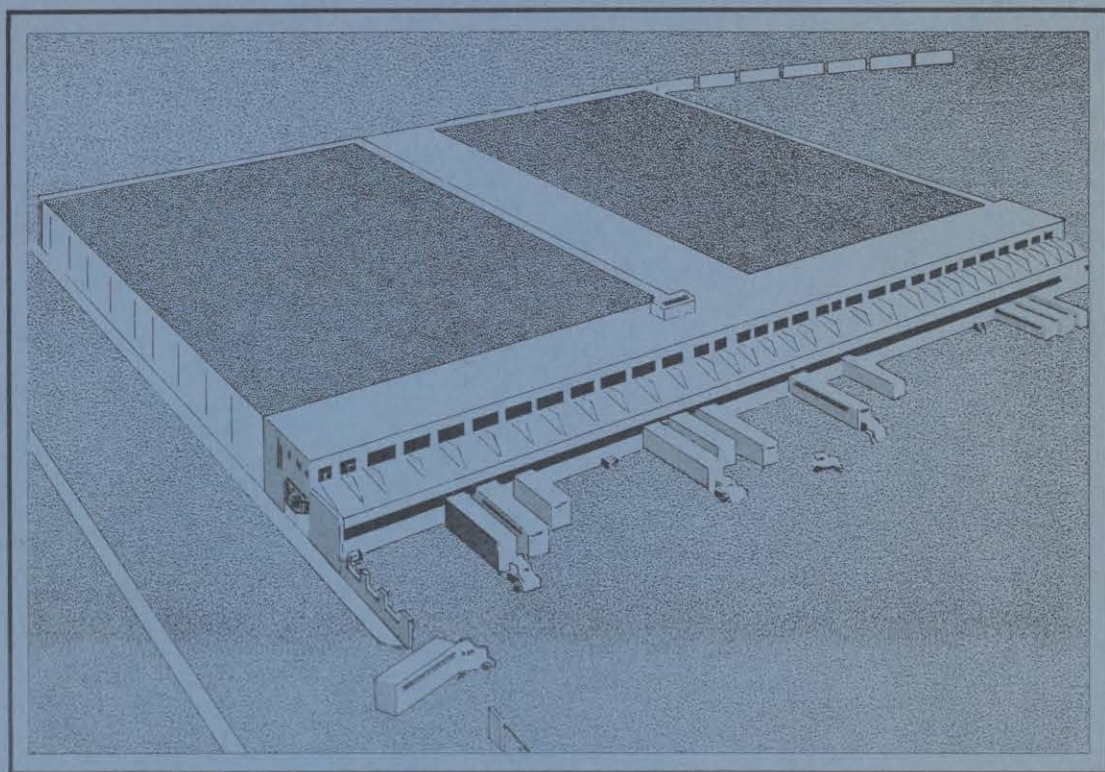


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REFRIGERATED STORAGE A LOOK AHEAD

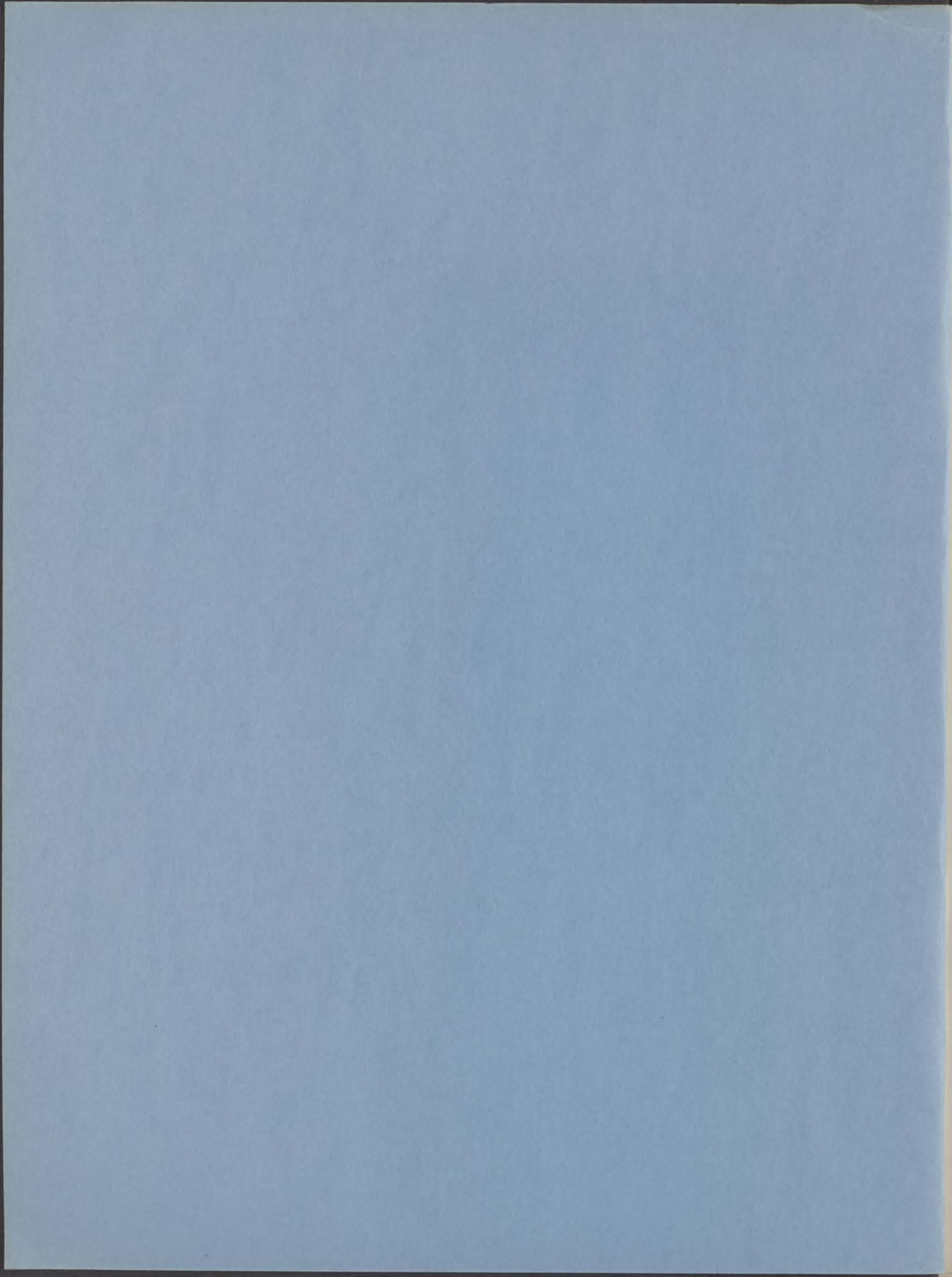


*A STUDY OF PROJECTED REQUIREMENTS
FOR
PUBLIC GENERAL REFRIGERATED WAREHOUSES
BY*

DEFENSE TRANSPORT ADMINISTRATION
WASHINGTON 25, D. C.

NOV 18 1953

MAY, 1953



REFRIGERATED STORAGE

A LOOK AHEAD

A Study of Projected Requirements for Public
General Refrigerated Warehouses Prepared by
The Warehousing and Storage Division

DEFENSE TRANSPORT ADMINISTRATION
Washington, D. C.

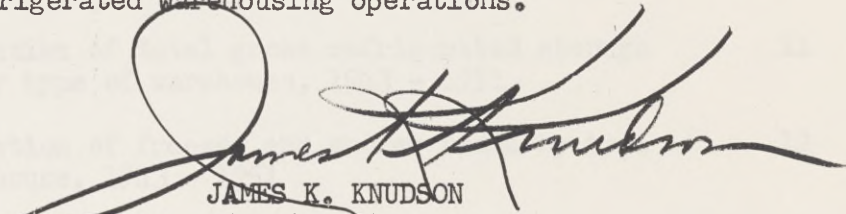
May 1953

ACKNOWLEDGEMENT

This pamphlet and the conclusions resulting therefrom concerning public general refrigerated warehousing facilities are based on a study made by the Defense Transport Administration to determine projected future requirements of refrigerated storage space under existing and anticipated mobilization conditions.

We wish to acknowledge with appreciation the cooperation of the Production and Marketing Administration of the United States Department of Agriculture, the several trade associations of the frozen food and warehousing industries, the authors of books, publishers of magazines concerning the refrigeration of foods, and individual companies within the public refrigerated warehousing industry, whose assistance in the preparation of this report has been invaluable.

Expressions of opinion on the part of those interested in this study and its conclusions will be welcomed. Such comments will receive full consideration in mobilization planning for public refrigerated warehousing operations.



JAMES K. KNUDSON
Administrator

May 18, 1953

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This pamphlet and the conclusions resulting therefrom concerning public refrigerated warehousing facilities are based on a study made by the Bureau of Plant Industry, Department of Agriculture, in cooperation with the Bureau of Entomology and Plant Quarantine, Department of Agriculture, and the Bureau of Plant Industry, Department of Agriculture, in cooperation with the Bureau of Entomology and Plant Quarantine, Department of Agriculture.

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Expressions of opinion on the part of those interested in this study and its conclusions will be welcome. Such comments will receive full consideration in subsequent editions for public refrigerated warehousing operations.

JOHN I. LUTCH
Administrator

May 15, 1933

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INTRODUCTION

The Defense Transport Administration was established by Executive Order of the President under authority of the Defense Production Act of 1950, as amended, and among other things, is charged with the responsibility for assuring the availability of adequate storage facilities.

The various forms of storage can be divided into four basic types, general merchandise, refrigerated, bulk storage of liquids and bulk storage of grains and feeds. While the Defense Transport Administration is concerned with all these forms of storage, this study is limited to refrigerated storage, and more especially, to refrigerated storage facilities operated as public general refrigerated warehouses.

It is the policy of DTA to encourage the public warehousing industry to develop with private capital as much of the storage space needed by the defense effort as is economically feasible, thus obviating the necessity of government construction and minimizing the need for allocation controls. It therefore becomes a matter of considerable importance to determine the requirements for refrigerated facilities to meet the needs of both the military and essential civilian economy. By reason of the long lead time required for the proper planning and construction of refrigerated warehouses, it was decided that a study should be made to project the requirements for such facilities through the end of 1955. It is hoped that the results of this study will assist the industry in formulating a program which will meet the demands of the defense activity and at the same time protect the requirement of the essential civilian economy. Particular attention has been given to those increased requirements resulting from the expansion of defense activity which could be a dominant influence on the future growth of the public refrigerated warehousing industry. The expected increased disposal income of consumers during the coming years, together with the anticipated continued heavy procurement of military items, should result in a continuing strong demand for frozen foods.

SECTION I

THE DEVELOPMENT OF REFRIGERATION

The preservation of perishables by freezing dates back to prehistoric times when nature suddenly engulfed animals and plants

with ice. The woolly mammoths that have been found frozen in Siberia evidence the fact that meat can be preserved by freezing and retain its good quality and appearance for thousands of years. However, the practical application of this method of preservation had to wait many centuries until man was able to control temperatures within limited areas.

History indicates that man-made cooling processes were known as far back as the ancient races of Egyptians, Greeks, Romans and East Indians. Porous clay vessels were filled with water and hung in the shade, and the water that passed through the porous walls was evaporated by the dry winds. The removal of heat by evaporation reduced the temperature of the remaining water in the vessel until it was cool, and this sometimes cooled sufficiently to form ice. But it was not until the beginning of the 19th century that natural ice was used for preserving food.

During the early days of our country, the composition of the population was basically rural, and consequently the storage of food was usually localized to each family. Then communities began to develop and as they grew, villages became towns and towns became cities. This gradual division between rural and urban populations led to the development of larger farms which, by reason of improved farm methods, were capable of higher productivity. The formation of urban communities, together with the increase in the distance over which fresh farm products could be marketed due to improved transportation facilities, resulted in changed methods for the preservation and distribution of foods and the storage of seasonal surplus production. Today the preservation and warehousing of perishable foods are an important part of our economy, and the health, welfare and well-being of an urban population would suffer if it were necessary to subsist without foods protected by refrigeration.

The acceptance by the public of foods preserved by freezing was a slow process, and it is only within the past few years that frozen foods have come to be accepted. The fault was not that of the public but rather that of the food merchants. The industry got off to a bad start because of the use made of so-called "cold storage". The early application of refrigeration seemed to be for the purpose of preventing a total loss when the market could not absorb the available supply of fresh foods. All too often such foods

as fish and meats were held on the market as "fresh" until deterioration was well under way. This food was then placed in cold storage as a last resort to prevent total loss. Under the circumstances, the public looked upon cold storage foods with considerable suspicion. The industry did little to overcome these objections on the part of the public or try to correct its own weaknesses. Instead, frozen or refrigerated foods were defrosted and then passed off as fresh foods. This suspicion on the part of the public continued to exist until a comparatively few years ago. In fact, the "old timers" still to this day will have nothing to do with anything that is, or has been, frozen. This prejudice was well expressed by W. R. Woolrich in the Southern Power Journal, September 1928, when he said, "The first mental picture that springs before fully half of the American people when you introduce the subject of cold storage is that of some egg storage rooms from which specimens that are none too fresh are drawn at intervals that are none too frequent." However, the last decade has brought almost universal acceptance of the preservation and freezing of foods of all kinds. With corrections in marketing practices; technological improvements in processing, distribution and salesmanship; and the increased use of mechanical refrigerators and freezer boxes in the home, frozen foods have changed from the category of "unusual" to commonplace items on the average American table.

There are two basic types of food preservation by means of refrigeration. Cooler facilities, which are maintained between temperatures of 29° and 50° Fahrenheit, are mainly for the purpose of retarding deterioration processes of fresh foods; and freezer facilities, maintained at temperatures as low as minus 20° Fahrenheit, to arrest such deterioration processes. Therefore, the freezing of foods permits long-term storage and preservation. Before the advent of frozen foods, methods of long-term preservation were limited to canning, cooking, salting, smoking and dehydration. The freezing method has resulted in a form of preservation, which for all practicable purposes, makes fresh food available during any season of the year and in locations far removed from the area of production. The production of concentrated orange juice, which rose from 12.2 million gallons during the 1948-1949 pack to an estimated 40.0 million gallons in 1951-1952, is in itself a striking example of the ever-increasing

importance of the distribution of frozen products. The availability of seafood to the lower income groups in the interior of the United States during all seasons of the year is an example of the advantages brought about by the freezing method of preservation.

The military has recognized the advantages of frozen foods and, from an almost insignificant quantity purchased prior to World War II, the procurement of frozen foods to feed the men and women of the armed services has increased to very significant totals. The military first initiated the procurement of frozen foods in an effort to supply as much fresh meat to overseas troops as possible, by avoiding the relatively short life span of such meats shipped in normal cooling facilities afforded by most ocean vessels. Furthermore, the overseas supply of fresh fruits and vegetables was generally limited to the amount which could be purchased at the local markets in the areas in which the troops were stationed, and it was necessary to supplement that supply by the shipment of canned or dehydrated items from this country. Here again it was found that frozen fruits and vegetables could supplement the fruits and vegetables procured in the local areas, although the quantity which could be shipped was necessarily limited by the availability of refrigerated ship space and freezer storage facilities at destination.

At the close of World War II military purchases of frozen fruits and vegetables dwindled and most of the frozen fruits and vegetables procured by the military in 1947, 1948 and 1949 was resold through the commissaries for the use of the families of military and civilian personnel. However, in 1950 Quartermaster Corps purchases of frozen foods rose to 44 million pounds and increased to 92 million pounds in 1951. For the calendar year 1952 military purchases exceeded 200 million pounds, or more than 400% above 1950 purchases.

It is thus obvious the use of frozen foods has assumed such an important place in both the civilian economy and the military use that it has become an essential element in the national defense program. During the entire period of development, the public refrigerated warehouses have assumed an ever-increasing role in the freezing

and distribution of frozen foods, and in 1951 such public warehouses provided 169 million cubic feet, or 80%, of the total sharp freezer space (0° Fahrenheit and below) in the United States. This service is extremely important, not only to the civilian economy, but to the armed services as well. Even today, with military procurement of frozen foods at the highest level in history, almost complete reliance is placed on the public refrigerated warehousing industry for the handling and storage of such commodities.

Notwithstanding the increase in the consumption of frozen foods, and more particularly frozen fruits, vegetables and concentrated juices, the total amount frozen is still exceptionally small when compared to the over-all amount of such fresh items consumed. But each year sees a continuing growth in the volume of frozen foods, and the extent of the growth is one of the present problems of this Administration and the industry. In considering that problem, three general objectives should be kept in mind: (1) the present defense effort must be promoted by effective utilization of existing warehousing facilities; (2) refrigerated warehousing services, adequate to support a high level of economic activity, must be effectively maintained during the present emergency; and (3) refrigerated warehousing facilities should be sufficient to render adequate service during wartime.

