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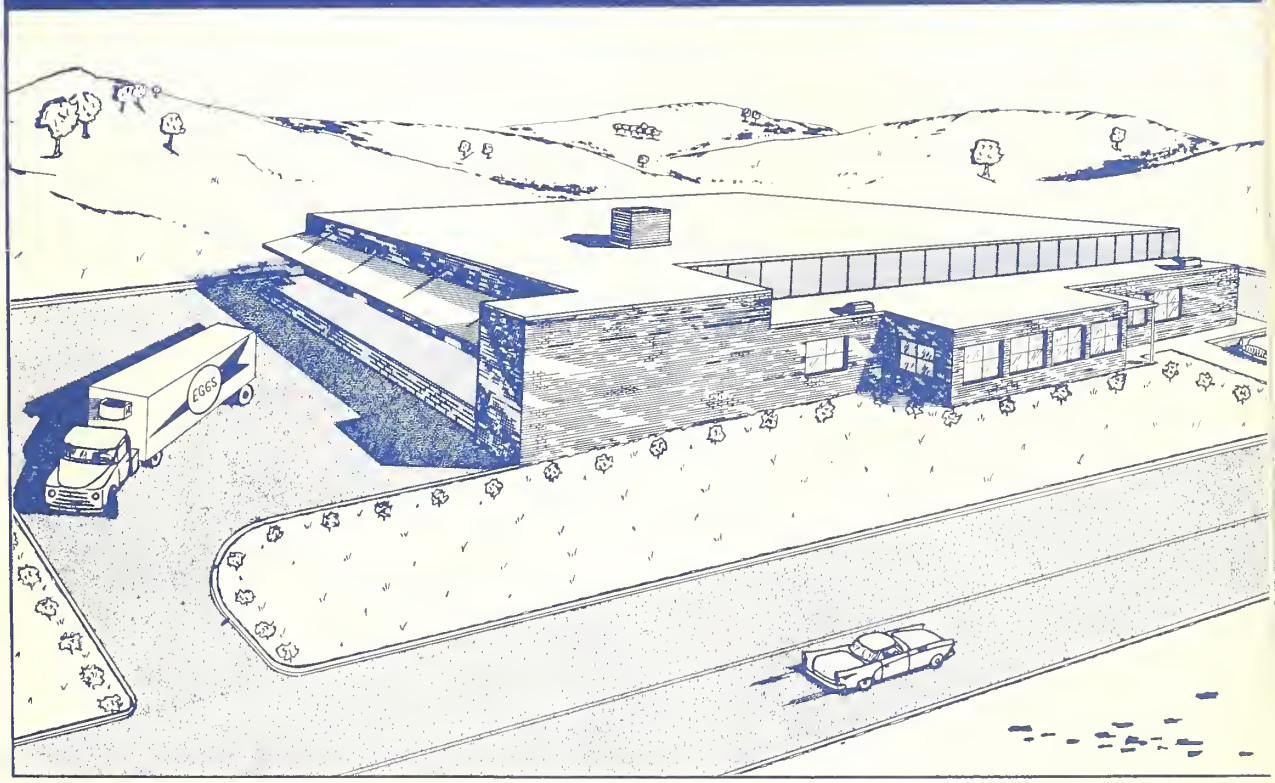
COMMERCIAL EGG GRADING and PACKING PLANTS



UNITED STATES DEPARTMENT OF AGRICULTURE

Agricultural Marketing Service

Transportation and Facilities Research Division

Preface

This study is a part of a larger research project covering the development of improved work methods, equipment, and related facilities for conditioning, handling, storing, and marketing shell eggs. It supplements an earlier study, "Handling Methods and Equipment Used in Egg Assembly Plants," Marketing Research Report No. 47. It was conducted in typical egg grading and packing plants by the Handling and Facilities Research Branch, Transportation and Facilities Research Division, Agricultural Marketing Service, U.S. Department of Agriculture.

This report is based on studies of actual problems of egg grading and packing plant facilities and equipment; it is intended to help solve some of them, particularly those arising from the increasing volume of receipts from large-scale commercial poultry flocks producing large quantities of fine-quality eggs. The recommendations will provide direct answers to inquiries from plant operators for suggestions on effective handling of these problems. The guidelines developed herein will enable them to take full advantage of the handling economies possible with this type of production. It is felt that operating cost will be reduced sufficiently to permit higher plant earnings, while also increasing returns to egg producers.

Norman G. Paulhus, agricultural economist, and Frank Delle Donne, industrial engineer, handled some of the earlier work on this study. Appreciation is expressed to the managements of the egg grading and packing plants evaluated, for their many helpful suggestions and wholehearted cooperation in the study.

Contents

Washington, D.C.

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Improved Designs for COMMERCIAL EGG GRADING AND PACKING PLANTS

By John A. Hamann, research analyst, and Thomas F. Todd, industrial engineer, Transportation and Facilities Research Division, Agricultural Marketing Service

Summary

Typical egg grading and packing plants in various parts of the country, ranging in size from 40,000 cases to 200,000 cases a year, were studied and evaluated to determine some of their problems and possible solutions for them. The types of problems studied were (1) those encountered by plant operators with respect to plant sites, buildings, equipment, and handling methods during normal operations; (2) those involved in the operations necessary to handle the eggs from the rapidly increasing number of large commercial poultry flocks; and (3) those that could be expected when converting from manual to mechanized grading, frequently recommended for large, uniform lots of fine-quality eggs. Study of the problems resulted in the development of guidelines for improved facilities for egg grading and packing plants. Application of the guidelines, coupled with recent experience with new and improved equipment, plus the application of industrial engineering layout principles, resulted in the development of a set of improved designs for egg grading and packing plants operating under assumed conditions. These designs were developed so as to provide for (1) expansion in production by gradual stages (from 62,500 cases a year to 275,000 cases), (2) minimum plant shutdown time and maximum operating efficiency at any expansion stage, and (3) efficient layouts with full consideration for maintaining product quality, service facilities for employees, and management control.

The improved layouts are designed to serve as guides to plant operators in developing long-range building programs.

Background

Receiving, grading, packing, and shipping 4.8 billion dozen eggs annually is one of the major handling operations in the poultry industry. In recent years, this job has become more complex with rapid expansion of the large, commercial "controlled quality" flocks. Although the large, uniform lots of fine-quality eggs that this trend is producing are a tribute to the advances in breeding and flock management and have added considerably to the producer's and marketman's income and to consumer satisfaction, they have also produced an adaptation problem at the egg grading and packing plants.

Several years ago, the typical plant performed mainly an egg assembly operation, with only limited grading and packing work. Small lots within wide ranges of quality were picked up at country receiving stations, assembled at a central plant, (*7*) [1] and reshipped in bulk packs on a wholesale grade basis. Generally, egg grading and packaging facilities were provided for only a limited part of the receipts. Changes in industry since then have been coming thick and fast. Although the assembly plant with its bulk wholesale pack is still very much in evidence, grading and packaging eggs in one-dozen cartons for direct delivery to the retail store from country shipping point is here to stay. Many plants that formerly only assembled small lots for reshipment, grading a comparatively small percentage of their receipts, converted their facilities to meet the new grading

[1] Italic numbers in parenthesis refer to items in literature cited, p. 45.

and packing practices, and some adopted or considered new facilities that would accommodate manual grading operations for eggs of average quality, as well as highly mechanized grading systems for large lots of eggs of uniformly fine quality. Conversion of facilities and interest in new plants equipped with the latest in egg grading and packing equipment brought on a rash of problems and questions that required evaluation and answers. The Department of Agriculture therefore made this study of typical plants.

Egg grading and packing plants ranging in capacity from 40,000 cases a year to 200,000 cases were evaluated as to their advantages and disadvantages, in the light of current needs. It was found that grading and packaging of eggs in one-dozen cartons for retail distribution had resulted in the introduction of many semimechanical combinations of grading and cartoning operations into plants that were not designed to handle them. In many cases, it had resulted in expensive operating inefficiencies. In most cases, change to newly developed, more fully mechanized equipment and improved plant layouts was impossible. On the basis of analysis of these findings by engineers and marketing specialists, and of experience with development of mechanized egg grading and packaging equipment (*11*) and layout principles, improved plant designs were developed as a guide for the egg industry.

Designs of Some Typical Egg Grading and Packing Plants

The plants for the case study were selected as being typical of their volume class and degree of egg grading and packing mechanization. Two plants were in single-story buildings and two occupied two-story buildings. In only one instance had the original facilities been specifically designed for shell egg grading and packing operations.

Plant A

Plant A, grading and packing about 40,000 cases of shell eggs and processing about 50,000 pounds of egg meat (whites and yolks), per year, was located [2] in a commercial cold storage plant in a semi-industrial area of a large eastern seaboard city. The multistory, brick, cold storage warehouse (fig. 1) was built 40 years ago, to serve the produce dealers in the vicinity and to provide operating facilities for dealers in eggs, poultry, fish, dairy products, meat, and other products. It provided semiprivate cold storage facilities, in connection with office, processing room, and dry storage space, on a monthly rental basis. In addition, considerable public storage space, dry, cool, and freezing, was available for intermittent storage at standard "by weight" storage rates.

The space occupied by plant A in this warehouse consisted of two separate building units (fig. 2). One, a two-story unit measuring approximately 13 by 95 feet per floor, had a narrow mezzanine on the second floor. The other, a two-story unit 38 by 70 feet, originally occupied by a hotel supply house, had been converted to cold and dry storage space. These buildings provided space for an office, a sales cooler (a cool room for

[2] This warehouse has now been razed in a municipal redevelopment program.

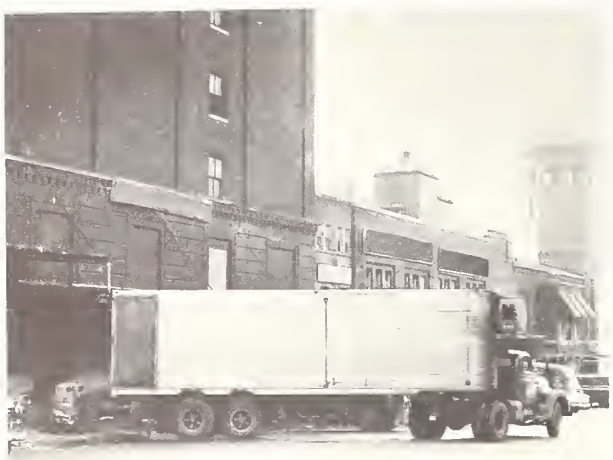

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Figure 1.—City traffic frequently restricted unloading at plant A.

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Figure 2.—Difference in building levels and required use of public sidewalk impeded unloading at plant A.

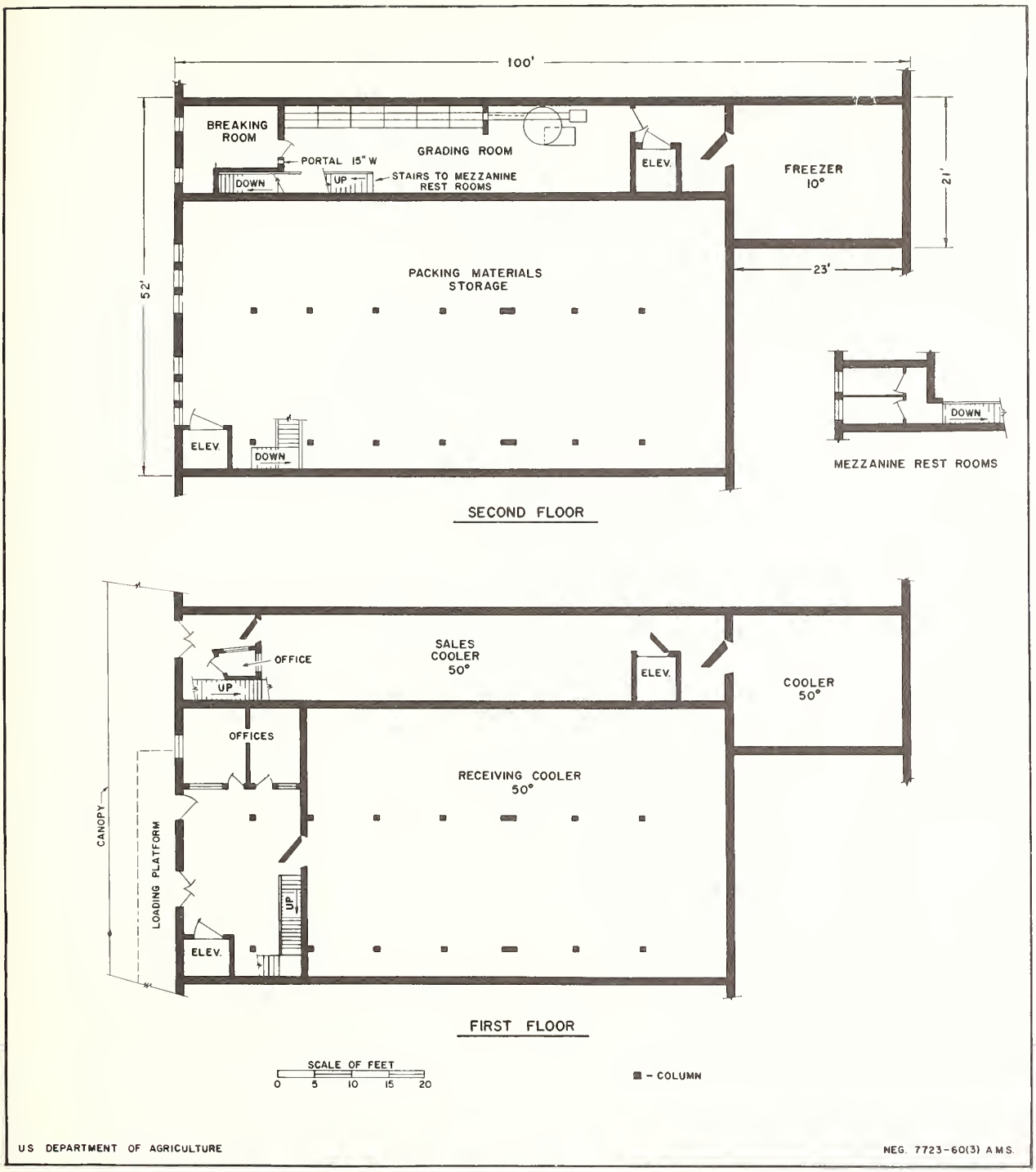

Figure 3.—Layout of plant A.

eggs about to be shipped out), a shell egg storage cooler, egg meat freezer, egg grading and packing room, storage space for packing materials, egg breaking room, and restrooms. Access to the first floor of the smaller building (fig. 3) was at sidewalk level; a double door opened on to a small lobby with a 4- by 5-foot office, a narrow aisle to the stairway, and a 4-foot aisle to the 13- by 70-foot sales cooler and a 20- by 25-foot egg storage cooler in the rear. A 5- by 7-foot elevator, used to move products and supplies to and from the second floor, also was near the rear of the sales cooler.

The second floor (fig. 3) was divided into an 8½- by 10-foot breaking room and a 13- by 70-foot egg grading and packing area. Floor space in this area was reduced considerably by the stairway to the restrooms on a small mezzanine over the breaking room. Adjoining the back of the egg grading room was a 13- by 23-foot sharp freezer for egg meat.

The second building unit was equipped with a 5- by 31-foot dock ranging in height from 2 to 3 feet. The interior provided a 20- by 37-foot dry storage, receiving area, stairway, and elevator to the second floor, plus a 36- by 60-foot shell egg cooler. The 37- by 80-foot second floor provided dry storage for packing materials (egg cases, cartons, and egg meat tins).

The walls were partly of painted brick and partly of plastered brick. The floors were of cement. Ceiling clearance in refrigerated areas ranged from 7 to 8 feet, and was approximately 8 feet in the dry storage area.

Materials-handling equipment consisted of 2 jacks and 13 2- by 4-foot semilive skids, 1 small 2-wheel handtruck, and several 4-wheel handtrucks.

Egg grading equipment consisted of a six-station grading and packing line equipped with individual grading lights, scales, and a common carton conveyor belt. It was served by a carton makeup machine and a 5-foot circular carton packing table. Depending on the quality of the eggs, the line was capable of handling about 140 to 160 cases a day.

The egg breaking room was equipped to handle about 50 cans of whole eggs a day. The two-work-station breaking table, egg meat receiving hopper, strainer, and egg meat scale were usually operated only 1 day a week.

Description of Operations

Ungraded, mostly presized, clean eggs and packing materials were generally received in truckload lots at the 5- by 31-foot dock in front of the storage building, loaded on the semilive skids, transported and stacked in the storage areas. Ungraded eggs were received also on the 13- by 15-foot sidewalk in front of the smaller building, unloaded onto semilive skids, moved through the sales cooler to the egg storage cooler in the rear, and stacked or moved by elevator to the grading room on the second floor.

As the grading and breaking rooms needed eggs or packing materials, they were supplied, a skidload at a time, from one of the storage areas (or direct from a truck being unloaded). Movement of eggs or packing materials from one building to another required restacking skidloads from the loading dock onto skids at the sidewalk level. This costly rehandling was required because a connecting passage between the buildings was not permitted by local fire ordinances.

Skidloads of eggs were placed near the graders who were served by the packer. One-dozen cartons, from a carton setup unit, were used for most of the production; the rest was bulk packed for institutional use, and undergrades were held for breaking stock. Bulk-pack cases were stacked on skids by graders as each case was filled.

Graded eggs were returned to the first-floor cooler for sales stock or for loading (at sidewalk level) into city delivery trucks. Cans of egg liquid prepared in the breaking room were frozen and held in the second-floor freezer awaiting shipment.

Principal Facility Defects

The principal defects in facilities of plant A were:

1. Sidewalk loading and unloading required excess labor and time loss due to rehandling and severe congestion in the area.
2. Most of the ungraded eggs and packing materials required expensive multiple handling, into storage, out of storage, and from dock level to sidewalk level to production area. Graded eggs received similar treatment, from grading room to elevator to sales cooler to unloading and stacking, restacking onto skids in proper delivery route sequence at time of loading, and, finally, loading from skid to truck.
3. Narrow frontage and street traffic restricted customer access and frequently delayed loading and unloading.
4. Narrow doorways and aisles, a small, slow-speed elevator, and inadequate temporary storage space at grading stations slowed production.
5. Plant location and construction prevented expansion of facilities without costly remodeling.
6. A small and poorly located office hindered proper management control.
7. Remote location of restrooms required excess time away from work stations and contributed to poor management control over workers.
8. Lack of a locker room and lunchroom indicated inadequate personal facilities for employees.
9. Lack of drainage facilities made plant cleanup difficult and costly.
10. Lack of a refuse room for the egg grading and breaking room made waste disposal costly and annoying.

The advantages of ample refrigerated storage were reduced considerably because of plant location and access restrictions. The small breaking room made possible a decided market advantage for undergrade eggs, but its limited space and inaccessibility greatly reduced its effectiveness.

Plant B

Plant B, a two-story concrete structure 24 by 37 feet (fig. 4), handles approximately 75,000 cases

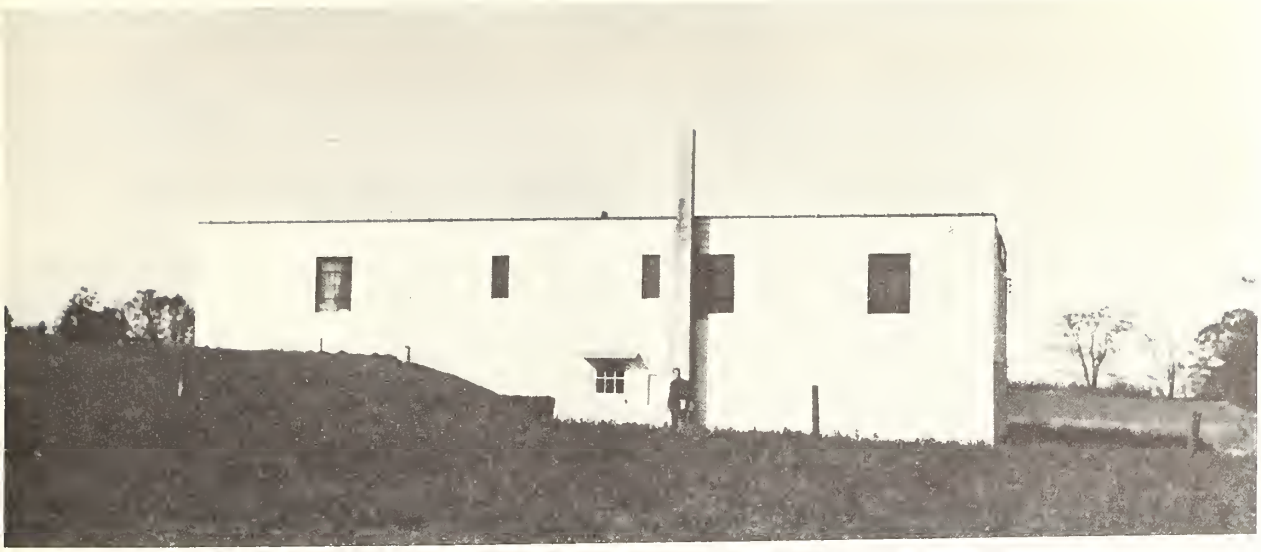

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Figure 4.—Sloping terrain of site of plant B limits possibilities for expansion.

of eggs a year. Its column-supported wood joist roof provides an average ceiling height of 8 feet 6 inches. The building is on a large lot with a sharp slope from back to front. There is ground-level access to both floors. The production area, egg storage area, and boiler room are on the first floor. The supply storage space, offices, and restrooms are on the second floor (fig. 5). There are no provisions for refrigerated egg storage, air-conditioning, or egg breaking and freezing.

