypton, oil pumped	Gray	Buff	Buff	Gray
Krypton, water pumped	Gray	Buff	Gray	Gray
Manufactured Gas—(Specify), Coal, oil, water, producer, etc.	Brown	Yellow	Yellow	Yellow
Methane	Yellow	White	Yellow	Yellow
Methylamine	Yellow	Brown	Yellow	Buff

See footnotes at end of table.

Table 10–10—Continued

Title	Top A	Band B	Band C	Body
Methylbromide	Brown	Black	Brown	Brown
Methyl bromide (fire only)	Red	Brown	Red	Red
Methyl chloride	Yellow	Brown	Orange	Orange
Methyl mercaptan	Brown	Yellow	Yellow	Brown
Methyl sulfide	Yellow	Brown	Buff	Brown
Methylene chloride	Gray	Blue	Orange	Orange
Natural gas	Yellow	Brown	Yellow	Yellow
Neon, oil pumped	White	Buff	Gray	Gray
Neon, water pumped	White	Buff	Buff	Gray
Nickel carbonyl	Yellow	White	Yellow	Brown
Nitric oxide	Brown	Buff	Brown	Brown
Nitrogen dioxide	Brown	Buff	Buff	Brown
Nitrogen, oil pumped	Gray	Black	Gray	Gray
Nitrogen, water pumped	Gray	Black	Black	Gray
Nitrosyl chloride	Brown	White	White	Brown
Nitrous oxide	Blue	Blue	Blue	Blue
Oxygen, medical	White	Green	Green	Green
Oxygen, aviator's	Green	White	Green	Green
Oxygen	Green	Green	Green	Green
Oxygen-Carbon dioxide	Gray[1]	White[2]	Green	Green
Petroleum Gas—(Specify) Acetogen, Butane, Butane-Propane, Butene-1, Cyclopropane, Isobutane, Isobutylen, Neopetane, Propane, etc.	Yellow	Orange	Yellow	Yellow
Phenylcarbylamine chloride	Brown	Gray	Gray	Brown
Phosgene	Brown	Orange	Brown	Brown
Propylene	Yellow	Gray	Buff	Buff
Sulfur dioxide	Brown	Gray	Brown	Brown
Sulfur hexafluoride	Gray	White	Black	Gray
Tetrafluoroethylene, inhibited	Buff	White	White	Buff
Trimethylamine, anhydrous	Yellow	Blue	Orange	Buff
Vinyl bromide	Buff	Blue	Blue	Buff
Vinyl chloride	Yellow	Orange	Buff	Buff
Vinyl methyl ether, inhibited	Yellow	Black	Buff	Buff
Xenon, oil pumped	White	Black	Black	Gray
Xenon, water pumped	White	Black	Gray	Gray

[1] A' or A" for medical gas mixtures.
[2] B' or B" for medical gas mixtures.

Table 10–11. Foreign Cylinder Colors

Gas	England	Australia	Japan	Italy	Germany
Acetylene	Purple	Maroon	Brown	Orange	Yellow
Carbon dioxide	Black	Brown	------	Yellow	
Freon 12	------	Light green			
Helium	Brown	Gray			
Hydrogen	Red	Signal red	Red	Red	Red
Methyl chloride	------	Light green			
Nitrogen	Gray	Dark gray	Purple	Green	Green
Oxygen	Black	Black	Black	White	Blue

Table 10–12. Characteristics of Cylinders Used for Certain Gases

Gas	Standard cylinder characteristics								
	ICC spec. number stamped on shoulder	Capacity cu. ft. of gas at atmospheric pressure	Capacity (lb. liquid)	Outside diam. (in.)	Lgth. (in.)	Max. pressure (p.s.i. at 70°F)	Weight empty (lb.)	Weight full (lb.)	Outlet valve threads [1]
Acetylene	8	10	------	4 7/16	13 1/8	250	92	100	Internal -left.
		40	------	7 1/8	26	------	100	196	
		100–110	------	8 1/2	30				
		225	------	12 1/2	36				
		300	------	12 1/2	39				
Ammonia	4A	--------	100	12 1/2	52 3/4	480	------	------	Internal -right.
		--------	150	15	53	------	------	------	
Carbon dioxide	3A	--------	20	7 1/8	29 1/2	2,015	68	88	External -right.
		--------	50	8 1/2	51	------	108	158	
Chlorine	3A	--------	10	4 1/2	21	480	------	------	External -right.
		--------	16	6 1/2	13 3/4	------	------	------	
		--------	150	10 1/2	48 5/8				
Helium	3A	220	------	9	51	2,015	120	122	[2]
Hydrogen	3A	115	------	7 1/8	43	2,015	120	121	External -left.
		220–240	------	9	51	2,015	120	121	
Methyl chloride	4B	--------	15	7	21 1/2	300	------	------	External -right.
		--------	30	8 1/2	27				
		--------	93	10 1/2	49 1/2				
		---- ---	100	10 1/2	49 1/2				
Nitrogen (water pumped)-(oil-pumped)	3A	220	------	9	51	2,015	120	137	Internal -right.
		220	------	9	51	------	120	137	Internal -left.
Oxygen	3A	12	------	4 7/16	16 1/4	2,015	79	88	External -right.
		110	------	7 1/8	43	------	120	137	
		220–240							
Sulfur dioxide	3B	--------	150	10 1/2	49 1/2	300	------	------	External -right.

[1] From U.S. Dept. of Commerce, National Bureau of Standards, Supplement to Screw-Thread Standards for Federal Services, 1944 (issued 15 June 1949), Supplement to Handbook H28 (1944).

[2] Water-pumped: Internal-right. Oil-pumped: Internal-left.

10–3. Camouflage Paints and Adhesives

Data on camouflage paints and adhesives are given in table 10–13.

Table 10–13. Camouflage Paints and Adhesives

Type of material	How issued	Color and finish	How prepared	Drying time	Remarks
Adhesive, glue-paste	Field expedient --	----------	Combine, as directed, flour paste, glue sizing, resin sizing, varnish, borax, and hot water.		
Adhesive, starch, field-expedient.	Any food containing starch, such as flour, grains, and potatoes.	----------	Prepare from raw materials as directed.		

Table 10–13—Continued

Type of material	How issued	Color and finish	How prepared	Drying time	Remarks
Adhesive, vegetation, field-expedient green.	Practically any green vegetation.		Boil fresh-cut plant material in water and treat as directed.		
Asphalt, cutback	55-gal. drums	Dark brown to black. Mat finish.	Ready mixed (slow-dry, diesel oil; medium-dry, kerosene; rapid-dry, gasoline.)	24 hrs. for medium-dry.	Commercially supplied. Good durability but flammable when exposed to jet exhaust. Surface to which it is applied must be dry. May be used at subfreezing temp.
Cement, asphalt	Commercial	Rough	Ready-mixed	30 min.	Good durability. Do not apply in temperatures under 45° F.
Compound, canvas refinishing.	Ready-mixed	Dark o.d., o.d., or green. Major unit commanders may requisition other colors. Mat finish.	Stir; dilute with gasoline if needed.	At least 2 hours.	
Dye fabric	Both liquid and powder.	Various	Mix with salt and water and use as directed.	At least 2 hours	Mat finish.
Molasses, raw (for field-expedient paint).	Liquid	Brown	Thin with water	Always sticky.	
Oil, used crankcase	Salvage from motor pools and air bases.	Brown	Use as supplied or mix with native colored earths.	NA	Used to tone down concrete and stabilize soil around encampments. Fair durability.
Paint, camouflage, bituminous emulsion, adhesive.	Ready-mixed, 55 gal. drums.	Dries to a blackish brown. Medium gloss, dulls rapidly.	Mixed with water. For better penetration, add wetting agent.	48 hrs.—completely dry. 8 hrs.—dry to touch.	Commercially supplied. Can be applied to damp surface. Temperature must be above 45° F. good in tropics.
Paint, camouflage, emulsifiable.	Paste	Standard camouflage colors. Flat finish.	Mix with water or organic solvents.	On wood or metal, not over 6 hours.	Cannot be painted over with lasting success.
Paint, camouflage, resin oil emulsion and resin emulsion type paste.	Ready-mixed	Fed Spec TT-C-295. Flat finish.	Mix with wator or mineral spirits.	About 24 hours.	
Paint, cement water.	Powder, cement; protein powder, modified cement; and oil paste, modified cement.	A range of light colors. Flat finish.	Mix with water.	30 minutes to 6 hours.	Hard surface.

Table 10–13—Continued

Type of material	How issued	Color and finish	How prepared	Drying time	Remarks
Paint, emulsified, field expedient.	Field expedient	Depends on range of earth colors available.	Mix, as directed, crankcase oil salvage or waste, water, and pigmented soil with: Type I, ground clay or powdered carbon and gasoline; or Type II, GI or field-expedient soap and clay or diatomaceous earth.		
Paint, face camouflage.	Stick form	White troops, dull light green and loam. Colored troops, dull light green and sand.	Ready for use.		
Paint, oil type for runways.	Ready-mixed	White and yellow flat finish.	Ready for application; can thin with mineral spirits or turpentine.	Less than 1 hour.	
Paint, paste, lusterless, gasoline removable.	Paste	White, in engr. depots; commercial, all colors. Flat finish.	Mix with gasoline or mineral spirits.	15 to 60 minutes.	
Paint, protein-binder, cold water.	Powder	Fed Spec TT–C–295. Flat finish.	Mix with water	48 hours to be slightly rain resistant; can handle in 6 hours.	Hard surface.
Paint, traffic	1 gal. cans	White	Ready-mixed. May be thinned with turpentine, gasoline, or naphtha.	1 hour	Best but costly; covers 300–350 sq. ft. per gal Jet exhaust blisters paint and causes it to lose color. Requires dry, clean surface.
Paint, water, paste	5 gal. can	All camouflage colors.	Must be thinned with gasoline, naptha, or water, 1 to 1 by volume.	6 hours	Covers 450 to 600 ft. per gal. Paint is removed by jet exhaust, but it is not combustible. Can be applied to dry surface. Good between −40° and +160° F.
Primer, enamel undercoater, phenolic.	Ready-mixed	Dull red, yellow	Stir with paddle	enough to recoat, 24 hours.	

Table 10–13—Continued

Type of material	How issued	Color and finish	How prepared	Drying time	Remarks
Silicate, sodium pigmented.	Varies	All camouflage colors.	Concentrate is thinned with water and sprayed on the surface. Calcium chloride is then sprayed on to set the silicate.	NA	Good for rough surfaces. On smooth surfaces brittle paint is pulverized by traffic. Can be applied when surface is damp.
Soap, field-expedient (for field-expedient paint).	Made by troops		Mix and treat waste kitchen grease and wood ashes.	NA.	
Stain, tent, field-expedient no. 1.	Made by troops	Dull dark gray or earth color.	Mix ½ lb soap with 8 gal. water. Add earth or a mixture of soot and paraffin to get desired shade.	Variable, fairly rapid.	Removal is not practical. Stain is not recommended for freezing tempertures.
Stain, tent, field-expedient no. 2.	Made by troops	Dull dark gray	Mix charcoal with water.	Fairly rapid	Removal not practical. Not recommended for freezing temperatures.
Stain, wood surface.	3 types, all ready-mixed.	Color varies with manufacturer. Flat finish.	Ready for use; can thin with mineral spirits or turpentine.	8–12 hours.	
Xylene and tar (Rt. 2). Kerosene and asphalt (similar to British pitch and creosote mix).	Varies	Brownish-black	Mix 80 tar to 0.20 xylene. Mix 25 asphalt to 75 kerosene by volume.	Rapid	Primarily a cheap stain. Fire hazard during application and when coated thickly on surfaces exposed to jet exhaust. Surface must be dry for application.

10–4. Weight of Clothing

Field laundry service usually is based on an average of approximately 6 pounds of laundry per man per week. Table 10–14 provides information which may be used as a guide in determining the weight of laundry bundles or in selecting items to be laundered.

