PLANT REQUIREMENTS TO SET UP AND OPERATE SMALL BREAD BAKERIES

DEPARTMENT OF STATE
AGENCY FOR INTERNATIONAL DEVELOPMENT
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FOREWORD

This brochure is one of a series of reports resulting from overseas technical inquiries on factory or commercial establishments, operation, management, and engineering. The report is designed to provide only a general picture of the factors that must be considered in establishing and operating a factory of this type. In most cases, plans for actual installations will require expert engineering and financial advice in order to meet specific local conditions.

Mention of the name of any firm, product, or process in this report is not to be considered a recommendation or an endorsement by the Agency for International Development, but merely a citation that is typical in its field.

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For further information and assistance, contact should be made with the local Productivity Center, Industrial Institute, Servicio, or United States AID Mission.

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SMALL BREAD BAKERIES

INTRODUCTION

The manufacturing plant described in this brochure is designed to produce bread at the rate of about 4,000 pounds per day and still have some plant capacity for production expansion into specialty items such as pastries and other baked goods. The scope of this study is restricted to the production of bread.

GENERAL ASSUMPTIONS

In order to make realistic estimates of annual costs, certain assumptions have been made. It is understood that in certain localities these assumptions cannot be made, and that in those instances the data presented here must be altered to conform. The assumptions made here are:

1. That adequate electric power, water, and sanitary facilities are available at the site;

2. That adequate transportation facilities are available for moving in supplies and moving out the baked bread;

3. That there is an existing market large enough to absorb the above production capacity;

4. That all costs for buildings, equipment, materials, labor, and supplies are based on costs in the United States;

5. That experienced bakers and other technicians are available locally, or may be trained economically;

6. That all estimates are based on one 8-hour work shift per day for six days per week;

7. That while general assumptions will be made for each of the following items, for the purpose of completing cost estimates adjustments should be made in accordance with local conditions:

   a. Freight or other transportation costs in and out;

   b. Distribution and sales costs;

   c. Interest on capital, taxes, and insurance;

   d. Value of land required;

   e. Labor costs;

   f. Materials costs, especially flour.

MANUFACTURING OPERATIONS

Making good bread is the combination of a skilled baker and good ingredients. The quality of the bread is greatly determined by the speed, completeness, and uniformity with which these changes come about. The skill of the baker can be measured by the understanding, use, and control of the factors that contribute to high quality bread. Primarily, the baker must understand the functions of each ingredient, then use the ingredient properly.

PROCEDURE OF MANUFACTURE

The procedure followed in the manufacture of bread or yeast products will vary slightly depending on prevailing conditions. The steps to be considered in the manufacture of bread always will be the same and are as follows:

1. ingredient consideration;

2. mixing the dough;

3. fermentation period;

4. make-up of the dough including dividing dough (sealing), rounding for intermediate proof, intermediate proofing period, moulding for panning;

5. proofing the loaves (pan proof);

6. baking;

7. cooling;

8. storing and serving.

Each of these steps is important. The quality of the bread is affected by the manner in which each step is performed. Perfect bread will be produced only if each step is executed perfectly.

INGREDIENT CONSIDERATIONS

In order to produce good bread the baker must have a thorough knowledge of the ingredients to be used. Those things that are important in regards to the ingredients are:

1. quality,
2. proper balance (formula),
3. care in scaling and assembling,
4. adding of ingredients to the batch.

Each ingredient should be of good quality and the type called for in the formula. Ingredients that are different from the type called for or of inferior quality may not function properly. Care should be taken in the storage of ingredients, both as to length of time and conditions. Good ingredients can be spoiled by improper storage.

All ingredients must be accurately scaled or measured according to the formula. The water should be of a temperature that will insure that the dough will be of a definite and desirable temperature at the end of the mixing. After the water has been properly tempered a portion should be taken off in a suitable container in which to suspend the yeast. The balance of the water should be put into the mixing bowl. It is good practice to dissolve the salt, sugar, and mineral yeast food in this portion of the water before adding the flour; this insures a uniform distribution of these ingredients in the dough.

After the small ingredients have been dissolved, the flour should be added. If dry milk is used it should be incorporated with the flour. The milk may be sifted in with the flour or placed on top of the flour in the mixing bowl. When the milk is handled in this manner it prevents lumps from forming when it comes in contact with water.

After the flour and milk have been added, allow the mixing arms to turn a few times and then add the yeast suspension. This will prevent the yeast from coming in direct contact with the salt solution. The shortening may be added any time after the flour has all been wetted and the dough has formed. Shortening should not come in contact with dry flour. If this happens the shortening coats some of the flour and prevents it from becoming wetted. This lowers the absorption of the dough and also prevents some of the gluten forming proteins from forming gluten. Gluten forming proteins form gluten only if wet. The absorption of the dough should be known before mixing is started. This will eliminate the need for changes during the mixing operation. If the dough is too stiff at the start of mixing it might be difficult or impossible to smooth out the lumps that form at this stage after water is added.

MIXING THE DOUGH

The mixing of a bread dough involves more than just combining the ingredients. If the dough is to be properly mixed, and made capable of producing quality bread, it must be mixed long enough for the gluten to form and become developed to the peak of development. The amount of mixing required will vary depending on the quality of the flour, the consistency of the dough and the ingredients in the dough. The danger of overmixing also depends on the quality of the flour.

As mixing proceeds the dough becomes decidedly more elastic and less sticky. When this condition has improved to its peak the dough is properly mixed. Any mixing after this peak is reached is taxing the mixing tolerance of the flour, and if the mixing tolerance of the flour is lacking there is a possibility that this peak may be passed over and the dough will become very soft and sticky. If the dough is not mixed until the gluten has properly developed, the dough will not be relaxed enough to yield good bread.

Proper mixing time can be determined by observing the dough as it is being mixed. During the early stages of mixing the dough will be sticky and appear rough and open or raw. As the gluten becomes more developed the dough will become less sticky and take on the appearance of having a skin. When this characteristic is most evident the gluten is properly developed and the dough is fixed.

Things to look for when the dough is fully developed are smoothness, dryness, and extensibility. The dough should have a dry feeling and when a piece of it is stretched between the two hands it should form a thin film, like tissue paper, with no streaks or veins. Should mixing continue too long the dough will start to become sticky again, and the skin will start to tear. The dough is properly mixed somewhere between the time the skin is formed, and the time the skin starts to break.

The approximate time required to mix a dough on a slow speed mixer is 30 minutes. The rise in the temperature of the dough mixed on a slow speed mixer is approximately 8 to 15° F. The rise in temperature of the dough mixed on a high speed mixer may range from 20 to 45° F. Some high speed mixers are equipped with a cooling jacket around the bowl of the mixer. The cooling effect of the jacket compensates for frictional heat in the mixing bowl, making it easier to control the dough temperature.

FERMENTATION PERIOD
(STRAIGHT DOUGHS)

1. Controlling Temperature. After the bread dough is mixed it is set aside for a period of time to allow the dough to ferment. The area where the dough is put to ferment should be clean and free from odors with a temperature of 80° F. and relative humidity of approximately 78%.

The area should be free of drafts or air currents, and if the relative humidity cannot be controlled the dough should be covered to prevent evaporation of moisture and crusting of the dough. If the temperature of the area cannot be controlled some effort should be made to keep the dough from becoming too warm or too cold. A piece of canvas, a blanket, or some paper may be wrapped around the dough container to help equalize the temperature.

In cases of extreme cold, the amount of yeast to be used in the dough can be increased and the temperature of the dough raised a few degrees. It might also be necessary to lengthen the fermentation time somewhat. If the weather is extremely hot, the amount of yeast in the dough might be reduced, the dough temperature lowered 3 or 4 degrees, and the fermentation time shortened somewhat. Since fermentation is the reason for setting the dough aside for a period of time, this period of the dough is referred to as the fermentation period or the conditioning period.

2. Changes in Dough. Several changes take place within the dough during the fermentation period which causes the dough to produce good bread if the dough is handled properly for the rest of the process. Some of the changes that occur in the dough are the development of enzymes and acidity.

a. Function of Enzymes. The enzymes in the dough become active and fermentation commences; during this period the following changes take place:

(1) Part of the sugar is made into simple sugar so the yeast can use it as an energy food.

(2) Part of the starch of the flour is converted into a simple sugar.

(3) Simple sugars are converted into carbon dioxide gas and alcohol which causes the dough to expand as the cell structure is formed and the cells are expanded by the captive carbon gas.

(4) The enzyme protease causes the gluten to become soft and more capable of stretching.

(5) The slow stretching of the gluten as a result of the expansion of the dough causes the gluten to be more elastic and easily expanded as the loaf is formed.

b. Development of Acid. As the dough ferments acidity is developed in the dough. This slight acidity contributes to the following:

(1) Aids in the softening of the gluten, contributing to its ability to expand.

(2) Contributes to the acility of the cell walls to stretch thin, causing the cell walls to be partially transparent to light giving the crumb of the loaf a whiter appearance.

(3) Contributes to the flavor of the bread.

(4) Acidity reduces the possibility of rope development in the bread.

3. Effect of Fermentation. The total fermentation and the effect of the fermentation helps develop the flavor of the bread. Excessive fermentation allows the changes discussed to be excessive, and the quality of the bread will reflect this fact. Lack of fermentation will result in the changes not taking place, this too will reflect in the finished bread. Common results of over fermentation are:

a. pale crust color,

b. sticky dough,

c. poor symmetry,

d. poor flavor.

Lack of fermentation has the opposite results which are just as detrimental to the quality of the finished bread.

MAKE-UP OF THE DOUGH

1. General. After the dough has fermented to a desirable degree it is necessary to divide the dough into pieces and to shape the pieces for panning. Here are the steps involved in the "make-up".

2. Divide into Uniform Pieces. The dough is divided into uniform pieces of the desired weight. In hand operated shops, this is done by cutting off pieces of dough with the scraper and weighing off the pieces, adding more dough if it is too light or removing some of the dough if the piece is too heavy. Sometimes this is called scaling the dough because the pieces of dough are scaled to the exact weight desired. In machine operated shop, this dividing is done by machine, the baker scales the pieces and adjusts the machine so that the pieces will be the desired weight.

The uniformity of these pieces of dough is important because they must be uniform in weight if the size of the loaves is to be uniform and if they are to bake-off uniformly. The weight of the pieces of dough will depend

on the amount of dough needed to make a desirable loaf in the pan being used and the desired weight of the baked loaf. Approximately 10% of the weight of the loaf will be lost due to evaporation during baking, so the pieces of dough should weigh a little more than the desired weight of the baked loaf (approximately 2 ounces extra for a desired 1½ pound loaf of bread).

3. Dough for Intermediate Proofing. Round the dough for the intermediate proof by tucking in the raw edges of the piece and forming a round piece of dough. This stretches the skin over the piece of dough and seals in the raw edges left when the piece of dough was divided.

4. Intermediate Proof. The intermediate proofing period is that period of time that the rounded piece of dough is allowed to rest between the time the dough is divided and rounded and the time when the piece of dough is formed for panning. The length of the intermediate proofing period should be just long enough for the piece of dough to recover from being divided, and rounded and become loose enough so that it can be easily moulded (from 8 to 15 minutes depending on the dough and the conditions of the shop)

Some of the advantages of rounding and giving the dough intermediate proof are:

(1) the pieces of dough are made round so as to be uniform in shape; the same shaped pieces of dough makes it possible to mould more uniform shaped loaves;

(2) pieces of dough that have risen are more easily shaped for panning, the texture of the moulded loaf is more uniform, and there are no lumps in the loaf as a result of part of the dough being spongy while other parts have been packed as a result of dividing;

(3) the slow stretching of the gluten continues to improve the elastic properties of the dough which will insure good volume in the bread;

(4) some of the gas is expelled and the cells are made smaller and more uniform, making for a closer and more uniform grain;

(5) a skin is formed over the surface of the dough to hold the gas as it forms again.

5. Moulding and Panning. The pieces of dough are shaped so that they can rise in the pan and form a desirable shaped loaf of bread. These shaped pieces of dough should be uniform, and the shape should be such that they will rise evenly the entire length of the pan. The seam on the piece of dough should be placed down so it will be on the bottom of the loaf. The loaf should be in the center of the pan and not across or in one side of the pan. The pan should be greased sufficiently to prevent the loaf from sticking but should not be excessively greasy. The pan should not be cold enough to chill the loaf, and it should not be hotter than 95° F.

6. Proofing the Loaves. After the pieces of dough have been shaped into loaves and placed in the pans they should be placed in a properly controlled room or cabinet for the final or pan proof. This room or cabinet is called the proof box or proof cabinet. During pan proofing, the action of the yeast is speeded up by the higher temperature and the gluten becomes more mellow and more extensible.

When the loaves are ready to go into the oven the yeast should be in its most active state and the dough in its most extensible condition. This will assure good oven spring and a good break and shred. The normal pan proof time should be approximately one hour. The conditions that are important to the bread being proofed are that the cabinet be maintained at about 98° F. and relative humidity at 38%.

PROOFING THE DOUGH

Conditions in the proof box should be such that the air is warm enough and sufficiently saturated with moisture so it will not draw moisture from the surface of the loaf being proofed. The skin of the loaf must be kept moist so that it can stretch as the loaf expands. The temperature of the proof box should be warm enough to speed the action of the yeast and to warm up the loaf slightly before it is placed in the oven for baking. To determine whether the loaf is properly proofed, touch the loaf lightly with one finger tip and press in slightly; if the impression made by the tip of the finger remains, the loaf is proofed; if the imprint does not remain and fills out when the finger tip is removed the loaf is still too tight and compact and should be proofed more. Usually, 60 or 65 minutes is sufficient.

BAKING

1. General. The oven temperature and the time required to bake a loaf of bread will vary depending on the size and shape of loaf, the total sugars in the dough at baking time, and the ability of the oven to hold heat.

2. Size and Shape of Loaf. If the loaf is large and the distance to the center of the loaf is great, it will take longer for the heat to penetrate and bake the center of the loaf. The temperature of the oven will have to be regulated so the surface of the loaf will not burn before the loaf is baked. If the loaf is small and the distance to the center of the loaf will allow the heat to penetrate quickly, the temperature of the oven will have to be raised so the loaf will brown off before the crumb of the loaf is overbaked.

3. Total Sugars in Dough at Baking Time. The coloring of the crust of the loaf is a result of the caramelization of the sugars near the surface of the loaf. If the loaf contains a great amount of residual sugars, the heat of the oven will have to be low and so that the crust will not color excessively by the time the center of the loaf is baked. If the sugar content of the loaf is low, the temperature of the oven should be raised so that the crust will color enough by the time the loaf is baked inside.

4. Ability of Oven to Hold Heat. The ability of the oven to hold heat will have some bearing on the baking temperature to the extent that if the oven does not reserve heat well, the temperature of the oven would have to be higher so the oven temperature would not drop too low as the loaves absorb the heat of the oven. If the heat of the oven is a steady heat, the bread could be baked at a slightly lower temperature. Baking temperatures for bread vary, normally, from 400 to 450° F. Extreme baking conditions caused by size and shape, sugar content, and the condition of the oven sometimes make it necessary for the temperature to be higher or lower.

EFFECTS CAUSED BY BAKING

When bread is baked, the primary concern is that the crust be browned properly and the inside of the loaf be sufficiently dried and set. The browning of the crust is a result of the caramelization of the sugars present in the loaf. The color and thickness of the crust is determined, to an extent, by the temperature and the length of time the loaf is subjected to the oven heat, and the concentration of sugars in the loaf. Regardless of type, certain chemical and physical changes must take place in a loaf of bread before it can be considered as truly baked. If the loaf is taken from the oven before these changes occur, no matter what may be the degree of crust color, the bread so treated will be lacking in some very desirable properties. Underbaked bread invariably will have an aroma suggestive of "greenness", the texture will be overmoist and clammy, probably will settle or collapse on the sides after coming out of the pans, and will not slice well. The inside of the loaf is baked when:

1. the cell walls are no longer sticky,

2. the action of the enzymes and yeast are killed,

3. the moisture is reduced until the loaf holds its form.