SECTION II

DEFINITIONS AND ASSUMPTIONS

For statistical purposes, refrigerated storage space is basically divided into two categories with respect to temperatures maintained. Storage space maintained above 29° Fahrenheit is referred to as "cooler", and space maintained below 29° Fahrenheit is referred to as "freezer". The "freezer" space is further divided into "normal freezer" (0° to 29° F) and "sharp freezer" (0° F and below). While these divisions of space are made for statistical purposes, the accepted industry practices may vary somewhat. For example, shell eggs are considered as a cooler item, but will be held in temperatures of 29° F or slightly lower. Also, there are few items maintained at temperatures between 15° to 29° F; and consequently, little space is maintained at that temperature range. Statistically, "sharp freezer" is any space held below 0° F, and the general application in the industry is space held at approximately

-20° F or lower. While this study is primarily concerned with projected requirements, the last two Sections, providing statistics concerning capacity and occupancy, are included as historical background and convenient reference. To some extent this information duplicates the publications issued by the United States Department of Agriculture and was largely obtained from that source.

Refrigerated warehouses are also generally classified by type of ownership or by particular speciality. The types of facilities used herein correspond substantially with those used by the United States Department of Agriculture and are defined as follows:

Public General Refrigerated Warehouse

Any artificially cooled warehouse, the operator of which is engaged in storing food commodities, requiring refrigeration, for others for pay.

Private General Refrigerated Warehouse

Any artificially cooled warehouse, the operator of which conducts a warehousing business to facilitate his main function as a producer, processor, or distributor but does not store commodities for others for pay.

Semiprivate General Refrigerated Warehouse

Any artificially cooled warehouse, the operator of which uses part of the space to care for the storage of his own commodities and in addition stores in his plant various food commodities for others for pay.

Meat Packing Establishment

Any plant engaged in processing dressed animals and animal products for food. For the purposes of this study, only that space which is used for the storage of products is included. Working space, chill rooms, and coolers used exclusively for hanging dressed carcasses prior to shipping are excluded.

Apple House

Any warehouse, public, private, and semiprivate, the owner and operator of which is engaged mainly or exclusively in the storage of apples or pears.

In any study to determine projected requirements it is necessary that certain basic assumptions be adopted in order to limit the number of factors which affect the results. Obviously, if any of the assumptions do not prove to be accurate, then the conclusions of this study will have to be modified accordingly. The following are the assumptions that have been adopted.

1. That a full-scale national emergency will not occur before the end of 1955.
2. That the Armed Services will not materially alter their present personnel strength.
3. That total national security expenditures and per capita income will remain at approximately the same level as 1951 and 1952.
4. That the present pattern of marketing and distribution of commodities requiring refrigeration will not be materially altered.
5. That there will be no material change in the type of commodities to be stored in refrigerated space.
6. That further expansion of private and semi-private refrigerated storage facilities will follow the present expansion ratio of public facilities.
7. That the present increased consumption trend of commodities requiring refrigeration will continue.

Many of the tabulations and charts present statistics on the basis of geographic regions of the United States. For the purpose of avoiding confusion, the geographic regions adopted correspond with those used by the United States Department of Agriculture in its surveys of refrigerated storage facilities.

New England: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut.

Middle Atlantic: New York, New Jersey, and Pennsylvania.

East North Central: Ohio, Indiana, Illinois, Michigan, and Wisconsin.

West North Central: Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, and Kansas.

South Atlantic: Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, and Florida.

East South Central: Kentucky, Tennessee, Alabama, and Mississippi.

West South Central: Arkansas, Louisiana, Oklahoma, and Texas.

Mountain: Montana, Idaho, Wyoming, Colorado, New Mexico, Arizona, Utah, and Nevada.

Pacific: Washington, Oregon, and California.

SECTION III

THE GROWTH OF REFRIGERATED STORAGE IN THE UNITED STATES

Refrigerated storage started its major development about 1890 when mechanical refrigeration began to assume practical importance, and by October 1951, a total of 711 million gross cubic feet of such space was available for the storage of perishables. Of this total, 52.7% is located in public general refrigerated warehouses, 13.3% in private and semi-private general warehouses, 13.8% in meat packing establishments, 7.1% in public apple houses, and 13.1% in private and semiprivate apple houses. Fig. A illustrates the distribution of refrigerated storage space by type of operation as of October 1, 1951.

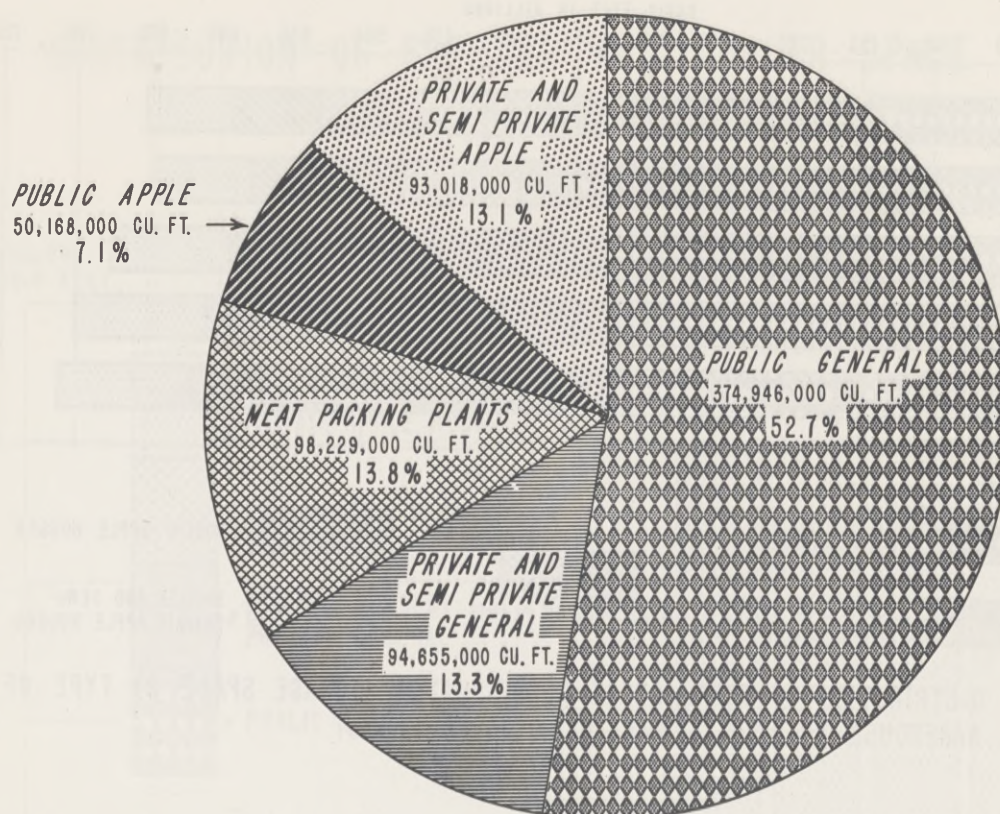


FIGURE "A" DISTRIBUTION OF GROSS REFRIGERATED STORAGE SPACE IN THE UNITED STATES BY TYPE OF OPERATIONS AS OF OCTOBER 1, 1951 INCLUDING "COOLER", "NORMAL FREEZER" AND "SHARP FREEZER" SPACE.

From 1921 to 1927 approximately 20 million cubic feet of space per year were added. This increase was stepped up during 1928 and 1929, and by October of the latter year there was a total availability of 729 million cubic feet of refrigerated space. This rapid pace slackened from 1929 to 1931 to about 6 million cubic feet per year, and from 1931 to 1935 there was a net decrease of 30 million cubic feet. However, in 1936, the industry again started to expand and by October 1941 the total capacity rose to 766 million cubic feet. Following the 1941 survey made by the United States Department of Agriculture, the basic questionnaire was changed to reflect only space in meat packing plants used for storage and to eliminate space used for processing. This resulted in an apparent decrease in national total capacity, but there was no actual decrease in space operated. Fig. 'B illustrates the growth of refrigerated space from 1943 to 1951.

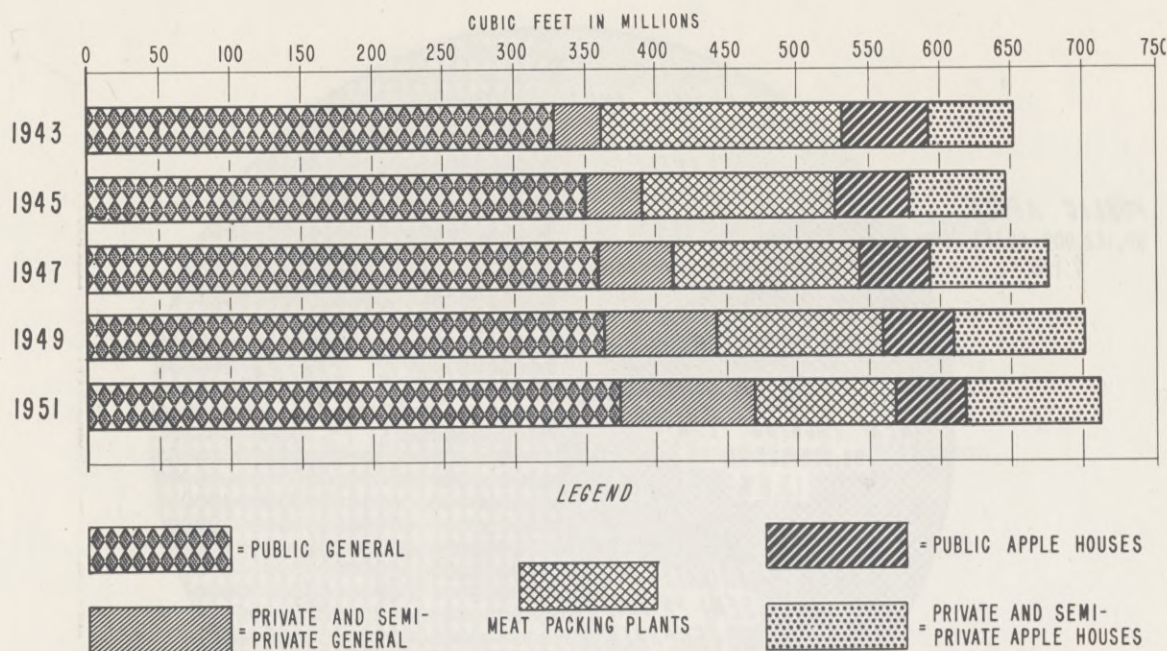


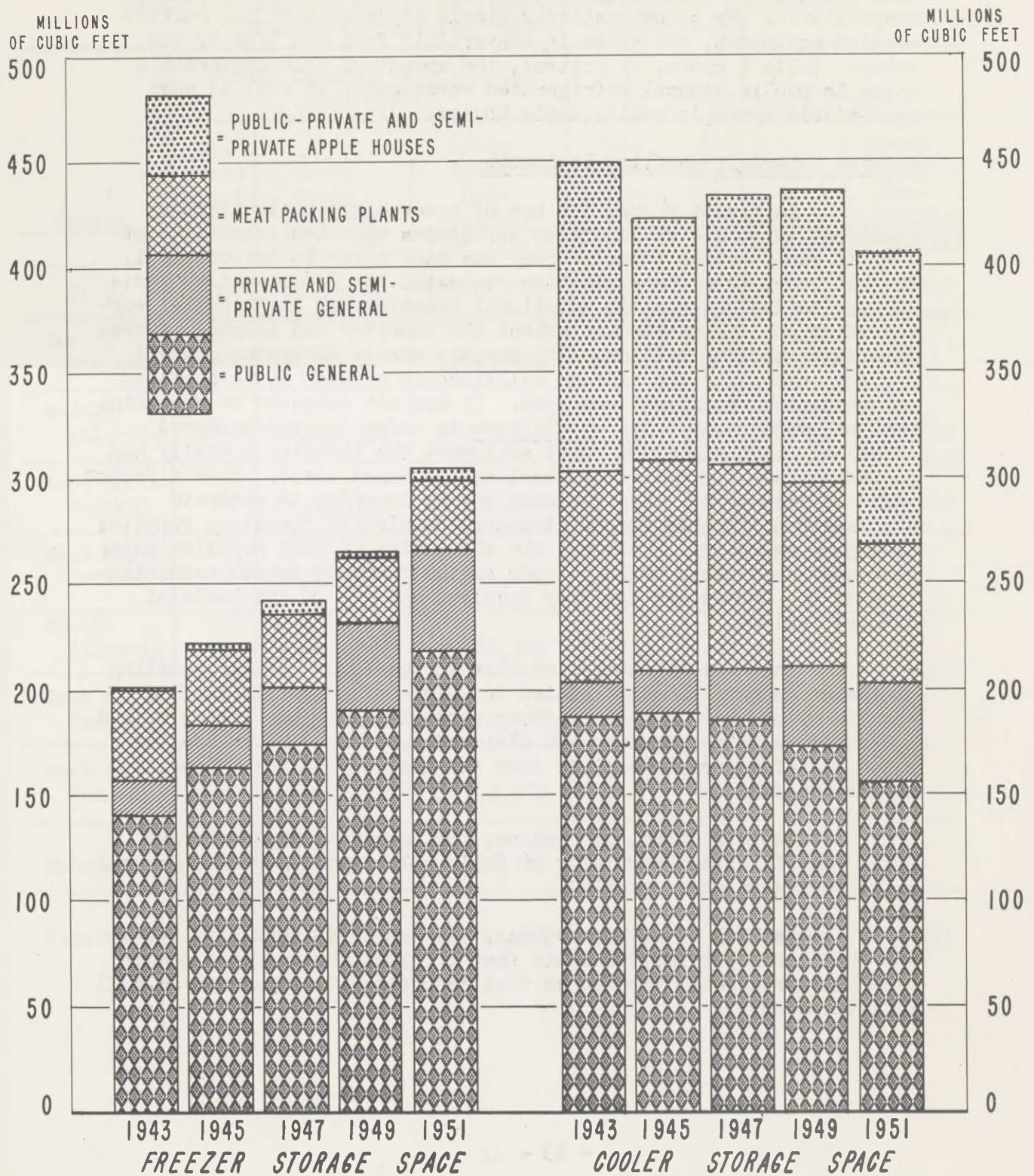
FIGURE "B" DISTRIBUTION OF TOTAL GROSS REFRIGERATED STORAGE SPACE BY TYPE OF WAREHOUSE OCTOBER 1, 1943 TO OCTOBER 1, 1951.

As of October 1951, the total national capacity of refrigerated space stood at 711 million cubic feet. Of this total, 304 million was "freezer" and almost 407 million was "cooler" space.

The refrigerated warehousing industry not only showed a continued increase in the amount of space operated, but there has been a decided shift in the distribution of this space according to temperature range. Prior to 1939, "freezer" space accounted for less than 25% of the total refrigerated space, but as of October 1951, "freezer" space represents better than 40% of the total, and more than two-thirds of this is maintained at below 0° Fahrenheit. Cooler space, on the other hand, has decreased since 1943 by about 10%. Fig. C shows separate trends in "freezer" and "cooler" storage capacity from 1943 to 1951 for all types of warehouses.

FIGURE "C"

DISTRIBUTION OF FREEZER AND COOLER SPACE BY TYPE OF WAREHOUSE



Convertible Space

There is a considerable amount of refrigerated storage space capable of being maintained at either "cooler" or "freezer" temperatures. By a comparatively simple adjustment of the refrigeration equipment, the space is convertible from one type to the other. Table I shows, by regions, the amount of such convertible space in public general refrigerated warehouses, as well as such convertible space in public apple houses.

Powered Materials Handling Equipment

In recent years, the use of powered materials handling equipment in public refrigerated warehouses has been increasing at a rapid pace, but no formal survey was made prior to October 1951. In that year, this Administration requested the Department of Agriculture to include certain additional questions in its biennial survey which would indicate the extent the industry had adopted powered materials handling methods. The purpose was to determine general factors concerning the average relationship between space operated and mechanical equipment employed. It was not intended to determine what an average warehouse should have in order to be considered adequately mechanized, but what equipment the industry actually had on the average for both a national and regional basis. Such a factor would be used by DTA as a claimant agency in order to estimate national requirements for maintenance, repair and operating supplies during an emergency. However, the allocation of such supplies under emergency conditions would be made on the basis of actual mechanization of the particular facility involved and not on the basis of average factors.

While it is recognized that the use of materials handling equipment is more closely related to volume of materials handled than to space operated, the factors established by the latter method are sufficient for planning and claimant purposes, and avoids the necessity of recurring reports from the industry on the number of tons handled.