Table 10–14. List of Dry Weights (Approximately)

STANDARD CLOTHING ITEMS

Item	*Wt lbs*
Bag, Duffel	2.33
Blanket, Wool	4.00
Cap, Field, Cotton	.18
Cap, Field, Cotton, Wool Pile Lining	.45
Coat, Lightweight	.97
Coat, Man's, Field, Cotton	3.25
Coat, Utility	1.36
Drawers, Cotton, Short	.22
Drawers, Men's, Winter	.88
Gloves, Insert, Wool	.14
Handkerchief	.10
Hood, Winter (Field Jacket)	.28
Hood, Winter (Fur Ruff)	.85
Liner, Coat, Man's	2.20
Liner, Parka, Man's	2.93
Liner, Trousers, Arctic	2.20
Liner, Trousers, Field (Cold-Dry)	1.70
Mitten Inserts, Trigger Finger	.21
Mitten Set, Arctic	1.45
Mitten, Shell, Cotton, White	.20
Muffler, Wool	.40
Parka, Man's	3.10
Parka, Overwhite, Man's	1.50

Table 10–14—Continued

Item	Wt lbs
Shirt, Man's, Wool, OG 108	1.60
Shirt, Utility, Cotton	1.35
Socks, Men's, Wool, Cushion Sole	.20
Suspenders, Trousers	.25
Towel, Bath	.75
Trousers, Lightweight	.92
Trousers, Men's, Cotton Jean, White	.90
Trousers, Men's, Cotton, Weather-Resistant WR Sateen	2.25
Trousers, Men's Outer	1.12
Trousers, Men's Wool Serge (Cold-Wet)	1.75
Trousers, Utility, Cotton	1.39
Undershirt, Cotton, Short Sleeve	.30
Undershirt, Winter	.87
VESICANT AGENT PROTECTIVE CLOTHING	
Coat, (Parka), Vesicant Agent Protective	1.80
Drawers, Cotton, Lightweight, Vesicant Agent Protective	.85
Gloves, Cotton, Special (CW Prot.)	.35
Hood, Field, Protective, M–4	.60
Trousers, Vesicant Agent Protective	.95
Undershirt, Cotton, Lightweight, Vesicant Agent Protective	.70
CHEMICAL PROTECTIVE CLOTHING	
Gloves, Cotton, Chemical Protective	.38
Liner, Shirt, Chemical Protective	2.13
Socks, Cushion Sole, Chemical Protective	.25
Liner, Trouser, Chemical Protection	1.63

10–5. Time Conversion

The time in any part of the world may be determined by referring to figure 10–1 and table 10–15. *Example*: Note in figure 10–1 that the eastern part of the United States lies in time zone R (5 hours later than Greenwich mean time) and that Vietnam lies in time zone G (7 hours earlier than Greenwich mean time). Table 10–15 indicates that at 1800 hours on a given day in New York it is 0600 on the next day in Vietnam. The top line of table 10–15 is Greenwich mean time.

Table 10–15. Table for conversion of time throughout the world.

(Located in back of manual)

10–6. Panel Code

Figure 10–2 gives panel codes, numerals, indicators, and special signs.

10–7. Ground-Air Emergency Code

The symbols shown in figure 10–3 may be made by using strips of fabric or parachute, pieces of wood, stones, or by tracking in the snow. The symbols should contrast with the background as much as possible and be 8 feet or more in length and 10 feet apart.

10–8. Phonetic Alphabet

The phonetic alphabet shown in table 10–16 was adopted 1 March 1956 for use by all personnel within the Department of the Army.

Table 10–16. Phonetic Alphabet

A	ALFA	(*AL* FAH)	N	NOVEMBER	(NO *VEM BER*)
B	BRAVO	(*BRAH* VOH)	O	OSCAR	(*OSS* CAH)
C	CHARLIE	(*CHAR* LEE)	P	PAPA	(PAH *PAH*)
D	DELTA	(*DELL* TAH)	Q	QUEBEC	(KEH *BECK*)
E	ECHO	(*ECK* OH)	R	ROMEO	(*ROW* ME OH)
F	FOXTROT	(*FOKS* TROT)	S	SIERRA	(SEE *AIR* RAH)
G	GOLF	(GOLF)	T	TANGO	(*TANG* GO)
H	HOTEL	(HOH *TELL*)	U	UNIFORM	(*YOU* NEE FORM)
I	INDIA	(*IN* DEE AH)	V	VICTOR	(*VIK* TAH)
J	JULIETT	(*JEW* LEE *ETT*)	W	WHISKEY	(*WISS* KEY)
K	KILO	(*KEY* LOH)	X	XRAY	(*ECKS* RAY)
L	LIMA	(*LEE* MAH)	Y	YANKEE	(*YANG* KEY)
M	MIKE	(MIKE)	Z	ZULU	(*ZOO* LOO)

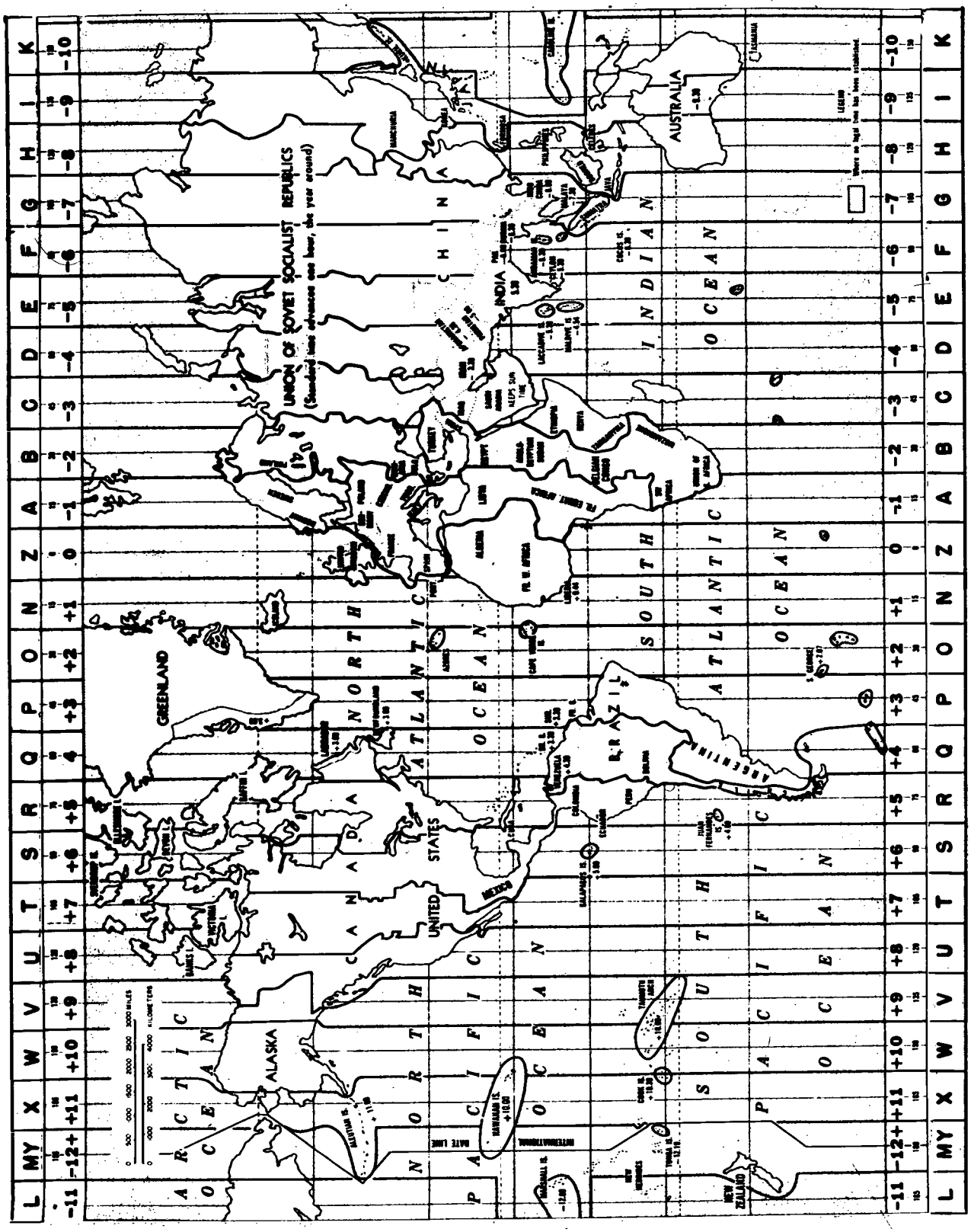


Figure 10–1. Time-zone chart.

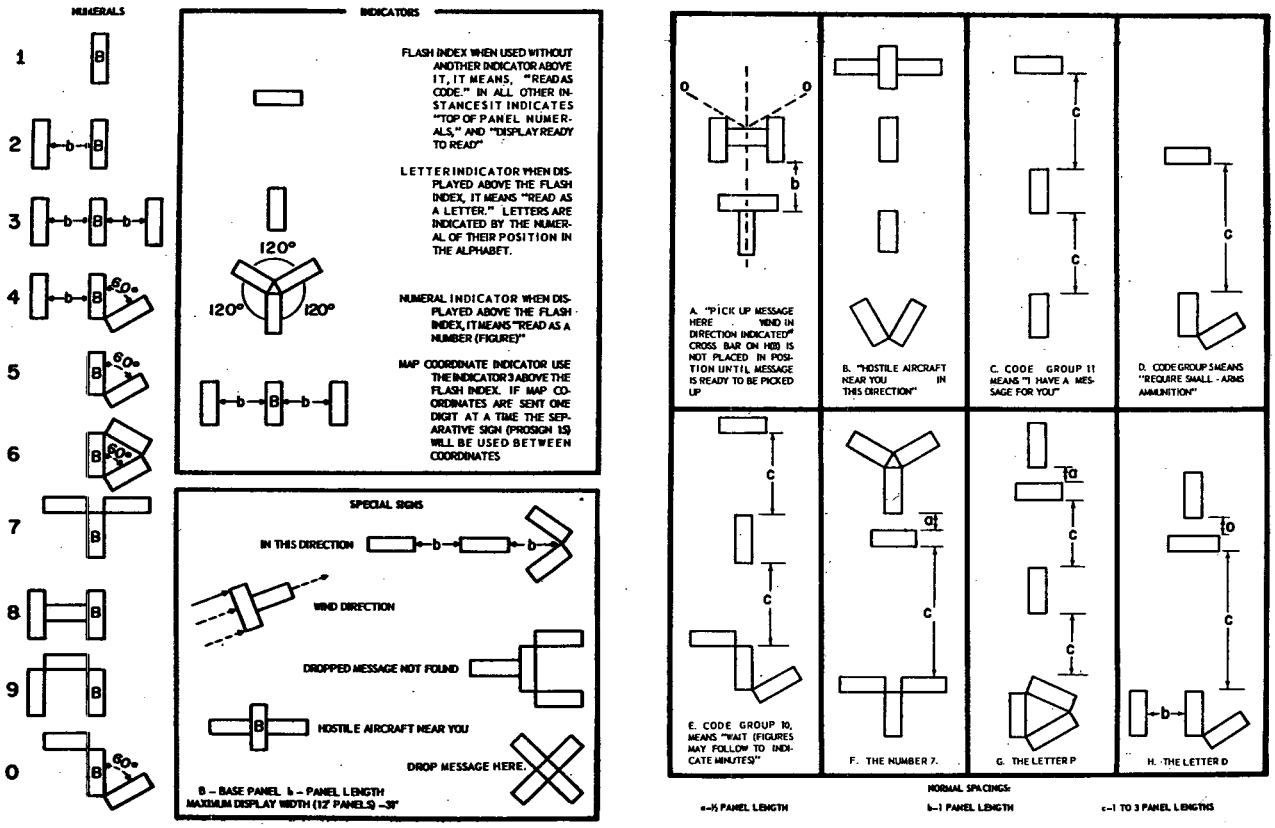


Figure 10–2. Panel code and messages.

GROUND SIGNALS

1. Require doctor
2. Require medical supplies
3. Unable to proceed
4. Require food and water
5. Require firearms and ammunition
6. Require map and compass
7. Require signal lamp with battery and radio
8. Indicate direction to proceed
9. Am proceeding this direction
10. Will attempt takeoff
11. Aircraft seriously damaged
12. Probably safe to land here
13. Require fuel and oil
14. All well
15. No
16. Yes
17. Not understood
18. Require engineer

ACKNOWLEDGMENT BY AIRCRAFT

Message received and understood	1. Rocking from side to side 2. Green flashes from signal lamp
Message not understood	1. Aircraft will make complete right-hand circuit 2. Red flashes from signal lamp

Figure 10–3. Ground-to-air emergency code.