COOLING OF THE BAKED LOAF

The loaf should not be cooled under conditions that will cause the loaf to dry excessively. Conditions which cause the loaf to dry excessively are that the air is too dry or warm in the cooling room or there is excessive air circulation in the cooling room.

STORING

Bread should be stored under conditions that will not dry the bread, and where the temperature is cool.

TYPICAL WHITE BREAD FORMULA

Ingredients	Percent of flour weight	Percent of total weight
Flour	100	53.7
Water	65 (variable)	34.7
Yeast	2	1.1
Yeast Food	0.25 - 0.50	0.2
Malt	0.5 - 1.0	0.4
Salt	2	1.1
Sugar	6	3.3
Non-fat dry milk solids	6	3.3
Shortening	4	2.2
Total weight	.....	100.0

PLANT SITE

The plant site for a bakery should be located as close to the market area as possible. For a bakery with a daily production rate of 4,000 pounds of bread, a site having 6,000 to 10,000 square feet will be adequate.

The bakery building itself will occupy from 5,000 to 6,000 square feet. The additional area is needed to accommodate vehicles for deliveries and shipments.

If on-premise sales are to be made, this must be considered in selecting a site. The plant site must also be provided with utility facilities. Water is the most important of these. For a plant with a production rate of 4,000 pounds of bread per day, from 300 to 500 gallons of good potable water will be used daily.

A bakery plant site should not be located near any industrial facilities that have objectionable odors as these may be absorbed by the bakery products.

The cost of a plant site will vary widely according to location within a city. For this reason an arbitrary sum of $5,000.00 is used in this study.

BUILDING REQUIREMENTS

A building with approximately 5,000 square feet of floor space on one floor is needed for a bakery with a daily production rate of 4,000 pounds of bread. It should be constructed of cinder block or brick.

A building of this type in the United States would cost around $5.00 per square foot to construct. This includes plumbing, wiring and ventilation. It does not include air-conditioning.

The weights of major pieces of equipment will not exceed two tons with the exception of the oven. Oven weights for a plant of this size will be approximately 350 lbs. per square foot. It may require structural reinforcing in the oven area. Floors in the oven area should be of fireproof construction.

Ceiling heights should be at least 12 to 15 feet high. Forced draft ventilation should be provided over the oven area.

Cleanliness is a prime factor for bakeries. This should be constantly considered in designing the bakery plant.

A bakery with these general specifications can be constructed for approximately $25,000.00.

PLANT LAYOUT

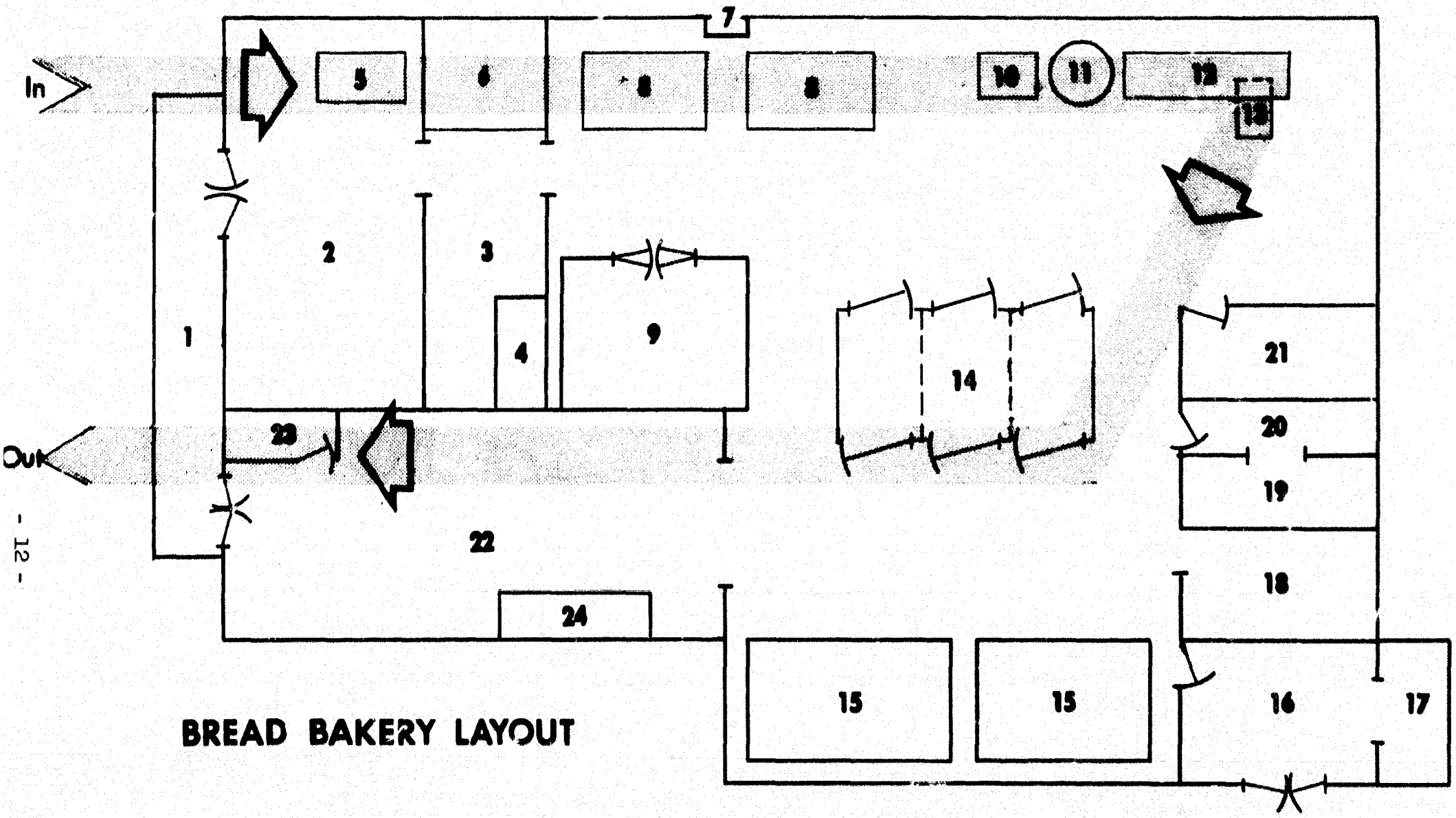
For a bakery producing 4,000 pounds of bread per day, a plant with approximately 5,000 square feet of floor space is needed. The floor plan (Figure 1) shows an ideal way to arrange equipment and facilities so that production flows in a U-shape pattern.

If sales are to be made on the premises, then a sales and display section should be added. Specific space areas will vary in size with the type of equipment installed, and the quantities of ingredients purchased. For this reason no individual area sizes have been denoted.

POWER

A dependable supply of electric power is required, and it is assumed that this will be available. Current is needed for lighting, and for operation of small motors ranging up to 3 horsepower for major pieces of equipment. Standard industrial wiring is adequate.

The annual cost of power is estimated at $1,000.00.



1. Receiving and loading platform
2. Flour storage room
3. Small ingredient room
4. Refrigerator
5. Flour dump bin
6. Water cooler
7. Waterflow meter
8. Mixer area
9. Fermentation room
10. Divider
11. Rounder
12. Intermediate proof area
13. Molder
14. Proofbox
15. Oven area
16. Heater room
17. Fuel room
18. Pan-cleaning room
19. Toilet
20. Lockers
21. Office
22. Cooling and storage
23. Checker
24. Slicing and wrapping

Figure 1. Bread Bakery Layout

WATER

Water is needed for bread production, drinking, and sanitary purposes. It must be potable water, since it is an ingredient in the production of bread. An estimated 300 to 500 gallons will be used daily. For the purposes of this study, it is estimated that 125,000 gallons of water will be used annually at an estimated cost of $100.00 per year.

FUEL

Fuel is needed for heating and hot water purposes, and for oven operation. Ovens can be fired with gas, oil, stoker coal or a combination of oil and gas. The type of fuel used for the oven will normally be used to supply the other fuel requirements. Annual fuel costs are estimated at $500.00.

TRANSPORTATION

A pick-up and delivery type truck will be needed to deliver bread and possibly obtain supplies. The estimated cost is $2,400.00.

MACHINERY AND EQUIPMENT

Flour-Handling Units

The primary function of the flour-handling unit is to sift flour to remove foreign matter and to loosen up and aerate it before forming it into dough.

Flour-handling units are designed to meet various production and building layout conditions. The common types include: (1) portable, motor-driven sifters, (2) semiportable, motor-driven sifters, and (3) stationary, power-driven units.

Refrigerated Water Coolers

The temperatures of dough discharged from the mixers should be 80° F. This temperature can best be obtained by using chilled water in the dough batch. Where mixers are provided with cooling jackets, chilled water furnished by a chilled water system can be circulated through the jackets to remove friction heat developed during mixing. Refrigerated water cooling, sometimes called bakery refrigeration plants, are desirable for the following reasons:

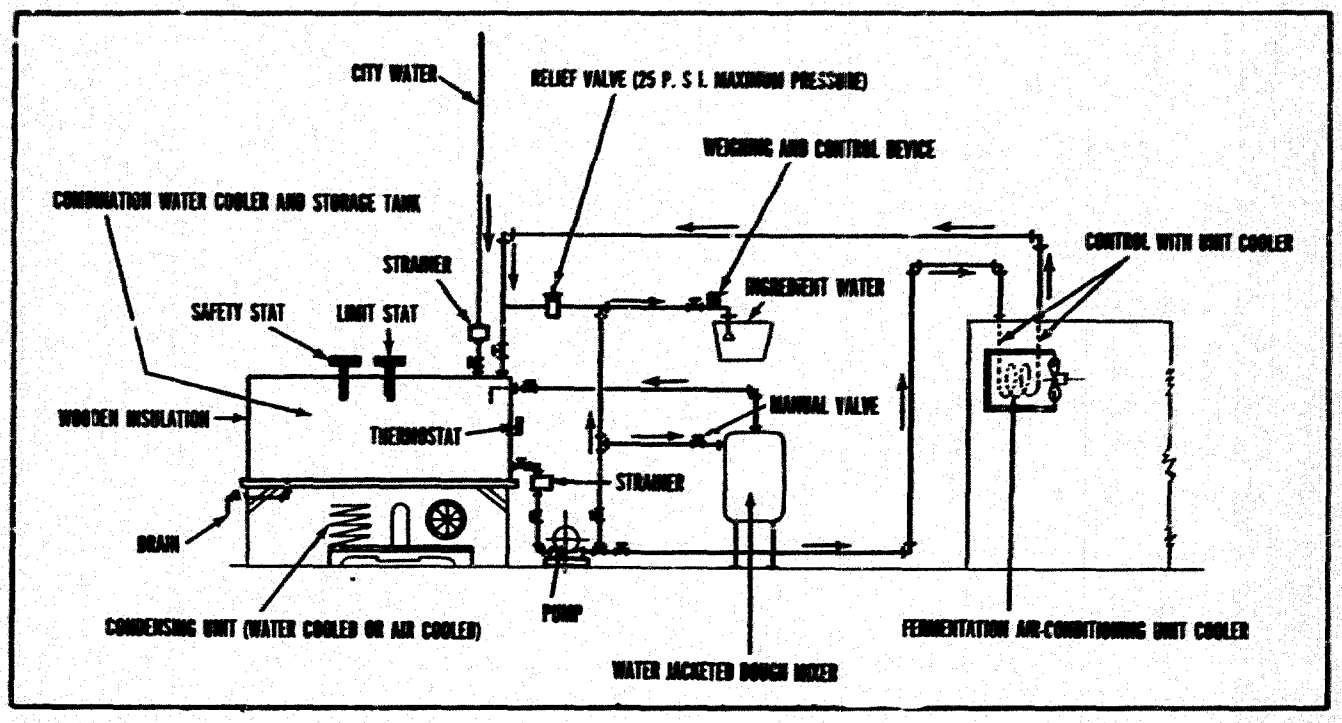


Figure 2. Chilled Water System For Bakeries

1. They supply clean, cold water, which, when tempered with warmer water, can be used in the dough to produce the desired final dough temperature.

2. Less labor is involved in maintaining the desired dough temperature.

3. If properly maintained, they are dependable and deliver water in adequate quantities and at a uniform temperature.

4. Chilled water can be circulated through mixer jackets, if mixers are so equipped, as well as through the cooling coil in the fermentation room, if such a cooling system is provided in the air-conditioning system.

Bakeries having a capacity of from 4,000 to 8,000 pounds of bread per 8-hour day require water coolers of 3- or 5-horsepower size. The smaller size is adequate if chilled water is required only for ingredient water. The larger size is needed if the mixer jackets and the fermentation room are cooled by this unit. These larger units are usually water cooled, and have water circulating pumps that deliver water from the storage tank to the water measuring device. The pumps also maintain circulation through the mixer jackets and the cooling coil.

Water Measuring Devices

The quantity and temperature of the dough ingredient water to be placed in the mixer are controlled by a water-tempering and measuring device. This equipment, when set by the operator, will deliver automatically to the mixer the proper quantity of water at the desired temperature.

There are several types and forms of water-tempering and measuring devices. Water-flow meters, however, are considered the ideal type. They are sanitary and convenient, with no tanks requiring periodic cleaning. Water-metering devices are supplied in several sizes and types. Meters with 300-pound dials, operating at pressures from 25 to 40 pounds per square inch, are most common. They deliver water at the rate of 150 to 200 pounds per minute.

Dough Mixers

The rapid and efficient mixing of large amounts of dough requires the use of mechanical mixers. Mixing machines are designated as high-speed or low-speed machines, depending on the number of revolutions the mixer arms make per minute. Modern mixers are constructed so that they may operate at both low and high speeds. Mixer arms of a low-speed mixer work with a cutting action through the dough mass, whereas those of a high-speed mixer exert a rolling and stretching action on the dough mass.

Large mixers are classified according to their capacity in barrels of flour; for example, 1-barrel mixer, 2-barrel mixer, etc. A 1-barrel mixer is of sufficient size to hold two 100-lb. sacks of flour plus the other bread ingredients.

Fermentation Rooms

The function of the fermentation room is to provide a storage space where atmospheric conditions suitable for fermentation may be maintained. The room is normally equipped with an air-conditioning unit. A temperature of 80° F., with a relative humidity of 75 percent, constitutes ideal atmospheric conditions for the fermentation of dough. The fermentation room should be so constructed that it may be easily cleaned to prevent the growth of mold. If possible, the room should be insulated.

Dividers

The dough divider measures and divides the mass of mixed dough into loaf-sized pieces. It has no dough-conditioning function. A scale for checking the weight of divided pieces of dough is placed beside the divider, but is not a part of it.