Egg grading equipment consists of an 11-station grading line equipped with individual egg scales, grading lights, and packaging shelves. Egg cartons are supplied to the stations and filled cartons are removed by a common conveyor belt. A 5-foot packing table and carton makeup machine serve the line.

Materials-handling equipment consists of two two-wheel handtrucks, one collapsible belt-type conveyor, and several sections of wheel-type gravity conveyor.

Description of Operations

Ungraded eggs are unloaded from route trucks through a first-floor wall portal into the receiving area. They are transported, four cases at a time, by two-wheel handtruck to the grading line or egg storage area nearby.

One worker supplies the grading line with ungraded eggs. These eggs are graded and packaged at the 11 grading stations, and moved to the packing table by conveyor belt, where they are packed into cases. A case handler removes packed cases from the packing table gravity conveyor and places them in stacks according to grade and size. Depending on the quality handled, production ranges from 250 to 300 cases a day. Eggs are loaded from the storage area into trucks by means of a collapsible conveyor that is moved into position for shipping or receiving. Empty cases from the grading line are handled by the same conveyor.

Packing materials and other supplies are unloaded at the second-story level and stored. Cartons and cases are supplied to the first-floor level by gravity chute.

Principal Facility Defects

The principal defects in facilities of plant B are:

1. The surrounding terrain and the roadway in front of the plant require an extensive (and expensive) earth-moving operation for building expansion at the first-floor level.
2. Lack of a truck-bed-height loading platform increases handling labor excessively.
3. Conveyorized loading and unloading, requiring setup and knockdown time for shipments and receipts, tends to increase overall handling time.
4. Lack of refrigerated storage space is detrimental to egg quality.
5. The small wall portal for unloading and loading creates a bottleneck in the flow of both graded and ungraded eggs.
6. The location of the packing materials supply chute, remote from the carton makeup machine, and the narrow aisle to the machine make the packing material supply operation time-consuming and difficult. Carton makeup and delivery from the second floor to each grading station could eliminate this problem.
7. The remote location of restrooms requires workers to spend additional time traveling to and from them.
8. Lack of a lunchroom or locker room indicates inadequate employee facilities.

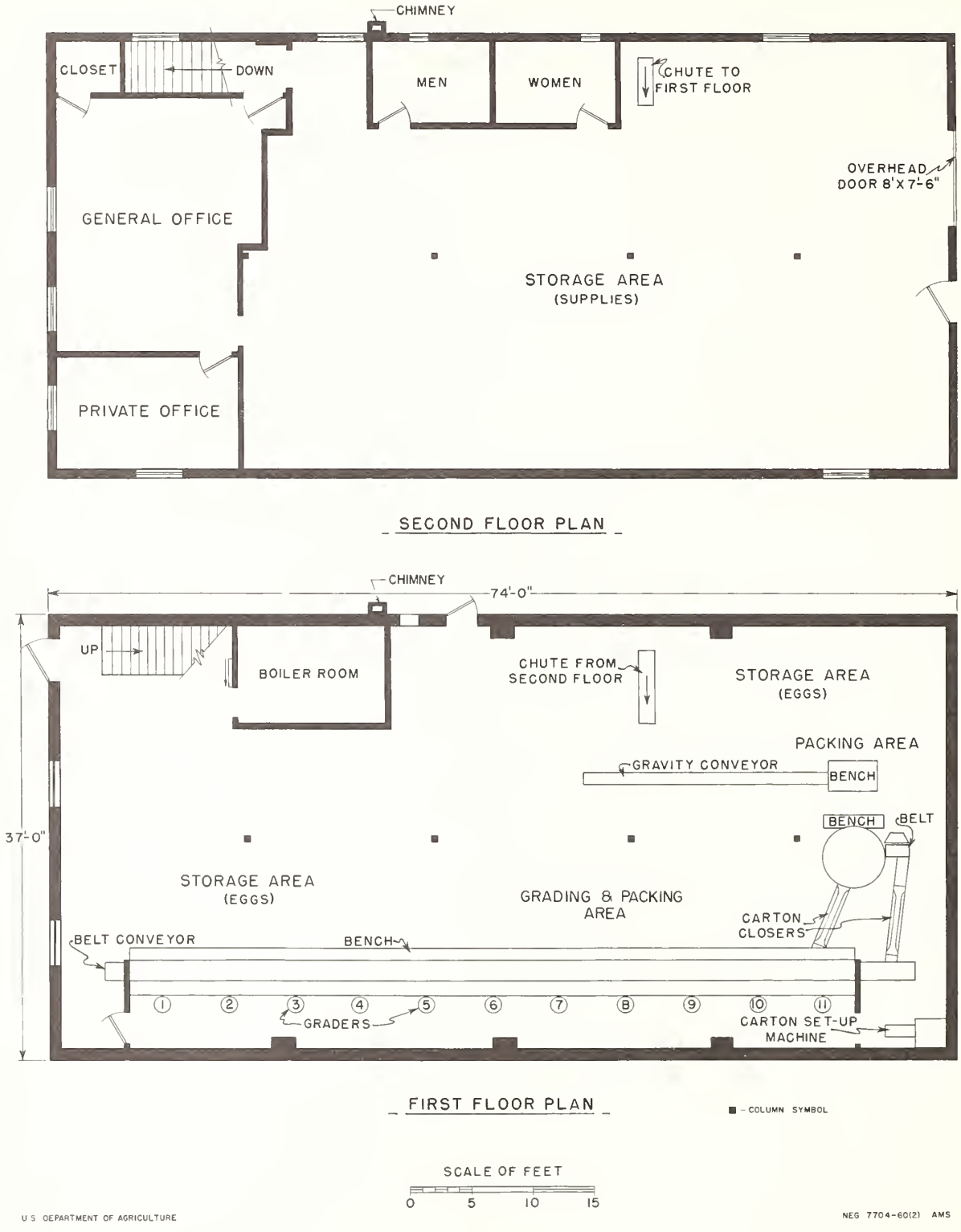

Figure 5.—Layout of plant B.

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Figure 6.—Street-level receiving and shipping area at plant C increases handling cost.

9. The boiler room occupies valuable space that could be used for egg refrigeration. Instead, ceiling-suspended space-heater and air-conditioning units could be used.

10. Remote location of the management offices reduces effective management control of plant operations.

11. Lack of an efficient materials-handling system increases handling labor.

12. Lack of floor drains and water outlets makes plant cleanup difficult.

13. Lack of a refuse room or incinerator makes waste disposal a problem, as well as a nuisance and a costly operation.

14. Lack of a small breaking room and freezer and dependence on sale of undergrades (leakers, checks, stained shells, dirties, and C quality) in the shell create an unfavorable trading position for this segment of the business.

Plant C

Plant C (fig. 6) markets about 150,000 cases of shell eggs and about 500,000 pounds of egg meat annually. It is in the downtown area of a small midwestern town and serves as the egg department of a midwestern supermarket chain. Its cartoned eggs are the main source of supply for the company's stores. Some of the egg meat is used by the company bakery department, in an adjoining building. The rest is sold commercially. The plant occupies most of two one-story buildings that are part of a group of adjoining buildings occupied by the chainstore firm.

The buildings in which the egg department is located are 118 by 149 feet (fig. 7), exclusive of a 10- by 23-foot covered receiving dock at one side and a 14- by 17-foot extension on another side. The buildings are bounded on two sides by city streets, on another by an alley, and on the fourth side by adjoining buildings and a loading yard common to all departments.

One building, 48 by 146 feet, houses a 17- by 48-foot receiving cooler for ungraded eggs, a 24- by 84-foot egg grading and packing area, a 24- by 84-foot packing materials storage area, and a 44- by 48-foot shipping cooler for graded eggs. On the loading-yard side, it is connected to a shipping dock (used by all departments) by a 7- by 16-foot inclined ramp with a 6-foot door. On the opposite side, access to the adjoining building is through a 5-foot archway.

The other building unit is a 66- by 146-foot building with a 14- by 17-foot extension at one end. It houses company and egg department offices, restrooms, lunchroom, packing materials storage space, an egg washing room, an egg breaking room (with laboratory and kitchen), a garbage disposal room, and an egg meat freezer.

The walls of the buildings are of brick and the floors are of concrete. The breaking room walls have a 4-foot wainscot of glazed tile. The floors of the egg receiving cooler, breaking room, refuse room, and restroom are pitched to trapped drains. Ceiling heights are 10 feet throughout the plant.

The breaking room is air-conditioned. Approximately 2,700 square feet of 32° F. cold storage is provided for shell eggs, and approximately 1,500 square feet of −20° freezer storage is available for egg meat.

Materials-handling equipment consists of a forklift truck, a supply of pallets, stainless steel

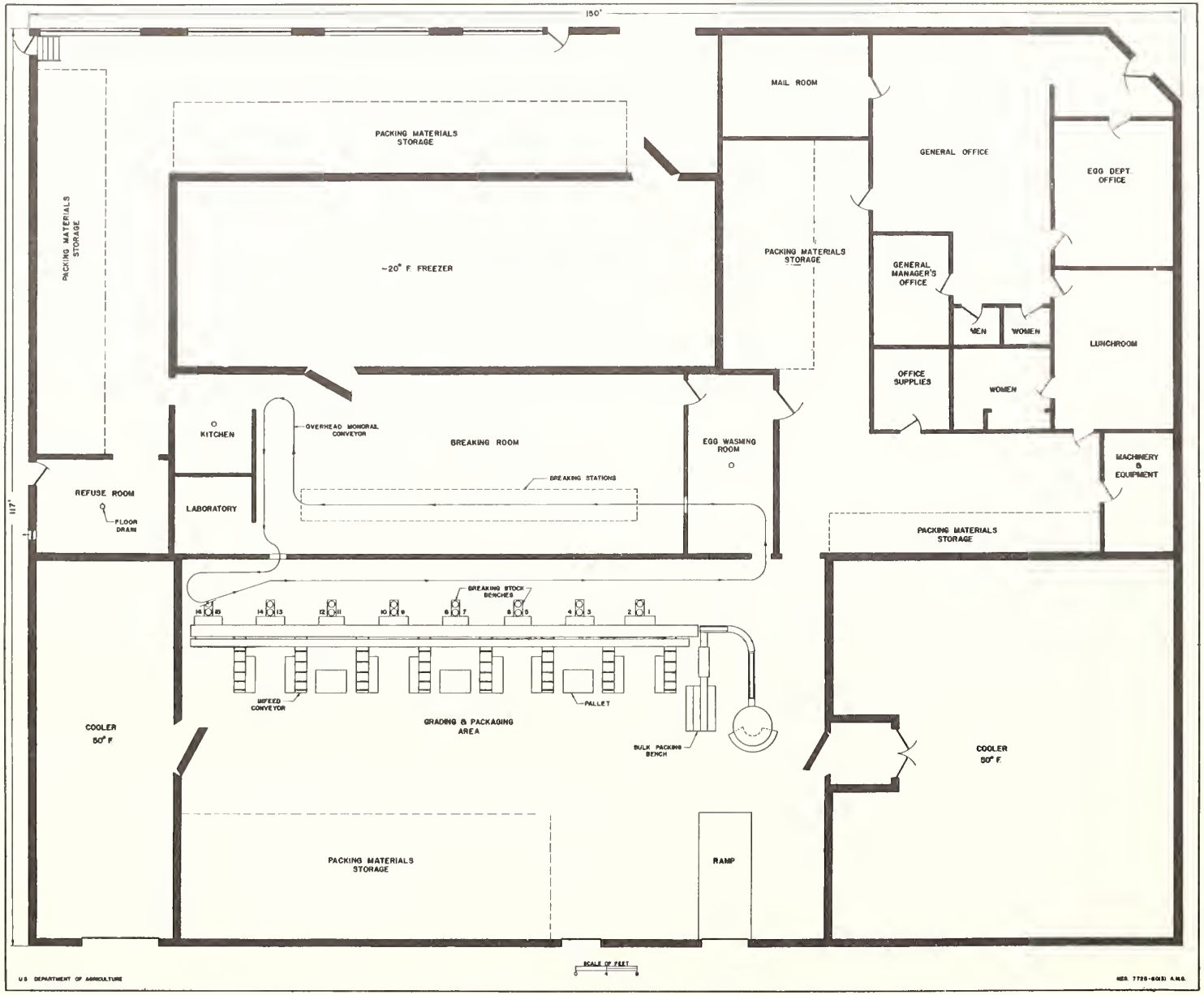

Figure 7.—Distances between storage, production, and office areas of plant C contribute to high materials-handling costs and reduce management control.

racks (for cans of egg meat), and several lengths of portable, wheel-type gravity conveyor.

Egg grading equipment consists of 8 conveyor-fed automatic sizing units and 16 manual egg grading stations. Empty cartons for grading stations are available at adjoining carton supply racks, and a belt conveyor removes full cartons or filler-flats. The grading line has a capacity of 600 cases a day.

An overhead conveyor transports dirty eggs from the egg grading room to the egg washing room, carries breaking stock to the breaking stations and moves the egg liquid to the inspection station and receiving hopper. The breaking room is equipped to handle up to 7,000 pounds of whole egg daily and is normally operated 2½ days a week.

The egg cleaning room, also using part of the overhead conveyor, supplies cleaned eggs to the breaking room. The egg washer has a capacity of 3 to 5 cases an hour.

Description of Operations

Ungraded eggs are received at the receiving cooler and palletized, 30 cases per pallet. A fork-lift truck places them into position in the receiving cooler or at one of the eight stations that supply the grading line.

Top-quality eggs are packed into one-dozen cartons, for retail sale, or are cartoned and shell treated by an in-line shell treating unit, for export. A small percentage also are shell treated and bulk packed for other export shipments. Full cases of graded eggs are stacked on pallets, and moved either to the shipping cooler for future shipment, or directly to the loading dock for immediate shipment.

Undergrades (C quality, stains, dirties, checks and leakers) are placed into baskets for breaking or cleaning. An overhead conveyor moves them to the egg washing or breaking room. When a basket is filled with undergrades or dirties, it is hung on the conveyor and an empty basket is removed from the same line. When baskets of dirties pass into the egg washing room, they are removed from the line for cleaning and replaced with baskets of washed eggs for the breaking room beyond. Baskets containing other undergrades continue to the breaking room.

The breaking room workers prepare whole egg liquids at six to eight breaking stations. The liquid is strained, churned, and drawn off into 30-pound tins for freezing at −20° F. and storage. The laboratory provides facilities and personnel for solids determination and microbiological tests. The kitchen furnishes continuous cleaning service for equipment and containers.

Some packing materials are received and palletized at the truck dock in the loading yard, and stored in the area contiguous to the egg grading and packing area or in the dry storage areas adjacent to the office space. Egg meat containers are received and palletized at the ground-level doorway of the larger building, for dry storage in the area next to the freezer.

Principal Facility Defects

The principal defects in facilities of plant C are:

1. Narrow aisles and doorways, above or below the level of receiving and shipping areas, decrease the effectiveness of unit load materials handling.
2. Widely scattered, narrow dry storage areas increase materials-handling cost.
3. The 16-station grading and packing line is frequently not used to capacity because the cartoned egg conveyor belt is overloaded.
4. Improper design of equipment serving the grading line requires unnecessary additional labor to divert eggs to the proper packing station.
5. A high incidence of small lots of ungraded eggs (one case or less) requires frequent empty spaces in the line loading conveyors, decreasing machine capacity. Frequent inventory counts necessitated by small lots reduce the time allotted to actual grading work.
6. Lack of a packing materials makeup and supply mezzanine calls for additional labor to supply graders with packing materials.
7. The floor space set aside for the breaking room is far in excess of processing needs.
8. The location of company offices remote from production, receiving, and shipping areas reduces management efficiency.

The unit load materials-handling system, egg breaking and freezing facilities, and single-story construction provide this firm with excellent advantages. The overall operating economy could be increased considerably, however, if the foregoing defects in the facility, layout, and equipment were corrected, and if egg quality were more uniform and lots were larger.

Plant D

Plant D (fig. 8) grades and packs approximately 200,000 cases a year. Located in the industrial district of a large city, it serves as the area egg department of a national supermarket chain. The one-story 90- by 150-foot building (fig. 9) houses an egg grading and packing room, cold storage rooms, and dry storage and service areas. A truck-bed-height, covered loading platform, ranging in width from 12 to 10 feet, and a 45-foot truck apron extend across the front of the building. In the 10-foot-wide area, the platform is 3 feet high, and it is 4 feet high the rest of the way. The canopy is about 1 foot short of completely covering the platform.

The building faces a main municipal thoroughfare, frequently congested with truck and auto traffic. The remainder of the plant is bounded by a narrow alley, a truck parking area, and a railroad spur track. Because of sloping terrain,

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Figure 8.—Truck-bed-height dock at plant D permits unit load handling, but highway traffic limits accessibility.

the floor level at the rear of the plant is about 10 feet below rail car floor level. Packing materials arriving on the spur track are received through a wall portal at roof level.

The building is of concrete blocks and brick veneer. The floors are of concrete, with trapped drains. Except for 10-foot ceiling clearance in the shipping cooler, the average ceiling height in the plant is 13 feet.

The egg grading and packing area is about 49 by 111 feet. The adjoining receiving and shipping coolers provide about 4,000 square feet of refrigerated storage space. Because of refrigeration equipment, an unused egg meat freezer, doorway locations, and aisle space requirements, more than 1,000 square feet of this space cannot be used effectively for cold storage. Also, the low ceiling in the shipping cooler prevents high stacking.

About 1,000 square feet of dry storage space is located at one end of the egg grading room. Limited temporary storage space is available also on the carton supply mezzanine. Storage for pallets is provided at the far end of the shipping dock. The 13-foot ceiling height permits high stacking in the dry storage area and in the receiving cooler. A 1,780-square-foot service area extends across one end of the plant, providing space for a general office, manager's office, lunchroom, machine room, and restrooms.

The entire plant is air-conditioned. A nearly constant 70°F. is maintained in the plant, winter and summer. Both cold storage rooms are usually kept at 50°. When the outside humidity is high, storage temperature is permitted to rise to 60° in order to minimize moisture condensation on cool eggs.

Materials-handling equipment consists of one rider-type forklift truck, one "walkie"-type high stacker, two pallet transporters, a supply of pallets, and six 10-foot lengths of wheel-type gravity conveyor.

Egg grading and packing equipment consists of one 9-station and one 11-station egg grading and packing line, served by a large carton packing table, a bulk packing bench, and an inspection station. Each grading station is equipped with an in-feed conveyor, in-line egg scales, ultraviolet grading light, overhead carton supply chutes, and mechanical tabulating and recording (printing) equipment.

Description of Operations

Ungraded eggs are received on the dock adjoining the receiving cooler, are palletized, 30 cases per pallet, and moved by forklift truck to the receiving cooler or to one of the 21 grading stations. When receipts arrive at a rate faster than the grading lines can normally handle, palletloads are high stacked in the receiving cooler, increasing its capacity from about 4,000 cases to about 8,000 cases.

Operators supply the grading lines, loading the conveyors at each grading station, 30 eggs at a time, with multiple egg lifters. Conveyors move the eggs to in-line egg scales for sizing before they are examined for quality.

The top qualities in all size classes and the B quality in the large size are packed in one-dozen cartons. B quality in the other sizes and all undergrades are bulk packed and sold to a local breaking establishment.

Cartons are supplied by overhead chutes to all grading stations.

As each lot is completed, an exact count of each quality and size involved is mechanically tallied

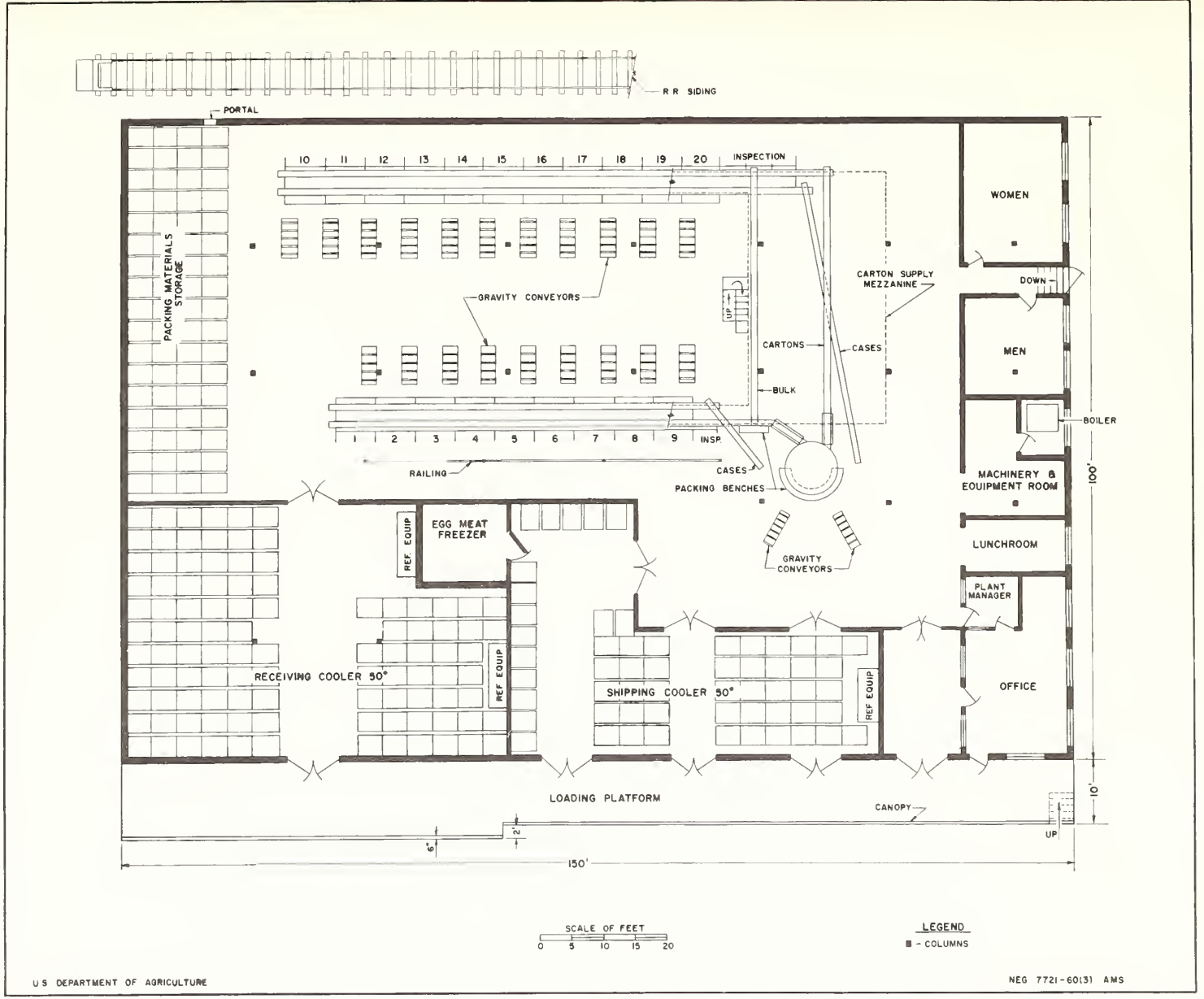


Figure 9.—Layout of plant D. Refrigeration space is reduced because of wall and aisle location.

and imprinted on a producer record card by a tabulator at each station.

