

*Economies of Size in  
Non-Slaughtering Meat  
Processing Plants*

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## SUMMARY

This study was made to provide estimates of the investment and operating cost requirements for three sizes of non-slaughtering meat processing plants designed to produce and handle meat products and customer service items in a ratio of 38.5 percent sausages, 38.5 percent cured meats, 15.5 percent fresh cuts, and 7.5 percent customer service items at three alternative percentages of designed capacity.

Results indicated that a plant designed to produce 50,000 pounds per week of processed meats would require an investment of \$451,221 in land, buildings, and equipment. The medium sized plant producing 100,000 pounds per week would require an investment of \$772,278, and the large plant producing 250,000 pounds per week would require an investment of \$1,260,590.

Annual depreciation investment was the largest single component of ownership and use costs amounting to \$19,999, \$32,200, and \$53,000 for the small, medium, and large plants respectively.

Wages and salaries were by far the largest single operating cost. The annual payroll for the small plant operating at 100 percent of designed output amounted to \$88,000. For the medium and large plants the respective annual payrolls were \$166,300 and \$287,065.

The average processing costs per pound decreased for each size of plant as output of the plant was increased from 50 to 100 percent of the designed capacity. The reductions amounted to 4.70, 3.13, and 2.86 cents per pound respectively, for the small, medium, and large plants.

The average processing cost per pound decreased from 11.29 cents per pound to 8.96 cents per pound as the plant size increased from 50,000 pounds per week to 250,000 pounds per week.

# Economies of Size in Non-Slaughtering Meat Processing Plants

by

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Processed meat production has trended upward in recent years due to increased consumption and subsequent increased production. Production of sausages and cured and smoked meats in federally inspected plants has increased from 9.5 billion pounds in 1952 to 10.8 billion pounds in 1964.

Between 1947 and 1963, the number of meat processing plants in the United States increased from 1,264 to 1,341; from 72 to 86 in the west south central region (Arkansas, Louisiana, Texas and Oklahoma); and from 7 to 11 in Oklahoma and coinciding with the changes in the number of meat processing plants there have been significant changes in processing technology.

This study was made to determine construction and operating costs of different sized non-slaughtering meat processing plants operating at 50, 75, and 100 percent of designed capacities.

## General Specifications of the Model Plants

For this analysis, the input-output relationships of three sizes of plants with maximum outputs of 50,000, 100,000, and 250,000 pounds per week were synthesized. Each plant was designed to comply with regulations of the United States Department of Agriculture.

Each plant consists of a receiving cooler, receiving freezer, sausage kitchen, cured meats processing area, smokeshouses, blast chill cooler, tempering cooler, slicing and packaging area, dry storage and box make-up area, order assembly area, welfare rooms, office space, areas for a plant shop, refrigeration equipment, boiler, and equipment storage, and sufficient parking area for delivery trucks, employees and visitors.

The plants were presumed to operate eight hours per day with a single labor shift for 260 operating days per year—a common practice in Southwestern plants.

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## Cost Classification

The cost data requirements of this study are classified according to three broad categories: capital investments, ownership and use, and operating costs. Capital investment includes buildings, equipment, real estate, and an allowance for operating capital. Ownership and use costs include taxes, depreciation, insurance, interest, and repairs and maintenance cost. Operating costs include wages and salaries, packaging materials, utilities, telephone, laundry, and other supplies.

## Building Description and Investment

The cost of constructing a meat processing plant depends upon many factors, not all of which were considered in detail in this study.<sup>1</sup> For this study, it was assumed that plants would be constructed on level ground in industrial areas suitable for meat processing operations and that the plants would meet all the requirements for Federal inspection.

The various departments and areas of a meat processing plant may be divided into four main categories for purposes of estimating construction costs. These consist of coolers and all refrigerated work areas to include the order assembly area and internal unloading dock; freezers; dry storage to include equipment storage, plant supplies storage, spice storage, plant shop, boiler room, refrigeration equipment room, and welfare rooms; and office space.

Cost estimates for coolers and refrigerated work areas, freezers, and dry storage areas assume that the Chicago construction cost index and Tulsa construction cost index had a relation to the construction cost index in 1961 similar to the current relation. These indices are presented in Table I. Applying this index relation to the mid-range cost figures

<sup>1</sup>The cost estimates for plant construction presented here compared favorably with estimates of other operations furnished by meat industry specialists such as R. Starr Parker Associates, engineers, architects, and consultants, Atlanta, Georgia.

**Table I — Construction Cost Indices**

Year	Chicago	Indices Tulsa	Historical
1965 <sup>1</sup>	104	98	100
1961	95 <sup>2</sup>	89 <sup>2</sup>	91 <sup>1</sup>

<sup>1</sup>As given in Robert Snow Means Company, Inc., *Building Construction Cost Data*, 1966, (Duxbury, 1966), p. 95.

<sup>2</sup>Estimated assuming that Chicago was 4 points higher than the historical index in 1961 as in 1965 and that Tulsa was 2 points below the historical index in 1961 as in 1965.

presented in *Meat Industry Trends—1961*, construction costs were estimated for these plant area categories. These costs are presented in Table II. The construction cost for office areas was estimated by applying the current Tulsa construction cost index to the rate of \$10 per square foot used by Franzmann and Kuntz (1) to obtain a cost rate of \$10.50 per square foot.

### Receiving Coolers and Receiving Freezers

Receiving coolers are usually designed to meet the particular needs of an individual plant, therefore, they are built in a variety of sizes and shapes. Several important factors are considered when designing any cooler. Nine such factors are listed: (1) the product flow pattern, (2) the type and amount of construction materials used, (3) the amount, type, and temperature of product to be handled, (4) the cooler room temperature and relative humidity to be maintained, (5) the outdoor temperature, (6) the amount and size of electrical equipment in the cooler, (7) the number of individuals working in the coolers, (8) the frequency of air changes, and (9) the orientation of the coolers to the compass.

Several assumptions regarding the construction detail of the chill and holding coolers were made as an aid in estimating the needs for refrigeration equipment.

If an individual plant uses frozen meat in its operations, as the model plants were specified to do, the receiving freezer will be designed to meet the specific needs of that plant. The same nine important factors as listed above are considered when designing a freezer.

To estimate the receiving cooler size, the following specifications were employed: (1) the rails were spaced on 2.5 feet centers with an

**Table II — Estimated Construction Cost Rates**

Type or Purpose	Cost \$/Sq. Ft.			
	FROM <sup>1</sup>	TO <sup>1</sup>	Mid-Range <sup>2</sup>	Computed <sup>3</sup>
30° Cooler or Refrigerated Work Area	15.00	20.00	17.50	18.25
Sub-Zero Freezer	18.00	23.00	20.50	22.25
Dry Storage Area	6.00	10.00	8.00	8.25

<sup>1</sup>From H. L. Rothra ed., *Meat Industry Trends* — 1961, (Chicago, 1961), p. 1-7.

<sup>2</sup>Mid-range of the "FROM" to "TO" columns.

<sup>3</sup>These figures assume the mid-range cost rate estimates for the Chicago area, 1961, to be equivalent to the estimated 1961 index for Chicago of 95 presented in Table I. By ratio these figures are computed to correspond to the current construction cost index of 98 for Tulsa.

allowance of 12 inches of rail space per beef quarter and 18 inches of rail space per pork carcass, (2) all rails were spaced 3 feet from any wall, and (3) ceilings were 12 feet high. Rail space was provided to allow for 2.5 days' storage of beef quarters and 2 days' storage of pork carcasses when 60 percent of the boned meat utilized by the plant is prechilled fresh beef and 36 percent is prechilled fresh pork.

The area requirements for the freezer were estimated considering that (1) 10 percent of the boned pork or 4 percent of the meat for sausage products used by the plant would be frozen pork which would be bought once weekly, (2) that approximately 7.5 percent of the plant output would be jobbed customer service items, and (3) all items would be stored on pallets. Area requirements and estimated costs of construction of receiving coolers and freezers and other departments of the model plants are presented in Table III.

### **Cutting and Boning Department**

In smaller plants, it may be found that the cutting and boning operation, sausage kitchen, and cured meats processing are all located in one large room. In larger plants, the cutting and boning operation is a separate department and if large enough, may be a conveyORIZED operation.

The space provided for this department varies widely among meat processing plants. In this study, area requirements for the cutting and boning department were based on the area required for the equipment and data on work areas and truckways of cutting and boning departments of plants in the Southwest. A conveyORIZED system is not included in any of the model plants.

The cutting and boning department was provided with refrigeration to maintain a temperature not higher than 50 degrees.