CHAPTER 11

AUTOMATIC DATA PROCESSING EQUIPMENT (ADPE)

11–1. General

The automatic data processing (ADP) systems discussed in this chapter were developed as a result of studies which began in the early 1950's. These studies revealed a need for greater efficiency in combat service support management and accounting. Increased automation has met the need by making possible more sophisticated analysis and faster response to huge masses of data. This chapter contains data on the equipment found in the current systems.

11–2. The Mechanized Stock Control and Accounting System (Magnetic Ledger) for Direct and General Support Units, NCR 500.

a. Deployment. The NCR 500 system is issued worldwide to all non-divisional direct and general support units for mechanizing their stock control and supply accounting. The system is used for repair parts supply and can handle up to 30,000 line items with a transaction rate of about 25,000 per month. Through program outputs, the system can be combined with other systems currently in use in the theater of operations, such as the UNIVAC 1005 or the IBM 360 model 40.

b. Equipment. The NCR 500 system is housed in two M373A vans in which the temperature is maintained at 68° F to 85° F and the humidity is held at 20 to 60 percent. The vans are 30 feet long, 8 feet wide, and 6 feet 4 inches high. One van, designated as the stock control van, contains two 029 card punchers and an 083 sorter. The other van houses the computer configuration and one 029 card punch machine. The computer configuration consists of a 517 Processor, a 590–1 Control console, a 582–1 Punched card reader, a 581–1 Punched card input controller, and a 576 Serial card punch. Table 11–1 gives a brief description of the capabilities of the equipment in the NCR 500 system.

Table 11–1. NCR 500 Equipment

ADP Equipment	Capability
517 Processor	Serves as the central controlling unit for the system. It houses the core memory which consists of 400 words of 12 digits each or 4,800 numeric characters.
590–1 Magnetic ledger card control console	Provides central access to the processor and all units of the 500 system.
582–1 Punched card reader	Reads alpha-numeric data serially from a full 80-column punched card at the rate of 100 cards per minute.
581–1 Punched card input controller	Controls, powers and serves as a table for the card reader.
576 Serial card punch	Serves as an on-line output device by serially punching and printing card simultaneously. It has a capability of punching and printing at a rate of 25 cards per minute.
083 Sorter	Sorts cards and edits alpha-numeric information at the rate of approximately 1000 cards per minute. Sorting pattern is determined by a 5-position rotating switch used to sort numerical, zone, alphabetic sort 1, alphabetic sort 2, and alpha-numerical.
029 Printing card punch	Punches cards and prints characters simultaneously. Transistorized operation requires no warm up.

11–3. Combat Service Support System (CS_3)

CS_3 is a data processing and data communication system designed for use at corps and division levels. It consists of several computer centers, one located at the corps support command (COSCOM) and one at the division support command (DISCOM) of each division assigned to the corps. The system is designed so that any computer in the system can take over the critical functions of another computer in the event of malfunction or loss of equipment. The equipment is shock-mounted in vans and can be transported wher-

ever the using unit moves. When not operating, the equipment can be moved by air, rail, water, or over all-weather roads without impairing its reliability or maintainability. Through the use of encrypting devices, the system can transmit data with security classification up to and including "SECRET".

a. Equipment. The equipment configuration on each van is given in table 11–2

(1) *CS_3 Corps Support Command Data Processing System.* The CS_3 system utilizes the IBM 360/40 model computer. It consists of a central computer complex composed of four airconditioned vans—Main Frame, Mass Storage, Communications, and Off-Line/Maintenance vans. Intervan cables, a covered walkway, and prime and backup power generators are also included. Connected to this complex is a group of 12 remote substations located at headquarters and at direct and general support units. The remote substation system is comprised of eight high-speed transceiver stations which process 100 cards a minute, four remote inquiry stations equipped with keyboard entry devices, and one mobile maintenance facility. The equipment for each substation is housed in a 7 x 12 foot, air-conditoned aluminum shelter mounted on a truck.

Table 11–2. CS_3 Vans and Equipment

Vehicle	ADP Equipment	Remarks
Main frame van (5 ton air conditioner).	2040 Processing unit	Central processing unit (CPU).
	1052 Printer keyboard	Supervises the entire computer complex and performs the actual arithmetic and logical operations on data. Capable of 50% core memory expansion.
	2540 [1] Card read/punch	2540, Read 1,000 cards per minute punch 300 cards per minute.
	2520 [2] Card read/punch	2520, Read and punch 500 cards per minute.
	1403–N–1 [1] Printer	
	1443 [2] Printer	
	2804–2 Tape control unit	
	2821–1 Control unit	
Mass storage van (7½ ton air conditioner).	2314 Direct access storage unit	Contains 233.4 million bytes [3] of information on eight magnetic disk packs. The system can retrieve the data at the rate of 312,000 bytes per second.
	2401–4 Magnetic tape units (4 per van)	The magnetic tape unit 2401 model 4 has a data transfer rate of 60,000 characters per second. The magnetic tape unit 2401 model 5 has a data transfer rate of 120,000 characters per second.
	2401–5 Magnetic tape units (2 per van)	
Communication van (4 ton air conditioner).	2701 Tape adapter unit	Transmits and receives digital data by wire or tactical radio with cryptographic security. Also provides for test and coordination of data transmission circuits.
	2702–1 Transmission control	
	1012 Tape punch	
	2822 Control	
	2671 Paper tape reader	
Off-line and maintenance van (4 ton air conditioner).	557 Alphabet interpreter	Contains storage and work areas, filing cabinets, and off-line equipment such as card punch alphabet interpreter, and verifier.
	059 Verifier	
	029 Card punch	
Transceiver station high speed (1½ ton air conditioner).	1013 Card transmission terminal	Transmits and receives data on punched cards at speeds of 150, 250, or 300 characters per second. Cards are punched at 160 columns per second or 100 cards per minute.
	029 Card punch	
	557 Alphabet interpreter	
Transceiver station low speed (1 ton air conditioner).	1051 Control unit	Provides basic control required for transmission of data to and from another system or another transmission control unit. Card reader transmits at 14.8 characters per second or 10 cards per minute.
	1058–1 Printing card punch	
	1056–1 Card reader	
Inquiry station (¾ ton air conditioner).	2740 Communications terminal	Provides remote inquiry to the system for immediate access to stored information.

[1] Corps only.
[2] Division only.
[3] A byte is the smallest unit of addressable storage.

(2) *CS_3 Division Support Command Data Processing System.* This system is similar to the corps system except that it has fewer magnetic tape units, slower printers, less centralprocessing-unit memory capability, and seven instead of 12 remote substations. A mobile maintenance facility is part of the system.

b. Power Source. A trailer-mounted 100KW diesel generator is the power source for the corps and division computer complexes. A backup generator is also provided with every complex. Each substation is powered by a single 10 KW generator. A backup unit for the substations is found with the mobile maintenance facility.

c. Mobility. CS_3 vans can be pulled by M–52 military tractors or commercial tractors, transported aboard ship, or carried in cargo aircraft such as the C–133. The S–280 shelters, which house the remote stations, are carried on M–35 2½ ton cargo trucks, cargo aircraft, or helicopters.

d. Expansibility. CS_3 can be expanded greatly through the use of disk packs and high-density tapes, and the core storage in the central processing unit can be doubled. Moreover, the modular concept used in the system permits extensive expansion of the overall capacity. For example, the communications van can handle twice the number of remote stations now in the system.

e. Equipment Density. The quantity of each piece of ADPE at corps and division level is shown in table 11–3.

11–4. Other Systems

Listed below are several other automated supply systems. The performance data are for the central processing unit and do not consider peripheral equipment. The input/output devices attached to each will vary according to the situation.

a. COSMOS—Centralization of Supply Management Operations. The basic aim COSMOS is to centralize stock management and stock fund management at the stock control center of the CONUS Army headquarters. The concept calls for the transfer of supply management, stock control, and stock fund management from the installation to a stock control center at the CONUS Army level. The present supply activity at the installation will become a storage location linked to the central IBM 360 computer at the stock control center by a field data terminal. The COSMOS computer system consists of the IBM 360/30 and 360/40 with related input/output devices including data transmission adapters located at the stock control center, and card handling equipment and data transmission adapters at the field data terminals. The 360/30, which controls inputs and outputs to the data processing systems, has a main storage capacity of 65,536 bytes. The model 40, which is used for processing transaction and storage of records, has a storage capacity of 64,536 bytes.

Table 11–3. CS_3 Equipment Density

ADPE	Equipment No.	Number in Corps	Number in Division
CENTRAL COMPUTER COMPLEX:			
Alphabet interpreter	557	1	1
Card punch	029	3	3
Card read/punch-high speed	2540	1	
Card read/punch-low speed	2520	--	1
Central processing unit	2040	1	1
Control unit	2821–1	1	1
Data adapter unit	2701	5	1
Direct storage access unit	2314	1	1
Magnetic tape units	2401–4	4	4
Magnetic tape units	2401–5	2	
Paper tape reader	2671	1	1
Paper tape reader control	2822	1	1
Printer	1403–N–1	1	
Printer	1443	--	1
Printer Keyboard	1052	1	1
Tape control	2804–2	1	1
Tape punch	1012	1	1
Transmission control	2702–1	1	1
Verifier	059	1	1
TRANSCEIVER STATION—HIGH SPEED:			
Alphabet interpreter	557	8	1
Card punch	029	8	1
Card transmission terminal	1013	8	1
TRANSCEIVER STATION—LOW SPEED:			
Card punch	1058–1	--	3
Card reader	1056–1	--	3
Control unit	1051	--	3
INQUIRY STATION			
Communications terminal	2740	4	3

b. NAPALM—National ADP Program for AMC Logistics Management. NAPALM is the Army Materiel Command's masterplan for automation at installation and command levels. The program includes not only materiel management but research, development, test and evaluation, and installation management as well. The objective of the program is to upgrade and standardize ADPE to permit the use of common programs and to support standard systems. The NAPALM program will ultimately consist of 11 IBM 360/65 systems, one IBM 360/50 system, and one IBM 360/40 system located throughout the six commodity commands of AMC.

c. MOWASP—Mechanization of Warehousing and Shipment Processing. MOWASP is a uniform ADP system employed at Defense Supply Agency storage locations. Centrally programed by the Data Systems Automation office, the system provides management information and automates warehousing and shipping procedures at the storage locations. The system utilizes the IBM 360/40, a disk-oriented computer which operates in three modes. The first mode, the computer's on-line locator file, admits remote inquiry from six locations and, through teleprocessing, locates stocks in up to 10 stock locations. The second mode makes computations, locates consignee addresses, and processes materiel release orders and shipping and receiving documents. At the same time, printouts are produced by the computer's third mode. MOWASP is used exclusively for warehousing and shipping and does not provide depot bookkeeping services such as civilian payroll and depot property record keeping.

APPENDIX A

REFERENCES

A–1. Army Regulations

11–8	Logistics Policies.
30–10	Central Food Facilities.
310–3	Department of the Army Publications—Preparation, Coordination, and Approval.
310–25	Dictionary of U.S. Army Terms.
310–50	Authorized Abbreviations and Brevity Codes.
700–15	Preservation, Packaging, and Packing.
700–60	Utilization of Automotive Gasoline.
700–68	Safe Handling, Storing, Shipping, Use, and Disposal of Compressed Gas Cylinders.
710–60	Replacement Factors for PEMA Major End Stems.
711–16	DSU/Installation Stock Control and Supply Procedures.
725–50	Requisitioning, Receipt, and Issue System.
740–11	Maintenance of the Joint Storage and Materials Handling Manual—TM 743–200.
740–15	Storage of Military Service-Owned Stocks in the DSA Distribution System.

A–2. Department of the Army Pamphlets

108–1	Index of Army Films, Transparencies, GTA Charts, and Recordings.
310-series	Military Publication Indexes (as applicable)

A–3. Field Manuals

3–8	Chemical Reference Handbook.
5–34	Engineer Field Data.
5–35	Engineers Reference and Logistical Data.
8–55	Army Medical Service Planning Guide.
10–63	Handling of Deceased Personnel in Theaters of Operations.
20–15	Pole and Frame Supported Tents.
21–5.	Military Training Management.
21–6	Techniques of Military Instruction.
21–15	Care and Use of Individual Clothing and Equipfense.
21–30	Military Symbols.
21–40	Chemical, Biological, Radiological, and Nuclear Defense.
21–41	Soldier's Handbook for Defense Against Chemical and Biological Operations and Nuclear Defense.
55–15	Transportation Reference Data.
101–10–1	Staff Officer's Field Manual: Organizational, Technical, and Logistical Data, Unclassified Data.