Graded eggs are packed into cases, palletized, and moved by forklift truck to the shipping cooler or loaded onto an awaiting truck.

Principal Facility Defects

The principal defects in facilities at plant D are:

1. Plant location in relation to streets and the railroad spur make expansion an expensive venture, probably involving a second story.
2. Location of the shipping dock hampers deliveries and shipments because of main-thoroughfare traffic.
3. The loading platform width in relation to the canopy provides inadequate protection for products and workers against the weather and encourages rapid deterioration of the bumper rail.
4. Lunchroom space is insufficient for all plant workers.
5. Limited access to the rail siding increases materials-handling costs.
6. The difference in the number of grading stations per line results in incomplete utilization of labor for the crew serving the graders.
7. The number and placement of refrigerator doors, the aisle space requirements, location of refrigerator equipment, and idle freezer room reduce available cooler space.
8. Lack of a breaking room reduces the flexibility of outlets for undergrade eggs.
9. The required production rate and the location of present equipment make conversion to mechanical equipment difficult without a shutdown.

There are many desirable features in this plant that assist materially in the proper handling of eggs during grading and packing. They include refrigerated storage space, plant air-conditioning, ultraviolet ray grading lights, effective grade tabulating and recording equipment, continuous delivery of unpacked eggs to the graders, in-line sizing, remote-control operation of refrigerator doors, unit load materials-handling equipment, sufficient aisle widths, and adequate loading platform widths. In addition, the company policy of buying eggs of uniformly fine quality and paying for them on a grade basis permits more rapid handling with less likelihood of poor workmanship.

However, correction of shortcomings will, in the main, involve expensive alterations. To utilize equipment and plant manpower fully, expand plant capacity, or convert to mechanized grading equipment, the required changes will be extremely difficult.

Guidelines for Egg Grading and Packing Facilities

The preceding descriptions of operating plants grading and packing eggs at different volume levels pointed out weaknesses of some typical plants. In considering some of the problems confronting industry in providing adequate yet economical facilities for handling standard egg production as well as fine-quality eggs from large commercial flocks, certain basic factors should receive foremost consideration. They are: (1) Selection of plant site, (2) building design and layout, (3) egg grading and packing facilities and equipment, (4) storage facilities, (5) receiving and shipping facilities, (6) machine room and shop, (7) offices, (8) restrooms, (9) plant utilities, and (10) materials-handling equipment. Other important considerations, such as proximity of production areas, community attitude, convenience to established markets, availability and wages of labor, and taxes, have not been included, since it is assumed that favorable conditions in these areas were basic to the idea of new construction or plant alteration.

Selection of Plant Site

Selection of a building site for an egg grading and packing plant should be based on layout sketches of a plant that will handle the immediate as well as the future needs.

Inadequacy of land for expansion places definite limitations upon the plant layout, since the plant must be adaptable to the property plat. The sketches should indicate the extent and direction of future expansion. If expansion is anticipated, provision should be made for it at the time of original purchase of a site. Although a comparatively large land area may seem costly at the outset, it frequently can be purchased cheaper than on a piecemeal basis.

The average small egg grading and packing plant, in a quality-conscious egg-producing community, can, under normal circumstances, be expected to grow over a period of years. As the volume of eggs increases, plans for building additions must include not only more space for the increase in volume, but also provision for different combinations of handling methods and equipment.

The plot of ground selected must provide sufficient space for maneuvering trucks and trailers into position for loading and unloading, as well as space for pickup and delivery trucks and customer and employee parking.

Soil conditions and the slope of the surrounding land must be studied, to avoid high building costs

due to problems of site preparation, building foundation, soil drainage, and retaining walls.

Building Design

If land values are within reasonable limits and the terrain is fairly level, a single-story structure is most desirable because of economies in operation and maintenance. However, the construction cost is greater per square foot of floor space. To permit the best utilization of materials-handling equipment and loading and unloading labor, the plant floor level should be at truck-bed height. Loading platforms should have a minimum width of 12 feet and should have all-weather roofs. Floor surfaces in the production area and service area in which wet cleaning is required should have smooth cement surfaces, pitched ¼ inch per foot to trapped drains.

Adequate aisle space in the plant requires a 6-foot width when materials-handling equipment includes 2- or 4-wheel handtrucks, manual jacks, or hydraulic lifts. Aisles 8 to 10 feet wide are recommended for forklift trucks, and 3-foot aisles for pedestrian traffic.

The building materials can be those that are most reasonable for the area. Cinderblock construction with brick veneer on the front of the building provides an attractive appearance at a reasonable cost.

The production and refrigeration areas should have at least a 14-foot ceiling clearance to meet high stacking requirements. The service areas need only an 8- to 10-foot ceiling height.

The production area should be, as nearly as possible, of clear span construction to avoid column interference. The roof can be insulated flat steel decking, weatherproofed with a tar and gravel covering, and supported on open-web welded steel roof trusses. The structural steel should be of sufficient strength to support the roof as well as a packing material supply deck or mezzanine over grading and packing lines. Supporting columns should be located so as to permit installation of equipment without reducing aisle space or requiring major structural alteration of the basic plant unit during expansion.

Egg Grading and Packing Facilities and Equipment

Grading Room Facilities

The egg grading and packing area is the heart of plant operations, and usually has more floor space than any other part of the plant. If it has a carton supply mezzanine or packing materials deck over the grading and packing stations, ceilings in this area should be at least 14 feet high. If the carton supply is handled from a second floor above the grading area, an 8-foot height is adequate. The area should be insulated against sharp temperature changes, well ventilated, and free of drafts. Ceilings and walls should have smooth surfaces painted with a nongloss paint of neutral color, to facilitate cleaning and reduce reflected light at grading and packaging stations. Aisles and areas for handling packing materials should be well lighted, but grading stations should be shielded.

The grading and packing area should have adequate floor space for: (1) Stationary equipment, (2) work stations, (3) inspection station(s), (4) temporary storage of eggs and packing materials, and (5) aisles. If eggs are examined individually before a grading light, efficient layout principles suggest a space approximately 5½ by 7½ feet for each grading station. This space includes provision for the grading and packaging work station as well as a 3-foot access aisle for workers. Aisles for movement of product and packing materials should be not less than 8 feet wide if pallet-type materials-handling equipment is used. Space requirements for automatic packaging equipment used in conjunction with semiautomatic grading equipment calls for slightly more floor space and differs somewhat as to overall dimensions. For example, the 20-case-per-hour semiautomatic grading and automatic packaging line recently developed by the Department of Agriculture and now available commercially requires approximately 13 by 20 feet of floor space.

A minimum of 200 square feet of floor space should be provided for the station packing cartoned eggs. This amount of space is adequate for a packing table, one worker, and five 3- by 4-foot pallets to receive cases of eggs. In addition, it provides an access aisle for personnel and materials.

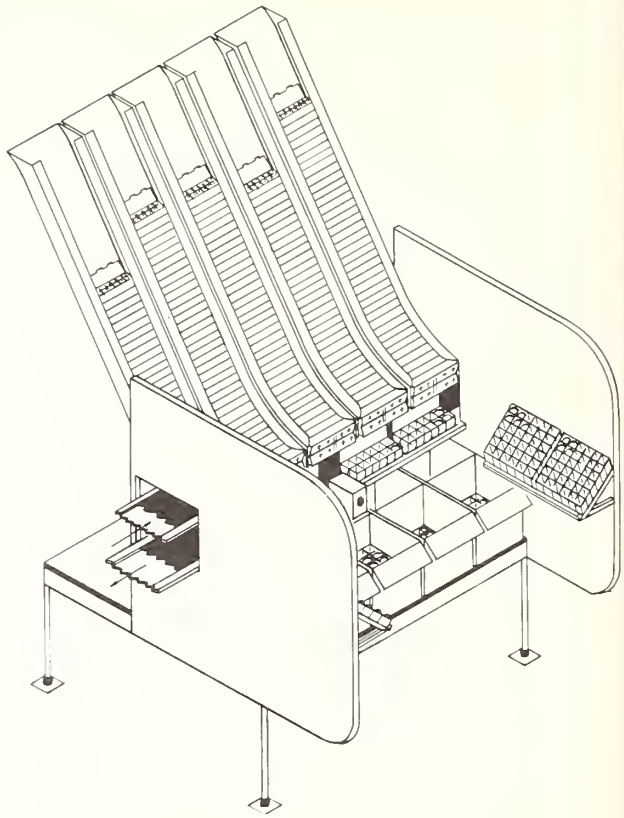
The packing materials makeup area (main floor or mezzanine) should be provided with a minimum of 100 square feet of floor space for container makeup equipment if required, a backlog of made-up cartons and cases, and a small reserve of materials from which to work. If a second-floor area is used for carton makeup, a 6- to 8-foot aisle is required for serving the grading stations from above. If a mezzanine is used, a catwalk or service lane over the grading benches and on the same level with the carton makeup area can be used. If preformed cartons are used and high stacking is employed, a packing materials supply deck over the grading stations can easily be stocked by the forklift truck operator. Within reason, the overall dimensions of the grading and packing area should be such as to permit a change to new or improved equipment.

Grading Room Equipment

A detailed analysis and evaluation of the more popular egg grading systems in use throughout the industry is being made, for publication in a later report. However, since the basic layout of the entire plant may be affected, and since the floor

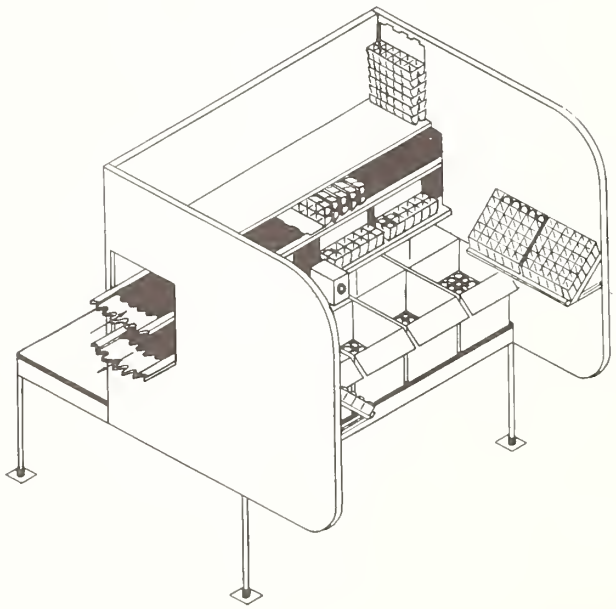
space required in the egg grading and packing area is directly affected by the type of equipment selected, some of the more popular types of grading equipment are described and illustrated here.

There are many combinations of equipment arranged into egg grading systems that can serve either the plant just starting operations or the older plant for which expansion or new construction is planned. Actually, the egg grading systems currently available do not grade eggs, but rather provide one or more mechanical aids to the grader and packer for performing their tasks. They employ materials-handling conveyors, automatic cleaners, sizers, tabulators, carton makeup and dispensing units, packagers, and carton closers. Basically, the main factors to consider in any of these systems is the efficiency of the mechanical devices in reducing the number of decisions and motions required of the egg grader, and the effect they have on worker fatigue, quality of workmanship, and quantity of output. Frequently, when equipment is selected without careful consideration of these factors, increased effectiveness is not the result; instead, added overhead and maintenance cost, not in keeping with the small increase in production, is the outcome. For example, grading lines are presently on the market that can provide economies in grading labor when the ungraded product is of uniform, high quality. If product quality is poor or irregular, the quality of the grader's workmanship generally decreases when a high production rate is maintained (*2*). Regardless of whether the simplest or the most complex mechanized egg grading and packing system is selected, there are certain fundamentals that should be considered in the selection and installation of the equipment. They include:



BN 10780

Figure 11.—Here carton supply is by overhead chute, and disposal is handled by conveyor belt. As in figure 10, all other operations are performed by the grader.



BN 10779

Figure 10.—Grading bench at which worker performs all grading and packaging, and records grades; carton supply and disposal are by conveyor belt.

1. Grading benches for manual grading should have candling lights that provide sufficient light at the aperture to illuminate the content of brown or white eggs for interior quality evaluation. A case light, generally a part of the candling light, for detecting dirty shells should be sufficient for this purpose without causing distraction in the candling operation. The candling aperture should be at the elbow height of the grader (*3*) and at least 8 inches above the eggs being graded.

2. Each grading bench should be equipped with an individual egg scale, if eggs are not automatically sized for the grader.

3. Automatic sizing equipment should be of a type that weighs eggs accurately while they are being moved at the machine's rated capacity.

4. Grading benches should be equipped with cartoning shelves, carton packing material supply chutes, and bulk pack shelves or racks for rejects and undergrades within convenient reach of the grader.

5. The grading bench should be so arranged as to afford the shortest reaches to the predominant grades.

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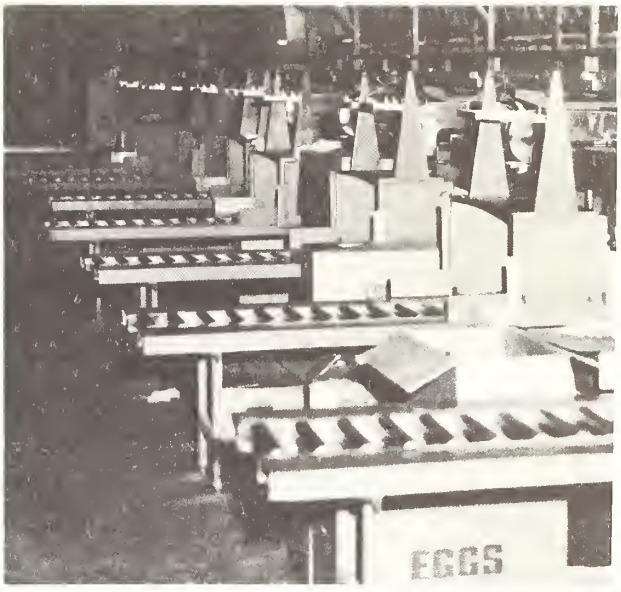

BN 10265

Figure 13.—Most commercial grading lines include conveyors to provide a reserve supply of eggs at grading stations.

BN 10267

FIGURE 12.—(Above) At this station, the supply and disposal operations are semiautomatic. The grader starts and stops the flow of ungraded eggs at will. (Below) Another worker unpacks fillers of eggs onto conveyors for several grading stations.

6. Uncomplicated mechanical grade tabulating and recording equipment should be provided for each bench in plants where buying is on a grade basis. It reduces time spent on record keeping, and the accounting is more accurate.

7. Each grading bench should be equipped with a combination of conveyors or chutes that delivers ungraded eggs and packing materials to the grader and moves the graded and packaged product away from the grader automatically at a rate determined by the grader. Thus the time spent in obtaining product and materials, as well as grader "wait" time, can be kept at a minimum.

8. If mass viewing devices that move groups of eggs over a light source are used, light rays should be deflected away from the grader's eyes. The lighting device should be so constructed that light rays are prefocused and can be adjusted by management only.

9. Mechanical equipment for grading and packing eggs should include the following features:

a. Cushioned corners and edges for egg receiving trays.

b. Receiving or packing tray construction and capacity that prevent loose eggs from piling up.

c. Gentle handling of individual eggs, especially when moving at high speeds.

d. Small-end-down positioning of eggs being placed into cartons.

e. An accurate mechanical tabulation and recording system.

f. Facilities for accurately and rapidly checking worker and machine performance.

g. Stop and start switches convenient to key workers.

h. Maximum worker safety.

i. Ready accessibility to all moving parts for service, replacement, and cleanup.

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BN 10127

BN 10567

FIGURE 14.—(Above) In this line, the operator grades for quality as a single file of eggs pass rapidly over a light source. (Below) Other workers supply eggs and pack the in-line sized eggs.

j. Unit replacement for complex electrical circuits.

k. A comprehensive maintenance service and cleanup schedule.

10. Regardless of whether egg grading equipment is manual or automatic, the following are essential:

a. The number of workers required to man it should be in balance with operations complementary to the grading operation, such as carton supply and makeup, egg supply, carton packing, and inspection.

b. The walking distance and reach required to work at or serve each work station should be at a minimum.

BN 10570

BN 10566

FIGURE 15.—(Above) The worker at this station unpacks and grades eggs. (Below) Other workers supply eggs and packing materials, and pack eggs. Tabulation and weighing (after evaluation for quality) are automatic.

c. The quality of product to be handled should be suited to the capabilities of the equipment; that is, eggs with a high incidence of thin or checked shells should not be submitted to mechanical handling, and eggs of irregular quality should not be candled in groups, in the interest of accurate grading.

11. Regardless of the excellence of egg quality, manual grading equipment should be available to handle occasional lots of irregular quality.

The grading equipment illustrated (figs. 10 through 19) provides a variety of services for the worker doing the grading. Similar devices are in use in numerous other systems not illustrated. The grading operation as performed at the grading bench, illustrated in figures 10 and 11, calls for

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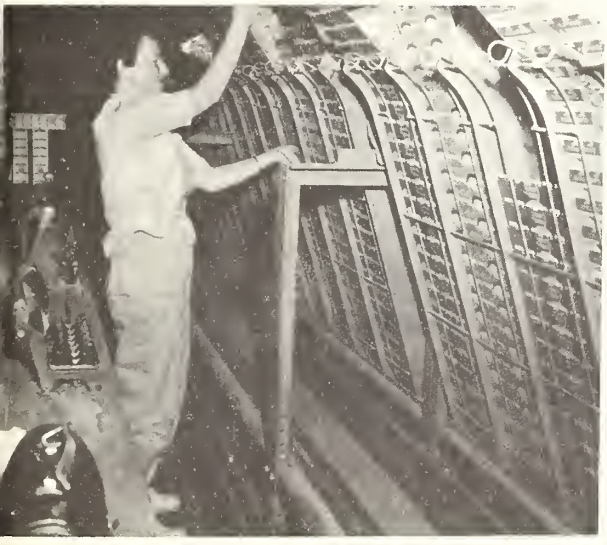
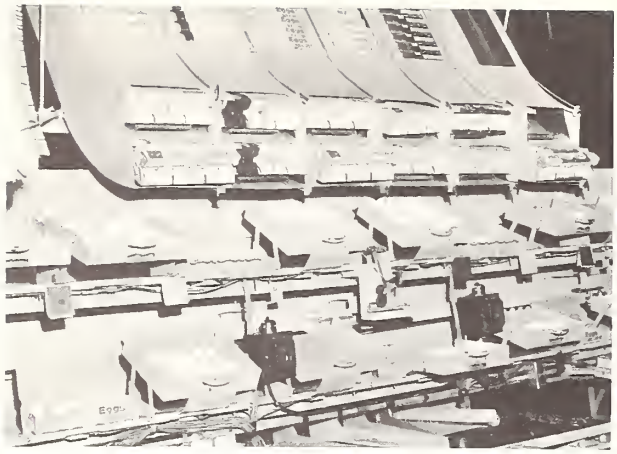


BN 10074 C

Figure 16.—A. At this station, the worker grades individual eggs for quality, and packages eggs. Automatic sizing (prior to quality evaluation), tabulating, and recording are provided. B. Unpacking eggs with multiple lifters. C. Supplying packing materials is handled by others.

BN 10071 C

Figure 17.—A. In this line, the workers grade for quality. Automatic sizing, packaging, tabulation, recording, and shell treating are provided. B. Others supply eggs. C. Still others supply packing materials, and monitor the packaging operation.



