FINAL REPORT

A HIGH SEASONAL PERFORMANCE FACTOR GAS HEAT PUMP FOR THE NORTH CENTRAL UNITED STATES

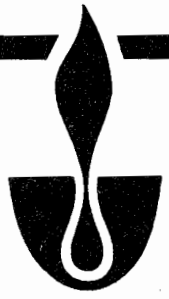
APPENDIX VOLUME III

7½ TON COMPARATIVE COST OF OWNERSHIP STUDY

Prepared By: Consolidated Natural Gas Service Company Inc.
Prepared For: The U.S. Department of Energy
Prepared Under: DOE Prime Contract EY-76-C-02-2883

January,1980

Consolidated Natural Gas Service Company Inc.



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FINAL REPORT

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Appendix Volume III

7-1/2 TON COMPARATIVE COST OF OWNERSHIP STUDY

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January, 1980

Appendices to Final Report

DEMONSTRATION OF A HIGH SPF GAS HEAT PUMP
FOR THE NORTH CENTRAL UNITED STATES

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*Contained herein.

APPENDIX VOLUME III

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APPENDIX VOLUME III

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1.0 OVERVIEW

1.1 Objectives

Key program objectives were to:

- Complete a preliminary examination, using the best data available, of the comparative owning and operating costs of the high SPF gas heat pump versus appropriate 1984 competitive equipment.
- Provide a customer-based simulation model for the gas heat pump to assist near-future design decisions.
- Refine the computer software to be used for advanced studies as new data become available, in support of the preparation of the business plan.

1.2 Study Scope

1.2.1 Equipment

Four types of equipment were studied.

1. Year-round Air Conditioning Combination Gas Heating and Electric Cooling Unit.....(YAC)
2. Single-package Electric Heat Pump.....(EHP)
3. Single-package Gas-Fueled Heat Pump Maximum Version....(GHPM)
4. Single-package Gas-Fueled Heat Pump Nominal Version....(GHPN)

The nominal version of the gas heat pump incorporated, among other differences, a projected higher coefficient of performance than the maximum version, at the rated condition level.

1.2.2 Building Types

Four representative commercial building types were studied.

1. Rest Home - Typical of a non-housekeeping residential building
2. Office Building - An industrial park type structure

3. Retail Store - Typical of a national chain type non-food operation

4. Light Manufacturing Plant - A plant using or manufacturing precision equipment.

Each of the four buildings studied was a single level, free-standing structure of 4,000 square feet floor area. Each building faced the same direction.

1.2.3 Geographics

Ten cities were selected to represent various weather conditions and utility rate structures across the nation.

Five Cities in North Central Region of United States	Five Cities Outside North Central Region of United States
Cleveland	Los Angeles
Pittsburgh	Dallas
Syracuse	St. Louis
Detroit	Atlanta
Chicago	Washington

As an example of the differences in climatic conditions, the ASHRAE winter dry-bulb design temperatures range from -4°F in Chicago to 41°F in Los Angeles.

Customer utility costs vary widely city to city, reflecting different company costs and rate policies.

1.3 Key Assumptions and Considerations

- The data presented were confined to equipment selected to satisfy a building with a 7-1/2-ton cooling capacity.
- Building model load calculations followed accepted ASHRAE methods.
- Constant inside temperature and advanced design standards with respect to insulation and double glazing were considered.
- Building internal loads were modeled by 24-hour profiles for each day-type.

- Performance criteria for advanced gas direct-fired heating and advanced electric compression cooling equipment were used.
- For both cooling and heating, equipment performance was governed by two-dimensional COP tables (outside air temperature and part-load performance).
- Electric heat pump COP tables accounted for degradation of efficiency due to defrost cycle, cycling, supplemental heating, power to drive auxiliaries, and compressor case losses.
- Initial equipment and annual utility costs were escalated to the beginning of the study period, January 1, 1984, and an assumed national inflation factor was applied to utility costs for the study period.
- Commercial gas and electric utility rates in effect in 1976 (including any PGA, FCA, tax and surcharge adjustments) were obtained for each city.
- Estimated installed costs for competitive equipment were obtained from a Carrier contractor in the Pittsburgh area.
- Gas heat pump premium cost variations in ranges of 10% to 50% and 30% to 70% for the maximum and nominal versions respectively were applied and the investment criteria applied accordingly.

1.4 Standards for Comparison

1.4.1 Seasonal Performance Factors

Seasonal performance factors were the measurement of each equipment type's efficiency for heating and cooling at the point of delivery. These efficiency measurements do not consider energy source.

1.4.2 Utility Costs

Utility costs were the measurement of the total annual costs for all the gas and electricity used for each building type, unitized by square foot or floor area - not the heating and cooling equipment only.

1.5 Investment Criteria

Investment criteria were the measurement of equipment comparisons on:

A) Discounted cash flow rate of return

B) Discounted cash flow payback

C) Simple payback.

EXPLANATORY NOTICE

The Cost of Ownership Study was initiated prior to the availability of manufacturing cost estimates. In order to initiate this study, the assumption was made that the 7½-ton HSPF would have a cost premium in the range of 30 to 70% relative to competitive electric and gas equipment. When the manufacturing cost estimates became available, the cost premium was found to be in the range of 400 to 550% as reported in Appendix Vol. IV. No effort was made to rectify the affected data relating to rate of return, discounted cash flow payback, and simple payback, as published herein. The simple payback can be adjusted by a linear scaling based on the price premium, e.g., the simple payback with a 400% premium is ten times that for a 40% premium.

TABLE 1-1

Seasonal Performance Factors

Retail Store (7-1/2 Tons)

Location	Service	YAC	EHP	GHPM	GHPN
CLEVELAND	Heating	0.711	1.860	1.328	1.313
	Cooling	2.219	2.557	0.866	0.911
PITTSBURGH	Heating	0.712	1.856	1.328	1.313
	Cooling	2.245	2.591	0.947	0.961
DETROIT	Heating	0.709	1.868	1.330	1.314
	Cooling	2.176	2.493	0.985	0.981
CHICAGO	Heating	0.710	1.844	1.323	1.309
	Cooling	2.183	2.509	0.962	0.968
SYRACUSE	Heating	0.712	1.842	1.326	1.312
	Cooling	2.245	2.580	0.983	0.985
WASHINGTON	Heating	0.680	1.937	1.310	1.289
	Cooling	2.234	2.578	0.939	0.951
ATLANTA	Heating	0.674	2.062	1.327	1.304
	Cooling	2.235	2.583	0.949	0.960
ST. LOUIS	Heating	0.683	1.818	1.284	1.264
	Cooling	2.184	2.520	0.925	0.940
DALLAS	Heating	0.673	2.077	1.332	1.310
	Cooling	2.131	2.455	0.857	0.877
LOS ANGELES	Heating	0.677	2.335	1.386	1.359
	Cooling	2.377	2.716	1.016	0.995

Equipment Seasonal Performance Factors are ratios of the cooling or heating effects (BTU outputs) divided by the respective equipment energy amounts (BTU inputs) at the point-of-use.

TABLE 1-2

Unitized Building Total Utility Costs

Retail Store (7-1/2 Tons)

Location	Unit Cost ¢/Sq. Ft.	YAC	EHP	GHPM	GHPN
CLEVELAND**	Elec.	63.19	90.77	45.34	45.34
	Gas	10.81	-----	11.20	11.02
	Total	74.00	90.77	56.54	56.36
PITTSBURGH	Elec.	55.51	60.74*	35.47	35.47
	Gas	9.89	-----	10.25	10.24
	Total	65.40	60.74	45.72	45.71
DETROIT	Elec.	50.48	68.82*	37.62	37.62
	Gas	13.56	-----	10.83	10.93
	Total	64.04	68.82	48.45	48.55
CHICAGO**	Elec.	62.12	47.77	43.57	43.58
	Gas	14.76	-----	11.46	11.52
	Total	76.88	47.77	55.04	55.10
SYRACUSE	Elec.	49.02	74.04	34.27	34.28
	Gas	13.64	-----	13.95	14.02
	Total	66.66	74.04	48.22	48.30
WASHINGTON	Elec.	67.12	71.59*	47.00	47.00
	Gas	4.94	-----	10.52	10.45
	Total	77.06	71.59	57.52	57.45
ATLANTA	Elec.	61.48	61.65	38.46	38.46
	Gas	2.23	-----	6.10	6.06
	Total	63.71	61.65	44.56	44.52
ST. LOUIS	Elec.	62.59	36.31*	44.55	44.56
	Gas	6.84	-----	8.36	8.32
	Total	69.43	36.31	52.91	52.88
DALLAS	Elec.	52.43	42.31*	32.24	32.24
	Gas	2.56	-----	10.60	10.42
	Total	54.99	42.31	42.84	42.66
LOS ANGELES	Elec.	114.91	115.89	103.05	103.05
	Gas	1.82	------	6.29	6.42
	Total	116.73	115.89	109.34	109.47

**Winter/Summer Rate

*All Electric or Heating Rate

TABLE 1-3

Unitized Building Total Utility Costs

Office Building (7-1/2 Tons)

Location	Unit Cost ¢/Sq. Ft.	YAC	EHP	GHPM	GHPN
CLEVELAND**	Elec.	71.61	94.06	55.55	55.55
	Gas	9.09	-----	9.99	9.84
	Total	80.70	94.06	65.54	65.39
PITTSBURGH	Elec.	59.20	61.93*	40.03	40.03
	Gas	8.16	-----	9.01	9.01
	Total	67.36	61.93	49.04	49.04
DETROIT	Elec.	57.94	70.57*	46.68	46.68
	Gas	11.54	-----	9.27	9.37
	Total	69.48	70.57	55.95	56.05
CHICAGO**	Elec.	67.98	49.42	49.90	49.90
	Gas	12.57	-----	10.31	10.36
	Total	80.55	49.42	60.21	60.26
SYRACUSE	Elec.	54.79	76.26	49.59	49.59
	Gas	11.65	-----	12.36	12.43
	Total	66.44	76.26	52.95	53.02
WASHINGTON	Elec.	76.16	76.24*	57.21	57.21
	Gas	3.25	-----	9.46	9.41
	Total	79.41	76.24	66.67	66.62
ATLANTA	Elec.	64.54	64.00	41.84	41.84
	Gas	1.37	-----	5.50	5.48
	Total	65.91	64.00	47.34	47.32
ST. LOUIS	Elec.	70.31	38.81*	53.50	53.51
	Gas	5.06	-----	7.53	7.51
	Total	75.37	38.81	61.03	61.02
DALLAS	Elec.	58.01	46.07*	38.03	38.02
	Gas	1.54	-----	9.99	9.82
	Total	59.55	46.07	48.02	47.84
LOS ANGELES	Elec.	118.73	122.62	108.14	108.14
	Gas	3.01	------	6.12	6.21
	Total	121.74	122.62	114.26	114.35

**Winter/Summer Rate

*All Electric or Heating Rate

TABLE 1-4

Retail Store (7 1/2 Tons) - YAC
Average Rates

	Electric ¢/KWH	Gas ¢/MCF
CLEVELAND	5.639	191.58
PITTSBURGH	4.863	183.05
DETROIT	4.856	197.59
CHICAGO	5.799	217.65
SYRACUSE	4.536	221.51
WASHINGTON	5.702	249.63
ATLANTA	5.207	169.50
ST. LOUIS	5.412	227.81
DALLAS	4.231	275.60
LOS ANGELES	9.503	170.65

TABLE 1-5

Investment Criteria

Retail Store (7 1/2 Tons)

Gas Heat Pump - Maximum Cooling vs Combination Heat/Cool Unit (YAC)

	- PREMIUM % -				
	10	20	30	40	50
CLE - DCF/ROR-%	216	111	76	58	48
DCF/PB-YRS	.47	.94	1.38	1.82	2.25
SIMPLE PB-YRS	.26	.52	.79	1.05	1.31
PIT - DCF/ROR-%	243	124	85	65	53
DCF/PB-YRS	.42	.83	1.23	1.62	2.01
SIMPLE PB-YRS	.23	.46	.70	.93	1.16
DTW - DCF/ROR-%	195	101	69	53	43
DCF/PB-YRS	.52	1.04	1.52	2.01	2.47
SIMPLE PB-YRS	.29	.59	.88	1.17	1.46
CHI - DCF/ROR-%	278	142	97	74	60
DCF/PB-YRS	.37	.73	1.08	1.42	1.76
SIMPLE PB-YRS	.20	.40	.61	.81	1.01
SYR - DCF/ROR-%	180	93	64	49	40
DCF/PB-YRS	.57	1.13	1.66	2.17	2.67
SIMPLE PB-YRS	.32	.63	.95	1.27	1.58
DCA - DCF/ROR-%	168	87	60	46	38
DCF/PB-YRS	.61	1.20	1.77	2.32	2.86
SIMPLE PB-YRS	.34	.68	1.02	1.36	1.70
ATL - DCF/ROR-%	228	117	80	61	50
DCF/PB-YRS	.45	.89	1.31	1.73	2.13
SIMPLE PB-YRS	.25	.50	.74	.99	1.24
STL - DCF/ROR-%	202	104	71	55	45
DCF/PB-YRS	.51	1.00	1.47	1.94	2.39
SIMPLE PB-YRS	.28	.56	.84	1.12	1.40
DAL - DCF/ROR-%	194	100	69	53	43
DCF/PB-YRS	.53	1.04	1.53	2.01	2.48
SIMPLE PB-YRS	.43	.87	1.30	1.74	2.17
LAX - DCF/ROR-%	84	44	31	30	18
DCF/PB-YRS	1.25	2.41	3.51	4.56	5.59
SIMPLE PB-YRS	.71	1.41	2.12	2.83	3.54

TABLE 1-6

Investment Criteria

Retail Store (7 1/2 Tons)

Gas Heat Pump - Nominal Cooling vs Combination Heat/Cool Unit (YAC)

	- PREMIUM % -				
	30	40	50	60	70
CLE - DCF/ROR-%	77	59	48	41	35
DCF/PB-YRS	1.38	1.80	2.22	2.63	3.04
SIMPLE PB-YRS	.78	1.04	1.30	1.55	1.81
PIT - DCF/ROR-%	85	65	53	45	39
DCF/PB-YRS	1.24	1.62	2.01	2.37	2.74
SIMPLE PB-YRS	.64	.93	1.16	1.39	1.62
DTW - DCF/ROR-%	69	53	43	36	32
DCF/PB-YRS	1.53	2.02	2.48	2.94	3.39
SIMPLE PB-YRS	.88	1.17	1.46	1.75	2.06
CHI - DCF/ROR-%	97	74	60	51	44
DCF/PB-YRS	1.09	1.43	1.76	2.10	2.42
SIMPLE PB-YRS	.61	.81	1.01	1.22	1.42
SYR - DCF/ROR-%	64	49	40	34	29
DCF/PB-YRS	1.66	2.19	2.69	3.18	3.67
SIMPLE PB-YRS	.95	1.27	1.59	1.91	2.23
DCA - DCF/ROR-%	60	46	38	32	28
DCF/PB-YRS	1.76	2.31	2.84	3.36	3.87
SIMPLE PB-YRS	1.01	1.35	1.69	2.02	2.36
ATL - DCF/ROR-%	80	61	50	42	37
DCF/PB-YRS	1.31	1.73	2.13	2.52	2.92
SIMPLE PB-YRS	.74	.99	1.24	1.49	1.74
STL - DCF/ROR-%	72	55	45	38	33
DCF/PB-YRS	1.47	1.94	2.38	2.82	3.25
SIMPLE PB-YRS	.84	1.12	1.40	1.68	1.96
DAL - DCF/ROR-%	69	53	43	37	32
DCF/PB-YRS	1.52	2.00	2.46	2.92	3.37
SIMPLE PB-YRS	1.28	1.71	2.13	2.56	2.98
LAX - DCF/ROR-%	30	23	18	18	12
DCF/PB-YRS	3.59	4.67	5.71	6.73	7.73
SIMPLE PB-YRS	2.17	2.90	3.62	4.35	5.07

TABLE 1-7

Investment Criteria

Retail Store (7 1/2 Tons)
Gas Heat Pump - Maximum & Nominal Versions

		20% PREMIUM GHPM	40% GHPN
CLE	DCF/ROR, %	111%	59%
	DCF PAYBACK, YRS	.94	1.80
	SIMPLE PAYBACK, YRS	.52	1.04
* PIT	DCF/ROR, %	124	65
	DCF PAYBACK, YRS	.83	1.62
	SIMPLE PAYBACK, YRS	.46	.93
* DTW	DCF/ROR, %	101	53
	DCF PAYBACK, YRS	1.04	2.02
	SIMPLE PAYBACK, YRS	.59	1.17
* CHI	DCF/ROR, %	142	74
	DCF PAYBACK, YRS	.73	1.43
	SIMPLE PAYBACK, YRS	.40	.81
SYR	DCF/ROR, %	93	49
	DCF PAYBACK, YRS	1.13	2.19
	SIMPLE PAYBACK, YRS	.63	1.27
* DCA	DCF/ROR, %	87	46
	DCF PAYBACK, YRS	1.20	2.31
	SIMPLE PAYBACK, YRS	.68	1.35
ATL	DCF/ROR, %	117	61
	DCF PAYBACK, YRS	.89	1.73
	SIMPLE PAYBACK, YRS	.50	.99
* STL	DCF/ROR, %	104	55
	DCF PAYBACK, YRS	1.00	1.94
	SIMPLE PAYBACK, YRS	.56	1.12
* DAL	DCF/ROR, %	100	53
	DCF PAYBACK, YRS	1.04	2.00
	SIMPLE PAYBACK, YRS	.87	1.71
LAX	DCF/ROR, %	44	23
	DCF PAYBACK, YRS	2.41	4.67
	SIMPLE PAYBACK, YRS	1.41	2.90

TABLE 1-8

Investment Criteria

Retail Store (7 1/2 Tons)

Electric Heat Pump vs Combination Heat/Cool Unit (YAC)

CLE -	DCF/ROR-%	---	- NO ALL ELECTRIC RATE
	DCF PAYBACK, YRS	---	
	SIMPLE PAYBACK, YRS	---	
PIT -	DCF/ROR-%	92	- ALL ELECTRIC RATE
	DCF PAYBACK, YRS	1.15	
	SIMPLE PAYBACK, YRS	.64	
DTW -	DCF/ROR-%	---	- ELECTRIC HEATING RATE
	DCF PAYBACK, YRS	---	
	SIMPLE PAYBACK, YRS	---	
CHI -	DCF/ROR-%	416	- ALL ELECTRIC RATE
	DCF PAYBACK, YRS	.24	
	SIMPLE PAYBACK, YRS	.13	
SYR -	DCF/ROR-%	---	- NO ALL ELECTRIC RATE
	DCF PAYBACK, YRS	---	
	SIMPLE PAYBACK, YRS	---	
DCA -	DCF/ROR-%	23	- SPACE HEATING RATE
	DCF PAYBACK, YRS	4.66	
	SIMPLE PAYBACK, YRS	2.89	
ATL -	DCF/ROR-%	37	- NO ALL ELECTRIC RATE
	DCF PAYBACK, YRS	2.88	
	SIMPLE PAYBACK, YRS	1.71	
STL -	DCF/ROR-%	446	- ELECTRIC HEATING RATE
	DCF PAYBACK, YRS	.23	
	SIMPLE PAYBACK, YRS	.12	
DAL -	DCF/ROR-%	154	- ELECTRIC HEATING RATE
	DCF PAYBACK, YRS	.67	
	SIMPLE PAYBACK, YRS	.33	
LAX -	DCF/ROR-%	18	- NO ALL ELECTRIC RATE
	DCF PAYBACK, YRS	5.69	
	SIMPLE PAYBACK, YRS	3.61	

TABLE 1-9

Investment Criteria

Retail Store (7 1/2 Tons)
Gas Heat Pump - Maximum & Nominal Versions vs Electric Heat Pump

	30% PREMIUM GHPM	50% GHPN
CLE - DCF/ROR, %	193%	102%
DCF PAYBACK, YRS	0.53	1.00
SIMPLE PAYBACK, YRS	0.29	0.57
* PIT - DCF/ROR, %	82%	44%
DCF PAYBACK, YRS	1.28	2.43
SIMPLE PAYBACK, YRS	0.72	1.43
* DTW - DCF/ROR, %	113%	60%
DCF PAYBACK, YRS	0.93	1.78
SIMPLE PAYBACK, YRS	0.52	1.02
* CHI - DCF/ROR, %	----	----
DCF PAYBACK, YRS	----	----
SIMPLE PAYBACK, YRS	----	----
SYR - DCF/ROR, %	141%	74%
DCF PAYBACK, YRS	0.73	1.42
SIMPLE PAYBACK, YRS	0.41	0.81
* DCA - DCF/ROR, %	76%	41%
DCF PAYBACK, YRS	1.38	2.60
SIMPLE PAYBACK, YRS	0.78	1.54
ATL - DCF/ROR %	99%	53%
DCF PAYBACK, YRS	1.07	2.00
SIMPLE PAYBACK, YRS	0.59	1.16
* STL - DCF/ROR, %	----	----
DCF PAYBACK, YRS	----	----
SIMPLE PAYBACK, YRS	----	----
* DAL - DCF/ROR, %	----	----
DCF PAYBACK, YRS	----	----
SIMPLE PAYBACK, YRS	----	----
LAX - DCF/ROR, %	36%	18%
DCF PAYBACK, YRS	2.99	5.72
SIMPLE PAYBACK, YRS	1.78	3.63

* Electric Heating Rate

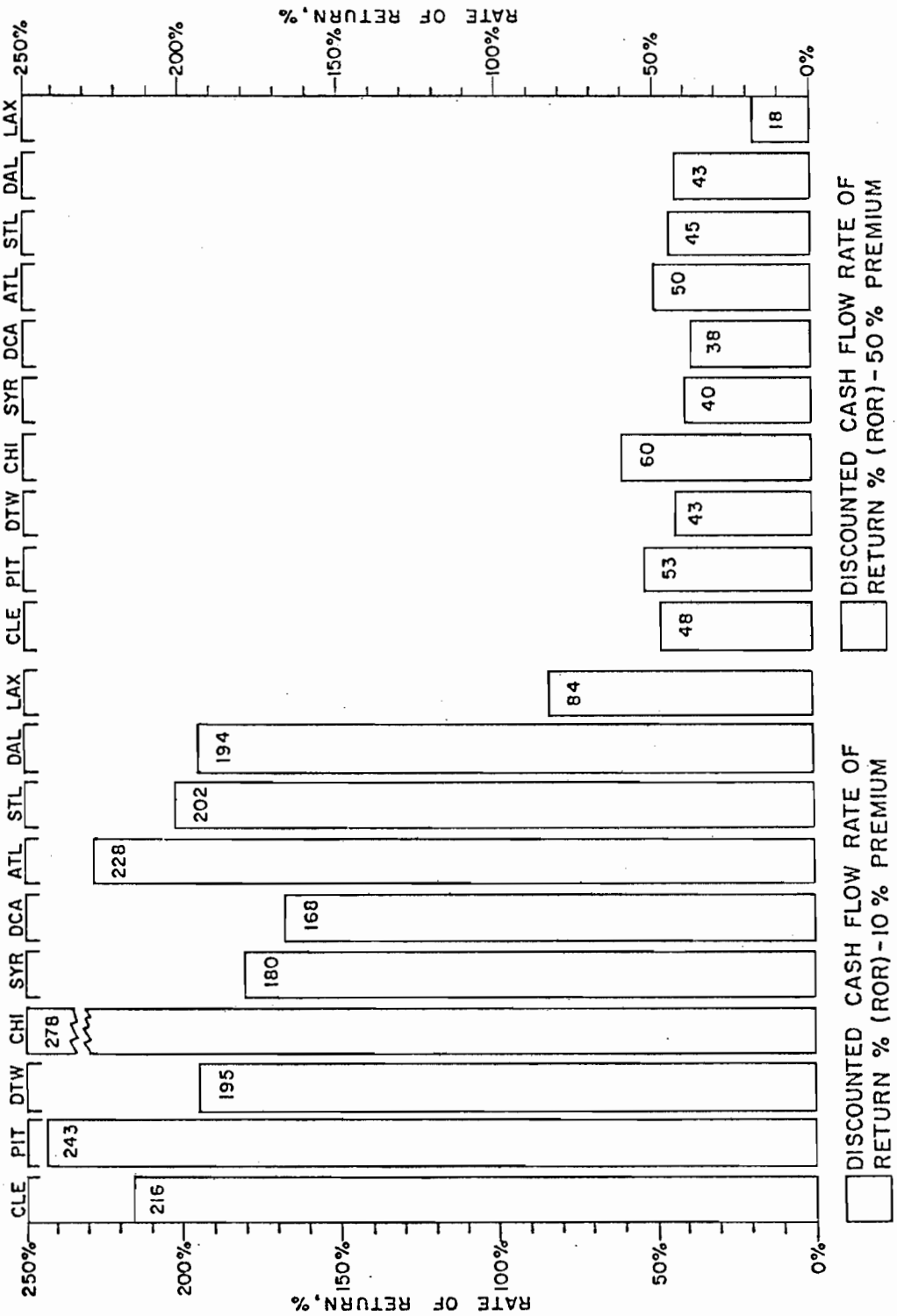

Fig. 1-1 Retail Store (7-1/2 Tons); Gas Heat Pump-Maximum Cooling Vs. Combination Heat/Cool Unit (YAC)