(C) 101–20	United States Army Aviation Planning Manual (U).

A–4. Technical Manuals

3–220	Chemical, Biological, and Radiological (CBR) Decontamination.
3–260	Operation of Radioactive Material Disposal Facilities.
5–330	Planning and Design of Roads, Airbases and Heliports in the Theater of Operations.
10–500-series	Airdrop of Supplies and Equipment.
10–210	Inspection and Storage of Subsistence Supplies.
10–706	Field Bakery, Portable, M1942.
10–1101	Petroleum Handling Equipment and Operations.
10–1619	Quartermaster Materials Handling Equipment.
10–1680A	Laundry, Unit, Trailer Mounted, With Extractor and Washer.
10–1690A	Industrial Motive Power Storage Batteries for Materials Handling Equipment.
10–4510–201–10	Bath Unit, Portable 8-Showerhead, M1958.
10–7360–201–10	Operator's Manual: Bakery Plant, Trailer Mounted.
38–230–1	Preservation, Packaging, and Packing of Military Supplies and Equipment: Preservation and Packaging (Volume I).
38–230–2	Preservation, Packaging, and Packing of Military Supplies and Equipment: Packing (Volume II).
55–450–8	Air Transport of Supplies and Equipment: External Transport Procedures.
55–450–15	Air Movement of Troops and Equipment (Administrative).
55–601	Troop Movement Guide.
55–2320–211–10–3	Transportability Guidance-Truck Cargo, 5–ton, 6x6, M54A1, and M54A2.
743–200	Storage and Materials Handling.
743–200–1	Storage and Materials Handling.

A–5. Supply Bulletins

10–495	Standard "B" Ration for the Armed Forces.
10–496	Wartime Replacement Factors and Consumption Rates for DSA/GSA Assigned (Quartermaster Type) Items.
38–8–1	Storage of Army Supplies and Equipment—Covered and Open Storage.
38–100	Preservation, Packaging, and Packing and Marking, Materials, Supplies, and Equipment Used by the Army.
708–21	Federal Supply Classification; Part I: Groups and Classes (Cataloging Handbook H 2–1).
708–22	Federal Supply Classification; Part 2: Numeric Index of Classes (Cataloging Handbook H 2–2).
708–23	Federal Supply Classification; Part 3: Alphabetic Index (Cataloging Handbook H 2–3).
710–1	Supply Control Replacement Factors for Army Materiel.

A–6. JCS Publication

JCS Pub–1 Dictionary of United States Military Terms for Joint Usage.

APPENDIX B

SUPPLY AND SERVICE TOE UNITS

10–7G	Supply and Service Company, Supply and Transport Battalion; Armored, Infantry, or Infantry (MECH) Divisions.
10–37G	Supply Company, Support Command, Airborne Division.
10–67T	Quartermaster Air Equipment Support Company, Supply Battalion, Airmobile Division.
10–202G	Headquarters and Headquarters Detachment, Petroleum Group.
10–206G	Headquarters and Headquarters Company, Petroleum Operating Battalion.
10–207G	Petroleum Operating Company.
10–226G	Headquarters and Headquarters Company Petroleum Supply Battalion.
10–227G	Petroleum Supply Company.
10–292G	Headquarters and Headquarters Detachment Graves Registration Group.
10–296G	Headquarters and Headquarters Company and Personal Effects Depot.
	Graves Registration Battalion or Headquarters and Headquarters Detachment, Graves Registration Battalion.
10–297G	Graves Registration Company, Communications Zone.
10–337G	Quartermaster Air Equipment Support Company, Airborne Division.
10–407G	Quartermaster Air Delivery Company.
10–417G	Airdrop Equipment Repair and Supply Company.
10–437G	Laundry and Renovation Company (General Support).
10–458G	Quartermaster Petroleum Supply Company, Forward.
10–475G	Quartermaster Petroleum Supply Battalion, Army.
10–476G	Headquarters and Headquarters Company, Quartermaster Petroleum Supply Battalion, Army.
10–477G	Quartermaster Petroleum Company (Army).
29–2G	Headquarters, Headquarters Company and Band, Support Command, Armored, Infantry, or Infantry (Mech) Divisions.
29–5G	Supply and Transport Battalion, Infantry Division.
29–6G	Headquarters and Headquarters Company, Supply and Transportation Battalion, Armored, Infantry, or Infantry (Mech) Division.
29–65G	Supply and Transport Battalion, Armored or Infantry (Mech) Division.

29–75G	Support Battalion, Separate Armored or Infantry (Mech) Brigade.
29–76G	Headquarters and Headquarters Detachment, Support Battalion, Separate Armored, Infantry, or Infantry (Mech) Brigades.
29–77G	Supply and Transport Company, Separate Armored, Infantry, or Infantry (Mech) Brigades.
29–95T	Supply Battalion Airmobile Division.
29–96T	Headquarters, Headquarters and Service Company, Supply Battalion, Airmobile Division.
29–97T	Supply Company, Supply Battalion, Airmobile Division.
29–105G	Support Battalion, Separate Airborne Brigade.
29–106G	Headquarters and Headquarters Detachment, Support Battalion, Separate Airborne Brigade.
29–107G	Supply and Service Company, Support Battalion, Separate Airborne Brigade.
29–114G	Field Service General Support Company, Forward.
29–116G	Headquarters and Headquarters Company, Supply and Service Battalion, General Support, Forward.
29–118G	General Supply Company, General Support.
29–119G	Repair Parts Supply Company, General Support Corps or Repair Parts Supply Company, General Support, Army or Repair Parts Supply Company, General Support Communications Zone.
29–124G	Field Service Company General Support, Army.
29–126G	Headquarters and Headquarters Company, Supply and Service General Support Battalion, Army or Communications Zone.
29–127G	Heavy Materiel Supply Company, General Support.
29–129G	Aircraft and Missile Repair Parts Supply Company General Support.
29–146G	Headquarters and Headquarters Company, Supply and Service Battalion.
29–147G	Supply and Service Company, Direct Support.
29–215F	Supply and Service Battalion, Direct Support.
29–216G	Headquarters and Headquarters Company Supply and Service Battalion, Direct Support.
29–217G	Supply and Service Company, Supply and Service Battalion, Direct Support.
29–402G	Inventory Control Company, Field Army Support Command.
29–404	Stock Control Company, Support Brigade.
29–512T	Headquarters and Headquarters Company, Field Depot.

INDEX

INDEX—Continued

INDEX—Continued

By Order of the Secretary of the Army:

W. C. WESTMORELAND,
General, United States Army,
Chief of Staff.

Official:
KENNETH G. WICKHAM,
Major General, United States Army,
The Adjutant General.

Distribution:

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Table 2-3. Ration Breakdown Chart

	1	2	3	4	5	6	7	8	9	10
0.5	.005	.01	.015	.02	.025	.03	.035	.04	.045	.05
1	.01	.02	.03	.04	.05	.06	.07	.08	.09	.1
2	.02	.04	.06	.08	.1	.12	.14	.16	.18	.2
3	.03	.06	.09	.12	.15	.18	.21	.24	.27	.3
4	.04	.08	.12	.16	.2	.24	.28	.32	.36	.4
5	.05	.1	.15	.2	.25	.3	.35	.4	.45	.5
6	.06	.12	.18	.24	.3	.36	.42	.48	.54	.6
7	.07	.14	.21	.28	.35	.42	.49	.56	.63	.7
8	.08	.16	.24	.32	.4	.48	.56	.64	.72	.8
9	.09	.18	.27	.36	.45	.54	.63	.72	.81	.9
10	.1	.2	.3	.4	.5	.6	.7	.8	.9	1.
11	.11	.22	.33	.44	.55	.66	.77	.88	.99	1.1
12	.12	.24	.36	.48	.6	.72	.84	.96	1.08	1.2
13	.13	.26	.39	.52	.65	.78	.91	1.04	1.17	1.3
14	.14	.28	.42	.56	.7	.84	.98	1.12	1.26	1.4
15	.15	.3	.45	.6	.75	.9	1.05	1.2	1.35	1.5
16	.16	.32	.48	.64	.8	.96	1.12	1.28	1.44	1.6
17	.17	.34	.51	.68	.85	1.02	1.19	1.36	1.53	1.7
18	.18	.36	.54	.72	.9	1.08	1.26	1.44	1.62	1.8
19	.19	.38	.57	.76	.95	1.14	1.33	1.52	1.71	1.9
20	.2	.4	.6	.8	1.	1.2	1.4	1.6	1.8	2.
21	.21	.42	.63	.84	1.05	1.26	1.47	1.68	1.89	2.1
22	.22	.44	.66	.88	1.1	1.32	1.54	1.76	1.98	2.2
23	.23	.46	.69	.92	1.15	1.38	1.61	1.84	2.07	2.3
24	.24	.48	.72	.96	1.2	1.44	1.68	1.92	2.16	2.4
25	.25	.5	.75	1.	1.25	1.5	1.75	2.	2.25	2.5
26	.26	.52	.78	1.04	1.3	1.56	1.82	2.08	2.34	2.6
27	.27	.54	.81	1.08	1.35	1.62	1.89	2.16	2.43	2.7
28	.28	.56	.84	1.12	1.4	1.68	1.96	2.24	2.52	2.8
29	.29	.58	.87	1.16	1.45	1.74	2.03	2.32	2.61	2.9
30	.3	.6	.9	1.2	1.5	1.8	2.1	2.4	2.7	3.
31	.31	.62	.93	1.24	1.55	1.86	2.17	2.48	2.79	3.1
32	.32	.64	.96	1.28	1.6	1.92	2.24	2.56	2.88	3.2
33	.33	.66	.99	1.32	1.65	1.98	2.31	2.64	2.97	3.3
34	.34	.68	1.02	1.36	1.7	2.04	2.38	2.72	3.06	3.4
35	.35	.7	1.05	1.4	1.75	2.1	2.45	2.8	3.15	3.5
36	.36	.72	1.08	1.44	1.8	2.16	2.52	2.88	3.24	3.6
37	.37	.74	1.11	1.48	1.85	2.22	2.59	2.96	3.33	3.7
38	.38	.76	1.14	1.52	1.9	2.28	2.66	3.04	3.42	3.8
39	.39	.78	1.17	1.56	1.95	2.34	2.73	3.12	3.51	3.9
40	.4	.8	1.2	1.6	2.	2.4	2.8	3.2	3.6	4.
41	.41	.82	1.23	1.64	2.05	2.46	2.87	3.28	3.69	4.1
42	.42	.84	1.26	1.68	2.1	2.52	2.94	3.36	3.78	4.2
43	.43	.86	1.29	1.72	2.15	2.58	3.01	3.44	3.87	4.3
44	.44	.88	1.32	1.76	2.2	2.64	3.08	3.52	3.96	4.4
45	.45	.9	1.35	1.8	2.25	2.7	3.15	3.6	4.05	4.5
46	.46	.92	1.38	1.84	2.3	2.76	3.22	3.68	4.14	4.6
47	.47	.94	1.41	1.88	2.35	2.82	3.29	3.76	4.23	4.7
48	.48	.96	1.44	1.92	2.4	2.88	3.36	3.84	4.32	4.8
49	.49	.98	1.47	1.96	2.45	2.94	3.43	3.92	4.41	4.9
50	.5	1.	1.5	2.	2.5	3.	3.5	4.	4.5	5.
51	.51	1.02	1.53	2.04	2.55	3.06	3.57	4.08	4.59	5.1
52	.52	1.04	1.56	2.08	2.6	3.12	3.64	4.16	4.68	5.2
53	.53	1.06	1.59	2.12	2.65	3.18	3.71	4.24	4.77	5.3
54	.54	1.08	1.62	2.16	2.7	3.24	3.78	4.32	4.86	5.4
55	.55	1.1	1.65	2.2	2.75	3.3	3.85	4.4	4.95	5.5
56	.56	1.12	1.68	2.24	2.8	3.36	3.92	4.48	5.04	5.6
57	.57	1.14	1.71	2.28	2.85	3.42	3.99	4.56	5.13	5.7
58	.58	1.16	1.74	2.32	2.9	3.48	4.06	4.64	5.22	5.8
59	.59	1.18	1.77	2.36	2.95	3.54	4.13	4.72	5.31	5.9
60	.6	1.2	1.8	2.4	3.	3.6	4.2	4.8	5.4	6.
61	.61	1.22	1.83	2.44	3.05	3.66	4.27	4.88	5.49	6.1
62	.62	1.24	1.86	2.48	3.1	3.72	4.34	4.96	5.58	6.2
63	.63	1.26	1.89	2.52	3.15	3.78	4.41	5.04	5.67	6.3
64	.64	1.28	1.92	2.56	3.2	3.84	4.48	5.12	5.76	6.4
65	.65	1.3	1.95	2.6	3.25	3.9	4.55	5.2	5.85	6.5
66	.66	1.32	1.98	2.64	3.3	3.96	4.62	5.28	5.94	6.6
67	.67	1.34	2.01	2.68	3.35	4.02	4.69	5.36	6.03	6.7
68	.68	1.36	2.04	2.72	3.4	4.08	4.76	5.44	6.12	6.8
69	.69	1.38	2.07	2.76	3.45	4.14	4.83	5.52	6.21	6.9
70	.7	1.4	2.1	2.8	3.5	4.2	4.9	5.6	6.3	7.
71	.71	1.42	2.13	2.84	3.55	4.26	4.97	5.68	6.39	7.1
72	.72	1.44	2.16	2.88	3.6	4.32	5.04	5.76	6.48	7.2
73	.73	1.46	2.19	2.92	3.65	4.38	5.11	5.84	6.57	7.3
74	.74	1.48	2.22	2.96	3.7	4.44	5.18	5.92	6.66	7.4
75	.75	1.5	2.25	3.	3.75	4.5	5.25	6.	6.75	7.5
76	.76	1.52	2.28	3.04	3.8	4.56	5.32	6.08	6.84	7.6
77	.77	1.54	2.31	3.08	3.85	4.62	5.39	6.16	6.93	7.7
78	.78	1.56	2.34	3.12	3.9	4.68	5.46	6.24	7.02	7.8
79	.79	1.58	2.37	3.16	3.95	4.74	5.53	6.32	7.11	7.9
80	.8	1.6	2.4	3.2	4.	4.8	5.6	6.4	7.2	8.
81	.81	1.62	2.43	3.24	4.05	4.86	5.67	6.48	7.29	8.1
82	.82	1.64	2.46	3.28	4.1	4.92	5.74	6.56	7.38	8.2
83	.83	1.66	2.49	3.32	4.15	4.98	5.81	6.64	7.47	8.3
84	.84	1.68	2.52	3.36	4.2	5.04	5.88	6.72	7.56	8.4
85	.85	1.7	2.55	3.4	4.25	5.1	5.95	6.8	7.65	8.5
86	.86	1.72	2.58	3.44	4.3	5.16	6.02	6.88	7.74	8.6
87	.87	1.74	2.61	3.48	4.35	5.22	6.09	6.96	7.83	8.7
88	.88	1.76	2.64	3.52	4.4	5.28	6.16	7.04	7.92	8.8
89	.89	1.78	2.67	3.56	4.45	5.34	6.23	7.12	8.01	8.9
90	.9	1.8	2.7	3.6	4.5	5.4	6.3	7.2	8.1	9.
91	.91	1.82	2.73	3.64	4.55	5.46	6.37	7.28	8.19	9.1
92	.92	1.84	2.76	3.68	4.6	5.52	6.44	7.36	8.28	9.2
93	.93	1.86	2.79	3.72	4.65	5.58	6.51	7.44	8.37	9.3
94	.94	1.88	2.82	3.76	4.7	5.64	6.58	7.52	8.46	9.4
95	.95	1.9	2.85	3.8	4.75	5.7	6.65	7.6	8.55	9.5
96	.96	1.92	2.88	3.84	4.8	5.76	6.72	7.68	8.64	9.6
97	.97	1.94	2.91	3.88	4.85	5.82	6.79	7.76	8.73	9.7
98	.98	1.96	2.94	3.92	4.9	5.88	6.86	7.84	8.82	9.8
99	.99	1.98	2.97	3.96	4.95	5.94	6.93	7.92	8.91	9.9
100	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
105	1.05	2.1	3.15	4.2	5.25	6.3	7.35	8.4	9.45	10.5
200	2.	4.	6.	8.	10.	12.	14.	16.	18.	20.
300	3.	6.	9.	12.	15.	18.	21.	24.	27.	30.