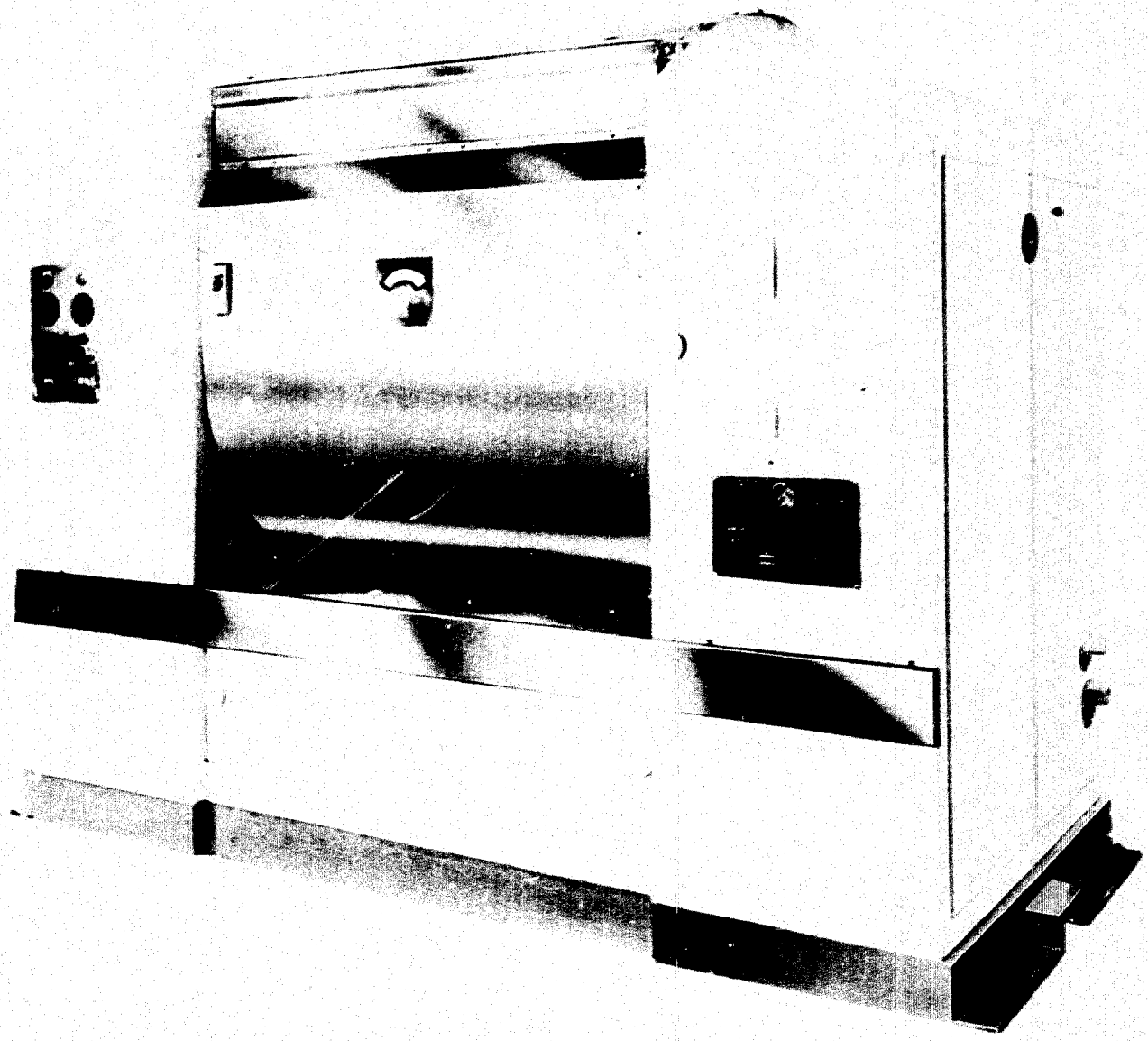


Figure 3. Dough Mixer and Kneader

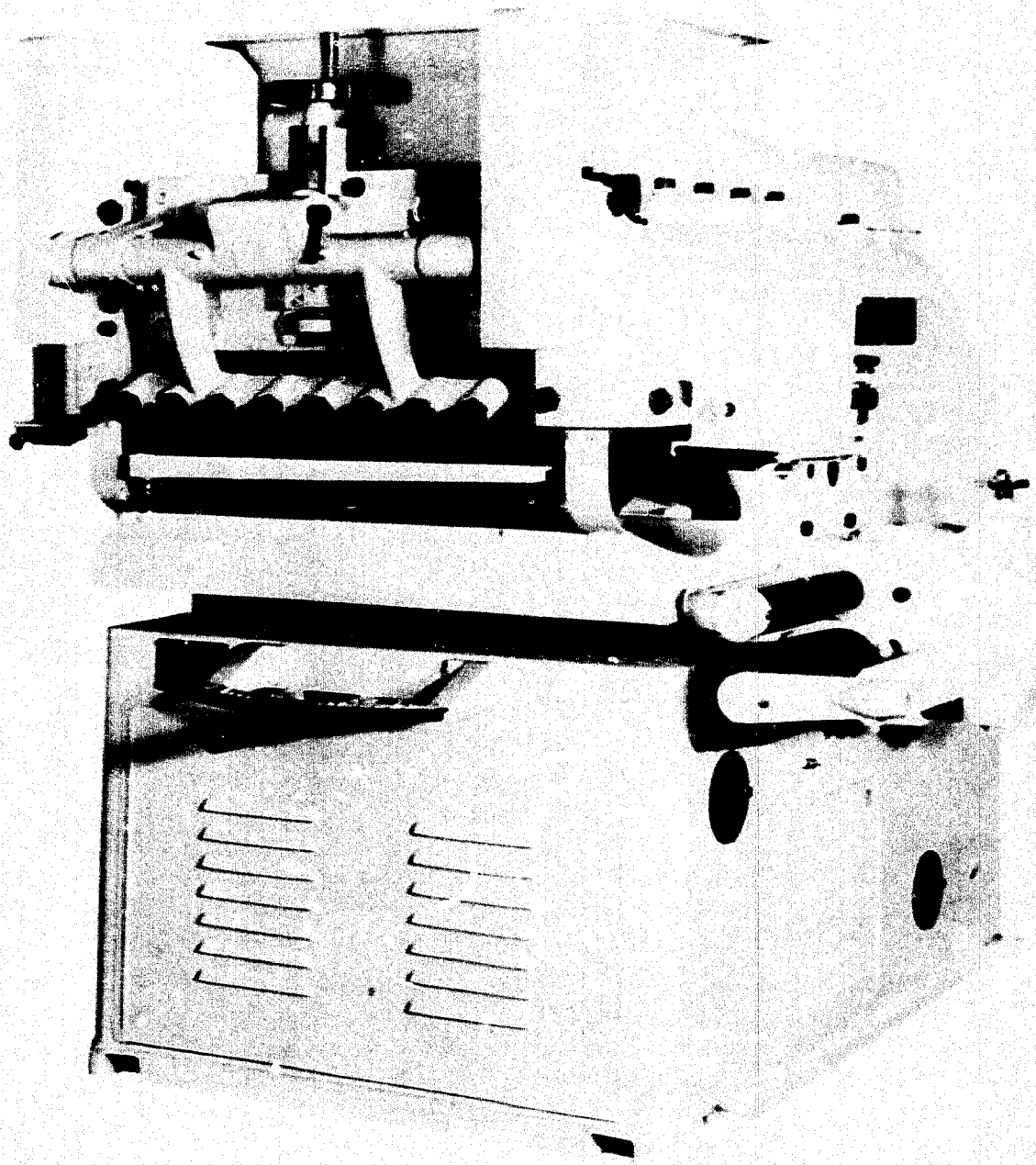


Figure 4. Divider

Dividers are built in many sizes, one to eight pockets, but all are constructed on the same principle.

Major dough-processing parts of the divider are: the dough hopper, compression plunger, knife, and cylinder. The cylinder contains pockets that receive the dough pieces, and pistons that regulate their size.

When the hopper is filled, the plunger moves backward, and suction causes the dough to drop into position in front of the knife and the plunger.

The knife then moves forward, cuts off part of the dough, and closes the opening of the hopper. The plunger then moves forward and forces pieces of dough into pockets of the cylinder. The stroke of the piston forces the dough pieces from the cylinder onto a conveyor belt, which carries them to the rounder. Pistons may be adjusted to change the size of the dough pieces.

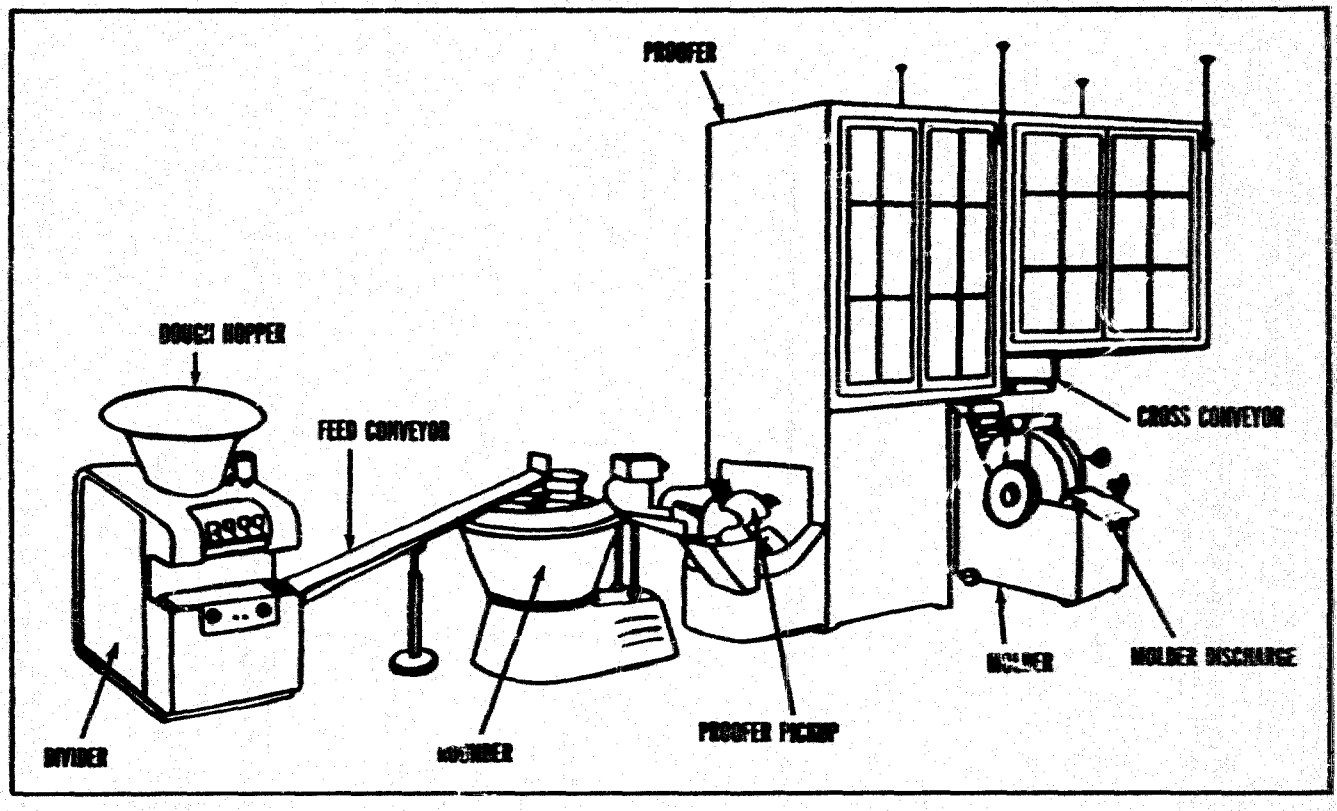


Figure 5. Complete Makeup Unit

Rounders

As measured pieces of dough come from the divider, they are conveyed to the rounder, which shapes each piece of dough into a firm ball with a smooth, unbroken skin over its entire surface.

Rounding insures an even distribution of gas throughout the dough. The unbroken skin seals the surface of the dough, so that the gas will be retained in the dough during the intermediate proofing.

Figure 6. Loaf Rounder

Intermediate Proofers

Before being molded into loaves, the pieces of dough are given a short proofing of 8 to 16 minutes in the intermediate proofer, the exact time depending on dough and temperature conditions. If this rest period, after the dough leaves the divider is not allowed, the dough will be rubbery in the molder and will not make up into satisfactory loaves.

Molders

The molding machine shapes loaves ready to be placed in pans. In the molder the dough passes through three stages: sheeting, curling, and rolling.

Sheeting, or flattening, is done in the head rolls of the molder.

The curling roll and the thread roll twirl or fold each piece of sheeted dough, thereby giving it a cylindrical shape.

The drum, or belt, and the pressure plate roll and seal the loaf into its final form.

Mechanical Ovens

The ovens are constructed in a great variety of types and sizes: rotary or revolving-hearth oven, reel oven, traveling-tray oven, and traveling-hearth oven.

Ovens may be fired with coal, gas, oil, or electricity. The oven should be heated to 450° F. before the bake is begun, and the temperature should be kept around 425° F. during the baking period. The baking period will vary with the type and size of the loaves.

Steam should be injected into the oven 3 to 5 minutes before the oven is loaded with bread. Proper use of steam after loading must be determined through the operation of each oven. The purpose of using steam is to produce moisture which, when it condenses, gives the bread an attractive appearance and keeps the loaf elastic and pliable, thereby preventing the crust from hardening until the expansion of the dough is complete.

When gas is used as a fuel, gas-regulating valves should be installed in the main supply line to insure a constant gas pressure, which is necessary in order to maintain a uniform baking heat during the oven operation.

When oil is used for fuel, the type of nozzle to be used on the burner will depend on the viscosity of the oil.

Slicing and Wrapping Machines

The function of slicing and wrapping machines is to provide a rapid and efficient means of slicing and wrapping bread. The bread slicer assures that the slices will be of a uniform size, thereby increasing ease in serving and economy of use. Wrapping each loaf in a moistureproof and dustproof package lengthens its keeping qualities and provides sanitary protection.

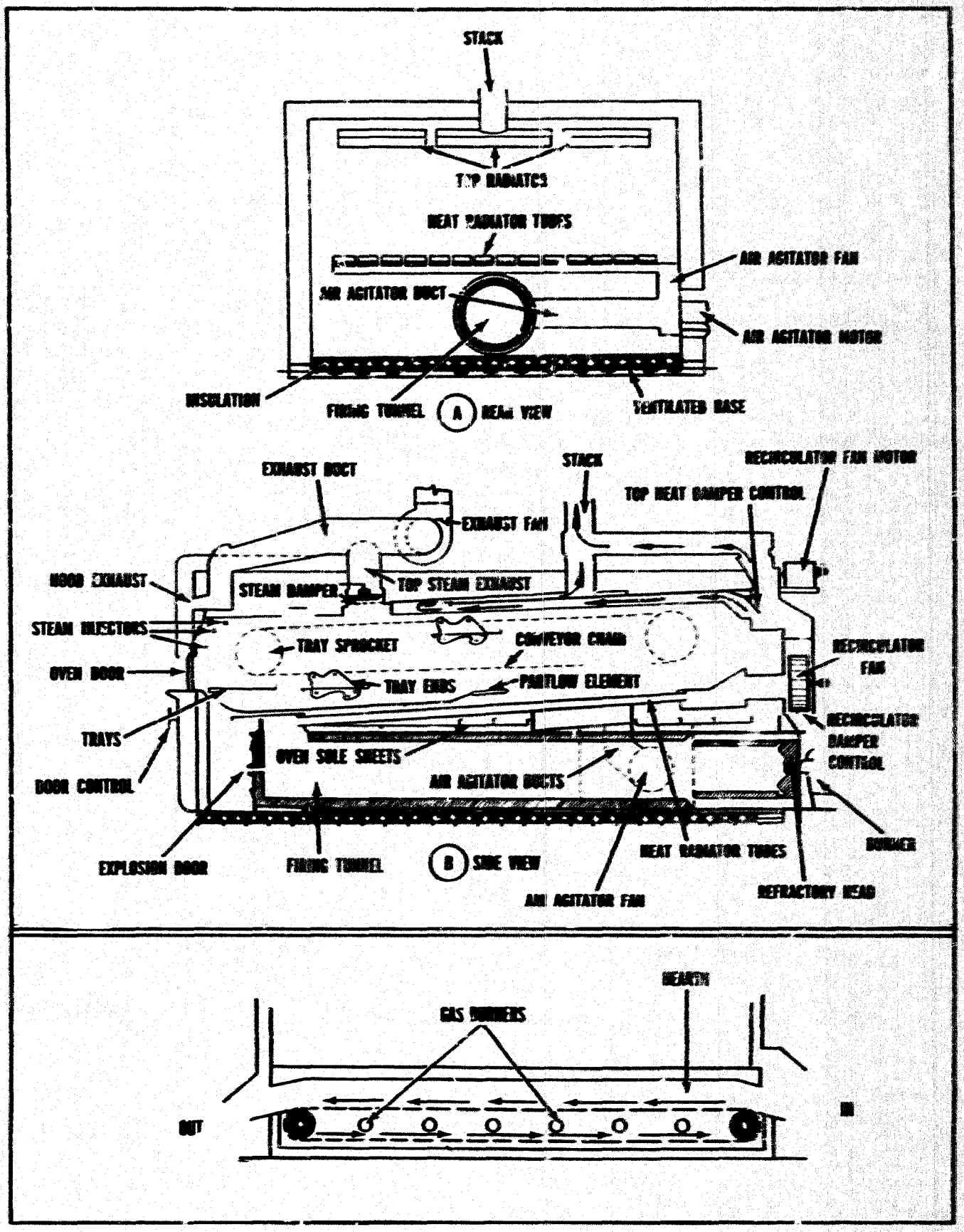


Figure 7. Ovens: Traveling Tray and Traveling Hearth

Miscellaneous Equipment

Flour Skids. Flour skids are wooden frames at least 5 inches high and of sufficient size and strength to hold at least twenty-five 100-lb. sacks of flour.