### **Sausage Kitchen and Cured Meats Department**

The entire meat processing plant should be designed to provide maximum efficiency in the flow of the product from the time the meat and supplies are received until the finished product leaves the plant.

The flow is extremely important in the sausage kitchen and cured meats departments since so many operations are performed in these departments. The area requirements for these departments were estimated from equipment space requirements and data on sausage and cured meats departments in plants of the Southwest.



Table III — Building Requirements and Costs for the Three Model Plants

Item	Cost Per sq. ft. <sup>1</sup> (Dollars)	Plant Size					
		Small		Medium		Large	
		Area (sq. ft.)	Total Cost <sup>2</sup> (Dollars)	Area (sq. ft.)	Total Cost <sup>2</sup> (Dollars)	Area (sq. ft.)	Total Cost <sup>2</sup> (Dollars)
Receiving Cooler	18.25	796	14,527.00	1,235	22,538.75	2,475	45,168.75
Receiving Freezer	22.25	389	8,665.25	650	14,462.50	709	15,775.25
Pork Cut & Beef Boning	18.25	584	10,658.00	881	16,078.25	1,980	36,135.00
Sausage Manufacturing	18.25	3,040	55,480.00	3,756	68,547.00	4,519	82,471.75
Cured Meats Department	18.25	1,161	21,188.25	1,542	28,141.50	3,404	62,123.00
Spice Storage	8.25	75	618.75	82	676.50	205	1,691.25
Smokehouses and Wash	18.25	953	17,392.25	1,781	32,503.25	2,339	42,686.75
Blast Chill	18.25	441	8,048.25	690	12,592.50	1,334	24,345.50
Tempering Cooler	18.25	761	13,888.25	1,415	25,823.75	2,826	51,574.50
Slicing and Packaging	18.25	1,739	31,736.75	3,001	54,768.25	5,566	101,579.50
Order Assembly	18.25	1,909	34,839.25	4,791	87,435.75	7,442	135,816.50
Equipment Storage	8.25	1,625	13,406.25	2,585	21,236.25	4,446	36,679.50
Packaging Supplies	8.25	440	3,630.00	4,693	38,717.25	6,147	50,712.75
Boiler Room	8.25	367	3,027.75	398	3,283.50	398	3,283.50
Plant Shop	8.25	—	—	570	4,702.50	588	4,851.00
Refrigeration Equipment	8.25	—	—	914	7,540.50	2,546	21,004.50
Dock	18.25	711	12,975.75	842	15,366.50	1,146	20,914.50
Welfare Room	8.25	473	3,902.25	860	7,095.00	1,294	10,675.50
Office	10.50	886	9,303.00	1,618	16,989.00	2,303	24,234.00
<b>Total</b>		<b>16,350</b>	<b>263,287.00</b>	<b>32,304</b>	<b>478,588.50</b>	<b>51,672</b>	<b>771,723.00</b>

<sup>1</sup>Estimated using procedure discussed in text.

<sup>2</sup>Cost per square foot multiplied by the appropriate area.

## **Spice Storage**

The area for spice storage in the model plants was estimated assuming that three percent of the sausage production was spices and that the average inventory of spices would be a three months' supply.

## **Smokehouses**

The smokehouse space was estimated considering that the smokehouses would operate 18 hours per day five days a week with 38.5 percent of the plant's output as sausages and 38.5 percent as cured meats. Of the sausage products, small casing products such as franks consisted of 49.7 percent; loaf products, 2.8 percent; large casing products such as bologna, 15.7 percent; ground beef and fresh sausage, 28.7 percent; and other products such as chili, 3.1 percent. Of the cured meats, bacon accounted for 45.2 percent; hams, 40.1 percent; picnics, 12.4 percent; and products such as cured jowls and hocks, 2.3 percent. The cost of the smokehouses was an average of prices received from major manufacturers of smokehouses.

Included in the smokehouse area was room for washing products after smoking and space for equipment storage. These areas were estimated using data compiled on operations of the Southwest.

## **Blast Chill**

The blast chill cooler area of meat processing plants varies widely. The type of product being produced, the product mix, and the type of refrigeration equipment are three important factors influencing the area of the blast chill. For the model plants, the blast chill cooler was designed to hold one day's production of products which were cooked and/or smoked. This will provide adequate facilities for blast chill when considering the product mix as listed in the paragraph describing the smokehouses.

## **Tempering Cooler**

The area of the tempering room was developed using data compiled on several meat processing plants in the Southwest. The size of this cooler varies from quite small to quite large among processing plants. This basis for computing the size of the tempering cooler provides adequate tempering area for plants producing sausages, and cured meats, in the ratios mentioned previously.

### **Slicing, Peeling, and Packaging Area**

Like the other preparation and processing departments of the meat processing plant, the area for the slicing, peeling and packaging operations was designed to provide sufficient space for equipment, work areas, and truckways to efficiently perform the slicing, peeling, and packaging operations.

### **Order Assembly Department**

The order assembly department brings all products of the plant to one central location for convenient and efficient filling of customer orders for distribution. The two largest model plants were equipped with an arrangement of roller shelves allowing easy shelving of products and efficiency in assembling orders. These order assembly departments were also equipped with a gravity roller conveyor which allows efficient loading of several trucks simultaneously. Sufficient space was also provided for storage of pallets which deliver the finished products to that department from the processing departments. In the small model plant, all products are stored on pallets and cart shelves and manually trucked to the loading points. The total area and arrangement of the order assembly department of the model plants is based upon order assembly departments of meat processing plants in the Southwest.

### **Packaging Supplies Storage and Box Make-Up**

The model plants' packaging supplies storage areas were designed to provide storage for a three months' supply of packaging materials and included adequate space for box construction.

### **Docks**

Unloading docks were provided for receiving carcass pork, quartered beef, frozen pork, and customer service items in the holding cooler and holding freezer. The docks, designed as an internal part of the building, were 10 feet wide and as long as the width of the holding cooler and the necessary length to extend to the adjacent holding freezer. Internal unloading dock space was also provided to allow convenient unloading of packaging materials and other plant supplies at a point most accessible to the storage areas.

Loading docks from the order assembly department were also designed as an internal part of the building. These docks were wide enough

to allow adequate work space to load delivery vehicles directly from the gravity assembly conveyor.

### **Employee Welfare Rooms**

Employee dressing rooms meeting the requirements for Federal inspection were specified for each of the model plants. The area of the dressing room was estimated on the basis of 17 square feet per production employee.

### **Offices**

Three types of offices are found in a meat processing plant. These are a general office, a manager's office, and the Federal inspector's office. The size of the inspector's office must be at least 7 feet by 9 feet in size, but the general office and manager's office vary widely in size often reflecting the personal preference of the manager more than any other factor. The office space for the model plants was estimated considering the number of office employees and management personnel.

The cost of constructing office areas can vary greatly depending upon the type of materials used in finishing. Tastes in office decor vary widely and are reflected in the cost of the office space.

### **Real Estate Requirements and Investment**

Values of land suitable for non-slaughtering meat processing sites in the Oklahoma City area ranged from \$1,000 per acre to \$8,000 per acre depending mainly upon access to expressways.<sup>2</sup> In the absence of any good criteria for assigning values in this range of particular sizes of plants, a cost of \$4,356 per acre was arbitrarily selected as the basis for estimating the real estate investment for the model plants.

### **Parking Lots and Dock Apron**

Parking lots are required by meat processing plants for the use of the plant employees and visitors. The procedure used to estimate the parking area in this study was that used by Franzmann and Kuntz. (1)

A concrete dock apron 20 feet wide and the length of the unloading and loading docks was provided complying with Federal inspection requirements. An additional span of asphaltic concrete 20 feet wide and the length of the concrete apron was provided as a driveway, turning space, and parking area for loading and unloading trucks. The construc-

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<sup>2</sup>Conversation with Mr. Charles Boat, Industrial Division, Oklahoma City Chamber of Commerce.

tion cost of the concrete dock aprons was estimated at \$0.50 per square foot. The construction cost of the asphaltic concrete areas of the dock aprons and the parking lots was estimated at \$0.56 per square foot. The parking lot and dock apron areas and costs of construction for the model plants are presented in Table IV.

### Landscape

The amount of land allowed for the landscape of the plant was arbitrarily estimated as an area equal to the length of the office front by 10 feet in width. Landscape areas are presented in Table V.