	15	20	25	30	35	40	45	50	55	60
0.5	.075	.1	.125	.15	.175	.2	.225	.25	.275	.3
1	.15	.2	.25	.3	.35	.4	.45	.5	.55	.6
2	.3	.4	.5	.6	.7	.8	.9	1.	1.1	1.2
3	.45	.6	.75	.9	1.05	1.2	1.35	1.5	1.65	1.80
4	.6	.8	1.	1.2	1.4	1.6	1.8	2.	2.2	2.4
5	.75	1.	1.25	1.5	1.75	2.	2.25	2.5	2.75	3.
6	.9	1.2	1.5	1.8	2.1	2.4	2.7	3.	3.3	3.6
7	1.05	1.4	1.75	2.1	2.45	2.8	3.15	3.5	3.85	4.2
8	1.2	1.6	2.	2.4	2.8	3.2	3.6	4.	4.4	4.8
9	1.35	1.8	2.25	2.7	3.15	3.6	4.05	4.5	4.95	5.4
10	1.5	2.	2.5	3.	3.5	4.	4.5	5.	5.5	6.
11	1.65	2.2	2.75	3.3	3.85	4.4	4.95	5.5	6.05	6.6
12	1.8	2.4	3.	3.6	4.2	4.8	5.4	6.	6.6	7.2
13	1.95	2.6	3.25	3.9	4.55	5.2	5.85	6.5	7.15	7.8
14	2.1	2.8	3.5	4.2	4.9	5.6	6.3	7.	7.7	8.4
15	2.25	3.	3.75	4.5	5.25	6.	6.75	7.5	8.25	9.
16	2.4	3.2	4.	4.8	5.6	6.4	7.2	8.	8.8	9.6
17	2.55	3.4	4.25	5.1	5.95	6.8	7.65	8.5	9.35	10.2
18	2.7	3.6	4.5	5.4	6.3	7.2	8.1	9.	9.9	10.8
19	2.85	3.8	4.75	5.7	6.65	7.6	8.55	9.5	10.45	11.4
20	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
21	3.15	4.2	5.25	6.3	7.35	8.4	9.45	10.5	11.55	12.6
22	3.3	4.4	5.5	6.6	7.7	8.8	9.9	11.	12.1	13.2
23	3.45	4.6	5.75	6.9	8.05	9.2	10.35	11.5	12.65	13.8
24	3.6	4.8	6.	7.2	8.4	9.6	10.8	12.	13.2	14.4
25	3.75	5.	6.25	7.5	8.75	10.	11.25	12.5	13.75	15.
26	3.9	5.2	6.5	7.8	9.1	10.4	11.7	13.	14.3	15.6
27	4.05	5.4	6.75	8.1	9.45	10.8	12.15	13.5	14.85	16.2
28	4.2	5.6	7.	8.4	9.8	11.2	12.6	14.	15.4	16.8
29	4.35	5.8	7.25	8.7	10.15	11.6	13.05	14.5	15.95	17.4
30	4.5	6.	7.5	9.	10.5	12.	13.5	15.	16.5	18.
31	4.65	6.2	7.75	9.3	10.85	12.4	13.95	15.5	17.05	18.6
32	4.8	6.4	8.	9.6	11.2	12.8	14.4	16.	17.6	19.2
33	4.95	6.6	8.25	9.9	11.55	13.2	14.85	16.5	18.15	19.8
34	5.1	6.8	8.5	10.2	11.9	13.6	15.3	17.	18.7	20.4
35	5.25	7.	8.75	10.5	12.25	14.	15.75	17.5	19.25	21.
36	5.4	7.2	9.	10.8	12.6	14.4	16.2	18.	19.8	21.6
37	5.55	7.4	9.25	11.1	12.95	14.8	16.65	18.5	20.35	22.2
38	5.7	7.6	9.5	11.4	13.3	15.2	17.1	19.	20.9	22.8
39	5.85	7.8	9.75	11.7	13.65	15.6	17.55	19.5	21.45	23.4
40	6.	8.	10.	12.	14.	16.	18.	20.	22.	24.
41	6.15	8.2	10.25	12.3	14.35	16.4	18.45	20.5	22.55	24.6
42	6.3	8.4	10.5	12.6	14.7	16.8	18.9	21.	23.1	25.2
43	6.45	8.6	10.75	12.9	15.05	17.2	19.35	21.5	23.65	25.8
44	6.6	8.8	11.	13.2	15.4	17.6	19.8	22.	24.2	26.4
45	6.75	9.	11.25	13.5	15.75	18.	20.25	22.5	24.75	27.
46	6.9	9.2	11.5	13.8	16.1	18.4	20.7	23.	25.3	27.6
47	7.05	9.4	11.75	14.1	16.45	18.8	21.15	23.5	25.85	28.2
48	7.2	9.6	12.	14.4	16.8	19.2	21.6	24.	26.4	28.8
49	7.35	9.8	12.25	14.7	17.15	19.6	22.05	24.5	26.95	29.4
50	7.5	10.	12.5	15.	17.5	20.	22.5	25.	27.5	30.
51	7.65	10.2	12.75	15.3	17.85	20.4	22.95	25.5	28.05	30.6
52	7.8	10.4	13.	15.6	18.2	20.8	23.4	26.	28.6	31.2
53	7.95	10.6	13.25	15.9	18.55	21.2	23.85	26.5	29.15	31.8
54	8.1	10.8	13.5	16.2	18.9	21.6	24.3	27.	29.7	32.4
55	8.25	11.	13.75	16.5	19.25	22.	24.75	27.5	30.25	33.
56	8.4	11.2	14.	16.8	19.6	22.4	25.2	28.	30.8	33.6
57	8.55	11.4	14.25	17.1	19.95	22.8	25.65	28.5	31.35	34.2
58	8.7	11.6	14.5	17.4	20.3	23.2	26.1	29.	31.9	34.8
59	8.85	11.8	14.75	17.7	20.65	23.6	26.55	29.5	32.45	35.4
60	9.	12.	15.	18.	21.	24.	27.	30.	33.	36.
61	9.15	12.2	15.25	18.3	21.35	24.4	27.45	30.5	33.55	36.6
62	9.3	12.4	15.5	18.6	21.7	24.8	27.9	31.	34.1	37.2
63	9.45	12.6	15.75	18.9	22.05	25.2	28.35	31.5	34.65	37.8
64	9.6	12.8	16.	19.2	22.4	25.6	28.8	32.	35.2	38.4
65	9.75	13.	16.25	19.5	22.75	26.	29.25	32.5	35.75	39.
66	9.9	13.2	16.5	19.8	23.1	26.4	29.7	33.	36.3	39.6
67	10.05	13.4	16.75	20.1	23.45	26.8	30.15	33.5	36.85	40.2
68	10.2	13.6	17.	20.4	23.8	27.2	30.6	34.	37.4	40.8
69	10.35	13.8	17.25	20.7	24.15	27.6	31.05	34.5	37.95	41.4
70	10.5	14.	17.5	21.	24.5	28.	31.5	35.	38.5	42.
71	10.65	14.2	17.75	21.3	24.85	28.4	31.95	35.5	39.05	42.6
72	10.8	14.4	18.	21.6	25.2	28.8	32.4	36.	39.6	43.2
73	10.95	14.6	18.25	21.9	25.55	29.2	32.85	36.5	40.15	43.8
74	11.1	14.8	18.5	22.2	25.9	29.6	33.3	37.	40.7	44.4
75	11.25	15.	18.75	22.5	26.25	30.	33.75	37.5	41.25	45.
76	11.4	15.2	19.	22.8	26.6	30.4	34.2	38.	41.8	45.6
77	11.55	15.4	19.25	23.1	26.95	30.8	34.65	38.5	42.35	46.2
78	11.7	15.6	19.5	23.4	27.3	31.2	35.1	39.	42.9	46.8
79	11.85	15.8	19.75	23.7	27.65	31.6	35.55	39.5	43.45	47.4
80	12.	16.	20.	24.	28.	32.	36.	40.	44.	48.
81	12.15	16.2	20.25	24.3	28.35	32.4	36.45	40.5	44.55	48.6
82	12.3	16.4	20.5	24.6	28.7	32.8	36.9	41.	45.1	49.2
83	12.45	16.6	20.75	24.9	29.05	33.2	37.35	41.5	45.65	49.8
84	12.6	16.8	21.	25.2	29.4	33.6	37.8	42.	46.2	50.4
85	12.75	17.	21.25	25.5	29.75	34.	38.25	42.5	46.75	51.
86	12.9	17.2	21.5	25.8	30.1	34.4	38.7	43.	47.3	51.6
87	13.05	17.4	21.75	26.1	30.45	34.8	39.15	43.5	47.85	52.2
88	13.2	17.6	22.	26.4	30.8	35.2	39.6	44.	48.4	52.8
89	13.35	17.8	22.25	26.7	31.15	35.6	40.05	44.5	48.95	53.4
90	13.5	18.	22.5	27.	31.5	36.	40.5	45.	49.5	54.
91	13.65	18.2	22.75	27.3	31.85	36.4	40.95	45.5	50.05	54.6
92	13.8	18.4	23.	27.6	32.2	36.8	41.4	46.	50.6	55.2
93	13.95	18.6	23.25	27.9	32.55	37.2	41.85	46.5	51.15	55.8
94	14.1	18.8	23.5	28.2	32.9	37.6	42.3	47.	51.7	56.4
95	14.25	19.	23.75	28.5	33.25	38.	42.75	47.5	52.25	57.
96	14.4	19.2	24.	28.8	33.6	38.4	43.2	48.	52.8	57.6
97	14.55	19.4	24.25	29.1	33.95	38.8	43.65	48.5	53.35	58.2
98	14.7	19.6	24.5	29.4	34.3	39.2	44.1	49.	53.9	58.8
99	14.85	19.8	24.75	29.7	34.65	39.6	44.55	49.5	54.45	59.4
100	15.	20.	25.	30.	35.	40.	45.	50.	55.	60.
105	15.75	21.	26.25	31.5	36.75	42.	47.25	52.5	57.75	63.
200	30.	40.	50.	60.	70.	80.	90.	100.	110.	120.
300	45.	60.	75.	90.	105.	120.	135.	150.	165.	180.