Table 2 shows, by regions, the amount of gross storage space that is either partially or fully palletized in public general refrigerated warehouses only.

Table 3 shows, by regions, the number of fork lift trucks and the number per 100,000 cubic feet of gross space in the public general refrigerated warehouses that reported either partial or full palletization.

TABLE 1 - SPACE IN PUBLIC REFRIGERATED WAREHOUSES CONVERTIBLE
BETWEEN "COOLER" AND "FREEZER" TEMPERATURES

Region	Public General Refrigerated Warehouses			Public Apple Houses		
	No. Firms Reporting	Gross Space Reported (Cu. Ft.)	Gross Space Convertible (Cu. Ft.)	No. Firms Reporting	Gross Space Reported (Cu. Ft.)	Gross Space Convertible (Cu. Ft.)
TOTAL U. S.	603	370,687,324	57,701,211	141	50,168,922	115,275
New England	30	17,098,528	1,815,414	7	715,414	0
Middle Atlantic	133	98,598,351	9,370,647	42	13,708,094	23,000
East North Central	86	77,012,582	8,188,288	24	3,673,061	10,000
West North Central	62	38,835,265	6,567,201	6	605,014	0
South Atlantic	78	32,945,355	2,964,189	24	15,971,194	0
East South Central	24	11,104,263	2,432,428	Not Reported	Not Reported	-
West South Central	45	23,217,887	10,147,833	2	168,276	0
Mountain	24	6,751,790	514,723	1	8,500	0
Pacific	121	65,123,303	15,700,488	35	15,319,369	82,275

TABLE 2 - PALLETIZATION OF PUBLIC GENERAL REFRIGERATED WAREHOUSES

Region	No. Firms Report- ing	Total Gross Space Reported (Cu. Ft.)	Fully Palletized			Partially Palletized		Total Gross Space Partially or Fully Palletized (Cu. Ft.)
			No. Firms	Gross Space (Cu. Ft.)	No. Firms	Gross Space (Cu. Ft.)		
TOTAL UNITED STATES	603	370,687,324	69	71,264,157	83	100,163,037	171,427,194	
New England	30	17,098,528	3	4,200,151	5	6,437,597	10,637,748	
Middle Atlantic	133	98,598,351	14	20,393,943	22	31,246,414	51,640,357	
East North Central	86	77,012,582	12	7,469,464	20	32,461,256	39,930,720	
West North Central	62	38,835,265	Not Reported	Not Reported	7	9,039,152	9,039,152	
South Atlantic	78	32,945,355	3	5,219,915	3	3,387,724	8,607,639	
East South Central	24	11,104,263	2	2,905,068	1	171,070	3,076,138	
West South Central	45	23,217,887	3	8,887,200	3	2,761,381	11,648,581	
Mountain	24	6,751,790	2	657,692	3	2,117,388	2,775,080	
Pacific	121	65,123,303	30	21,530,724	19	12,541,055	34,071,779	

TABLE 3 - FORK LIFT TRUCKS IN PUBLIC GENERAL REFRIGERATED WAREHOUSES

Region	Fully Palletized Operations			Partially Palletized Operations		
	No. Fork Lift Trucks	Gross Space (Cu. Ft.)	No. Fork Lift Trucks Per 100,000 Cu. Ft.	No. Fork Lift Trucks	Gross Space (Cu. Ft.)	No. Fork Lift Trucks Per 100,000 Cu. Ft.
TOTAL UNITED STATES	288	71,264,157	4.0	231	100,163,037	2.3
New England	15	4,200,151	3.6	25	6,437,597	3.9
Middle Atlantic	59	20,393,943	2.9	54	31,246,414	1.7
East North Central	32	7,469,464	4.3	75	32,461,256	2.3
West North Central	Not Reported	Not Reported	-	12	9,039,152	1.3
South Atlantic	9	5,219,915	1.7	4	3,387,724	1.2
East South Central	13	2,905,068	4.5	0	171,070	0
West South Central	33	8,887,200	3.7	15	2,761,381	5.4
Mountain	5	657,692	7.6	3	2,117,388	1.4
Pacific	122	21,530,724	5.7	43	12,544,055	3.4

SECTION IV

PROJECTED REQUIREMENTS

From an operating standpoint, net usable storage space cannot be fully occupied except for items of "dead" storage. The need for space to maneuver stocks during in-and-out movement, restrictions on piling height due to type of commodity or packing, and the scheduling of receipts and shipments all contribute to the fact that one hundred percent occupancy cannot be maintained for other than very short periods. Ninety percent occupancy of net piling space is generally considered the maximum occupancy at which material can be efficiently handled and, beyond this point, both manpower and equipment show a marked decrease in effectiveness. In times of national emergency, the inefficient use of manpower and equipment is detrimental to the defense effort and should be avoided. It is also true that the crowded conditions in a warehouse caused by occupancy above 90% result in excessive detention of transportation vehicles, and such unnecessary detention reduces the transportation potential at a time when its efficient use is most necessary to the national interests.

There is yet another important point to be considered. Additional "freezer" space cannot be improvised by the use of other facilities, and the construction of large blocks of additional space requires a minimum lead time of at least six months. Should a full-scale national emergency strike, it will probably be sudden and, unless private industry can plan to absorb the initial impact of such an emergency, it might be necessary for the Government to construct additional facilities. This is not desirable from either the standpoint of the Government or of industry. To avoid such a possibility, the Defense Transport Administration has encouraged the maintenance of a reasonable reserve of "freezer" space, to absorb this initial impact and thus permit the necessary lead time for the industry to construct additional facilities. It is believed that a 10% space reserve is the minimum that would meet this requirement. Under these circumstances, it has been the objective of this Administration's incentive programs to encourage the public general refrigerated warehousing industry to expand its capacity during the defense mobilization period at a rate that would maintain "freezer" occupancy at a national average of eighty percent during the peak storage season. Such an occupancy should provide the necessary reserve without financial sacrifice on the part of the industry.

The problem involved in the projection of "freezer" requirements is to determine a relationship between storage requirements and some factor which is capable of reasonable projection for an extended period of time.

The principal commodities stored in "freezer" storage space are frozen fruits, juices, vegetables, dairy products, meats, poultry and seafood. It is recognized that any single factor that is developed to tie in with storage requirements cannot be absolutely accurate. A high carry-over from one crop to another can frequently alter the storage pattern. Of the "freezer" stocks, plastic and fluid cream historically reach a high in July and August, frozen beef and pork in March and April, frozen poultry in December and January, frozen eggs in June and July, frozen vegetables in September, October and November, frozen fruits and juices in June, July and August. Occupancy is therefore influenced by the manner in which each of these crops is distributed and consumed, and a large carry-over of one commodity can interfere with the storage of the next following commodity. Increased production of a commodity does not necessarily mean increased storage holdings. The recent increase in the production of frozen citrus juices has not increased public "freezer" space requirements in proportion to the increased production. Furthermore, it has tended to reach the public warehouses in the early spring at a time of otherwise low occupancy.

However, notwithstanding disrupting influences, a detailed analysis indicates that, in the past, a reasonably constant relationship has existed between the production of certain frozen commodities and over-all storage requirements for "freezer" space. A discussion of all the various avenues of approach which were studied in order to arrive at what appears to be a proper conclusion is not included for the obvious reason that it would not benefit the results and final conclusions.

One of the first inconsistencies that developed from the analysis of storage holdings was the variation between the weight of commodities on hand and the reported space occupancy. A detailed review of occupancy reports reflecting the number of pounds in storage and the percentage of space occupied revealed a considerable difference at various times in the number of pounds stored per cubic foot of occupied space. This was eventually attributed to improper estimates of occupancy and less effective utilization of space during periods of

low holdings. It was noted that generally as the reported percentage of occupancy increased the number of pounds of commodities per cubic foot of storage space also increased. Therefore, in order to arrive at a proper conclusion, it was necessary to determine space occupancy during different periods of the year on the basis of the space that would have been used if the commodities were piled in such a manner that full utilization of space would result. To arrive at this figure, the reported rate of occupancy for each month and the number of pounds in storage for the corresponding period were both placed on a graph. The indicated trend coordinates were then superimposed upon the same graph to determine the point of intersection. This graph is shown in Fig. D.

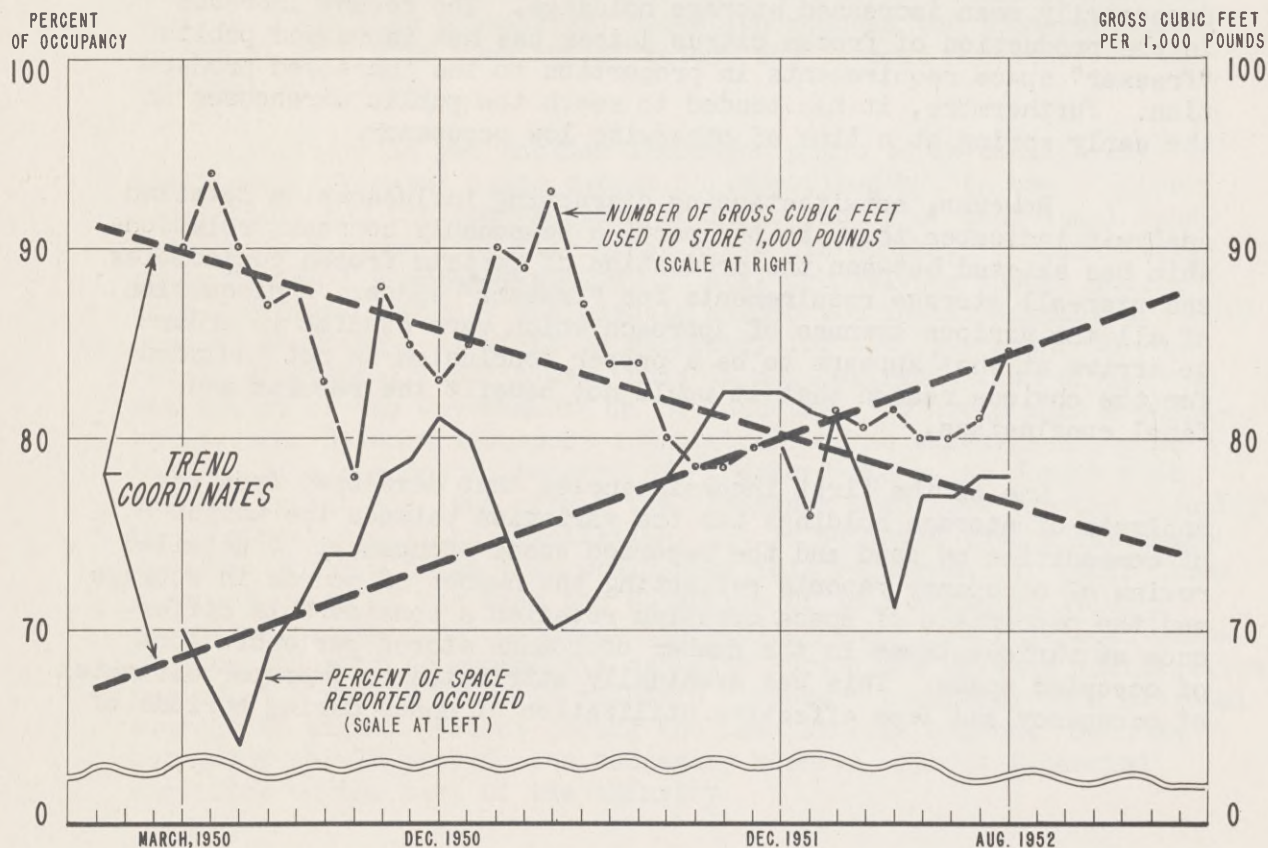


FIGURE "D" RELATIONSHIP BETWEEN REPORTED PERCENT OF OCCUPANCY AND NUMBER OF CUBIC FEET OF FREEZER SPACE USED TO STORE 1,000 POUNDS OF FOOD.

It should be noted that the trend coordinates intersect at 80 gross cubic feet. This means that with an occupancy of 80% the effective utilization of space for that degree of occupancy requires 80 gross cubic feet of space to store 1000 pounds of material. It should also be noted that with an occupancy of 85%, it would take only 76 gross cubic feet of space to store the same quantity of material. Since an 80% over-all occupancy is considered a good average for planning purposes, the 80 gross cubic feet per 1000 pounds of commodities has been adopted as the standard for effective utilization of space. Due to the many variations in construction, layout and commodities found in particular facilities, this figure cannot be used to determine the effective utilization of a single refrigerated warehouse. It can be used, however, to reflect and study over-all utilization of space on a national or regional basis.

In recent years there has been a steady trend which has moved peak holdings from September to December and January, and at the present time the highest "freezer" holdings have been at the close of the calendar year. In comparing annual production to year-end freezer stocks, the study disclosed that the relationship of year-end storage stocks of butter, fish, poultry, meat and eggs to the total quantity of these items produced or processed was relatively small, while in the case of frozen fruits and vegetables, it was much larger. For example, the twelve-year average ratio between year-end "freezer" stocks and annual production indicates that for every pound of the frozen fruit and vegetable pack three-quarters of a pound of such items will still be in storage at the year end, while for every pound of butter, fish, poultry, meat and eggs produced or processed the year-end holdings were three-tenths of a pound. This indicated that over-all increases in the production of butter, fish, poultry, meat and eggs will have much less impact on the year-end holdings than will corresponding increases in the frozen fruit and vegetable pack.

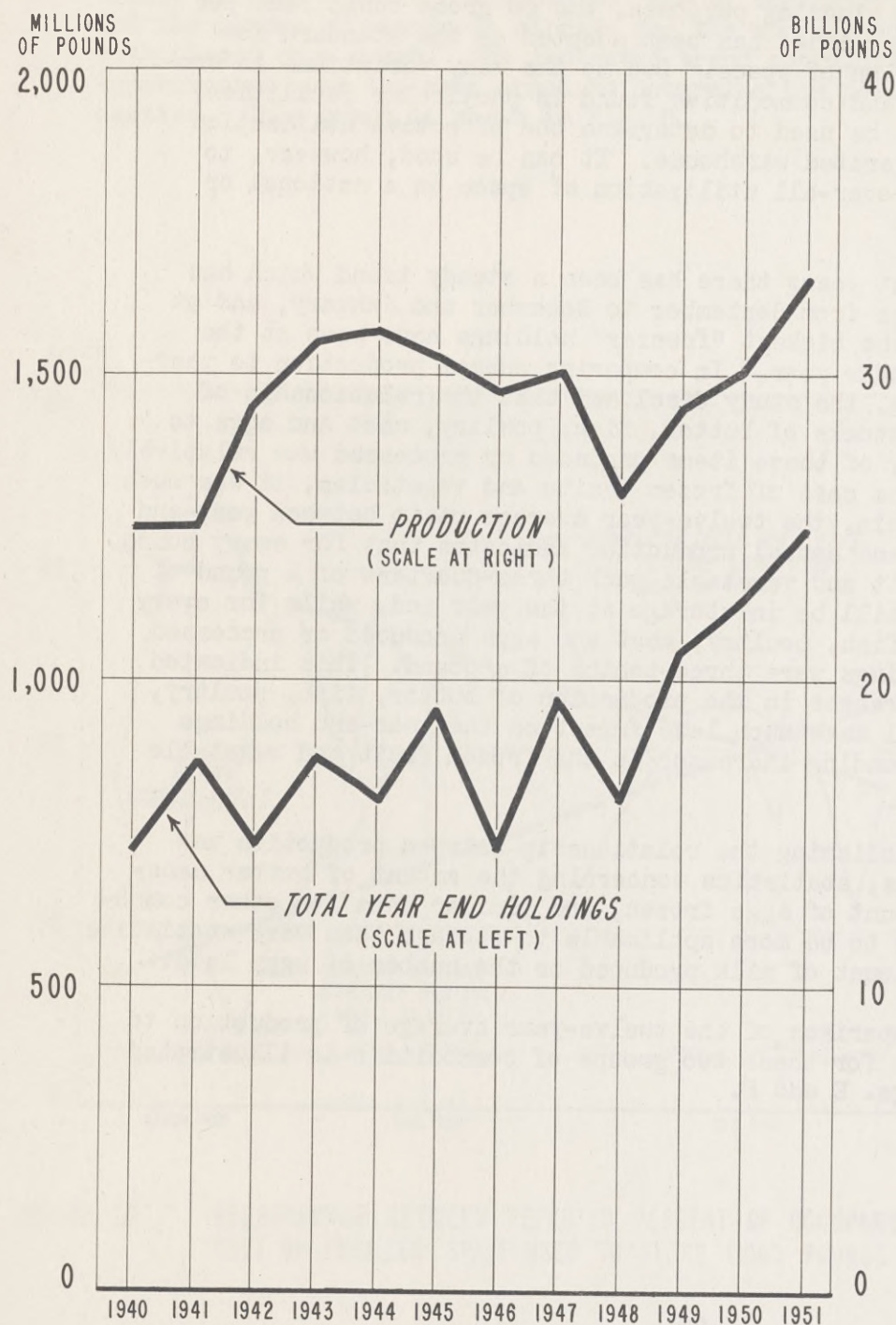
In establishing the relationship between production and "freezer" holdings, statistics concerning the amount of butter manufactured, the amount of eggs frozen, and similar data for other commodities were found to be more applicable to storage than were statistics concerning the amount of milk produced or the number of eggs laid.