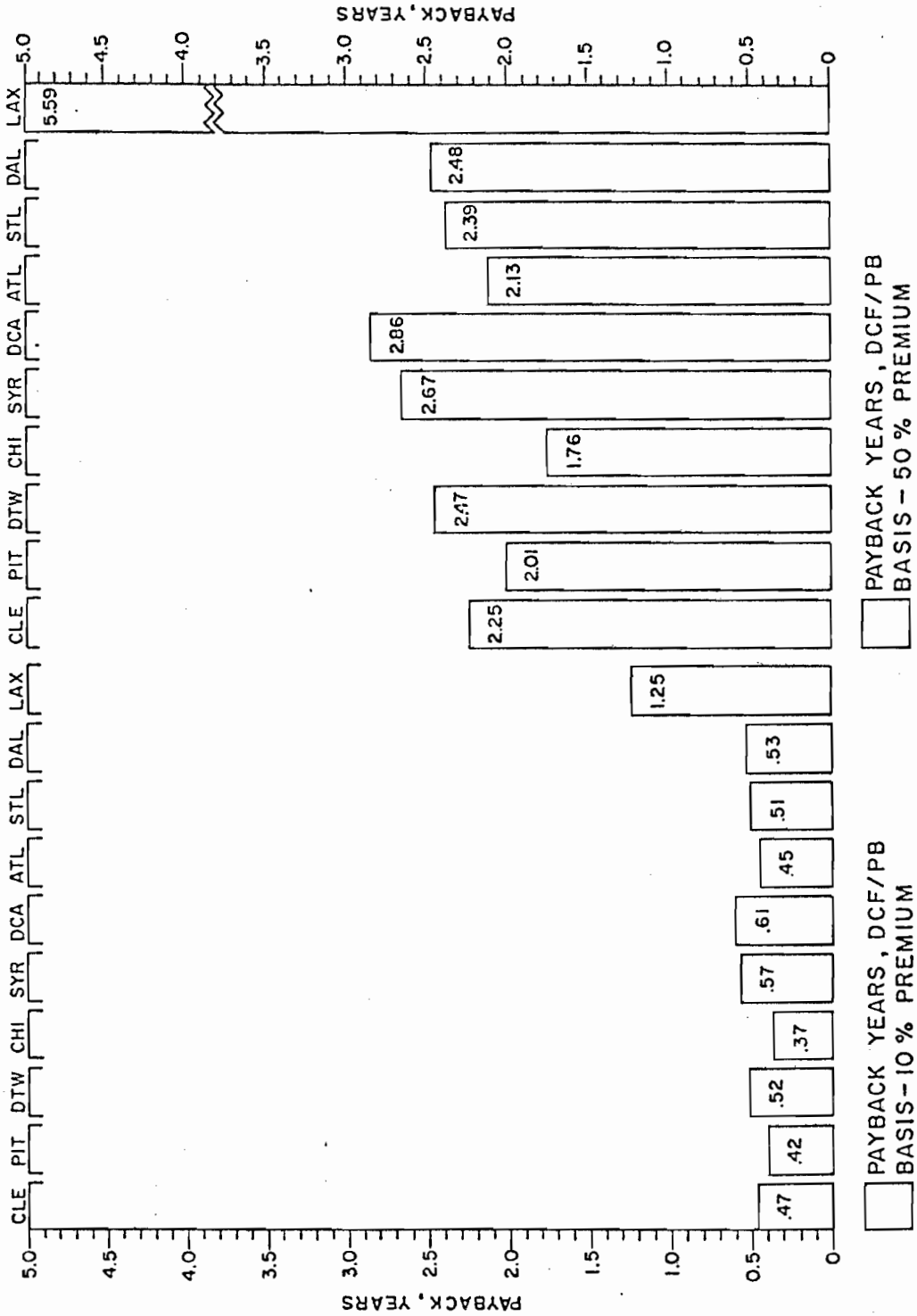

Fig. 1-2 Retail Store (7-1/2 Tons); Gas Heat Pump - Maximum Cooling Vs. Combination Heat/Cool Unit (YAC)

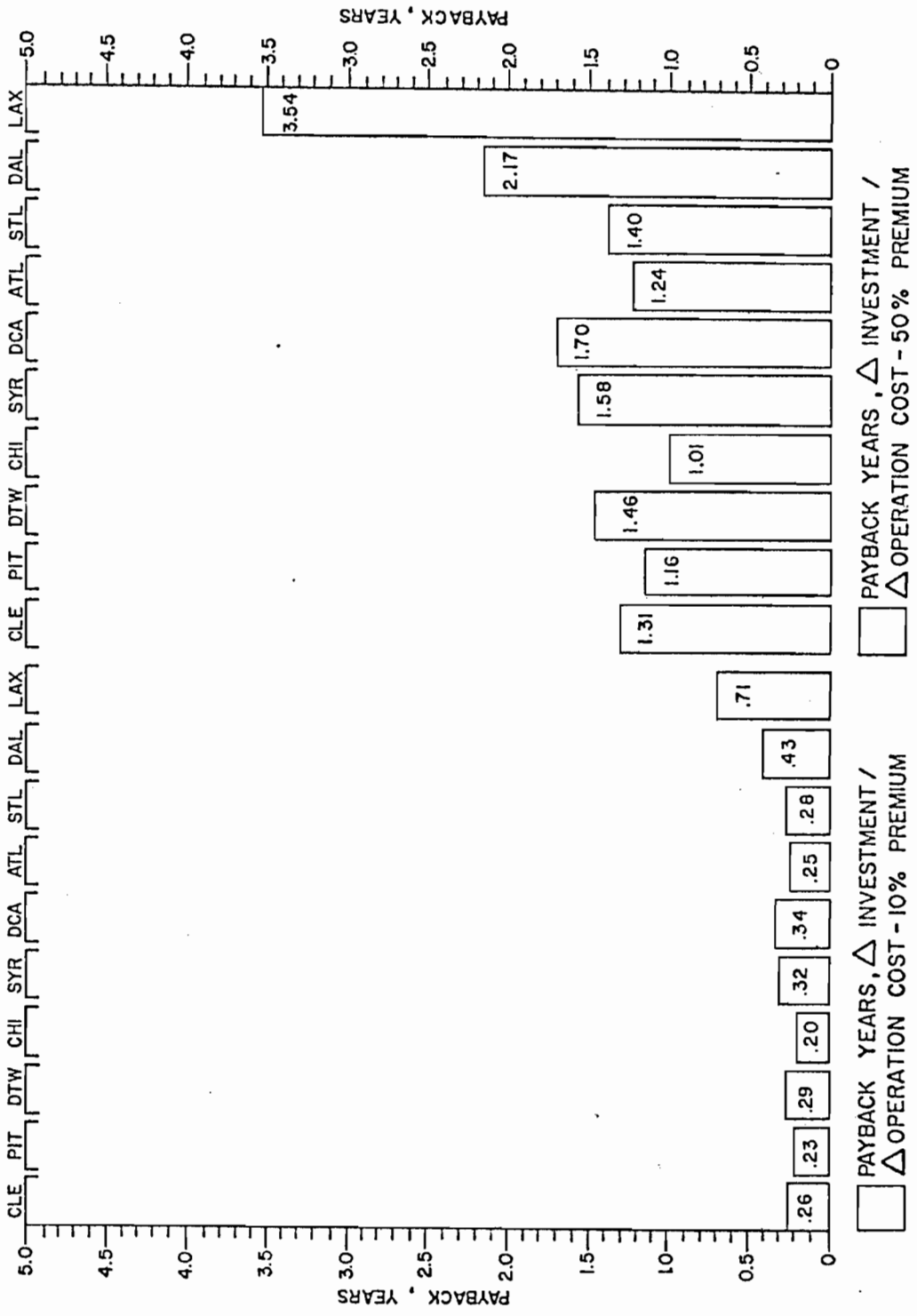

Fig. 1-3 Retail Store (7-1/2 Tons); Gas Heat Pump - Maximum Cooling Vs. Combination Heat/Cool Unit (YAC)

2.0 KEY OBSERVATIONS

1. The heating seasonal performance or efficiency of the gas heat pump approached twice that of advanced direct-fired gas heating equipment.

2. The cooling seasonal performance or efficiency of the gas heat pump was approximately twice that of present-day direct-fired absorption cooling units.

3. The design assumptions for a projected, lower-cost maximum cooling version of the gas heat pump were shown to have minimal effect on cooling and heating seasonal performance with respect to the nominal version.

4. Only a small differential existed in annual operating or utility costs between the maximum and nominal versions of the gas heat pump.

5. Annual operating or utility costs for the gas heat pump were shown to be significantly lower than the year-round air conditioning units in all study cities.

6. Annual operating or utility costs for the gas heat pump were shown to be less than those of the electric heat pump in most of the study cities.

7. The effect of electric heating rates on the competitive position of the gas and electric heat pumps was substantial.

8. On economic criteria, the projected advanced design electric heat pump appeared to be a better investment than a YAC in seven of the ten cities studied.

9. A direct economic comparison of the gas heat pump with the projected advanced design electric heat pump indicated that the gas heat pump had a competitive advantage in seven of the ten cities studied.

10. These preliminary data indicate that the maximum version, relative to the YAC, fell well within the reported constraints of the market of no more than 30% initial cost premium and a two-year payback.

11. The nominal unit, despite a projected cost of more than 30% cost premium compared to YAC, had less than a two-year payback in most cities.

12. The HSPF gas heat pump will be the most resource efficient option in any of the metropolitan areas studied for either heating or cooling source.

13. A simulation model which enables improved characterization of the gas heat pump and comparisons with advanced competitive equipment is available for future gas heat pump product development and market studies.

3.0 SEASONAL PERFORMANCE FACTORS TABLES

The following tables contain the Annual Cooling and Heating Seasonal Performance Factors computed by the Equipment Selection and Energy Consumption Program.

- Table 3-1 - Rest Home
- Table 3-2 - Office Building
- Table 3-3 - Retail Store
- Table 3-4 - Light Manufacturing Building

The primary controlling data for the SPF factors in the program were COP tables which were constructed for each system type. The factors are shown for each of the ten location cities.

TABLE 3-1

Equipment Performance Data
Seasonal Performance Factors

Rest Home (7-1/2 Tons)

Location	Study #	Service	YAC	EHP	GHPM	GHPN
CLE	1	Heating	0.679	1.734	1.262	1.244
		Cooling	2.154	2.479	0.948	0.949
PIT	25	Heating	0.679	1.731	1.263	1.245
		Cooling	2.171	2.501	0.952	0.954
DTW	49	Heating	0.689	1.759	1.281	1.264
		Cooling	2.127	2.433	0.968	0.956
CHI	57	Heating	0.683	1.718	1.261	1.243
		Cooling	2.139	2.455	0.962	0.955
SYR	65	Heating	0.681	1.721	1.262	1.244
		Cooling	2.171	2.491	0.974	0.969
DCA	73	Heating	0.622	1.735	1.186	1.162
		Cooling	2.156	2.479	0.961	0.958
ATL	81	Heating	0.626	1.841	1.204	1.183
		Cooling	2.157	2.476	0.970	0.964
STL	89	Heating	0.691	1.795	1.296	1.280
		Cooling	2.020	2.230	0.848	0.838
DAL	97	Heating	0.623	1.879	1.201	1.178
		Cooling	2.083	2.402	0.921	0.913
LAX	105	Heating	0.675	2.228	1.379	1.356
		Cooling	2.262	2.577	0.994	0.984

YAC - One carrier combination Heat/Cool Unit - 48 DP 008
EHP - One carrier electric Heat Pump Unit - 50 DQ 008
GHPM - One MTI/CNG/ERDA Gas Heat Pump - Maximum cooling version
GHPN - One MTI/CNG/ERDA Gas Heat Pump - Nominal Cooling Version

TABLE 3-2

Equipment Performance Data
Seasonal Performance Factors

Office Building (7-1/2 Tons)

Location	Study #	Service	YAC	EHP	GHPM	GHPN
CLE	7	Heating Cooling	0.705 2.240	1.817 2.577	1.313 0.883	1.298 0.922
PIT	31	Heating Cooling	0.707 2.259	1.806 2.602	1.312 0.969	1.297 0.978
DTW	51	Heating Cooling	0.702 2.193	1.835 2.509	1.314 0.995	1.299 0.987
CHI	59	Heating Cooling	0.705 2.194	1.804 2.521	1.306 0.959	1.291 0.965
SYR	67	Heating Cooling	0.707 2.251	1.808 2.587	1.311 0.990	1.296 0.992
DCA	75	Heating Cooling	0.673 2.264	1.867 2.607	1.295 0.955	1.277 0.963
ATL	83	Heating Cooling	0.667 2.268	1.980 2.615	1.313 0.966	1.293 0.973
STL	91	Heating Cooling	0.674 2.224	1.753 2.563	1.261 0.942	1.243 0.952
DAL	99	Heating Cooling	0.669 2.188	2.009 2.520	1.327 0.874	1.307 0.893
LAX	107	Heating Cooling	0.718 2.365	2.330 2.684	1.463 1.006	1.444 0.990

YAC - One carrier combination Heat/Cool Unit - 48 DP 008
EHP - One carrier electric Heat Pump Unit - 50 DQ 008
GHPM - One MTI/CNG/ERDA Gas Heat Pump - Maximum cooling version
GHPN - One MTI/CNG/ERDA Gas Heat Pump - Nominal cooling version

TABLE 3-3

Equipment Performance Data
Seasonal Performance Factors

Retail Store (7-1/2 Tons)

Location	Study #	Service	YAC	EHP	GHPM	GHPN
CLE	13	Heating Cooling	0.711 2.219	1.860 2.557	1.328 0.866	1.313 0.911
PIT	37	Heating Cooling	0.712 2.245	1.856 2.591	1.328 0.947	1.313 0.961
DTW	53	Heating Cooling	0.709 2.176	1.868 2.493	1.330 0.985	1.314 0.981
CHI	61	Heating Cooling	0.710 2.183	1.844 2.509	1.323 0.962	1.309 0.968
SYR	69	Heating Cooling	0.712 2.245	1.842 2.580	1.326 0.983	1.312 0.985
DCA	77	Heating Cooling	0.680 2.234	1.937 2.578	1.310 0.939	1.289 0.951
ATL	85	Heating Cooling	0.674 2.235	2.062 2.583	1.327 0.949	1.304 0.960
STL	93	Heating Cooling	0.683 2.184	1.818 2.520	1.284 0.925	1.264 0.940
DAL	101	Heating Cooling	0.673 2.131	2.077 2.455	1.332 0.857	1.310 0.877
LAX	109	Heating Cooling	0.677 2.377	2.335 2.716	1.386 1.016	1.359 0.995

YAC - One carrier combination Heat/Cool Unit - 48 DP 008
EHP - One carrier electric Heat Pump Unit - 50 DQ 008
GHPM - One MTI/CNG/ERDA Gas Heat Pump - Maximum cooling version
GHPN - One MTI/CNG/ERDA Gas Heat Pump - Nominal cooling version

TABLE 3-4

Equipment Performance Data
Seasonal Performance Factors

Light Mfg. (7-1/2 Tons)

Location	Study #	Service	YAC	EHP	GHPM	GHPN
CLE	19	Heating	0.712	1.857	1.330	1.315
		Cooling	2.222	2.559	0.971	0.979
PIT	43	Heating	0.734	1.830	1.359	1.350
		Cooling	2.216	2.553	0.977	0.985
DTW	55	Heating	0.709	1.856	1.327	1.311
		Cooling	2.221	2.545	1.015	1.011
CHI	63	Heating	0.689	1.801	1.290	1.272
		Cooling	2.214	2.549	0.983	0.988
SYR	71	Heating	0.722	1.843	1.341	1.329
		Cooling	2.211	2.541	0.996	0.997
DCA	79	Heating	0.689	1.947	1.331	1.313
		Cooling	2.222	2.564	0.970	0.975
ATL	87	Heating	0.684	2.036	1.349	1.330
		Cooling	2.234	2.580	0.978	0.985
STL	95	Heating	0.665	1.785	1.260	1.243
		Cooling	2.223	2.571	0.953	0.964
DAL	103	Heating	0.652	2.017	1.308	1.288
		Cooling	2.188	2.537	0.883	0.906
LAX	111	Heating	0.725	2.350	1.475	1.457
		Cooling	2.231	2.552	1.001	1.003

YAC - One carrier combination Heat/Cool Unit 48 DP 008
EHP - One carrier electric Heat Pump Unit - 50 DC 008
GHPM - One MTI/CNG/ERDA Gas Heat Pump - Maximum Cooling Version
GHPN - One MTI/CNG/ERDA Gas Heat Pump - Nominal Cooling Version

4.0 UNITIZED BUILDING TOTAL UTILITY COST TABLES

The following tables contain the total building electric and natural gas utility costs for each system type, building type and location city.

- Table 4-1 - Rest Home
- Table 4-2 - Office Building
- Table 4-3 - Retail Store
- Table 4-4 - Light Manufacturing Building

Note that the costs which are tabulated are shown by system type and the costs shown are the total building annual utility costs in cents per square foot of floor area. All building utility costs for a given building type are identical except for the energy used by the particular HVAC System. Therefore, the difference in costs per square foot is solely attributable to the cost of utilities required by the HVAC System except for the Rest Home which is the only building type which includes gas water heating.

TABLE 4-1

UNIT UTILITY COST DATA

Rest Home (7-1/2 Tons) 4000 square feet

System Indentification Codes			C1	E1	E2	E3
Location	Study #	Unit Cost ¢/Sq. Ft.	YAC	EHP	GHPM	GHPN
CLE**	1	Elec.	101.72	118.20	82.59	82.59
		Gas	11.02	4.52	13.39	13.43
		Total	112.74	122.72	95.98	96.02
PIT	25	Elec.	81.77	77.12*	63.22	63.23
		Gas	10.17	4.24	12.35	12.38
		Total	91.94	81.36	75.57	75.61
DTW	49	Elec.	86.18	88.71*	73.97	73.97
		Gas	13.24	4.15	12.53	12.64
		Total	99.42	92.86	86.50	86.61
CHI**	57	Elec.	93.11	61.28	76.84	76.83
		Gas	14.21	5.41	13.03	13.12
		Total	107.32	66.69	89.87	89.95
SYR	65	Elec.	76.82	93.66	63.74	63.74
		Gas	13.56	6.04	15.68	15.76
		Total	90.38	99.70	79.42	79.50
DCA	73	Elec.	107.79	108.15*	83.29	83.29
		Gas	6.96	5.19	15.80	15.85
		Total	114.75	113.34	99.09	99.14
ATL	81	Elec.	91.95	89.23	66.35	66.35
		Gas	4.32	3.51	10.30	10.35
		Total	96.27	92.74	76.65	76.70
STL	89	Elec.	95.59	58.32*	80.09	80.09
		Gas	13.18	4.81	13.64	13.75
		Total	108.77	63.13	93.73	93.84
DAL	97	Elec.	88.79	68.33*	60.28	60.28
		Gas	6.32	5.37	19.81	19.93
		Total	95.11	73.70	80.09	80.21
LAX	105	Elec.	132.91	135.35	123.48	123.48
		Gas	5.20	2.86	8.12	8.15
		Total	138.11	138.21	131.60	131.63

**Winter/Summer Rate

*All Electric or Heating Rate

YAC - One carrier combination Heat/Cool Unit - 48 DP 008
EHP - One carrier electric Heat Pump Unit - 50 DQ 008
GHPM - One MTI/CNG/ERDA Gas Heat Pump - Maximum Cooling Version
GHPN - One MTI/CNG/ERDA Gas Heat Pump - Nominal Cooling Version

TABLE 4-2

UNIT UTILITY COST DATA

Office Building (7-1/2 Tons) 4000 Square Feet

System Indentification Codes			C1	E1	E2	E3
Location	Study #	Unit Cost ¢/Sq. Ft.	YAC	EHP	GHPM	GHPN
CLE**	7	Elec.	71.61	94.06	55.55	55.55
		Gas	9.09	-----	9.99	9.84
		Total	80.70	94.06	65.54	65.39
PIT	31	Elec.	59.20	61.93*	40.03	40.03
		Gas	8.16	-----	9.01	9.01
		Total	67.36	61.93	49.04	49.04
DTW	51	Elec.	57.94	70.57*	46.68	46.68
		Gas	11.54	-----	9.27	9.37
		Total	69.48	70.57	55.95	56.05
CHI**	59	Elec.	67.98	49.42	49.90	49.90
		Gas	12.57	-----	10.31	10.36
		Total	80.55	49.42	60.21	60.26
SYR	67	Elec.	54.79	76.26	49.59	49.59
		Gas	11.65	-----	12.36	12.43
		Total	66.44	76.26	52.95	53.02
DCA	75	Elec.	76.16	76.24*	57.21	57.21
		Gas	3.25	-----	9.46	9.41
		Total	79.41	76.24	66.67	66.62
ATL	83	Elec.	64.54	64.00	41.84	41.84
		Gas	1.37	-----	5.50	5.48
		Total	65.91	64.00	47.34	47.32
STL	91	Elec.	70.31	38.81*	53.50	53.51
		Gas	5.06	-----	7.53	7.51
		Total	75.37	38.81	61.03	61.02
DAL	99	Elec.	58.01	46.07*	38.03	38.02
		Gas	1.54	-----	9.99	9.82
		Total	59.55	46.07	48.02	47.84
LAX	107	Elec.	118.73	122.62	108.14	108.14
		Gas	3.01	------	6.12	6.21
		Total	121.74	122.62	114.26	114.35

**Winter/Summer Rate

*All Electric or Heating Rate

YAC - One carrier combination Heat/Cool Unit - 48 DP 008
EHP - One carrier electric Heat Pump Unit - 50 DQ 008
GHPM - One MTI/CNG/ERDA Gas Heat Pump - Maximum Cooling Version
GHPN - One MTI/CNG/ERDA Gas Heat Pump - Nominal Cooling Version

TABLE 4-3

UNIT UTILITY COST DATA

Retail Store (7-1/2 Tons) - 4000 Square Feet

System Indentification Codes			C1	E1	E2	E3
Location	Study #	Unit Cost ¢/Sq. Ft.	YAC	EHP	GHPM	GHPN
CLE**	13	Elec.	63.19	90.77	45.34	45.34
		Gas	10.81	-----	11.20	11.02
		Total	74.00	90.77	56.54	56.36
PIT	37	Elec.	55.51	60.74*	35.47	35.47
		Gas	9.89	-----	10.25	10.24
		Total	65.40	60.74	45.72	45.71
DTW	53	Elec.	50.48	68.82*	37.62	37.62
		Gas	13.56	-----	10.83	10.93
		Total	64.04	68.82	48.45	48.55
CHI**	61	Elec.	62.12	47.77	43.57	43.58
		Gas	14.76	-----	11.46	11.52
		Total	76.88	47.77	55.04	55.10
SYR	69	Elec.	49.02	74.04	34.27	34.28
		Gas	13.64	-----	13.95	14.02
		Total	66.66	74.04	48.22	48.30
DCA	77	Elec.	67.12	71.59*	47.00	47.00
		Gas	4.94	-----	10.52	10.45
		Total	77.06	71.59	57.52	57.45
ATL	85	Elec.	61.48	61.65	38.46	38.46
		Gas	2.23	-----	6.10	6.06
		Total	63.71	61.65	44.56	44.52
STL	93	Elec.	62.59	36.31*	44.55	44.56
		Gas	6.84	-----	8.36	8.32
		Total	69.43	36.31	52.91	52.88
DAL	101	Elec.	52.43	42.31*	32.24	32.24
		Gas	2.56	-----	10.60	10.42
		Total	54.99	42.31	42.84	42.66
LAX	109	Elec.	114.91	115.89	103.05	103.05
		Gas	1.82	-----	6.29	6.42
		Total	116.73	115.89	109.34	109.47

**Winter/Summer Rate

*All Electric or Heating Rate

YAC - One carrier combination Heat/Cool Unit - 48 DP 008
EHP - One carrier electric Heat Pump Unit - 50 DQ 008
GHPM - One MTI/CNG/ERDA Gas Heat Pump - Maximum Cooling Version
GHPN - One MTI/CNG/ERDA Gas Heat Pump - Nominal Cooling Version

TABLE 4-4

UNIT UTILITY COST DATA

Light Manufacturing (7-1/2 Tons) 3974 Square Feet

System Indentification Codes			C1	E1	E2	E3
Location	Study #	Unit Cost ¢/Sq. Ft.	YAC	EHP	GHPM	GHPN
CLE**	19	Elec.	64.05	92.80	51.68	51.68
		Gas	11.12	-----	9.50	9.54
		Total	75.17	92.80	61.18	61.22
PIT	43	Elec.	58.83	71.91*	42.75	42.76
		Gas	15.65	-----	11.23	11.25
		Total	74.48	71.91	53.98	54.01
DTW	55	Elec.	53.49	69.19*	42.96	42.96
		Gas	12.56	-----	9.59	9.68
		Total	66.05	69.19	52.55	52.64
CHI**	63	Elec.	67.64	42.19	51.08	51.08
		Gas	10.04	-----	8.40	8.45
		Total	77.68	42.19	59.48	59.53
SYR	71	Elec.	51.15	84.71	39.93	39.93
		Gas	15.69	-----	14.27	14.33
		Total	66.84	84.71	54.20	54.26
DCA	79	Elec.	76.66	90.71*	61.12	61.12
		Gas	9.16	-----	10.61	10.65
		Total	85.82	90.71	71.73	71.77
ATL	87	Elec.	65.62	69.02	47.15	47.15
		Gas	3.62	-----	5.07	5.07
		Total	69.24	69.01	52.22	52.22
STL	95	Elec.	63.55	34.96*	49.88	49.88
		Gas	5.62	-----	6.87	6.88
		Total	69.17	34.96	46.75	46.76
DAL	103	Elec.	54.30	42.44*	37.91	37.91
		Gas	2.13	-----	8.06	7.91
		Total	56.43	42.44	45.97	45.82
LAX	111	Elec.	113.08	125.00	106.59	106.59
		Gas	7.77	------	6.21	6.26
		Total	120.85	125.00	112.80	112.85

**Winter/Summer Rate

*All Electric or Heating Rate

YAC - One carrier combination Heat/Cool Unit - 48 DP 008
EHP - One carrier electric Heat Pump Unit - 50 DQ 008
GHPM - One MTI/CNG/ERDA Gas Heat Pump - Maximum Cooling Version
GHPN - One MTI/CNG/ERDA Gas Heat Pump - Nominal Cooling Version

5.0 INVESTMENT COMPARISION CRITERIA TABLES AND FIGURES

5.1 Gas Heat Pump Versus Year-round Air Conditioner

The three investment criteria factors: 1) Discounted Cash Flow Rate of Return, %; 2) Discounted Cash Flow Payback, Years; and 3) Simple Payback, Years are shown in the following tables. Separate tables are used for the maximum and nominal versions of the gas heat pump and the factors are shown for premium cost ranges of 10% to 50% and 30% to 70% for the maximum and nominal versions, respectively. The data are shown for all four building types in each of the ten location cities. The tables and figures are given as follows:

- Rest Home
  - 10% to 50% Assumed Gas Heat Pump First-Cost Premium
    -- Table 5-1, Figures 5-1, 5-2 and 5-3
  - 30% to 70% Assumed Gas Heat Pump First-Cost Premium
    -- Table 5-2, Figures 5-4, 5-5 and 5-6
- Office Building
  - 10% to 50% Assumed Gas Heat Pump First-Cost Premium
    -- Table 5-3, Figures 5-7, 5-8 and 5-9
  - 30% to 70% Assumed Gas Heat Pump First-Cost Premium
    -- Table 5-4, Figures 5-10, 5-11 and 5-12
- Retail Store
  - 10% to 50% Assumed Gas Heat Pump First-Cost Premium
    -- Table 5-5, Figures 5-13, 5-14 and 5-15
  - 30% to 70% Assumed Gas Heat Pump First-Cost Premium
    -- Table 5-6, Figures 5-16, 5-17 and 5-18
- Light Manufacturing
  - 10% to 50% Assumed Gas Heat Pump First-Cost Premium
    -- Table 5-7, Figures 5-19, 5-20 and 5-21
  - 30% to 70% Assumed Gas Heat Pump First-Cost Premium
    -- Table 5-8, Figures 5-22, 5-23 and 5-24

5.2 Year-round Air Conditioner (YAC) Versus Electric Heat Pump

Comparison of the economic attractiveness of the electric heat pump and the combination heat/cool unit (YAC) is shown on the following tables:

- Table 5-9 - Rest Home
- Table 5-10 - Office Building
- Table 5-11 - Retail Store
- Table 5-12 - Light Manufacturing Building

The program shows comparison criteria for only seven (7) of the ten (10) cities since the combination heat/cool unit had higher operating costs in three (3) cities - Cleveland, Detroit and Syracuse.