Scales. Scales of varying types and capacities must be provided in the bakery and must be used carefully. Bread formulas have been developed by experts after much research; the success of these formulas depends on the accurate measuring of the prescribed ingredients. Scales must be easily accessible in the ingredient room and also beside the divider. Before the start of operations each day, the scales should be checked for accuracy.

Thermometers. Thermometers check the temperature of flour, water, and dough accurately for each dough mix.

Racks. Proof racks are movable racks for carrying the loaves of dough from the molder to the proofroom and from the proofroom to the oven. The panned loaves remain on the racks while in the proofroom.

Bread racks are similar to proof racks, only they are used for carrying bread from the oven to the cooling room and for storing bread after it has been sliced and wrapped.

Pan Trucks. A pan truck is a small movable platform on casters, and is used for carrying pans from the oven to the molder.

PRODUCTION EQUIPMENT
(4,000-lb. per day production rate)

Item	No.	Estimated cost	Actual cost
Mixer (2-bbl. hi-speed)	1	$ 5,000.00	_____
Divider & rounder (2-pocket)	1	5,000.00	_____
Molding machine	1	4,000.00	_____
Oven	1	10,000.00	_____
Slicing & wrapping machine	1	10,000.00	_____
Cost of major equipment		$34,000.00	_____
Other equipment: pans, scales, water meter, refrigerator, racks, measuring equipment, handling equipment, thermometers, etc.		6,000.00	_____
Total		$40,000.00	_____

The tabulation above shows the estimated cost for the major equipment needed for a bread bakery with a 4,000-lb. per day production rate. A lump sum of $6,000.00 has been used for the cost of the other equipment that will be needed.

Due to the wide variance in the selection offered in this type of equipment, a detailed listing has not been made. Actual purchase of most of this equipment would be done on the recommendation of the plant supervisor or baker using it.

The production equipment requirements listed are minimum. For a bakery of this size, many operations will be performed by hand. With the listed equipment, for example, it will be necessary to beat and pan the bread by hand, as well as to dump and rack by hand. This is an accepted procedure in small bread bakeries. If production rates are increased, then, additional machinery can be added.

DIRECT LABOR REQUIREMENTS
(4,000-lb. per day production rate)

Skill	No.	Hourly rate	Estimated daily cost (8 hrs.)	Estimated annual cost (2504 hrs.)	Actual annual cost
Supervisor	1	$2.48	$ 19.84	$ 6,209.92	_____
Baker (dough mixer)	1	2.48	19.84	6,209.92	_____
Oven man	1	2.48	19.84	6,209.92	_____
helper	1	1.25	10.00	3,130.00	_____
Molder	1	1.25	10.00	3,130.00	_____
Divider	1	2.48	19.84	6,209.92	_____
Wrapper	1	2.00	16.00	5,008.00	_____
helper	1	1.25	10.00	3,130.00	_____
Misc. helpers	3	1.05	25.20	7,887.60	_____
Total	11		$150.56	$47,125.28	_____

The tabulation above shows the direct labor required to produce 4,000 pounds of bread per day. The hourly wage scale is based on union rates for small bread bakeries in effect in 1959 in the Washington, D. C. area.

The matter of providing a plant of this size with a supervisor is optional. This duty is often handled by a bakery manager or owner. Where bread is not to be sliced and wrapped, the wages of a wrapper and his helper can also be eliminated.

With the exception of the supervisor, the above manning scale is considered a minimum. However, it is possible to double the production rate without increasing manpower requirements.

This is possible because the skills employed will not be utilized a full 8 hours to achieve a 4,000 pound daily production rate. However, since manpower normally cannot be hired for less than a daily period, this prevents any reduction in force.

If bread production is not increased, it may prove profitable to expand into pastry and confectionery lines. This, however, will depend upon local conditions for each bakery.

Employees proficient in the skills listed will be needed as soon as the bakery is to start production. The time required for helpers to acquire the skills of bread production will depend entirely on the individuals.

DIRECT MATERIALS
(4,000-lb. per day production rate)

Item	Pounds per day	Avg. cost per pound (cents)	Daily cost	Pounds per year (313 days)	Estimated cost	Actual cost
Flour	2,148	(6.2)	$133.17	672,324	$41,682.21	_____
Yeast	44	(17.0)	7.48	13,772	2,341.24	_____
Yeast food	8	(34.0)	2.72	2,504	851.36	_____
Malt	16	(34.0)	5.44	5,008	1,702.72	_____
Salt	44	(5.0)	2.20	13,772	888.60	_____
Sugar	132	(10.0)	13.20	41,316	4,131.60	_____
Non-fat dry milk	132	(17.0)	22.44	41,316	7,023.72	_____
Shortening	88	(12.0)	10.56	27,544	3,305.28	_____
Wrapping paper	125		32.00	39,000	10,000.00	_____
Total			$229.21		$71,926.73	_____

The above table shows an estimate of the daily and yearly quantities and cost of direct materials needed to produce 4,000 pounds of bread per day. The quantities of materials are derived from an accepted bread formula, and thus will not vary appreciably. Costs of the materials, however, are estimated at United States price levels, and will vary considerably in different geographical locations. Materials costs, too, will be affected by seasonal price fluctuations and volume purchases.

The wrapping of bread is standard practice in the United States and has been included as a direct materials cost. For a 4,000 pound daily production rate, (assuming that one-pound loaves are produced) the daily wrapping costs would be approximately $32.00, using around 125-lbs. of paper. The yearly cost would be about $10,000.00 with some 39,000 pounds of paper needed. This expense can be saved if the bread is not wrapped.

FURNITURE AND FIXTURES

Item	No.	Estimated cost	Actual cost
Desk and chair (set)	2	$ 50.00	_____
Filing cabinet	2	30.00	_____
Typewriter	1	75.00	_____
Adding machine	1	175.00	_____
Cash register	1	200.00	_____
General fixtures	allowable	200.00	_____
Total cost		$810.00	_____

SUPPLIES

Item	Estimated annual cost	Actual annual cost
Office supplies, misc.	$200.00	_____
Plant supplies:		
Cleaning and housekeeping	300.00	_____
Indirect expendable items (brushes, knives, etc.)	100.00	_____
Maintenance, misc.	50.00	_____
Total cost	$650.00	_____

COST BREAKDOWN PER POUND FOR WHITE BREAD

(For plants with less than 1,000-lbs per hour capacity)

Item	Estimated cost (cents)	Actual cost
Ingredients	6.8	_____
Direct production labor	1.8	_____
Indirect labor and overhead	1.2	_____
Wrapping materials	.8	_____
Cost to produce and wrap	10.6	_____
Selling and delivery expense (Routeman's and supervisors' compensation)	1.8	_____
Delivery vehicle expense	.6	_____
Other selling expense	.8	_____
Total selling and delivery expense	3.2	_____
Administrative and general expense	.6	_____
Total cost to produce and sell	14.4	_____

In the table above, it can be seen that ingredients constitute nearly half of the total cost to produce a pound of bread. Of these, flour costs will account for about two-thirds of the total ingredient costs.

Certain elements of the cost to produce bread are considered fixed. They include direct and indirect labor costs, overhead costs, vehicle operating expenses, and sales supervisors' salaries.

Costs that will vary are such items as wrapping supplies, selling expenses, and ingredients.

Obviously, the marketing practices of individual bakeries will directly affect the cost components for production. For example, if bread is not wrapped, this expense is reduced 100 percent. If bread is not sold by house to house route, but is delivered to retail stores only, this cost will be partially reduced.

Ingredient costs will remain stable for each pound of bread produced, but will vary for each particular day's production. This will, of course, be determined from marketing experience.

INDIRECT LABOR COST

Skill	No.	Estimated annual salary	Actual annual salary
Manager	1	$ 6,000.00	_____
Bookkeeper (secretary)	1	6,000.00	_____
Sales clerk	1	4,000.00	_____
Utility man (truck & maintenance)	1	4,000.00	_____
Total indirect labor		$22,000.00	_____

DEPRECIATION

Item	Estimated cost	Estimated life (yrs.)	Estimated annual depreciation	Actual annual depreciation
Building	$25,000.00	20	$ 1,250.00	_____
Equipment	40,000.00	15	2,666.00	_____
Truck	2,400.00	4	600.00	_____
Total estimated annual depreciation			$ 4,516.00	_____

MANUFACTURING OVERHEAD

Item	Estimated annual rate	Actual annual rate
Heat, light, water	$ 1,600.00	_____
Indirect labor	22,000.00	_____
Depreciation	4,516.00	_____
Supplies	650.00	_____
Employee fringe benefits (vacations, etc.)	2,000.00	_____
Insurance, real estate taxes, etc.	1,000.00	_____
*Selling costs	32,064.00	_____
Total manufacturing overhead	$ 63,830.00	_____

*Selling costs have been listed separately from indirect labor because of the various ways in which bread can be marketed. This may be done with a company's own salesmen, by a percentage to route salesmen, through a markdown to retail outlets, etc.

In the United States, the baking industry has found that, on an average, it costs approximately 3.2 cents per pound to market bread. From the previous table on indirect labor costs, it can be seen that almost one-third of this cost is chargeable to selling costs.

ANNUAL MANUFACTURING COST

Item	Estimated annual cost	Actual annual cost
Direct materials	$ 71,926.73	_____
Direct labor	47,125.28	_____
Manufacturing overhead	63,830.00	_____
Total	$182,882.01	_____

FIXED ASSETS

Item	Estimated cost	Actual cost
Land	$ 5,000.00	_____
Building	25,000.00	_____
Equipment	40,000.00	_____
Truck	2,400.00	_____
Total	$72,400.00	_____

WORKING CAPITAL

Because of the nature of the baking industry, a large working capital is not required. Supplies are readily available and make it unnecessary to maintain large inventories. Cash collections for goods sold are received daily in many cases.

It is estimated that a working capital of approximately $22,500.00 would be sufficient to begin bakery operations. This constitutes a 45-day coverage of manufacturing costs.

CAPITAL REQUIREMENTS

Item	Estimated amount	Actual amount
Fixed assets	$ 72,400.00	_____
Working capital	22,500.00	_____
Total	$ 94,900.00	_____

SALES REVENUE

Annual production (1-lb. loaves)	Sales price	Estimated annual sales	Actual annual sales
1,252,000	16 cents	$200,320.00	_____

The tabulation above is based on a daily production of 4,000 one-pound loaves of bread, and 100 percent sales at 16 cents per loaf. Obviously, 100 percent of a plant's production will not be sold. This may be compensated for by higher production or a higher price per loaf.

RECAPITULATION OF COSTS, SALES, AND PROFITS

Item	Estimated annual cost	Actual annual cost
Sales	$200,320.00	_____
Manufacturing costs	182,882.01	_____
Profit before taxes	$ 17,437.99	_____

The above estimate is based on a sales price of 16 cents per one-pound loaf of bread. The price of bread will depend upon individual market conditions. Price changes must necessarily be made in one-cent steps. Where it is necessary to alter the price of bread by a fraction of a penny for competitive reasons, this is sometimes done by varying the weight of the loaf rather than by changing the selling price.

TRAINING

In some areas skilled bakery operators may be available locally. In other areas most of the operators may have to be trained.

If ample skilled bakery operators are not available, adequate training would be assured by using one or more of the following methods:

1. If the plant is designed and installed by a competent engineering firm, the contract should be negotiated, if possible, on a turn-key basis. On this basis the contractor agrees to operate the plant and produce the quality and quantity of the product stated in the contract for an agreed period of time. Such a contract would assure adequate personnel training, since full quantity and quality could not be produced with an untrained staff.

2. The engineering firm that designs and installs the plant can usually make training arrangements to have key personnel placed, for training purposes, in a foreign bakery. This would provide training for the key personnel while the plant is being installed.

3. If neither of the above methods is possible, then qualified and experienced individuals should be employed for the key positions, either permanently or temporarily, to perform the key operations and assist in training the organization, even if they must be secured outside the country.

4. The manager should have years of successful experience in this type of business and be fully qualified in all phases of management, including the training of employees.

SANITATION

Bakery personnel should maintain the highest personal cleanliness standards. New employees should be given medical examinations, with periodic examination being given to all personnel. The Bakery Industry Sanitation Standards Committee, 511 Fifth Ave., New York 17, N. Y. has prepared and published standards covering all common bakery machinery and facilities. These standards are for sale at the above address, and are generally observed in the United States bakeries.

Equipment Care. Clean bakery equipment is mandatory in bread manufacture, because unsanitary equipment may cause rope,* mold, or other serious faults in the bread produced. Breeding of insect and animal pests may also result from unsanitary conditions. Therefore, clean all bakery equipment thoroughly each time it is used. Clean the exterior surfaces of the equipment with soap and hot water (with an unusually hard water, water softening chemicals should be added). Use chemical cleansing agents according to instructions issued with the chemical, and then carefully rinse the item.

Each vehicle used for transporting bread must be kept scrupulously clean.

Building Care. The interior and exterior of the bakery building must be inspected and maintained properly to insure good sanitation. Establish a work schedule for periodic cleaning of the interior and exterior of the building that will include the following:

a. Inspect, wash, and clean washrooms daily or more often if necessary. Make sure that soap and towels are on hand at all times.

b. Clean the floors of the bakery at the end of each bread run.

c. Clean bakery windows at regular intervals. Windows and doors that are frequently opened in warm weather must be equipped with screens to keep out flies and other insects.

d. Store ingredients on skids to facilitate cleaning, to allow air circulation around the ingredients, and to prevent the development of insect-breeding places.

e. Wash interior of walls and doors periodically with hot water.

f. Check exterior of bakery building for cleanliness of ground around building and for security of all screens.

g. Do not use any disinfectants or insecticides that are poisonous to human beings or that might impart off odors to bread. Store the necessary disinfectants or insecticides in a separate storeroom away from the bakery supplies.