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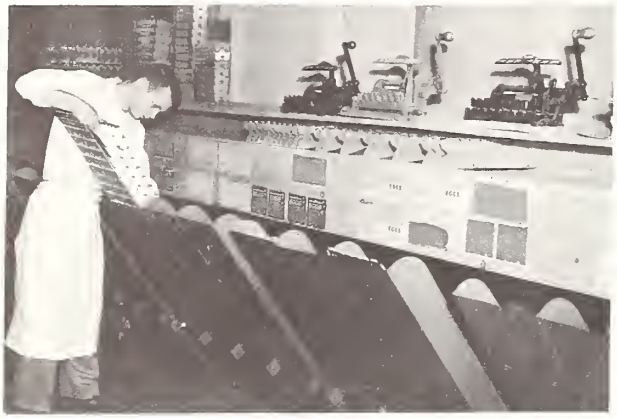

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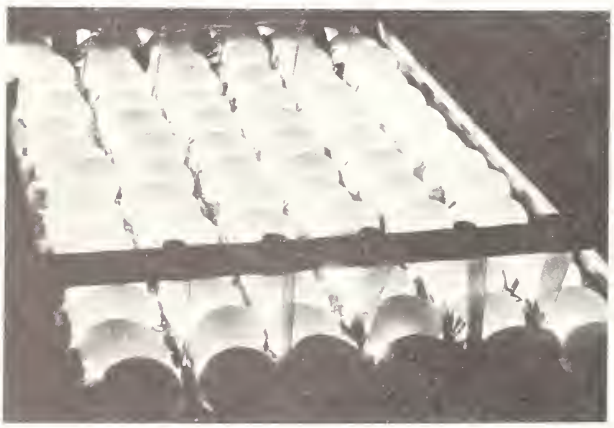
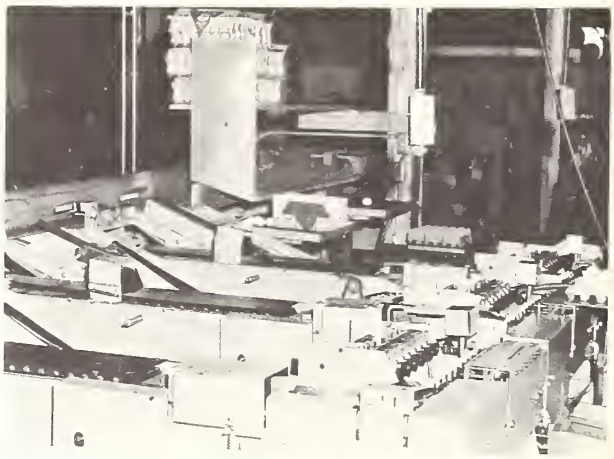


BN 10400 C

Figure 18.—A. At this packaging station, a worker inspects prescanned eggs only when quality is not uniformly good. Automatic sizing and tabulation are provided. B. Other workers supply packing materials and ungraded eggs. C. Others scan groups of eggs over a lighted area to remove eggs with obvious defects.



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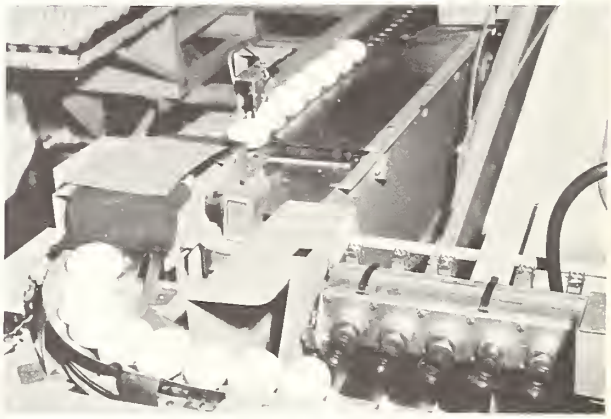

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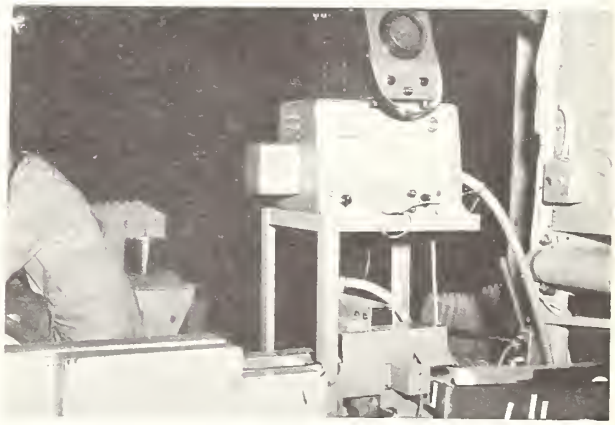
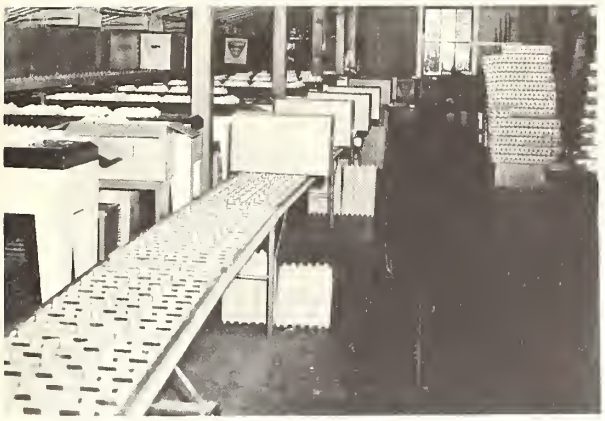


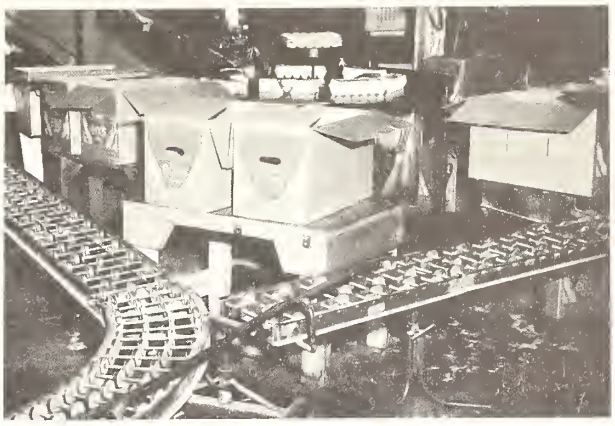
BN 10078 C

Figure 19.—A. This grading line, recently developed and now being evaluated by the Department of Agriculture (*11*), utilizes the group scanning and in-line weighing principles employed in the line in figure 18, and has added: B. Automatic packaging, and C. electronic bloodspot detection, which have nearly eliminated the need for individual egg handling.



BN 10072

Figure 20.—Wheel-type gravity conveyors help with the egg supply operation.



BN 10068

Figure 21.—Wheel-type gravity conveyors adjacent to packing table reduce the packer's labor in moving full cases.

the operator to perform all the services auxiliary to candling eggs, except obtaining and disposing of cartons. It is still the only grading equipment used in many egg grading and packing plants. Automatic devices for sizing, quality determination, tabulation, and packaging permit greater accuracy and productivity per grader, lower operating costs, and higher returns to the producer. As egg quality reaches a uniformly high level, it is feasible also to use group viewing of eggs (figs. 18 and 19) instead of individual manipulation of each egg, if workmanship is backed up by careful inspection, that is, the "breakout" method of quality check [3] (*5*) (*8*).

The selection of egg grading and packing equipment, either manual, semiautomatic, automatic, or a combination, should be governed by the volume of product handled, the type of package and amount of grading required, the range of quality of product, the ownership and operating costs of the equipment, and the most effective utilization of plant floor space and manpower.

Representatives of equipment manufacturers should be consulted to assist in the determination of performance and of equipment costs. Caution should be exercised in selecting equipment solely on the basis of original cost. Frequently, when a rapid increase in volume can be anticipated, equipment of a higher first cost may in the long run provide more economical handling methods because of its flexibility and the ability to expand with a minimum of plant alteration and down time.

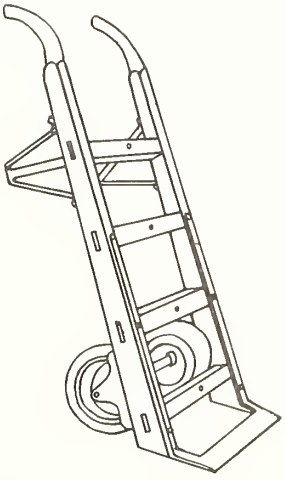
[3] Adequate facilities, including an enclosed, well-lighted booth, equipped with stool, level glass breaking surface, and albumen height micrometer, are necessary when albumen height measurement is used in quality evaluation.

Materials-Handling Equipment

The equipment selected to move product and packing materials into, about, and away from an egg grading and packing plant, even a small one, should be capable of doing the job efficiently and be adaptable to operations involving greater volume in the event of plant expansion.

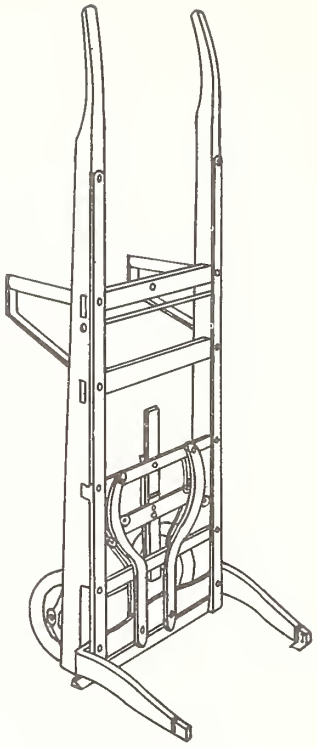
Broadly speaking, materials-handling equipment consists of all mechanisms or devices used in moving materials or products. The objective of its use is to minimize the labor and time required to handle products and materials as they pass through the various cycles of plant operations, while keeping in mind its cost in relation to the frequency with which it can be used efficiently.

In an egg grading and packing plant, containers and packing materials for eggs and cases of eggs



Neg. 7168–59(4)AMS

Figure 22.—A two-wheel stevedore-type handtruck.



Neg. 6339–58(7)AMS

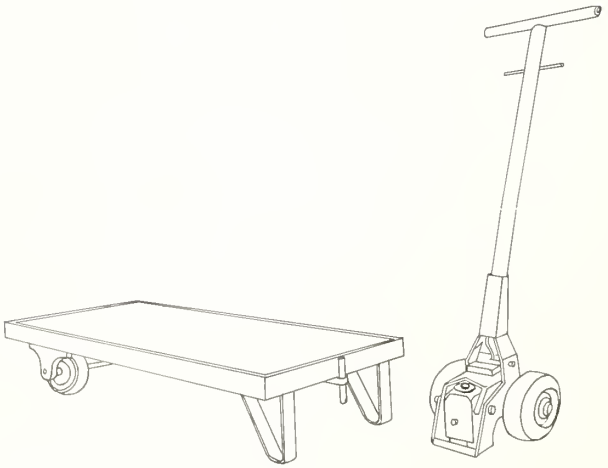
Figure 23.—A two-wheel clamp truck.

lend themselves to handling by relatively simple and standardized equipment, permitting the use of gravity conveyors and skids or pallets of uniform size for efficient unit load handling.

The conveyors (figs. 20 and 21) frequently installed with grading lines provide considerable saving in labor and reduce worker fatigue.

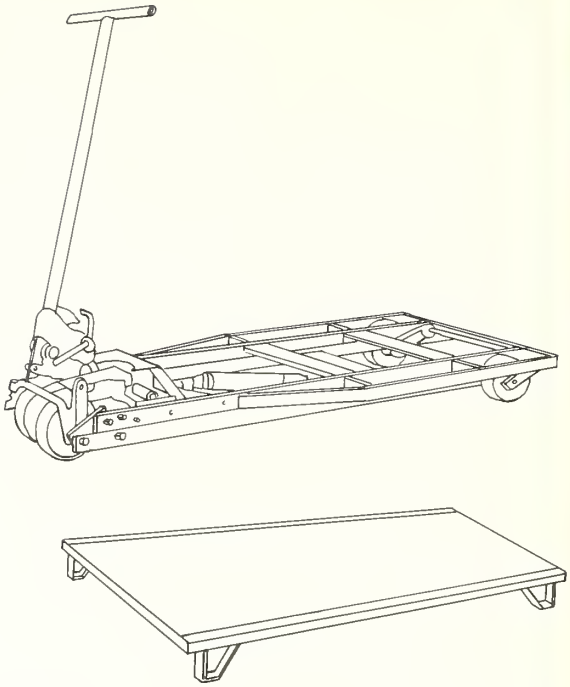
For small loads (approximately four or five cases) of products and materials, good use can be made of a two-wheel handtruck (figs. 22 and 23), the stevedore type for fiber or wood containers and the clamp type for wood containers.

When inaugurating the unit load system of materials handling in a small egg grading and pack-



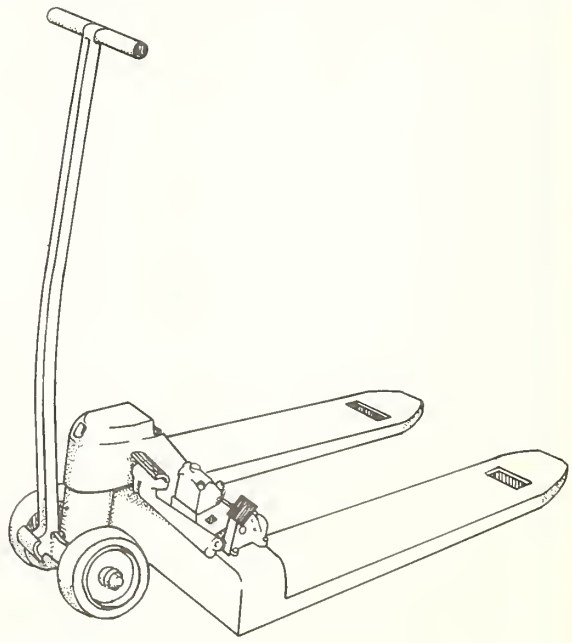
BN 10079

Figure 24.—Jack and semilive skid.



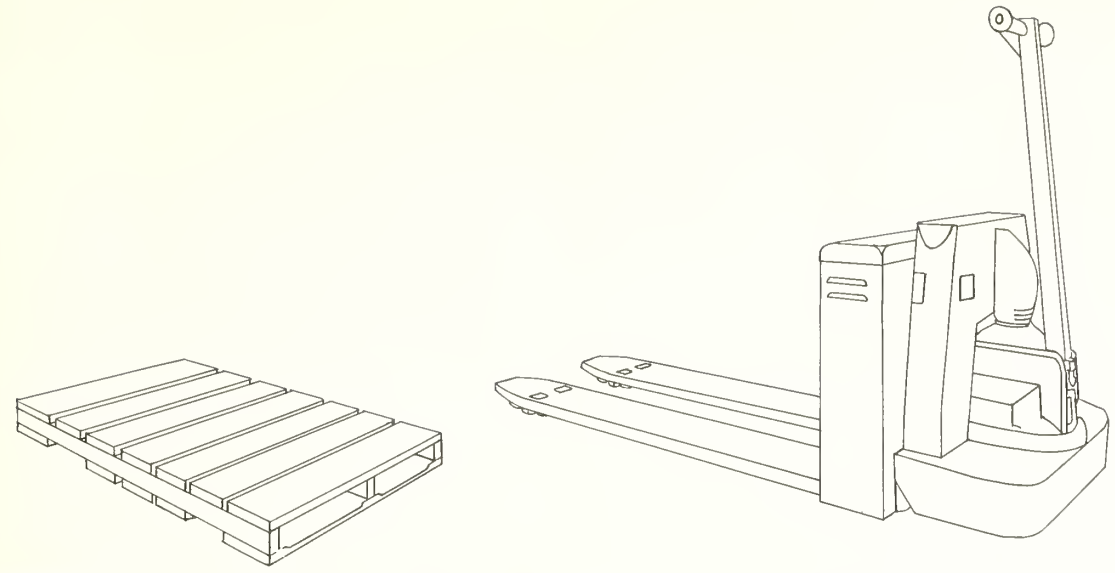
BN 10080

Figure 25.—Manual hydraulic low-lift platform truck and dead skid.



BN 10128

Figure 26.—Manual pallet transporter.



Neg. 6344–58(7)AMS

Figure 27.—Pallet and walk-type electric pallet transporter.

ing operation (600 cases per week or less), it is best to start either with one or two jacks (fig. 24) and a small supply of semilive skids, a manual low-lift platform truck (fig. 25), and a small supply of dead skids; or with a manually operated pallet transporter (fig. 26) and a supply of pallets. These provide unit load economies for truck loading and unloading and storage of packing materials and eggs. However, use of a pallet system should receive most favorable consideration, since it permits the most economical conversion later to forklift truck and high stacking.

Determination of the number of skids or pallets needed depends on the volume and frequency with which the product and packing materials move in and out of the plant, plus consideration of storage space. If storage space permits, it is good practice to have a few more skids than would be re-

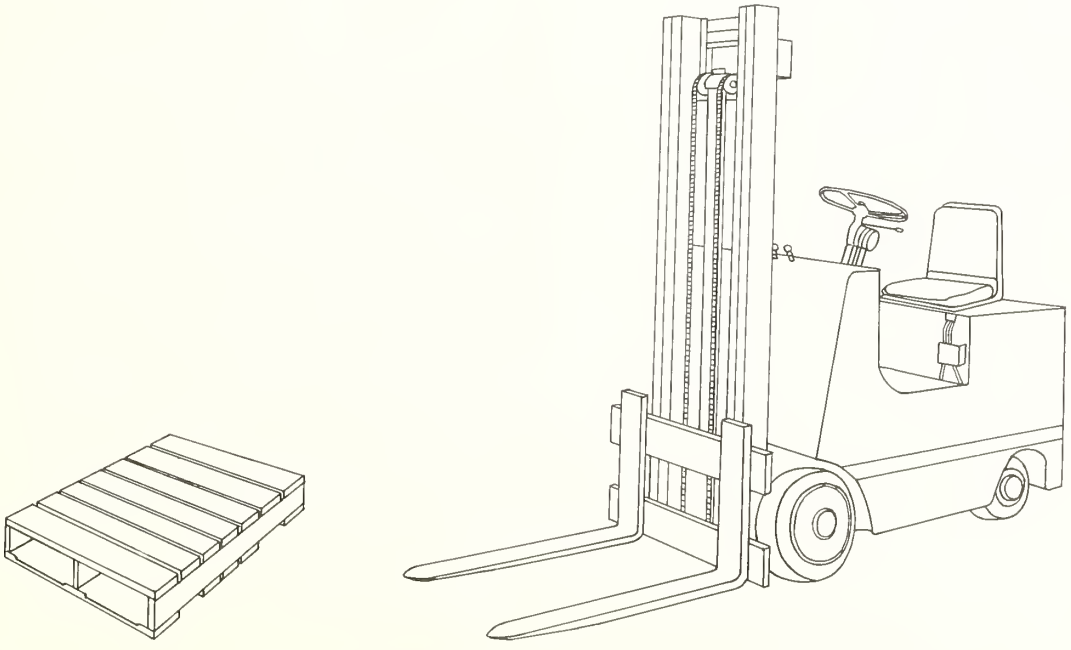


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Figure 28.—Pallet and rider-type electric forklift truck.

quired to provide unit load space for one week's production of graded product (figuring at least weekly inventory turnover) three days of ungraded receipts (for weekend receipts), and approximately a month's supply of packing materials (to provide savings through large-volume purchases). As the volume in a plant increases, more expensive labor-saving unit-load equipment can be used to a greater advantage. The pallet transporter (fig. 27), a battery-powered low-lift truck, eliminates the manual effort required to move a loaded pallet, increases speed of movement, and has good maneuverability in congested areas. The forklift truck (fig. 28), a battery-powered transporter and high stacker combination, requires greater volume of product for complete utilization.

Storage Facilities

The determination of the size, type, and location of storage facilities is dependent upon such factors as products handled, the kinds of packages, production methods, the volume handled, and the frequency of shipments or inventory turnover. The highly perishable nature of eggs and egg products imposes definite temperature requirements on areas where they are handled and stored. These requirements are the most important consideration in planning storage facilities.

The storage requirements for an egg grading and packing plant fall into two broad categories: Refrigerated storage, and nonrefrigerated, or dry storage. Refrigerated storage is further subdivided into cool storage for eggs in the shell (including air-conditioning for work areas and adjoining areas in which eggs may be held temporarily) and freezing temperature storage for freezing and holding egg meat.

Refrigerated Storage

Under normal plant operating conditions, it is not feasible to maintain storage temperature and humidity at the optimum levels (29° F. and 70 to 75 percent relative humidity), because of moisture condensation on the eggs when they are moved to higher temperatures in the work areas. If eggs have been cooled to between 50° and 60° within a few hours after production, as good management practice dictates, it is best to provide similar temperatures during transport to the plant and during storage before grading and before shipment from the plant.

Generally, if eggs have been held at temperatures of 50° to 60° at the farm and during shipment to the plant, separate refrigerated receiving facilities are not necessary if the eggs can be unloaded directly from the refrigerated truck to an air-conditioned grading and packing room and are then moved to refrigeration at 50° after grading. If receipts of cooled eggs are scheduled properly, only one egg cooler is necessary. In accordance with the plant's receiving and shipping cycle, this cooler should normally be capable of holding the weekly graded production and overflow of ungraded eggs as the occasion requires (weekends, holidays, nonscheduled weekday deliveries, or small daily holdovers). It should be of clear-span construction, providing (1) a 14-foot ceiling to permit high stacking, (2) cooling of daily receipts to 50° within 24 hours, (3) air-conditioned grading and packing area, (4) automatic opening and closing refrigerator doors for refrigeration economy and efficient product movement, (5) walls and ceiling impervious to moisture, (6) a smooth concrete floor pitched ¼ inch per foot to a central trapped floor drain, (7) wall bumper guard rails, and (8) sufficient aisle space to permit convenient maneuvering of pallet-loads of cases of eggs (not less than 8-foot aisles for forklift trucks).

The grading and packing area serves as temporary storage space for both eggs and packing materials, as well as a working area for operating personnel. The air-conditioning, therefore, involves cooling in the summer, heating in the winter, and year-round ventilation without draft on the workers. This can be managed with overhead ducts from a central plant or with a sufficient number of ceiling-suspended, self-contained air-conditioning units to provide temperature and humidity conditions comfortable for the workers and at levels that maintain product quality.