The comparison of the twelve-year average of production to year-end holdings for these two groups of commodities is illustrated separately in Figs. E and F.

FIGURE "E"

COMPARISON BETWEEN ANNUAL PRODUCTION AND TOTAL YEAR END FREEZER
HOLDINGS OF BUTTER, FISH, POULTRY, MEAT AND EGGS

1940 - 1951



.03 REPRESENTS 12
YEAR AVERAGE RATIO
OF YEAR END HOLDINGS
TO PRODUCTION.

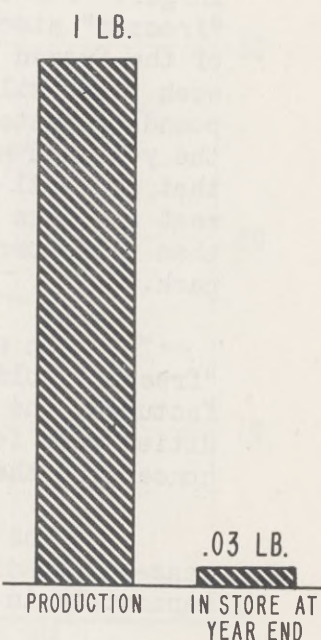
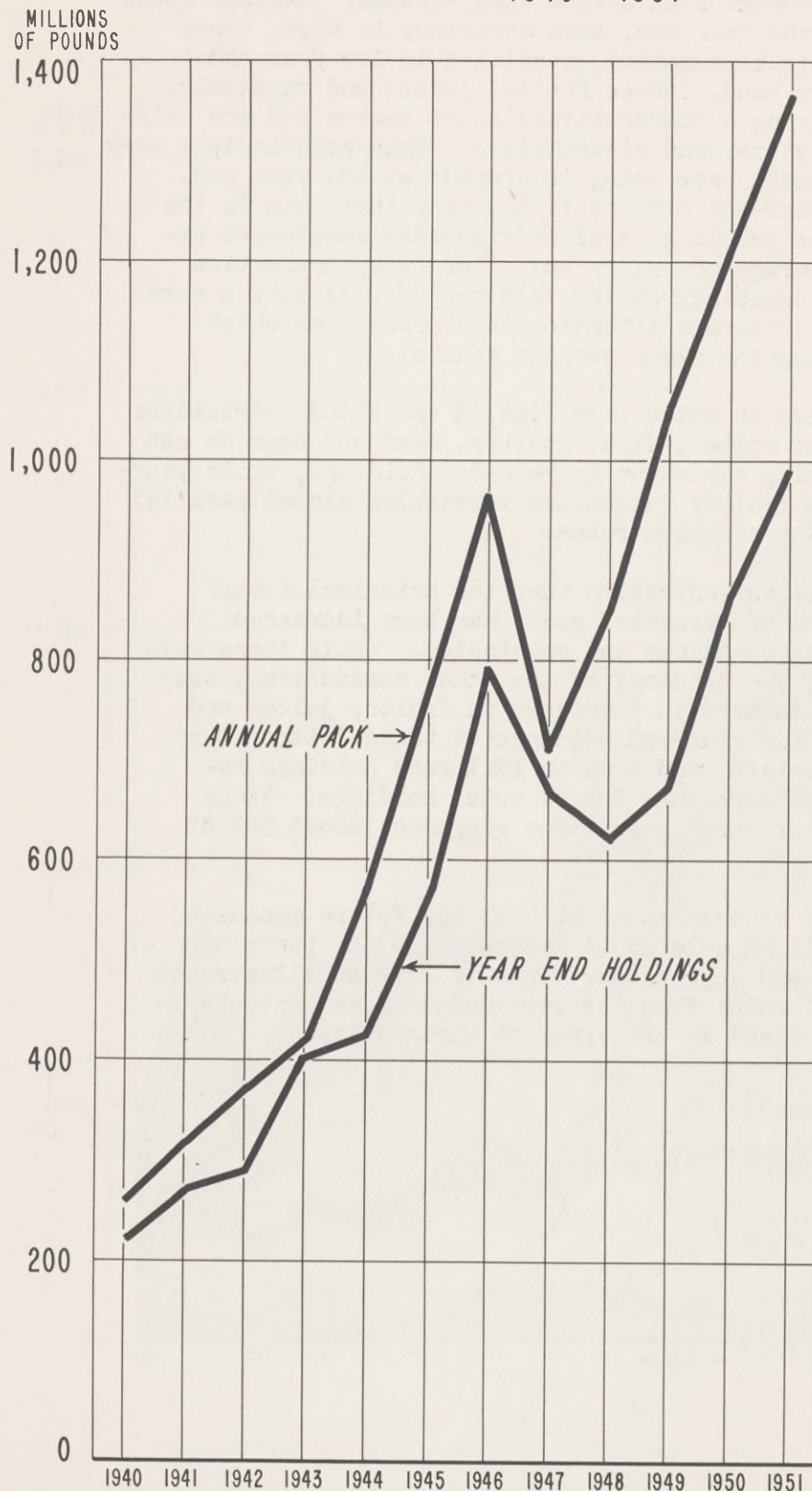
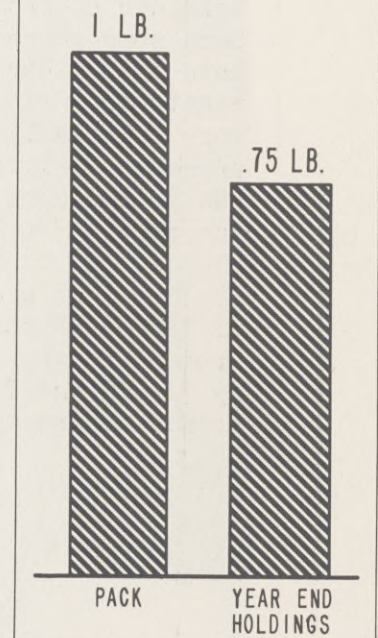


FIGURE "F"

ANNUAL PACK AND TOTAL YEAR END HOLDINGS OF
FROZEN FRUITS, JUICES AND VEGETABLES
1940 - 1951



AS AN AVERAGE FOR
THE 12 YEAR PERIOD
75 LBS. ARE IN STORE
AT THE END OF THE
YEAR FOR EVERY 100
LBS. PACKED.



It should be noted that Figs. E and F are stated in terms of year-end holdings compared to total annual production. The production of butter, fish, poultry, meat and eggs (Fig. E) prevails to some extent throughout the year, with the flush season occurring in the summer months at a time when "freezer" storage space occupancy is low. By the year end, when occupancy is high, these products have moved into consumption, resulting in low year-end holdings. On the other hand, frozen fruits, juices and vegetables (Fig. F) are packed during a comparatively short season and are maintained in storage for year-round distribution. This results in a very high portion of the annual pack being in storage at the year end. The purpose of using year-end figures is the fact that this is the period during which the public general refrigerated warehouses experience their peak storage occupancy and, therefore, production which affects storage occupancy during this period will have a more serious impact upon the storage situation than production which affects occupancy during the slack storage season.

It should also be noted from Figs. E and F that variations in annual production of butter, fish, poultry, meat and eggs do not result in a corresponding variation in year-end holdings, while year-end holdings of frozen fruits, juices and vegetables almost parallel fluctuations in annual production rates.

Thus there is an indication that the principal factor affecting the expansion of "freezer" space has been increased holdings of frozen fruits, juices and vegetables. While there have been some increases in the holdings of the other commodities, they have been minor when compared to increases in fruits, juices and vegetables. In 1935, the year-end holdings of these latter items were relatively unimportant, and even in 1941 such holdings represented only a little more than 20% of total holdings. Today the year-end holdings of these same items represent about 50% of the total.

It therefore becomes apparent that the future expansion of "freezer" space will be related to increases in the packs of frozen fruits, juices and vegetables. This is further illustrated by Fig. G and Table 4, which show the year-end "freezer" stocks in pounds of frozen food items in all types of warehouses.

FIGURE "G"

YEAR END FREEZER STOCKS OF ALL FOOD ITEMS, ACTUAL AND ESTIMATED
IN ALL PUBLIC, SEMI-PRIVATE AND PRIVATE WAREHOUSES

1935 - 1951

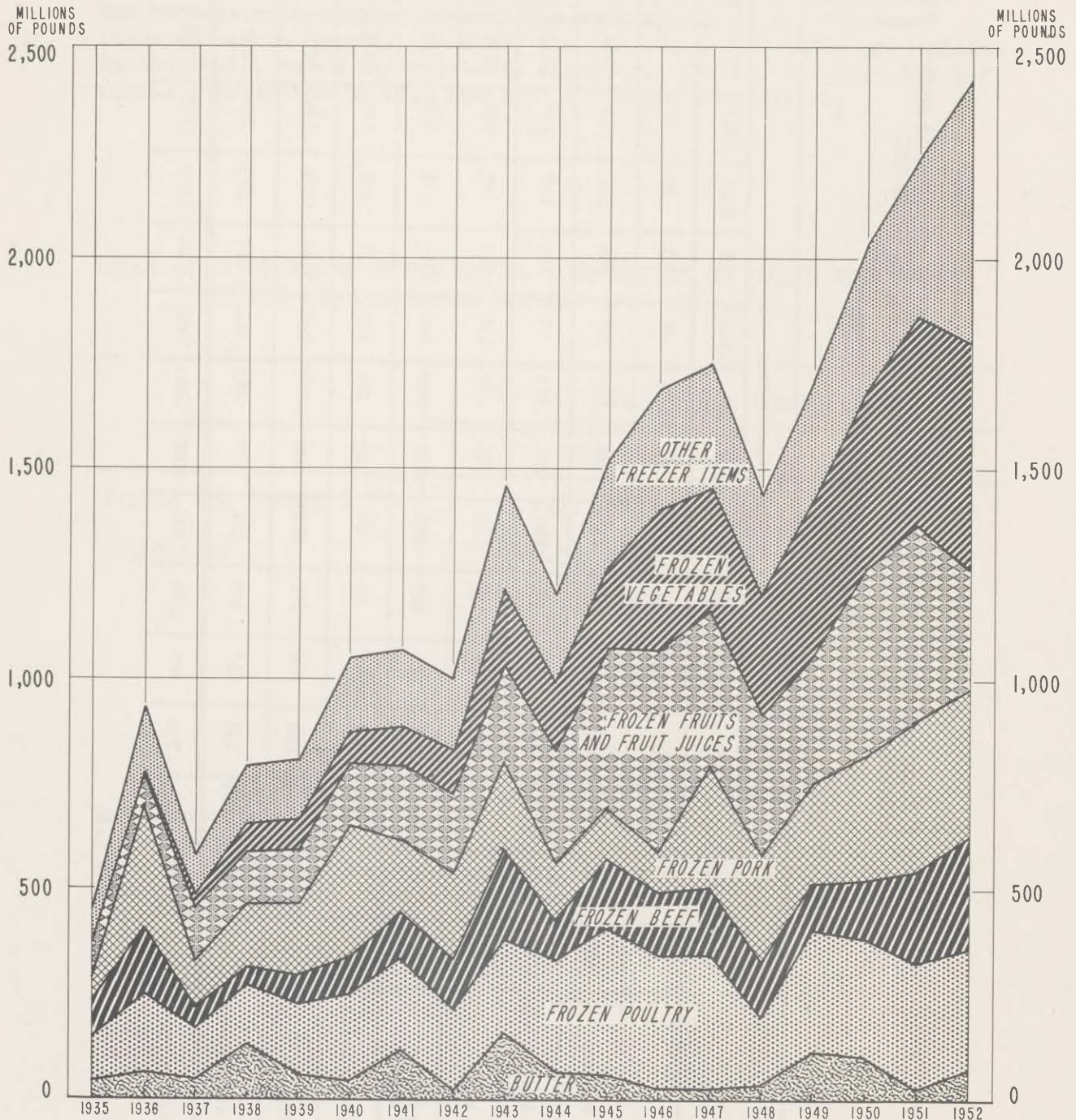


TABLE 4 - YEAR END FREEZER STOCKS OF ALL FOOD ITEMS, ACTUAL AND ESTIMATED, IN PUBLIC, PRIVATE, AND SEMI-PRIVATE REFRIGERATED WAREHOUSES - 1935 THROUGH 1952

(Figures Expressed in Millions of Pounds)

Item	Year																	
	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952
Butter	40	61	43	129	55	41	114	25	155	61	53	28	24	34	114	105	27	72
Frozen Poultry	107	188	124	139	168	208	218	188	226	269	356	318	317	161	293	282	302	287
Frozen Beef	84	159	47	42	63	88	110	121	213	97	164	149	160	133	108	134	213	265
Frozen Pork	58	286	116	152	179	314	176	205	210	134	123	97	297	255	241	293	359	355
Frozen Fruits and Juices	81	71	125	126	128	143	178	188	227	268	376	478	369	336	300	450	468	291
Frozen Vegetables	0	9	29	66	72	78	93	103	186	167	191	337	292	282	371	425	493	537
TOTAL	370	774	484	654	665	872	889	830	1217	996	1263	1407	1459	1201	1427	1689	1862	1807
Other (Estimated)	80	156	96	136	140	178	181	170	243	204	257	283	291	239	283	341	378	611
GRAND TOTAL	450	930	580	790	805	1050	1070	1000	1460	1200	1520	1690	1750	1440	1710	2030	2240	2418

Increases in the number of pounds produced as well as in storage holdings are brought about by two major factors: (1) Increased population and (2) increased per capita consumption. The increased population affects the consumption of all "freezer" items across the board. However, the per capita increases predominate in the fruit, juice and vegetable category. Table 5 compares the per capita consumption in 1940 and 1950 for these commodities.

TABLE 5 - COMPARISON OF PER CAPITA CONSUMPTION OF FROZEN FRUITS, JUICES AND VEGETABLES BETWEEN 1940 AND 1950

Item	Per Capita Consumption	
	1940	1950
Fruits and Juices	1.27 Lbs.	4.30 Lbs.
Vegetables	0.58 Lbs.	3.31 Lbs.

This further illustrates the fact that the fruit, juice and vegetable pack will have the greatest influence on requirements for "freezer" space. Since such space is largely located in public general refrigerated warehouses (Fig. A), this type of facility will be most sensitive to variations in annual production of such packs.

In view of the fact that "freezer" requirements are primarily related to production of the principal "freezer" commodities, the estimated future production was discussed with the interested Federal Agencies and industry representatives. The consensus of opinion appears to be as follows:

While consumption of frozen foods has continued to rise, the percentage of increase has declined during the past two years. It is not anticipated that the rate of consumption of fruits will increase between now and 1955, but vegetables should show a continual increase, although at a slower rate than in the past. However, military consumption of frozen foods has exceeded earlier estimates. The continuation of this trend would have no serious impact on storage during the spring and summer months of normal low occupancy; however, it would tend to further increase storage holdings in October, November and December, which is the period of peak occupancy for normal stocks, thus presenting potential difficulties.

Frozen concentrates have shown a major increase in production, and substantial increases can be expected. However, this increase in frozen concentrate production results in higher storage holdings during the spring, which historically has been a period of relatively low total freezer holdings in public warehouses. The increase in frozen concentrates, therefore, will not have too serious an impact on total space requirements in public refrigerated warehouses.

The demand for poultry is expected to continue as strong in 1953 as in 1952. While the sale of young birds and mature birds from farm flocks has materially decreased since 1943, this decrease has been more than offset by the tripling of specialized broiler production. Storage holdings of frozen poultry, which generally are close to the peak at year-end, have not differed materially for the past four years, and it is anticipated that these holdings will continue at about the same level.

While total meat output varies from year to year, storage requirements for frozen meats depend on a change in the percentage of meat frozen rather than from increased total production. With the possible exception of military procurements, it is not anticipated that the total volume of frozen meats will increase for other than increased population during the period of this study.