Insect Control. The following preventive or exterminative procedure is recommended for insect control:

Prevention.

(1) Screen all doors, windows, and ventilators with ordinary wire of not less than 18 meshes per inch or with heavy copper wire of 16 meshes per inch. Be sure that screens open outward and are kept in good repair.

(2) To prevent the entrance of crawling insects, seal tightly all cracks or other openings in bakery floor, walls, and ceiling. Be sure to close the openings through which the piping for plumbing or other facilities enter the building.

*See glossary, page 53

(3) Cover all floor drains with a metal grating. If the openings in grating are large enough to admit insects, face the bottom of the grating with metal screening.

(4) Inspect inside of all incoming bags and containers for insects.

(5) Inspect materials in storage room frequently, and remove all infested materials immediately.

Extermination. Insects may be exterminated by the use of disinfectants, insecticides, or fumigants. Disinfectant solutions, when used as a wash for walls and floors, often prove effective for the extermination of insects in bakeries.

Rodent Control. Rodents not only eat costly bakery ingredients and manufactured products but also create a potential danger to consumers of the bakery products. Rodents are dangerous as transmitters of yellow jaundice, typhus, food poisoning, and tapeworms or other intestinal parasites.

Prevention. To prevent the entrance of rodents, seal the bakery tightly and keep it well cleaned. Examine all incoming ingredients to prevent the entrance of rodents in this manner.

Extermination. When preventive measures fail and rodents get inside a bakery, they must be exterminated.

SAFETY

The requirement for, the cost of, a safety program in a bakery can be justified on either economic or humanitarian bases. Some of the economic reasons are: reduced labor turnover, less machine shutdown time and less repair cost, and less labor time lost through accidents.

There is always danger of accident and injury in a bakery through burns, materials handling, and accidents caused by the improper use of machinery. Because of this, the manager should take action to bring to the attention of each employee the importance of safety precautions and prompt first aid.

In general, the equipment manuals that are usually furnished with each machine contain guidance for the operator to insure his own safety, and these manuals should be made available to the operators. The most critical instructions for operator safety should be displayed as warning signs on or near the machine. Some space provision should be made for a first aid room.

A fire brigade should be established and each member trained as to his responsibility in case of fire. Fire drills should be conducted periodically.

In addition to manufacturer's manuals mentioned above, there is a large body of safety literature to guide a plant operator. The U. S. Navy Safety Precautions, OPNAV 34P1, is available through the Government Printing Office and contains valuable guidance in the safe use of most manufacturing tools. Industrial Accident Prevention, H. W. Heinrich, McGraw-Hill Book Co., New York, is a standard text on the principles and techniques of industrial accident prevention.

Because a bakery is a highly mechanized establishment, the handling, processing, and distribution of materials and products present many hazards to working personnel. Therefore, it is imperative for each bakery to have a clearly defined safety program in operation. If good safety measures are initiated and carefully observed, there will be no interruptions in production or any loss of man-hours through injuries to personnel. All bakery personnel should understand and memorize all rules of safety that apply to every piece of bakery equipment as well as those precautionary rules that apply to the daily habits of the bakers themselves.

Safety Program

The following list of safety measures is presented as a guide in setting up a safety program.

Organize a safety committee and take an active interest in the committee's work.

Hold safety meetings often, stressing the importance of obeying all safety regulations or rules.

Encourage personnel to present safety suggestions.

Display safety posters in advantageous places.

Train all new bakery personnel, emphasizing the following points regarding accident prevention:

(1) Safe practices in regard to specific hazards of the job.

(2) The use of provided safeguards.

(3) The type and location of safety equipment.

(4) The necessity for reporting every scratch or cut for first aid treatment.

(5) A description of past accidents in the bakery to point out hazards of the job.

(6) The importance of operating as a team in carrying out a successful safety program so that the new worker will be conscious of his individual responsibility in protecting himself and his coworkers.

Equipment Safety Rules. In the overall production of bread, there are specific safety rules that must be observed by personnel when performing each step in the baking process.

1. Raw Materials Handling.

a. Encourage the careful use of knives used for opening flour sacks.

b. Install covers or guards over flour bins and conveyor screws.

c. Check ropes on counterweights often and replace if worn.

d. Install a safety cutout on flour dumps.

e. Never clean bins or elevators while the unit is in operation.

f. Have personnel sweep up any spillage promptly.

g. If hands are greasy, wipe them off before attempting to handle flour and other ingredients.

h. Teach personnel the proper methods of lifting, trucking, and handling ingredients; see that they adhere to these methods.

i. Know the physical limitations of employees handling flour and other ingredients, so that you will not expect more than they are capable of producing.

j. Establish a rule that nothing is to be carried in the shirt pockets, thereby minimizing the danger of miscellaneous objects falling into the ingredients.

2. Dough Mixers.

a. Be sure that operator is thoroughly acquainted with mixer controls.

b. Before using mixer, make a careful check to see that no one has left tools, scrapers, or oilcans in mixer.

c. Do not rest fingers on edges of mixer bowl.

d. If inching buttons do not have a safeguard, install the type of safety device on the mixer that requires the operator to use both hands on the inching buttons while the bowl is being tilted.

e. Remember that the mixer makes a number of revolutions after the power has been shut off. This flywheel action is just as dangerous as when the mixer is running under power.

f. Do not cut dough loose from agitator arms while mixer is still running.

g. When using vertical mixers, always secure beaters and agitators properly before starting machine.

h. When machinery is being repaired, post notices to keep unauthorized persons away from the machinery.

i. See that slippery or greasy spots on the floor are removed at once.

3. Dough Troughs and Fermentation Room.

a. See that doors of fermentation room are equipped with bumpers.

b. To avoid hand injury, be extremely careful when moving dough troughs through the doors of the fermentation room.

c. Check fermentation room doors often for splinters, and sand down splintered area immediately.

d. Be sure that casters on dough troughs are perfectly round and rotate easily on floor.

e. Keep bakery floor in the best possible condition.

4. Divider.

a. Make no adjustments other than scaling adjustment while divider is in operation.

b. Never climb on divider to make adjustments.

5. Rounder.

a. Clean the rounder when it is not in operation, because scraping the inside of the rounder while it is running is often hard on the fingers, and the dropping of a scraper can ruin a machine.

b. Be extremely careful when extracting "dough doubles" from the rounder.

6. Proofer.

a. If "dough doubles" reach the proofer, let them pass through. Never reach in and attempt to remove them by hand.

b. Shut down intermediate proofer to clean out any dough pieces that might have stuck to proofer trays.

c. Put covers or safeguards around gears, chains, and sprockets.

7. Molders.

a. Do not attempt to clean roll with a scraper while machine is in operation. It is much easier and safer to remove hardened dough with trough grease.

b. If extender is driven by molder, improvise a safeguard for the extender.

c. Keep fingers out of rolls.

8. Bread Racks.

a. Use handles in guiding racks. Never grab racks by shelves.

b. Check casters often to make sure that they are in good condition.

c. Repair any broken wires at once.

d. Equip racks with fenders or bumpers.

9. Ovens.

a. Always use proper gloves and pads when unloading ovens.

b. Establish correct procedures for dumping baked bread from hot pans.

c. To avoid eye injury from steam and heat at the oven door, be sure that all personnel know the proper method of turning the head while reaching into the oven for a strap of pans.

10. Slicers.

a. When cleaning knives, be sure to stop the slicer. A good protective measure is to install a safety device that shuts off the machine when the door to the blades is opened.

b. Furnish covers or safeguards for sprocket wheels, chains, gears, and other hazardous moving parts.

c. Never adjust slicer while it is in motion.

d. Lock starting switch when repairing slicer.

e. Use a broken loaf to push last loaf through slicer.

f. If stale bread is available, run it through knives after cleaning them in order to remove excess oil.

11. Wrapping Machine.

a. Never clean wrapping machine while it is in motion.

b. Use thermostatically controlled heating plates.

c. Extend control lever so that machine can be stopped from rear.

d. Use pilot lights to show whether or not resistance coils are hot.

e. Keep fingers out of machine while it is running.

f. Improvise any safeguards that will reduce hazards of this machine, because the wrapping machine ranks first in bakery machinery accidents.

g. Supply full and proper operating instructions to a new operator.

12. Boxes and Trays. Be careful when handling boxes and trays to prevent dropping them on the toes.

Personnel Safety Hints. Observance of the following safety suggestions concerning individual movements of personnel in the bakery will greatly reduce the accident rate and thereby strengthen the overall bakery operation.

1. Keep your mind on your work.

2. Watch where you are walking.

3. Learn to lift properly.

4. Report any unsafe conditions.

5. Read and heed safety signs.

6. Stay clear of moving machinery.

7. Use the right tool for the job.

8. Keep all safeguards in place.

9. Keep your work area clean.

10. If injured, get first aid promptly.

CONSERVATION AND ACCOUNTING FOR LOSSES IN BAKING OPERATIONS

Records

A suitable system of records and accounts in a bakery points out the various factors which enter into production losses. One man should be placed in charge of all ingredients and materials used in a bakery and held accountable for the stock at all times. Usually, the baker in charge of the shop is the man to handle the job. The duty of the baker is to verify the weights or quantities of materials that are received to the account of the bakery, to keep a record of all materials withdrawn from storage, and maintain a continuing inventory record.

Other men in the shop should not be permitted to procure any material except through the baker; this is a sure way of material check. When starting a system of controlling materials in the bake shop, an inventory of stock on hand should be taken. Thereafter, all materials received from the store room should be checked carefully at the time of receipt in order to ascertain any possible shortage and make sure that the amount of each material charged for actually represents the amount received. By keeping a continuous, accurate record of all material received and dispensed there will be a perpetual inventory record of material on hand at all times.

An actual physical inventory of all material on hand including the flour in the shop should be taken weekly or monthly. This should agree with the perpetual inventory record after the physical inventory is taken. If there is any difference between the two, it indicates a loss or leakage which should be checked.

Inventory Shortage

If the shortage noted in flour or other ingredients cannot be accounted for as normal shrinkage then it must be investigated from the angles of dehydration or evaporation, improper scaling, pilferage, or error in recorded entries. In the event that any loss in material can be attributed to actual spoilage during storage, this loss should be recorded on the stock records. That the cause of such spoilage and loss can be recognized and corrected is important.

Ingredient Conservation

Normally, when careful scaling of ingredients is practiced, the baker will have a reliable record of supplies used. See figure 8 for a typical record form. There are ingredients used, however, that are not scaled into the dough, such as flour used for dusting, grease used to grease the pans, and the trough grease used on the troughs. Normally, this latter group of ingredients is not weighed direct, so the customary practice is to determine the amount of these materials used per day and calculate into the percentage of the dough processed. Experience has shown that good operation will hold the use of these materials to:

INGREDIENT RECORD

DATE 18 Feb 1960

1 DOUGH NO.	2 TYPE OF BREAD	3 ISSUE FLOUR LBS	OZ	4 WHEAT FLOUR LBS	OZ	5 WATER LBS	OZ	6 YEAST LBS	OZ	7 SALT LBS	OZ	8 SUGAR LBS	OZ	9 MILK LBS	OZ	10 SHORTENING LBS	OZ	11 MALT LBS	OZ	12 RAISINS LBS	OZ	13 EGGS LBS	OZ	14 VINEGAR LBS	OZ	15 Wheat Bran LBS	OZ	16 Rye Flour LBS	OZ	17 LBS	OZ
1	White	320				192		6	6	8		9	10	19	3	16		3	3												
2	"	320				192		6	6	8		9	10	19	3	16		3	3												
3	"	320				192		6	6	8		9	10	19	3	16		3	3												
4	Raisin	227				148		9	2	5	12	13	10	10	3	11	6	2	5	147	10										
5	Whole Wht	160		160		158		6	6	8		9	10	9	10	16		6	6												
6	Whole Wheat Wheat Bran	272				192		6	6	8		9	10	19	3	16		3	3							48					
7	Rye	273				158		10	3	8	8					8	8	8	8									68			
8	White	320				192		6	6	8		9	10	19	3	16		3	3												
9	"	320				192		6	6	8		9	10	19	3	16		3	3												
10	"	320				192		6	6	8		9	10	19	3	16		3	3												
11	"	320				192		6	6	8		9	10	19	3	16		3	3												
12	"	320				192		6	6	8		9	10	19	3	16		3	3												
TOTAL		3192		160		2272		83	1	94	4	109	14	192	8	179	14	45	14	147	10					48		68			

FINISHING MATERIALS	LBS	OZ
DUSTING FLOUR	69	
DIVIDER OIL	3	5
PAN GREASE	7	

APPROVED BY CHIEF BAKER

George Mann
SIGNATURE

I CERTIFY THAT THE FORMULA HAS BEEN COMPLIED WITH

Fred Smith
SIGNATURE OF MIXER

Figure 6. Ingredient Record

Pan grease ---------- 0.5 to 1% of dough weight
Trough grease ---------- 0.5 to 1% of dough weight
Dusting flour ---------- 1% of dough weight

Excessive use of these supplementary materials is in part lost, and what is not lost is to a large extent not weighed out when scaling the pieces. The operator impairs the external appearance of the product by way of grey crust streaks and blotches. By careful observation and investigation of various doughs and the conditions under which handled, a baker should know in each case just what yield he is entitled to expect. If the stock records are maintained accurately, but the yield of usable baked goods produced from the raw materials used is below standard, the baker should recognize this fact by daily inspection of the dough reports and other records, and investigate the underlying cause of the condition. Carelessness in handling ingredients will cause losses of materials that should not occur. Sources of such losses are spillage in storage and handling, losses from flour handling equipment, and incomplete emptying of material containers. Inasmuch as each individual dough should be mixed according to a definite formula, the weight of the dough out of the mixer should agree closely with the total weight of the ingredients in the formula provided all ingredients are carefully weighed.

A floor scale may be used to weigh the dough directly after it is mixed. The trough in which the dough is to be placed is first weighed empty. The trough containing the dough is then weighed and the difference between these two weights represents the weight of the dough.

Causes for Shortage in Weight of Doughs When Mixed

1. General. The causes for shortage in the weight of doughs when mixed can be traced to several different things. When this occurs it is up to the person in charge to locate these differences. The finding of these facts is a sure way to economize in the bakery and economy is stressed throughout the commissary field. The job of the commissaryman in the bakery is to economize in every way. Some of these shortages in the weight of dough when mixed are that dough may be lost in careless cleaning of the mixer; scales are defective; loss of weight through fermentation; careless scaling of ingredients, which results at times in the use of materials not accounted for by the record; cripples; or leftovers.

2. Dough Particles Left in Mixer. There may be tiny particles of dough retained in the mixer; this amount should not be appreciable, provided the mixer is properly cleaned and scraped when moving dough into the trough. When the weight of the dough out of the mixer shows an appreciable difference in weight from that shown in the dough report, it is likely that there has been a mistake in weighing the ingredients or in recording those weights on the dough report. Sometimes the full amount of water specified in the formulas cannot be used without undue slackening of the dough. The formula should then be corrected accordingly.