Since many factors are involved and variables in climatic conditions and product volume exist in each installation, only limited recommendations for refrigeration are made in this report. Specific capabilities and limitations of equipment should be determined through a competent refrigeration and air-conditioning equipment contractor.

Plants that carry on a small breaking and freezing operation to handle the liquid from leakers and undergrade eggs should provide facilities for rapid and continuous movement of canned egg liquid into a −10°F. freezer with air circulation, in order to provide a quick freeze. Storage of frozen egg meat requires a temperature of 0°F. (*9*). If the volume of canned egg meat is less than 300 pounds per day, consideration should be given to using a family-size deep freezer capable of maintaining −20° F., with use of a nearby commercial cold storage plant for storing after freezing.

Nonrefrigerated Storage

The determination of dry storage space requirements depends upon the quantities of packing materials purchased, the size of the inventory, and the number of brands, sizes, and styles of 1-dozen

and 30-dozen containers used. Sufficient space must be provided also for such materials as egg trays (filler-flats) or flats and fillers, gummed tape, and egg meat containers.

In a two-story building with efficient elevating equipment, it is possible to use the upper floor for storage of materials, with gravity chutes to transport the materials to the work stations. In single-story buildings, sufficient storage space for packing materials is required on the same floor with the production area. If a mezzanine for packing materials makeup is used, a small part of it can be used for storage. Regardless of whether the major dry storage area is at an elevated level or on the ground floor, it should be well lighted, dust free, and well ventilated.

The rapid change from the use of wood egg cases to fiber has materially decreased the problem of maintaining a large number of madeup wood cases for day-to-day operations. It has correspondingly reduced the dry storage space necessary to maintain an adequate stockpile of empty cases.

Receiving and Shipping Facilities

The receiving and shipping areas are important to management from the standpoint of moving product in and out of the plant with the least possible hazard to its quality and at the lowest labor and equipment costs. Further, they provide a convenient place for checking and counting the product and maintaining contact with producers and buyers. Although such direct contact is frequently difficult, an intimate knowledge of the movement of goods in and out of the plant helps to maintain good public relations, reduces pilfering, and provides management with a running account of plant production. If inadequate truck turnaround and backup space exists or short docks of improper height plague these areas, they create a bottleneck for production, and product quality suffers. Adequacy in these areas therefore calls for certain basic plant site requirements. The building should be located far enough back from the streets or highways to permit maneuvering space for tractor-and-trailer units. Sufficient parking space for customers and plant employees is necessary. Dock space for receiving and shipping should provide for two or more trucks unloading or loading simultaneously. Plant traffic flow from unloading and to storage or loading areas should pass near the office and should be so located in relation to plant operations that the flow of ungraded product does not restrict the flow of graded product. Other requirements include:

1. Docks of truck-bed height to permit movement of unit load equipment onto the trucks being loaded and unloaded. To permit this operation for trucks of different bed heights, a range of ramp heights avoids the expense of hydraulic aprons or bothersome ramp blocks.
2. Adequate shelter from unfavorable weather.
3. Sufficient dock width for free passage of unit loads and storage space for empty pallets used in unloading.

Machine Room and Shop

Heating and refrigerating equipment and other machinery, and storage space for spare parts should be centralized in one room with a well-equipped workshop. Its location in relation to the plant layout affects the length of pipes, ducts, and wiring required for heating, lighting, and cooling. The size is determined by the kinds of heating and air-conditioning equipment and the amount of parts stored and workshop space needed. In many small plants, no special area is set aside for a workshop because equipment repairs are made by outside service agencies. However, in view of the rapid increase in mechanized egg grading, it is recommended that workshop facilities be provided.

Offices

The floor space occupied by offices is usually small in relation to the rest of the plant. In large plants (500 cases or more a day), it is desirable to provide two separate rooms—one for record keeping and sales and the other as an office for the manager. In small plants, these activities can be confined to one room. It is important that the office be convenient to the work areas so as to facilitate production control. In this respect, it is helpful to provide a window in an inside wall so that operations can be observed from the office. Such an arrangement, coupled with a communications system, materially assists in conserving the manager's time in maintaining a smooth operation.

Personnel Facilities

In recent years, there has been a marked trend toward providing plant workers with more comfortable surroundings, both at their work stations and in the rest areas. Better morale, greater worker productivity, improved workmanship, and lower labor turnover have resulted.

Lunchroom

Egg grading and packing plant managers frequently give little consideration to employee eating facilities. Generally, the employees' personal autos, the loading dock, or work stations are made to serve as eating places. A well-lighted, airy room, equipped with tables and benches sufficient

to seat the entire working crew at one time, should be provided. These facilities can also be supplemented by refreshment and food vending machines. Locating the room convenient to the restrooms and employees' work stations is wise, since walk time is reduced.

Toilet Rooms

Toilet rooms should be designed to accommodate the plant complement of employees in a short time at lunch and "break" periods. A sufficient number of toilet bowls and lavatories, proper facilities for hot and cold running water, soap, towels, and covered receptacles for used paper towels are required. The room entranceways should be properly vestibuled. Partitions should be wall- or ceiling-suspended.

It is important that walls and floors of toilet rooms be of a material impervious to water such as tile or glazed brick, so as to permit easy cleanup. Ceilings may be of finished wood, plaster, or smooth cement, but should be painted with a light-colored paint.

Proper ventilation is one of the important requirements of toilets and washrooms. It can be provided through windows opening to the outside air. Six square feet of window opening for one toilet bowl, plus an additional square foot for each additional fixture, is recommended. Windows should open to half their area. In air-conditioned quarters, an exhaust fan can supplement air circulation. The local health authorities should always be consulted before planning restroom facilities.

Refuse Room

Accumulations of trash and waste from daily egg grading and packing operations are seldom provided for adequately. Frequently, old oil drums are used as waste containers and are placed on the dock with the day's accumulation of trash for pickup by garbage-disposal trucks. This is not only an unsightly practice but one that can easily become a public nuisance.

In addition to attracting rodents, such waste as loss eggs, packing materials moistened by smashed eggs from the grading room, and egg shells and other breaking room waste rapidly develop offensive odors and attract swarms of flies during warm weather. Waste accumulations should be disposed of at intervals throughout the day. A small, readily accessible, refuse room, equipped with a floor drain and hot and cold water outlets for cleanup purposes, and vented to the outside will materially reduce this problem. It is desirable to equip the room with an exhaust fan.

Plant Utilities

The utilities serving an egg grading and packing plant were at one time considered rather inconsequential, mainly because operations were small and little consideration had been given to expansion. In planning the modern egg grading and packing plant, lighting, heating, refrigeration, and water supply play an important role in efficient operation. Proper planning requires considerable technical knowledge, and it is usually advisable to employ the services of qualified specialists to assure proper installation and operation.

Electricity

Before an electrical system can be designed, it is necessary to know the maximum load requirements, the location of outlets, and future expansion plans. Although strategic location of electrical outlets is becoming increasingly important to provide power for mechanical equipment, the main concern in developing an adequate electrical system in an egg grading plant involves illumination. Natural lighting is used to good advantage in some of the plant work areas, such as offices, loading platforms, dry storage space, and receiving and shipping areas. However, the varying intensities of daylight must be supplemented by overhead electric lighting throughout the plant, as well as special lighting for specific work areas in offices, grading rooms, and areas for packing materials makeup.

In most communities, installation of electric equipment is governed by local ordinances. While these are not uniform everywhere, they have much in common, since practically all of them are based on the National Electrical Code (*6*). The essential function of the code is to provide safety from fire and accident hazards. Other guides to adequate wiring also are available (*4*).

To insure that a given illumination will be maintained even where conditions are unfavorable, the system must be designed to produce at least 25 percent more light than the required minimum.

Ease of seeing without eyestrain or fatigue is fundamental to safe, efficient, economical operation. Good illumination can result in (1) increased production, (2) better workmanship, (3) a neater plant with easier housekeeping, (4) improved employee morale, and (5) fewer accidents.

The efficiency of illumination can be greatly improved by the use of paints with proper reflection values. Unpainted and dark surfaces found in some plants not only are unsightly, but they cause a sharp reduction in efficiency of the illumination system. Proper painting of plant interiors can increase the intensity of illumination as much as 50 percent. Numerous studies have been made to determine the suitability of different colors for use throughout a plant, and recommendations have been developed to serve as a guide to plant operators (*10*).

A simple communications system should be included in the electrical system. A wide variety of communications systems are available to facilitate communication between different parts of a plant. Most systems employ master and speaker stations. Master stations have selector switches that permit the user to select the area he wishes to contact. The speaker stations can receive and talk back only to the master station. A simple buzzer system, using a code to call key workers, also is effective.

Gas

Various heating systems are available, but in all the egg grading and packing plants studied, gas-fired hot-air unit heaters were used. Among the advantages reported were ease of installation, low space requirements, low installation expense, and air circulation furnished by blower fans. The unit heaters also can be used effectively in large spaces or storage areas which do not require the heating of the entire areas, but only of the work stations.

The comfort of the workers in egg grading plants presents a problem because of the difference between the temperature of eggs coming from a refrigerated area and the temperature considered optimum for worker comfort at the work stations in the grading room. Temperatures of 66° to 73° F. (*1*) are recommended for the comfort of workers.[4] This effective range of temperatures for workers is in direct conflict with the 50° to 60° temperatures recommended for eggs. It is, however, desirable to keep eggs from "sweating" during the normal sequence of plant operations. As previously pointed out, this problem involves consideration of air-conditioning.

In addition to space heating for offices, restrooms, and work areas, gas fire is effective for heating water for restroom lavatories, egg grading and packing room cleanup, egg breaking room cleanup, and some types of egg cleaning.

Water

An efficient, modern egg grading and packing operation requires provision for an adequate supply of potable water. In addition to refrigeration and drinking water requirements, egg washing, egg breaking, and grading and packing equipment cleaning requirements must be met. The public water supply is frequently used, and it may be supplemented by a private water supply from a well on the property if approved by State health authorities.

The plant's water lines should be laid out so as to provide adequate pressure in areas of heavy use. Adequacy involves a full flow per outlet when all outlets from a common source are open simultaneously. Strategic location of outlets throughout the plant should include easy accessibility for cleanup purposes and convenience to work stations employing water-using equipment.

Plant Layout

For an acceptable degree of operating efficiency, an egg grading and packing plant building must be designed to fit the internal layout of the plant, and vice versa. Both must be suited to the processing equipment, operations, and needs for storing the product.

To visualize the sequence of operations and their interrelationships as they affect the size and location of facilities and equipment, it is helpful to develop a flow process chart of an egg grading operation (fig. 29), supplemented by a flow process chart of an egg breaking and cleaning operation (fig. 30). The illustrations are intended to visualize all the combinations of processes that can be expected in an average commercial plant. Charting the processes in proper sequence is helpful in working out the problems of a detailed layout. The problems generally involve (1) adequate and properly proportioned space for production, storage, and service areas; (2) location of load-bearing walls, building columns, aisles, windows, and docks; (3) width of aisles, doorways, and docks; (4) height of ceilings, docks, and doorways; (5) avoiding possible bottlenecks in flow of product and materials; (6) operations in which distances within the plant are critical or in which they are of minor significance. Practical answers to these problems generally result in a sound overall layout.

[4] Classifying egg grading room work as "light work" is an arbitrary determination by the authors.

FLOW PROCESS CHART FOR EGG GRADING & PACKING OPERATIONS

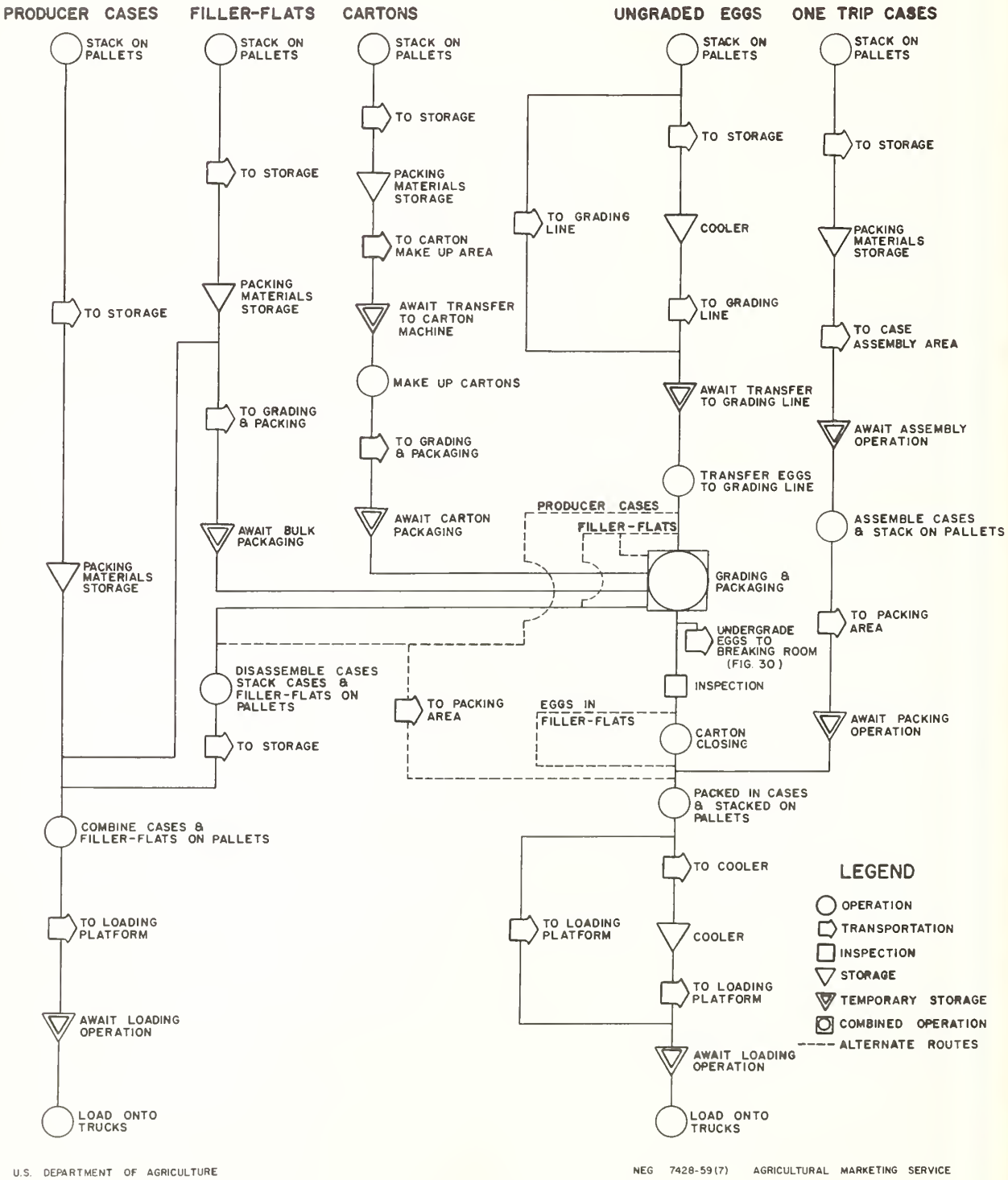

Figure 29.

FLOW PROCESS CHART FOR EGG BREAKING & CLEANING OPERATIONS

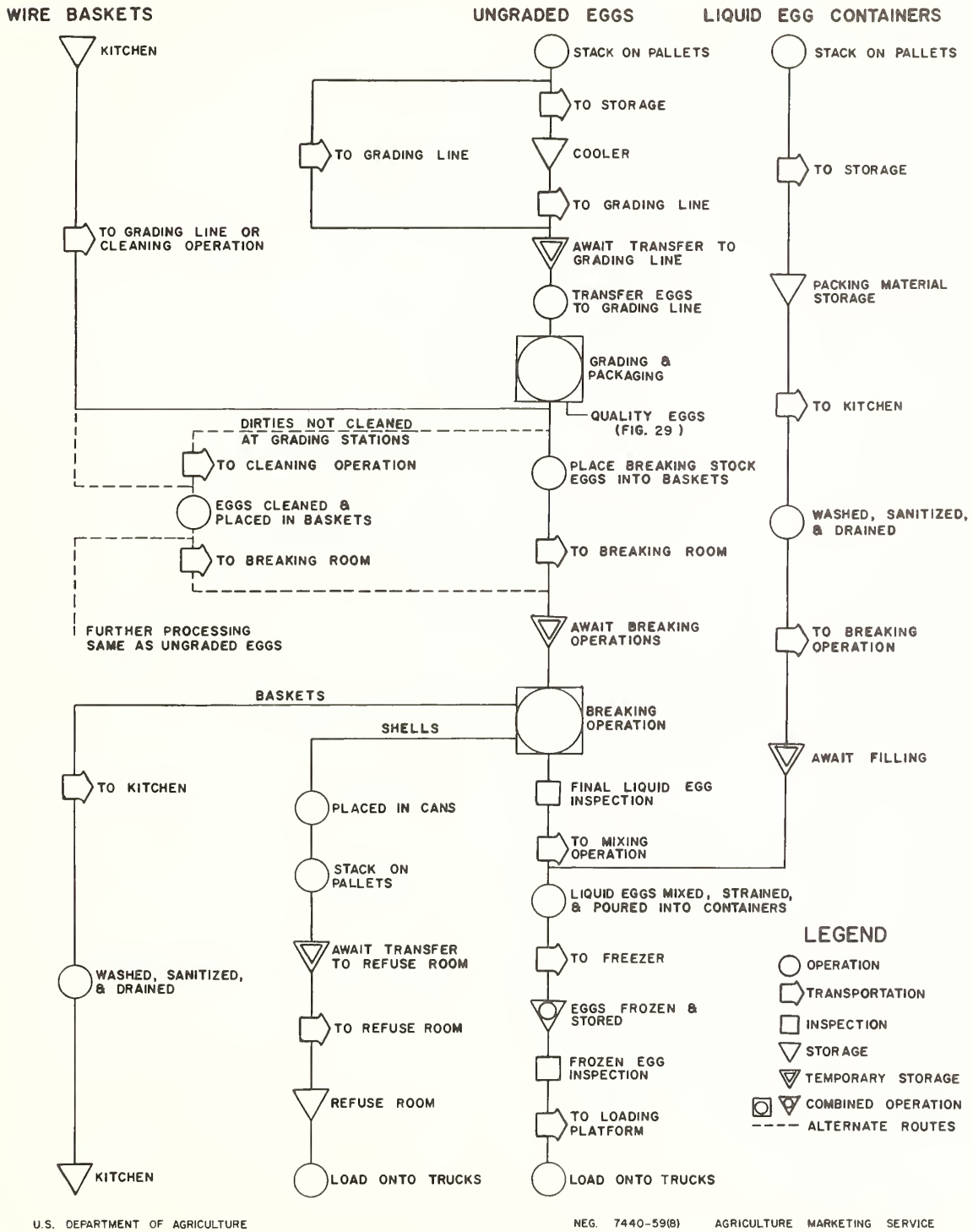

Figure 30.

Improved Designs for Commercial Egg Grading and Packing Plants

The egg grading and packing plant designs set forth in this report were developed to provide an effective approach toward solving some problems of plant location, construction, layout, equipment selection, and expansion when construction of a new plant is considered.

To develop sound recommendations, a number of assumptions were made:

1. Most of the graded-egg volume in the U.S. originates in plants whose volume ranges between 60,000 and 275,000 or more cases of eggs annually.

2. Although the present trend towards large-scale producing enterprises, marketing large lots of uniform, fine-quality eggs, will probably continue, irregular quality frequently found in standard egg production still prevails throughout the country and probably will never be eliminated entirely.

3. Eggs of irregular quality require manual grading, while production from large commercial flocks producing uniform fine quality can be graded effectively on recently developed grading lines that do not require the manual manipulation of each egg before a candling light.