5.3 Electric Heat Pump Versus Gas Heat Pump (Maximum) and Gas Heat Pump (Nominal)

The economic attractiveness of the electric heat pump was compared with both versions of the gas heat pump (maximum at 30% premium and nominal at 50% premium) in Retail Stores. Data shown (Table 5-13) are for seven (7) cities, since the gas heat pump had higher operating costs in three cities and therefore an investment comparison could not be computed.

TABLE 5-1

REST HOME (7 1/2 Tons)

Gas Heat Pump - Maximum Cooling vs Combination Heat/Cool Unit (YAC)

	- PREMIUM % -				
	10	20	30	40	50
CLE - DCF/ROR-%	203	105	72	55	45
DCF/PB-YRS	.50	1.00	1.47	1.93	2.38
SIMPLE PB-YRS	.28	.56	.84	1.12	1.40
PIT - DCF/ROR-%	198	102	70	54	44
DCF/PB-YRS	.52	1.03	1.50	1.98	2.44
SIMPLE PB-YRS	.23	.57	.86	1.14	1.43
DTW - DCF/ROR-%	164	85	58	45	37
DCF/PB-YRS	.63	1.24	1.82	2.38	2.93
SIMPLE PB-YRS	.35	.70	1.05	1.40	1.74
CHI - DCF/ROR-%	219	113	77	59	48
DCF/PB-YRS	.47	.93	1.36	1.79	2.21
SIMPLE PB-YRS	.26	.52	.77	1.03	1.29
SYR - DCF/ROR-%	167	87	60	46	37
DCF/PB-YRS	.61	1.21	1.78	2.33	2.87
SIMPLE PB-YRS	.34	.68	1.02	1.36	1.71
DCA - DCF/ROR-%	173	90	62	47	39
DCF/PB-YRS	.59	1.17	1.72	2.25	2.77
SIMPLE PB-YRS	.33	.66	.99	1.32	1.64
ATL - DCF/ROR-%	228	117	80	61	50
DCF/PB-YRS	.45	.89	1.31	1.72	2.13
SIMPLE PB-YRS	.25	.50	.74	.99	1.24
STL - DCF/ROR-%	190	98	67	52	42
DCF/PB-YRS	.54	1.07	1.57	2.06	2.54
SIMPLE PB-YRS	.30	.61	.91	1.22	1.52
DAL - DCF/ROR-%	152	79	54	42	34
DCF/PB-YRS	.68	1.33	1.95	2.55	3.14
SIMPLE PB-YRS	.38	.75	1.13	1.50	1.88
LAX - DCF/ROR-%	77	41	28	21	17
DCF/PB-YRS	1.36	2.62	3.80	4.95	6.06
SIMPLE PB-YRS	.77	1.54	2.32	3.09	3.86

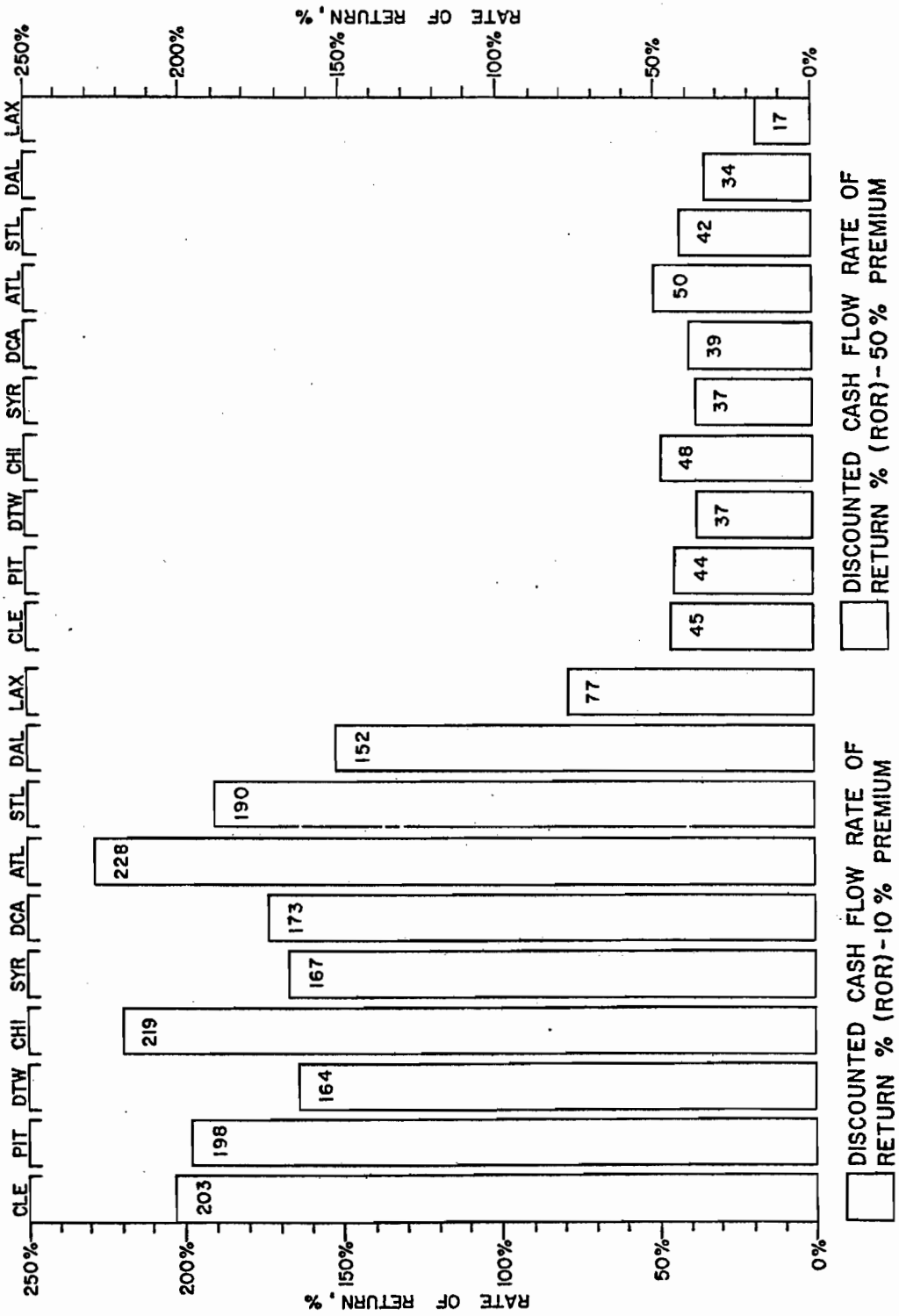

Fig. 5-1 Rest Home (7-1/2 Tons); Gas Heat Pump - Maximum Cooling Vs. Combination Heat/Cool Unit (YAC)

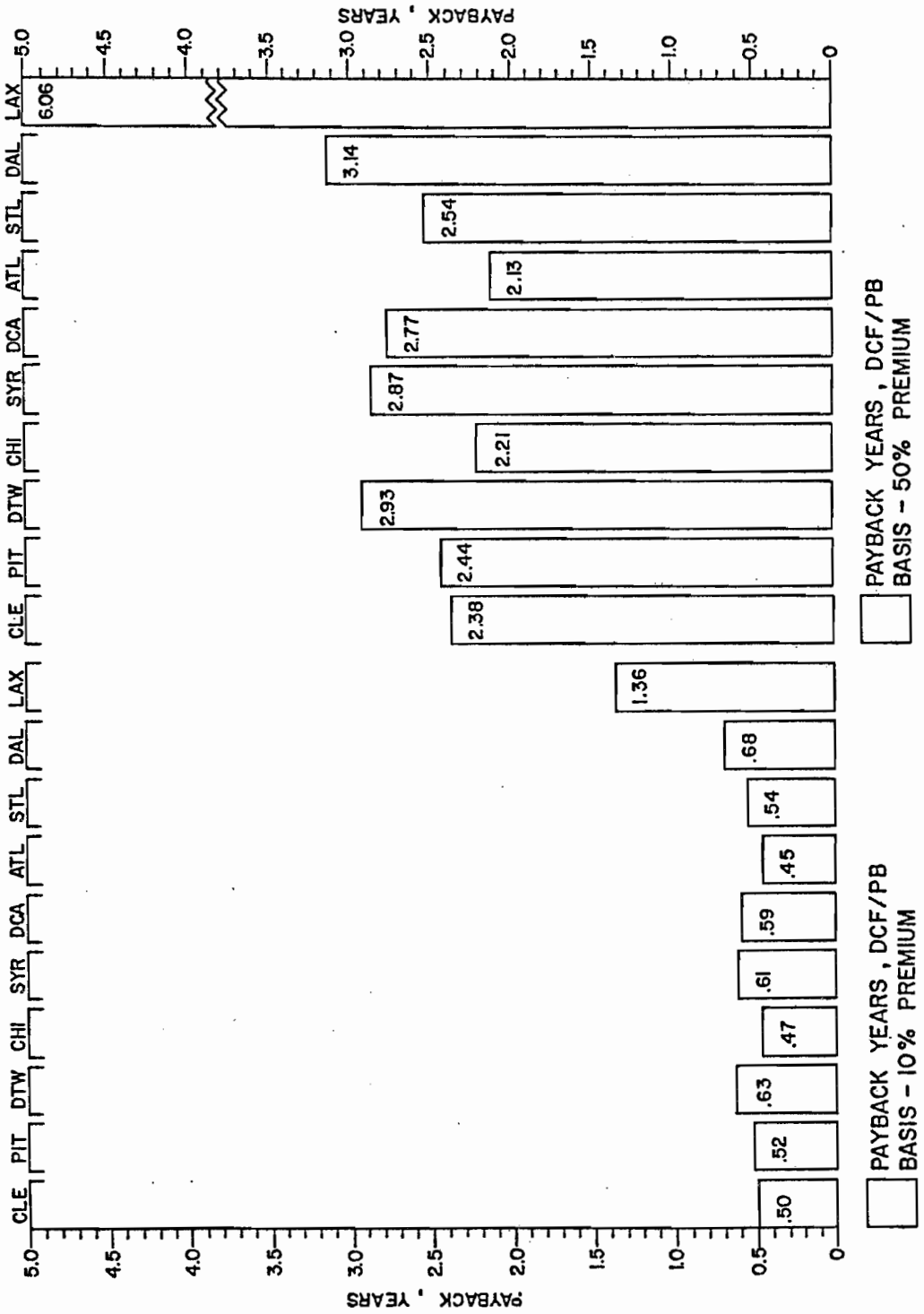

Fig. 5-2 Rest Home (7-1/2 Tons); Gas Heat Pump - Maximum Cooling Vs. Combination Heat/Cool Unit (YAC)

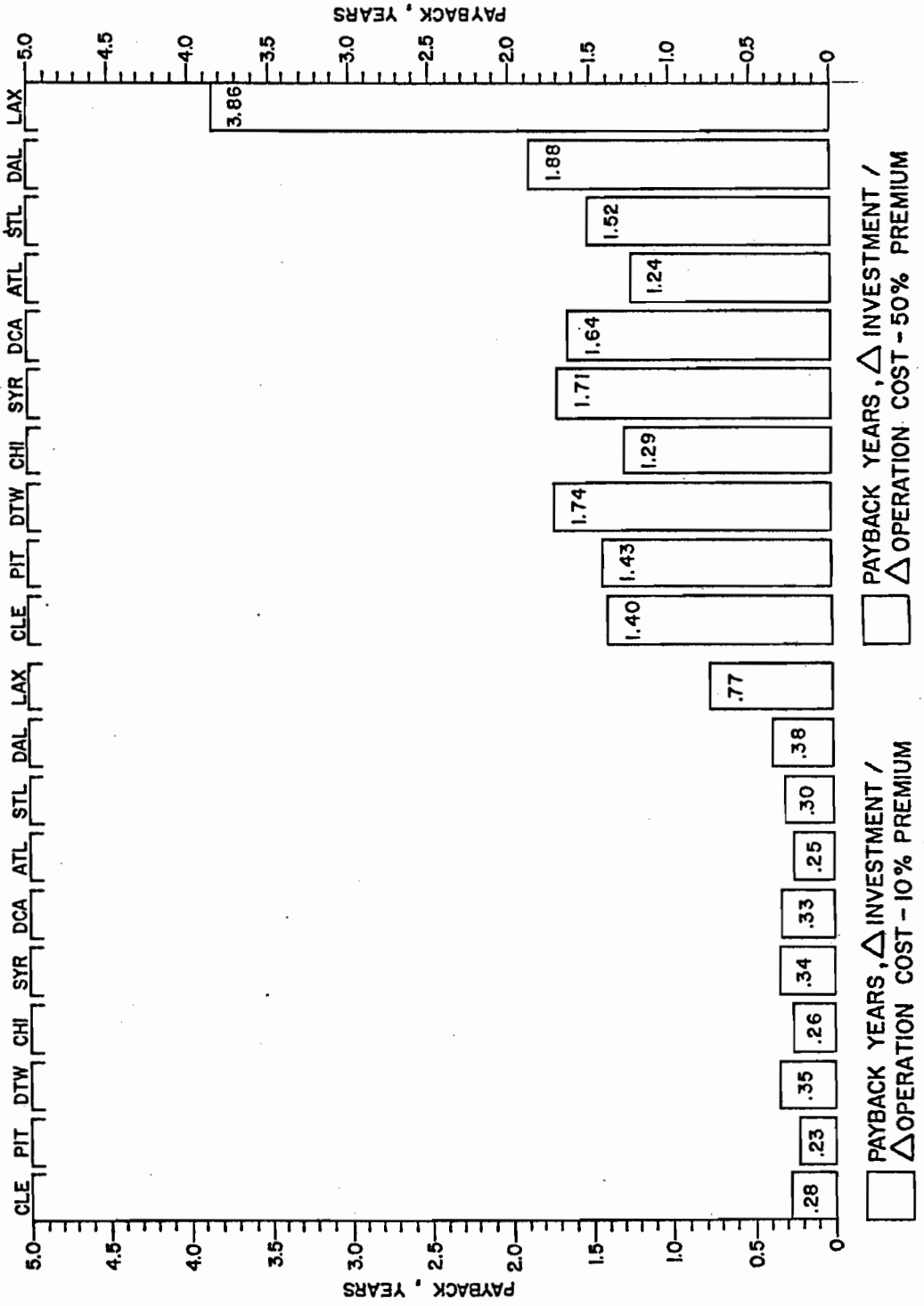

Fig. 5-3 Rest Home (7-1/2 Tons) Gas Heat Pump - Maximum Cooling Vs. Combination Heat/Cool Unit (YAC)

TABLE 5-2

REST HOME (7 1/2 Tons)

Gas Heat Pump - Nominal Cooling vs Combination Heat/Cool Unit (YAC)

	- PREMIUM % -				
	30	40	50	60	70
CLE - DCF/ROR-%	71	55	45	38	33
DCF/PB-YRS	1.47	1.94	2.39	2.83	3.26
SIMPLE PB-YRS	.84	1.12	1.40	1.68	1.96
PIT - DCF/ROR-%	70	54	44	37	32
DCF/PB-YRS	1.51	1.98	2.44	2.89	3.33
SIMPLE PB-YRS	.86	1.15	1.43	1.72	2.00
DTW - DCF/ROR-%	58	45	37	31	27
DCF/PB-YRS	1.82	2.38	2.93	3.47	3.99
SIMPLE PB-YRS	1.05	1.40	1.74	2.09	2.44
CHI - DCF/ROR-%	77	59	48	41	35
DCF/PB-YRS	1.37	1.80	2.22	2.63	3.04
SIMPLE PB-YRS	.78	1.04	1.30	1.56	1.82
SYR - DCF/ROR-%	47	36	30	25	21
DCF/PB-YRS	2.25	2.94	3.61	4.26	4.91
SIMPLE PB-YRS	1.31	1.75	2.19	2.63	3.06
DCA - DCF/ROR-%	62	48	39	33	28
DCF/PB-YRS	1.71	2.24	2.76	3.27	3.77
SIMPLE PB-YRS	.98	1.31	1.70	1.97	2.29
ATL - DCF/ROR-%	80	61	50	42	37
DCF/PB-YRS	1.32	1.73	2.14	2.53	2.92
SIMPLE PB-YRS	.75	.96	1.24	1.49	1.74
STL - DCF/ROR-%	67	51	42	35	31
DCF/PB-YRS	1.58	2.08	2.56	3.03	3.49
SIMPLE PB-YRS	.92	1.23	1.54	1.84	2.15
DAL - DCF/ROR-%	54	42	34	29	25
DCF/PB-YRS	1.97	2.58	3.17	3.75	4.31
SIMPLE PB-YRS	1.14	1.52	1.90	2.28	2.66
LAX - DCF/ROR-%	28	21	16	13	11
DCF/PB-YRS	3.84	4.99	6.11	7.19	8.25
SIMPLE PB-YRS	2.33	3.11	3.90	4.68	5.46

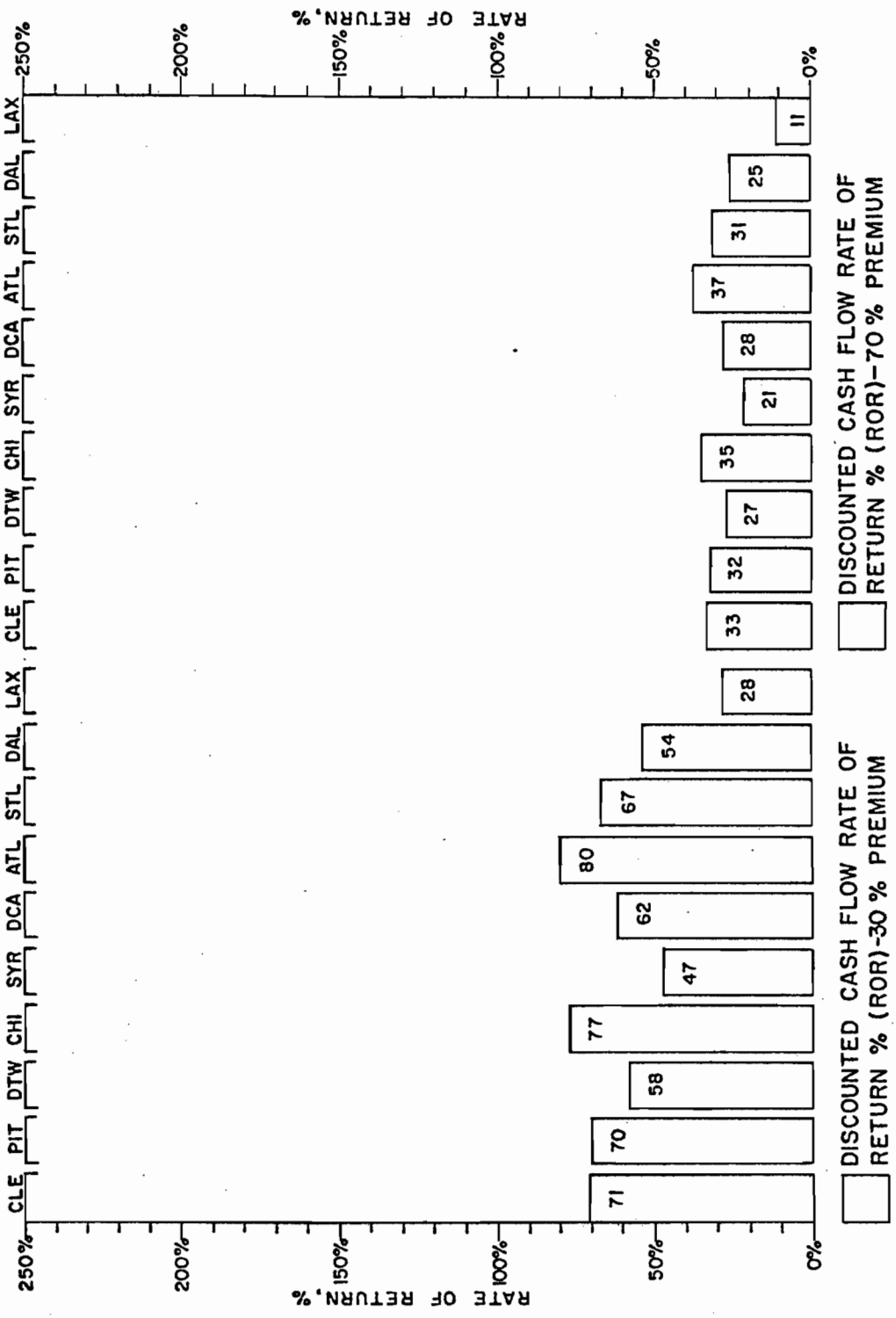

Fig. 5-4 Rest Home (7-1/2 Tons); Gas Heat Pump - Nominal Cooling Vs. Combination Heat/Cool Unit (YAC)

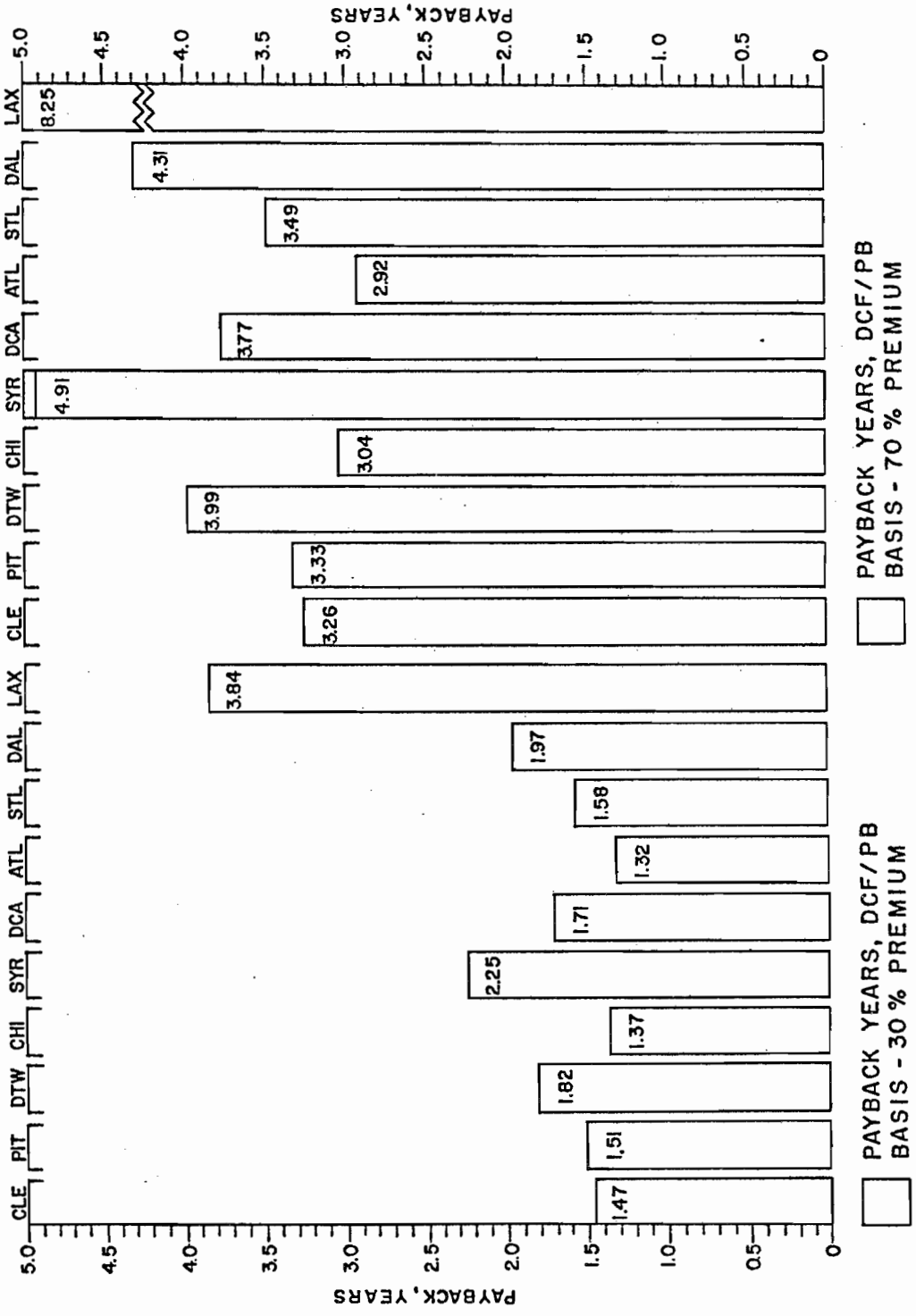

Fig. 5-5 Rest Home (7-1/2 Tons); Gas Heat Pump - Nominal Cooling Vs. Heat/Cool Unit (YAC)