SCHEDULE OF BAKERY OPERATIONS

MIXER'S DAILY WORK SHEET

DATE 15 Feb 1960

1 DOUGH NO.	2 TYPE OF BREAD	3 TIME TO START MIX	4 MIXING TIME		5 TIME DOUGH OUT OF MIXER		6 TEMPERATURE OF DOUGH		7 TEMPERATURE OF FERMENTATION ROOM		8 TIME OF FIRST PUNCH	9 TIME TO DIVIDER	
			SLOW	FAST	SCHEDULED	ACTUAL	SCHEDULED	ACTUAL	WET BULB	DRY BULB		SCHEDULED	ACTUAL
1	White	0600	3	8	0611	0611	80	80	75	80	0811	0841	0841
2	White	0625	3	8	0636	0636	80	80	75	80	0836	0906	0906
3	White	0650	3	8	0701	0701	80	80	75	80	0901	0931	0931
4	White	0715	3	8	0726	0726	80	80	75	80	0926	0956	0956
5	White	0740	3	8	0751	0751	80	80	75	80	0951	1021	1021
6	White	0805	3	8	0816	0816	80	80	75	80	1016	1046	1046
7	White	0830	3	8	0841	0841	80	80	75	80	1041	1111	1111
8	White	0855	3	8	0906	0906	80	80	75	80	1106	1136	1136

REMARKS

None

SIGNATURE OF MIXER OPERATOR: Fred Smith

SIGNATURE OF CHIEF BAKER: George Mann

Figure 9. Mixer's Daily Work Sheet

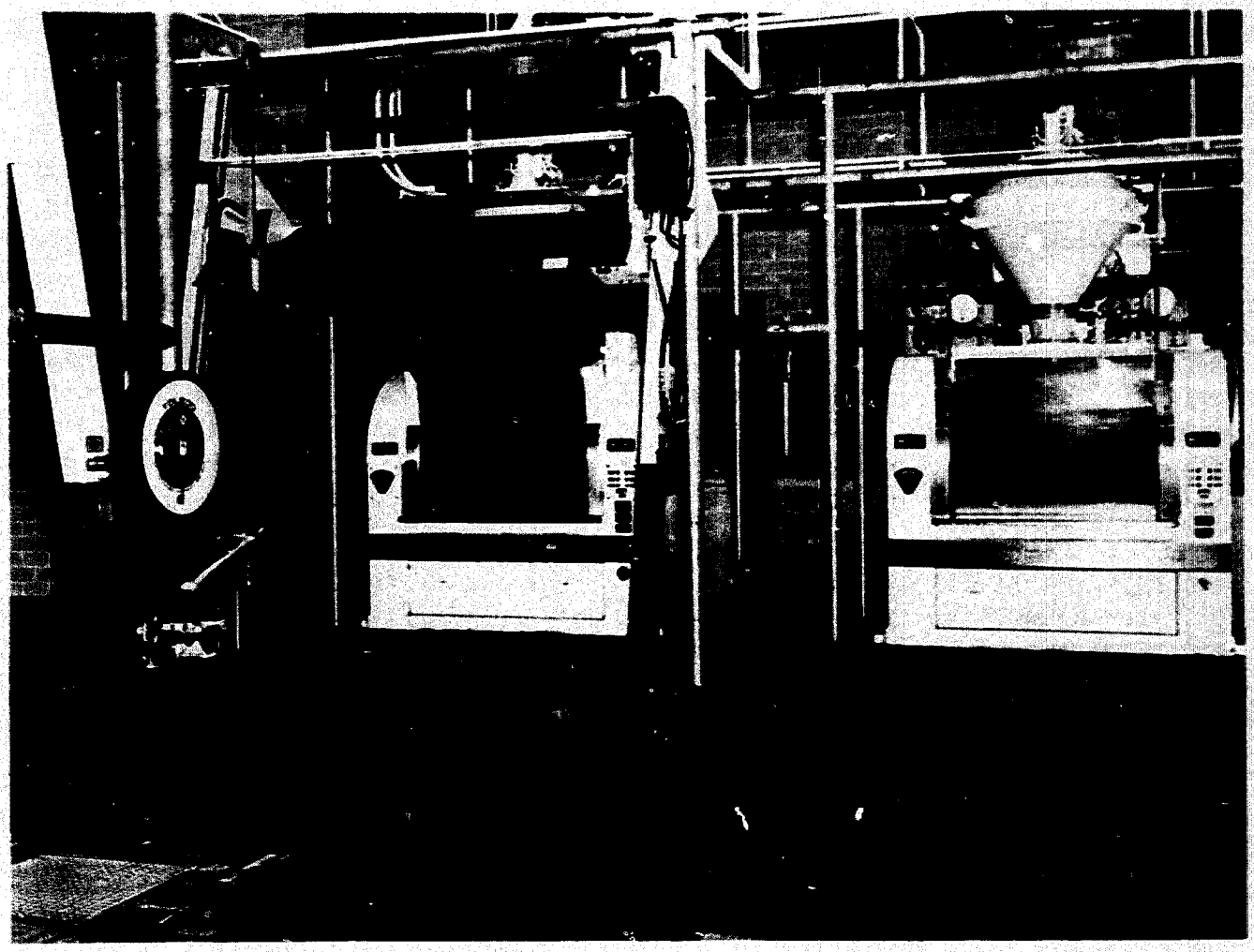


Figure 10. Flour Scale, Elevator and Dough Mixers

3. Scales Are Defective. Improper care of scales and weights is another source of invisible loss. If these pieces of equipment are left unclean and foreign matter is allowed to accumulate, the actual amount of material being weighed will not be correct.

4. Loss of Weight Through Fermentation. Loss of weight of dough in trough occurs through fermentation loss and evaporation losses during the fermentation period. If modern methods are used, true fermentation loss should not exceed $\frac{1}{2}$ of 1% of the weight of the dough. The evaporation of moisture from the dough during the fermentation period in many cases is greater than the true fermentation loss. If the temperature and humidity of the dough room are adequately controlled, this evaporation loss should be practically eliminated.

5. Careless Scaling of Ingredients. If the actual number of pieces of dough from any given batch is less than calculated, the possible causes should be investigated. Possible causes could be that dough is left in troughs, chute, or divider; dough is damaged and lost in dividing and scaling; or over-scaling of dough pieces. If the scaling weight is below standard, there will be an apparent gain in the number of dough units secured. Such a condition is in no sense an advantage and should be corrected.

6. Cripples. If due caution is not exercised, dough loaves are sometimes crippled in the moulding machine or during panning in a similar way to those produced during dividing and scaling. Loaves are crippled in other ways such as damage in the proof box, during baking, or in the wrapping process. Water cripples the loaves in the proof box; excessive humidity causes this. During the baking process loaves are burned and become unusable. Loaves, while being wrapped get crushed and become a total loss. Loaves are often crippled during baking by being burned in the oven, or by irregular bursts in the oven which result in deformed, unsymmetrical loaves. Oven cripples can be avoided by proper regulation of oven temperature and steam and also by maintaining the proper conditions during pan proofing. There is one accountable loss during the baking process which is called oven loss and is approximately 10%. For example: A loaf of bread is scaled twenty ounces before make-up, then moulded, panned, proofed, and baked off in the oven. When the finished loaf comes out it will weigh approximately two ounces less. This loss is accountable in baking and must be considered when figuring the amount of pounds of bread that will come out of a given dough.

Perfection Is Practically Unattainable

A bakery is not 100% efficient, and some losses are bound to occur even in the best regulated shops. The important thing is to discover all losses when they occur, ascertain the cause, and then take necessary steps to reduce such losses to a minimum. Other ways to attain near perfection are:

1. To maintain clean and accurate records.

2. To use manpower efficiently.

3. To spend ample time in training and education of personnel.

Summary

There are several points to keep in mind in order to cut waste to a minimum in a bakery. These points are:

1. There must be a reliable person responsible for keeping the physical and perpetual inventories which cover materials received and dispersed.

2. To remember there are two types of losses in baking and these are normal and accountable losses.

3. To remember the evaporation loss while the products are in storage and during fermentation and that the proper control of temperature and humidity will cut the evaporation loss to a minimum.

4. That there are losses to try to eliminate, such as scaling losses, cripples, and handling and distribution losses.

All these causes, when eliminated, create a well-run and economy-wise bakery.

SUMMARY

A small bakery, built and operated according to the assumptions made in this study, would be a profitable undertaking.

There are some determinations, however, that should be made before a decision is reached to build and operate such a bakery. Among the necessary determinations to be made are those with respect to the following items:

MATERIALS AND SUPPLIES

1. Are the majority of materials and supplies available locally?

2. Is the local material market competitive?

3. Are satisfactory delivery of local materials and flour assured at reasonable prices?

4. What materials and supplies must be imported?

5. Are they available in world markets at competitive prices?

6. Would prompt delivery of imported materials and supplies be assured so that large inventories would not be required?

MARKET FACTORS

1. Is there already a demand for the product?

   a. Who are the principal customers? (Individuals or institutions?)

2. How is demand for the product now satisfied?

   a. By local production? If so, what is the volume of annual production?

b. What percentage of consumption is filled by local production?

c. By imports? If so, what is the volume of annual imports?

d. What percentage of consumption is met by imports?

e. From what areas are imports derived?

3. What is the estimated annual increase in local consumption over the next five years?

a. How were such estimates made?

b. By reference to official figures on population growth, family budgets, imports, etc.?

c. By consultation with trade or industry, ministries, associations, bankers, commercial houses, wholesalers, retailers, industrial consumers, etc.?

4. If the product is already being manufactured, can the existing and estimated future local market absorb production of the new plant without price-cutting or other dislocations?

5. Would the estimated sales price and quality of the new product make it competitive with an imported equivalent? After adjusting cost to local conditions, is the estimated sales price of the product so high that tariff protection is necessary to protect it from imports?

MARKETING PROBLEMS

1. In calculating costs of the product, has adequate allowance been made for the expense of a sales department, advertising, and promotion that might be required?

2. Do marketing and distribution facilities for the product exist?

a. If not, can they be set up?

b. What would it cost to do so?

3. Will the product be sold to:

a. Wholesalers?

b. Retailers?

c. Direct to consumer?

d. Other industries?

e. Government?

ECONOMIC FACTORS

1. How much foreign exchange (and in what currency) is required to import machinery, equipment and supplies:

a. How much foreign exchange (and in what currency) is required for annual interest payments and amortization of any loans contracted to import machinery and equipment, or for payment of royalties and technical services?

b. How much foreign exchange (and in what currency) is required for annual import of raw materials and supplies?

c. What are estimated annual foreign exchange earnings and in what currencies?

d. Has careful consideration been given to the possibility of depreciation in the foreign exchange value of the local currency?

e. Has careful consideration been given to the possibility of import controls, or restrictions on availabilities of foreign exchange necessary to operate the business?

f. What benefits would the new business bring to the economy in the use of local raw materials: in employment and in technology?

g. Do dependable facilities exist for transportation, power, fuel, water, and sewage?

(1) If not, can existing deficiencies be eliminated satisfactorily?

(2) What would be the cost to do so?

PERSONNEL

1. Is there an adequate skilled labor supply of bakers and helpers near the plant location?

a. If not, how can the problem be solved?

2. Can the problem of training competent management and supervisory personnel be solved?

a. Also, the training of skilled labor?

b. Is technical advice available in the locality?

c. If not, where can it be obtained and what will it cost?

LAWS AND REGULATIONS

1. Do existing labor laws, government regulations, laws and taxes favor establishment of new business?

a. If not, can existing obstacles be removed?

b. If so, how and when?

FINANCIAL FACTORS

1. Technical advice on selection of machinery and equipment.

a. In selecting the machinery and equipment for the new plant, have reputable and competent engineers and technicians been consulted?

b. Have they been asked for advice on the most suitable types of machinery and equipment for the process and locality?

c. Have they carefully compared costs of various suppliers?

d. Credit terms offered purchasers?

FINANCIAL REQUIREMENTS OF THE PROJECT

1. In estimating the cost of the project, has careful consideration been given to:

a. The effect on costs of delays in construction schedules?

b. In delivery and installation of machinery and equipment?

c. In import of essential raw materials and supplies?

2. In calculating cash flow and working capital requirements, has careful consideration been given to:

a. Maintaining adequate inventories of raw materials?

b. Supplies and spare parts?

c. Seasonal fluctuations in the business?

d. The time required to liquidate credit sales to customers and bad debts?

e. The period necessary to get the plant into production?

f. Cash required to amortize its principal loans?

3. If the economy is in a period of inflation, has full allowance been made for the influence of rising prices and wages on the cost of the project and on working capital requirements?

SHORT TERM BANK CREDITS

1. Has it been possible to make arrangements with local banks to finance short-time working capital requirements of the business?

FINANCIAL PLAN

1. Has a definite plan to finance the project been worked out?

a. Is sufficient capital available locally?

b. If not, what is the plan to obtain the required capital?

BOOKS AND PERIODICALS ON BAKING

Books

Conversion Factors and Technical Data for the Food Industry, Harrell and Thelen, Burgess Publishing Co., 426 South 6th St., Minneapolis 15, Minn.

Baking Science and Technology, E. J. Pyler, Siebel Publishing Co., 4055 West Peterson, Chicago, Illinois. **Price $15.00**

Baking in America, W. G. Panschar and C. C. Slater, Northwestern University Press, Evanston, Illinois. **Price $15.00**

Periodicals

Baker's Weekly, 71 Vanderbilt Ave., New York 17, New York
Baking Industry, 105 West Adams St., Chicago 3, Illinois
Bakers Review, 625 Eighth Ave., New York, New York

ENGINEERS

The services of professional engineers are desirable in the design of this bakery, even though the proposed plant is small.

A correct design is one which provides the greatest economy in the investment of funds and establishes the basis of operation that will be most profitable in the beginning and will also be capable of expansion without expensive alteration.

The addresses of professional engineers who specialize in industrial design, some of whom may be willing to undertake such work on low cost projects overseas, can be secured by reference to the published cards in various engineering magazines. They may also be reached through their national organizations, one of which is the

National Society of Professional Engineers
2029 K Street, Northwest
Washington 6, D. C.

Manufacturers of industrial equipment employ engineers familiar with the design and installation of their specialized products. These manufacturers are usually willing to give prospective customers the benefit of technical advice by those engineers in determining the suitability of their equipment in any proposed project.

BAKERY INDUSTRY ORGANIZATIONS

American Bakers Association, 20 North Wacker Drive, Chicago 6, Ill.

American Institute of Baking, 400 East Ontario St., Chicago 11, Ill.

Associated Retail Bakers of America, 735 West Sheridan Road, Chicago, Ill.

Bakery Equipment Manufacturers Association, 511 Fifth Ave., New York 17, N. Y.

Baking Industry Sanitation Standards Committee, 511 Fifth Ave., New York 17, N.Y.

Quality Bakers of America, 120 West 42nd St., New York, N. Y.

The American Society of Bakery Engineers, 121 West Wacker Drive, Chicago 1, Ill.

W. E. Long Company, 188 West Randolph St., Chicago 6, Ill.

BAKERY MACHINERY MANUFACTURERS

The bakery equipment manufacturing industry is highly developed and specialized, and the entire list of manufacturers of equipment is too extensive to be reproduced here. A copy of such a list can be obtained from the Bakery Equipment Manufacturers Association, 511 Fifth Ave., New York, N. Y.

GLOSSARY OF BAKING TERMS

Absorption — A taking in or reception, by molecular and/or physical action. The property of flour to absorb and hold liquid.

Acidity — Sourness or tartness in a food product; a condition indicating excess fermentation in yeast doughs. Also, a factor used with soda to generate carbon dioxide for cake leavening.

Aeration — The treatment of dough or batter by charging with gas to produce a volume increase.

Albumen — Egg white.

Almond paste — Almonds ground to paste with sugar.

Angel food cake — A fine white cake, without shortening, made of egg whites, sugar, flavoring, and flour; usually, baked in a tube pan.

Ash — The incombustible residue left after burning matter.

Bacteria — Microscopic organisms, various species of which are concerned in fermentation and spoilage of foods.

Bake — To cook or roast by dry heat in a closed place, such as an oven.

Baking powder — A chemical leavening agent composed of soda, dry acids, and cornstarch (to absorb moisture); when wet and heated carbon dioxide is given off to raise the batter during baking.