On the basis of these considerations and of observations in numerous egg grading and packing plants, typical examples of which were illustrated earlier in this report (figs. 1 to 9), improved designs for plants were developed (figs. 31 to 37). They provide some answers to the following management problems: (1) Plant site restrictions on expansion; (2) inability to expand without curtailing production or causing a plant shutdown; (3) inability, because of plant design, to use economical handling methods or mechanized grading and packing equipment; (4) plant congestion, due to column location, narrow aisles, and crisscrossing traffic; (5) excessive equipment maintenance and replacement costs due to improper equipment maintenance facilities or lack of facilities; (6) inability to capitalize on economies of large-scale purchases of packing materials because of insufficient dry storage space; (7) lack of adequate refrigeration facili-

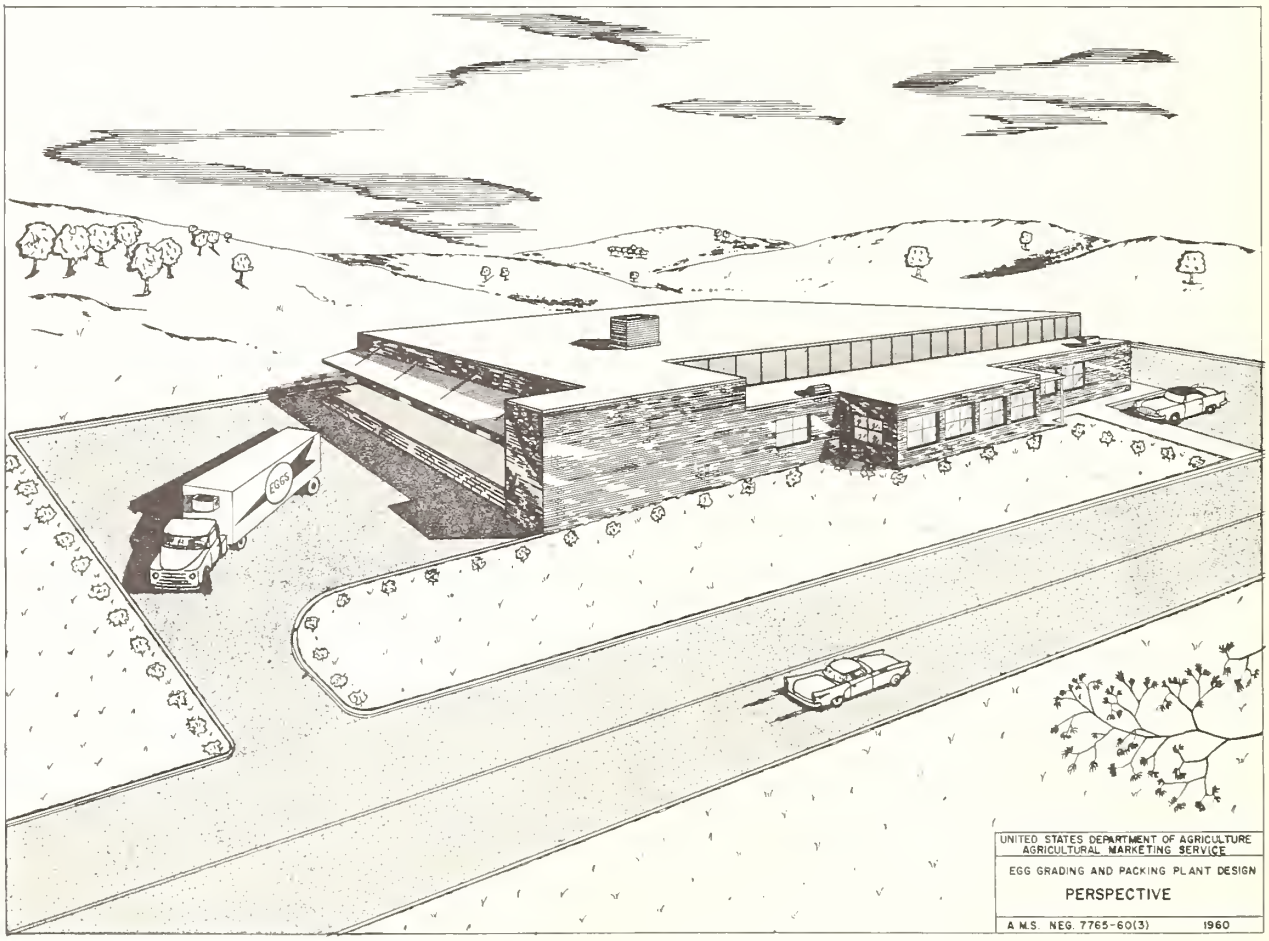

Figure 31.

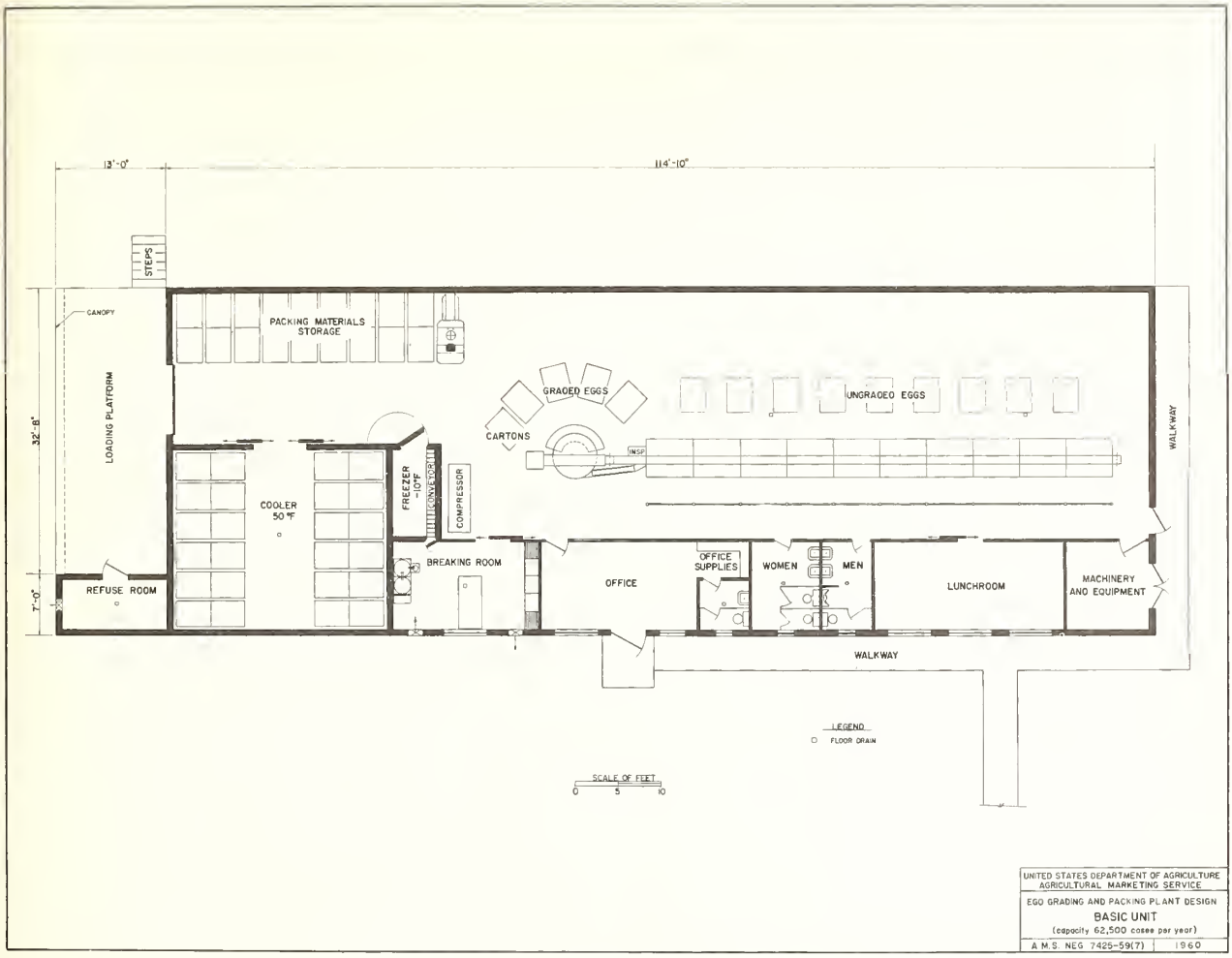

Figure 32.

ties; (8) lack of flexibility in shipping schedules due to inadequate loading, unloading, and storage facilities; (9) lack of adequate worker facilities; (10) costly or inadequate plant housekeeping due to improper floor surfaces or plumbing and refuse disposal facilities; (11) lack of facilities for an egg breaking operation to salvage undergrades.

Plant Layout

The plant designs developed start with a basic plant unit and provide for three expansions (figs. 31 to 36). These layout designs permit management several choices:

1. Expansion from a small capacity of approximately 60,000 cases a year to a capacity of approximately 275,000 cases a year, with 2 intermediate expansion steps at 125,000 and 200,000 cases a year.

2. Expansion to the largest capacity in one or two steps instead of three, if volume warrants.

3. Construction of only the basic unit or any of the expanded units.

Regardless of the selection made, any choice will provide effective facilities. Obviously, if production is never to exceed the capacity of the basic unit or the first two expansion steps, land requirements for a plant with capacity of 275,000 cases will not be needed. It is also obvious that if the first, second, or third expansion stage (figs. 32 to 35) is selected as the initial plant unit, the hallway between coolers could be aligned with the production aisles by having coolers of equal length.

Production capacities in the basic unit and each expansion step are based on a 7½-hour day and a 250-day work year. It is assumed that all the grading and packaging at first will be manual, at a row of 10 manual grading stations.[5] As the receipts of fine-quality eggs increase, each ex-

[5] If management prefers to test mechanized grading and packing equipment on a small scale before making the first expansion step, or if a goodly percentage of the initial volume lends itself to mechanical handling, a mechanized grading unit can be blocked in as a guide for dimension requirements in the basic unit (fig. 32).

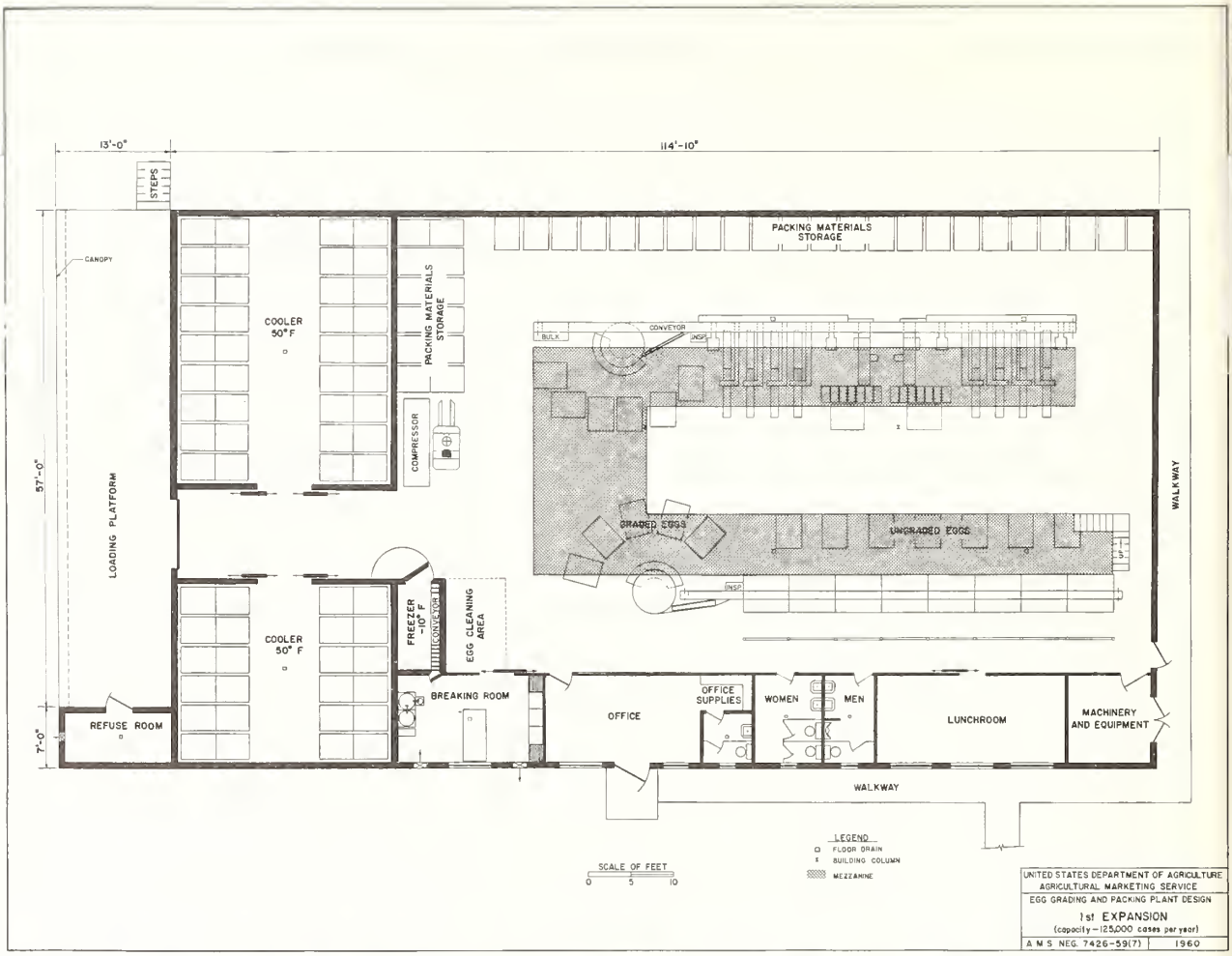

Figure 33.

pansion step provides for the addition of mechanized grading and packaging equipment to handle the uniform fine-quality lots. After the first expansion, the plant would be able to handle up to 60 percent of its volume on mechanized equipment; at the second step, up to 75 percent; and at the final step, over 80 percent.

Each expansion stage is accomplished by extending the floor, wall, and roof of the basic unit (or of the expanded unit) and removing the intervening walls after construction of the addition is complete. Thus, the original building and the additions become a single new unit. This provides both construction economy and expansion without a plant shutdown or curtailment of production.

Property Plat

The rectangular parcel of land (fig. 36) is approximately 158 by 276 feet. Although the basic unit (fig. 32) with loading areas, driveways, and parking areas requires only about one-third of the land area, three stages of expansion (figs. 33, 34, and 35) can be accomplished without significant change in the original plant design or plant site.

The driveways from the highway provide adequate accessibility for trucks of all sizes at one end, and space for employee parking at the other end. The parking area in the front provides for customer and plant management parking. At the loading-dock side of the building, sufficient space is available for maneuvering and parking trucks and trailers (fig. 31).

The land at the rear of the site is intended to serve as a narrow buffer strip between the building and the property line after the last building expansion has been completed.

Construction

The buildings (basic unit and each addition) are single-story structures, 17 feet from plant floor level to roof in the production area and 10 feet to roof level in the service area. The overall

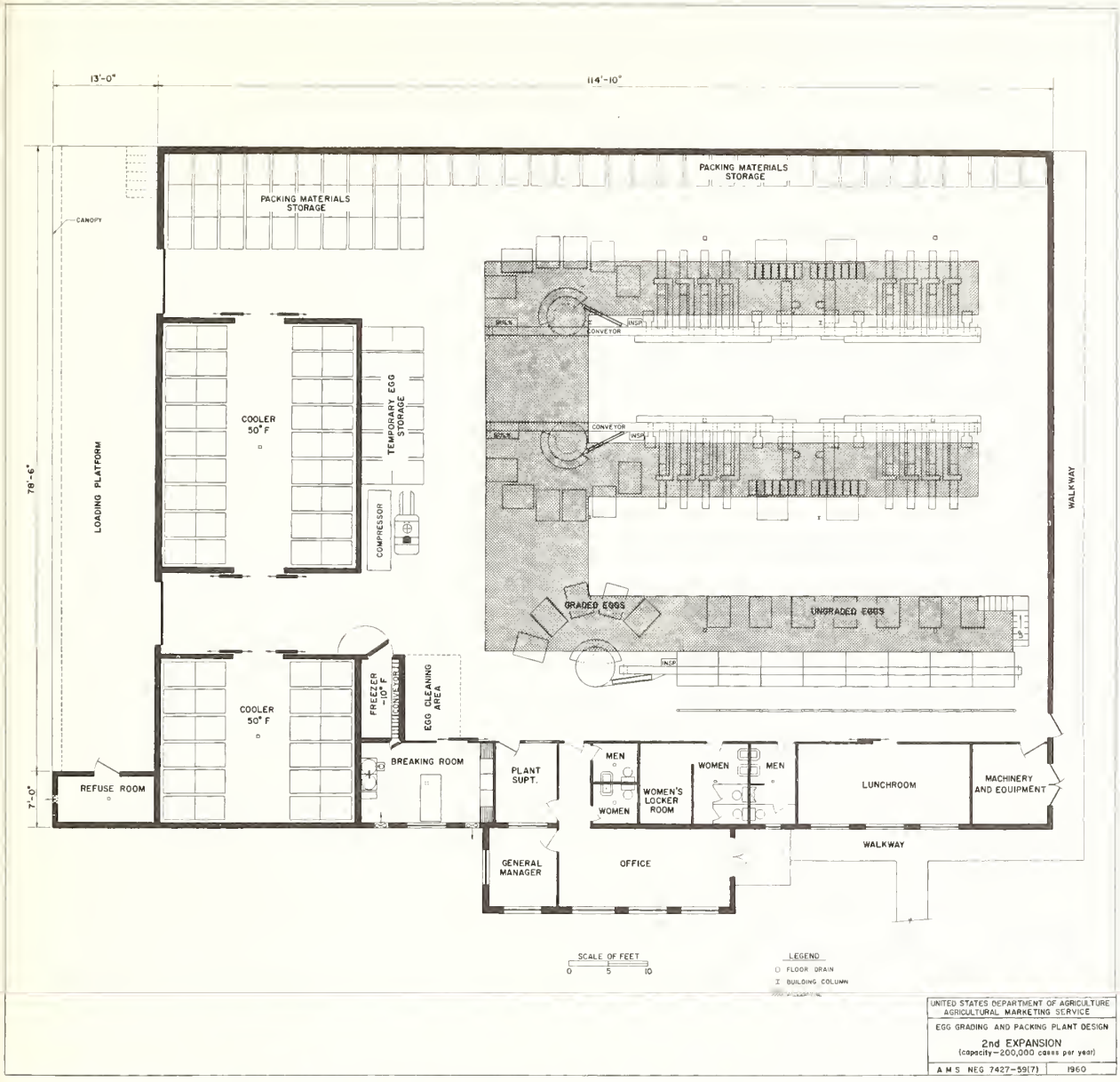

Figure 34.

dimensions are approximately 40 by 125 feet for the basic unit. In each of three expansion steps, the overall length stays the same; the depth is increased from 40 to 65, to 85, and to 105 feet, respectively, a section of mezzanine is added over the production area in successive steps, and at the third and fourth expansion steps, the office and restroom space is increased slightly.

The building materials that are most reasonably priced in the area can be used. For the purposes of this report, concrete block construction was selected for the production area and concrete block faced with brick veneer for the service area. The building wall between the roof of the production area and the roof of the service area is of insulated metal paneling, providing durable, economical construction.

The floor is of reinforced concrete at truck-bed height. Smooth, troweled cement surfaces are pitched ¼ inch to the foot to trapped floor drains in the production areas (and parts of the service area using water) [6] to permit cleaning. The service area, about 60 feet long, occupies most of the front of the building. For the third and fourth expansion steps, an 11- by 33-foot extension provides additional office and restroom space.

[6] Unglazed ceramic tile recommended for breaking room and restrooms.

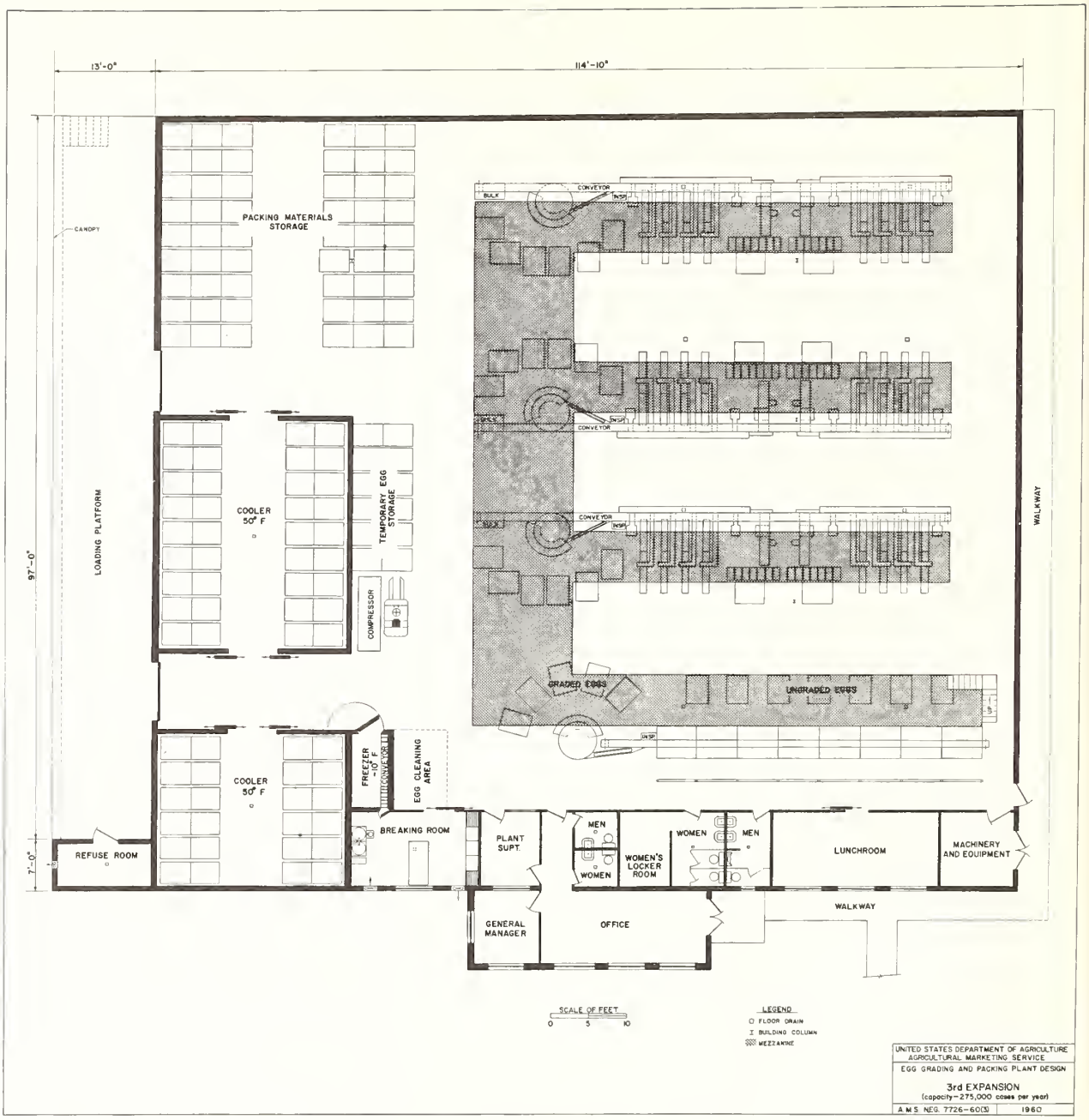

Figure 35.