### Equipment Investment

Equipment for meat processing plants includes all equipment from office and welfare room equipment to the manufacturing and refrigeration equipment. The equipment requirements of the meat processing

**Table IV — Synthesized Parking Lot and Loading Dock Apron Areas and Costs for the Three Model Plants**

Item	Weekly Plant Output <sup>1</sup>		
	50,000 lbs.	100,000 lbs.	250,000 lbs.
Employee Parking Lot Area (sq. ft.)	5,670	10,800	17,820
Visitor Parking Lot Area (sq. ft.)	567	1,080	1,782
Concrete Dock Apron (sq. ft.)	1,840	3,180	3,900
Asphaltic Concrete Dock Apron (sq. ft.)	1,840	3,180	3,900
Total Parking Lot and Dock Apron Area (sq. ft.)	9,917	18,237	27,402
Parking Lot and Dock Apron Cost (dol.)	\$5,443.12	\$10,053.84	\$16,061.12

<sup>1</sup>Designed output including customer service items.

**Table V — Land Requirements and Costs for the Three Model Plants**

Plant Output <sup>1</sup>	Plant Area	Landscape	Total Land Area	Total Land Cost	Annual Interest Cost
(Pounds)	(Square Feet)		(Dollars)		
50,000	26,399	420	26,819	2,681.90	160.91
100,000	44,655	650	45,315	4,531.50	271.89
250,000	73,044	650	73,694	7,369.40	442.16

<sup>1</sup>Designed weekly output including customer service items.

plants considered in this study may be placed in ten general categories: (1) sausage kitchen, (2) cured meats, (3) packaging, (4) smoking, (5) boning, (6) order assembly, (7) refrigeration, (8) office, (9) welfare, and (10) miscellaneous. Total costs of equipment by category for each plant are given in Table VI. No attempt was made to estimate the specific items of refrigeration equipment required for each plant. The capacity of the refrigeration equipment was estimated in terms of tons of refrigeration required to remove the total heat load from the plant.<sup>3</sup>

Equipment used in the processing of sausage and cured meats varies from manually operated models to the highly advanced electronically controlled and operated models for some items of equipment.

When purchasing meat processing equipment, a firm may buy new equipment or used equipment. New equipment costs vary widely depending on the degree of sophistication of the machines. And in general, used equipment costs are much different from costs of new equipment and vary greatly.

In this study, new equipment was specified throughout the model plants, thereby allowing more uniformity in equipment prices as well as in specifying the items of equipment and establishment of maintenance costs.

Size models of processing equipment are not perfectly divisible, therefore machines were specified for each model plant which would most nearly meet the requirements of that plant operating at its maximum designed volume.

<sup>3</sup>The total heat load was calculated assuming certain construction specifications and considering refrigeration loss due to the people working in the various plant areas, electric motors powering the equipment, lights, and infiltration from open doors.

**Table VI — Total Equipment Costs by Category for the Three Model Plants**

Equipment	Cost <sup>2</sup>	Weekly Plant Output <sup>1</sup>		
		50,000 lbs.	100,000 lbs.	250,000 lbs.
			(Dollars)	
Refrigeration		25,800.00	48,000.00	79,500.00
Sausage Kitchen		35,889.61	64,992.59	95,719.33
Cured Meats		21,809.57	29,963.07	38,621.69
Smoking		47,868.58	63,611.24	122,154.10
Packaging		24,755.10	27,067.39	37,414.56
Boning		1,625.59	4,028.62	4,535.22
Order Assembly		2,754.70	8,040.26	25,927.38
Miscellaneous		11,705.08	23,286.53	47,264.48
Office		6,445.00	8,284.00	11,599.00
Welfare Room		1,136.00	1,830.00	2,700.00
		179,809.33	279,104.20	465,435.76

<sup>1</sup>Includes jobbed customer service items.

<sup>2</sup>Itemized equipment lists and costs may be obtained from the authors.

Costs for the items of this equipment were supplied by several equipment manufacturers. Freight costs are included as a charge from Chicago to Oklahoma City. Installation cost is also included where installation is a separate charge.

Estimates of the cost of refrigeration equipment varied considerably among the major manufacturers contacted. A cost rate of \$750 per ton of refrigeration was used for this study.

The office equipment requirements were estimated from observations of several offices of meat processing plants in the Southwest. The cost estimates for the office equipment were obtained from price lists of several office equipment manufacturers. Welfare room equipment prices were obtained from manufacturer's price lists.

## **Costs of Ownership and Use**

The costs of ownership and use are incurred after a firm has invested capital in buildings, equipment, and real estate. These costs are indubitable, since the firm must consider the income forgone had the capital been invested elsewhere, the depreciation incurred from obsolescence and use, the taxation for ownership, the insurance to protect the investment, and the cost of maintenance and repairs to defer future investment.

### **Interest**

One cost which a firm must face is interest on the funds invested. An interest rate of six percent was applied to the land investment and to the non-depreciating salvage value of the equipment. A three percent rate was applied to the depreciable balance of the buildings, parking lots, and equipment. The interest charges on the capital investment for the model plants are presented in Table VII.

### **Depreciation**

The annual depreciation cost for buildings and parking lots was estimated by dividing the total cost of the building including architectural costs, and the total cost of the parking lot, by their respective estimated useful lives. For all equipment, an estimate of the salvage value was subtracted from the total cost of new equipment before dividing by the estimated useful life.<sup>4</sup>

The annual depreciation cost for buildings, parking lots, processing equipment, and office equipment are presented in Table VIII.

<sup>4</sup>The salvage value of all equipment was assumed to be equal to 10 percent of the initial cash price. Buildings were assumed to be fully depreciated in 45 years; parking lots in 20 years; processing equipment in 12 years; and office equipment in 10 years.

**Table VII — Annual Interest Cost and Insurance Cost Computations for the Three Model Plants**

Item	Plant Size		
	Small (50,000 lbs.) <sup>1</sup>	Medium (100,000 lbs.) <sup>1</sup>	Large (250,000 lbs.) <sup>1</sup>
	(Dollars)		
1. Building and Parking Lot	268,730.12	488,612.10	787,784.12
2. Architectural	16,123.81	29,316.72	47,267.05
3. Total Building and Parking Lot	284,853.93	517,928.82	835,051.17
4. Equipment	179,809.33	279,104.20	465,435.76
5. Salvage Value of Equipment	17,980.93	27,910.42	46,543.58
6. Depreciable Balance of Equipment	161,828.40	251,193.78	418,892.18
7. Total Depreciable Balance of Building, Parking Lots, and Equipment	446,682.33	769,122.60	1,253,943.35
8. Land Value	2,681.90	4,531.50	7,369.40
9. Insured Value of Building and Equipment	354,477.06	606,154.16	989,727.01
10. Annual Insurance	585.60	1,001.37	1,635.03
11. Annual Interest	14,640.23	25,020.20	40,853.07

<sup>1</sup>Maximum designed output including customer service items.

## Taxes

For this study, personal property taxes were computed using the procedures and rates used in Oklahoma County.

The assessment value of the plant, usually some percentage of actual market value, was determined by assessing the model plants at the following percentages: 25 percent of the market value of land, buildings, and parking lots; and 35 percent of the value of the equipment.

A tax rate of \$92 per \$1000 of assessed valuation was used in this study, since it is typical of the rate used for meat processing plants in Oklahoma City. A full tax rate was applied to the assessed value of land, buildings, and parking lots. Taxing equipment based on the assessed value of new equipment would be over estimating the taxes of the plant since the value of equipment is decreasing over time. For this reason, the salvage value of the new equipment was subtracted and a tax rate of \$46 per \$1000 assessed value or one-half of the full rate, was applied to the depreciable balance. The salvage value which does not depreciate was taxed at the full rate.

Personal property taxes must also be paid on the average inventory of product owned by the plant. The practice used in Oklahoma County is to average the inventory of the last day of the old year and the inventory of the first day of the new year and apply a tax rate of \$92 per



\$1000 to 35 percent of the market value of the inventory.<sup>5</sup> The annual personal property taxes for the three model plants each operating at three levels of output are presented in Table IX.

## Insurance

Because of the additional fire protection provided and the lower rates involved, the model plants were specified to be equipped with sprinkler systems. In computing the insurance cost, rate of \$1.652 per \$1000.00 was applied to 80 percent of the cost of the buildings and equipment.<sup>6</sup> The \$1.652 rate was selected from the lower end of the range of rates because the model plants were assumed to approximate "ideal" risks. The insurance cost on the buildings and equipment are listed in Table VII.

## Maintenance and Repairs

To minimize the expense of down-time, a meat processing plant must keep its equipment in good operating condition. Maintenance and repair costs of the building are included in the annual maintenance costs.