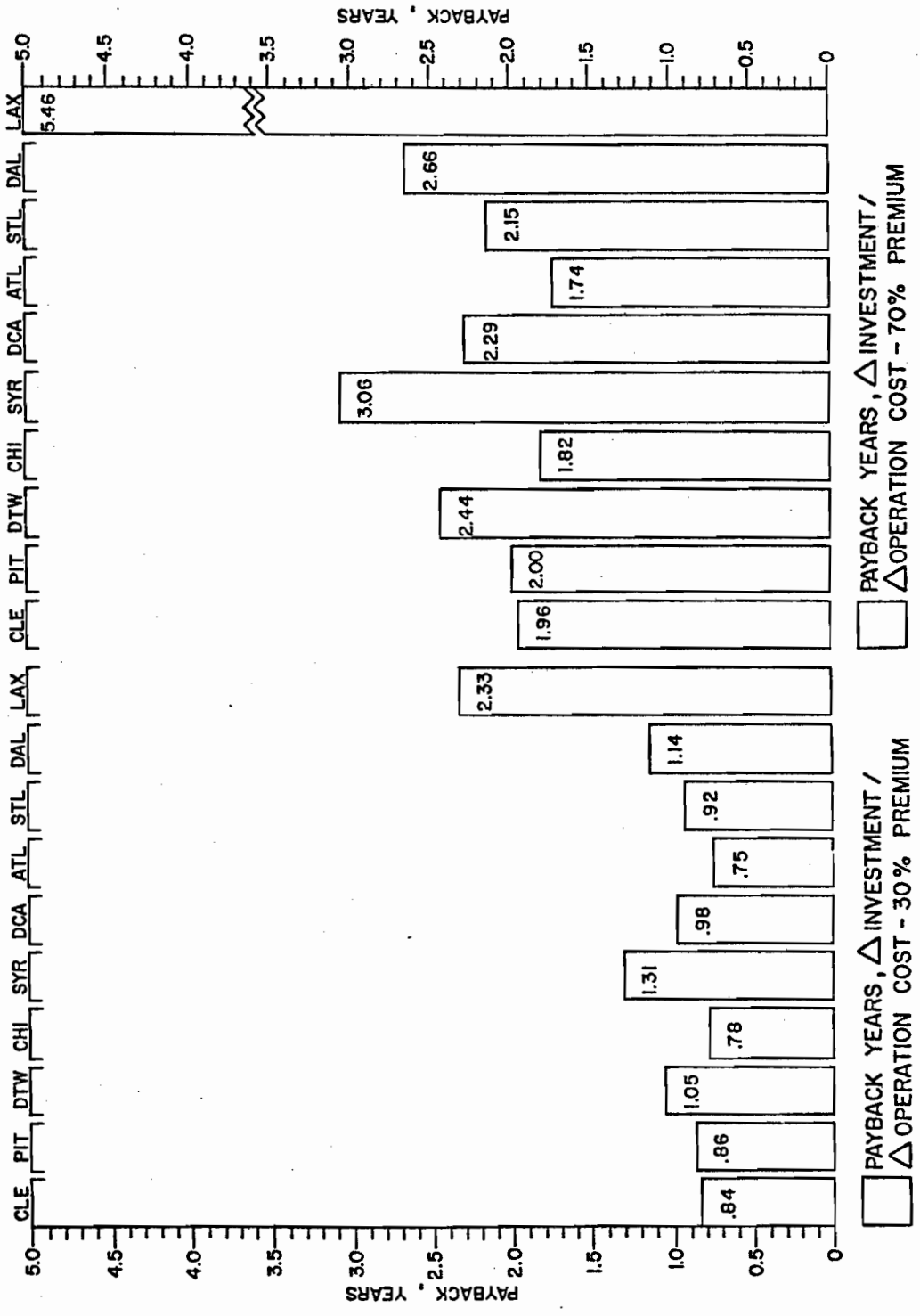

Fig. 5-6 Rest Home (7-1/2 Tons); Gas Heat Pump - Nominal Cooling Vs. Combination Heat/Cool Unit (YAC)

TABLE 5-3

OFFICE BUILDING (7 1/2 Tons)

Gas Heat Pump - Maximum Cooling vs Combination Heat/Cool Unit (YAC)

	- PREMIUM % -				
	10	20	30	40	50
CLE - DCF/ROR-%	188	97	66	51	42
DCF/PB-YRS	.54	1.08	1.58	2.08	2.55
SIMPLE PB-YRS	.30	.60	.90	1.19	1.49
PIT - DCF/ROR-%	233	120	82	63	51
DCF/PB-YRS	.44	.87	1.28	1.68	2.08
SIMPLE PB-YRS	.25	.50	.75	1.00	1.24
DTW - DCF/ROR-%	177	92	63	48	40
DCF/PB-YRS	.58	1.15	1.68	2.21	2.72
SIMPLE PB-YRS	.32	.64	.97	1.29	1.61
CHI - DCF/ROR-%	259	133	90	69	57
DCF/PB-YRS	.39	.78	1.16	1.52	1.88
SIMPLE PB-YRS	.22	.43	.65	.87	1.09
SYR - DCF/ROR-%	169	87	60	46	38
DCF/PB-YRS	.61	1.20	1.77	2.32	2.85
SIMPLE PB-YRS	.34	.68	1.02	1.36	1.69
DCA - DCF/ROR-%	146	76	52	40	33
DCF/PB-YRS	.71	1.38	2.04	2.66	3.27
SIMPLE PB-YRS	.39	.79	1.18	1.57	1.97
ATL - DCF/ROR-%	222	114	78	60	49
DCF/PB-YRS	.46	.91	1.35	1.77	2.18
SIMPLE PB-YRS	.25	.51	.76	1.02	1.27
STL - DCF/ROR-%	175	90	63	48	39
DCF/PB-YRS	.59	1.16	1.70	2.23	2.75
SIMPLE PB-YRS	.33	.65	.98	1.30	1.58
DAL - DCF/ROR-%	125	65	45	35	28
DCF/PB-YRS	.83	1.62	2.37	3.09	3.79
SIMPLE PB-YRS	.46	.92	1.38	1.85	2.31
LAX - DCF/ROR-%	89	47	32	24	20
DCF/PB-YRS	1.18	2.27	3.31	4.30	5.27
SIMPLE PB-YRS	.66	1.33	1.99	2.65	3.32

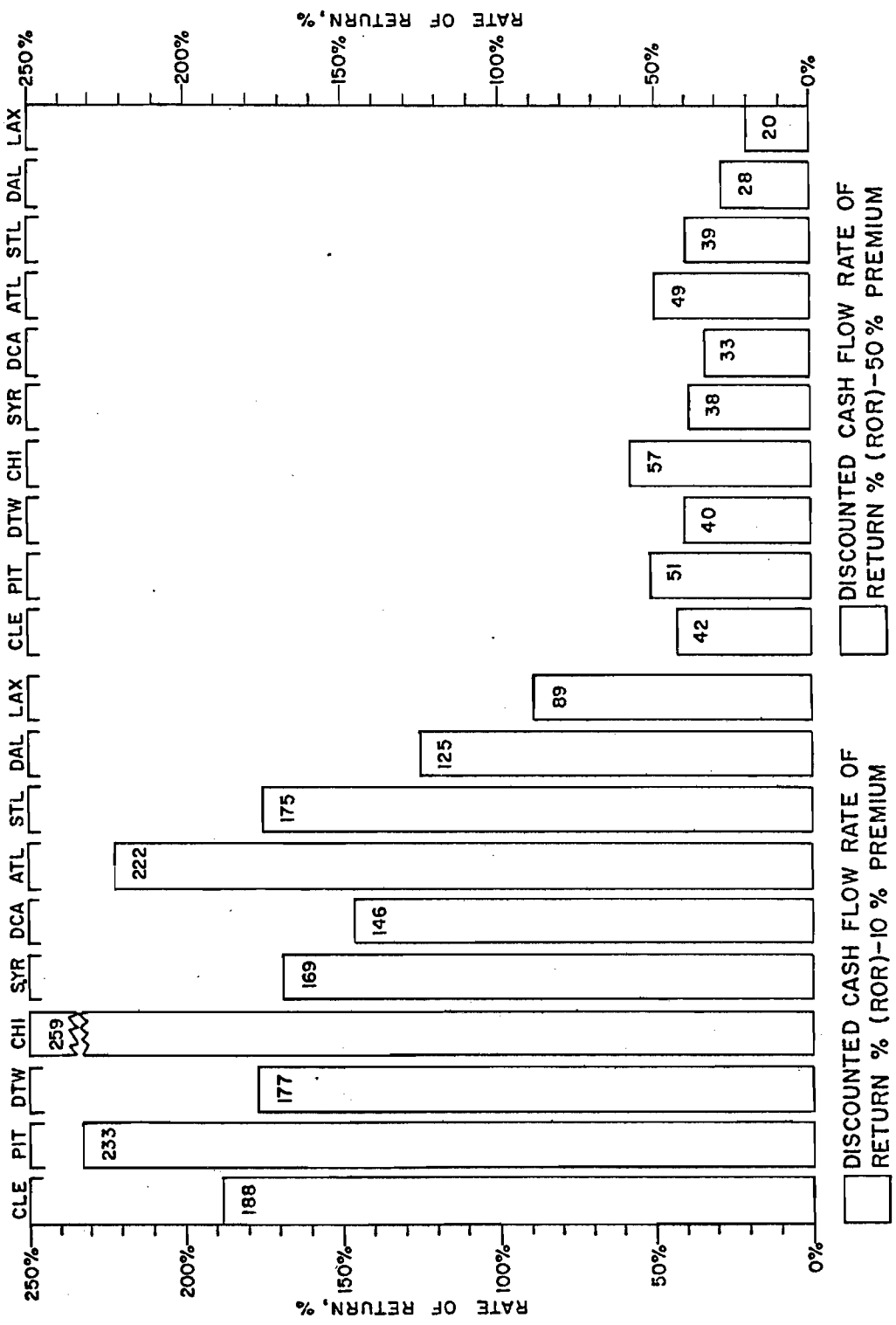

Fig. 5-7 Office Building (7-1/2 Tons); Gas Heat Pump-Maximum Cooling Vs. Combination Heat/Cool Unit (YAC)

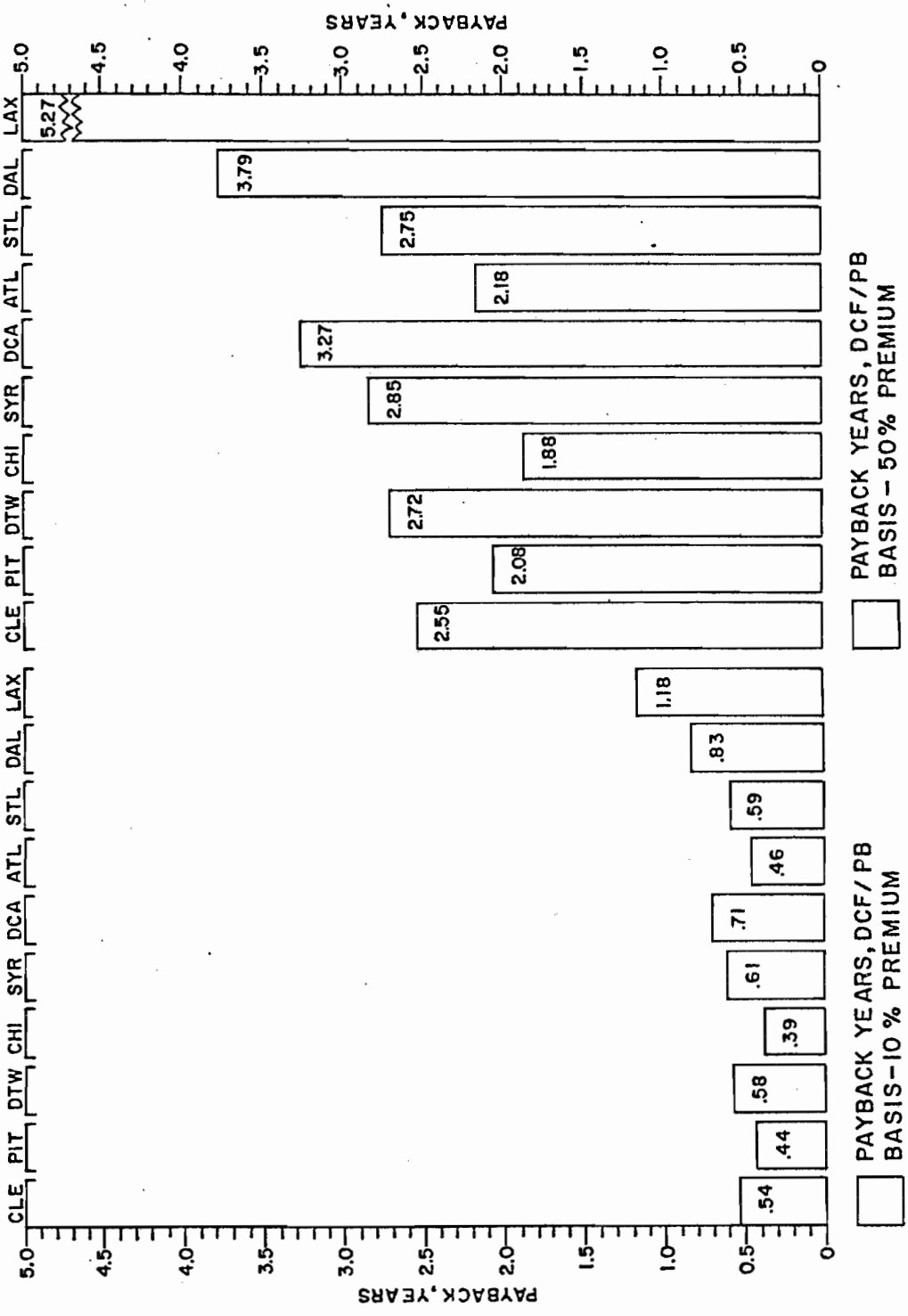

Fig. 5-8 Office Building (7-1/2 Tons); Gas Heat Pump-Maximum Cooling Vs. Combination Heat/Cool Unit (YAC)

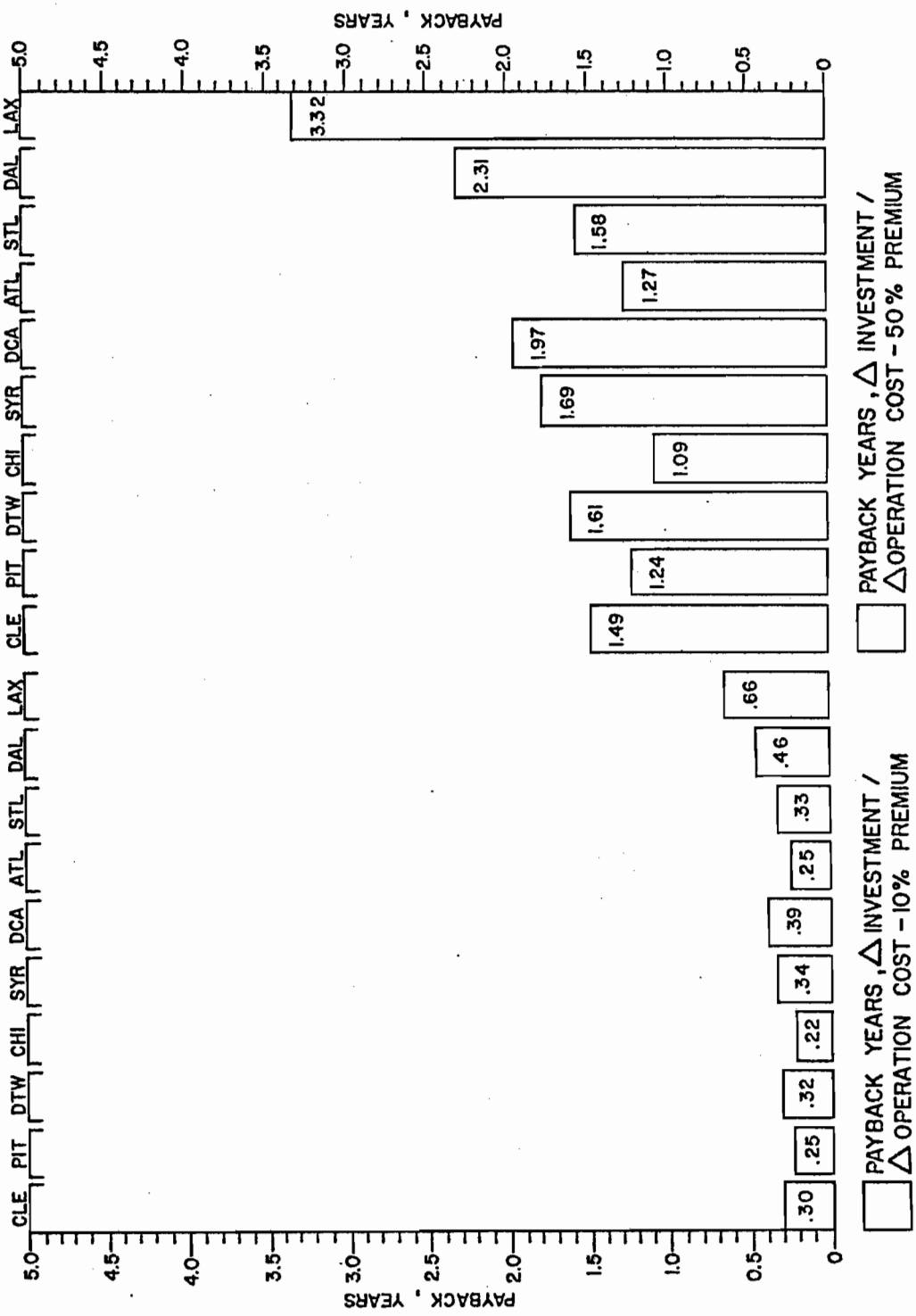

Fig. 5-9 Office Building (7-1/2 Tons); Gas Heat Pump - Maximum Cooling Vs. Combination Heat/Cool Unit (YAC)

TABLE 5-4

OFFICE BUILDING (7 1/2 Tons)

Gas Heat Pump - Nominal Cooling vs Combination Heat/Cool Unit (YAC)

	- PREMIUM % -				
	30	40	50	60	70
CLE - DCF/ROR-%	67	51	42	35	31
DCF/PB-YRS	1.56	2.06	2.53	3.00	3.45
SIMPLE PB-YRS	.89	1.18	1.48	1.77	2.07
PIT - DCF/ROR-%	82	63	51	43	38
DCF/PB-YRS	1.28	1.68	2.08	2.46	2.84
SIMPLE PB-YRS	.75	1.00	1.24	1.49	1.74
DTW - DCF/ROR-%	62	48	39	33	29
DCF/PB-YRS	1.70	2.23	2.74	3.24	3.74
SIMPLE PB-YRS	.97	1.30	1.62	1.95	2.27
CHI - DCF/ROR-%	90	70	56	48	41
DCF/PB-YRS	1.16	1.53	1.89	2.24	2.58
SIMPLE PB-YRS	.65	.87	1.09	1.31	1.52
SYR - DCF/ROR-%	60	46	38	32	27
DCF/PB-YRS	1.77	2.33	2.86	3.38	3.90
SIMPLE PB-YRS	1.02	1.36	1.70	2.04	2.74
DCA - DCF/ROR-%	53	41	33	28	24
DCF/PB-YRS	2.03	2.65	3.26	3.85	4.43
SIMPLE PB-YRS	1.17	1.57	1.96	2.35	2.81
ATL - DCF/ROR-%	78	60	49	41	36
DCF/PB-YRS	1.34	1.77	2.18	2.58	2.99
SIMPLE PB-YRS	.76	1.02	1.27	1.52	1.79
STL - DCF/ROR-%	62	48	39	33	29
DCF/PB-YRS	1.70	2.23	2.75	3.25	3.75
SIMPLE PB-YRS	.98	1.30	1.63	1.95	2.28
DAL - DCF/ROR-%	46	35	29	24	21
DCF/PB-YRS	2.32	3.03	3.72	4.39	5.06
SIMPLE PB-YRS	1.35	1.81	2.26	2.71	3.16
LAX - DCF/ROR-%	32	24	19	16	13
DCF/PB-YRS	3.36	4.38	5.36	6.32	7.27
SIMPLE PB-YRS	2.03	2.70	3.38	4.06	4.73

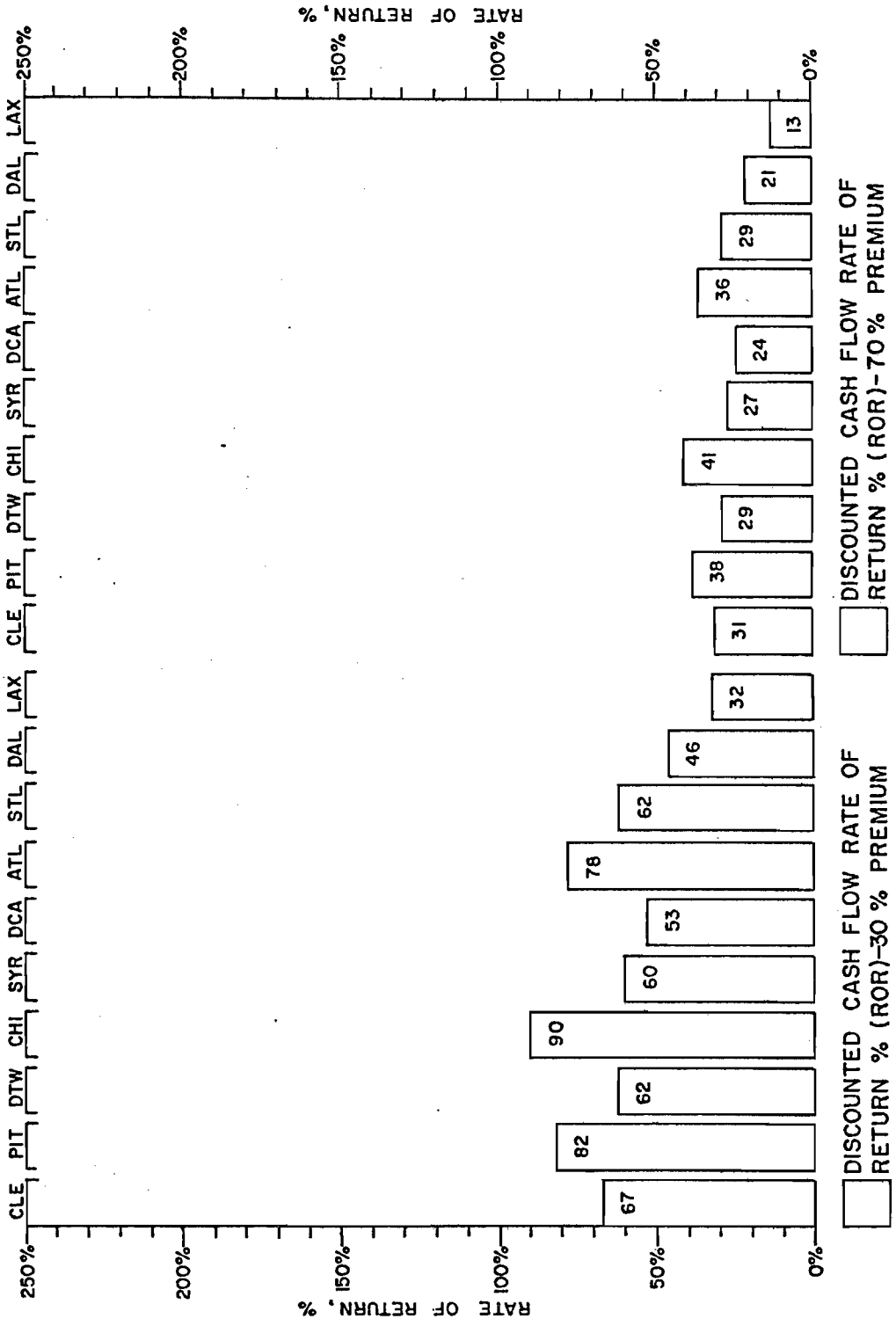

Fig. 5-10 Office Building (7-1/2 Tons); Gas Heat Pump - Nominal Cooling Vs. Combination Heat/Cool Unit (YAC)

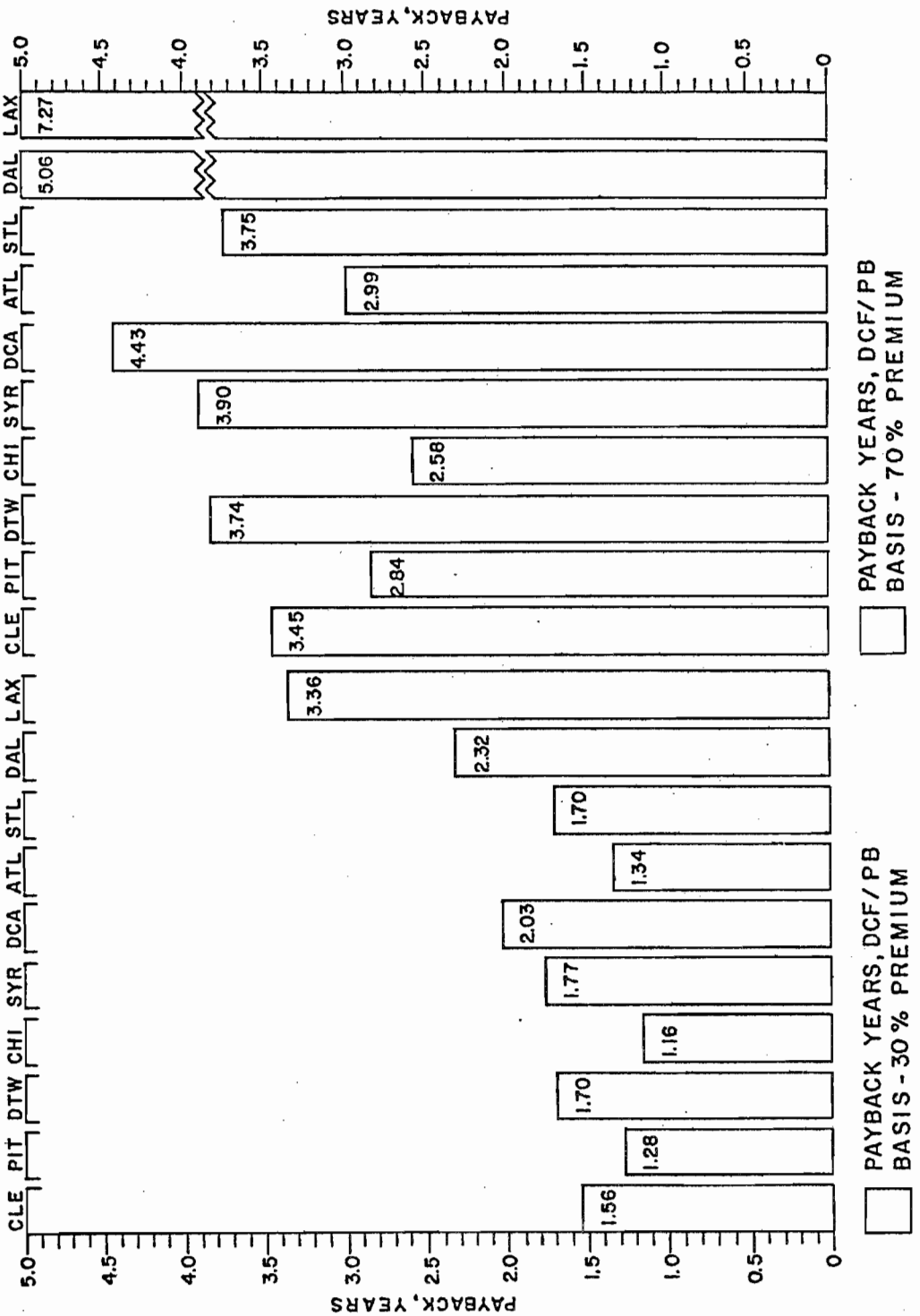

Fig. 5-11 Office Building (7-1/2 Tons) Gas Heat Pump - Nominal Cooling Vs. Combination Heat/Cool Unit (YAC)