	65	70	75	80	85	90	95	100	200	300
0.5	.325	.35	.375	.4	.425	.45	.475	.5	1	1.5
1	.65	.7	.75	.8	.85	.9	.95	1	2	3
2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2	4	6
3	1.95	2.1	2.25	2.4	2.55	2.7	2.85	3	6	9
4	2.6	2.8	3.	3.2	3.4	3.6	3.8	4	8	12
5	3.25	3.5	3.75	4.	4.25	4.5	4.75	5	10	15
6	3.9	4.2	4.5	4.8	5.1	5.4	5.7	6	12	18
7	4.55	4.9	5.25	5.6	5.95	6.3	6.65	7	14	21
8	5.2	5.6	6.	6.4	6.8	7.2	7.6	8	16	24
9	5.85	6.3	6.75	7.2	7.65	8.1	8.55	9	18	27
10	6.5	7.	7.5	8.	8.5	9.	9.5	10	20	30
11	7.15	7.7	8.25	8.8	9.35	9.9	10.45	11	22	33
12	7.8	8.4	9.	9.6	10.2	10.8	11.4	12	24	36
13	8.45	9.1	9.75	10.4	11.05	11.7	12.35	13	26	39
14	9.1	9.8	10.5	11.2	11.9	12.6	13.3	14	28	42
15	9.75	10.5	11.25	12.	12.75	13.5	14.25	15	30	45
16	10.4	11.2	12.	12.8	13.6	14.4	15.2	16	32	48
17	11.05	11.9	12.75	13.6	14.45	15.3	16.15	17	34	51
18	11.7	12.6	13.5	14.4	15.3	16.2	17.1	18	36	54
19	12.35	13.3	14.25	15.2	16.15	17.1	18.05	19	38	57
20	13.	14.	15.	16.	17.	18.	19.	20	40	60
21	13.65	14.7	15.75	16.8	17.85	18.9	19.95	21	42	63
22	14.3	15.4	16.5	17.6	18.7	19.8	20.9	22	44	66
23	14.95	16.1	17.25	18.4	19.55	20.7	21.85	23	46	69
24	15.6	16.8	18.	19.2	20.4	21.6	22.8	24	48	72
25	16.25	17.5	18.75	20.	21.25	22.5	23.75	25	50	75
26	16.9	18.2	19.5	20.8	22.1	23.4	24.7	26	52	78
27	17.55	18.9	20.25	21.6	22.95	24.3	25.65	27	54	81
28	18.2	19.6	21.	22.4	23.8	25.2	26.6	28	56	84
29	18.85	20.3	21.75	23.2	24.65	26.1	27.55	29	58	87
30	19.5	21.	22.5	24.	25.5	27.	28.5	30	60	90
31	20.15	21.7	23.25	24.8	26.35	27.9	29.45	31	62	93
32	20.8	22.4	24.	25.6	27.2	28.8	30.4	32	64	96
33	21.45	23.1	24.75	26.4	28.05	29.7	31.35	33	66	99
34	22.1	23.8	25.5	27.2	28.9	30.6	32.3	34	68	102
35	22.75	24.5	26.25	28.	29.75	31.5	33.25	35	70	105
36	23.4	25.2	27.	28.8	30.6	32.4	34.2	36	72	108
37	24.05	25.9	27.75	29.6	31.45	33.3	35.15	37	74	111
38	24.7	26.6	28.5	30.4	32.3	34.2	36.1	38	76	114
39	25.35	27.3	29.25	31.2	33.15	35.1	37.05	39	78	117
40	26.	28.	30.	32.	34.	36.	38.	40	80	120
41	26.65	28.7	30.75	32.8	34.85	36.9	38.95	41	82	123
42	27.3	29.4	31.5	33.6	35.7	37.8	39.9	42	84	126
43	27.95	30.1	32.25	34.4	36.55	38.7	40.85	43	86	129
44	28.6	30.8	33.	35.2	37.4	39.6	41.8	44	88	132
45	29.25	31.5	33.75	36.	38.25	40.5	42.75	45	90	135
46	29.9	32.2	34.5	36.8	39.1	41.4	43.7	46	92	138
47	30.55	32.9	35.25	37.6	39.95	42.3	44.65	47	94	141
48	31.2	33.6	36.	38.4	40.8	43.2	45.6	48	96	144
49	31.85	34.3	36.75	39.2	41.65	44.1	46.55	49	98	147
50	32.5	35.	37.5	40.	42.5	45.	47.5	50	100	150
51	33.15	35.7	38.25	40.8	43.35	45.9	48.45	51	102	153
52	33.8	36.4	39.	41.6	44.2	46.8	49.4	52	104	156
53	34.45	37.1	39.75	42.4	45.05	47.7	50.35	53	106	159
54	35.1	37.8	40.5	43.2	45.9	48.6	51.3	54	108	162
55	35.75	38.5	41.25	44.	46.75	49.5	52.25	55	110	165
56	36.4	39.2	42.	44.8	47.6	50.4	53.2	56	112	168
57	37.05	39.9	42.75	45.6	48.45	51.3	54.15	57	114	171
58	37.7	40.6	43.5	46.4	49.3	52.2	55.1	58	116	174
59	38.35	41.3	44.25	47.2	50.15	53.1	56.05	59	118	177
60	39.	42.	45.	48.	51.	54.	57.	60	120	180
61	39.65	42.7	45.75	48.8	51.85	54.9	57.95	61	122	183
62	40.3	43.4	46.5	49.6	52.7	55.8	58.9	62	124	186
63	40.95	44.1	47.25	50.4	53.55	56.7	59.85	63	126	189
64	41.6	44.8	48.	51.2	54.4	57.6	60.8	64	128	192
65	42.25	45.5	48.75	52.	55.25	58.5	61.75	65	130	195
66	42.9	46.2	49.5	52.8	56.1	59.4	62.7	66	132	198
67	43.55	46.9	50.25	53.6	56.95	60.3	63.65	67	134	201
68	44.2	47.6	51.	54.4	57.8	61.2	64.6	68	136	204
69	44.85	48.3	51.75	55.2	58.65	62.1	65.55	69	138	207
70	45.5	49.	52.5	56.	59.5	63.	66.5	70	140	210
71	46.15	49.7	53.25	56.8	60.35	63.9	67.45	71	142	213
72	46.8	50.4	54.	57.6	61.2	64.8	68.4	72	144	216
73	47.45	51.1	54.75	58.4	62.05	65.7	69.35	73	146	219
74	48.1	51.8	55.5	59.2	62.9	66.6	70.3	74	148	222
75	48.75	52.5	56.25	60.	63.75	67.5	71.25	75	150	225
76	49.4	53.2	57.	60.8	64.6	68.4	72.2	76	152	228
77	50.05	53.9	57.75	61.6	65.45	69.3	73.15	77	154	231
78	50.7	54.6	58.5	62.4	66.3	70.2	74.1	78	156	234
79	51.35	55.3	59.25	63.2	67.15	71.1	75.05	79	158	237
80	52.	56.	60.	64.	68.	72.	76.	80	160	240
81	52.65	56.7	60.75	64.8	68.85	72.9	76.95	81	162	243
82	53.3	57.4	61.5	65.6	69.7	73.8	77.9	82	164	246
83	53.95	58.1	62.25	66.4	70.55	74.7	78.85	83	166	249
84	54.6	58.8	63.	67.2	71.4	75.6	79.8	84	168	252
85	55.25	59.5	63.75	68.	72.25	76.5	80.75	85	170	255
86	55.9	60.2	64.5	68.8	73.1	77.4	81.7	86	172	258
87	56.55	60.9	65.25	69.6	73.95	78.3	82.65	87	174	261
88	57.2	61.6	66.	70.4	74.8	79.2	83.6	88	176	264
89	57.85	62.3	66.75	71.2	75.65	80.1	84.55	89	178	267
90	58.5	63.	67.5	72.	76.5	81.	85.5	90	180	270
91	59.15	63.7	68.25	72.8	77.35	81.9	86.45	91	182	273
92	59.8	64.4	69.	73.6	78.2	82.8	87.4	92	184	276
93	60.45	65.1	69.75	74.4	79.05	83.7	88.35	93	186	279
94	61.1	65.8	70.5	75.2	79.9	84.6	89.3	94	188	282
95	61.75	66.5	71.25	76.	80.75	85.5	90.25	95	190	285
96	62.4	67.2	72.	76.8	81.6	86.4	91.2	96	192	288
97	63.05	67.9	72.75	77.6	82.45	87.3	92.15	97	194	291
98	63.7	68.6	73.5	78.4	83.3	88.2	93.1	98	196	294
99	64.35	69.3	74.25	79.2	84.15	89.1	94.05	99	198	297
100	65.	70.	75.	80.	85.	90.	95.	100	200	300
105	68.25	73.5	78.75	84.	89.25	94.5	99.75	105	210	315
200	130.	140.	150.	160.	170.	180.	190.	200	400	600
300	195.	210.	225.	240.	255.	270.	285.	300	600	900