The cost of equipment and building repair and maintenance is presented in Table X. The cost of maintenance and repair of equipment was furnished by a plant engineer of a cooperating firm. The cost of building maintenance and repair was estimated to cost one cent per square foot of floor space.<sup>7</sup>

<sup>5</sup>Market value of the product inventory was estimated using January through December 1966 average Chicago wholesale processed meat prices obtained from weekly issues of the *National Provisioner*. Average wholesale prices were computed and weighted from these price data as listed for the following products: franks, .151; bologna, .062; polish sausage, .040; olive loaf, .021; liver loaf, .002; pork sausage, .109; hams, .158; bacon, .173; picnics, .054; and loins, .155. Customer service items were not considered in the inventory.

<sup>6</sup>The present practice is to insure buildings for 80 percent of their value. One hundred percent coverage is offered but only at a much higher rate.

<sup>7</sup>This information based on conversation with a plant owner and on records of cooperating firms. Names are withheld to avoid identity of the firms.

**Table VIII — Annual Depreciation Cost for the Three Model Plants**

Item	Plant Size		
	Small (50,000 lbs.) <sup>1</sup>	Medium (100,000 lbs.) <sup>1</sup>	Large (250,000 lbs.) <sup>1</sup>
Depreciable Balance:	(Dollars)		
1. Buildings	263,287.00	478,588.50	771,723.00
2. Parking Lots	5,443.12	10,053.84	16,061.12
3. Processing Equipment	156,027.90	243,738.18	408,453.08
4. Office Equipment	5,800.50	7,455.60	10,439.10
Annual Depreciation Cost:			
5. Building	5,850.82	10,635.30	17,149.40
6. Parking Lot	449.85	502.69	1,272.60
7. Processing Equipment	13,002.32	20,311.52	34,037.76
8. Office Equipment	580.05	745.56	1,043.91
9. Total	19,883.04	32,195.07	53,503.67

<sup>1</sup>Maximum weekly output of model plant.

Table IX — Annual Personal Property Taxes for the Three Model Plants

Output <sup>1</sup> (Pounds)	Assessed Value			Product	Taxes			Total	
	Real Estate	Equipment	Equipment Salvage		Real Estate	Equipment	Equipment Salvage		
				(Dollars)					
25,000	67,853.01	56,639.94	6,293.33	1,799.26	6,242.48	5,210.87	289.49	165.53	11,908.37
37,500	67,853.01	56,639.94	6,293.33	2,698.90	6,242.48	5,210.87	289.49	240.02	11,982.86
50,000	67,853.01	56,639.94	6,293.33	3,598.54	6,242.48	5,210.87	289.49	331.07	12,073.91
50,000	123,293.46	87,917.82	9,768.65	3,598.54	11,342.00	8,088.43	372.07	331.07	20,133.57
75,000	123,293.46	87,917.82	9,768.65	5,397.80	11,342.00	8,088.43	372.07	496.60	20,299.10
100,000	123,293.46	87,917.82	9,768.65	7,197.08	11,342.00	8,088.43	372.07	662.13	20,464.63
125,000	198,788.38	146,612.26	16,290.25	8,996.34	18,288.53	13,488.33	620.46	827.66	33,224.98
187,500	198,788.38	146,612.26	16,290.25	13,494.52	18,288.53	13,488.33	620.46	1,241.50	33,638.82
250,000	198,788.38	146,612.26	16,290.25	17,992.70	18,288.53	13,488.33	620.46	1,655.33	34,052.65

<sup>1</sup>Weekly output including customer service items.

**Table X — Total Annual Maintenance Costs for the Three Model Plants**

Item	Plant Output <sup>1</sup>		
	Plant Size		
	Small	Medium	Large
		(Dollars)	
Plant Machinery	3,622.00	4,150.00	5,637.50
Office Equipment	210.25	270.25	330.25
Refrigeration Equipment	774.00	1,440.00	2,385.00
Total Equipment	4,616.75	5,870.75	8,363.25
Building <sup>2</sup>	163.50	323.04	516.72
Grand Total	4,780.25	6,193.79	8,879.97

<sup>1</sup>Designed weekly output; 50,000, 100,000, and 250,000 pounds respectively, for the small, medium and large plants.

<sup>2</sup>Respective building areas taken from Table III, multiplied times .01.

## Operating Costs

Three operating levels were considered in the non-slaughtering meat processing plants in this study; 50, 75, and 100 percent of the designed outputs. The operating costs estimated for each output level were wages and salaries; plant supplies including casings, packaging materials, and spices; sales expense; delivery costs; interest on operating capital; advertising; utilities; laundry; telephone; and miscellaneous costs such as legal and audit fees, office supplies, claims and adjustments, postage, dues, and subscriptions.

## Wages and Salaries

Wages and salaries constituted the largest single operating expense item in this study. Changes in the cost of labor may be a result of changes in the length of the work week, or changes in the size of the labor force, or changes in wage rates. In this study, changes in the output of a model plant were considered only as a result of a change in the size of the labor force.<sup>8</sup>

Management and office personnel specifications were synthesized on the basis of observations of meat processing plants in Oklahoma and Texas. Total personnel requirements for each department of the model plants are presented in Table XI.

Wages for personnel of the production departments were based upon 1963 meat industry wage statistics for the Southwest which were assumed to be in effect in 1965. Wage data for office employees were developed

<sup>8</sup>Data were not available for the extended work week analysis and since the common practice of Oklahoma meat processors is to operate on a single shift basis, only the change in labor force is considered here.

**Table XI — Personnel Required to Operate the Three Model Plants**

Employment	Plant Size								
	Small			Medium			Large		
	25	37	50	50	75	100	125	187	250
Boning Department	—	—	—	—	—	—	—	—	—
Curing Department	4	1	1	1	2	3	3	4	5
Sausage Department	4	5	6	6	9	11	14	17	20
Order Assembly	3	3	4	4	5	8	9	12	13
Sanitation and Maintenance	3	4	5	5	7	9	9	10	11
Office Personnel	1	1	1	3	3	3	6	6	6
Management	2	2	2	4	4	4	5	5	5
Total Employment	1	1	1	1	1	1	3	3	3
	15	17	20	24	31	39	49	57	63

<sup>1</sup>Output in pounds including jobbed customer service items.

<sup>2</sup>Department personnel specifications may be obtained from the authors.

based on an Oklahoma City survey. Salaries for management personnel were developed from information supplied by management of meat processing plants.

Three costs associated with the number of employees and their wages are Social Security tax, employee benefits, and liability insurance. For purposes of this study Social Security taxes were computed using the 1967-68 rate of 4.4 percent of employee earnings up to \$6,600. The cost to the firm for Social Security taxes is presented for the three model plants, each operating at three levels of output, in Table XII.

Employee benefits included in this study included retirement contributions, life and health insurance, vacation, and holiday pay. Of the plants cooperating in this study, these benefits were the most common. Social Security was assumed to be 3.5 percent of the wages and benefits cost; vacation and holidays, 3.4 percent; retirement, 2.5 percent; and insurance, 2.6 percent. The percentages assumed for vacation and holidays, retirement, and insurance, were each calculated as a percent of the Social Security percentage (i.e., 3.4/3.5, 2.5/3.5, and 2.6/3.5, respectively). These decimal fractions were summed, then multiplied by the 1967-1968 Social Security contribution rate of .044 to give the constant .106857. This constant was then multiplied by the actual amount of the Social Security contribution to estimate the employee benefits cost. These costs for each of the model plants operating at three output levels are presented in Table XII.

Both general liability and product liability insurance coverages were included in this analysis. Rates for these coverages are the same for all meat processing firms in the state. A general liability coverage of \$25,000 bodily injury and \$100,000 property damage was specified for all plants

**Table XII — Estimated Total Annual Payroll for the Three Model Plants**

Item	Plant Size								
	Small			Medium		Large			
	25,000	37,500	50,000	Weekly Output <sup>1</sup> 50,000	75,000	100,000	125,000	187,500	250,000
	(Dollars)								
Curing Department	13,852.80	17,472.00	21,673.60	21,673.60	32,136.00	39,062.40	49,899.20	59,841.60	70,678.40
Boning Department	3,744.00	3,744.00	3,744.00	3,744.00	7,488.00	10,150.40	10,150.40	13,894.40	17,638.40
Sausage Department	9,921.60	9,921.60	12,979.20	13,187.20	16,244.80	25,688.00	28,745.60	38,667.20	41,308.80
Order Assembly	10,254.40	13,998.40	16,764.80	22,963.20	22,963.20	29,473.60	29,473.60	33,217.60	35,984.00
Sanitation and Maintenance	977.60	977.60	977.60	7,488.00	7,488.00	7,488.00	14,976.00	14,976.00	14,976.00
Office Salaries	8,497.00	8,497.00	8,497.00	17,971.60	17,971.60	17,971.60	21,928.00	21,928.00	21,928.00
Management Salaries	12,000.00	12,000.00	12,000.00	15,000.00	15,000.00	15,000.00	48,000.00	48,000.00	48,000.00
Social Security	2,369.30	2,693.28	3,134.41	3,846.89	4,879.23	5,366.80	7,690.84	8,902.30	9,781.79
Fringe Benefits	6,331.00	7,117.81	8,189.13	10,240.04	12,746.16	15,476.55	21,710.47	24,633.17	26,769.12
<b>Total Annual Payroll</b>	<b>67,947.70</b>	<b>76,421.69</b>	<b>87,959.74</b>	<b>109,916.13</b>	<b>136,917.99</b>	<b>166,312.99</b>	<b>232,588.36</b>	<b>264,060.27</b>	<b>287,064.51</b>