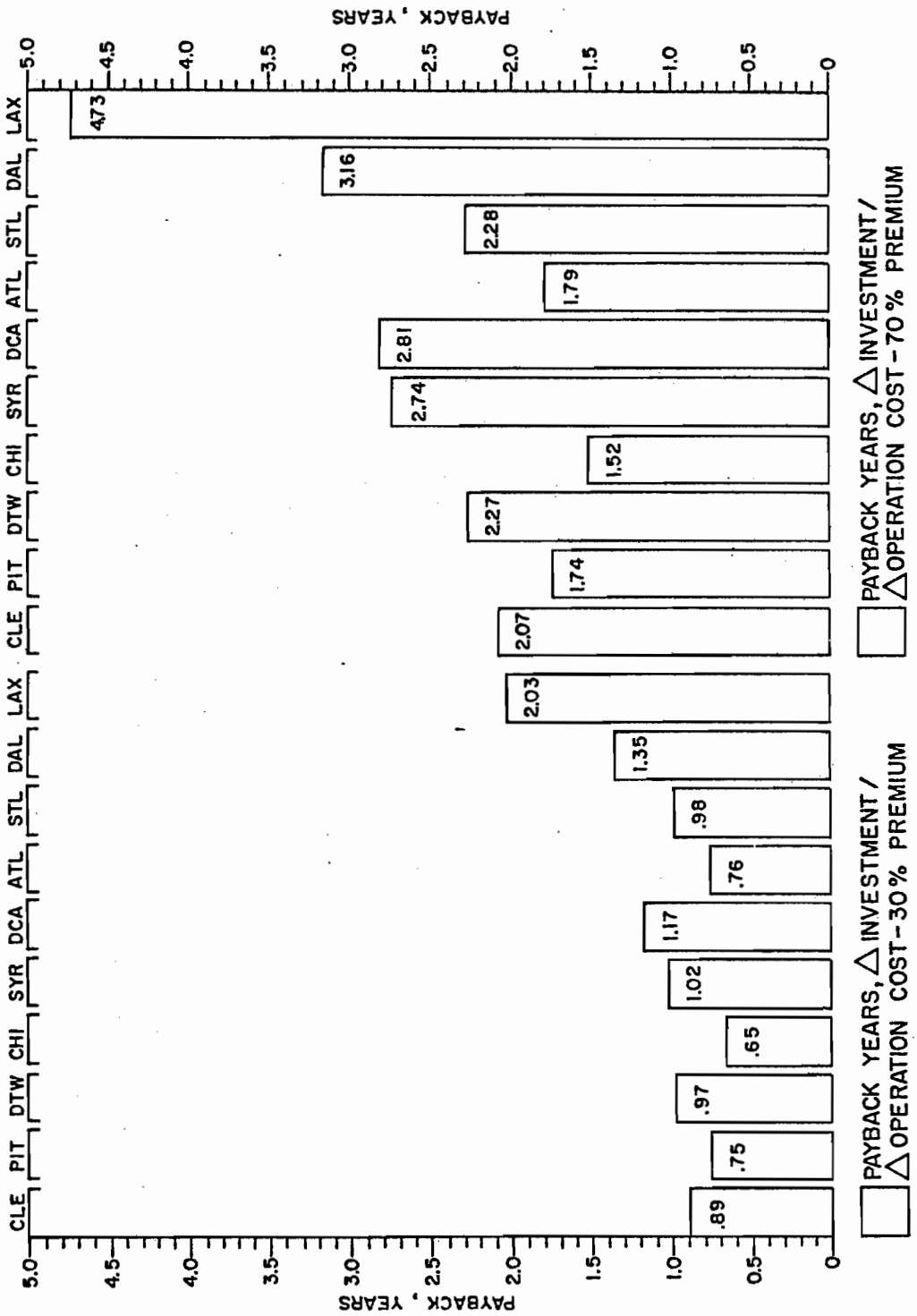

Fig. 5-12 Office Building (7-1/2 Tons); Gas Heat Pump - Nominal Cooling Vs. Combination Heat/Cool Unit (YAC)

TABLE 5-5

RETAIL STORE (7 1/2 Tons)

Gas Heat Pump - Maximum Cooling vs Combination Heat/Cool Unit (YAC)

	- PREMIUM % -				
	10	20	30	40	50
CLE - ROR %	216	111	76	58	48
ROR/PB	.46	.90	1.32	1.72	2.08
SIMPLE PB	.26	.52	.79	1.05	1.31
PIT - ROR	243	124	85	65	53
ROR/PB	.41	.81	1.18	1.54	1.89
SIMPLE PB	.23	.46	.70	.93	1.16
DTW - ROR	201	104	71	55	45
ROR/PB	.50	.96	1.41	1.82	2.22
SIMPLE PB	.28	.56	.84	1.13	1.41
CLT - ROR	278	142	97	74	60
ROR/PB	.36	.70	1.03	1.35	1.67
SIMPLE PB	.20	.40	.61	.81	1.01
SYR - ROR	180	93	64	49	40
ROR/PB	.56	1.08	1.56	2.04	2.50
SIMPLE PB	.32	.63	.95	1.27	1.58
BOS - ROR	168	87	60	46	38
ROR/PB	.60	1.15	1.67	2.17	2.63
SIMPLE PB	.34	.68	1.02	1.36	1.70
ATL - ROR	228	117	80	61	50
ROR/PB	.44	.85	1.25	1.64	2.00
SIMPLE PB	.25	.50	.74	.99	1.24
STL - ROR	202	104	71	55	45
ROR/PB	.50	.96	1.41	1.82	2.22
SIMPLE/PB	.28	.56	.84	1.12	1.40
DAL - ROR	194	100	69	53	43
ROR/PB	.52	1.00	1.45	1.89	2.33
SIMPLE PB	.43	.87	1.30	1.74	2.17
LAX - ROR	84	44	31	23	18
ROR/PB	1.19	2.27	3.23	4.35	5.56
SIMPLE PB	.71	1.41	2.12	2.83	3.54

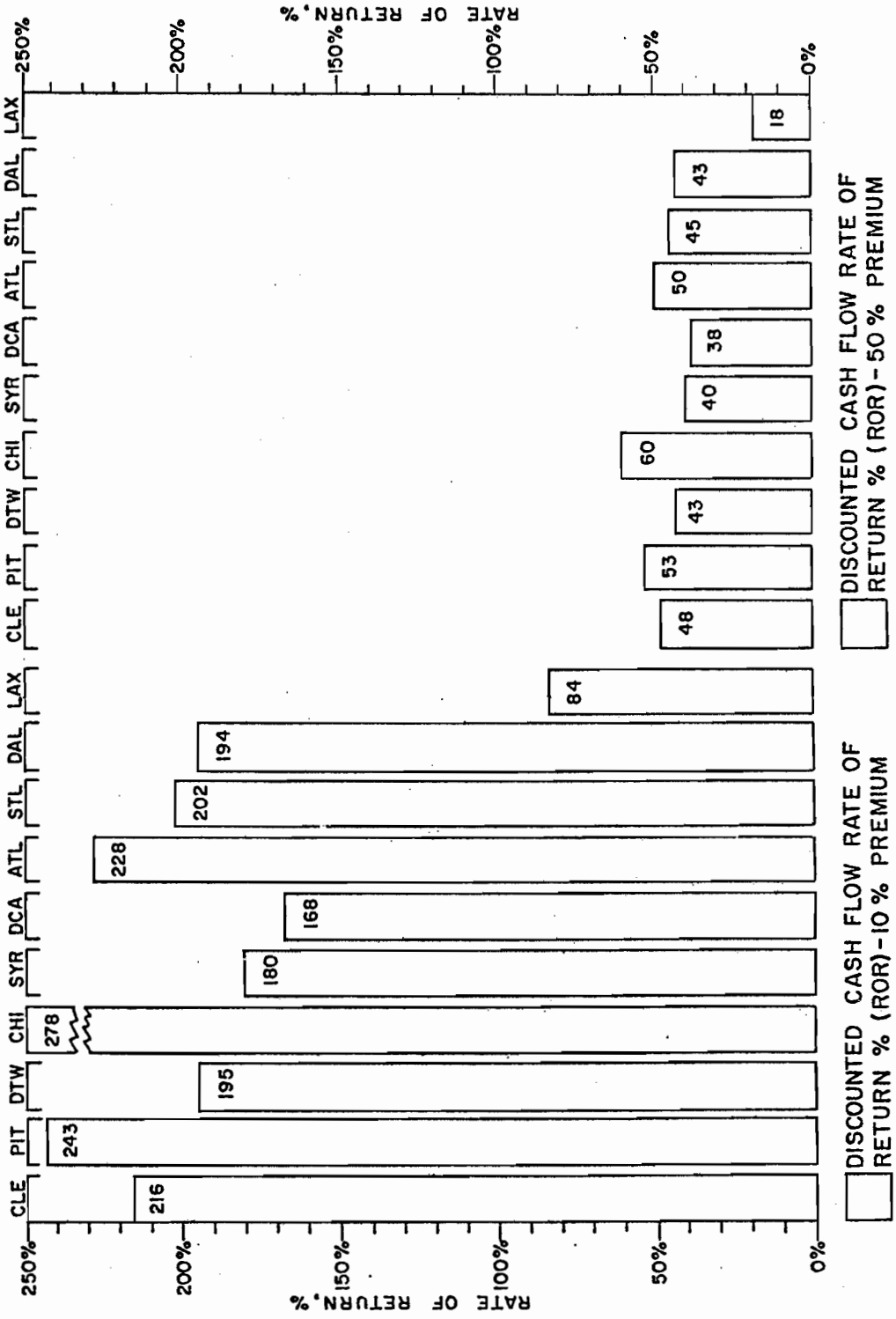

Fig. 5-13 Retail Store (7-1/2 Tons); Gas Heat Pump - Maximum Cooling Vs. Combination Heat/Cool Unit (YAC)

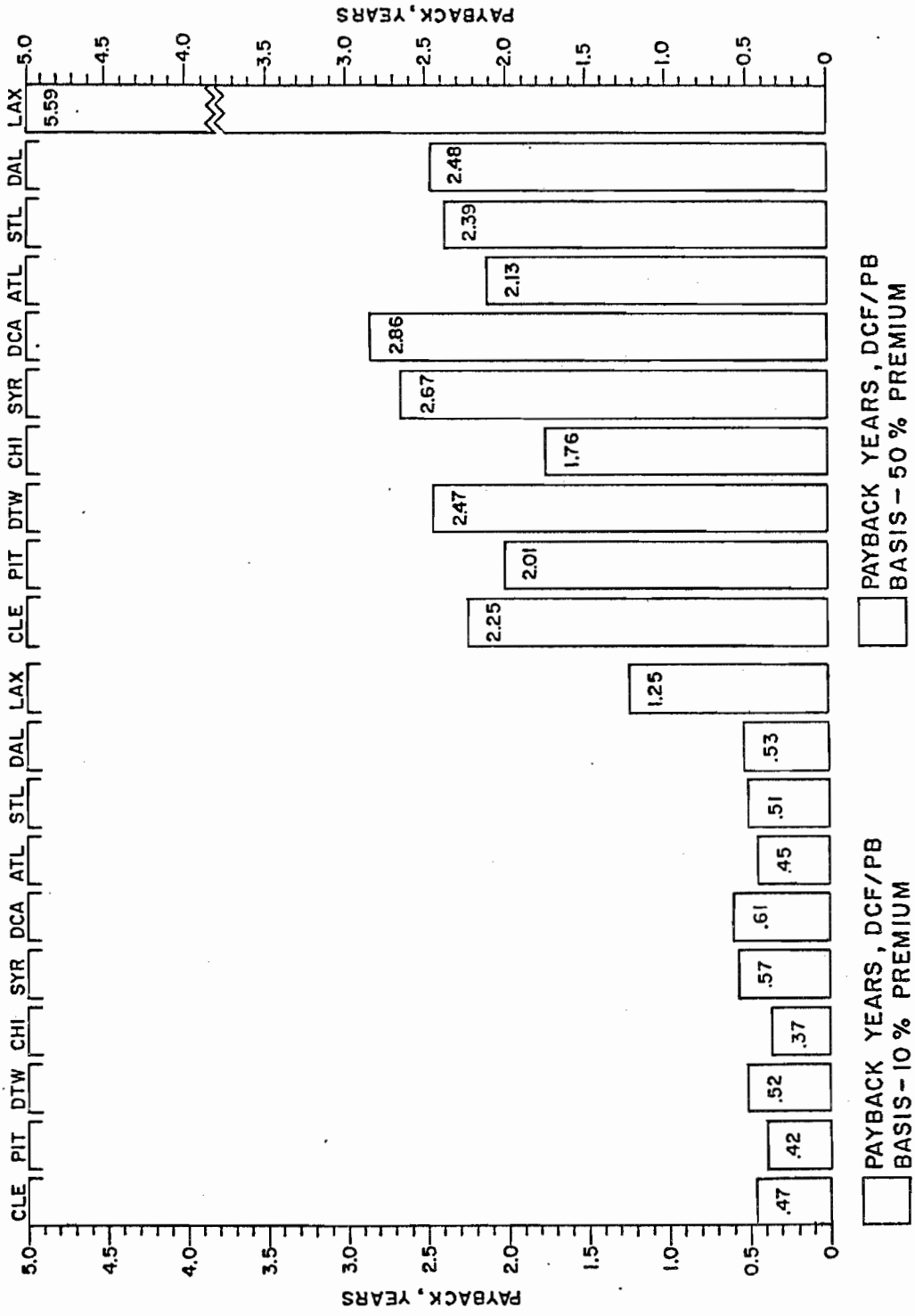

Fig. 5-14 Retail Store (7-1/2 Tons); Gas Heat Pump - Maximum Cooling Vs. Combination Heat/Cool Unit (YAC)

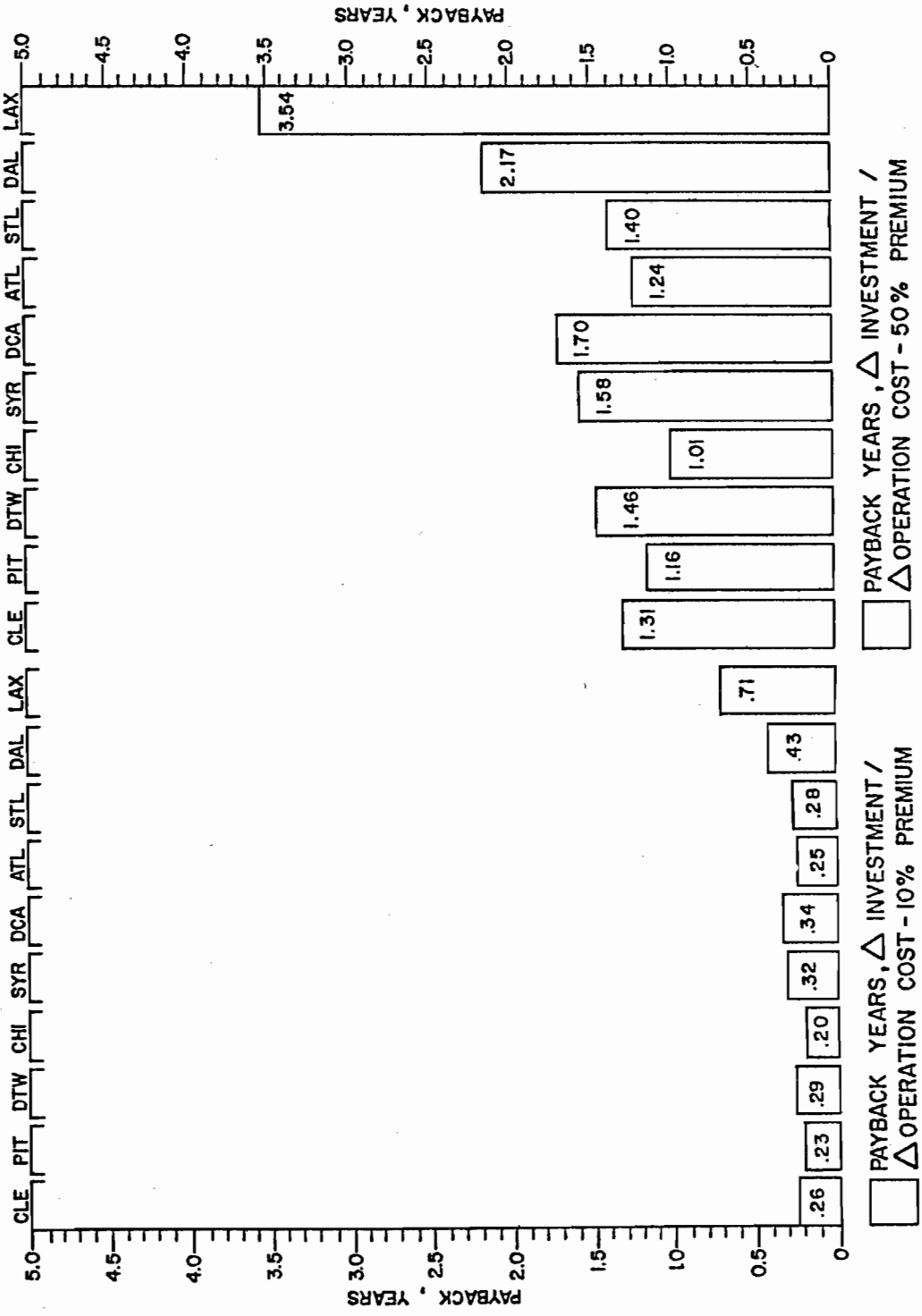

Fig. 5-15 Retail Store (7-1/2 Tons); Gas Heat Pump - Maximum Cooling Vs. Combination Heat/Cool Unit (YAC)

TABLE 5-6

RETAIL STORE (7 1/2 Tons)

Gas Heat Pump - Nominal Cooling vs Combination Heat/Cool Unit (YAC)

	- PREMIUM % -				
	30	40	50	60	70
CLE - ROR %	77	59	48	41	35
ROR/PB	1.30	1.69	2.08	2.44	2.86
SIMPLE PB	.78	1.04	1.30	1.55	1.81
PIT - ROR	85	65	53	45	39
ROR/PB	1.18	1.54	1.89	2.22	2.56
SIMPLE PB	.64	.93	1.16	1.39	1.62
DTW - ROR	71	54	44	38	33
ROR/PB	1.41	1.85	2.27	2.63	3.03
SIMPLE PB	.85	1.13	1.42	1.70	1.98
CHI - ROR	97	74	60	51	44
ROR/PB	1.03	1.35	1.67	1.96	2.27
SIMPLE PB	.61	.81	1.01	1.22	1.42
SYR - ROR	64	49	40	34	29
ROR/PB	1.56	2.04	2.50	2.94	3.45
SIMPLE PB	.95	1.27	1.59	1.91	2.23
DCA - ROR	60	46	38	32	28
ROR/PB	1.67	2.17	2.63	3.13	3.57
SIMPLE PB	1.01	1.35	1.69	2.02	2.36
ATL - ROR	80	61	50	42	37
ROR/PB	1.25	1.64	2.00	2.38	2.70
SIMPLE PB	.74	.99	1.24	1.49	1.74
STL - ROR	72	55	45	38	33
ROR/PB	1.39	1.82	2.22	2.63	3.03
SIMPLE/PB	.84	1.12	1.40	1.68	1.96
DAL - ROR	69	53	43	37	32
ROR/PB	1.45	1.89	2.33	2.70	3.13
SIMPLE PB	1.28	1.71	2.13	2.56	2.98
JX - ROR	30	23	18	14	12
ROR/PB	3.33	4.35	5.56	7.14	8.33
SIMPLE PB	2.17	2.90	3.62	4.35	5.07

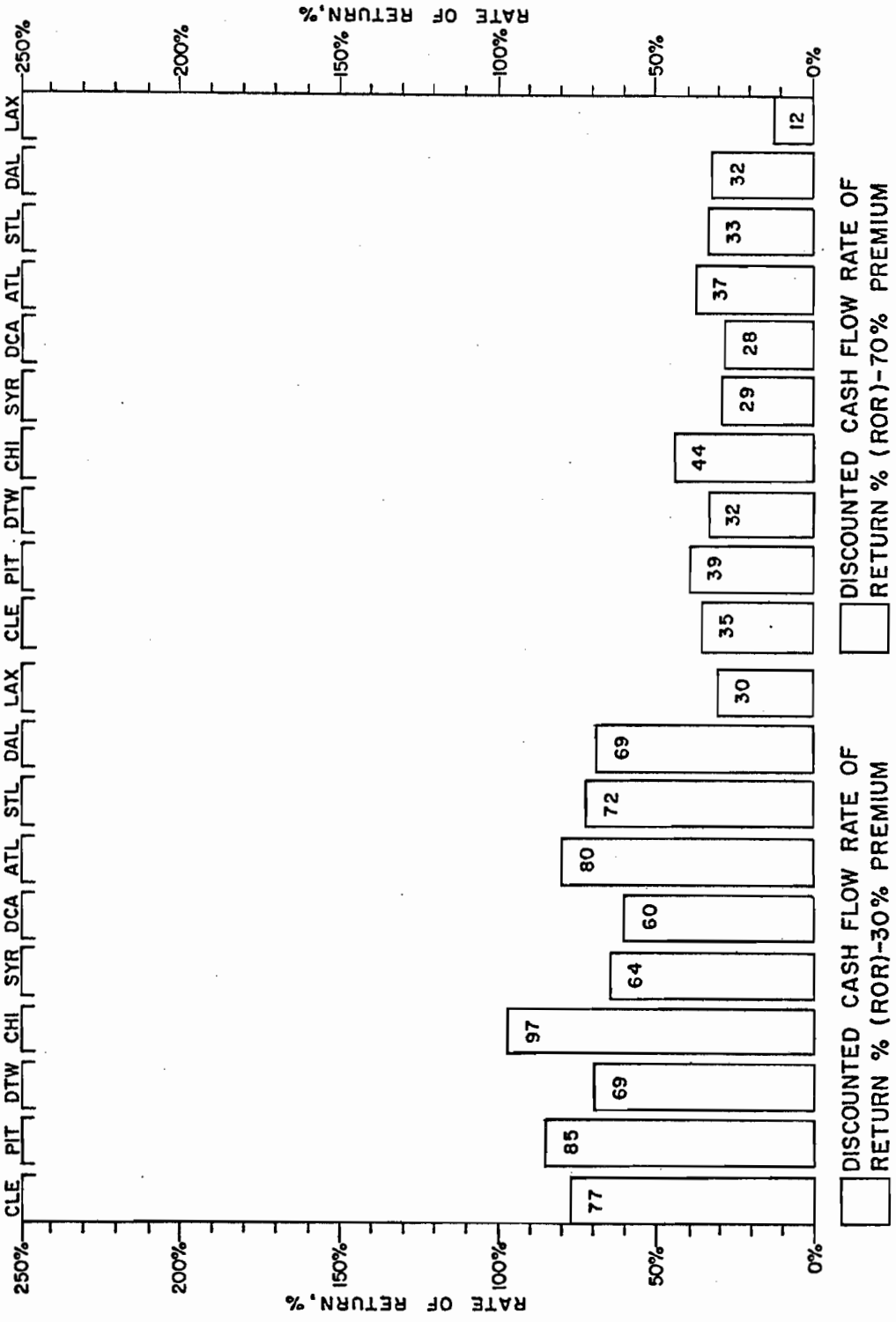

Fig. 5-16 Retail Store (7-1/2 Tons); Gas Heat Pump - Nominal Cooling Vs. Combination Heat/Cool Unit (YAC)

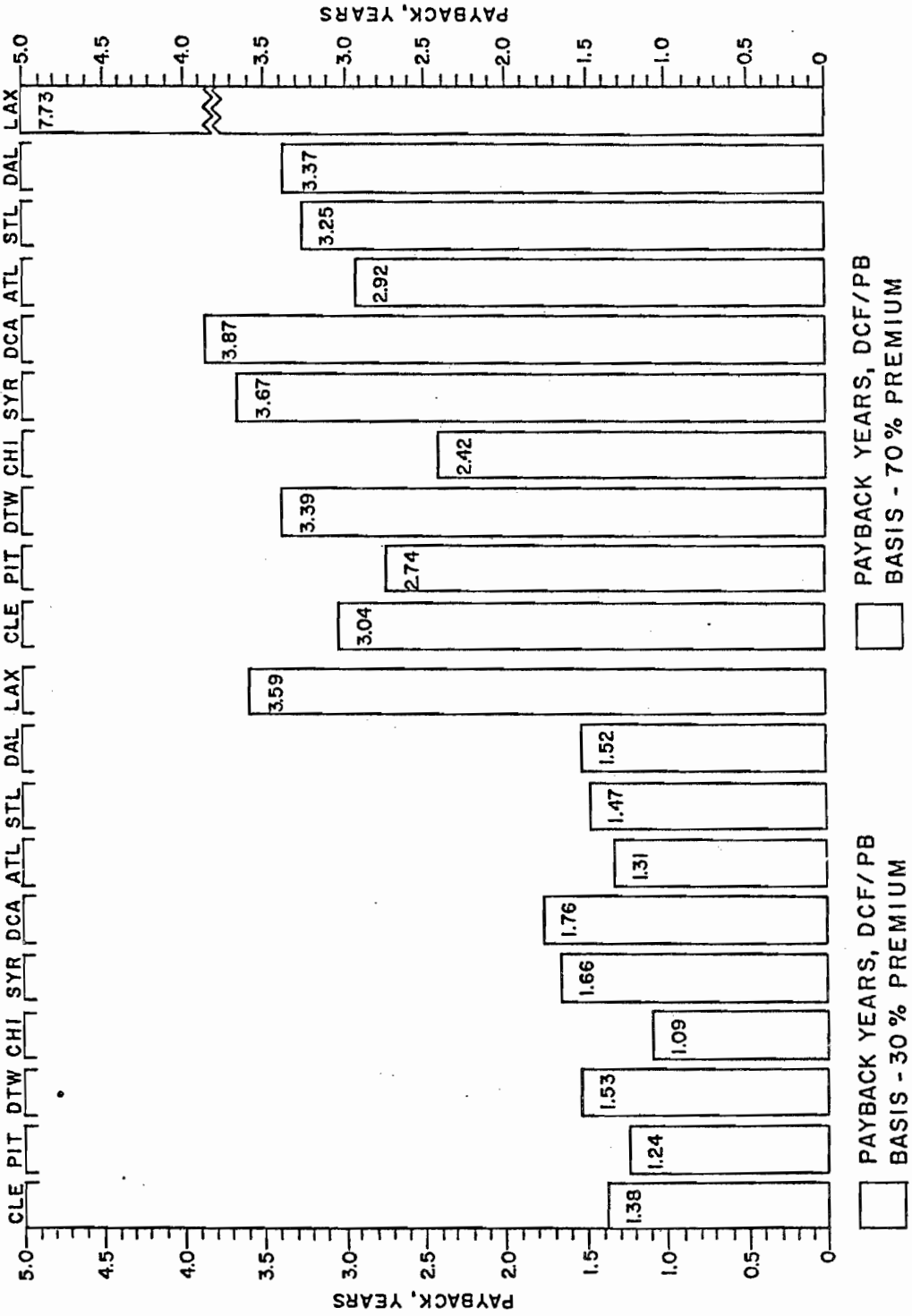

Fig. 5-17 Retail Store (7-1/2 Tons); Gas Heat Pump - Nominal Cooling Vs. Combination Heat/Cool Unit (YAC)