	400	500	600	700	800	900	1000	2000	3000
0.5	2	2.5	3	3.5	4	4.5	5	10	15
1	4	5	6	7	8	9	10	20	30
2	8	10	12	14	16	18	20	40	60
3	12	15	18	21	24	27	30	60	90
4	16	20	24	28	32	36	40	80	120
5	20	25	30	35	40	45	50	100	150
6	24	30	36	42	48	54	60	120	180
7	28	35	42	49	56	63	70	140	210
8	32	40	48	56	64	72	80	160	240
9	36	45	54	63	72	81	90	180	270
10	40	50	60	70	80	90	100	200	300
11	44	55	66	77	88	99	110	220	330
12	48	60	72	84	96	108	120	240	360
13	52	65	78	91	104	117	130	260	390
14	56	70	84	98	112	126	140	280	420
15	60	75	90	105	120	135	150	300	450
16	64	80	96	112	128	144	160	320	480
17	68	85	102	119	136	153	170	340	510
18	72	90	108	126	144	162	180	360	540
19	76	95	114	133	152	171	190	380	570
20	80	100	120	140	160	180	200	400	600
21	84	105	126	147	168	189	210	420	630
22	88	110	132	154	176	198	220	440	660
23	92	115	138	161	184	207	230	460	690
24	96	120	144	168	192	216	240	480	720
25	100	125	150	175	200	225	250	500	750
26	104	130	156	182	208	234	260	520	780
27	108	135	162	189	216	243	270	540	810
28	112	140	168	196	224	252	280	560	840
29	116	145	174	203	232	261	290	580	870
30	120	150	180	210	240	270	300	600	900
31	124	155	186	217	248	279	310	620	930
32	128	160	192	224	256	288	320	640	960
33	132	165	198	231	264	297	330	660	990
34	136	170	204	238	272	306	340	680	1020
35	140	175	210	245	280	315	350	700	1050
36	144	180	216	252	288	324	360	720	1080
37	148	185	222	259	296	333	370	740	1110
38	152	190	228	266	304	342	380	760	1140
39	156	195	234	273	312	351	390	780	1170
40	160	200	240	280	320	360	400	800	1200
41	164	205	246	287	328	369	410	820	1230
42	168	210	252	294	336	378	420	840	1260
43	172	215	258	301	344	387	430	860	1290
44	176	220	264	308	352	396	440	880	1320
45	180	225	270	315	360	405	450	900	1350
46	184	230	276	322	368	414	460	920	1380
47	188	235	282	329	376	423	470	940	1410
48	192	240	288	336	384	432	480	960	1440
49	196	245	294	343	392	441	490	980	1470
50	200	250	300	350	400	450	500	1000	1500
51	204	255	306	357	408	459	510	1020	1530
52	208	260	312	364	416	468	520	1040	1560
53	212	265	318	371	424	477	530	1060	1590
54	216	270	324	378	432	486	540	1080	1620
55	220	275	330	385	440	495	550	1100	1650
56	224	280	336	392	448	504	560	1120	1680
57	228	285	342	399	456	513	570	1140	1710
58	232	290	348	406	464	522	580	1160	1740
59	236	295	354	413	472	531	590	1180	1770
60	240	300	360	420	480	540	600	1200	1800
61	244	305	366	427	488	549	610	1220	1830
62	248	310	372	434	496	558	620	1240	1860
63	252	315	378	441	504	567	630	1260	1890
64	256	320	384	448	512	576	640	1280	1920
65	260	325	390	455	520	585	650	1300	1950
66	264	330	396	462	528	594	660	1320	1980
67	268	335	402	469	536	603	670	1340	2010
68	272	340	408	476	544	612	680	1360	2040
69	276	345	414	483	552	621	690	1380	2070
70	280	350	420	490	560	630	700	1400	2100
71	284	355	426	497	568	639	710	1420	2130
72	288	360	432	504	576	648	720	1440	2160
73	292	365	438	511	584	657	730	1460	2190
74	296	370	444	518	592	666	740	1480	2220
75	300	375	450	525	600	675	750	1500	2250
76	304	380	456	532	608	684	760	1520	2280
77	308	385	462	539	616	693	770	1540	2310
78	312	390	468	546	624	702	780	1560	2340
79	316	395	474	553	632	711	790	1580	2370
80	320	400	480	560	640	720	800	1600	2400
81	324	405	486	567	648	729	810	1620	2430
82	328	410	492	574	656	738	820	1640	2460
83	332	415	498	581	664	747	830	1660	2490
84	336	420	504	588	672	756	840	1680	2520
85	340	425	510	595	680	765	850	1700	2550
86	344	430	516	602	688	774	860	1720	2580
87	348	435	522	609	696	783	870	1740	2610
88	352	440	528	616	704	792	880	1760	2640
89	356	445	534	623	712	801	890	1780	2670
90	360	450	540	630	720	810	900	1800	2700
91	364	455	546	637	728	819	910	1820	2730
92	368	460	552	644	736	828	920	1840	2760
93	372	465	558	651	744	837	930	1860	2790
94	376	470	564	658	752	846	940	1880	2820
95	380	475	570	665	760	855	950	1900	2850
96	384	480	576	672	768	864	960	1920	2880
97	388	485	582	679	776	873	970	1940	2910
98	392	490	588	686	784	882	980	1960	2940
99	396	495	594	693	792	891	990	1980	2970
100	400	500	600	700	800	900	1000	2000	3000
105	420	525	630	735	840	945	1050	2100	3150
200	800	1000	1200	1400	1600	1800	2000	4000	6000
300	1200	1500	1800	2100	2400	2700	3000	6000	9000

	4000	5000	6000	7000	8000	9000	10000	11000	12000	13000	14000
0.5	20	25	30	35	40	45	50	55	60	65	70
1	40	50	60	70	80	90	100	110	120	130	140
2	80	100	120	140	160	180	200	220	240	260	280
3	120	150	180	210	240	270	300	330	360	390	420
4	160	200	240	280	320	360	400	440	480	520	560
5	200	250	300	350	400	450	500	550	600	650	700
6	240	300	360	420	480	540	600	660	720	780	840
7	280	350	420	490	560	630	700	770	840	910	980
8	320	400	480	560	640	720	800	880	960	1040	1120
9	360	450	540	630	720	810	900	990	1080	1170	1260
10	400	500	600	700	800	900	1000	1100	1200	1300	1400
11	440	550	660	770	880	990	1100	1210	1320	1430	1540
12	480	600	720	840	960	1080	1200	1320	1440	1560	1680
13	520	650	780	910	1040	1170	1300	1430	1560	1690	1820
14	560	700	840	980	1120	1260	1400	1540	1680	1820	1960
15	600	750	900	1050	1200	1350	1500	1650	1800	1950	2100
16	640	800	960	1120	1280	1440	1600	1760	1920	2080	2240
17	680	850	1020	1190	1360	1530	1700	1870	2040	2210	2380
18	720	900	1080	1260	1440	1620	1800	1980	2160	2340	2520
19	760	950	1140	1330	1520	1710	1900	2090	2280	2470	2660
20	800	1000	1200	1400	1600	1800	2000	2200	2400	2600	2800
21	840	1050	1260	1470	1680	1890	2100	2310	2520	2730	2940
22	880	1100	1320	1540	1760	1980	2200	2420	2640	2860	3080
23	920	1150	1380	1610	1840	2070	2300	2530	2760	2990	3220
24	960	1200	1440	1680	1920	2160	2400	2640	2880	3120	3360
25	1000	1250	1500	1750	2000	2250	2500	2750	3000	3250	3500
26	1040	1300	1560	1820	2080	2340	2600	2860	3120	3380	3640
27	1080	1350	1620	1890	2160	2430	2700	2970	3240	3510	3780
28	1120	1400	1680	1960	2240	2520	2800	3080	3360	3640	3920
29	1160	1450	1740	2030	2320	2610	2900	3190	3480	3770	4060
30	1200	1500	1800	2100	2400	2700	3000	3300	3600	3900	4200
31	1240	1550	1860	2170	2480	2790	3100	3410	3720	4030	4340
32	1280	1600	1920	2240	2560	2880	3200	3520	3840	4160	4480
33	1320	1650	1980	2310	2640	2970	3300	3630	3960	4290	4620
34	1360	1700	2040	2380	2720	3060	3400	3740	4080	4420	4760
35	1400	1750	2100	2450	2800	3150	3500	3850	4200	4550	4900
36	1440	1800	2160	2520	2880	3240	3600	3960	4320	4680	5040
37	1480	1850	2220	2590	2960	3330	3700	4070	4440	4810	5180
38	1520	1900	2280	2660	3040	3420	3800	4180	4560	4940	5320
39	1560	1950	2340	2730	3120	3510	3900	4290	4680	5070	5460
40	1600	2000	2400	2800	3200	3600	4000	4400	4800	5200	5600
41	1640	2050	2460	2870	3280	3690	4100	4510	4920	5330	5740
42	1680	2100	2520	2940	3360	3780	4200	4620	5040	5460	5880
43	1720	2150	2580	3010	3440	3870	4300	4730	5160	5590	6020
44	1760	2200	2640	3080	3520	3960	4400	4840	5280	5720	6160
45	1800	2250	2700	3150	3600	4050	4500	4950	5400	5850	6300
46	1840	2300	2760	3220	3680	4140	4600	5060	5520	5980	6440
47	1880	2350	2820	3290	3760	4230	4700	5170	5640	6110	6580
48	1920	2400	2880	3360	3840	4320	4800	5280	5760	6240	6720
49	1960	2450	2940	3430	3920	4410	4900	5390	5880	6370	6860
50	2000	2500	3000	3500	4000	4500	5000	5500	6000	6500	7000
51	2040	2550	3060	3570	4080	4590	5100	5610	6120	6630	7140
52	2080	2600	3120	3640	4160	4680	5200	5720	6240	6760	7280
53	2120	2650	3180	3710	4240	4770	5300	5830	6360	6890	7420
54	2160	2700	3240	3780	4320	4860	5400	5940	6480	7020	7560
55	2200	2750	3300	3850	4400	4950	5500	6050	6600	7150	7700
56	2240	2800	3360	3920	4480	5040	5600	6160	6720	7280	7840
57	2280	2850	3420	3990	4560	5130	5700	6270	6840	7410	7980
58	2320	2900	3480	4060	4640	5220	5800	6380	6960	7540	8120
59	2360	2950	3540	4130	4720	5310	5900	6490	7080	7670	8260
60	2400	3000	3600	4200	4800	5400	6000	6600	7200	7800	8400
61	2440	3050	3660	4270	4880	5490	6100	6710	7320	7930	8540
62	2480	3100	3720	4340	4960	5580	6200	6820	7440	8060	8680
63	2520	3150	3780	4410	5040	5670	6300	6930	7560	8190	8820
64	2560	3200	3840	4480	5120	5760	6400	7040	7680	8320	8960
65	2600	3250	3900	4550	5200	5850	6500	7150	7800	8450	9100
66	2640	3300	3960	4620	5280	5940	6600	7260	7920	8580	9240
67	2680	3350	4020	4690	5360	6030	6700	7370	8040	8710	9380
68	2720	3400	4080	4760	5440	6120	6800	7480	8160	8840	9520
69	2760	3450	4140	4830	5520	6210	6900	7590	8280	8970	9660
70	2800	3500	4200	4900	5600	6300	7000	7700	8400	9100	9800
71	2840	3550	4260	4970	5680	6390	7100	7810	8520	9230	9940
72	2880	3600	4320	5040	5760	6480	7200	7920	8640	9360	10080
73	2920	3650	4380	5110	5840	6570	7300	8030	8760	9490	10220
74	2960	3700	4440	5180	5920	6660	7400	8140	8880	9620	10360
75	3000	3750	4500	5250	6000	6750	7500	8250	9000	9750	10500
76	3040	3800	4560	5320	6080	6840	7600	8360	9120	9880	10640
77	3080	3850	4620	5390	6160	6930	7700	8470	9240	10010	10780
78	3120	3900	4680	5460	6240	7020	7800	8580	9360	10140	10920
79	3160	3950	4740	5530	6320	7110	7900	8690	9480	10270	11060
80	3200	4000	4800	5600	6400	7200	8000	8800	9600	10400	11200
81	3240	4050	4860	5670	6480	7290	8100	8910	9720	10530	11340
82	3280	4100	4920	5740	6560	7380	8200	9020	9840	10660	11480
83	3320	4150	4980	5810	6640	7470	8300	9130	9960	10790	11620
84	3360	4200	5040	5880	6720	7560	8400	9240	10080	10920	11760
85	3400	4250	5100	5950	6800	7650	8500	9350	10200	11050	11900
86	3440	4300	5160	6020	6880	7740	8600	9460	10320	11180	12040
87	3480	4350	5220	6090	6960	7830	8700	9570	10440	11310	12180
88	3520	4400	5280	6160	7040	7920	8800	9680	10560	11440	12320
89	3560	4450	5340	6230	7120	8010	8900	9790	10680	11570	12460
90	3600	4500	5400	6300	7200	8100	9000	9900	10800	11700	12600
91	3640	4550	5460	6370	7280	8190	9100	10010	10920	11830	12740
92	3680	4600	5520	6440	7360	8280	9200	10120	11040	11960	12880
93	3720	4650	5580	6510	7440	8370	9300	10230	11160	12090	13020
94	3760	4700	5640	6580	7520	8460	9400	10340	11280	12220	13160
95	3800	4750	5700	6650	7600	8550	9500	10450	11400	12350	13300
96	3840	4800	5760	6720	7680	8640	9600	10560	11520	12480	13440
97	3880	4850	5820	6790	7760	8730	9700	10670	11640	12610	13580
98	3920	4900	5880	6860	7840	8820	9800	10780	11760	12740	13720
99	3960	4950	5940	6930	7920	8910	9900	10890	11880	12870	13860
100	4000	5000	6000	7000	8000	9000	10000	11000	12000	13000	14000
105	4200	5250	6300	7350	8400	9450	10500	11550	12600	13650	14700
200	8000	10000	12000	14000	16000	18000	20000	22000	24000	26000	28000
300	12000	15000	18000	21000	24000	27000	30000	33000	36000	39000	42000