The production area extends from one end of the building to the storage area at the other end. A 15½-foot clearance to roof trusses is provided. Bay dimensions permit maximum freedom in equipment placement, aisle space, and installation of a mezzanine for packing materials makeup and supply for the grading lines. The storage areas adjoining the production area are served by a wide, covered loading dock. Ceiling heights are 15½ feet in the dry storage area and 15 feet in the coolers.

The plant roof is flat, and consists of steel decking on open-web welded steel roof trusses. The decking is provided with an exterior layer of gypsum insulation and tar and gravel weatherproofing.

There are no window openings in the rear of the building. Standard doors are used in the service areas and 8-foot overhead doors serve the loading and unloading area. The receiving and shipping dock is 12 feet wide, at truck-bed height (ranging from 3½ to 4½ feet), with a 13-foot

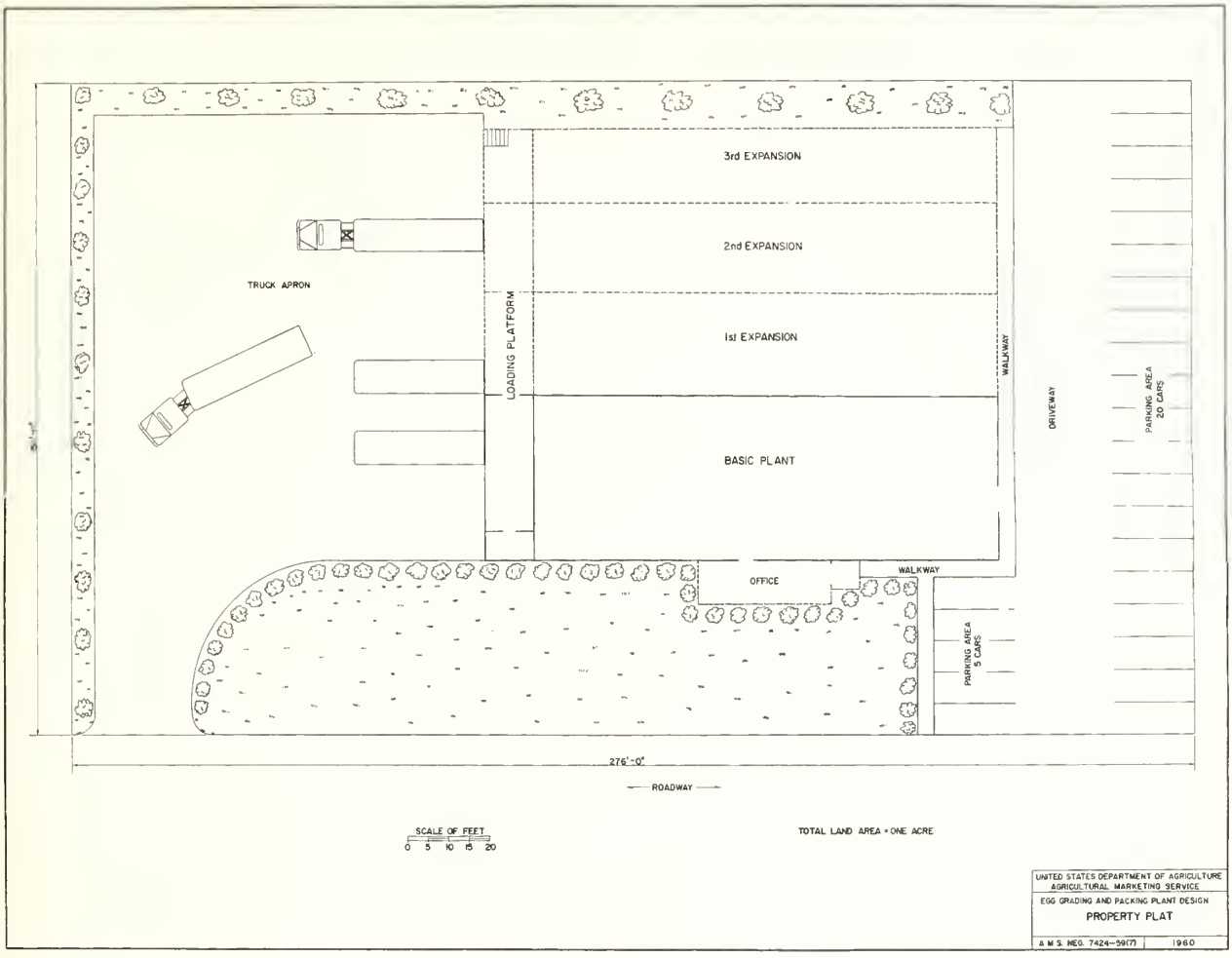

Figure 36.

canopy extending across the end of the building with the exception of a 7- by 13-foot space occupied by the refuse room.

Typical construction materials that can be used are:

Framework.—Structural steel.

Floor and footings.—Reinforced concrete.

Floor covering.—Asphalt, rubber, or vinyl tile in offices and lunchroom; unglazed ceramic tile in restrooms and breaking room; smooth, troweled cement (not glazed) in the remainder of the plant; and tongue-and-groove flooring over subflooring for the mezzanine.

Roof.—Web trusses on steel joists, with corrugated metal decking.

Roof covering.—Gypsum insulation with tar and gravel covering.

Ceiling.—Suspended ceiling in service areas with plaster on expanded metal lathing; cork insulation and troweled plaster in refrigerated storage; open ceiling in rest of plant.

Walls, interior.—Four-inch concrete block (painted); 48-inch tile wainscot in restrooms and breaking room; and cork insulation with troweled plaster finish in refrigerated storage rooms.

Walls, exterior.—Eight-inch concrete block in production areas; 4-inch concrete block veneered with 4-inch brick in service area; metal-clad insulated panel wall above service area.

Windows.—Aluminum awning or casement.

Doors.—Steel-clad.

Gutters and downspouts.—Aluminum or galvanized iron.

Egg Grading and Packing Area

The egg grading and packing area in the basic unit and each of the three additions occupies more floor space than any of the other areas (except aisle space) in the plant. In each instance, it provides space for grading and packing equipment and pallets for graded and ungraded eggs at the various work stations.

Basic Unit

To grade and pack 250 cases of eggs a day manually requires 1,125 square feet of floor space

(table 1) or about 25 percent of the plant space. This plant employs a 10-station manual grading line for the grading and packing operation.

In the event that the volume of fine-quality eggs warrants, one mechanized unit can be accommodated instead of four of the manual grading stations. The floor space indicated includes work space at each station and access aisles for the operators.

First Expansion

At the first stage of expansion, the building extension adds 656 square feet of grading and packing area to that already available in the basic unit, for a total of 1,781 square feet or 25 percent of the plant space. The original floor space for egg grading and packing is reduced slightly to provide 80 square feet of floor space for an egg cleaning area. Lack of published data on existing cleaning equipment prevented specific equipment layout recommendations. Research studies in this problem area are now being undertaken.

In order to provide a central area for packing materials, convenient to both lines, the space over the packing area is utilized for a 13- by 26-foot mezzanine for packing materials makeup, and the space over the grading lines is utilized for mezzanine-height service lanes. The mezzanine and walkways are 8 feet above the floor level, and provide 1,066 square feet of space.[7] This installation converts the manual line to an overhead

[7] The total grading and packing floor space (table 1) does not include the packing materials mezzanine and service lane floor space. A mezzanine is not recommended for the basic unit, since the worker's time in the packing materials supply operation could not be fully utilized. Recent development of floor-mounted automatic carton makeup and supply devices (currently being tested) for automatic packaging units may also rule out the need for a mezzanine.

TABLE 1.—*Space utilization in improved-design plants*

Area [1]	Basic plant		First expansion		Second expansion		Third expansion	
	Square feet	*Percent*	*Square feet*	*Percent*	*Square feet*	*Percent*	*Square feet*	*Percent*
Production:								
Grading and packing	1, 125	25. 7	1, 781	25. 0	2, 587	27. 0	3, 393	29. 5
Egg cleaning			80	1. 1	80	0. 8	80	0. 7
Breaking	188	4. 3	188	2. 6	188	2. 0	188	1. 6
	1, 313	30. 0	2, 049	28. 7	2, 855	29. 8	3, 661	31. 8
Aisle	1, 376	31. 2	2, 318	32. 5	3, 205	33. 5	4, 113	35. 7
Storage:								
Packing materials	244	5. 6	496	7. 0	744	7. 8	1, 008	8. 7
Refrigerated (egg)	538	12. 2	1, 335	18. 7	1, 335	14. 0	1, 335	11. 5
Temporary (egg)					160	1. 7	160	1. 4
Freezer (canned eggs)	50	1. 1	50	0. 7	50	0. 5	50	0. 4
	832	18. 9	1, 881	26. 4	2, 289	24. 0	2, 553	22. 0
Service for production:								
Fork truck (servicing)	44	1. 0	44	0. 6	44	0. 5	44	0. 4
Refuse room	70	1. 6	70	1. 0	70	0. 7	70	0. 6
Machinery and equipment	128	2. 9	142	2. 0	142	1. 5	142	1. 2
	242	5. 5	256	3. 6	256	2. 7	256	2. 2
Service for personnel:								
Men's locker room	62	1. 4	62	0. 9	62	0. 6	62	0. 5
Women's locker room	86	2. 0	86	1. 2	145	1. 5	145	1. 3
Lunch room	230	5. 2	230	3. 2	230	2. 4	230	2. 0
	378	8. 6	378	5. 3	437	4. 5	437	3. 8
Offices:								
General office	215	4. 9	215	3. 0	231	2. 4	231	2. 0
Office rest rooms	36	0. 9	36	0. 5	67	0. 7	67	0. 6
Office aisle					44	0. 5	44	0. 4
Superintendent's office					83	0. 9	83	0. 7
Manager's office					95	1. 0	95	0. 8
	251	5. 8	251	3. 5	520	5. 5	520	4. 5
Total area	4, 392	100	7, 133	100	9, 562	100	11, 540	100

[1] Does not include loading platform in all plants or mezzanine in first, second, and third expansions.

supply system for packing materials. The plant can handle 500 cases a day (about 300 cases by the mechanized units and 200 by the manual line).

Second Expansion

The second expansion (fig. 34) provides an additional 806 square feet of floor space to the grading and packing area, plus 286 square feet of additional mezzanine and a 7- by 50-foot service lane. Excluding the mezzanine, the grading and packing area now occupies 2,587 square feet (27 percent) of the floor space. At this stage of expansion, the area can handle 800 cases of eggs a day.

Third Expansion

The third expansion of the overall layout enables the plant to handle 1,100 cases a day and requires a total of 3,393 square feet of floor space (29.4 percent) for the grading and packing area. Another 352 square feet of mezzanine and another 7- by 50-foot overhead walkway are added.

Egg Grading and Packing Equipment

The choice of egg grading room equipment was governed by the basic requirements for acceptable egg grading, listed earlier in this report, and by research findings from Department developmental work on mechanized egg grading and packing equipment. Probably the greatest single factor involved was ease and economy in converting from a manual to a mechanized operation.

Basic Unit

The manual grading line shown in figure 32 is a row of 10 work stations, illustrated in figure 10. It is served by a common carton conveyor belt and inspection station. It was selected because of its low cost of ownership and operation, flexibility, and efficiency for a manual grading operation. The line has an estimated daily capacity of 250 cases (table 2). Ungraded eggs are positioned under the candling light by a worker serving all stations on the line. Empty cartons are supplied to the grader by conveyor belt at eye level, and cartoned eggs are removed by the same conveyor belt on its return travel. Undergrade eggs are packed in filler-flats or into wire baskets for the breaking room. The grader is required to unpack and classify eggs as to size and quality, package and dispose of graded eggs and packing materials, and tabulate (if grade and count tally is required) grading results. Other grading lines that require manual manipulation of individual eggs, but provide various services to the graders, such as egg unpacking, automatic sizing, and tabulation (figs. 12 and 16), also can be used with only slight layout modification and without forfeiting compactness. However, the cost would be higher. If other grading equipment is selected, templates of each station unit, cut to exact scale and complete with required aisle space, should be used with an enlarged scale drawing of the layout, to ascertain compatibility with building dimensions and service aisle widths.

A standard carton setup machine furnishes the required cartons from the packing materials supply area. Filled cartons from the grading line are delivered to a standard carton closer (after a sample has been inspected) and packing table in the packing area at the end of the grading line. If molded pulp cartons are used instead of chipboard cartons, a setup machine is unnecessary.

First Expansion

Equipment selection in this layout provides for an operation in which approximately 60 percent of the plant's egg receipts are of uniformly fine quality. Such eggs can be graded and packed with mechanical equipment, and it is not necessary that each egg be placed before a grading light for quality determination. The remaining 40 percent require manual grading.

A reduction in size of the original line provides space for an egg cleaning operation if the frequency of dirties dictates. The remaining eight-station manual grading line and two mechanized units in the other line have a combined capacity of 500 cases a day (table 2). Each line is equipped with a carton packing table and inspection stations. They are served packing materials by overhead chutes from separate overhead service lanes leading to a common mezzanine for packing materials makeup. Moving packing materials makeup and supply to the mezzanine eliminates the carton makeup area next to the carton packing station in the basic unit.

The mechanized line consists of two units rated at 20 cases an hour. It is operated by four workers and a part-time fifth worker. The units provide group scanning, in-line electronic bloodspot detection,[8] sizing and positioning (small end up), and mechanical packaging. The line is a commercial model of the experimental line illustrated in figure 19.

Second and Third Expansions

To accomplish each of the second and third expansion steps, a duplication of egg grading and packing equipment required for the first expansion is added, in two steps. The resulting equipment capacity is changed from 500 cases a day to 800 and to 1,100 cases (table 2). It is assumed that 75 percent of the 800-case volume is fancy quality that can be handled by mechanized lines, and that about 80 percent of the 1,100-case volume will be in this category.

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[8] Although use of electronic detection equipment is optional, recent Department studies show that electronic detection and removal of bloodspots ⅛ inch and larger occurring in white eggs is 40 percent more accurate than removal by a trained operator.

TABLE 2.—*Operating capacities of improved-design plants* [1]

Types of plants	Units	Daily capacity	Plant capacity, in cases/year
Basic plant:	*Number*	*Cases*	*Cases*
Manual grading bench [2]	[4] 10	250	62, 500
Mechanized grading and packing units [3]			
			62, 500
First expansion:			
Manual grading bench	8	200	50, 000
Mechanized grading and packaging units	2	300	75, 000
			125, 000
Second expansion:			
Manual grading bench	8	200	50, 000
Mechanized grading and packaging units	4	600	150, 000
			200, 000
Third expansion:			
Manual grading bench	8	200	50, 000
Mechanized grading and packaging units	6	900	225, 000
			275, 000

[1] Based on a 7½-hour day and a 250-day year.
[2] The egg quality permits acceptable workmanship at an average rate of 3⅓ cases an hour.
[3] Egg quality permits acceptable workmanship and continuous operation at the rated capacity of 20 cases an hour.
[4] If a mechanized unit is used in this plant instead of 4 of the manual units, the daily capacity is increased to 300 cases.

Materials-Handling Equipment

Determination of the type and quantity of materials-handling equipment required for the basic plant and three expansion steps was based on a planned rate of inventory turnover within specified storage capacity for each plant, the average distance that eggs and packing materials were required to travel, and three planned stages of expansion of plant capacity from 62,500 to 275,000 cases a year. Maximum storage capacity for eggs was provided to handle from 3.3 to 7.2 days of the plant's production and from 15 to 24 days' supply of packing materials (table 3). These maximum inventories require high stacking in the storage areas of each plant. If high stacking equipment is considered too costly at the smallest plant level (62,500 cases), smaller inventories must be maintained. However, high stacking is required for the materials-handling system used at all larger plant levels.

Basic Unit

The volume of product that can be handled with the greatest utilization of space in this plant (fig. 32) is approximately 62,500 cases a year if a fairly uniform daily flow of ungraded product is experienced. The plant layout permits the use (but not full-time) of a battery-powered forklift truck (fig. 28). One operator can handle the movement of ungraded eggs from the loading platform or cooler, and the movement of packing materials from the loading platform to storage or grading area, and can also be available to move graded eggs from the packing area to the cooler or loading platform. A manual pallet transporter (fig. 26) is recommended to move palletloads at the packing station.

As previously mentioned, if the rate of inventory turnover for the graded product is semiweekly and the packing materials backlog is expected to provide only a 2-week supply, then a low-lift battery-powered pallet transporter (fig.

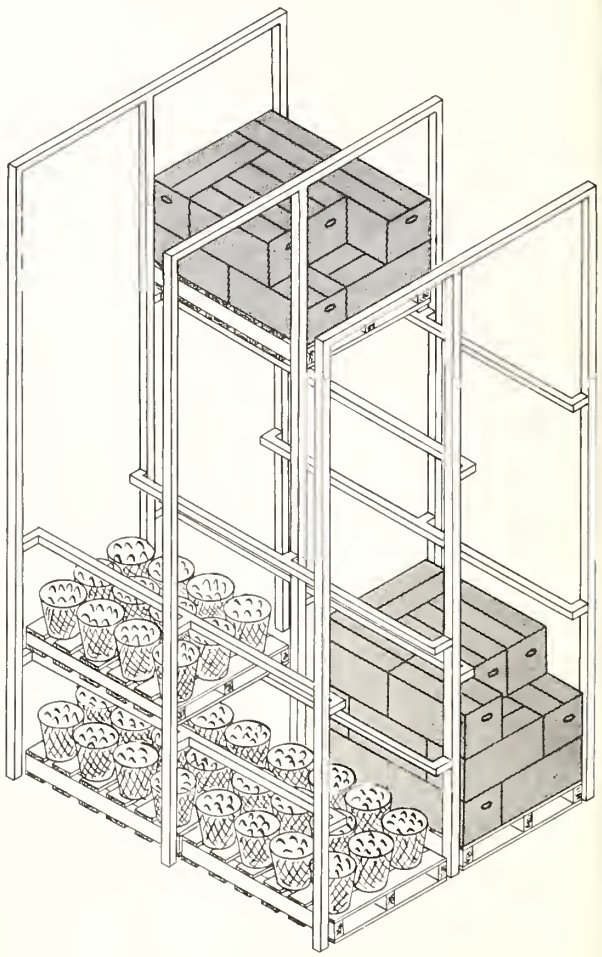

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Figure 37.—Drive-in pallet rack permits high stacking of partly loaded pallets.

27) can be used temporarily instead of a forklift truck (for high stacking). It is again emphasized, however, that the plant is laid out to operate most effectively at its rated capacity, which includes high stacking.

It is recommended that approximately 108 pallets be provided to implement the unit transport and storage within the plant (table 4).

It is assumed that part palletloads will be doubled up into single palletloads so that a maximum pallet capacity can be maintained. However, since occasionally, partly loaded pallets will require a holdover in the cooler for a night, over a weekend, or for breaking stock (in wire baskets, about 18 baskets per pallet), a pallet rack (fig. 37) for approximately 12 part palletloads should be provided in the cooler.

To handle the movement of small quantities of product and packing materials (four cases of eggs, four cans of egg meat, four bundles of cartons, or less) a two-wheel handtruck (fig. 22) is needed to handle an occasional job in the production and loading areas.

A 10-foot section of roller-type gravity conveyor with supports is required in the freezer to receive canned egg meat from the breaking room. A bridgeplate is needed to facilitate movement of palletloads on or off trucks.

First Expansion

The volume of product that can most effectively utilize the facilities of this plant after the first expansion (fig. 33) is approximately 125,000 cases a year. A maximum egg inventory turnover in this case requires use of the forklift high stacker (fig. 28). Another manual low-lift pallet transporter is needed in the packing area of the new grading line. This increases the number of pallet transporters to two (table 4).

Since a two-wheel handtruck was already in use before plant expansion, an additional truck is not necessary. The same is true for the gravity conveyor in the freezer and bridgeplate on the dock.

An additional 127 pallets for storage and transport of packing materials (table 4) and eggs is considered essential, because the total volume of product handled will be twice that handled in the basic plant unit. The additional pallets (over

TABLE 3.—*Inventory control factors in plants of improved design*

Plant and item	Daily requirements [1]	Quantity per pallet load 36″ x 48″	Maximum inventory [2]		Recommended minimum inventory [3]	Recommended purchase quantity
			Pallets	Days		
Basic plant:	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
Shell eggs (30-dozen cases)	250	30	48	5. 8		
Packing materials:						
Fiber cases [4]	233	400	13	22	2, 330	3, 000
Cartons (Chipboard)	6, 000	9, 000	15	22	60, 000	75, 000
Filler-flats	455	4, 500	2	19	4, 550	4, 375
Tin cans	30	60	6	[5] 24	300	400
First expansion:						
Shell eggs (30-dozen cases)	500	30	120	7. 2		
Packing materials:						
Fiber cases [4]	465	400	25	21	4, 650	5, 000
Cartons (Chipboard)	12, 000	9, 000	29	21	120, 000	141, 000
Filler-flats	910	4, 500	5	24	9, 100	13, 375
Tin cans	60	60	17	[5] 23	600	750
Second expansion:						
Shell eggs (30-dozen cases)	800	30	120	4. 5		
Packing materials:						
Fiber cases [4]	744	400	39	21	5, 200	10, 400
Cartons (Chipboard)	19, 200	9, 000	44	20	134, 400	261, 500
Filler-flats	1, 456	4, 500	7	21	10, 200	21, 300
Tin cans	96	60	28	[5] 21	680	1, 360
Third expansion:						
Shell eggs (30-dozen cases)	1, 100	30	120	3. 3		
Packing materials:						
Fiber cases [4]	1, 023	400	40	15	5, 200	10, 800
Cartons (Chipboard)	26, 400	9, 000	46	15	134, 400	279, 000
Filler-flats	2, 002	4, 500	7	15	10, 200	21, 300
Tin cans	132	60	29	[5] 15	680	1, 380

[1] Assuming 80 percent of receipts are cartoned, 10 percent are bulk packed, 10 percent are breaking stock; provision for replacing 3 percent of "producer case" packing materials is included in case and filler-flat requirements.