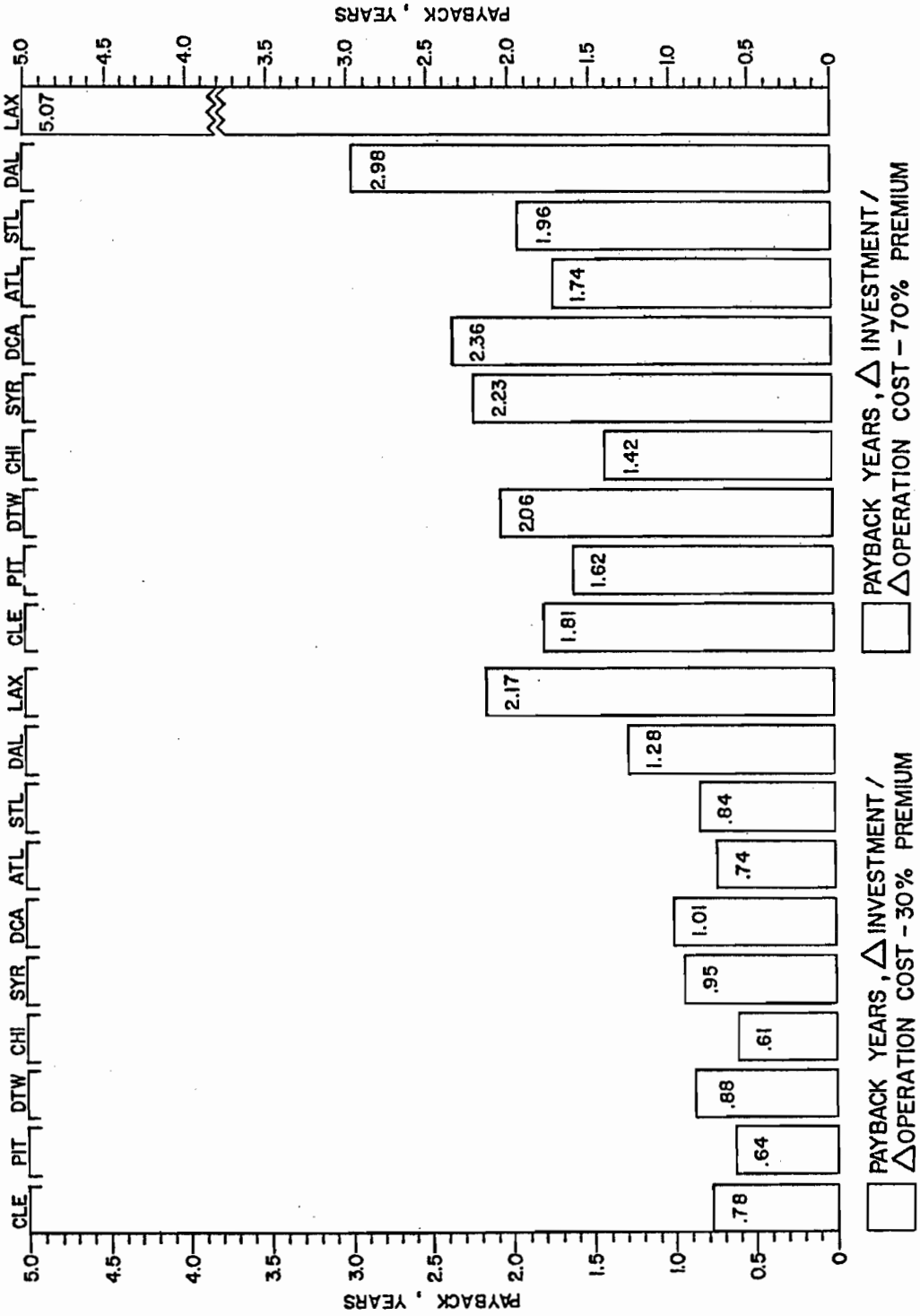

Fig. 5-18 Retail Store (7-1/2 Tons); Gas Heat Pump - Nominal Cooling Vs. Combination Heat/Cool Unit (YAC)

TABLE 5-7

LIGHT MANUFACTURING (7 1/2 Tons)
Gas Heat Pump - Maximum Cooling vs Combination Heat/Cool Unit (YAC)

	- PREMIUM % -				
	10	20	30	40	50
CLE - DCF/ROR-%	176	91	63	48	39
DCF/PB-YRS	.58	1.15	1.69	2.22	2.73
SIMPLE PB-YRS	.32	.65	.97	1.29	1.62
PIT - DCF/ROR-%	256	130	89	69	55
DCF/PB-YRS	.39	.79	1.17	1.54	1.91
SIMPLE PB-YRS	.22	.43	.65	.86	1.08
DTW - DCF/ROR-%	159	82	57	44	36
DCF/PB-YRS	.65	1.27	1.87	2.45	3.02
SIMPLE PB-YRS	.36	.72	1.08	1.44	1.80
CHI - DCF/ROR-%	135	70	49	37	30
DCF/PB-YRS	.77	1.50	2.19	2.87	3.52
SIMPLE PB-YRS	.25	.50	.75	1,00	1.25
SYR - DCF/ROR-%	160	83	57	44	36
DCF/PB-YRS	.64	1.26	1.86	2.43	3.00
SIMPLE PB-YRS	.36	.71	1.07	1.43	1.79
DCA - DCF/ROR-%	206	106	73	56	45
DCF/PB-YRS	.50	.99	1.45	1.91	2.35
SIMPLE PB-YRS	.36	.71	1.07	1.43	1.79
ATL - DCF/ROR-%	205	106	72	56	45
DCF/PB-YRS	.50	.99	1.46	1.92	2.36
SIMPLE PB-YRS	.28	.55	.83	1.11	1.38
STL - DCF/ROR-%	151	78	54	42	34
DCF/PB-YRS	.68	1.34	1.97	2.58	3.17
SIMPLE PB-YRS	.37	.76	1.14	1.52	1.90
DAL - DCF/ROR-%	115	60	42	32	26
DCF/PB-YRS	.91	1.76	2.57	3.35	4.12
SIMPLE PB-YRS	.50	1.01	1.52	2.02	2.52
LAX - DCF/ROR-%	114	60	41	32	26
DCF/PB-YRS	.91	1.77	2.58	3.37	4.14
SIMPLE PB-YRS	.55	1.10	1.65	2.21	2.76

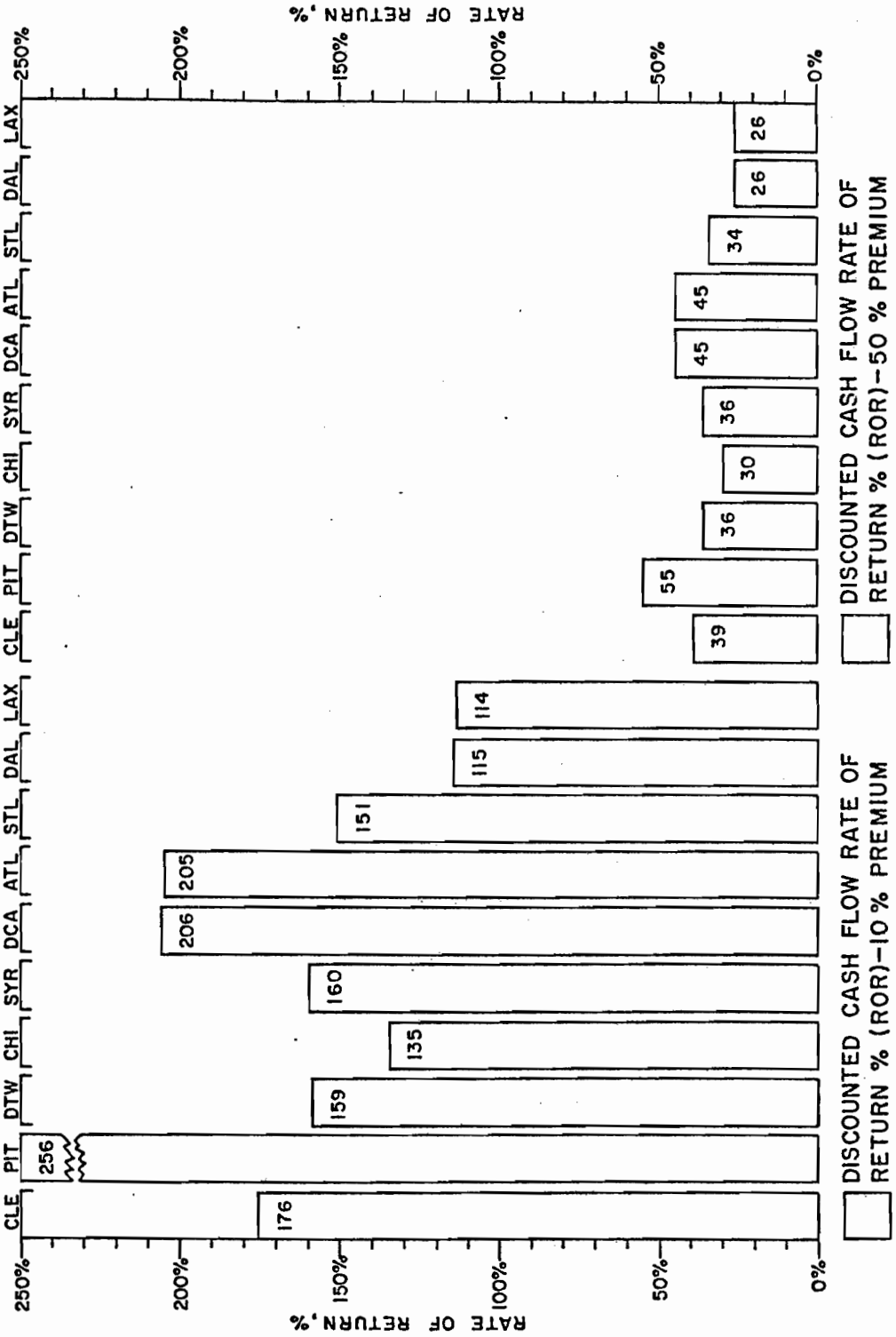

Fig. 5-19 Light Manufacturing (7-1/2 Tons); Gas Heat Pump - Maximum Cooling Vs. Combination Heat/Cool Unit (YAC)

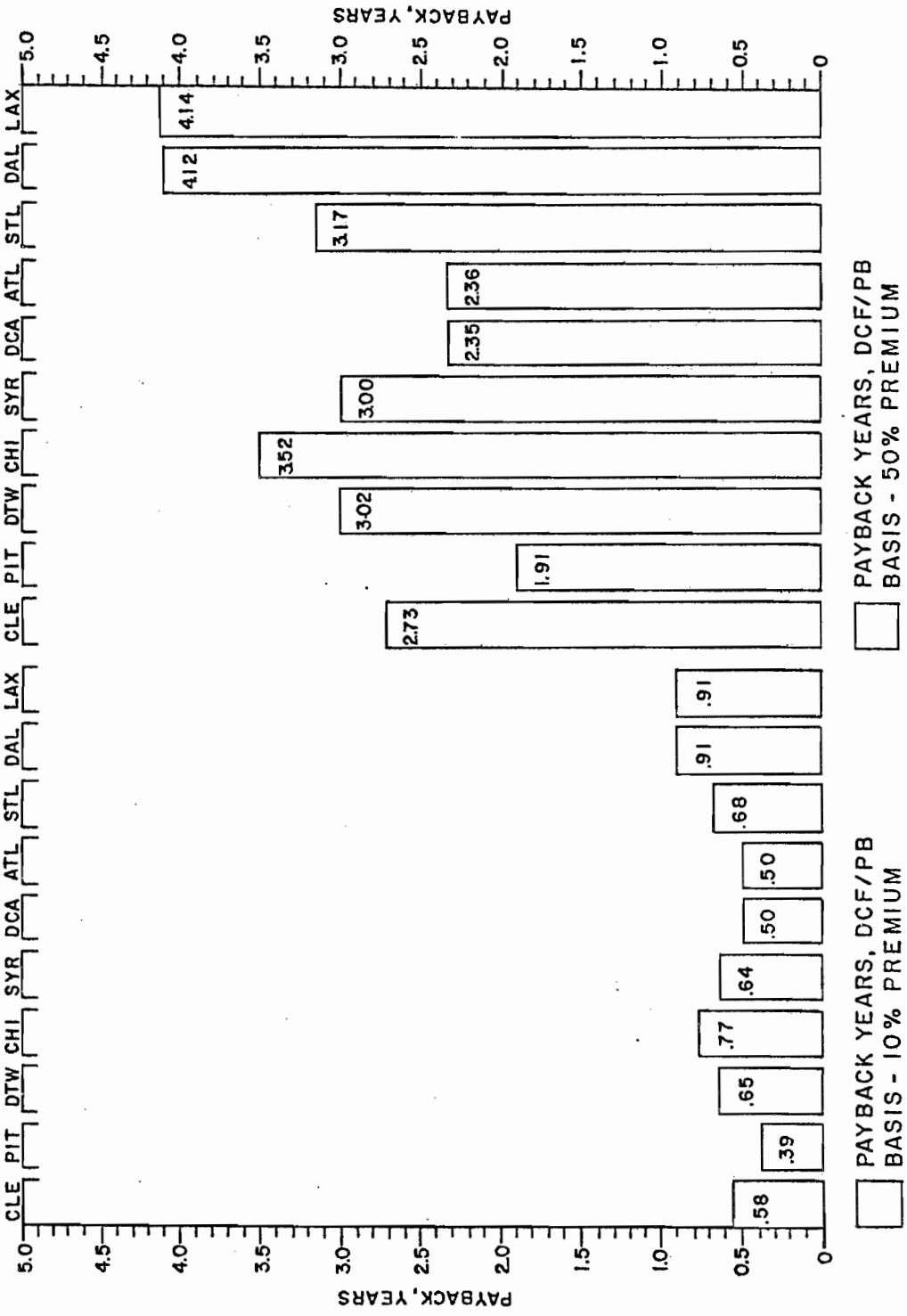

Fig. 5-20 Light Manufacturing (7-1/2 Tons); Gas Heat Pump - Maximum Cooling Vs. Combination Heat/Cool Unit (YAC)

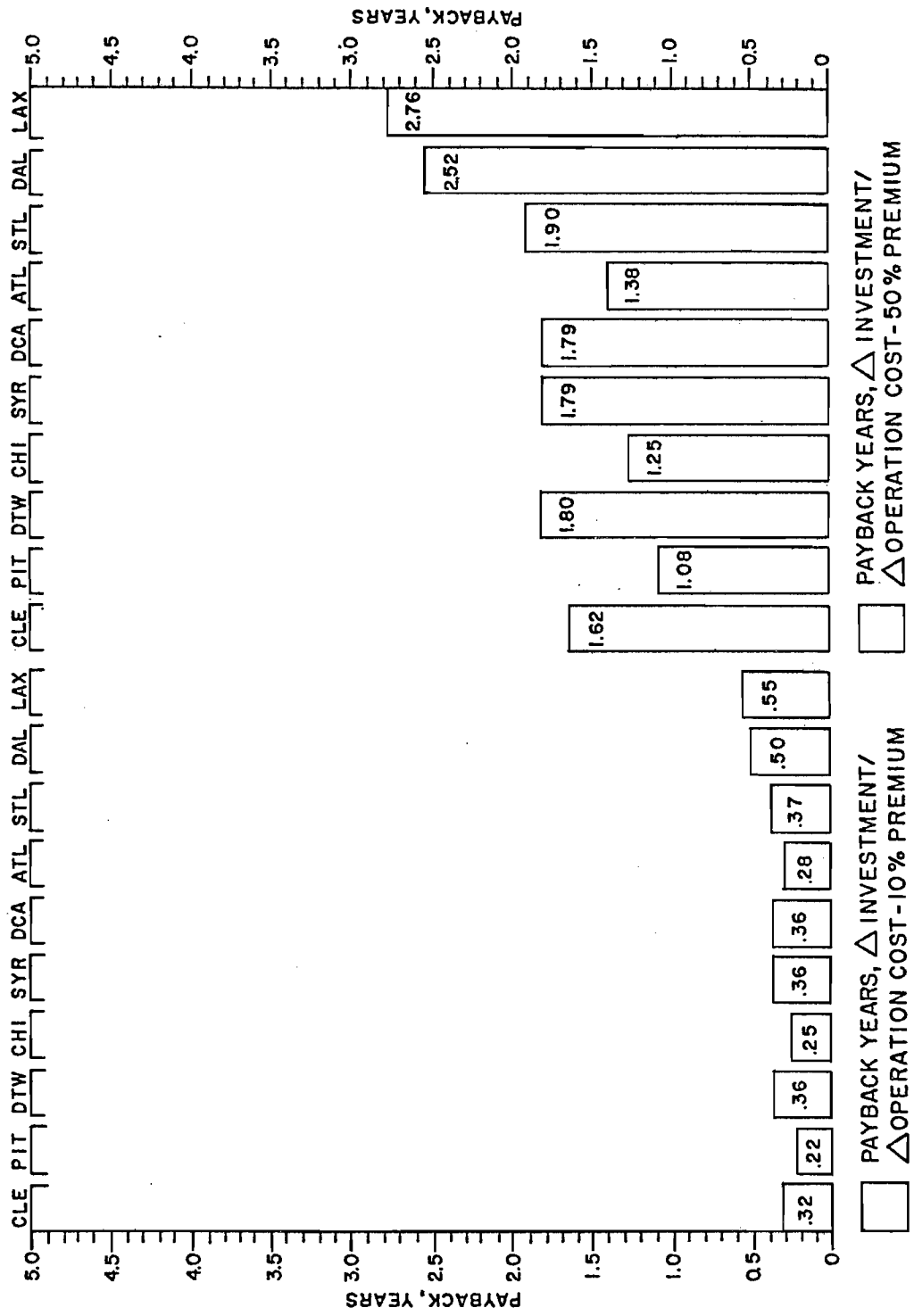

Fig. 5-21 Light Manufacturing (7-1/2 Tons); Gas Heat Pump - Maximum Cooling Vs. Combination Heat/Cool Unit (YAC)

TABLE 5-8

LIGHT MANUFACTURING (7 1/2 Tons)
Gas Heat Pump - Nominal Cooling vs Combination Heat/Cool (YAC)

	- PREMIUM % -				
	30	40	50	60	70
CLE - DCF/ROR-%	63	48	39	33	29
DCF/PB-YRS	1.69	2.22	2.73	3.03	3.73
SIMPLE PB-YRS	.97	1.29	1.62	1.94	2.26
PIT - DCF/ROR-%	89	68	55	46	40
DCF/PB-YRS	1.17	1.54	1.91	2.27	2.63
SIMPLE PB-YRS	.65	.87	1.08	1.30	1.51
DTW - DCF/ROR-%	57	43	35	30	26
DCF/PB-YRS	1.88	2.46	3.03	3.58	4.13
SIMPLE PB-YRS	1.09	1.45	1.81	2.17	2.53
CHI - DCF/ROR-%	48	37	30	25	22
DCF/PB-YRS	2.21	2.98	3.55	4.19	4.88
SIMPLE PB-YRS	.75	1.00	1.25	1.50	1.75
SYR - DCF/ROR-%	57	44	36	30	26
DCF/PB-YRS	1.90	2.45	3.02	3.56	4.10
SIMPLE PB-YRS	1.08	1.44	1.80	2.16	2.16
DCA - DCF/ROR-%	72	55	45	38	33
DCF/PB-YRS	1.48	1.92	2.36	2.80	3.22
SIMPLE PB-YRS	1.08	1.44	1.80	2.16	2.52
ATL - DCF/ROR-%	72	55	45	38	33
DCF/PB-YRS	1.48	1.92	2.36	2.80	3.23
SIMPLE PB-YRS	.83	1.11	1.38	1.66	1.94
STL - DCF/ROR-%	54	41	34	28	25
DCF/PB-YRS	2.01	2.58	3.18	3.76	4.32
SIMPLE PB-YRS	1.14	1.52	1.90	2.29	2.67
DAL - DCF/ROR-%	42	33	26	22	19
DCF/PB-YRS	2.59	3.29	4.04	4.77	5.49
SIMPLE PB-YRS	1.49	1.98	2.47	2.47	3.46
LAX - DCF/ROR-%	41	32	25	21	18
DCF/PB-YRS	2.61	3.40	4.17	4.93	5.67
SIMPLE PB-YRS	1.67	2.23	2.79	3.34	3.90

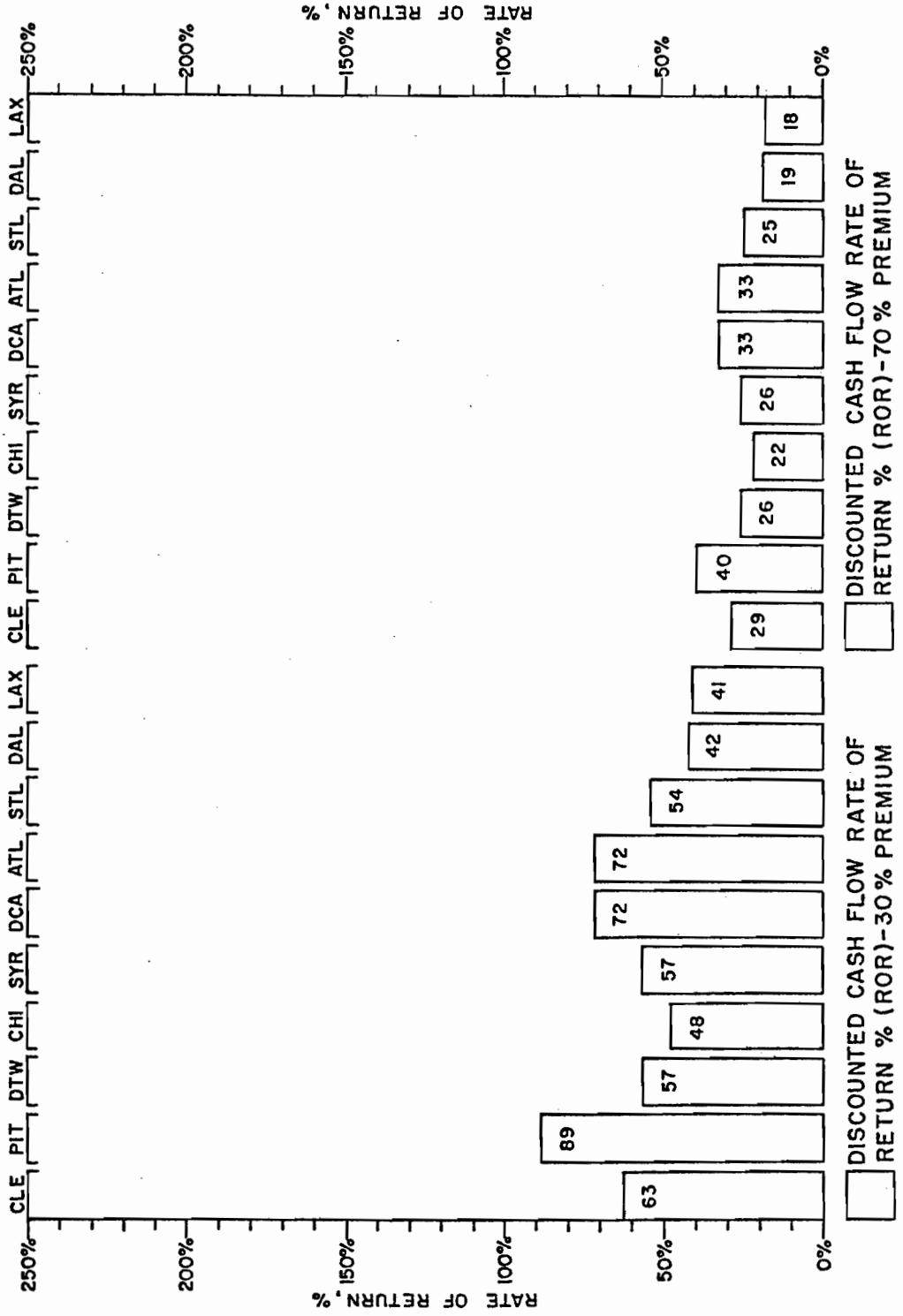

Fig. 5-22 Light Manufacturing (7-1/2 Tons); Gas Heat Pump - Nominal Cooling Vs. Combination Heat/Cool Unit (YAC)