<sup>1</sup>Output is expressed as pounds including customer service items.

as well as \$50,000 product liability. The rates for these coverages are based on the total payroll: for property damage, \$.0234 per \$100 of payroll; for bodily injury, \$.096 per \$100 of payroll; and for product liability; \$.068 per \$100 of payroll. A fee of \$25 is charged for writing each general liability policy and a \$15 fee is charged for attaching the product liability rider. The costs of liability insurances are presented in Table XIII. Estimated total annual payrolls for the three model plants are presented in Table XII.

### Plant Supplies

Items included under plant supplies costs were casings, product packaging, and spices. Plants cooperating in this study reported costs ranging from 1.58 cents per pound to 1.70 cents per pound for these items. The median figure of 1.64 cents per pound was arbitrarily selected as the cost rate for plant supplies. This price was applied to all items of production.<sup>9</sup> The cost for plant supplies of the three model plants each operating at three levels of output are presented in Table XIV.

### Delivery and Sales Cost

For the purposes of this study, sales cost was estimated by applying a cost of one dollar per hundredweight of plant output including customer service items. The one dollar per hundredweight is a figure considered by some cooperating plant owners as their cost of sales exclusive of any sales manager's salary.

A figure of \$1.25 per hundredweight was used to estimate the delivery cost of processed meats for the model plants, assuming all product to be delivered within a 150 mile radius of the plant. Both the sales cost

<sup>9</sup>Does not include customer service items.

**Table XIII—Estimated Annual Liability Insurance Cost for the Three Model Plants**

Plant Size	Weekly Output <sup>1</sup>	Wage Payroll	Bodily Injury	Property Damage	Product Liability	Policy Fee and Rider	Total Liability Insurance Cost
	(Pounds)				(Dollars)		
Small	25,000	59,247.40	56.88	13.86	40.29	40.00	151.00
	37,500	66,610.60	63.95	15.59	45.30	40.00	165.00
	50,000	76,636.20	73.57	17.93	52.11	40.00	184.00
Medium	50,000	95,829.20	92.00	22.42	64.80	40.00	219.00
	75,000	119,291.60	114.52	27.91	81.12	40.00	264.00
	100,000	145,334.00	139.52	34.01	98.83	40.00	312.00
Large	125,000	203,173.05	195.05	47.54	138.16	40.00	421.00
	187,500	230,524.80	221.30	53.94	156.76	40.00	472.00
	250,000	250,513.60	240.49	58.62	170.35	40.00	509.00

<sup>1</sup>Includes customer service items.

and delivery cost for the three model plants operating at three different levels of output are presented in Table XIV.

### Interest on Operating Capital

For the purposes of this study, it was assumed that the operating capital requirements were supplied by both internal and external sources in such proportions that the effective average interest rate was five percent per annum. Costs of interest on operating capital for each of the model plants are computed in Table XV and included in Table XIV.

### Advertising

Advertising and promotion expenditures for the model plants were based on accounting records data of cooperating firms. For the small plant, producing from 25,000 to 50,000 pounds of product, weekly advertising expenditures were estimated to be .2161 cent per pound of processed product.<sup>10</sup> For the medium sized plant, producing from 50,000 to 100,000 pounds weekly, advertising expenditures were estimated to be .3839 cent per pound of processed product. For the large plant, producing from 125,000 to 250,000 pounds weekly, advertising expenditures were estimated to be .4757 cent per pound of processed products. Advertising expenses are presented in Table XIV.

### Utilities

Any plant processing meats must have an adequate and dependable supply of electricity, gas, and water. Equally important and often considered coupled with the water supply, is the need for adequate sewer service. Earlier it was assumed that the model plants would be located in an industrial area suitable for a meat processing plant where these utilities are readily available. Therefore, there would be no capital investment in a water well system, a sewer system, or any other equipment of this nature.

*Electricity.* The lack of similarities in the sample plants' and the model plants' electrical requirement requirements rendered the utility records of the same plants virtually useless for purposes of estimating the electrical consumption of the model plants directly from plant records. Comparison of actual electricity consumption records and a synthesized estimate for one cooperating plant revealed that the synthesized electrical consumption for a one-month average period was within three percent of the actual average monthly consumption for a twenty-four month period. Since the magnitude of the cost of electricity is quite

<sup>10</sup>Processed products for advertising purposes exclude customer service items for each of the model plants.

Table XIV — Specific Operating Costs of the Three Model Plants<sup>1</sup>

Item	Unit	Plant Size								
		Small			Medium			Large		
		25,000	37,500	50,000	Weekly 50,000 <sup>2</sup>	Output <sup>2</sup> 75,000	100,000	125,000	187,500	250,000
Total Annual Output <sup>3</sup>	lbs.	1,300,000	1,950,000	2,600,000	2,600,000	3,900,000	5,200,000	6,500,000	9,750,000	13,000,000
Packaged Items	lbs.	1,196,781	1,803,750	2,393,562	2,393,562	3,590,343	4,787,124	5,983,904	8,975,856	11,967,809
Customer Service Items	lbs.	103,219	146,250	206,438	206,438	309,657	412,876	516,096	774,144	1,032,191
Casings, Packaging Materials and Spices Expense	Dol.	19,627	29,582	39,254	39,254	58,900	78,533	98,166	147,249	196,322
Delivery Cost	Dol.	16,250	24,375	32,500	32,500	48,750	65,000	81,250	121,875	162,500
Sales Cost	Dol.	13,000	19,500	26,000	26,000	39,000	52,000	65,000	97,500	130,000
Advertising Expense	Dol.	2,586	3,802	5,172	9,189	13,783	18,378	28,465	42,698	56,931
Interest on Operating Capital	Dol.	6,882	8,678	10,634	12,111	16,402	20,798	27,566	36,491	44,975
Laundry Expense	Dol.	1,767	2,039	2,447	2,583	3,761	4,623	5,574	6,662	7,478
Telephone Expense	Dol.	1,954	2,324	2,697	2,286	3,201	3,949	4,053	5,797	7,052
Legal & Audit Fees	Dol.	598	880	1,197	1,197	1,795	2,394	2,992	4,488	5,984
Office Supplies	Dol.	419	631	838	775	1,163	1,550	1,556	2,334	3,112
Claims & Adjustments	Dol.	273	402	546	546	820	1,093	1,366	2,049	2,732
Dues, Subscriptions, Donations	Dol.	165	242	330	330	495	659	824	1,236	1,649
Postage	Dol.	127	186	253	253	380	507	633	950	1,266
Total	Dol.	63,965	93,046	122,383	127,584	189,121	250,458	318,691	471,043	622,175

<sup>1</sup>All cost items were computed as explained in the section on operating costs.

<sup>2</sup>Output is expressed in pounds including customer service items.

<sup>3</sup>Output breakdown assumes 92.5 percent of total annual output to be packaged items and 7.5 percent to be customer service items which are not packaged.



**Table XV — Estimated Annual Operating Capital for the Three Model Plants**

Plant Size	Weekly Output <sup>1</sup>	Wages and Salaries	Maintenance	Utilities	Liability Insurance	Product Inventory Taxes	Other Operating Expenses	Interest on Operating Capital	Total Operating Capital
	(Pounds)	—	—	—	(Dollars)	—	—	—	—
Small	25,000	67,948	4,780	7,841	151	166	56,766	6,882	144,534
	37,500	76,422	4,780	7,994	165	240	83,963	8,678	182,242
	50,000	87,960	4,780	8,185	184	331	111,234	10,634	223,308
Medium	50,000	109,916	6,194	10,640	219	331	114,913	12,111	254,324
	75,000	136,918	6,194	12,212	264	497	171,958	16,402	344,445
	100,000	166,313	6,194	13,802	312	662	228,686	20,798	436,767
Large	125,000	232,582	8,880	18,663	421	828	289,879	27,563	578,816
	187,500	264,060	8,880	22,324	472	1,242	432,838	36,491	766,307
	250,000	287,065	8,880	26,356	509	1,655	575,036	44,975	944,476

<sup>1</sup>Includes customer service items.

small when compared to the total operating costs, synthesized estimates of the electricity requirements of the model plants were made using the procedures used to estimate the actual operation mentioned above.