Bars — Cookies made in oblong or rectangular shape.

Batter — A homogeneous mixture of ingredients with liquid to make a mass that is of a soft plastic character.

Bench tolerance — The property of dough to ferment at a rate slow enough to prevent overfermentation while dough is being made-up into units on the bench.

Biscuit — Small roll made with yeast dough; small round bread made of dough raised with baking powder; kind of crisp hard bread thin and flat made without leavening.

Bleeding — Term applied to dough that has been cut and left unsealed at the cut, thus, permitting the escape of leavening gas.

Blend — A mixture of several ingredients or grades of any ingredient.

Boil — To bubble, emitting vapor, when heat is applied. Boiling temperature for water is 212° F. at sea level.

Boiled icing — An icing made by boiling sugar and water to thread state (238° F.) then slowly adding to beaten egg whites with additional beating.

Bolting — Sifting of ground grain to remove the bran and coarse particles.

Boston brown bread. — A dark sweet bread (chemically leavened) containing among the ingredients cornmeal, and molasses; steamed, not baked.

Bowl knife — A spatula or flexible dull edged knife used to scrape batter or dough from bowl sides.

Bran — Skin or outer covering of the wheat berry.

Bran muffin — Sweet muffin containing a large percentage of bran.

Bread — The accepted term for baked foods made of flour, sugar, shortening, salt, and liquid, and leavened by the action of yeast.

Bread dough — The unbaked mass of ingredients used to make bread.

Bread faults — Deviations from standards of perfection, used to determine wrong factors in the process of production of bread.

Buns — Small shapes of bread dough, sometimes slightly sweetened or flavored.

Butter — Fat obtained by churning sweet or sour cream.

Butter cream frosting. — Rich, uncooked frosting containing powdered sugar, butter and/or other shortening and whipped to a plastic condition.

Butter horns — Basic sweet dough cut and shaped like horns.

Butter sponge — Cake made from sponge cake batter to which shortening has been added.

Butterscotch — A flavor produced by the use of butter and brown sugar.

Cake — A product obtained by baking a leavened and shortened batter containing flour, sugar, salt, egg, milk, liquid, flavoring, shortening, and a leavening agent.

Cake faults — Deviations from the standards of perfection for the type of cake.

Cake machine — Machine with vertical agitators operating at different speeds, used for mixing cake ingredients.

Caramel buns — Sweet dough pieces baked in a sugared pan.

Caramelized sugar. — Dry sugar heated with constant stirring until malted and dark in color, used for flavoring and coloring.

Carbohydrates — Sugars and starches derived chiefly from fruits and vegetable sources which contain set amounts of carbon, hydrogen, and oxygen.

Carbon dioxide — A colorless, tasteless edible gas obtained during fermentation or from a combination of soda and acid.

Carbonated ammonia. — Leavening agent made of ammonia and carbonic acid.

Cardamon — Seed of an East Indian spice plant used for flavoring.

Casein — The principle nitrogenous or protein part of milk.

Cheese cake — Either a shell made from sweet or short dough with a filling of combined cheese, eggs, and milk, or a batter base with a filling of combined cheese, eggs, and milk.

Chocolate snaps — Fairly crisp drop cookies flavored with chocolate.

Cinnamon — The aromatic bark of certain trees of the laurel family, ground and used as a spice flavoring.

Citron — The sweetened rind of the fruit.

Clear flour ..... Lower grade and higher ash content flour remaining after the patent flour has been separated.

Cocoa ..... A powder made from chocolate from which part of the cocoa butter has been expressed or extracted.

Coconut ..... The inside meat of the coconut, shredded or grated.

Coffee cake ..... Sweet yeast leavened dough made in various shapes, with filling or topping.

Colors ..... Shades produced by the use of dyes.

Compounds ..... In the baking industry, certain mixtures of fats and oils.

Congealing point. Temperature at which a liquid changes to a plastic or a solid.

Cornmeal ..... A coarse meal made by grinding corn.

Corn muffin ..... Sweet muffin containing corn flour or meal.

Cottage cheese ..... The drained curd of soured or coagulated milk.

Cream cheese ..... The drained curd of soured or coagulated cream, pressed and mixed until smooth.

Cream ..... The fat portion of cows milk; also a thickened cooked mass of sugar, egg, milk, and a thickener used for pies and fillings.

Creaming ..... The process of mixing and aerating shortening and another solid, such as sugar or flour.

Cream pies ..... One crust pies having cream filling, usually topped with whipped cream or meringue.

Cream puffs ..... Baked puffs of cream puff dough which are hollow, usually, filled with whipped cream or cooked custard.

Crescent rolls ..... Hard crusted rolls shaped into crescents, often with seeds on top.

Cripple ..... A misshapen, burnt, or otherwise undesirable unit.

Crullers ..... Long twisted, baking powder doughnuts.

Crusting ..... Formation of dry crust on surface of doughs due to evaporation of water from the surface.

Cup cakes ..... Small cakes of layer cake batter baked in muffin pans.

Currant ..... The acidulous berry of a shrub; usually dried.

Custard ..... A sweetened mixture of eggs and milk which is baked or cooked over hot water.

Danish pastry ..... A flaky yeast dough having butter or shortening rolled into it.

Dates ..... The fruit of a species of palm.

Date filling ..... A cooked blend of dates, water, and sugar.

Diastase ..... An enzyme possessing the power to convert starches into dextrose and maltose.

Dissolve ..... To bring a solid into solution in a solvent.

Divider ..... A machine used to cut dough into a desired size or weight.

Docking ..... Punching a number of vertical impressions in a dough with a smooth round stick about the size of a pencil, or smaller. Docking is done so that doughs expand uniformly without bursting during baking.

Dough ..... The thickened uncooked mass of combined ingredients for bread, rolls, and cookies, but usually applied to bread.

Dough room ..... Special room in which bread doughs are mixed.

Dough temperatures. Temperature of dough at different stages of processing.

Doughnut ..... A cake, frequently with a center hole, made of yeast or baking powder dough and fried in deep fat.

Dry milk ..... Milk from which the water has been removed by drying.

Dry fruit ..... Fruit from which most of the moisture has been removed by drying.

Dry yeast ..... A dehydrated form of yeast.

Dusting ..... Distributing of film of flour or starch on pans or work bench surfaces.

Dusting flour ..... Flour used to sift on to dough handling equipment to prevent dough from sticking.

Eclair ..... A long thin shell of the same paste as cream puffs.

Emulsification ..... The process of blending together fat and water solutions of ingredients to produce a stable mixture which will not separate on standing.

Enriched bread ..... Bread made from enriched flour and containing federally prescribed amounts of thiamin, riboflavin, iron, and niacin.

Enzyme ..... A substance produced by living organisms which has the power to bring about changes in organic materials.

Evaporated milk ..... Unsweetened canned milk from which water has been removed before canning.

Extract ..... Essence of fruits or spices used for flavoring.

Fat absorption ..... Fat which is absorbed in food products as they are fried in deep fat.

Fermentation ..... The chemical changes of an organic compound due to action of living organisms (yeast or bacteria), usually producing a leavening gas.

Fillings ..... Sweet creams, jams, or jellies placed between baked layers in cakes or shaped into yeast raised goods.

Finger rolls ..... A bun about five inches long and one inch wide.

Flavor ..... An extract, emulsion, or spice used to produce a pleasant taste.

Flour ..... Finely ground meal of grain.

Fluff ..... A mass of beaten egg white, air, and crushed fruit.

Foam ..... Mass of beaten egg and sugar, as in a sponge cake before the flour is added.

Fold ..... To lap yeast dough over on to itself. With cake batter to lift and lap the batter on to itself to lightly incorporate ingredients.

Fondant ..... Low moisture content sugar sirup containing a small quantity of invert sirup which has been rapidly cooled so that the sugar crystals are small in size.

Formula ..... In baking a recipe giving ingredients, amounts to be used, and the method of preparing the finished product.

French bread — An unsweetened crusty bread, baked in a narrow strip and containing little or no shortening.

French knife — A long knife with a pointed blade used in cutting cakes, doughs, and nuts.

Fruit cake — A cake containing large amounts of fruit and nuts with only enough cake batter to bind them together.

Frying — In baking, cooking in deep fat.

Germ — That part of the seed from which the new plant grows.

Ginger — The spicy root of a tropical plant used for flavoring.

Glace — Sugar so treated as to resemble ice.

Gliadin — One of the two proteins comprising gluten which provides elasticity.

Glucose (corn sirup). — A simple sugar made by action of acid on starch.

Gluten — The elastic protein mass that is formed when the protein material of the wheat flour is mixed with water.

Glutenin — One of the two proteins comprising gluten, which gives it strength.

Graham flour — Finely ground whole wheat flour.

Greasing — Spreading a film of fat on a surface.

Graining — After boiling a sugar solution to the desired temperature the solution will crystallize upon cooling. If cooling is slow, large crystals will form. Rapid cooling produces small crystals as will rapid mixing during cooling. Small fine crystals are desired in making fondant and this is accomplished by cooling and mixing. This process is called "graining."

Hamburger roll — A soft round roll about 4 inches in diameter and, usually, about one and one-half inches thick. Made from yeast leavened dough.

Hardness of water. — A measure of mineral salts in greater amounts than is found in soft water.

Hearth — The heated baking surface of the floor of an oven.

Honey — A sweet sirupy substance produced by bees from flower nectar.

Horseshoes — Danish or puff pastry shaped like horseshoes.

Hot cross buns — Sweet, spicy, fruity, buns with cross cut on top which usually is filled with a plain frosting.

Humidity — Usually expressed as "Relative Humidity" which is an expression of percent of moisture in air related to the total moisture capacity of that air at a particular temperature.

Hydrogenated oil. — A natural oil that has been treated with hydrogen to convert it to a hardened form.

Ice — To frost or put on an icing or frosting.

Ingredients — Food material blended to give palatable products.

Invert sugar — A mixture of dextrose and levulose made by inverting sucrose with acid or enzymes.

Jelly — A combination of fruit juice and sugar, stiffened by the action on the pectin of the fruit as a result of heating.

Jelly wreath — A rolled ring of basic sweet dough containing jelly.

Lactose — The sugar of milk.

Lady Baltimore cake. — Rich white layer cake with fruit and nut filling and white icing.

Lard — Rendered hog fat.

Leavening — Raising or lightening by air, steam, or gas (carbon dioxide). Usually, the agent for generating gas in a dough or batter is yeast or baking powder.

Levulose — A simple sugar found in honey and fruits.

Loaf cake — Cake baked in bread pans or similar deep containers.

Macaroons — Small cookies made from coconut or almond paste, sugar, and egg whites.

Make-up — Manual or mechanical manipulation of dough to provide a desired size and shape.

Malt extract — A sirupy liquid obtained from malt mash; a product obtained as a result of converting the starch to sugar.

Maple flavoring — An extract of maple sugar or a sirup, or an artificial flavoring extract.

Maraschino cherries. — Artificially colored and flavored cherries.

Marble cake — Cake of two or three colored batters partially mixed.

Marshmallow — A white confection of meringue like consistency.

Marzipan — Almond paste used for modeling, masking and torten.

Masking — Act of covering with icing or frosting.

Meal — Coarsely ground grain.

Melting point — The temperature at which a solid becomes a liquid.

Meringue — A white frothy mass of beaten egg whites and sugar.

Middlings — Granular particles of the endosperm of wheat made during grinding of the grain in the mills.

Milk — The fluid secreted by the mammary glands of mammals.

Mince meat — Combination filling of raisins, apples, spices, and beef suet.

Mix — The combined ingredients of a dough or batter.

Mixing bowl — A concave, hemispherical container for mixing.

Mocha — A flavor combination of coffee and chocolate, but predominately that of coffee.

Moisture — Water content of a substance.

Molasses — Light to dark brown sirup obtained in making cane sugar.

Moulder — Machine that shapes dough pieces for various shapes.

Muffins — Small light quickbreads baked in muffin pans.

Oatmeal (rolled oats) — Meal made by rolling oats.

Old doughs — Yeast dough which has become overfermented due to long fermentation. This produces a finished baked loaf dark in crumb color, sour in flavor, low in volume, corse in grain, and tough in texture.

Pans (tins)	Various shaped metal containers for baking or cooking.
Parker House rolls.	Folded buns of fairly rich dough.
Patent flour	The clean flour made by grinding the choice portion of the inner portion of wheat.
Pie	Dessert with pastry bottom, fruit or cream filling and topped with meringue, whipped cream, or pastry.
Plasticity	The consistency or feel of shortening.
Proof box	A tightly closed box or cabinet equipped with shelves to permit the introduction of heat and steam; used for fermenting dough.
Proofing period	The time during which dough rises between moulding and baking.
Puff paste	A pastry dough interlayered with butter or shortening to attain flakiness. Leavened during baking by the internally generated steam.
Quick breads	Bread products baked from a lean chemically leavened batter.
Raisins	Dried sweet grapes, may be dark or bleached.
Rocks	Small rough-surfaced fruited cookies made from a stiff batter.
Rolling pins	Smooth surfaced wood pieces for rolling dough.
Rolls	Small bread made from yeast leavened dough sometimes called buns; may be hard or soft crusted.
Rope	A spoiling bacterial growth in bread experienced when the dough becomes infected with bacterial spores. Poor sanitation can result in rope in bread.
Rounding or rounding-up.	Shaping of dough pieces into a ball to seal end and prevent bleeding and escape of gas.
Royal icing	Decorative frosting of cooked sugar and egg whites.
Salt	Sodium chloride, used for flavor and fermentation control.
Saturation	Absorption to the limit of the capacity.
Scale	An instrument for weighing.
Scaling	Apportioning batter or dough according to unit of weight.
Scoring	Judging finished goods according to points of perfection; or to cut or slash the top surface of dough pieces.
Shortening	Fat or oil used to tenderize bakery products or to fry bakery products.
Sifting	Passing through fine sieve for effective blending and to remove foreign or oversize particles.
Snaps	Small cookies that run flat during baking and become crisp on cooling.
Solidifying point.	Temperature at which a fluid changes to a solid.
Spices	Aromatic vegetable substances (dry) used for flavoring.
Stabilizers	Commercial preparations sold for use in meringue pie fillings, icings, and marshmallows. (If used follow package directions.)
Steam	Vapor formed and given off from heated water.
Starch water	A mixture of cornstarch and water made by boiling together 1 or 2 tablespoons of cornstarch with 1 quart of water. This is used for brushing on bread to give a shine to the crust.
Straight flour	Flour containing all the wheat berry except the bran and feeds; termed 100%.
Sugar:	
Cane or beet (sucrose).	Common and usually granulated sweetening agent.
Corn (dextrose).	A form of sugar made from corn and readily fermentable.
Maltose	A form of sugar obtained by germinating cereal grain. Usually, supplied as a sirup.
Tarts	Small pastries with heavy fruit filling or cream.
Tea rolls	Small sweet buns.
Temperature	Degrees of heat or cold.
Tempering	Adjusting temperature of ingredients to a certain degree.
Testing	Trying a cake or bread at the oven for doneness.
Texture	Describes the measure of silkiness of the interior structure of a baked product as sensed by the touch of the cut surface.
Thermometer	An instrument for measuring heat or cold.
Torten	Large fancy cakes enriched with creams, marzipan, fruits, and nuts.
Troughs	Large containers, usually on wheels used for holding large masses of raising dough.
Tutti fruiti	A confection or filling made of a fruit mixture.
Vegetable colors.	Liquids or pastes of vegetable nature, used for coloring. Highly concentrated, use with caution.
Vienna bread	A hearth type bread with heavy crisp crust, sometimes finished with seed topping.
Wash	A liquid brushed on the surface of an unbaked or baked product (may be water, milk, starch solution, thin sirup, or egg).
Water absorption.	Water required to produce a bread dough of desired consistency. Flours vary in ability to absorb water. This depends on the age of flour, moisture content, wheat from which it is milled, storage conditions, and milling process.
Whip	A hand or mechanical beater of wire construction used to whip materials such as cream or egg whites to a frothy consistency.
Yeast	A microscopic plant which reproduces by budding and causes fermentation and the giving off of carbon dioxide.
Young doughs	Yeast dough which is underfermented. This produces finished yeast goods which are light in color, tight in grain, and low in volume (heavy).
Zwieback	A toast made of bread or plain coffee cake dried in slow oven.