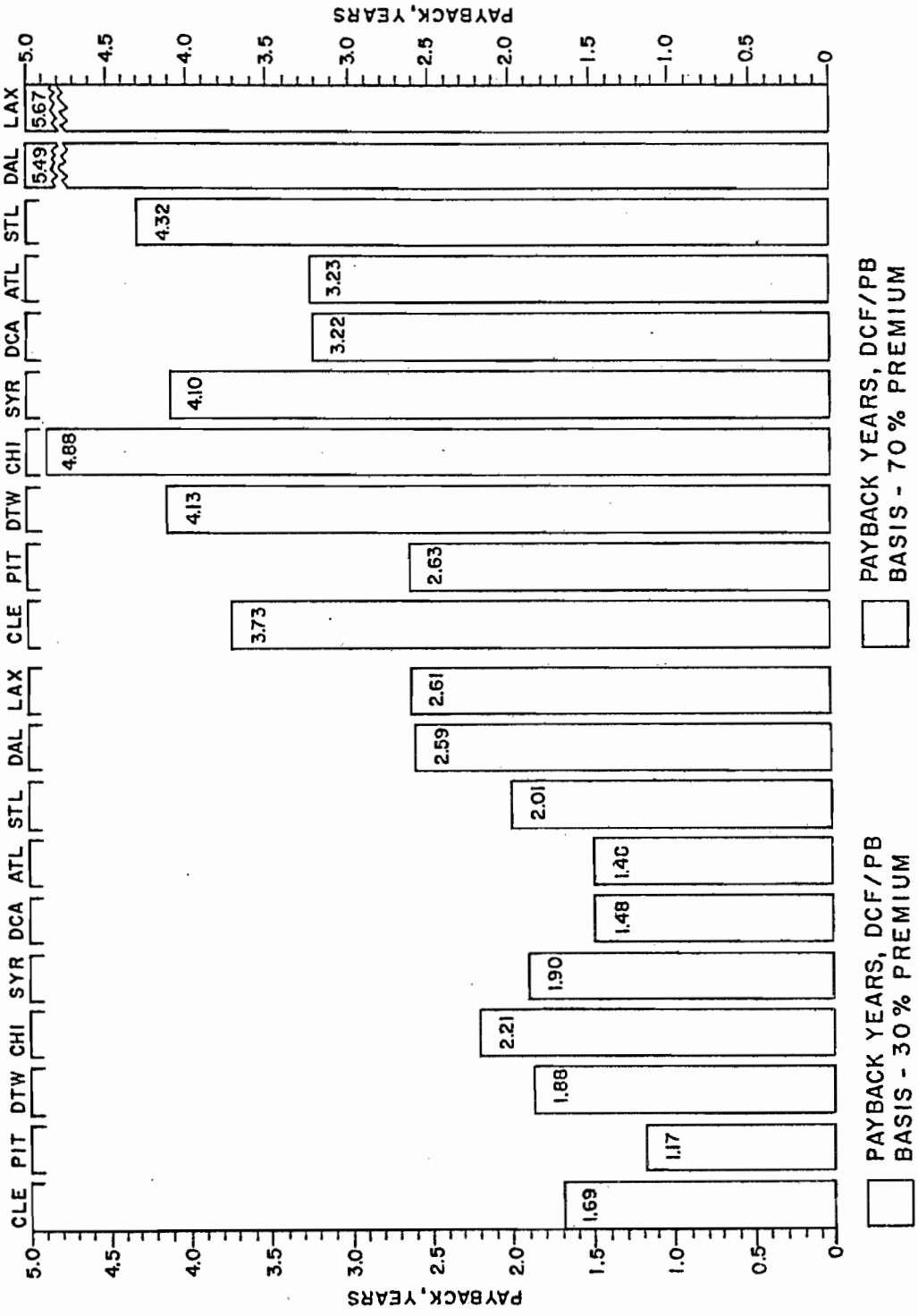

Fig. 5-23 Light Manufacturing (7-1/2 Tons); Gas Heat Pump - Nominal Cooling Vs. Combination Heat/Cool Unit (YAC)

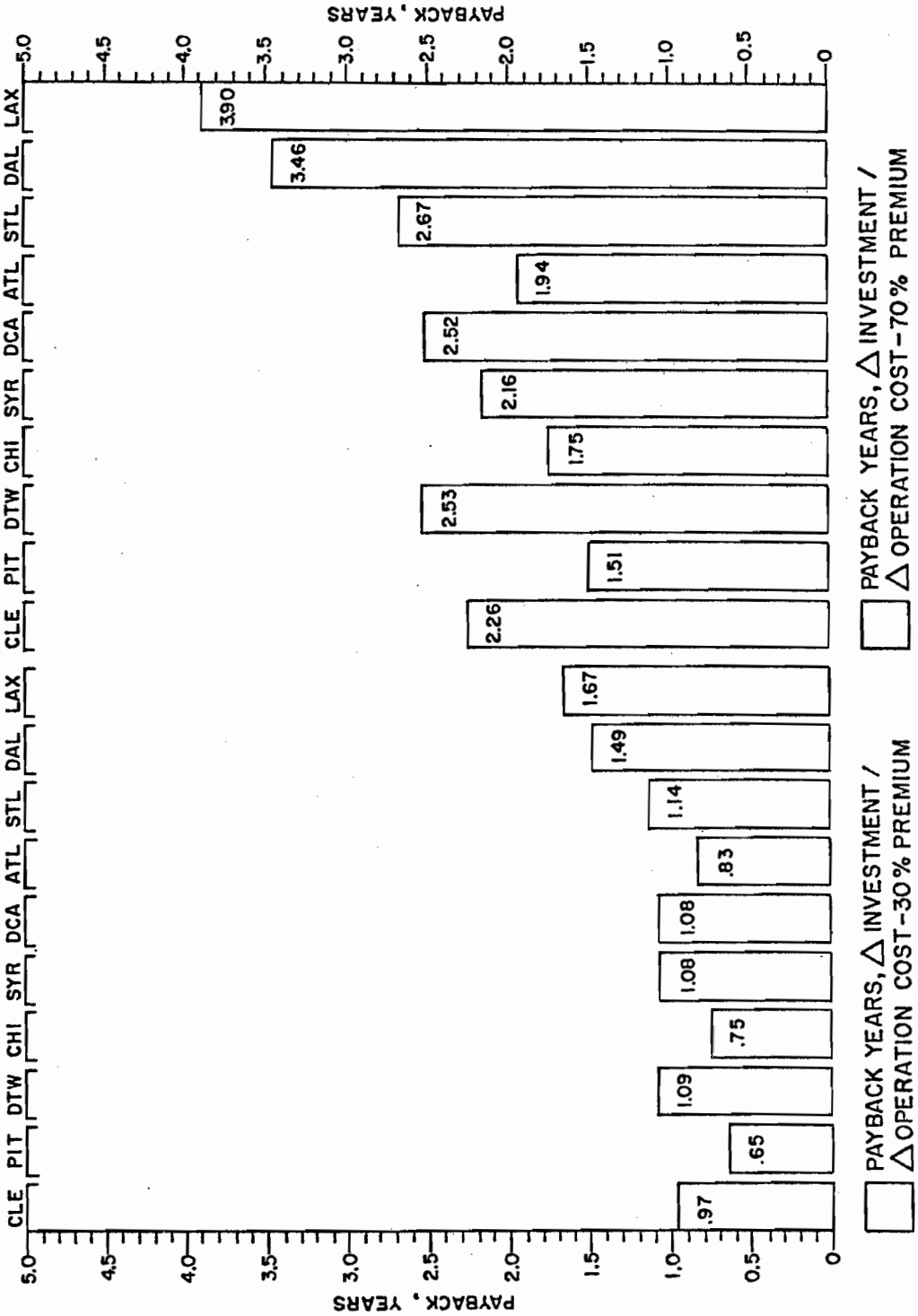

Fig. 5-24 Light Manufacturing (7-1/2 Tons); Gas Heat Pump - Nominal Cooling Vs. Combination Heat/Cool Unit (YAC)

TABLE 5-9

REST HOME (7 1/2 Tons)

Combination Heat/Cool Unit (YAC) vs Electric Heat Pump

CLE	DCF/ROR-%	- *	- NO ALL ELECTRIC RATE
	DCF PAYBACK, YRS	-	
	SIMPLE PAYBACK, YRS	-	
PIT	DCF/ROR-%	137%	- ALL ELECTRIC RATE
	DCF PAYBACK, YRS	75 Yrs.	
	SIMPLE PAYBACK, YRS	.41 Yrs.	
DTW	DCF/ROR-%	100%	- ELECTRIC HEATING RATE
	DCF PAYBACK, YRS	1.05	
	SIMPLE PAYBACK, YRS	.56	
CHI	DCF/ROR-%	476%	- ALL ELECTRIC RATE
	DCF PAYBACK, YRS	.21	
	SIMPLE PAYBACK, YRS	.12	
SYR	DCF/ROR-%	- *	- NO ALL ELECTRIC RATE
	DCF PAYBACK, YRS	-	
	SIMPLE PAYBACK, YRS	-	
DCA	DCF/ROR-%	24%	- SPACE HEATING RATE
	DCF PAYBACK, YRS	4.46	
	SIMPLE PAYBACK, YRS	2.76	
ATL	DCF/ROR-%	47%	- NO ALL ELECTRIC RATE
	DCF PAYBACK, YRS	2.27	
	SIMPLE PAYBACK, YRS	1.33	
STL	DCF/ROR-%	532%	- ELECTRIC HEATING RATE.
	DCF PAYBACK, YRS	.19	
	SIMPLE PAYBACK, YRS	.10	
DAL	DCF/ROR-%	245%	- ELECTRIC HEATING RATE
	DCF PAYBACK, YRS	42	
	SIMPLE PAYBACK, YRS	.23	
LAX	DCF/ROR-%	-.93%	- NO ALL ELECTRIC RATE
	DCF PAYBACK, YRS	10.9	
	SIMPLE PAYBACK, YRS	12.8	

* RATE OF RETURN NOT COMPUTABLE
(Higher Investment Cost, Higher Operation Cost and No All Electric Rate)

TABLE 5-10

OFFICE BUILDING (7 1/2 Tons)

Electric Heat Pump vs Combination Heat/Cool Unit (YAC)

CLE -	DCF/ROR-%	- *	- NO ALL ELECTRIC RATE
	DCF PAYBACK, YRS	-	
	SIMPLE PAYBACK, YRS.	-	
PIT -	DCF/ROR-%	28%	- ALL ELECTRIC RATE
	DCF PAYBACK, YRS	3.78 Yrs.	
	SIMPLE PAYBACK, YRS	.62 Yrs.	
DTW -	DCF/ROR-%	19	- ELECTRIC HEATING RATE
	DCF PAYBACK, YRS	5.33 Yrs.	
	SIMPLE PAYBACK, YRS	3.36 Yrs.	
CHI -	DCF/ROR-%	429%	- ALL ELECTRIC RATE
	DCF PAYBACK, YRS	.24 Yrs.	
	SIMPLE PAYBACK, YRS	.13 Yrs.	
SYR -	DCF/ROR-%	- *	- NO ALL ELECTRIC RATE
	DCF PAYBACK, YRS	-	
	SIMPLE PAYBACK, YRS	-	
DCA -	DCF/ROR-%	54%	- SPACE HEATING RATE
	DCF PAYBACK, YRS	1.97 Yrs.	
	SIMPLE PAYBACK, YRS	1.14 Yrs.	
ATL -	DCF/ROR-%	33%	- NO ALL ELECTRIC RATE
	DCF PAYBACK, YRS	3.29 Yrs.	
	SIMPLE PAYBACK, YRS	1.98 Yrs.	
STL -	DCF/ROR-%	476%	- ELECTRIC HEATING RATE
	DCF PAYBACK, YRS	.21 Yrs.	
	SIMPLE PAYBACK, YRS	.12 Yrs.	
DAL -	DCF/ROR-%	179%	- ELECTRIC HEATING RATE
	DCF PAYBACK, YRS	.57	
	SIMPLE PAYBACK, YRS	.32 Yrs.	
LAX -	DCF/ROR-%	- *	- NO ALL ELECTRIC RATE
	DCF PAYBACK, YRS	-	
	SIMPLE PAYBACK, YRS	-	

* RATE OF RETURN NOT COMPUTABLE
(Higher Investment Cost, Higher Operation Cost and No All Electric Rate)

TABLE 5-11

RETAIL STORE (7 1/2 Tons)

Electric Heat Pump vs Combination Heat/Cool Unit (YAC)

CLE -	DCF/ROR-%	---- *	- NO ALL ELECTRIC RATE
	DCF PAYBACK, YRS	----	
	SIMPLE PAYBACK, YRS	----	
PIT -	DCF/ROR-%	92	- ALL ELECTRIC RATE
	DCF PAYBACK, YRS	1.15	
	SIMPLE PAYBACK, YRS	.64	
DTW -	DCF/ROR-%	---- *	- ELECTRIC HEATING RATE
	DCF PAYBACK, YRS	----	
	SIMPLE PAYBACK, YRS	----	
CHI -	DCF/ROR-%	416	- ALL ELECTRIC RATE
	DCF PAYBACK, YRS	.24	
	SIMPLE PAYBACK, YRS	.13	
SYR -	DCF/ROR-%	---- *	- NO ALL ELECTRIC RATE
	DCF PAYBACK, YRS	----	
	SIMPLE PAYBACK, YRS	----	
DCA -	DCF/ROR-%	23	- SPACE HEATING RATE
	DCF PAYBACK, YRS	4.66	
	SIMPLE PAYBACK, YRS	2.89	
ATL -	DCF/ROR-%	37	- NO ALL ELECTRIC RATE
	DCF PAYBACK, YRS	2.88	
	SIMPLE PAYBACK, YRS	1.71	
STL -	DCF/ROR-%	446	- ELECTRIC HEATING RATE
	DCF PAYBACK, YRS	.23	
	SIMPLE PAYBACK, YRS	.12	
DAL -	DCF/ROR-%	154	- ELECTRIC HEATING RATE
	DCF PAYBACK, YRS	.67	
	SIMPLE PAYBACK, YRS	.33	
LAX -	DCF/ROR-%	18	- NO ALL ELECTRIC RATE
	DCF PAYBACK, YRS	5.69	
	SIMPLE PAYBACK, YRS	3.61	

* RATE OF RETURN NOT COMPUTABLE
(Higher Investment Cost, Higher Operation Cost and No All Electric Rate)

TABLE 5-12

LIGHT MANUFACTURING (7 1/2 Tons)

Electric Heat Pump vs Combination Heat/Cool Unit (YAC)

CLE -	DCF/ROR-%	-*	- NO ALL ELECTRIC RATE
	DCF PAYBACK, YRS	-	
	SIMPLE PAYBACK, YRS	-	
PIT -	DCF/ROR-%	-	- ALL ELECTRIC RATE
	DCF PAYBACK, YRS	-	
	SIMPLE PAYBACK, YRS	-	
DTW -	DCF/ROR-%	317	- ELECTRIC HEATING RATE
	DCF PAYBACK, YRS	.32	
	SIMPLE PAYBACK, YRS	.17	
CHI -	DCF/ROR-%	471	- ALL ELECTRIC RATE
	DCF PAYBACK, YRS	.21	
	SIMPLE PAYBACK, YRS	.11	
SYR -	DCF/ROR-%	-*	- NO ALL ELECTRIC RATE
	DCF PAYBACK, YRS	-	
	SIMPLE PAYBACK, YRS	-	
DCA -	DCF/ROR-%	-	- SPACE HEATING RATE
	DCF PAYBACK, YRS	-	
	SIMPLE PAYBACK, YRS	-	
ATL -	DCF/ROR-%	16	- NO ALL ELECTRIC RATE
	DCF PAYBACK, YRS	6.35	
	SIMPLE PAYBACK, YRS	4.07	
STL -	DCF/ROR-%	493	- ELECTRIC HEATING RATE
	DCF PAYBACK, YRS	.20	
	SIMPLE PAYBACK, YRS	.11	
DAL -	DCF/ROR-%	459	- ELECTRIC HEATING RATE
	DCF PAYBACK, YRS	.22	
	SIMPLE PAYBACK, YRS	.12	
LAX -	DCF/ROR-%	-	- NO ALL ELECTRIC RATE
	DCF PAYBACK, YRS	-	
	SIMPLE PAYBACK, YRS	-	

* RATE OF RETURN NOT COMPUTABLE
(Higher Investment Cost, Higher Operation Cost and No All Electric Rate)

TABLE 5-13

RETAIL STORE (7 1/2 Tons)
Gas Heat Pump - Maximum & Nominal Versions vs Electric Heat Pump

	30% PREMIUM GHPM	50% PREMIUM GHPN
CLE - DCF/ROR, %	193%	102%
DCF PAYBACK, YRS	0.53	1.00
SIMPLE PAYBACK, YRS	0.29	0.57
* PIT - DCF/ROR, %	82%	44%
DCF PAYBACK, YRS	1.28	2.43
SIMPLE PAYBACK, YRS	0.72	1.43
* DTW - DCF/ROR, %	113%	60%
DCF PAYBACK, YRS	0.93	1.78
SIMPLE PAYBACK, YRS	0.52	1.02
* CHI - DCF/ROR, %	----	----
DCF PAYBACK, YRS	----	----
SIMPLE PAYBACK, YRS	----	----
SYR - DCF/ROR, %	141%	74%
DCF PAYBACK, YRS	0.73	1.42
SIMPLE PAYBACK, YRS	0.41	0.81
* DCA - DCF/ROR, %	76%	41%
DCF PAYBACK, YRS	1.38	2.60
SIMPLE PAYBACK, YRS	0.78	1.54
ATL - DCF/ROR %	99%	53%
DCF PAYBACK, YRS	1.07	2.00
SIMPLE PAYBACK, YRS	0.59	1.16
* STL - DCF/ROR, %	----	----
DCF PAYBACK, YRS	----	----
SIMPLE PAYBACK, YRS	----	----
* DAL - DCF/ROR, %	----	----
DCF PAYBACK, YRS	----	----
SIMPLE PAYBACK, YRS	----	----
LAX - DCF/ROR, %	36%	18%
DCF PAYBACK, YRS	2.99	5.72
SIMPLE PAYBACK, YRS	1.78	3.63

* Electric Heating Rate

6.0 ADDENDUM

6.1 Selection of Building Type/Size/Location Combinations

The following study control table (Table 6-1) shows the study building type/size/location combinations; equipment size definitions; and study numbers for the project. The A model building study results are included in the first edition of the study. The B and C building model results will be added as supplements and included in later editions of the study.

6.2 Description of Study of Operating Cost and Investment Analysis for the Prototype HSPF Gas Heat Pump

The study examined the operating cost and projected owning costs of the Prototype HSPF Gas Heat Pump under development in comparison with other equipment expected to be concurrently marketed. The latter equipment will perform a similar function although energized with electricity or a combination of electricity and natural gas.

It is expected that the gas-fueled heat pump will have significantly lower annual operating cost (fuel plus maintenance) but will require a higher investment (initial cost) than the comparable equipment. The study sought to determine whether the total gas heat pump operating costs were sufficiently lower than the competitive equipment similar costs to attract buyers to it on the basis of economics alone. With the major exception of the ability to generate its own electrical requirements, including the indoor fan power, other unique characteristics of the machine which have potential competitive advantages were not considered in this study.

The computer programs utilized were:

- E-Cube Energy Requirements Program
- E-Cube Equipment Selection & Energy Consumption Program
- Monthly Utility Cost Program
- General Investment Analysis Program

TABLE 6-1

Selections of Building Type/Size/Location Combinations

Equipment Sizes:

A (1) 7-1/2 Ton Unit - (1) Zone ..... one (1) Load Calculation
B (1) 30 Ton Unit - (1) Zone ..... one (1) Load Calculation
C (4) 7-1/2 Ton Units - (4) Zones..... four (4) Load Calculations

Building Types	Rest Home	Office Building	Retail Store	Light Mfg.
Locations	Size/Study #	Size/Study #	Size/Study #	Size/Study #
Cleveland/CLE	A 1 B 2 C 3, 6	A 7 B 8 C 9, 12	A 13 B 14 C 15, 18	A 19 B 20 C 21, 24
Pittsburgh/PIT	A 25 B 26 C 27, 30	A 31 B 32 C 33, 36	A 37 B 38 C 39, 42	A 43 B 44 C 45, 48
Detroit/DTW	A 49 B 50	A 51 B 52	A 53 B 54	A 55 B 56
Chicago/CHI	A 57 B 58	A 59 B 60	A 61 B 62	A 63 B 64
Syracuse/SYR	A 65 B 66	A 67 B 68	A 69 B 70	A 71 B 72
Wash. D.C./DCA	A 73 B 74	A 75 B 76	A 77 B 78	A 79 B 80
Atlanta/ATL	A 81 B 82	A 83 B 84	A 85 B 86	A 87 B 88
St. Louis/STL	A 89 B 90	A 91 B 92	A 93 B 94	A 95 B 96
Dallas/DAL	A 97 B 98	A 99 B 100	A 101 B 102	A 103 B 104
Los Angeles/LAX	A 105 B 106	A 107 B 108	A 109 B 110	A 111 B 112
Building Usages	24 Hrs/Day	8-10 Hr/Day 5-6 Days/Wk	8-12 Hr/Day 5-6 Days/Wk	8-10 Hr/Day 5-6 Days/Wk
Day Types	(7) Week Days	(5) Week Days (1) Saturday (1) Sunday (8) Holidays	(6) Week Days (1) Sunday	(5) Week Days (1) Saturday (1) Sunday (8) Holidays

The four representative building types, which are described in detail in Section 6.3.3, are:

Representative Building Type #1 - Rest Home (Non-housekeeping residential-type structure) (Figure 6-1)

Representative Building Type #2 - Office Building (Industrial park type structure) (Figure 6-2)

Representative Building Type #3 - Retail Store (Typical of a national chain type non-food operation) (Figure 6-3)

Representative Building Type #4 - Light Manufacturing Plant (Typical of a plant using or manufacturing precision equipment). (Figure 6-4)

6.2.1 E-Cube Energy Requirements Program

The heating, cooling and process loads of the Representative Building Types were computed. The respective building loads were calculated to match the equipment capacities shown for the Representative Building Size Classes shown below. The building heating and cooling loads were calculated based on local climatic conditions in each of ten location cities. The loads were calculated in accordance with the ASHRAE Handbook of Fundamentals. The climatic conditions (design temperatures) used were obtained from the same source. Building load matching was accomplished by varying the radiant solar loads and the opaque wall and roof heat transfer factors. Building square footage as well as interior loads were maintained constant. All buildings had the same orientation. Building operation and usage were described by 24-hour profiles for each of the four (4) building types.

The Building size classifications are:

Building Size Class A - 7-1/2 tons cooling load - One (1) Zone.

Building Size Class B - 30 tons cooling load - One (1) Zone.

Building Size Class C - 30 tons cooling load - Four (4) Zones, each 7-1/2 tons.

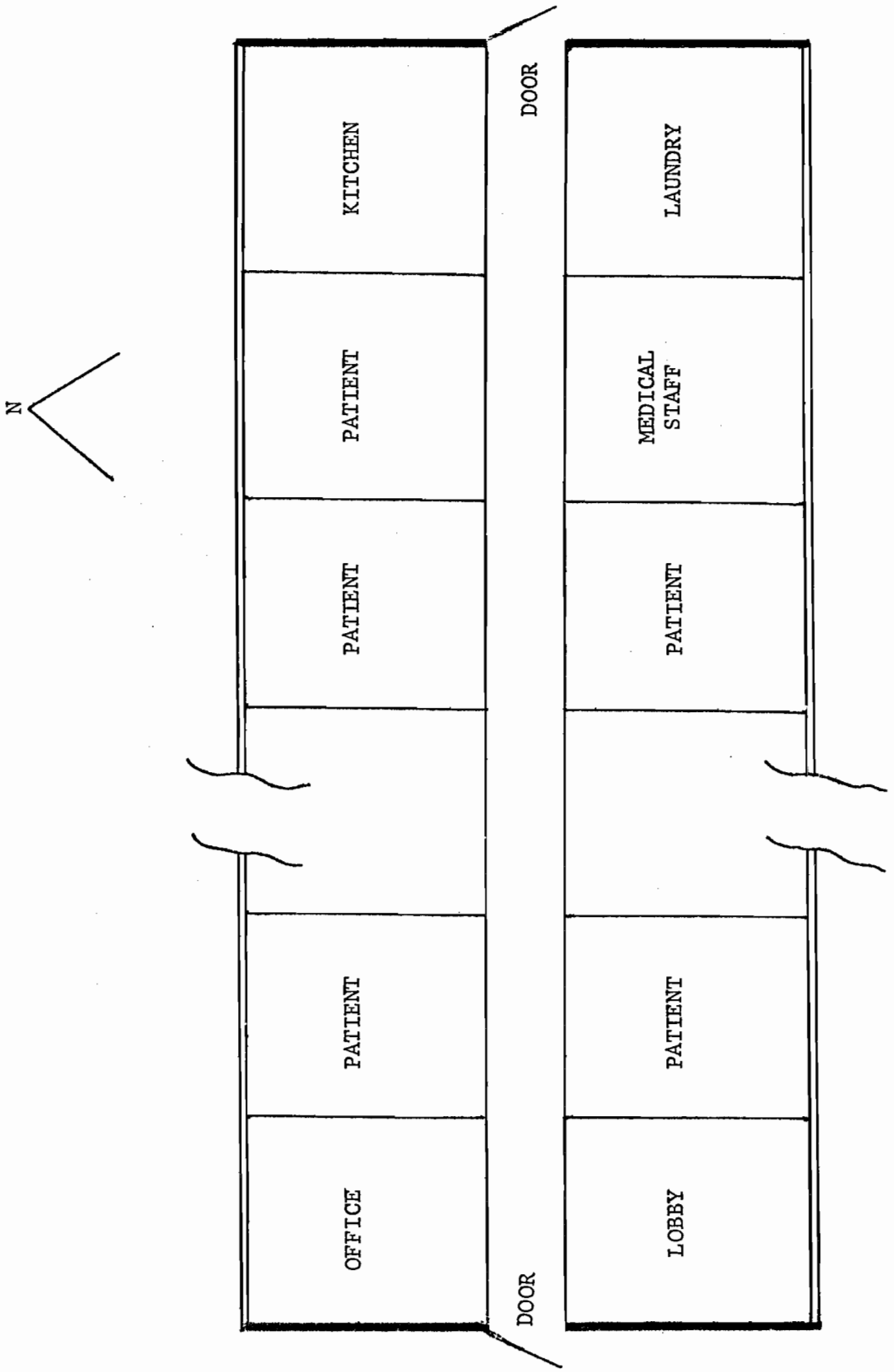

Fig. 6-1 Rest Home (no scale)