Between 1945 and 1951, the per capita freezer space in public general refrigerated warehouses increased from 1.19 cubic

feet to 1.43 cubic feet, or an increase of 20.17%. This represents an increase in capacity due to a greater per capita consumption and not due to increased population, since the increase in population is automatically taken into consideration by the required mathematical computation of determining per capita storage availability. On the basis of this trend, the per capita increase between now and 1955 should be 13.4% over the 1951 figure. However, since the rate of increase in consumption has recently been somewhat less than in the past, it is not expected that the per capita increase in "freezer" space will exceed 10% by 1955. This will result in the availability of approximately 1.57 cubic feet per person.

According to the population figures developed by the United States Department of Commerce, the estimated total population of the United States at 12:00 o'clock noon, April 29, 1953, was 159,249,820. That Department estimates that there is one birth every 9 seconds, one death every 21 seconds, one immigrant every 2 minutes, one emigrant every 17 minutes, with the resulting net gain in population of one person every 13 seconds. On this basis, the estimated population at midnight December 31, 1955, would be approximately 165 million. This means that during a calendar year, the equivalent of a city of approximately 2,500,000 population is added to the economy of this country. With an anticipated requirement of 1.57 cubic feet of public general freezer space per capita, it is concluded that 259 million gross cubic feet of freezer space will be required by December 31, 1955, in public general refrigerated warehouses.

SECTION V

CAPACITY AND OCCUPANCY OF COOLER STORAGE SPACE

Capacity

Storage space which can be maintained only at temperatures above 29° Fahrenheit is referred to as "cooler". Storage space which is convertible from "cooler" to "freezer" is classified at the lowest temperature at which the space can be maintained.

In the early history of the public general refrigerated warehousing industry, storage space was maintained almost completely at "cooler" temperatures, due mainly to the limitation which resulted from the use of ice as the refrigerant. With the advent of mechanical refrigeration, the use of lower temperatures became possible, but

nevertheless the predominant quantity of space continued to be held at temperatures within the "cooler" range. As techniques for freezing foods were improved and their use became more and more acceptable to the public, the emphasis in public general refrigerated warehouses has been shifting to the use of "freezer" space (See Sec. VI), and this shift has gained considerable momentum during the past twelve years. This trend does not indicate a lesser over-all need for "cooler" space, but that the expansion of public refrigerated warehouses has been primarily in "freezer" space.

While public refrigerated warehouses have somewhat reduced the amount of available "cooler" space since 1939, the private and semiprivate categories of refrigerated warehouses have increased the amount of such space. Public refrigerated warehouses, including public apple houses, show a decrease of 38 million cubic feet of "cooler" space between 1941 and 1951. During the same period, private and semiprivate general and apple warehouses, other than meat packing establishments, show an increase of 62 million cubic feet, or a net gain of "cooler" space to the extent of 24 million cubic feet. However, the reduction in "cooler" space in public general and meat packing warehouses resulted in a total over-all loss of 43 million cubic feet of "cooler" space between 1943 and 1951. Fig. H and Table 6 show the distribution of gross "cooler" storage space in all types of refrigerated warehouses from 1943 to 1951.

The continuing need for "cooler" space is also illustrated by Fig. J on page 34, which shows the number of pounds of commodities in "cooler" storage by month from 1946 to 1952 for all types of refrigerated warehouses.

It would appear from Fig. H and Table 6 that public refrigerated warehouses have reduced their available capacity of "cooler" space while private and semiprivate refrigerated warehouses have increased such capacity. However, it cannot be concluded that present operators of public general facilities actually reduced the amount of "cooler" space they previously operated to any appreciable extent. A part of this shift is undoubtedly due to the fact that many private and semiprivate warehouses made space available during World War II for the storage of government commodities and thus reported the space during that period as "public" space. Following the termination of hostilities, this service was discontinued and the reporting of such space has shifted to "private" or "semiprivate". Another factor that may have contributed to the apparent increase in private and semiprivate "cooler" space is the increased coverage obtained in later space surveys as against the earlier ones. However, it is not believed that the total effect of these two factors is of sufficient importance to materially distort the trend as reflected.

FIGURE "H"

DISTRIBUTION OF COOLER STORAGE SPACE BY TYPE
OF WAREHOUSE
1943 - 1951

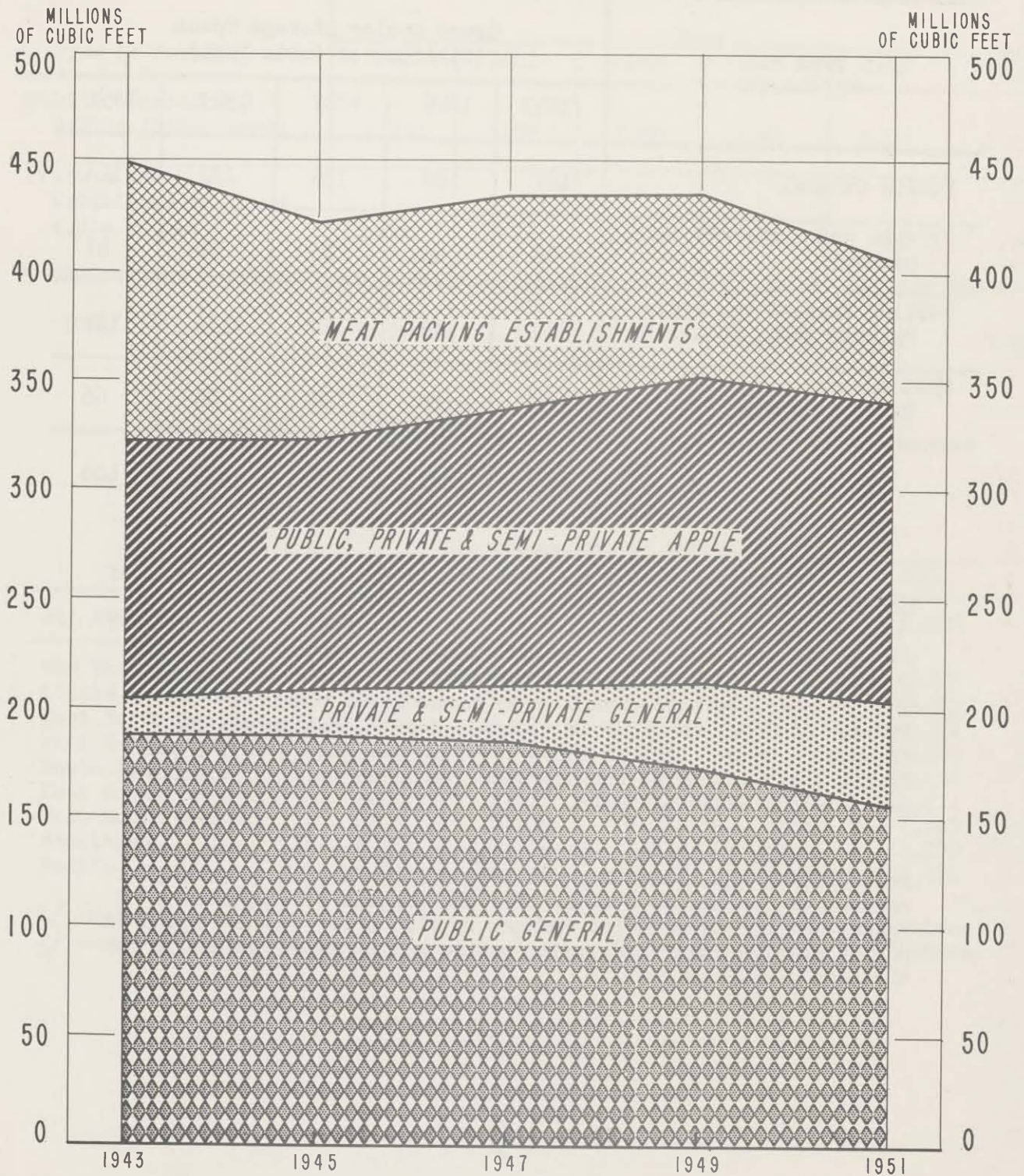


TABLE 6 - DISTRIBUTION OF COOLER STORAGE SPACE BY TYPE OF WAREHOUSE
AS OF OCTOBER 1943 THROUGH 1951

Type of Warehouse	Gross Cooler Storage Space (Millions of Cubic Feet)				
	1943	1945	1947	1949	1951
Public General	187	188	185	173	156
Private and Semi-Private General	16	20	25	39	47
Public, Private and Semi-Private Apple Houses	119	115	127	139	137
Meat Packing Establishments	127	100	97	85	66
TOTAL	449	423	434	436	406

Notwithstanding the increase in the number of pounds of commodities in "cooler" storage, the per capita availability of "cooler" space has decreased from 2.39 cubic feet in 1941 to 2.22 cubic feet in 1951, and it therefore has not kept pace with the growing population of the United States. It would thus appear that the per capita consumption of commodities requiring "cooler" storage is down, and this is probably due to greater use of "freezer" items. Table 7 shows the biennial change in the per capita availability of cooler space from 1941 to 1951, excluding meat packing establishments.

The change in availability of "cooler" space in public refrigerated warehouses has not been uniform in all geographical regions of the United States. For the purpose of comparison, Table 8 shows the biennial changes by region of "cooler" space in public refrigerated warehouses, public apple houses included, for the period 1943 to 1951.

TABLE 7 - NUMBER OF CUBIC FEET OF "COOLER" REFRIGERATED STORAGE SPACE
AVAILABLE PER PERSON IN THE UNITED STATES, EXCLUDING MEAT
PACKING ESTABLISHMENTS, 1941 - 1951

Type of Facility	Year					
	1941	1943	1945	1947	1949	1951
Public General and Public Apple Houses	1.83	1.82	1.69	1.61	1.49	1.34
Private and Semi- Private General and Apple Houses	.56	.55	.62	.72	.87	.88
TOTAL	2.39	2.37	2.31	2.33	2.36	2.22

TABLE 8 - TOTAL GROSS "COOLER" STORAGE SPACE IN PUBLIC GENERAL
REFRIGERATED WAREHOUSES AND PUBLIC APPLE HOUSES
BY REGIONS, 1943 - 1951

Region	YEAR (Thousands of Cubic Feet)				
	1943	1945	1947	1949	1951
ALL REGIONS	247,041	237,232	232,332	221,721	204,558
New England	7,525	6,454	6,140	5,469	5,006
Middle Atlantic	73,847	71,371	66,525	70,015	60,285
East North Central	53,834	56,625	55,055	43,679	42,074
West North Central	17,354	16,535	16,173	16,381	14,460
South Atlantic	29,182	31,551	32,566	31,592	29,516
East South Central	6,224	5,557	5,517	5,871	4,711
West South Central	9,857	9,044	9,028 ^{1/}	7,689	7,703 ^{1/}
Mountain	2,898	2,852	2,699 ^{2/}	2,455	2,189 ^{2/}
Pacific	46,320	37,243	38,629	38,570	38,614

^{1/} Includes a small amount of space in apple houses in the Mountain Region.

^{2/} Does not include the small amount of space included in Footnote ^{1/} above.

TABLE 9 - DISTRIBUTION OF "COOLER" STORAGE SPACE BETWEEN PUBLIC GENERAL REFRIGERATED WAREHOUSES AND PUBLIC APPLE HOUSES, BY REGIONS, AS OF OCTOBER 1, 1951

Region	GROSS SPACE		
	(Thousands of Cubic Feet)		
	Public General	Public Apple	TOTAL
ALL REGIONS	156,141	48,417	204,558
New England	4,298	708	5,006
Middle Atlantic	47,175	13,110	60,285
East North Central	38,464	3,610	42,074
West North Central	13,855	605	14,460
South Atlantic	14,402	15,114	29,516
East South Central	4,711	-	4,711
West South Central	7,538	165 ^{1/}	7,703 ^{1/}
Mountain	2,189	- ^{2/}	2,189 ^{2/}
Pacific	23,509	15,105	38,614

^{1/} Includes a small amount of space in apple houses in the Mountain Region.

^{2/} Does not include the small amount of space included in Footnote ^{1/} above.

Occupancy of "Cooler" Space

The occupancy of "cooler" storage space in public general refrigerated warehouses has remained comparatively low since before World War II. During the war there were a few times when the occupancy went above 80% but this did not last for any prolonged period of time and, generally speaking, such occupancy has remained well below the 80% figure. Table 10 and Fig. I show the reported percentage of occupancy of "cooler" space in public general refrigerated warehouses.

TABLE 10 - PERCENTAGE OF OCCUPANCY OF "COOLER" STORAGE SPACE IN PUBLIC GENERAL REFRIGERATED WAREHOUSES, 1946 - 1952

Month	Year						
	(Occupancy expressed in Percentage)						
	1946	1947	1948	1949	1950	1951	1952
January	60	65	69	52	59	65	59
February	62	62	65	48	55	60	57
March	67	61	59	48	54	60	59
April	75	65	62	49	54	59	59
May	77	68	65	50	56	62	61
June	79	74	67	52	60	65	63
July	76	77	67	53	61	64	63
August	80	76	65	53	64	65	63
September	78	73	64	60	63	65	65
October	80	76	64	68	72	69	69
November	77	78	59	67	71	66	68
December	69	74	54	64	67	63	64
Annual Average	73.3	70.8	63.3	55.3	61.3	63.6	62.5

By comparing Fig. H with the percentage of occupancy figures in Table 10, it will be noted that the sharp decline in available "cooler" space in public general refrigerated warehouses (Fig. H), which started in 1949, corresponds with the low annual average occupancy in 1949 (Table 10). However, percentage figures do not always reveal the actual trend because of the variations in the amount of available space. Fig. J shows the number of pounds of commodities in "cooler" storage by month from 1946 to 1952 for all types of warehouses.

FIGURE "I"