(Strength)

Table 7–11. Army Aircraft Characteristics

	O-1 Bird Dog	OV-1A Mohawk	OV-1B Mohawk	OV-1C Mohawk	U-1A Otter	U-6A Beaver	U-8D Seminole	U-8F Seminole	U-10A Courier	U-21 Ute	OH-6A Cayuse	OH-13S Sioux	OH-23G Raven	OH-58A Kiowa	UH-1B Iroquois	UH-1C Iroquois	UH-1D/H Iroquois	CH-34C Choctaw	CH-37B Mojave	CH-47A Chinook	CH-47B Chinook	CH-47C Chinook	CH-54A Tarhe	AH-1G Cobra	AH-56A Cheyenne
Crew (200 lbs. ea.)	1	2	2	2	1 (2 for IFR)	1 (2 for IFR)	1 (2 for IFR)	1 (2 for IFR)	1	2	1	1	1	1	2	2	2	3	3	4	4	4	4	2	2
Dimensions:																									
Length-fuselage	25′ 10″	41′ 1″	41′ 9″	42′ 0″	42′ 0″	30′ 6″	31′ 6″	33′ 4″	30′ 4″	35′ 10″	23′0″	31′7″	28′0″	32′3″	42′7″	42′7″	41′11″	46′9″	64′11″	51′0″	51′0″	51′0″	70′0″	44′5.2″	53′3″
Length-blades unfolded	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	30′4″	43′3″	40′8″	40′11.8″	52′10.8″	52′10″	57′1″	65′10″	88′0″	98′3″	99′0″	99′0″	88′5″	52′11.7″	60′1″
Length-blades folded	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	23′0″	NA	NA	NA	NA	NA	NA	37′0″	55′8″	51′0″	51′0″	51′0″	70′3″	NA	53′3″
Width-blades folded	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4′6″	NA	NA	NA	9′4″	NA	NA	13′0″	27′4″	12′5″	12′5″	12′5″	21′10″	10′5″	27′0″
Width-thread	7′ 7″	9′ 2″	9′ 2″	9′ 2″	11′ 2″	10′ 2″	12′ 9″	12′ 9″	9′ 0″	12′ 9″	6′9″	8′7″	10′	6′3.6″	8′4″	8′4″	9′6″	12′0″	19′9″	11′11″	11′11″	11′11″	19′9″	7′	
Height extreme	7′ 6″	13′	13′	13′	12′ 5″	10′ 5″	11′ 7″	14′ 2″	8′ 10″	14′ 2″	8′3″	9′4″	9′4″	9′6.5″	13′2″	16′5″	17′2″	15′10″	22′0″	18′6.6″	18′7.8″	18′7.8″	24′5″	11′10.6″	13′9″
Diameter main rotor	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	26′4″	37′1″	34′4″	35′4″	44′0″	44′0″	48′0″	56′0″	72′0″	59′1″	60′0″	60′0″	72′0″	44′0″	50′0″
Diameter tail or rear rotor	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4′3″	5′10″	5′6″	5′2″	8′6″	8′6″	8′6″	9′4″	15′0″	59′1″	60′0″	60′0″	16′0″	8′6″	10′0″
Wingspan	36′ 0″	42′ 0″	48′ 0″	42′ 0″	58′ 0″	48′ 0″	45′ 4″	45′ 11″	39′ 0″	45′ 11″	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	10′4″	27′0″
Cargo door:																									
Dimensions-width/height (in.)	45 x 33	NA	NA	NA	46 x 45 (left)	39 x 40	35 x 36.5	50.5 x 26.5	47 x 35	50.5 x 53	40 x 26	NA	NA	40 x 35	48 x 48	48 x 48	92 x 49	52 x 48	87 x 72 nose 72 x 48 hatch	90 x 78	90 x 78	90 x 78	104.5 (POD)	NA	NA
Location-side of fuselage (in.)	right	NA	NA	NA	30 x 45 (right)	(left & right)	right	left	left	right	left & right	NA	NA	left & right	left & right	left & right	left & right	right	72 x 48 right	rear	rear	rear	rear	NA	NA
Cargo compartment:																									
Height of floor above ground (in.)	22	NA	NA	NA	46	46	48	48	27	48	24.5	NA	NA	22.5	14	14	15	34	36	30	31	31	27 (POD)	NA	NA
Length usable (in.)	NA	NA	NA	NA	152	76	86	110.5	65	110.5	69	NA	NA	39	60	60	92	164	364	360	360	362	329 (POD)	NA	NA
Width floor (in.)	NA	NA	NA	NA	60	48	53.5	55	41	55	38	NA	NA	50	80.5	80.5	96	59	87	90	90	90	104.5 (POD)	NA	NA
Height (clear of obstructions) (in.)	NA	NA	NA	NA	60	51	53	55	38	55	38	NA	NA	50	54	54	54	70	78	78	78	78	78 (POD)	NA	NA
Cargo space optimum (cu. ft.)	NA	NA	NA	NA	293	125	115	158	50	158	38	NA	NA	56	140	140	220	372	1,252	1,474	1,474	1,474	1,552 (POD)	NA	NA
External cargo:																									
	each wing	each wing	each wing	each wing		each wing																			
Maximum recommended external load (lb.)	250	2,000	2,000	2,000	NA	496	NA	NA	900	NA	NA	NA	NA	NA	3,000	3,787	4,000	5,000	7,500	16,000	20,000	20,000	20,000	2,200	12,000
Rescue hoist capacity (lb.)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	600	600	600	600	600	600	NA	NA	NA
Cargo loading winch capacity (lb.)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2,000	3,000	3,000	3,000	20,000	NA	NA
Passenger capacity:																									
No. of troop seats (240 lbs. per man)	1	0	0	0	10	5	5	5	5	10	3	1	1	4	7	7	11	12–18	23	33	33	33	68 (POD)	0	0
No. of litters and ambulatory	0+1	NA	NA	NA	6+3	2+5	0+5	0+5	1+4	3+3	0+3	2+0	2+0	2+4	3+0	3+0	6+0	8+0	24+0	24+0	24+0	24+0	48 (POD)	0	0
Operational characteristics [1]:																									
Maximum allowable gross weight [2]	2,400	14,722	15,795	14,823	8,000	5,100	7,300	7,700	3,811	9,500	2,400	2,850	2,800	3,000	8,500	9,500	9,500	13,300	31,000	33,000	40,000	44,800	42,000	9,500	25,750
Basic weight [3]	1,618	9,910	10,983	10,011	4,900	3,100	4,990	5,490	2,313	5,383	1,163	1,980	1,740	1,583	4,635 [8]	4,800 [8]	4,920 [8]	7,768	21,500	18,153	19,591	20,481	19,825	5,510	13,520
Useful load [4]	782	4,812	4,812	4,812	3,100	2,000	2,310	2,210	1,498	4,167	1,237	870	886	1,417	3,865	4,700	4,500	5,532	9,500	14,888	20,445	23,380	20,170	3,590	12,230
Payload/normal mission (lb.) [5]	111	NA	NA	NA	1,600	992	690	590	938	2,000	650 [9]	200 [9]	200 [9]	760 [9]	2,372	2,027	3,056	3,600	6,197 [9]	10,300	15,900	19,100	18,565 [9, 11]	2,600	5,100
Internal fuel capacity (lb./gal.)	252/42	1,900/297	1,900/297	1,900/297	1,281/213.5	570/95	1,380/230	1,380/230	360/60	2,409/378	382/59	258/43	276/46	455/70	1,072/165	1,573/246.7	1,430/224	1,572/262	2,388/39 [6]	4,036/621	4,036/621	7,351/1,131	5,888/914	1,600/251	2,847/438
Fuel consumption per hour (lb./gal.)	51/8.5	1,105/170	1,105/170	1,105/170	180/30	138/23	240/40	240/40	84/14	500/83	146/22	130/21	133/22	190/29	479/75	636/99.8	550/85	690/115	1,398/233 [10]	2,120/342	2,780/427	3,038/467	3,460/532	533/83.6	900/140
Normal cruising speed (knots) [6]	87	225	225	225	105	109	160	160	110	210	119	70	70	102	75–95	92–110	92–110	85–107	85	130	150	155	100/90 [12]	130	210
Endurance at cruising speed (hr., min.) [7]	4+0	1+15	1+25	1+25	6+30	3+6	5+30	5+30	3+24	4+20	2+15	1+42	1+48	2+0	1+45	1+58	2+08	1+46	1+15 [10]	1+22	0+57	1+57	1+30	2+0 [10]	3+0
Grade of fuel (octane)	115/145 [13]	JP–4	JP–4	JP–4	115/145 [13]	115/145 [13]	115/145	115/145	100/130	JP–4	JP–4	115/145	115/145	JP–4	JP–4	JP–4/5	JP–4/5	115/145	115/145	JP–4	JP–4	JP–4	JP–4/5	JP–4/5	JP–4

[1] The operational characteristics cited here were computed under normal conditions at sea level; they are subject to change as a result of continuing developmental testing of equipment.

[2] Maximum allowable gross weight. The maximum allowed total weight of the aircraft prior to takeoff; total weight is the basic weight of the aircraft plus the crew, personnel equipment, special devices, passengers/cargo, and usable fuel and oil. This is limited by structure, power available, or landing load.

[3] Basic weight. The weight of an empty aircraft is its basic configuration, including all appointments, integral equipment, instrumentation and trapped fuel and oil, but excluding passengers, cargo, crew, and usable fuel and oil.

[4] Useful load. The load-carrying capability of an aircraft. It includes the payload, crew and usable fuel, and oil required for the mission. Here it is the difference between maximum allowable gross weight and the basic weight as defined above. Thus, it is evident that a reduction of the fuel load will increase the payload capacity. Flying endurance, however, will be decreased. Full oil is required for all missions.

[5] Payload. The payload is the useful load less the crew, usable fuel, and oil required for the mission. Payload, then, is the weight of the cargo and/or passengers the aircraft can carry.

[6] Normal cruising speed. The true airspeed which an aircraft normally can be expected to maintain at some standard power setting below rated military power. This speed will vary with altitude. Airspeeds and fuel consumptions will vary with gross weight, altitude, power settings, and aircraft. See appropriate operators manual for correct airspeed.

[7] Endurance at cruising speed. The time that an aircraft can remain airborne at normal cruising speed without using the required fuel reserve.

[8] Weapons systems and components not included.

[9] Does not meet 200 nautical miles range requirement of normal mission definition.

[10] Varies with load carried. Figure given is for a normal mission profile.

[11] Maximum with reduced fuel.

[12] 100 knots with or without pod. 90 knots with external outside load.

[13] May be used with no change in operation but requires special inspection and maintenance. By waiver granted to Fort Rucker, CONUS, and ARADCOM, these aircraft are authorized for operation with 80–87 grade fuel.

Table 10–15. Table for conversion of time throughout the world.

HOURS OF DAY IN LOCAL MEAN TIME

PREVIOUS DAY — SAME DAY — NEXT DAY

TIME ZONE																																																
0 (Z)	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11
-1 (A)	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12
-2 (B)	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13
-3 (C)	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14
-4 (D)	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
-5 (E)	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
-6 (F)	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17
-7 (G)	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18
-8 (H)	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19
-9 (I)	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20
-10 (K)	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21
-11 (L)	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22
-12 (M)	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
+1 (N)	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10
+2 (O)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09
+3 (P)	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08
+4 (Q)	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07
+5 (R)	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06
+6 (S)	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05
+7 (T)	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04
+8 (U)	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03
+9 (V)	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02
+10 (W)	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01
+11 (X)	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
+12 (Y)	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23

PREVIOUS DAY — SAME DAY