[2] Number of days' supply of packing materials is rounded to next lowest whole number.

[3] Represents a 10-day supply for basic plant and first expansion, a 7-day supply for the second expansion and a little more than a 5-day supply for the third expansion.

[4] Cases are received and stored in bundles of 20 (knocked down).

[5] Storage space for 360 tin cans on roof of freezer.

TABLE 4.—*Materials-handling equipment requirements of improved-design plants*

Equipment item	Quantity required in design plant				Purpose
	Basic plant	First expansion	Second expansion	Third expansion	
	Number	*Number*	*Number*	*Number*	
Manual pallet transporter (2,000-lb. capacity).	1	2	3	4	Used at packing areas to place loaded pallet aside.
Powered pallet transporter (2,000-lb. capacity).	----	----	[1] 1	[1] 1	For palletload handling where high stacking is not required and powered transport is desirable.
Forklift truck (2,000-lb. capacity, rider or walkie type).	[2] 1	[2] 1	2	2	For high stacking in storage areas and intraplant handling of palletloads.
Pallets (2-way entry, 36" x 48")	[3] 108	[3] 235	[3] 288	[3] 299	Storage and intraplant transport of eggs and packing materials.
Handtruck (2-wheel)	1	1	2	2	Miscellaneous handling, refuse, egg shells, filler-flats, etc.
Gravity conveyor (12" wide, 10' straight section with supports).	1	[4] 1	[4] 1	[4] 1	To transfer canned eggs into freezer from breaking room.
Bridgeplate	1	1	2	2	To permit materials-handling equipment to move on and off trucks.

[1] May be substituted for second forklift truck in second and third expansions.

[2] At this level of equipment use, a straddle-type forklift truck employing automobile-type batteries is recommended because of its lower cost.

[3] Figures are based on double stacking in storage areas and single stacking on mezzanine and in packing areas. A 10 percent allowance for pallets undergoing repair is included. Pallets for temporary egg storage in the second and third expansion layouts are not included.

[4] Additional conveyor lengths may be needed for carton handling on mezzanine.

twice the number in the basic design) are needed to utilize fully the proportionately larger storage areas. An additional pallet rack also is required for the second cooler.

Second Expansion

The plant, after its second expansion, is designed to handle 200,000 cases of eggs a year (fig. 34). In addition to the materials-handling equipment required for a 125,000-case plant, another fork-lift truck is required to handle intraplant transport and the increased amount of high stacking in storage. An additional manual pallet transporter (for the third-line packing area), one more bridgeplate, and another two-wheel handtruck are necessary. Conveyor requirements are the same as in the smaller plants. Fifty-three additional pallets are required to handle the increase in volume (table 4).

Third Expansion

Handling an additional 75,000 cases of eggs per year in the plant after the third expansion (fig. 35) requires only the addition of one manual pallet transporter (for the fourth line) and 11 more pallets (table 4).

Storage Areas

The storage areas in the plants of improved design are divided into two broad categories, dry storage and refrigerated storage. Ceiling clearance in dry storage areas is 15½ feet, and in cool storage areas, 15 feet.

The air-conditioned dry storage areas are maintained at 70° F., the cool storage provides 50° for graded eggs, and the small freezer delivers −10° for egg meat. The refrigeration tonnage requirements are shown in table 5.

The 6-foot doorways to the cooler are equipped with biparting (sliding) refrigerator doors. The motor and chain-driven opening and closing mechanism is activated by remote control. In order to keep door damage by materials-handling equipment at a minimum, stout guard rails are needed around the door recesses. Doors of this type, although more costly than hinged doors, provide considerable savings in labor and refrigeration loss, because they can be opened or closed from either side by a truck operator without stopping his load. Elimination of the ordinary type of wide door swinging into an active aisleway reduces accidents and facilitates a smooth flow of traffic.

The freezer is equipped with a standard 4- by 7-foot refrigerator door because it is used infrequently. At the opposite end of the freezer, a 2- by 2-foot freezer door serves as a breaking room delivery portal.

The cooler floor is of smooth concrete, pitched ¼ inch to the foot toward a trapped drain. The walls and ceiling of the cooler and freezer are plastered cork insulation, painted with a waterproof mold-inhibiting paint.

Basic Unit

The egg cooler provides approximately 525 square feet of floor space for refrigerating a 1-week production of graded eggs (fig. 32).

The dimensions permit the positioning of two rows of six pallets (3 by 4 feet) on either side of an 8-foot center aisle. When the pallets are high stacked (2 high) at 30 cases per pallet, the total capacity is 1,440 cases. Since the weekly volume in this plant is only 1,250 cases, a small part of the cooler is available for a pallet rack (fig. 38) for part palletloads. There is room for daily receipts of ungraded eggs in the air-conditioned production area at the grading line. This eliminates the need for moving eggs in and out of the cooler before grading, except as may be required overnight or weekends or on occasions when receipts are out of balance with production.

The space set aside for dry storage is an open area across the aisle from the egg cooler (fig. 32), occupying about 250 square feet of floor space, sufficient for nine short rows of two pallets each. To utilize the space fully, high stacking is required during periods in which a maximum inventory of packing materials is maintained. When packing materials (in a plant packing 250 cases a day, 90 percent in one-dozen cartons) are stacked 2 high, sufficient space is available to carry approximately a 22-day backlog of packing materials (table 3).

The 5- by 10-foot freezer is 8½ feet high from floor to ceiling and is designed to handle egg meat from undergrade eggs when market conditions warrant breaking, canning, and freezing instead of sale of undergrades in the shell. It is capable of freezing 100 cans [9] of egg liquid per day, and storing 2 weeks' production.[10] A ceiling-suspended blower unit provides quick-freezing temperatures and the compressor outside the cooler supplies refrigeration (fig. 32).

A loading port from the breaking room is equipped with a small refrigerator door, vestibule for cans, and heavy canvas, providing quick-freezing temperatures for canned egg meat immediately after canning.

The gravity roller conveyor allows free air circulation around containers, and it can accommodate up to 15 containers. In addition to providing rapid, convenient egg meat handling, this arrangement reduces refrigeration loss due to in-and-out traffic by workers with small loads of egg meat.

First Expansion

Another cooler, 25 by 30 feet, is added at the first expansion step (fig. 33). It is located opposite to and in line with the cooler in the basic unit. As in the basic unit, it is equipped with automatic biparting refrigerator doors that open on an 8-foot aisle. The floor has space for 36 pallets (4 rows of 9 pallets each) and permits double stacking throughout. The total refrigerated storage space can accommodate 3,600 cases.

Although the total cooler capacity exceeds the weekly volume of the plant, the proposed size is advisable as an economy measure in future expansion. It also provides space in one cooler for incoming ungraded eggs when necessary.

The location of the refrigeration compressor equipment adjacent to the new cooler wall (fig. 33) provides a central location for compressors and also releases space for an egg cleaning area adjacent to the breaking room and manual grading line. As indicated in the layout of this plant (fig. 33), space is available along the second cooler wall for two rows of six pallets each for storing packing materials. Another area designed for this purpose is along the building wall adjoining the new grading area. It provides space for 1 row of 23 pallets. Both areas provide space for stacking palletloads two high. This space and the 75 square feet on the new mezzanine provide space to store 76 palletloads of packing materials. When about 90 percent of the 2,500 cases a week (or 2,250 cases) are converted into a carton pack and there is a normal replacement of producer cases (approximately 10 percent a month), storage space is available for about 21 days' supply of packing materials (table 3).

Since the total egg meat volume should not exceed 300 cans a week, the freezer storage capacity is capable of handling about 7 days' egg breaking operations.

Second Expansion

Since the cooler capacity available, after the first expansion, provided space for 3,600 cases of graded eggs, sufficient space for a 4.5-day backlog of graded eggs is still available for the production expected after the second expansion step (table 3).

Because of the increase in overall dry storage space available in this plant, the area next to the second cooler (fig. 34), used to store packing materials in the first expansion stage, can now be used as necessary for temporary storage of incoming ungraded eggs.

The new dry storage area provides 744 square feet of storage space for packing materials. One area opposite the second cooler has sufficient space for 10 rows of 3 pallets each. The other area has space for a single row of 24 pallets. In addition, space for the daily packing materials requirements of 10 palletloads is available on the mezzanine. These areas jointly accommodate 118 pallets. At maximum capacity, they provide a backlog of packing materials for 20 days' operation (table 3).

As in the case of the cooler, the freezer size was not increased. Assuming that the production of undergrades will not exceed 10 percent of the

[9] One can represents approximately 86 percent of the egg liquid in a case of undergrades.

[10] A total of 384 cans arranged in four rows of ninety-six 30-pound cans each.

daily egg receipts, the freezing facilities and storage space provide capacity for approximately 4 days' breaking room production.

Third Expansion

In the third and last expansion (fig. 35), total refrigerated storage space (shell egg cooler, freezer, and temporary holding space for ungraded eggs) is not increased. It is anticipated that, at this level of plant operating capacity, the rate of inventory turnover of graded eggs and egg meat will be higher. The rated refrigeration capacity at this plant volume provides cooler space for 3.3 days' production (table 3) of graded eggs, and if 10 percent of all receipts are converted to breaking stock, the freezer capacity will accommodate 3 days' production of the breaking room when operating at capacity.[11]

The dry storage space opposite the second egg cooler has now been increased to accommodate nine rows of three pallets on either side of a 9-foot aisle, for a total dry storage space of 1,008 square feet. This area, plus additional space on the packaging material mezzanine, provides a 15-day operating backlog of packing materials (table 3).

Receiving and Shipping Area

The receiving and shipping area for the basic plant and each expansion step consists of a loading dock at truck-bed height, 12 feet wide, with a 14-foot all-weather canopy. The dock length of the basic unit is 32 feet 8 inches. Expansion steps provide extensions of 25 feet 4 inches, 21 feet 6 inches, and 18 feet 6 inches. The docks can accommodate two trucks and trailers or three smaller trucks per plant unit. The all-weather-surface truck yard provides adequate space to maneuver truck and trailer units to and away from the dock (figs. 31 and 36). The 12-foot dock width provides space to maneuver mechanical handling equipment without interfering with the loading or unloading operations. The wide canopy provides all-weather protection to workers and product.

If receipts are frequent and in small lots and if shipments also are frequent, requiring a dock office for a shipping clerk, consideration can be given to providing a small (3½- by 5-foot) glass enclosure on the dock. Since it was anticipated that most receipts would be picked up in truck lots on producer routes and that shipments of graded eggs would be palletized in delivery sequence at the time of packing, provision for a shipping dock office was not included in the improved-design plants.

Service Area

The service facilities for the employees, the offices, and the facilities auxiliary to the egg grading and packing operation occupy most of the front portion of the building in the basic plant unit and in each expansion. They are: Machinery and equipment room, lunchroom, restrooms, office, breaking room, and refuse room. The area was designed in such a way that it could serve both the basic unit and first expansion step without change, and the second and third expansions with only slight modification and a small building addition. Starting with about 950 square feet of floor space, only about 300 square feet of additional space is required for these purposes in the largest operation. The entire area is on the same floor level as the rest of the plant, and, except for the refuse room, is 10 feet from floor to roof.

Machine Room and Shop

The machine room and shop occupy an area 10 by 10 feet. The room houses the central heating unit for the service area and plant air-conditioning equipment, water heater, electric power panel, and workshop. Heating, refrigeration, and air-conditioning specialists should be consulted at the time of equipment selection to determine the need for increased capacities as the basic unit is expanded.

Restrooms

The area for restroom facilities in the basic plant unit and for each expansion step was designed to provide comfortable facilities, moderate initial cost, and minimum alteration as the number of employees increased with each expansion. By careful planning of fixture location, the plumbing alterations and moving of partitions are kept at a minimum.

The lunchroom occupies 230 square feet of floor space. It seats approximately 30 employees at lunch or "break" periods, with some of the aisle space and corners available for refreshment and food vending machines. The capacity is actually in excess of the needs for the basic plant unit and the first expansion step, but the small amount of floor space that could be gained by tailoring the room size to the exact requirements of the work force of the smaller plants is more than offset by alteration costs at each expansion step.

The toilet rooms are convenient to the work area for most of the workers, and adjoin the lunchroom and office. Since the increase in the working force in each plant expansion is mostly female, the women's restroom is increased in size for the last two expansion steps. The alteration is made by relocating the office restroom and office supply space, closing the doorway leading to the office restroom, and removing the partition that separates these areas from the women's restrooms (figs. 33 and 34).

Office

The 215 square feet of office space, plus 36 square feet of restroom floor space, is considered adequate for the size of the operation in the basic

[11] Based on the assumption that 4 operators are capable of breaking out 100 cases per day (whole egg), and an average yield of 35 pounds of acceptable egg liquid per case of undergrades (also see footnotes 9 and 10, p. 41).

plant unit and the first expansion step (table 1). In the later expansion steps, 289 square feet are added to the office area by replacing the space lost to other uses and by providing an office for the plant superintendent and general manager.

Breaking Room

The breaking room, occupying 170 square feet, is the same size in the basic plant unit and after each expansion. Although the volumes of product anticipated in the basic unit and first expansion steps are too small to fully utilize the potential of the facilities, the equipment and space provided were deemed necessary for an acceptable breaking operation. It is assumed that, in operations of the basic unit and in the first expansion step, breaking stock accumulates for several days before each breaking cycle is begun. Thus, sufficient volume of product is processed to assure acceptable handling and better equipment utilization.

Egg Cleaning Area

Recommendations for egg cleaning methods and equipment are not included in this report because of the lack of research data on acceptable techniques and equipment in commercial operations. Equipment outlines also are omitted in the 80 square feet of floor space set aside for this purpose in the three expanded plants (figs. 33–35).[12] If wet cleaning methods are employed, management should observe basic precautions against contamination of eggs, as recommended by the Department of Agriculture (*3*).

Utilities

Electricity, gas, and water for the plants of improved design have their main controls located in the machine room, for convenient maintenance.

The electric power panel has capacity to handle the maximum load at the third expansion step. Overhead lighting, of the fluorescent type, is furnished throughout the plant except for the freezer and dock, for which the incandescent type is recommended. Switches are provided so as to permit selective lighting, depending upon the work schedule and whether or not the work requires artificial illumination. Wall and elevated floor outlets for fixed power-driven equipment are convenient to equipment locations in the production areas. Several wall outlets also are provided at key locations in the breaking room, office, lunchroom, shop, and loading dock, for power equipment and extension light cords. All-weather flood lighting is provided for the main entrance, the employees' entrance, building corners, parking lot, and loading area. The office is connected with the production areas, receiving and shipping dock, and other service areas by a two-way intercommunication system.

The water supply lines extend the length of the building from the shop to the refuse room. Hot and cold water outlets are provided in the refuse room, breaking room, restroom, lunchroom, and shop room, as well as on either side of the production area. Water is of drinking quality, from the local city supply or from a private well with health authority approval.

The heating and cooling system is capable of maintaining room temperature at 70° F. throughout the plant in both summer and winter. It is recommended that the improved-design plants be cooled throughout by means of overhead cool air ducts from the central air-conditioning unit in the machine room. Overhead ducts are required also to move heated air to the service area from a central heating unit in the machine room. The production area is heated throughout by overhead self-contained space heater-blower units. A guide to refrigeration and heating capacities is provided in table 5. Detailed heating, refrigeration, and air-conditioning estimates and recommendations should be obtained from local contractors in order to determine the capacity suited to the climatic conditions in the area in which the plant is located.

TABLE 5.—*Heating, refrigeration, and air-conditioning loads and requirements for plants of improved design*

	Basic unit	First expansion	Second expansion	Third expansion
Heating load (BTU/HR)[1]	240, 000	310, 000	430, 000	500, 000
Refrigeration (tons):[2]				
20′6″ x 25′ cooler	4	4	4	4
25′ x 30′6″ cooler		6	6	6
5′ x 10′ freezer	4	4	4	4
Total refrigeration (tons)	8	14	14	14
Air-conditioning (tons)[2]	12	19	28	34

[1] Figures are rounded to nearest 10,000 BTU/HR.
[2] Figures are rounded to nearest whole number.

Recommended Labor Force

The recommendations for the labor force for handling the operations in each of the plants of improved design (table 6) do not attempt to set forth labor requirements for each operation nor to justify crew sizes. To set forth the labor re-

[12] Manual cleaning (hand buffing) at each grading bench, as necessary, is considered most feasible for the volume of dirty eggs that could be anticipated at the basic plant unit level.

quirements and establish crew sizes for daily operations, it is necessary that each actual operation at a plant of each size be carefully evaluated. Although the results of such a study will probably influence recommendations as to cross-utilization of crews, the total work force suggested probably will not be materially affected. It is felt, therefore, that the recommendations can be useful as a guide to the plant operator.

The labor force for the manual grading operation is based on the average capabilities of workers handling eggs of average quality, with consideration for intermittent irregular quality and for some below-average worker performance. The labor force for the mechanized grading operation is based on limited information about the capabilities of trained workers operating well-maintained mechanized grading and packing equipment at or near its rated capacity, while handling eggs of uniformly fine quality (*11*).

It should be noted that for each two additional mechanized grading units, only two workers are added under the heading "grading" (table 6). This is done on the assumption that the same operator who feeds eggs into the mechanized line also does the grading. Industry practice suggests the addition of one more worker to load each two machines when undergrades are divided into more than two categories. The size of the labor force handling the auxiliary services, such as packing cartoned eggs into cases and supplying ungraded eggs to the graders, was determined from findings in a recent study (*2*).

The crew size and suggested operating schedule for the breaking room are based on the accepted industry practice of accumulating a backlog of breaking stock sufficient for 1 day's work for four breakers, in order to provide production of egg meat at a rate fast enough to keep the spoilage hazard low. This level of production normally requires one kitchen worker to clean and sanitize containers and equipment and to operate the drawoff tank, move full containers to the freezer, remove egg shells, and handle breaking room cleanup. When the breaking room is operated every fourth day at the basic unit level, a day's supply of breaking stock is available for four breakers and a kitchen worker. The same schedule can be followed every other day at the volume handled after the first expansion. At the volume of undergrades anticipated after the second expansion, three breakers would require daily part-time assistance from the kitchen helper in order to break out each day's production of breaking stock. The same crew recommended for the basic unit, operating on a daily basis, could handle the undergrade output at the volume anticipated for the third expansion.

Since the workload for the forklift truck operators at the volume anticipated for the basic unit and after the first expansion is insufficient to fully utilize their time, they also handle plant maintenance and general cleanup. At the second and third expansion levels, a full-time worker handles the plant maintenance and cleanup duties.

The force of office workers includes a plant superintendent after the second and third expansions. A second clerical worker also is suggested at these volume levels, to handle the increase in bookkeeping required by buying a large percentage of total receipts on a grade basis.

Since an inspector's time would not be fully utilized at the basic plant level, a grader can perform this task on a part-time basis. After the first expansion, his full time is occupied with inspection duties. An additional inspector is suggested for the production rate expected after the second and third expansions.

TABLE 6.—*Recommended labor forces for improved-design plants*

Operation	Basic plant	First expansion	Second expansion	Third expansion
Production:	*No. workers*	*No. workers*	*No. workers*	*No. workers*
Manual and mechanized grading	10	[1] 10	[1] 12	[1] 14
Packing one-dozen cartons and filler-flats	1	2	3	4
Egg supplying [2]	1	2	3	4
Carton and case supplying [3]	-------	1	2	2
Egg breaking and canning [4]	5	5	4	5
Materials handling	1	2	2	3
Maintenance and cleanup [5]	-------	-------	1	1
Inspection [6]	-------	1	2	2
Total	18	23	29	35
Office:				
Manager	1	1	1	1
Superintendent	-------	-------	1	1
Clerical	1	1	2	2
Total	2	2	4	4

[1] If the line loader and grader is required to do considerable grading, a third worker (loader) is recommended for each two mechanized units.

[2] Includes tending packaging units after first, second, and third expansions.

[3] Performed by packer at carton packing table in basic unit.

[4] Crew of four breakers and one kitchen worker for sanitizing and canning. Breaking is done in basic plant every fourth day, and every other day after first expansion. After second and third expansions, the operation is performed daily. The kitchen worker assists breakers after second expansion.

[5] Material handlers perform this job in basic unit and first expansion.

[6] Inspection is essential for adequate quality control. One of the regular graders can serve as inspector at basic plant level.

Space Utilization

An examination of the layouts of the improved-design plants (figs. 32 to 35) shows that more than 60 percent of the plant floor space is devoted to the production operation and the aisles that are used to serve it (table 1). Storage space occupies from 19 to 26 percent of the total plant floor space, and the rest is devoted to the service area. The size relationship between areas is about the same in each of the improved-design plants.

Conclusions

The case study plants evaluated in this study were generally not constructed to permit (1) conversion to mechanized egg grading and packing without work stoppage, (2) economic building expansion or alteration, (3) efficient service facilities for personnel or operations auxiliary to the egg grading and packing operation, (4) an efficient materials-handling system, (5) adequate refrigeration, or (6) effective utilization of space.

The plants of improved design developed answers to these problems while permitting efficient operations regardless of plant volume levels.

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