PERCENTAGE OF OCCUPANCY OF COOLER STORAGE SPACE IN
PUBLIC GENERAL REFRIGERATED WAREHOUSES
1946 - 1952

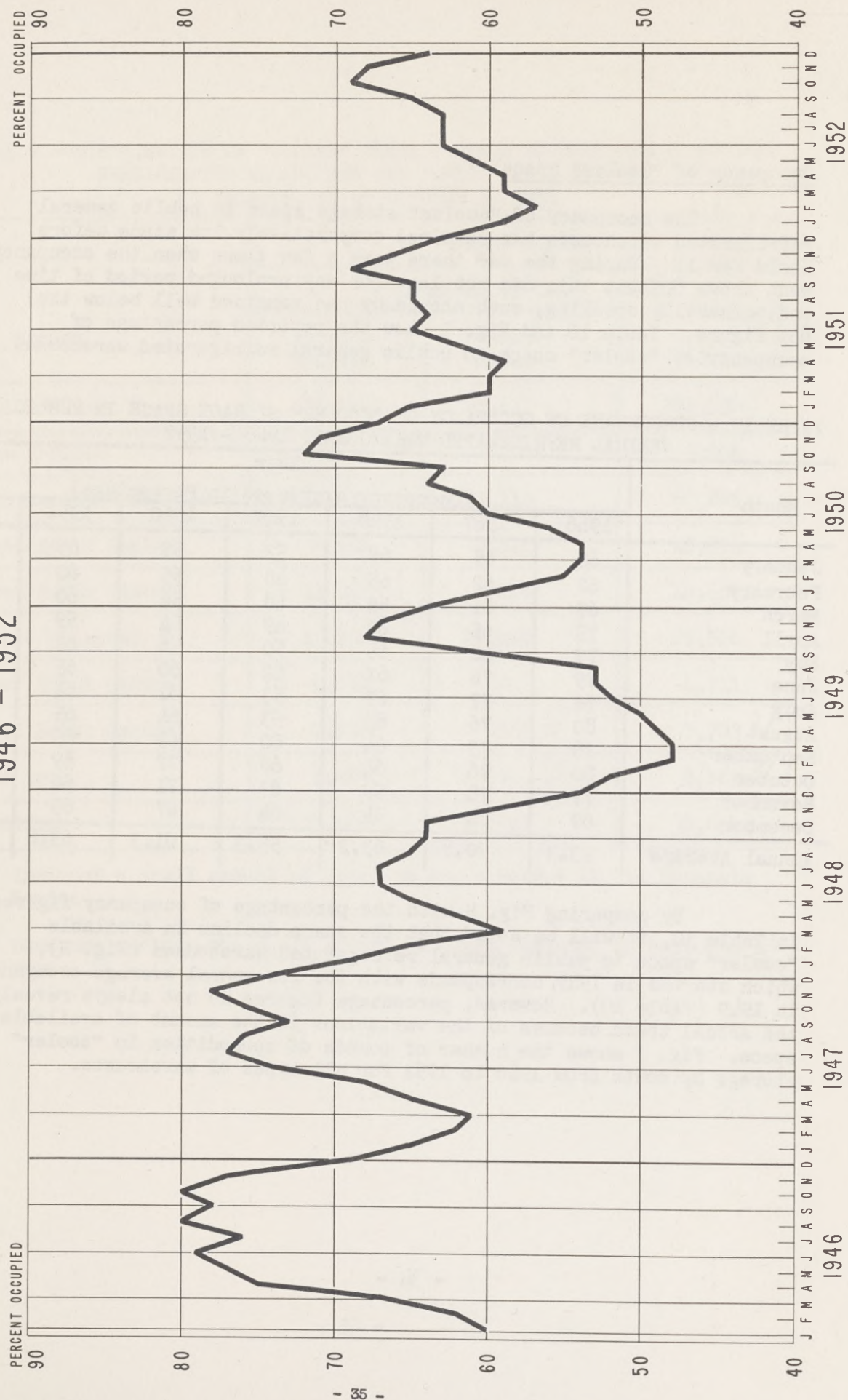
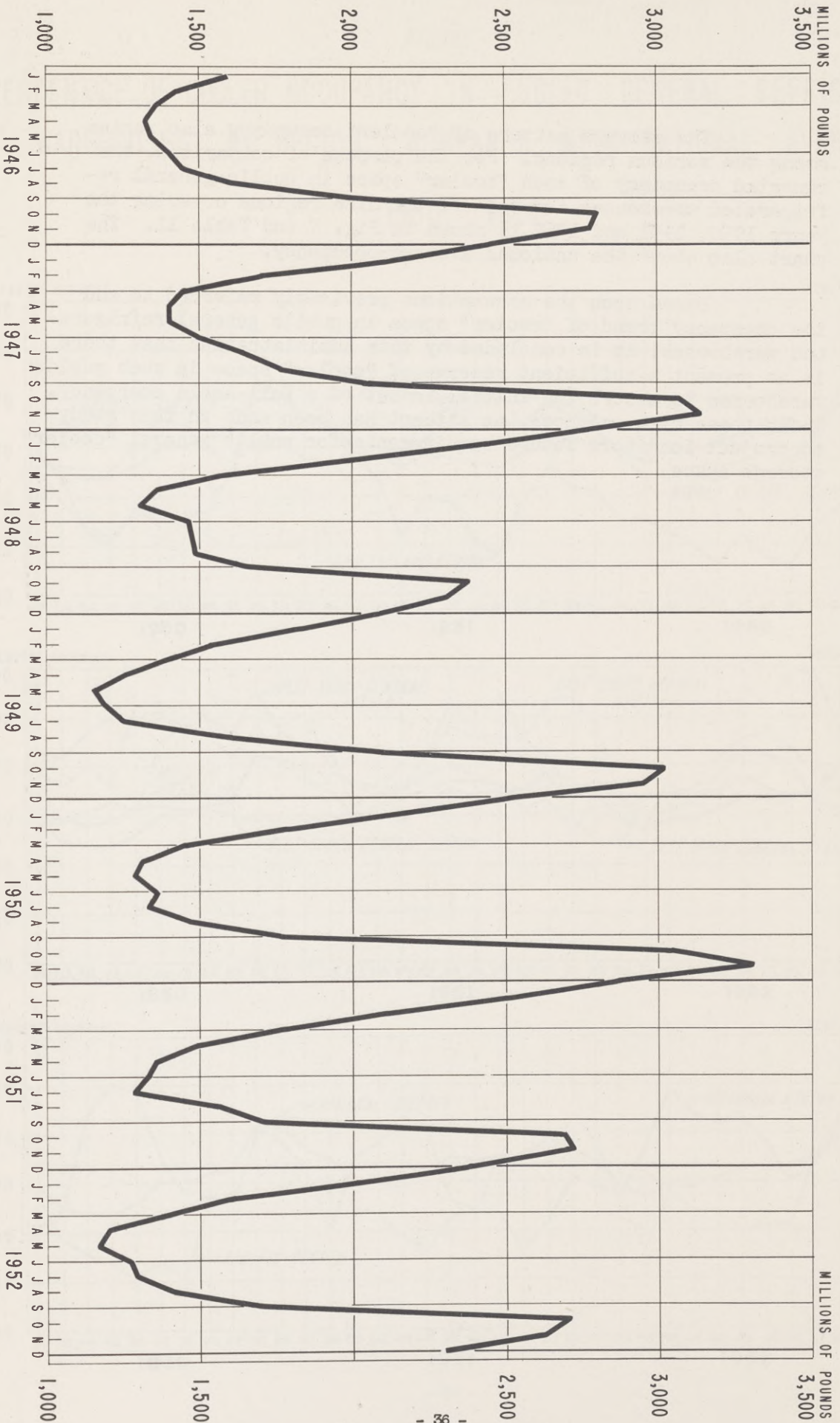


FIGURE "J"

TOTAL WEIGHT OF COOLER COMMODITIES IN ALL TYPES OF WAREHOUSES
AT END OF MONTH, 1946 - 1952



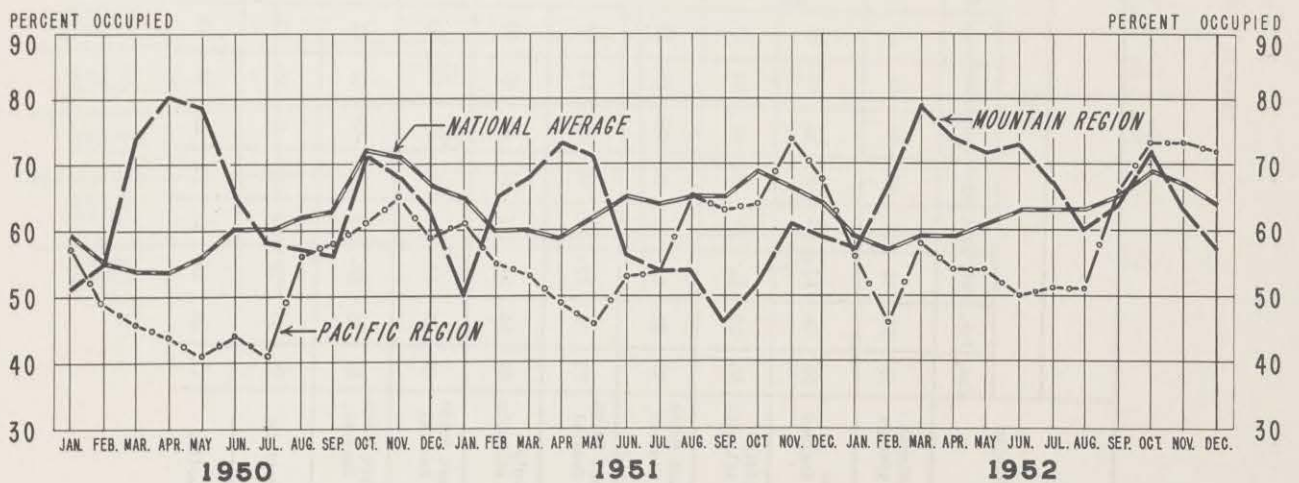
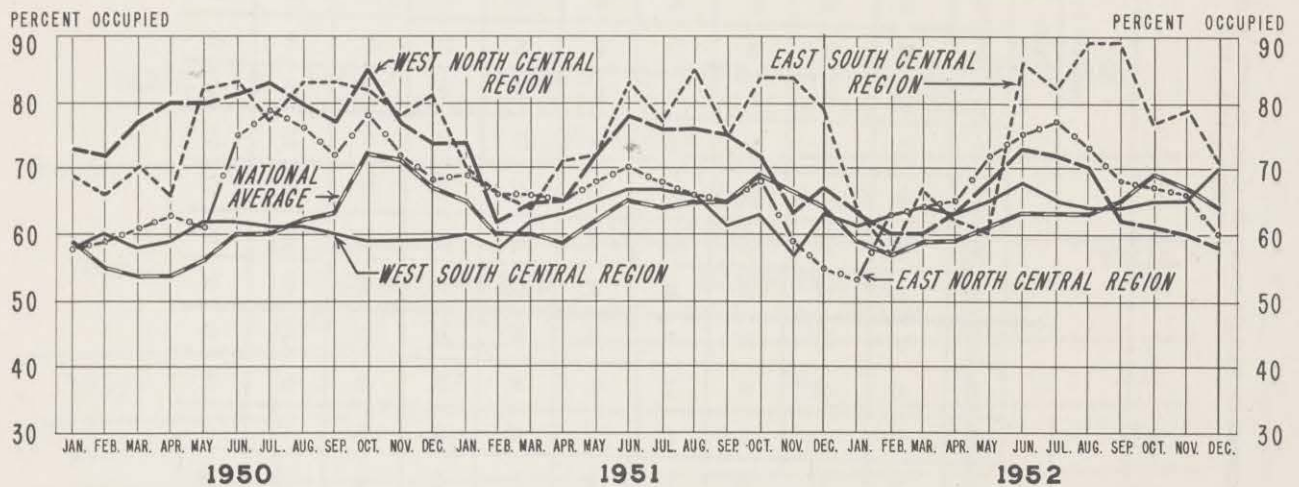
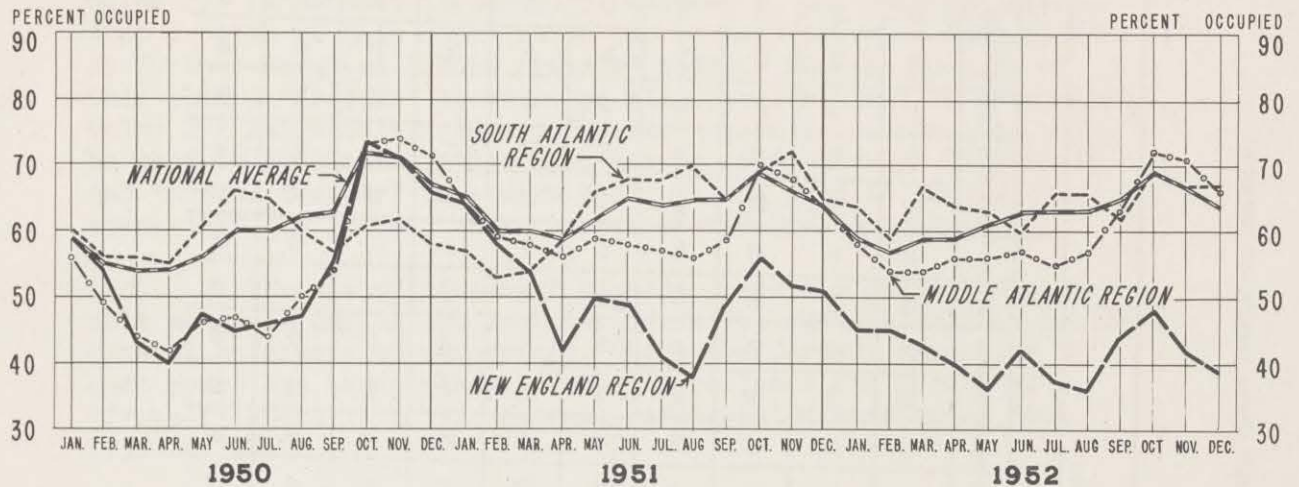
The storage pattern of "cooler" occupancy also varies among the various regions. For the purpose of comparison, the reported occupancy of such "cooler" space in public general refrigerated warehouses for each of the nine regions covering the years 1950, 1951 and 1952 is shown in Fig. K and Table 11. The chart also shows the national average occupancy.

Based upon the assumptions previously referred to and the occupancy trend of "cooler" space in public general refrigerated warehouses, it is concluded by this Administration that there is at present a sufficient reserve of "cooler" space in such public warehouses to absorb the initial impact of a full-scale emergency. Under these circumstances, no attempt has been made in this study to project long term future requirements for public general "cooler" storage space.

FIGURE "K"

PERCENTAGE OF COOLER OCCUPANCY IN PUBLIC GENERAL REFRIGERATED WAREHOUSES, BY REGION, COMPARED WITH NATIONAL AVERAGE

1950 - 1952



SECTION VI

CAPACITY AND OCCUPANCY OF FREEZER SPACE

Capacity

All storage space capable of maintaining temperatures below 29° Fahrenheit is commonly referred to as "freezer" space. That portion of this space which can be held below 0° Fahrenheit is further known as "sharp freezer" space. For the purpose of this study, "freezer" space means all space that can be maintained below 29° Fahrenheit. "Sharp freezer" space is a term that will be used to denote the space that can be held below 0° Fahrenheit and "normal freezer" is a term that will be used to denote the space that can be held only between 0° and 29° Fahrenheit.

The use of "freezer" storage space has gained considerable momentum during the last twelve years, particularly in public general refrigerated warehouses, where the largest expansion of such space has taken place. Table 12 reflects the growth of "freezer" space in public general refrigerated warehouses from 1939 to 1951.

TABLE 12 - CAPACITY OF "FREEZER" STORAGE SPACE IN PUBLIC GENERAL REFRIGERATED WAREHOUSES AND PUBLIC APPLE HOUSES
1939 - 1951

Year	GROSS SPACE (Millions of Cubic Feet)		TOTAL
	NORMAL FREEZER Above 0° through 29° F.	SHARP FREEZER 0° F. and Below	
1939	42	66	108
1941	45	84	129
1943	57	86	143
1945	56	110	166
1947	59	117	176
1949	57	134	191
1951	51	169	220

As previously indicated, the expansion of "freezer" space has occurred primarily in public general refrigerated warehouses. Table 13, which shows the gross "freezer" storage space in all types of warehouses except meat packing plants from 1941 to 1951, is included for comparison with Table 12 in order to illustrate this growth.

TABLE 13 - CAPACITY OF "FREEZER" STORAGE SPACE BY TYPE OF FACILITY
1941 - 1951

Year	Gross Refrigerated Storage Space (Millions of Cubic Feet)						Total Space
	Public Facilities			Private and Semi-Private Facilities ^{1/}			
	General Warehouses	Apple Houses	Total	General Warehouses	Apple Houses	Total	
1941	←129→		129	←13→		18	147
1943	142	1	143	16	-	16	159
1945	163	3	166	20	1	21	187
1947	174	2	176	27	4	31	207
1949	189	2	191	41	1	42	233
1951	218	2	220	47	4	51	271

^{1/} Does not include Meat Packing Establishments.

The public refrigerated warehousemen have not only increased the total amount of available "freezer" space but, with respect to "sharp freezer", they have more than doubled the per capita availability since 1939. The per capita amount of "normal freezer" space, however, has remained almost constant, which means that this classification of space has just about kept pace with the increasing population. Table 14 shows the per capita increase of "freezer" and "sharp freezer" space from 1939 to 1951 in public general refrigerated warehouses.

TABLE 14 - PER CAPITA GROSS CUBIC FEET OF "FREEZER" STORAGE SPACE
IN PUBLIC REFRIGERATED WAREHOUSES
1939 - 1951

Type of Space	YEAR (Cubic Feet Per Person)						
	1939	1941	1943	1945	1947	1949	1951
Normal Freezer (0° to 29° F.)	0.32	0.34	0.42	0.40	0.41	0.38	0.33
Sharp Freezer (0° F. and Below)	0.50	0.63	0.63	0.79	0.81	0.90	1.10

Since private and semiprivate facilities also show increases in "sharp freezer" space, the per capita increase in "sharp freezer" space would indicate an increasing demand and consumption of foods which require temperatures below 0° Fahrenheit. This fact is further supported by an analysis of new construction in 1952 of public general refrigerated warehouses. The facilities constructed in that year were almost entirely in the "freezer" category, and by far the greatest percentage was space that is either operated as, or can be converted to operation as, "sharp freezer".

It might also be of interest to note the distribution of this increase in "normal freezer" and "sharp freezer" space among the various geographical regions. Table 15 shows the biennial change, by region, of "normal freezer" and "sharp freezer" space in public general refrigerated warehouses and public apple houses from 1943 to 1951. This Table includes figures for both public general warehouses and public apple houses. However, it should be noted that public apple houses maintain only a small amount of "freezer" space. This is illustrated by Table 16, which shows the distribution of "normal freezer" and "sharp freezer" storage space between public general refrigerated warehouses and public apple houses as of October 1, 1951.