APPENDIX I

STRAIGHT DOUGHS—AVERAGE AMOUNTS OF ESSENTIAL INGREDIENTS USED IN COMMON VARIETY PRODUCTS

Note: Ingredient amounts may be modified to meet local conditions
Calculations based upon 100 lbs. or 100% flour
If so desired, from 0.125 to 0.5% mineral yeast feed may be used in all formulas

Kind of Dough	15 Minutes Pan Bread	Lean Pan Bread	Quality Pan Bread	Pan Bread Containing S. C. Milk	Pan Bread Containing Dry S. Milk	French Bread	Vienna Twist	Egg Twist	White Cheese Bread	Genuine Whole Wheat	Bran Raisin	Cracked Wheat	White Rye	Dark Rye	Cheese Rye	Swedish Rye	Hard Rolls	Soft Rolls	Sweet Rolls	Basic Sweet Dough	Coffee Cake	Danish Pastry	Potato	Gluten	Raisin	Cocoa	Honey Bread	Nut Bread	50% Pumpernickel	Form Cakes	Zwieback
FORMULA NUMBER	1	2	3	4	5	6	7	8	9[1]	10	11[2]	12[3]	13	14[4]	15[5]	16[6]	17	18	19[7]	20[8]	21[9]	22[10]	23[11]	24	25[12]	26[13]	27[14]	28[15]	29[16]	30[17]	31[18]
Patent flour	100	100	100	100	100	100	100	100	100		100						100	85	80	76	80	100	100		100		100	85		50	85
1st clear flour												45	60	70	70	70										100		15	50		15
Whole wheat flour										100		40																			
Bran											10																				
Cracked wheat												15																			
White rye flour													40		20																
Medium rye flour																30															
Dark rye flour														30	10																
Soft winter pat. flour																		15	20	24	20									50	
Whole rye meal																													50		
Gluten flour																								100							
Water (approx)	64	60	64	60	64	60	63	56	70	68	70	66	62	58	75	60	62	62	54	54	57	58	62	75	64	68	62	63	65	60	58
Yeast	4	2	2	2	2	2	2	2.5	2.5	2	2.5	2.5	2	2	2.25	2.25	2.5	3	6	6	6	5	2	4	2.5	2.5	2	2.5	2.5	0.25	3
Salt	1.75	1.75	2	2	2	1.75	1.75	1.5	2.25	2.25	2	2	2	2.25	2.25	2	1.75	1.75	1	1	1.25	1	2	2	1.75	1.75	2	2	2.25	1	1.25
Sugar	3	2	4.5		4		1.5	3	3	2.5	5		1				1	8	15	12	10	14	4		5	14		6		30	5
Shortening	3	1.5	3.5	3	3.5	1	1.25	5.5		3	3	2	1.5			2.5	1	8	12	15	12	12	3	3	4	2	3	4		33	12
Malt extract opt'l	1.5	1	1.5	1	1	0.75	0.5	3		1.5	1	1.75	2	2	1.5		0.5	1.5	1	2.5	2		1		2	1		1.5	1		
Sweet cond. milk				10								1																			4
Dry skim milk	4		6		4	3	3			3	3.5						3	5	5	3	4	3	3		4	4	4	4		3	
Eggs (by weight)								6											12	13	10	10		5						20	
Raisins																									65					17	
Molasses														2															3		
Caraway seed													1	1.25																	

NOTES

1. Ingredients in **bold face** can be excluded if so desired.
2. A variety of flavors other than those given can be used in sweet doughs. Extreme care in measuring flavoring extracts is necessary because any excess will spoil the products.

[1] 20% Dehydrated Grated Cheese. [2] 40–60% Small Raisins. [3] 5% Honey. [4] 12–15% Old Dough. [5] 20% Dehydrated Grated Cheese. [6] 10% Limper Flavor, 10% Golden Syrup.

[7] 0.05 Vanilla, 0.03 Mace. [8] 0.18 Mace 9 to 11 Lemons Gratings Used. [9] Base Suitable For "Rolled In" Goods {0.12% Vanilla, 0.12% Mace} [10] Roll in 2 to 3 Ounces of Butter to each 1 lb Dough {0.05% Vanilla, 0.05 Mace} [11] 4–6% Potato Flour.

[12] Soak or Steam Raisins. [13] 8% Cocoa. [14] 8% Honey. [15] 35% Walnuts or Mixed Nuts. [16] **5–10% Old Dough.** [17] 0.06 Lemon Ext., 0.06 Mace Ext., 17% Mixed Nuts.

[18] 0.06 Lemon Ext., 0.25% Cardamom, 0.06 Mace Ext, Seeds.

APPENDIX II

CONVERSION OF WEIGHTS

CONVERSION OF AVOIRDUPOIS TO METRIC SYSTEM OF WEIGHTS

Avoirdupois		Metric	
Pound	Ounce	Gram	Kilogram
1	16	453.6	0.454
0.0625	1	28.35	0.0283

Note. For practical calculations use 453 grams as equal to 1 pound, and 28 grams as equal to 1 ounce.

CONVERSION OF OUNCES (AVOIRDUPOIS) TO POUNDS
(Fractional and Decimal)

Ounces	Pounds		Ounces	Pounds	
	(Fractions)	(Decimals)		(Fractional)	(Decimals)
1	1/16	0.0625	15	15/16	0.938
2	1/8	0.125	16	1	1.000
3	3/16	0.188	17	1 1/16	1.063
4	1/4	0.25	18	1 1/8	1.125
5	5/16	0.313	19	1 3/16	1.188
6	3/8	0.375	20	1 1/4	1.25
7	7/16	0.438	30	1 7/8	1.875
8	1/2	0.5	40	2 1/2	2.5
9	9/16	0.563	50	3 1/8	3.125
10	5/8	0.625	60	2 3/4	3.75
11	11/16	0.688	70	4 3/8	4.375
12	3/4	0.75	80	5	5.000
13	13/16	0.813	90	5 5/8	5.625
14	7/8	0.875	100	6 1/4	6.25

Note. To change pounds to ounces multiply by 16. To change ounces to pounds divide by 16. For any number of ounces or pounds not listed above, add two or more numbers listed above which will equal the given number and then add the corresponding equivalents.

WEIGHTS OF WATER AND THEIR EQUIVALENTS

Weight	*Equivalent in measure*
1 pound (approx.)	1 pint
2 pounds 1½ ounces (approx.)	1 quart
8.35 ponds (approx.)	1 gallon
20 pounds 14 ounces	10-quart pail
25 pounds	12-quart pail
29 pounds 3 ounces	14-quart pail

WEIGHTS OF BAKING INGREDIENTS CONTAINED IN NO. 56 DIPPER (1 QUART), CANTEEN CUP, AND MESS-KIT SPOON
(All measurements level)

Ingredient	No. 56 Dipper (1 quart)	Canteen cup	Mess-kit spoon (tablespoon)
Flour	1 pound 5 ounces	1 pound	⅓ ounce
Water	2 pounds	1½ pounds	½ ounce
Yeast (compressed)			½ ounce
Yeast (active dry)			⅓ ounce
Salt	2 pounds 9 ounces	2 pounds	⅔ ounce
Sugar	2 pounds	1½ pounds	½ ounce
Shortening	2 pounds	1½ pounds	½ ounce
Dry skim milk	1 pound 5 ounces	1 pound	⅓ ounce

WEIGHTS, MEASURES, AND THEIR ABBREVIATIONS

Measure	Abbreviation	Equivalent
Teaspoon	t	3t = 1T
Tablespoon	T	16T = 1c
Cup	c	2c = 1 pt
Pint	pt	2 pt = 1 qt
Quart	qt	4 qt = 1 gal
Gram	gm	
Ounce	oz	28.35 gm = 1 oz
Pound	lb	16 oz = 1 pound

CONVERSION OF WATER FROM MEASURE TO WEIGHT

Cups	Pints	Quarts	Ounces	Pounds and Ounces	
½	¼	⅛	4.15	0	4
1	½	¼	8.31	0	8¼
1½	¾	⅜	12.46	0	12½
2	1	½	16.62	1	½
2½	1¼	⅝	20.77	1	4¾
3	1½	¾	24.93	1	9
3½	1¾	⅞	29.08	1	13
4	2	1	33.24	2	1¼
4½	2¼	1⅛	37.39	2	5¼
5	2½	1¼	41.55	2	9½
5½	2¾	1⅜	45.70	2	13¾
6	3	1½	49.86	3	1¾
6½	3¼	1⅝	54.01	3	6
7	3½	1¾	58.17	3	10¼
7½	3¾	1⅞	62.32	3	14¼
8	4	2	66.48	4	2½
8½	4¼	2⅛	70.63	4	6½
9	4½	2¼	74.80	4	10¾
9½	4¾	2⅜	78.94	4	15
10	5	2½	83.10	5	3¼
10½	5¼	2⅝	87.25	5	7¼
11	5½	2¾	91.40	5	11½
11½	5¾	2⅞	95.56	5	15½
12	6	3	99.72	6	3¾
12½	6¼	3⅛	103.87	6	8
13	6½	3¼	108.03	6	12
13½	6¾	3⅜	112.18	7	¼
14	7	3½	116.34	7	4¼
14½	7¼	3⅝	120.49	7	8¼
15	7½	3¾	124.65	7	12½
15½	7¾	3⅞	128.80	8	1
16	8	4	133.00	8	5

CONVERSION OF OTHER FORMS OF MILK TO APPROXIMATE EQUIVALENTS IN LIQUID WHOLE MILK

Liquid whole milk (pound)	Evaporated milk		Dry whole milk				Dry skim milk					
	Milk (14½-oz. can)	Water (pound)	Milk (whole dry)		Water		Milk (dry skim)		Butter or shortening		Water	
			Pound	Ounce	Pound	Ounce	Pound	Ounce	Pound	Ounce	Pound	Ounce
2.1 (1 qt.)	1	1		4	1	12		3		1	1	14
5	4½	4	1		4			12		4	7	6
8.6 (1 gal.)	2½	2½		10	4	6		7		3	4	6
10	5½	5	1	3	8	13		14		6	8	12
20	11	10	2	6	17	10	1	12		11	17	9
30	16½	15	3	9	25	7	2	10	1		26	6
40	22	20	4	12	35	4	3	8	1	6	35	2
50	27½	25	5	15	43	1	4	6	1	12	43	14
60	33	30	7	2	51	14	5	5	2	1	52	10
70	38½	35	8	5	60	11	6	3	2	6	61	7
80	44	40	9	12	70	4	7	1	2	12	70	3
90	49½	45	10	14	79	2	8		3	2	78	14
100	55	50	12		88		9		3	8	87	8

MINERAL SUBSTANCES IN WATER AND THEIR EFFECT ON BREAD

Type of water	Substance present	Effect	Remedy
Soft	Mineral free	Softens gluten; makes sticky dough.	Use mineral yeast food or more salt.
Temporarily hard	Calcium, iron, magnesium, bicarbonate.	Retard fermentation	Boil, filter, use vinegar.
Permanently hard	Calcium or magnesium surfates	Retard fermentation and toughen gluten.	Use more yeast; filter.
Saline	Sodium chloride (common salt).	Taste	Reduce salt slightly or distill.
	Iron	Color	Filter.
	Sulfur	Taste	Aerate; filter.
Alkaline	Alkali such as sodium carbonate.	Slows fermentation; bad taste.	Use vinegar, lactic acid, or more yeast.
Acid	Acid	Hastens fermentation	Filter through limestone.
	Sulfides	Dissolve gluten	Distill.
	Manganese	Sludge in pipes	Filter.
	Suspended matter	Cloudiness; dirt	Filter.
	Organic matter and bacteria	Unsafe for human consumption	Chlorinate.

MEASURES OF TEMPERATURE

CONVERSION OF FAHRENHEIT DEGREES TO CENTIGRADE DEGREES OF TEMPERATURE

Fahrenheit	*Centigrade*	*Fahrenheit*	*Centigrade*
0	17.8	85	29.4
10	12.2	90	32.2
15	9.4	95	35.0
20	6.7	100	37.8
32	0	110	43.3
35	1.7	120	48.9
40	4.4	150	65.6
45	7.2	200	93.3
50	10.0	212	100.0
55	12.8	250	121.1
60	15.6	300	148.9
65	18.3	350	176.7
70	21.1	400	204.4
75	23.9	450	232.2
80	26.7	500	260.0

Rule. Subtract 32 from Fahrenheit degrees, and multiply the remainder by 5/9. The product is the equivalent in centigrade degrees.

CONVERSION OF CENTIGRADE DEGREES TO FAHRENHEIT DEGREES OF TEMPERATURE

Centigrade	*Fahrenheit*	*Centigrade*	*Fahrenheit*
0	32	50	122
10	50	75	167
15	59	100	212
20	68	125	257
25	77	150	302
30	86	175	347
35	95	200	392
40	104	225	437
45	113	250	482

Rule. Multiply centigrade degrees by 9/5 and add 32. The product is the equivalent in Fahrenheit degrees.

DRY AND LIQUID MEASURES

DRY MEASURE

2 pints = 1 quart = 1.101 liters.
8 quarts = 1 peck = 8.808 liters.
4 pecks = 1 bushel = 35.24 liters.

LIQUID MEASURE

4 gills = 1 pint = 473.25 cubic centimeters.
2 pints = 1 quart = 0.9465 liters.
4 quarts = 1 gallon = 3.786 liters.
31½ gallons = 1 barrel.
2 barrels = 1 hogshead.

LIQUID MEASURE CONVERSION TABLE (UNITED STATES, IMPERIAL, AND METRIC MEASURES)

	United States measure				Imperial measure (British)				Metric measure		Weight of indicated volume of water	
United States measure	Gallon	Quart	Pint	Gill	Gallon	Quart	Pint	Gill	Liter	Cubic centimeter	Pound (avoirdupois)	Kilogram
1 gallon	1	4	8	32	0.833	3.33	6.66	26.66	3.785	3,785.4	8.33	3.785
1 quart	.25	1	2	8	.208	.833	1.666	6.67	.946	946.4	2.08	.946
1 pint	.125	.5	1	4	.104	.417	.833	3.33	.473	473.2	1.04	.473
1 gill	.031	.125	.25	1	.026	.104	.208	.833	.118	118.3	.26	.118
Imperial measure (British												
1 gallon	1.2	4.8	9.6	38.4	1	4	8	32	4.543	4,543.5	10	4.543
1 quart	3	1.2	2.4	9.6	.25	1	2	8	1.136	1,135.9	2.5	1.136
1 pint	.15	.6	1.2	4.8	.125	.5	1	4	.568	567.9	1.25	.568
1 gill	.038	.15	.3	1.2	.031	.125	.25	1	.142	142.0	.312	.142
Metric measure												
1 liter	.264	1.057	2.11	8.45	.220	.880	1.761	7.044	1	1,000	2.20	1
1 cubic centimeter.	.0003	.001	.002	.008	.0002	.0009	.002	.007	.001	1	.002	.001