The demand charge percentage of the electricity consumption was estimated using the data of two cooperating firms. In terms of the output of the model plants defined in this study, one of these plants would be classified as very small and the other as a medium sized plant. The demand charge percentage for the very small plant was .28969 percent of the total electrical consumption. The demand charge percentage at the higher output was .35609 percent of the total electrical consumption.

Both of these observations were 18 month averages of data from the actual plants' records. Although this limited data suggests that the demand charge percentage may be a function of output, it is possible that the difference in the demand charge percentages (.28969 percent to .35609 percent of the total electrical consumption) is variation from a mean and thus there is possibly no relation of the demand charge percentage and electricity consumption at different output levels. However, it is possible for the demand charge to vary with a plant's output since the demands of electrical equipment are usually greater with increased production.

Using the above data, the demand charge percentage of the total electricity consumption was estimated for the various output levels under consideration using the following equation:  $E_D = .26741 - .02589X$  where  $E_D$  represents the estimated demand charge percentage and  $X$  represents the annual output of the plant in millions of pounds excluding customer service items. Table XVI presents the estimated demand charge percentages used in computing the electricity costs for the model plants.<sup>11</sup>

<sup>11</sup>Since the consumption of electricity at the three output levels of the small model plant does not meet the minimum monthly consumption requirement for the industrial electricity rate in any instance, the demand charge percentages in Table XVI for the small plant are irrelevant.

**Table XVI — Estimated Electricity Demand Charge Percentages**

Plant Size	Weekly Output <sup>1</sup>	Constant Term <sup>2</sup>	Production Coefficient <sup>2</sup>	Annual Production <sup>3</sup>	Estimated Demand Charge Percentage
Small	25,000	.26741	.02589	1.191781	.29839
	37,500	.26741	.02589	1.759172	.31389
	50,000	.26741	.02589	2.393562	.32938
	50,000	.26741	.02589	2.393562	.32938
Medium	75,000	.26741	.02589	3.590343	.36036
	100,000	.26741	.02589	4.787124	.39135
	125,000	.26741	.02589	5.983904	.42233
Large	187,500	.26741	.02589	8.975856	.49979
	250,000	.26741	.02589	11.967809	.57725

<sup>1</sup>Weekly output in pounds including customer service items.

<sup>2</sup>From equation,  $E_D = .26741 - .02589X$ .

<sup>3</sup>Annual production in millions of pounds excluding customer service items.

Total estimated electricity consumption for lighting, manufacturing equipment, and refrigeration equipment, and the annual cost of the consumption for each model plant operating at each of three specified output levels are presented in Table XVII.

The cost of the electricity consumed by each model plant, operating at each of three output levels, was computed by applying the industrial electricity rate for Oklahoma City to the consumption estimates. The rates used were as follows:

*Demand Charge—*

- First 100 KW of billing demand \$1.90 per KW per month
- Next 400 KW of billing demand \$1.45 per KW per month
- Next 500 KW of billing demand \$1.25 per KW per month
- Excess KW of billing demand \$1.15 per KW per month

*Energy Demand—*

- First 200,000 KWH per month at .75¢ per KWH
- Next 800,000 KWH per month at .6¢ per KWH
- Excess KWH per month at .44¢ per KWH.

*Natural Gas.* Several attempts were made to relate natural gas consumption to the output of processed meat products, but no significant relationship was indicated from the analyses of accounting records of several firms.

Since analyses of accounting records gave no good indications of gas consumption related to output, gas consumption was synthesized using estimates from *Meat Industry Trends—1961* and Logan and King (2) of BTU requirements for cooking and smoking meats and for operation of boilers. The cost of the natural gas consumption for each model plant operating at three different output levels was computed using the estimated consumption and applying the industrial rate presented below.

Table XVIII presents the gas consumption estimates and annual cost of natural gas for each of the model plants.

- First 10 CCF per month at 18.1¢ per CCF
- Next 10 CCF per month at 6.7¢ per CCF
- Next 10 CCF per month at 6.5¢ per CCF
- Next 970 CCF per month at 4.6¢ per CCF
- Next 19,000 CCF per month at 2.3¢ per CCF
- Next 20,000 CCF per month at 1.9¢ per CCF
- Next 60,000 CCF per month at 1.8¢ per CCF
- Next 200,000 CCF per month at 1.75¢ per CCF

Table XVII — Estimated Electricity Consumption and Annual Cost

Plant Size	Weekly Output <sup>1</sup>	Electricity Consumption					Annual Cost	Kilowatt Demand
		Lighting	Processing Equipment	Refrigeration Equipment	Total	Monthly		
	(Pounds)	—	—	—	—	—	(Dollars)	
				(Kilowatt Hours)				
Small	25,000	46,549.7	30,654.0	116,580.0	193,783.7	16,148.6	4,560.00	— <sup>2</sup>
	37,500	46,549.7	38,452.5	135,690.0	220,692.2	18,391.0	4,560.00	— <sup>2</sup>
	50,000	46,549.7	46,148.4	154,800.0	247,498.1	20,624.8	4,560.00	— <sup>2</sup>
Medium	50,000	78,453.8	96,623.9	274,170.0	449,247.7	37,437.3	6,099.00	123.29
	75,000	78,453.8	122,720.6	330,165.0	531,339.4	44,278.3	7,354.00	159.56
	100,000	78,453.8	140,175.7	386,160.0	604,789.5	50,399.1	8,568.00	197.24
Large	125,000	108,684.1	145,832.6	462,960.0	717,476.7	59,789.7	10,387.00	252.51
	187,500	108,684.1	196,005.8	554,910.0	859,599.9	71,633.3	13,302.00	358.02
	250,000	108,684.1	239,193.8	646,860.0	994,737.9	82,894.8	16,426.00	478.51

<sup>1</sup>Includes customer service items.

<sup>2</sup>Kilowatt demands for the small plant are irrelevant since at all outputs under consideration the small plant does not meet the minimum billing requirements.

Table XVIII — Estimated Gas Consumption and Annual Cost

Plant Size	Weekly	Monthly Gas Consumption			Annual Cost <sup>3</sup>
	Output <sup>1</sup>	Boiler	Smoking	Total <sup>2</sup>	
			CCF		
Small	25,000	8,022.0	793.0	8,815.0	2,730
	37,500	8,022.0	1,152.5	9,172.5	2,829
	50,000	8,022.0	1,508.5	9,530.5	2,927
Medium	50,000	10,526.4	1,508.5	12,035.0	3,619
	75,000	10,526.4	2,262.9	12,789.5	3,827
	100,000	10,526.4	3,017.1	13,543.5	4,035
Large	125,000	20,301.0	3,754.7	24,056.5	6,742
	187,500	20,301.0	5,227.6	25,529.0	7,078
	250,000	20,301.0	7,438.0	27,739.0	7,581

<sup>1</sup>Weekly output in pounds including customer service items.

<sup>2</sup>Gas consumption estimates are rounded to nearest 50 cubic feet.

<sup>3</sup>The gas rate given in the text applied to the total monthly gas consumption estimate, then rounded to the nearest dollar.

*Water.* Several attempts were made to relate water consumption to the output of processed meat products using multiple regression, but, like natural gas consumption, no relationship obtained from analyses of accounting records adequately explained the water consumption for the sample plants of this study.

For purposes of this study, the water consumption was synthesized considering that the water was to be used for cleaning, manufacturing, and employee welfare. For cleaning purposes, welfare rooms, curing departments, slicing, peeling, and packaging areas, boning departments, and sausage kitchens were assumed to be cleaned daily. Receiving coolers and equipment storage areas were assumed to be cleaned once each week. A rate of two gallons per square yard per cleaning was considered sufficient to adequately clean the areas. Total water requirements for cleaning the model plants are presented in Table XIX.

The water requirements for manufacturing which include all water required for cooking, showering, and cleanup in the smoking area were obtained from *Meat Industry Trends — 1961*. For those output levels not given, interpolations were made between the nearest two given outputs assuming linear relationships. The total water requirements for manufacturing for the model plants, each operating at three output levels, are presented in Table XIX.

Employee welfare water requirements assumed sixteen gallons per employee for 22 work days per month. Total employee welfare water requirements are presented in Table XIX.