TABLE 15 - GROSS FREEZER STORAGE SPACE IN PUBLIC GENERAL REFRIGERATED WAREHOUSES
AND PUBLIC APPLE HOUSES, BY REGION, 1943 - 1951

Region	Year and Classification of Space (Thousands of Gross Cubic Feet)									
	1943		1945		1947		1949		1951	
	Below 0° F.	0° to 29° F.	Below 0° F.	0° to 29° F.	Below 0° F.	0° to 29° F.	Below 0° F.	0° to 29° F.	Below 0° F.	0° to 29° F.
ALL REGIONS	86,245	56,705	110,448	56,152	116,957	58,943	134,296	57,239	169,388	51,168
New England	7,016	1,091	7,818	1,286	5,966	3,409	8,442	5,581	12,680	3,106
Middle Atlantic	26,478	13,783	29,156	14,589	35,253	13,926	33,414	14,083	41,870	10,632
East North Central	22,945	10,886	30,739	9,585	27,942	12,789	30,000	7,599	30,419	8,192
West North Central	15,604	5,354	19,119	3,390	19,503	2,833	20,268	3,720	21,800	3,180
South Atlantic	1,318	6,897	3,170	4,994	3,967	5,383	5,322	5,775	12,784	6,683
East South Central	1,621	1,349	2,932	2,004	3,497	1,634	3,605	1,827	4,983	1,676
West South Central	2,344	2,944	3,707	3,393	4,478	2,161 ^{1/}	12,167	2,481	13,787 ^{1/}	2,136
Mountain	1,156	1,344	1,715	1,614	1,726	1,628 ^{2/}	3,583	744	4,325 ^{2/}	238
Pacific	7,763	13,057	12,092	15,297	14,625	15,180	17,495	15,429	26,740	15,325

^{1/} Includes a small amount of space in public Apple Houses in the Mountain Region.

^{2/} Does not include space included in Footnote ^{1/} above.

TABLE 16 - GROSS FREEZER STORAGE SPACE IN PUBLIC GENERAL REFRIGERATED
WAREHOUSES AND PUBLIC APPLE HOUSES, BY CLASSIFICATION OF
SPACE AND BY REGION, AS OF OCTOBER 1, 1951

Region	Type and Classification of Space (Thousands of Cubic Feet)					
	Public General		Public Apple		Total	
	Below 0° F.	0° to 29° F.	Below 0° F.	0° to 29° F.	Below 0° F.	0° to 29° F.
ALL REGIONS	168,634	50,171	754	997	169,388	51,168
New England	12,673	3,106	7	-	12,680	3,106
Middle Atlantic	41,558	10,345	312	287	41,870	10,632
East North Central	30,389	8,159	30	33	30,419	8,192
West North Central	21,800	3,180	-	-	21,800	3,180
South Atlantic	12,499	6,111	285	572	12,784	6,683
East South Central	4,983	1,676	-	-	4,983	1,676
West South Central	13,776	2,136	11 <u>1/</u>	-	13,787 <u>1/</u>	2,136
Mountain	4,325	238	- <u>2/</u>	-	4,325 <u>2/</u>	238
Pacific	26,631	15,220	109	105	26,740	15,325

1/ Includes a small amount of space in public Apple Houses in the Mountain Region.

2/ Does not include space included in Footnote 1/ above.

Occupancy of "Freezer" Storage

The occupancy of "freezer" storage space since just before World War II in public general refrigerated warehouses has been relatively high, and even during the post war years, except 1948 and 1949, the national average went above 80% during the peak storage season of the year. In some major cities the occupancy often went well above 90% during these same years. Table 17 reflects the biennial occupancy of "freezer" space in public general refrigerated warehouses during the peak storage period for the years 1941 through 1951.

TABLE 17 - HIGHEST REPORTED OCCUPANCY OF FREEZER STORAGE SPACE
IN PUBLIC GENERAL REFRIGERATED WAREHOUSES, INCLUDING
APPLE HOUSES, 1941 - 1951

Year	Gross Space Operated	Maximum Gross Space Occupied	Per Cent Occupied
	Millions of Cubic Feet		
1941	129	99	76.7
1943	143	129	90.2
1945	166	141	84.9
1947	176	150	85.2
1949	191	145	75.9
1951	220	182	82.7

The occupancy of "freezer" space usually reaches its peak during the period from October through January, and the trend is starting a shift from the earlier part of this period to the latter. This trend is evident in Table 18 and Fig. L, which show the percentage of "freezer" occupancy, by month, for 1946 to 1952.

TABLE 18 - PERCENTAGE OF FREEZER SPACE OCCUPANCY AT END OF MONTH
IN PUBLIC GENERAL REFRIGERATED WAREHOUSES,
1946 - 1952

Month	Year and Percentage of Occupancy						
	1946	1947	1948	1949	1950	1951	1952
January	83	84	84	71	75	80	81
February	81	82	81	68	74	76	81
March	80	80	75	64	69	72	78
April	79	73	70	60	67	70	76
May	80	74	70	59	64	71	77
June	80	78	71	61	69	73	77
July	86	79	72	63	71	76	78
August	88	80	72	66	74	78	78
September	87	81	71	67	74	81	77
October	87	83	72	70	78	83	78
November	85	84	72	73	79	83	78
December	86	85	72	76	81	83	78
ANNUAL AVERAGE	83.5	80.3	73.5	66.5	72.9	77.2	78.1

As was the case in "cooler" space, percentage of occupancy figures alone may sometimes distort the picture with respect to use of refrigerated storage because of the increasing amount of space available. Therefore, the continuing increased use of such facilities is perhaps better illustrated by Table 19 and Fig. M, which compare the number of pounds of commodities in storage for the year 1946 with 1951. This Table and Figure include holdings in all types of refrigerated warehouses in order to give a more comprehensive view of the entire situation.

FIGURE "L"
 PERCENTAGE OF OCCUPANCY OF FREEZER STORAGE SPACE IN
 PUBLIC GENERAL REFRIGERATED WAREHOUSES
 1946 - 1952

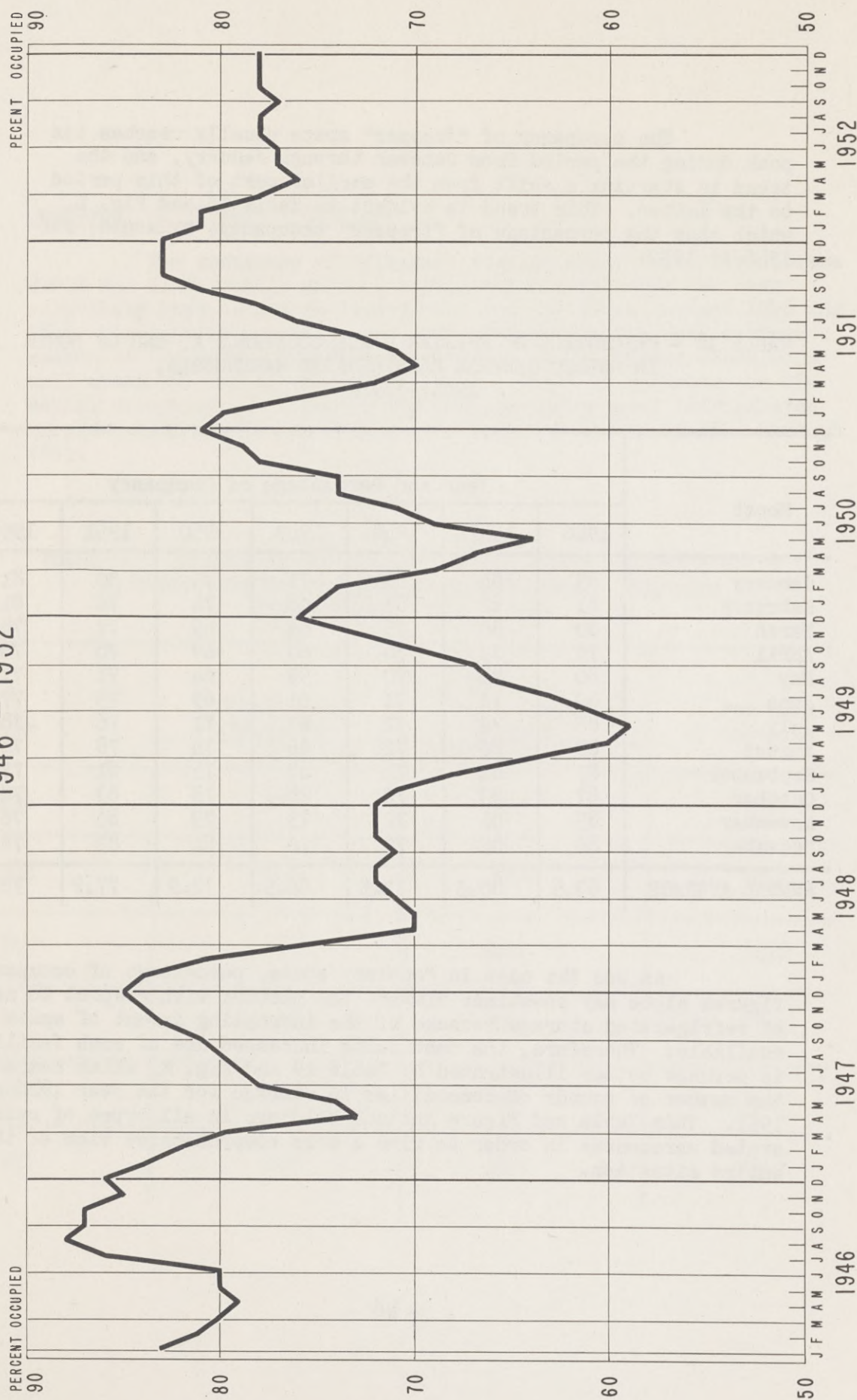
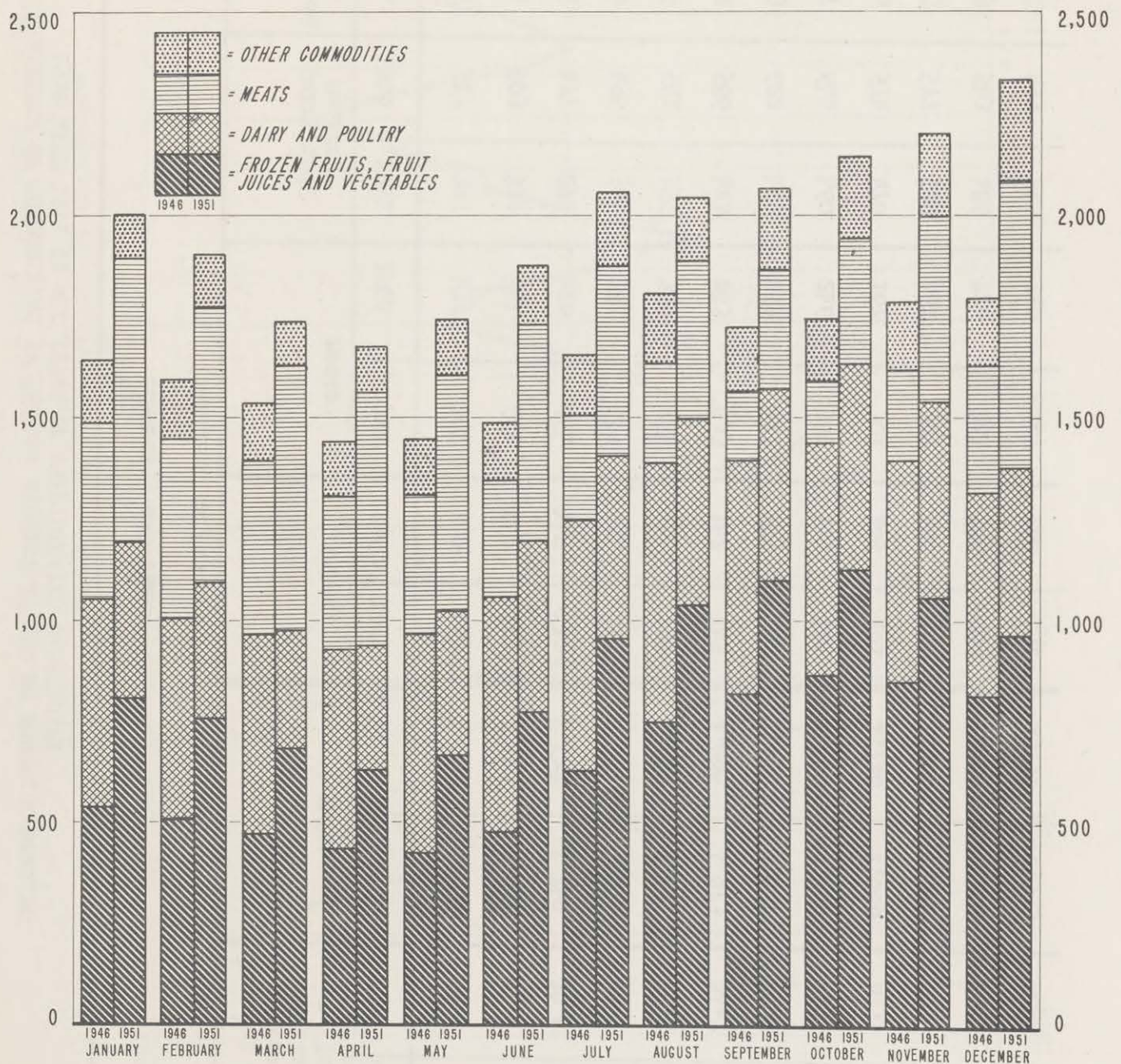


TABLE 19 - WEIGHTS OF COMMODITIES IN FREEZER STORAGE AT END OF MONTH, COMPARING
1946 WITH 1951 IN ALL TYPES OF REFRIGERATED WAREHOUSES

Month	COMMODITY AND YEAR (Millions of Pounds)											
	Fruits, Fruit Juices and Vegetables		Dairy and Poultry		Meats		Other		TOTAL		Percent Fruits, Juices and Vegetables to Total	
	1946	1951	1946	1951	1946	1951	1946	1951	1946	1951	1946	1951
January	535	804	517	393	433	701	160	161	1,645	2,059	32.5	39.0
February	500	754	503	339	441	681	149	133	1,593	1,907	31.4	39.5
March	469	681	497	292	426	654	145	113	1,537	1,740	30.5	39.1
April	431	629	495	304	381	629	134	113	1,441	1,675	29.9	37.6
May	423	666	541	355	345	584	140	136	1,449	1,741	29.2	38.3
June	473	772	586	423	283	533	142	145	1,484	1,873	31.9	41.2
July	626	953	622	452	253	471	155	181	1,656	2,057	37.8	46.3
August	744	1,037	644	460	246	387	175	161	1,809	2,045	41.1	50.7
September	820	1,094	574	470	167	301	165	201	1,726	2,066	47.5	53.0
October	862	1,125	577	509	151	307	156	208	1,746	2,149	49.4	52.3
November	849	1,053	543	486	224	461	166	203	1,782	2,203	47.6	47.8
December	814	961	499	413	316	707	168	252	1,797	2,333	45.3	41.2

FIGURE "M"

WEIGHTS OF COMMODITIES IN FREEZER STORAGE AT END OF MONTH,
COMPARING 1946 WITH 1951 IN ALL TYPES
OF REFRIGERATED WAREHOUSES



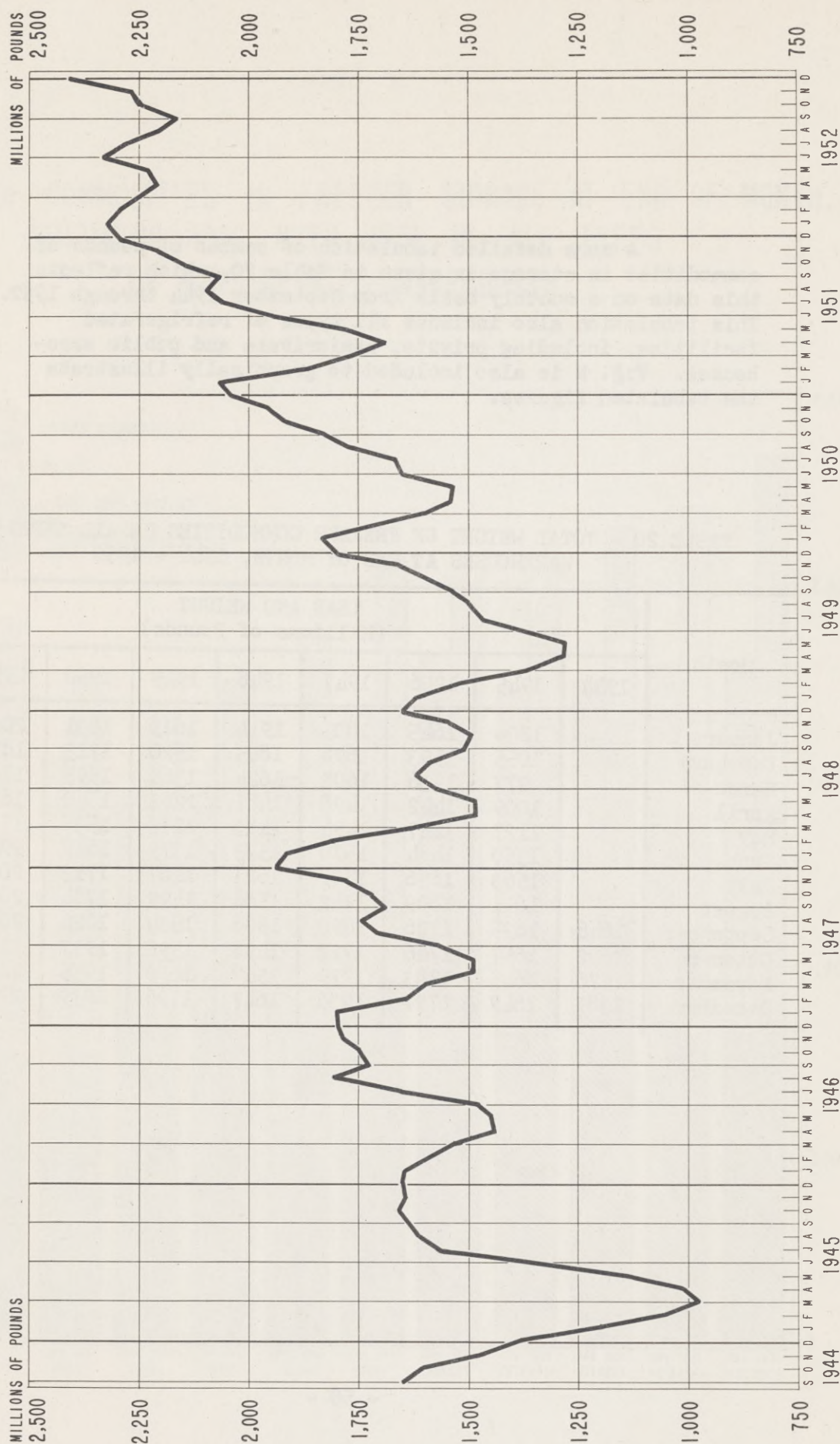
A more detailed tabulation of number of pounds of commodities in storage is given in Table 20, which reflects this data on a monthly basis from September 1944 through 1952. This tabulation also includes all types of refrigerated facilities, including private, semiprivate and public warehouses. Fig. N is also included to graphically illustrate the tabulated figures.