The cost of the water consumed was estimated by applying the water rates of Oklahoma City to the consumption estimates. The rate used was as follows:

*Water Rates*

		Gross	Discount	Net
First	1,000 gallons	Included in Minimum Bill		
Next	4,000 gallons	.62	.02	.60
Next	10,000 gallons	.54	.02	.52
Next	135,000 gallons	.39	.02	.37
Next	350,000 gallons	.29	.02	.27
Next	4,000,000 gallons	.22	.02	.20
All over	5,000,000 gallons	.18	.02	.16

**Table XIX — Estimated Water Consumption and Annual Cost**

Plant Size	Weekly Output	Monthly Water Consumption			Annual Cost	
		Employee Use	Cleaning	Manufacturing	Total <sup>1</sup>	Water and Sewer <sup>2</sup>
	(Pounds)	—	(Gallons)	—	—	
Small	25,000	5,632	33,276	30,800	69,708	551.00
	37,500	6,336	33,276	41,800	81,412	605.00
	50,000	7,040	33,276	52,800	98,116	698.00
Medium	50,000	9,504	53,476	52,800	115,780	923.00
	75,000	11,968	53,476	81,400	146,844	1,032.00
	100,000	14,784	53,476	110,000	179,260	1,199.00
Large	125,000	17,600	86,792	141,174	245,566	1,534.00
	187,500	21,120	86,792	219,142	327,054	1,945.00
	250,000	23,232	86,792	297,000	407,024	2,348.00

<sup>1</sup>Sum of monthly water consumption by employees, clean-up and manufacturing.

<sup>2</sup>The water and sewer rates discussed in the text applied to the total monthly water consumption, then rounded to the nearest dollar.

Sewer service costs are based directly upon the water consumption of a plant. For plants producing no more than 250,000 pounds per week, the following sewer rate is applicable for Oklahoma City.

First 30,000 gallons of water \$4.50

All Over 30,000 gallons of water at 15¢ per 1,000

In addition to the above rate, an additional \$5.25 per month metering charge is included. Water and sewer costs for each of the model plants operating at three different output levels are presented in Table XIX.

**Laundry Expense**

Common practice of plants in Oklahoma is for the plant to furnish this service. Plant owners and managers said this service costs them, on the average, \$11.33 per manufacturing employee per month. The laundry cost for the model plants operating at three different outputs is presented in Table XIV.

**Telephone Expense**

The type of telephone communications equipment and the numbers of pieces of equipment have a significant bearing on the telephone ex-

pense of a firm. In this study no assumptions were made with respect to the telephone system equipment or the percentage of the telephone expense which was attributed to long distance services. Average costs taken from accounting records were used to estimate the telephone costs which are presented in Table XIV.

### Miscellaneous

Five other costs which may be referred to as office costs were considered as operating costs for meat processing firms. These items included: (1) office supplies, (2) postage, (3) dues, subscriptions, and donations, (4) claims and adjustments, and (5) legal and audit fees. Average costs per pound of processed product were taken from accounting records to estimate these costs on an annual basis. Due to the nature of the accounting data, individual estimates were not available for each output level for all cost items considered in this study. The rates used were: .035, .032, and .026 cents per pound for office supplies for the small, medium, and large plants, respectively; .010 cent per pound for postage expenses; .013 cent per pound for dues, subscriptions and donations; .022 cent per pound for claims and adjustments; and .05 cent per pound for legal and audit fees. These costs are presented in Table XIV.

### Total Annual Costs

Annual fixed ownership cost comprised the smaller portion of the total annual costs when compared with operating costs. Depreciation was the largest component of the annual fixed ownership cost and ranged from approximately \$19,883 for the smallest plant to \$53,504 for the largest plant as can be seen in Table XX. In relative terms the depreciation ranged from 10.39 to 7.36 percent for the small plant, from 9.69 to 6.25 percent for the medium plant, and from 7.56 to 3.81 percent for the

**Table XX — Annual Fixed Ownership Costs**

Item	Plant Output <sup>1</sup>		
	50,000	100,000	250,000
		(Dollars)	
Depreciation	19,883.04	32,195.07	53,503.67
Interest	14,640.23	25,020.03	40,853.07
Insurance	585.60	1,001.37	1,635.03
Taxes	11,742.84	19,802.50	32,397.32
Total	46,851.71	78,018.97	128,389.09

<sup>1</sup>Maximum designed weekly output in pounds.

large plant as presented in Table XXII. Interest on the investment ranked second and amounted to less than one-third of the annual fixed ownership cost. Taxes and insurance on the investment formed the balance of the fixed investment cost. Taxes ranged from approximately \$11,743 for the small plant to \$32,397 for the large plant. These costs are also presented in Table XX.

Total annual fixed ownership costs were estimated to be \$46,852, \$78,019, and \$128,389 for the small, medium, and large plants respectively and are presented in Tables XX and XXI. In relative terms these figures represent 17.34, 15.16, and 11.97 percent of the total annual costs, respectively, for the model plants operating at 100 percent of their designed outputs. In Table XXII it can be seen that as output increases for each model plant, that annual fixed ownership costs become a smaller percentage of the total annual costs. Although these costs can be ignored in the short run, they must be covered in the long run if the firm is to survive.

Annual operating costs, including all operating costs except wages and salaries were the largest component of the total annual costs. Of the operating costs considered, packaging and casing materials, delivery, sales and advertising were the four main components in that order of ranking. Total operating costs, exclusive of wages and salaries as presented in Table XV, were estimated at 50.10, 52.53, and 61.27 percent of the total annual costs respectively for the small, medium, and large plants operating at 100 percent of the designed output.

Payroll costs to include wages and salaries as presented in Table XXI comprised the remainder of the total annual costs. These costs were estimated as 32.56, 32.31, and 26.76 percent respectively for the small, medium, and large plants operating at 100 percent of the designed output. These percentages are presented in Table XXII.

An examination of the total annual costs in relation to the size of plant provides information concerning the existence or nonexistence of size economies. Using the small plant at its designed output for comparison, it can be noted that as the size of the plant was increased by multiples of 2 and 5, that total costs were increased respectively by 1.90 and 3.98. These results imply the existence of some economies of size for the model plants.



**Table XXI — Annual Costs**

Total Annual Output	Percent of Designed Output	Ownership	Maintenance	Payroll	Other Operating	Utilities	Total	Average Cost per Pound
(Pounds)				Dollars				
1,196,781	50	46,851.71	4,780.00	67,948.00	63,965.00	7,841.00	191,386.00	.159917
1,803,750	75	46,851.71	4,780.00	76,422.00	93,046.00	7,994.00	229,094.00	.127010
2,393,562	100	46,851.71	4,780.00	87,960.00	122,383.00	8,185.00	270,160.00	.112870
2,393,562	50	78,018.97	6,194.00	109,916.00	127,574.00	10,640.00	332,343.00	.138849
3,590,343	75	78,018.97	6,194.00	136,918.00	189,121.00	12,212.00	422,464.00	.117667
4,787,124	100	78,018.97	6,194.00	166,313.00	250,458.00	13,802.00	514,786.00	.107536
5,893,904	50	128,389.09	8,880.00	232,582.00	318,691.00	18,663.00	707,205.00	.118184
8,975,856	75	128,389.09	8,880.00	264,060.00	471,043.00	22,324.00	894,696.00	.099678
11,967,809	100	128,389.09	8,880.00	287,065.00	622,175.00	26,356.00	1,072,865.00	.089646

Table XXII — Cost Components as Percentages of Total Annual Costs

Cost Item	Plant Size								
	Small			Medium			Large		
	25,000	37,500	50,000	Weekly Output (Pounds)			125,000	187,500	250,000
			50,000	75,000	100,000				
	Percentages								
Ownership	24.48	20.45	17.34	23.48	18.47	15.16	18.15	14.35	11.97
Depreciation	10.39	8.68	7.36	9.69	7.62	6.25	7.56	5.98	4.99
Interest	7.65	6.39	5.42	7.53	5.92	4.86	5.78	4.57	3.81
Insurance	.30	.26	.21	.30	.24	.19	.23	.18	.15
Taxes	6.14	5.12	4.35	5.96	4.69	3.85	4.58	3.62	3.02
Payroll	35.50	33.36	32.56	33.07	32.41	32.31	32.89	29.51	26.76
Management	7.09	5.92	5.02	5.08	4.00	3.28	7.64	6.03	5.03
Salaries									
Clerical Salaries	5.11	4.27	3.62	6.22	4.90	4.02	3.57	2.82	2.35
Labor	23.30	23.16	23.91	21.77	23.51	25.01	21.68	20.66	19.37
Other Operating	33.42	40.61	45.30	38.39	44.77	48.65	45.06	52.65	57.99
Packaging, etc.	10.26	12.91	14.53	11.81	13.94	15.26	13.88	16.46	18.30
Delivery	8.49	10.64	12.03	9.78	11.54	12.63	11.49	13.62	15.15
Sales	6.79	8.51	9.62	7.82	9.23	10.10	9.19	10.90	12.12
Advertising	1.35	1.66	1.91	2.76	3.26	3.57	4.02	4.77	5.31
Interest on Operating Capital	3.60	3.79	3.94	3.64	3.88	4.04	3.90	4.08	4.19
Laundry									
Telephone									
Legal and Audit									
Office Supplies									
Claims and Adjustments									
Dues, Subscriptions and Donations	2.93	3.10	3.27	2.58	2.92	3.05	2.58	2.82	2.92
Postage									
Liability									
Product Inventory Taxes									
Maintenance	2.50	2.09	1.77	1.86	1.46	1.20	1.26	.99	.83
Utilities	4.10	3.49	3.03	3.07	2.89	2.68	2.64	2.50	2.45