TABLE 20 - TOTAL WEIGHT OF FREEZER COMMODITIES IN ALL TYPES OF WAREHOUSES AT END OF MONTH, 1944 - 1952

Month	YEAR AND WEIGHT (Millions of Pounds)								
	1944	1945	1946	1947	1948	1949	1950	1951	1952
January		1200	1645	1801	1914	1615	1831	2062	2333
February		1055	1593	1692	1805	1520	1713	1871	2295
March		977	1536	1603	1624	1365	1595	1762	2251
April		1009	1442	1498	1481	1282	1540	1686	2216
May		1127	1447	1494	1483	1279	1535	1775	2231
June		1350	1484	1570	1573	1379	1649	1945	2330
July		1563	1656	1707	1621	1467	1713	2049	2288
August		1611	1809	1742	1588	1499	1774	2094	2207
September	1648	1635	1726	1690	1506	1534	1826	2066	2163
October	1602	1657	1746	1722	1498	1592	1917	2149	2245
November	1476	1645	1783	1779	1547	1656	1955	2219	2266
December	1387	1649	1797	1936	1647	1796	2039	2291	2418

FIGURE "N"

TOTAL WEIGHT OF FREEZER COMMODITIES IN ALL TYPES OF WAREHOUSES AT END OF MONTH, 1944 - 1952



A comparison of "freezer" occupancy with "cooler" space clearly indicates the substantially higher occupancy of "freezer" facilities. The peak occupancy for "freezer" space occurred in February 1944 when an all-time high of 92% was recorded. However, it should be noted that due to increased availability of "freezer" space the volume of commodities in storage has increased by the end of 1952 even though the percentage of occupancy was lower than in February 1944.

As of December 31, 1951, which was the peak period for that year, the over-all occupancy for "freezer" space was 83%. However, seven of the nine regions reported an occupancy above the national average.

The occupancy pattern of the different geographical regions differs, and for purposes of comparison, Table 21 shows the occupancy of "freezer" space in public general refrigerated warehouses by region for the years 1950, 1951 and 1952.

Figure 0 shows the occupancy for each region as compared with the national average.

It should be noted that, with the exception of the West South Central Region, all regions recorded a peak occupancy of "freezer" space at some time during 1952 of at least 85%. It is also of interest that within each regional area the occupancy rate of "freezer" space in the larger metropolitan areas was above the average for the region. This would indicate that the lower occupancy generally occurs in the smaller cities and in the rural areas. Thus, even though over-all occupancy figures might appear to indicate the availability of some space, such space may well be out of line with normal distribution channels and may not be usable without increasing the workload on the transportation system.

Approximately 45.5% of the total "freezer" space in public general refrigerated warehouses is located in 18 cities. On December 31, 1952, each of these cities, except Cleveland and Kansas City, showed an occupancy of 83% or higher, and 5 cities showed occupancy of 90% or over. Table 22 shows the 18 cities and their reported occupancy of "freezer" space, quarterly, from December 1951 to December 1952.

TABLE 21 - PERCENTAGE OF FREEZER OCCUPANCY IN PUBLIC GENERAL REFRIGERATED WAREHOUSES,
BY MONTH, 1950 - 1952

Region	Year and Month																																				
	1950												1951												1952												
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
National Average	75	74	69	67	64	69	71	73	74	78	79	81	80	76	72	69	71	73	76	78	81	83	83	83	81	81	77	76	77	77	78	78	78	78	78	78	78
New England	84	80	68	67	65	69	64	70	76	72	77	87	88	84	76	69	68	70	80	82	90	92	91	92	83	81	78	74	75	74	72	73	77	78	75	76	76
Middle Atlantic	71	72	65	60	61	64	71	77	81	87	87	85	82	77	73	68	71	73	80	83	84	87	87	85	82	79	74	74	76	79	80	83	85	85	85	85	82
East North Central	71	75	71	71	61	68	69	69	72	77	79	84	86	80	76	74	77	77	78	78	79	84	83	83	85	86	85	83	83	81	81	81	80	82	82	82	80
West North Central	83	83	82	84	82	86	85	80	75	76	76	85	88	84	84	84	84	84	80	76	71	71	78	86	87	90	91	90	88	88	79	71	63	62	67	78	78
South Atlantic	77	74	72	71	73	75	73	68	71	75	69	80	81	77	78	76	78	80	78	82	79	87	88	89	86	84	81	83	80	79	79	73	72	72	69	70	70
East South Central	82	80	81	80	89	90	80	85	86	86	84	83	80	78	77	77	89	88	87	86	87	89	89	90	92	88	69	84	94	94	92	89	86	87	88	88	88
West South Central	58	58	59	60	59	59	58	58	58	59	61	60	62	61	60	57	61	61	62	61	62	65	65	64	63	63	61	62	64	65	63	61	60	59	59	62	62
Mountain	80	78	72	72	65	65	77	81	80	81	83	88	71	73	67	69	63	58	69	72	84	86	92	92	90	91	88	87	85	78	76	80	87	78	78	78	78
Pacific	75	68	64	59	55	63	67	76	72	78	79	76	72	66	61	57	54	64	70	75	84	86	80	80	75	74	68	62	63	65	74	79	85	83	82	80	80

FIGURE "O"

PERCENTAGE OF FREEZER OCCUPANCY IN PUBLIC GENERAL REFRIGERATED WAREHOUSES, BY REGION, COMPARED WITH NATIONAL AVERAGE 1950 - 1952

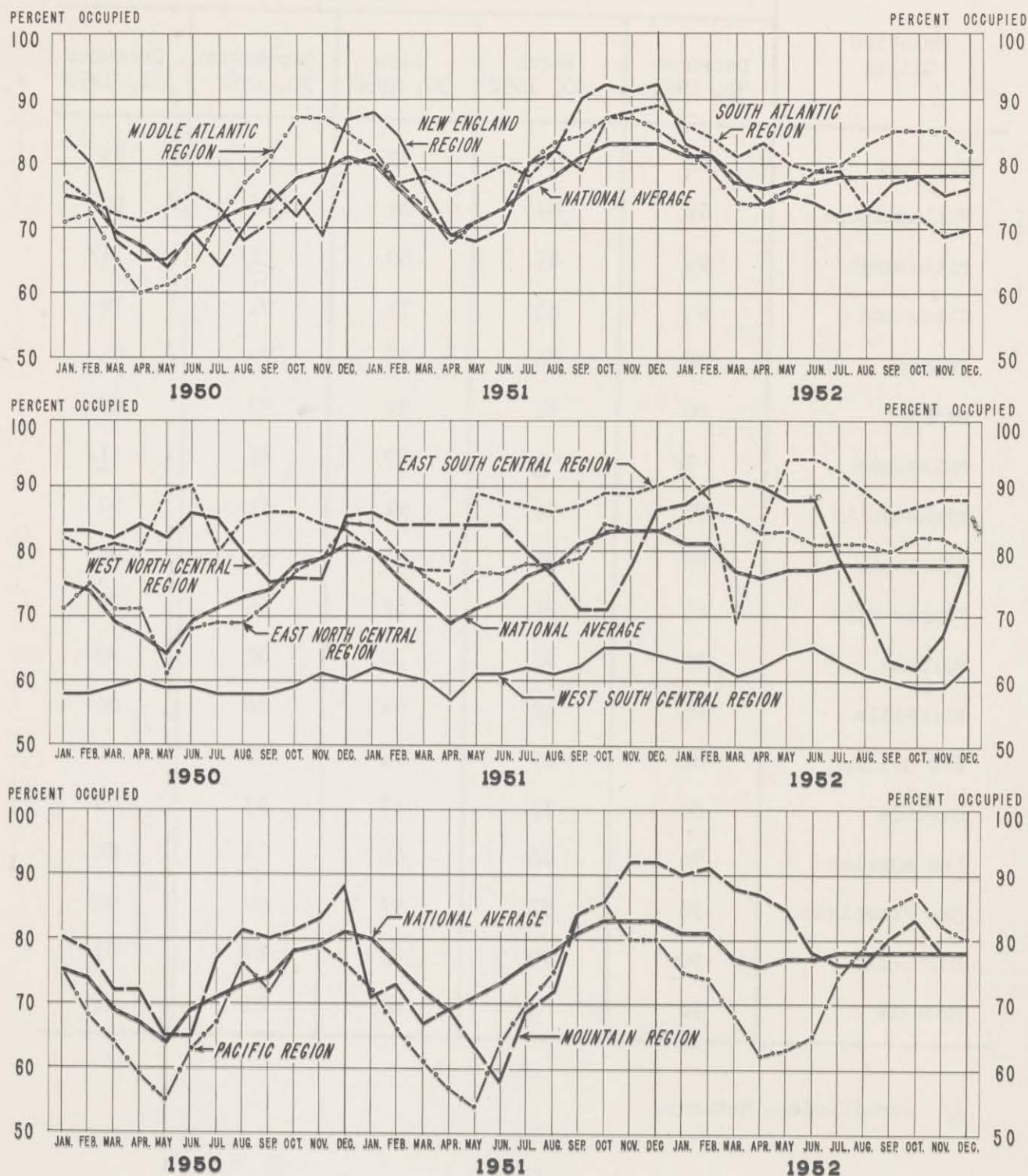


TABLE 22 - OCCUPANCY OF FREEZER SPACE IN PUBLIC GENERAL REFRIGERATED
WAREHOUSES IN SELECTED CITIES

Selected Cities	DATE AND PERCENTAGE OF OCCUPANCY				
	December 31, 1951	March 30, 1952	June 30, 1952	September 30, 1952	December 31, 1952
New York	82	80	89	85	83
Philadelphia	87	85	87	86	90
Pittsburgh	95	85	89	<u>1/</u>	<u>1/</u>
Cleveland	93	83	77	91	78
Chicago	78	86	78	70	84
Detroit	90	84	89	92	87
Milwaukee	<u>1/</u>	<u>1/</u>	89	85	<u>1/</u>
Minneapolis	93	96	91	81	93
St. Louis	85	94	93	59	88
Kansas City	85	85	87	65	79
Norfolk	95	91	42	82	90
Nashville	84	40	91	86	86
New Orleans	80	95	94	85	90
Seattle	88	74	67	93	88
Los Angeles	94	86	84	88	82
San Francisco	96	97	97	98	94
San Jose	90	74	81	87	91
Modesto	92	<u>1/</u>	62	61	85

1/ Insufficient Returns.

Based upon the assumptions previously referred to and the occupancy trend of "freezer" space in public general refrigerated warehouses, it is concluded by the Defense Transport Administration that by the end of 1955 the requirement for such public "freezer" space will be 259 million gross cubic feet, which represents an expansion of approximately 30 million gross cubic feet over the amount in operation at the end of 1952.

The following table shows the results of the experiments conducted on the 1st, 2nd, 3rd, 4th, 5th, 6th, 7th, 8th, 9th, 10th, 11th, 12th, 13th, 14th, 15th, 16th, 17th, 18th, 19th, 20th, 21st, 22nd, 23rd, 24th, 25th, 26th, 27th, 28th, 29th, 30th, 31st, 32nd, 33rd, 34th, 35th, 36th, 37th, 38th, 39th, 40th, 41st, 42nd, 43rd, 44th, 45th, 46th, 47th, 48th, 49th, 50th, 51st, 52nd, 53rd, 54th, 55th, 56th, 57th, 58th, 59th, 60th, 61st, 62nd, 63rd, 64th, 65th, 66th, 67th, 68th, 69th, 70th, 71st, 72nd, 73rd, 74th, 75th, 76th, 77th, 78th, 79th, 80th, 81st, 82nd, 83rd, 84th, 85th, 86th, 87th, 88th, 89th, 90th, 91st, 92nd, 93rd, 94th, 95th, 96th, 97th, 98th, 99th, 100th.

Experiment No.	1st	2nd	3rd	4th	5th
1	10	15	20	25	30
2	12	18	22	28	32
3	14	20	24	30	34
4	16	22	26	32	36
5	18	24	28	34	38
6	20	26	30	36	40
7	22	28	32	38	42
8	24	30	34	40	44
9	26	32	36	42	46
10	28	34	38	44	48
11	30	36	40	46	50
12	32	38	42	48	52
13	34	40	44	50	54
14	36	42	46	52	56
15	38	44	48	54	58
16	40	46	50	56	60
17	42	48	52	58	62
18	44	50	54	60	64
19	46	52	56	62	66
20	48	54	58	64	68
21	50	56	60	66	70
22	52	58	62	68	72
23	54	60	64	70	74
24	56	62	66	72	76
25	58	64	68	74	78
26	60	66	70	76	80
27	62	68	72	78	82
28	64	70	74	80	84
29	66	72	76	82	86
30	68	74	78	84	88
31	70	76	80	86	90
32	72	78	82	88	92
33	74	80	84	90	94
34	76	82	86	92	96
35	78	84	88	94	98
36	80	86	90	96	100
37	82	88	92	98	102
38	84	90	94	100	104
39	86	92	96	102	106
40	88	94	98	104	108
41	90	96	100	106	110
42	92	98	102	108	112
43	94	100	104	110	114
44	96	102	106	112	116
45	98	104	108	114	118
46	100	106	110	116	120
47	102	108	112	118	122
48	104	110	114	120	124
49	106	112	116	122	126
50	108	114	118	124	128
51	110	116	120	126	130
52	112	118	122	128	132
53	114	120	124	130	134
54	116	122	126	132	136
55	118	124	128	134	138
56	120	126	130	136	140
57	122	128	132	138	142
58	124	130	134	140	144
59	126	132	136	142	146
60	128	134	138	144	148
61	130	136	140	146	150
62	132	138	142	148	152
63	134	140	144	150	154
64	136	142	146	152	156
65	138	144	148	154	158
66	140	146	150	156	160
67	142	148	152	158	162
68	144	150	154	160	164
69	146	152	156	162	166
70	148	154	158	164	168
71	150	156	160	166	170
72	152	158	162	168	172
73	154	160	164	170	174
74	156	162	166	172	176
75	158	164	168	174	178
76	160	166	170	176	180
77	162	168	172	178	182
78	164	170	174	180	184
79	166	172	176	182	186
80	168	174	178	184	188
81	170	176	180	186	190
82	172	178	182	188	192
83	174	180	184	190	194
84	176	182	186	192	196
85	178	184	188	194	198
86	180	186	190	196	200
87	182	188	192	198	202
88	184	190	194	200	204
89	186	192	196	202	206
90	188	194	198	204	208
91	190	196	200	206	210
92	192	198	202	208	212
93	194	200	204	210	214
94	196	202	206	212	216
95	198	204	208	214	218
96	200	206	210	216	220
97	202	208	212	218	222
98	204	210	214	220	224
99	206	212	216	222	226
100	208	214	218	224	228