### Short-Run Average Costs

By examining the short-run cost curves of the model plants, the implied size economies may be investigated more closely. The average cost estimates obtained for the three model plants, operating at their respective designed outputs were 11.29 cents per pound for the small plant, 10.75 cents per pound for the medium plant, and 8.96 cents per pound for the large plant.<sup>12</sup> These estimates for each model plant are presented in Table XXIII and plotted in Figure 1.

<sup>12</sup>Cost estimates per pound are for those products produced by the plant and does not include jobbed customer service items.

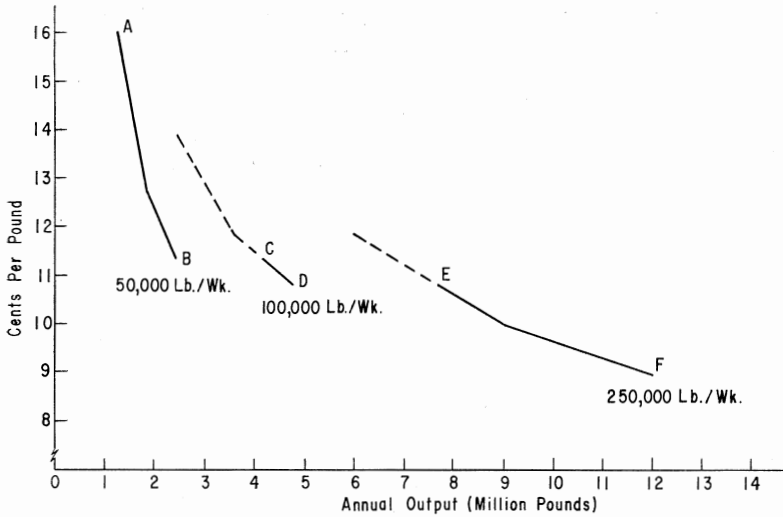


Figure 1. Short-Run and Long-Run Average Cost Curves

A reduction in short-run average costs from 11.29 cents per pound for the small plant to 10.75 cents per pound for the medium plant results in a total annual cost reduction of \$26,534. This would indicate that one medium sized plant producing at its designed output is more efficient than two small sized plants producing at their designed outputs, when the medium plant has twice the designed output of the small plant. When the small plant and the large plant are compared at maximum designed outputs, the reduction in average cost per pound from 11.29 cents per pound to 8.96 cents per pound results in reducing total annual costs \$277,935, when the designed output of the large plant is five times the designed output of the small plant.

Average short-run costs decreased for each size of plant as the output increased from 50 to 100 percent of its designed output. The average cost decreased 4.70, 3.13, and 2.86 cents per pound, respectively for the small, medium, and large plants as output increased from 50 to 75 to 100 percent of the designed output. This comparison must be extended further to appreciate the magnitude of the change in average cost per pound. A 4.70 cents per pound change in average cost for the small plant amounted to \$112,570, a 3.13 cents per pound change in average cost of the medium plant amounted to \$149,667; and a 2.86 cents per

Table XXIII — Average Costs Per Pound<sup>1</sup>

Cost Item	Plant Size								
	Small			Medium			Large		
	25,000	37,500	50,000	Weekly Output (Pounds) 50,000	75,000	100,000	125,000	187,500	250,000
	(Cents per Pound)								
Ownership	3.91	2.60	1.96	3.26	2.17	1.63	2.15	1.43	1.07
Depreciation	1.66	1.10	.83	1.35	.90	.67	.89	.60	.45
Interest	1.22	.81	.61	1.05	.70	.52	.68	.46	.34
Insurance	.05	.03	.02	.04	.03	.02	.03	.02	.01
Taxes	.98	.65	.49	.83	.55	.41	.54	.36	.27
Payroll	5.68	4.24	3.68	4.59	3.81	3.47	3.89	2.94	2.40
Management	1.13	.75	.57	.71	.47	.35	.90	.60	.45
Salaries									
Clerical	.82	.54	.41	.86	.58	.43	.42	.28	.21
Labor	3.73	2.94	2.70	3.02	2.77	2.69	2.56	2.06	1.74
Other Operating	5.34	5.16	5.11	5.33	5.27	5.23	5.33	5.25	5.20
Packaging	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64
Delivery	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36
Sales	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09
Advertising	.22	.22	.22	.38	.38	.38	.48	.48	.48
Interest on Operating Capital	.58	.48	.44	.51	.46	.43	.46	.41	.38
Other	.47	.39	.37	.36	.34	.33	.30	.23	.26
Maintenance	.40	.27	.20	.26	.17	.13	.15	.10	.07
Utilities	.66	.44	.34	.43	.34	.29	.31	.25	.22
Total Cost per Pound	15.99	12.70	11.29	13.88	11.77	10.75	11.82	9.97	8.96

<sup>1</sup>Average costs per pound are based on the product manufactured and do not include customer service items.

<sup>2</sup>Costs are rounded to the second decimal place and may not necessarily equal the total. These costs are based on the cost percentages of Table XXII and the annual costs of Table XXI.

pound reduction in average cost for the large plant amounted to \$342,-130. For each plant, average costs declined at a slower rate from 75 to 100 percent of the designed output than from 50 to 75 percent of the designed output, thus, producing a "kinked" relationship.

Examination of Table XXI reveals three cost groups. One group, ownership, management, clerical, and maintenance costs are fixed in total for each model plant, producing a kinked average cost relationship. A second group, packaging, delivery, sales, advertising, and certain miscellaneous expenses, have a constant per unit cost (average cost) for each model plant, thus, a straight line average cost curve for these costs. In the third group, ownership and use costs, and utilities have a variable relationship to output; thus, producing a kinked relationship when connecting only three points.

Individual comparisons of some cost items for the three model plants may not seem to yield logical results. Labor costs per pound of output

are decreasing more rapidly for the large plant. This results from the imperfect divisibility of processing equipment. Fewer people are required to operate the more highly automated, increased-capacity equipment of the large plant.

Utility costs decrease most rapidly for the small plant. This results from the utility cost rate structure, and the equipment starting demands for electricity not being significantly different for various outputs.

Maintenance costs per pound are higher for the small plant reflecting the greater building maintenance cost per pound for the small plant. Also, maintenance costs for a specific machine, whether a large machine or a smaller machine, were insignificantly different.

The point of least average cost for each of the model plants was attained at 100 percent of the designed output.

### **Long-Run Average Costs**

Theoretically, the long-run average cost curve is a locus of points tangent to an infinite number of short-run average cost curves, thus, representing the least cost of producing any output under the given assumptions. When less than an infinite number of short-run average cost curves are possible, then the solid line portions, AB, CD, and EF of the short-run cost curves as shown in Figure 1 describe the long-run cost curve. The broken line portions of the short-run average cost curves are irrelevant in the long run since the firm could reduce costs by changing size of plants.

In the long run, economies of size are indicated for plants with a designed capacity at least up to 250,000 pounds of total product per week. A comparison of the minimum points of the small and medium plants indicates economies of .54 cent per pound. Comparison of the minimum points of the medium and large plants indicate further economies of 1.79 cents per pound.

The reduction in long-run average costs between the 50,000 and 100,000 pounds per week plants is the aggregate effect of a .33 cent per pound reduction in fixed ownership costs and a .21 cent per pound reduction in payroll costs.

The reduction in long-run average costs between the 100,000 and 250,000 pounds per week plants is the aggregate effect of a .56 cent per pound reduction in fixed ownership costs; a 1.07 cents per pound reduction in payroll costs; and a .16 cent per pound reduction in all other operating costs.

## References

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