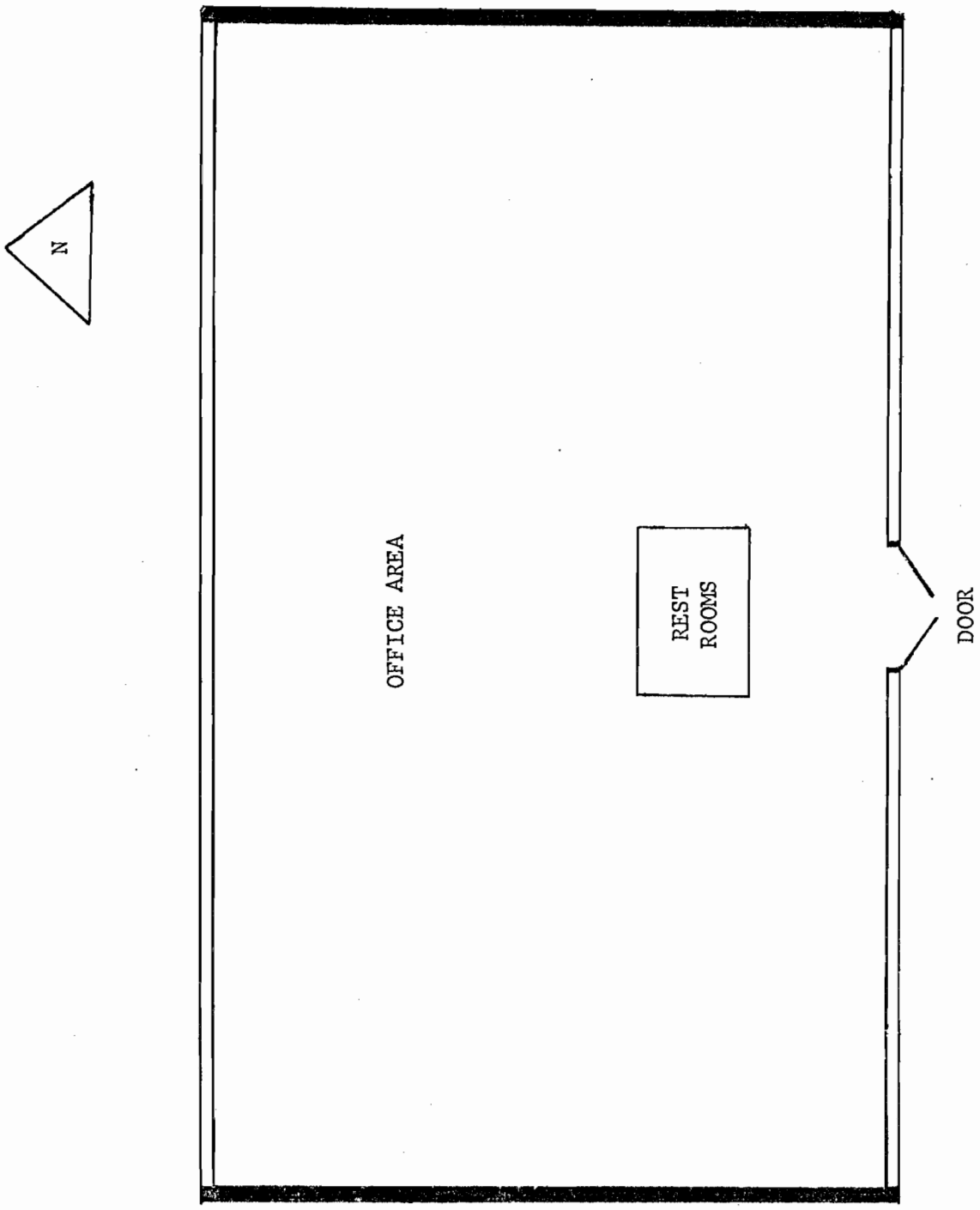

Fig. 6-2 Office Building (no scale)

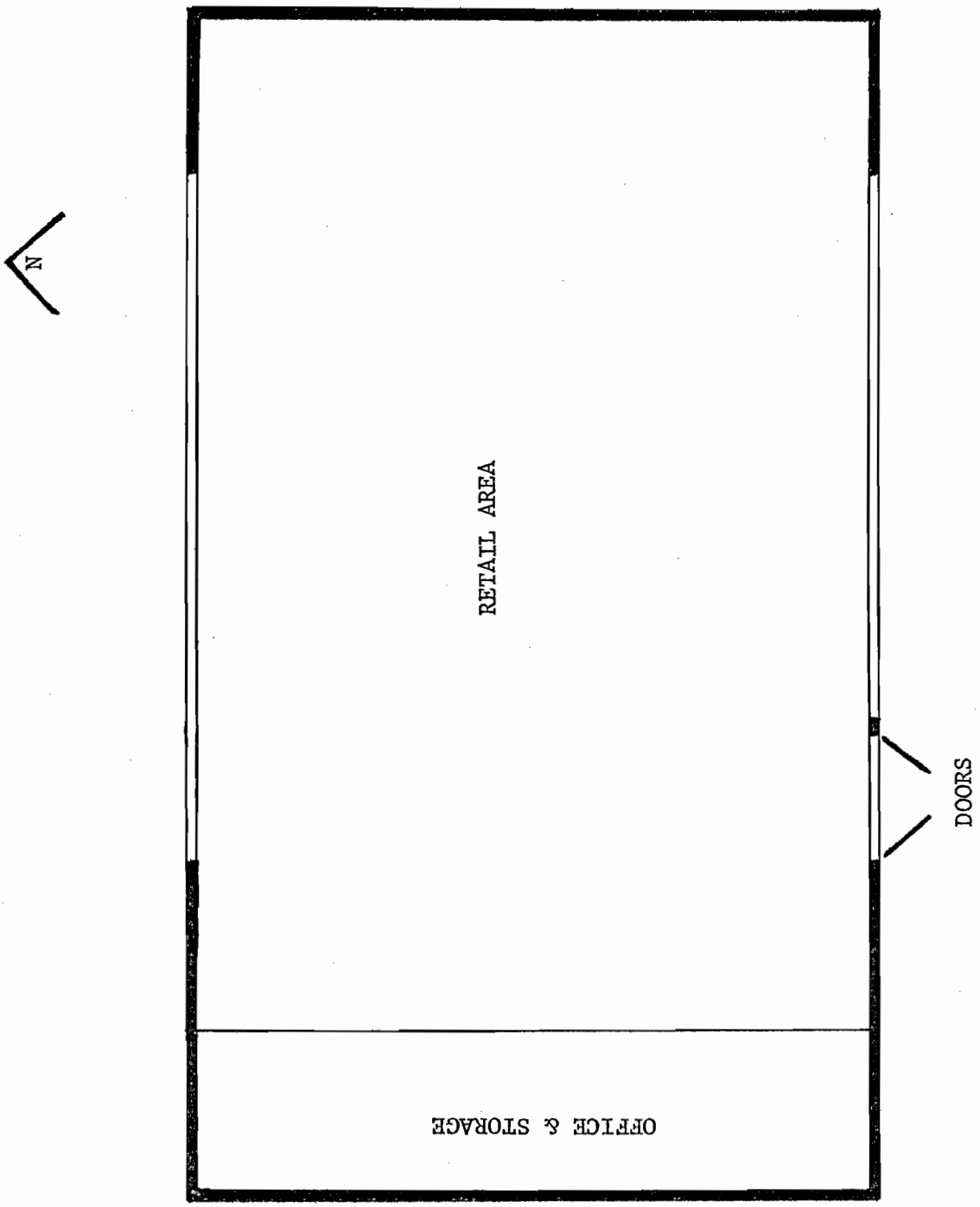

Fig. 6-3 Retail Store (no scale)

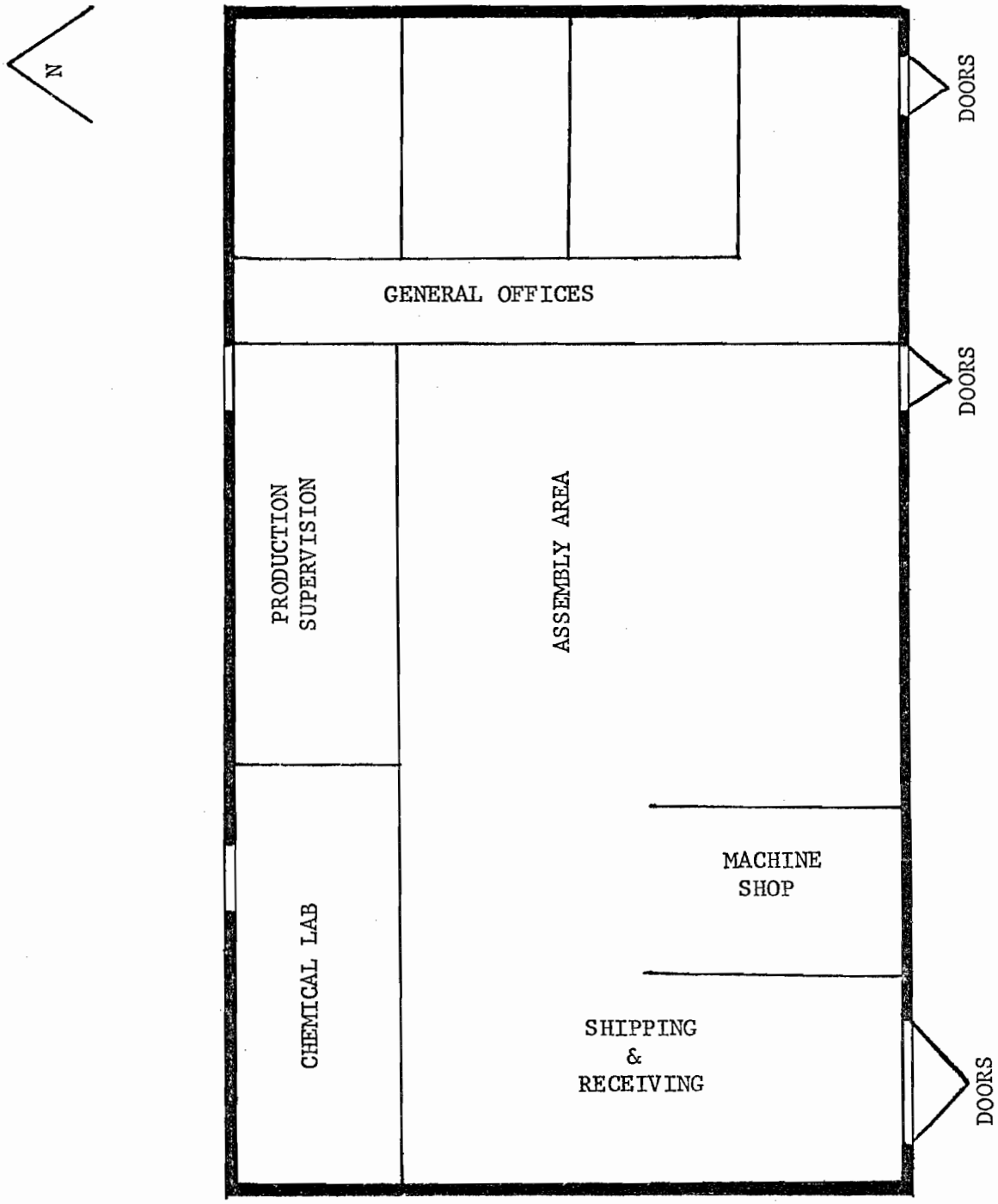

Fig. 6-4 Light Manufacturing (no scale)

The E-Cube Energy Requirements Program determined the hourly energy requirements of each structure. A detailed description of how this program operated is included.

6.2.2 E-Cube Equipment Selection and Energy Consumption Program

The types of equipment studied were:

Equipment System C1 - Combination Heating and Cooling Unit (Electric Cooling/Gas Heating)

Equipment System E1 - Single Package Electric Heat Pump

Equipment System E2 - Single Package Gas-Fueled Heat Pump (Development Version with Maximum Cooling Capacity)

Equipment System E3 - Single Package Gas-Fueled Heat Pump (Development Version with Nominal Cooling Capacity)

The sizes and models of the above equipment and the building size class to which they were applied are:

Equipment System C1/ Building Size Class A & C -	Combination Heating and Cooling Unit. Carrier Model 48 DP 008 Rated Cooling Capacity 8.16 Tons (98000 Btuh) Rated Heating Capacity - 168,000 Btuh Input - 225,000 Btuh
Equipment System E1/ Building Size Class B -	Combination Heating and Cooling Unit. Carrier Model 48 DD 034 Rated Cooling Capacity 30.25 Tons (363,000 Btuh) Rated Heating Capacity - 540,000 Btuh Input - 720,000 Btuh
Equipment System E2/ Building Size Class A & C -	Single Package Electric Heat Pump Carrier Model 50 DQ 008 Rated Cooling Capacity 7.42 Tons (89,000 Btuh) Rated Heating Capacity - 89,000 Btuh @ 45°F
Equipment System E2/ Building Size Class B -	Two (2) Single Package Heat Pumps Carrier Model 50 DQ 016 Rated Cooling Capacity 27.5 Tons (330,000 Btuh) Rated Heating Capacity - 370,000 Btuh @ 45°F

Equipment System E3/ Building Size Class A	-	Single Package Gas-Fueled Heat Pump Prototype - Maximum Version Assumed Cooling Capacity 7.42 Tons (89,000 Btuh) Nominal Heating Capacity = Cooling Capacity
Equipment System E3/ Building Size Class A	-	Single Package Gas-Fueled Heat Pump Prototype - Maximum Version Assumed Cooling Capacity 27.5 Tons (330,000 Btuh) Nominal Heating Capacity = Cooling Capacity
Equipment System E4/ Building Size Class A	-	Single Package Gas-Fueled Heat Pump Prototype - Nominal Version Assumed Cooling Capacity 7.42 Tons (89,000 Btuh) Nominal Heating Capacity = Cooling Capacity
Equipment System E4/ Building Size Class B	-	Single Package Gas-Fueled Heat Pump Prototype - Nominal Version Assumed Cooling Capacity 27.5 Tons (330,000 Btuh) Nominal Heating Capacity = Cooling Capacity

The cooling capacities of both versions of the Development Gas-Fueled Heat Pump were chosen to be identical with the cooling capacities of the Electric Heat Pumps. The Combination Heating and Cooling Unit Rated Cooling Capacities were slightly over capacity due to catalog selection limitations. The distinction between the Maximum and Nominal Cooling Capacity Gas Heat Pump was that the Nominal Version incorporated a projected higher coefficient of performance than the Maximum version at the rated condition level.

As indicated above, a prime study objective was the estimation of the energy savings of the HSPF gas-fueled heat pump relative to competitive equipment predicted to be concurrent on the market at the time the gas-fueled heat pump becomes available. Therefore, the present efficiencies (coefficients of performance) of the commercially available equipment specified were adjusted to reflect the projected improvements in future equipment. The modified ESEC program utilized Coefficient of Performance (COP) Tables for each type equipment system to provide ability to select the appropriate COP for each hourly combination of Building Load and Outside Dry Bulb Temperature. The COP number thus obtained was divided into the actual hourly load to attain the energy input to the machine during that hour.

The equipment models, as described, were simulated in the Equipment Selection and Energy Requirements Program to determine the respective utility energy use and demand to satisfy building requirements as determined by the Energy Requirement Program. A detailed description of the Equipment Selection and Energy Consumption Program is included in Section 6.4.

6.2.3 Scope

Five of the study locations are in the North East section since this area is of prime interest. The other five study locations were chosen to obtain information on operation in other representative national sectors. Hourly weather data respective to each location were applied. Comparisons of operating costs were made at each location. Since Equipment/Building Size classifications were common to all ten locations, except for Size C, variation in the gas heat pump competitive position which was affected by location can also be shown. Two Equipment/Building Size Classifications were identical for all building types. All three size classes were not examined at each of the ten locations in order to minimize the number of building load calculations. It was proposed that the third (Class C) Equipment/Building Size be studied for Pittsburgh and Cleveland in a later addendum to this study. The Building Type/Size Table (Table 6-1) shows the selected combinations of Building Size Classifications, Representative Building Types, and Location Cities, as well as Building Hours and Day Types.

The equipment size of approximately 7-1/2 tons and 30 tons cooling capacities were specified by the Research Department as expected optimum capacities for the initial prototype gas-fueled heat pumps. The 30-ton equipment size was applied in two ways -- (1) Single Zone and (2) Four Zones (each 7-1/2 tons) on the basis that substantial market potential is presumed to exist for these configurations.

Also included in this study was the Cooling and Heating Load Calculation Design Temperatures (Table 6-2) and a listing of the Natural Gas Heating Values (Table 6-3) for each of the ten (10) location cities.

TABLE 6-2

Cooling & Heating Load Calculation Design Conditions
ASHRAE Handbook of Fundamentals

	Winter db	Summer db	Summer wb
Cleveland	2	91	76
Pittsburgh	5	90	75
Detroit	4	92	76
Chicago	- 4	93	77
Syracuse	- 2	90	76
Washington D.C.	16	94	78
Atlanta	18	95	78
St. Louis	4	98	79
Dallas	19	101	79
Los Angeles	41	86	69

TABLE 6-3

Natural Gas Heating Values

1	Cleveland	1015
2	Pittsburgh	1015
3	Detroit	1020
4	Chicago Area	1033
5	Syracuse	1015
6	Washington D. C.	1012
7	Atlanta	1030
8	St. Louis	1035
9	Dallas	1025
10	Los Angeles	1060

6.3 Design Criteria and Building Descriptions

6.3.1 Rest Home, Office Building and Retail Store

6.3.1.1 People, Internal Heat and Outside Air Loads - Surveys of actual facilities established that the overall peak loading of internal heat gains due to electrical appliances was the same for three subject models. The peak people loads (determining the outside air requirements) were also the same. However, the hourly occupancy and use profiles varied widely between the models (see the individual Building Descriptions).

6.3.1.2 Building Envelope Load - The building envelopes were designed for energy conservation. There was no glass on the east or west wall. The air conditioning peak load calculations were made for August at 4:00 p.m. Glass was provided on the north and south facings which were the long sides of the buildings. The effect of the radiant solar load on the glass due to the sun being low on the horizon during the fall, winter, and spring months during midday was to lessen the need for heating.

The envelope heat transfer was minimized by using an opaque overall wall thermal conductivity factor (U factor) in the order of 0.1 Btu/ft^2/°F. The roof U-factor was in the order of 0.05. Glass was assumed to be tinted double-pane, with interior shading. The U-factors and shading factors varied with the building type and location.

Cleveland was selected as the bench mark study. The air conditioning load was the controlling parameter (not heating) for sizing the air conditioning unit. The load parameters were comprised of Radiant Solar, (RAD SOL) People (PEP) and Lights, (LIT) Outside Air-Sensible, (OAS) Transmission, (TRA) (included wall, roof and glass conduction) and Outside Air Latent (OAL).

In the load calculations the amount of glass area was balanced against the amount of wall and roof area required to meet the specified U-factors based on 4,000 square feet of floor space for the Type A Buildings. The radiant solar load was then modified by a shading coefficient so that the glass area used for radiant was the same as the glass area used for the

glass conduction calculation.

The additional nine cities studied divide into those that had summer dry bulbs (DB) above that of Cleveland and those with DB's below. There was some variation in the amount of the outside air load between cities, but primarily the radiant solar and transmission were the two parameters that were to be calculated and adjusted. The people and lighting load remained constant in all cities. The cities that have summer dry bulb temperatures (DBT's) lower than Cleveland were Pittsburgh, Syracuse, and Los Angeles. The wall and glass areas did not change for these cities. The shading co-efficient (SC) applied to the radiant solar was increased to compensate for the reduced transmission load after the OAS and OAL had been calculated.

The cities with summer DPT's above Cleveland were Detroit, Chicago, Washington, D.C., Atlanta, St. Louis and Dallas. The amount of glass was one half of that for the above mentioned cities. The glass was replaced with opaque wall. This was necessary because the transmission load was greater in these cities than it was for the base city Cleveland. The radiant load was again balanced with the glass conduction load by varing the SC.

After inspection of the ER runs it was felt that the heating consumption for Detroit and Chicago were unrealistically low. (This was because the composite U-factor was reduced by the installation of the opaque wall.) For these cities the transmission was arbitrarily increased and the solar radiant decreased.

6.3.2 Light Manufacturing

The light manufacturing plant had only a minimum solar radiant load which was held constant through all cities.

The people heat load and other internal-heat loads were held constant for all cities. The OAS and OAL loads are calculated for each city. The transmission load was then set as the difference between 7.5 tons (90,000 Btu) and the sum of the RAD SOL, PEP, LIT and OAS and OAL.

The floor area remained constant for all cities. The result was that the U-factor of the shell increased for cities having summer DBT's below Cleveland and decreased for cities with a DBT above Cleveland.

City	Tra
Dallas	17.90
St. Louis	16.28
Atlanta	17.21
Wash., D.C.	17.53
Chicago	17.82
Detroit	19.82
Cleveland	18.88
Pittsburgh	20.88
Syracuse	20.42
Los Angeles	24.28

6.3.3 Building Descriptions

6.3.3.1 Rest Home 7.5 Tons - Model - Milam Rest Home, Houston, Texas. The rest home was a 4,000 square foot, 10-foot high, 25-foot wide building. There were 11 patient rooms, a lobby, office, kitchen, medical staff room and laundry.

The building was operated 24 hours a day, 7 days a week and visitors were allowed during the day. Color television sets were provided for the patient rooms and lobby.

The kitchen was all-electric and meals were prepared three times daily. Natural gas was used for domestic water-heating for the kitchen, laundry and patient rooms.

6.3.3.2 Office Building 7.5 Tons - Model - Sline Industries, Houston, Texas. The office building was 4,000 square foot, 30-foot wide, 10-foot high and considered to be a single tenant rental.

The building was usually in operation Monday through Friday. Workers arrived as early as 6:00 a.m. and left at 7:00 p.m., however, business hours were 8:00 a.m. to 5:00 p.m. A clean-up crew was on duty from 7:00 p.m. to 11:00 p.m. A small, variable people occupancy and lighting load occurred

on Saturday from 6:00 a.m. to 2:00 p.m. Safety lighting remained on when the building was closed.

The overall lighting level was 2.25 watts per square foot. No domestic water heat was considered.

The building was closed on Sundays and holidays. One holiday a month occurred in January, February, May, July, September, October, November and December. The outside air was shutdown when the building was not in use.

The heating was never shut-off. The air conditioning was shut-off during January, February, March, November and December, and when the building was shutdown during the summer months.

6.3.3.3 Retail Store 7.5 Tons. Model - Cloth World, Houston, Texas. The retail store was a 4,000 square feet, 16-feet high, 20-feet wide building. An area of low lighting level was provided for the storage room and small office area. The remainder of the floor space was for retail sales and had high level lighting.

The store was open Monday through Saturday all year from 10:00 a.m. to 8:00 p.m. The store was busy between 11:00 a.m. and 3:00 p.m. followed by a slack period until 5:00 p.m. After 5:00 p.m. the occupancy increased until closing time. All doors were either double or revolving in order to minimize heating or cooling losses and to obtain conservation.

The store was closed on Sunday and no security lighting was provided. The outside air was shut-off when the store was not in use. The heating was never shut-off. No domestic water heating was provided.

The air conditioning was shut-off during January, February, March, November and December and when the building was shutdown during the summer months.

6.3.3.4 Light Manufacturing 7.5 Tons - Model - Oceanic International, Bryan, Texas. The light manufacturing plant had 4,000 square feet of floor space, and 18-foot high walls that measured 49 feet 4 inches by 40 feet in length.

The interior space was allotted to general offices, production supervision, a chemical laboratory, assembly area, a machine shop and shipping/receiving area.

The plant was operated Monday through Friday from 8:00 a.m. to 4:00 p.m. with some personnel remaining until 6:00 p.m. The plant was closed on Saturdays, Sundays and holidays. There were eight holidays during the year which were the same as those for the office buildings. There was no domestic water heating. Security lighting was provided whenever the plant was closed. The outside air was shutdown when the building was not in use.

The air conditioning was shutdown in January, February, March, November, and December and during the summer months when the building was not in use.

6.4 Monthly System Gas and Electric Consumption

The Equipment Selection and Energy Consumption program furnished summary print-outs which showed Monthly Gas Consumption (Mcf), Electric Demand (kW) and Electric Consumption (kWh) in addition to other information. These consumptions figures were supplied to the Monthly Utility Cost program to obtain the monthly and annual utility costs for each system.

Separate tables for each Representative Building Types (Size A) in each of the ten location cities follow:

- Rest Home - Tables 6-4 through 6-13
- Office Building - Tables 6-14 through 6-23
- Retail Store - Tables 6-24 through 6-33
- Light Manufacturing - Tables 6-34 through 6-43

TABLE 6-4

CLEVELAND - REST HOME - SIZE A

MONTHLY DEMAND AND CONSUMPTION VALUES

SYS	MO	GAS DEMAND MCF	GAS CONSUMP MCF	ELECTRIC DEMAND KW	ELECTRIC CONSUMP KWH	AUXILARY FUEL CONSUMP	AUX FUEL HOURS	COOLING DEMAND TONS	COOLING CONSUMP TONS-HRS	HEAT DEMAND MBH	HEAT CONSUMP MBTU
C1	1	2.33	46.01	15.91	5316.50	0.0	0.0	0.0	0.0	87.61	27903.58
C1	2	2.08	34.41	15.89	4774.72	0.0	0.0	0.0	0.0	78.53	19788.64
C1	3	1.62	29.02	17.79	5268.48	0.0	0.0	1.73	9.72	57.35	15174.00
C1	4	0.95	15.76	21.84	5299.56	0.0	0.0	4.80	158.76	40.71	5893.39
C1	5	0.63	9.12	26.49	6950.01	0.0	0.0	6.73	1079.75	28.61	1320.65
C1	6	0.28	7.13	27.74	7582.58	0.0	0.0	7.74	1560.72	10.43	153.29
C1	7	0.24	7.14	26.75	8698.38	0.0	0.0	7.59	2161.19	2.89	7.13
C1	8	0.23	7.13	27.65	9520.09	0.0	0.0	7.88	2673.69	0.0	0.0
C1	9	0.43	7.69	26.42	7643.73	0.0	0.0	7.88	1621.31	19.53	515.41
C1	10	0.79	12.14	22.42	5684.50	0.0	0.0	7.39	299.98	33.15	3306.42
C1	11	1.70	25.63	17.46	5118.64	0.0	0.0	4.57	27.77	66.43	12905.74
C1	12	1.51	29.13	15.77	5251.45	0.0	0.0	0.0	0.0	52.81	15096.96
E1	1	0.23	7.13	33.02	10476.35	0.0	0.0	0.0	0.0	87.61	27903.58
E1	2	0.23	6.44	27.68	8184.10	0.0	0.0	0.0	0.0	78.53	19788.64
E1	3	0.23	7.13	21.17	7601.87	0.0	0.0	1.73	9.72	57.35	15174.00
E1	4	0.23	6.90	21.11	6104.48	0.0	0.0	4.80	158.76	40.71	5893.39
E1	5	0.23	7.13	24.94	6905.56	0.0	0.0	6.73	1079.75	28.61	1320.65
E1	6	0.23	6.90	26.02	7262.96	0.0	0.0	7.74	1560.72	10.43	153.29
E1	7	0.23	7.13	25.15	8233.23	0.0	0.0	7.59	2161.19	2.89	7.13
E1	8	0.23	7.13	26.01	8942.75	0.0	0.0	7.88	2673.69	0.0	0.0
E1	9	0.23	6.90	24.93	7367.57	0.0	0.0	7.88	1621.31	19.53	515.41
E1	10	0.23	7.13	21.41	6088.55	0.0	0.0	7.39	299.98	33.15	3306.42
E1	11	0.23	6.90	22.64	7092.36	0.0	0.0	4.57	27.77	66.43	12905.74
E1	12	0.23	7.13	20.87	7531.15	0.0	0.0	0.0	0.0	52.81	15096.96
E2	1	1.69	29.67	15.42	5175.47	0.0	0.0	0.0	0.0	87.61	27903.58
E2	2	1.38	22.05	15.42	4674.71	0.0	0.0	0.0	0.0	78.53	19788.64
E2	3	1.01	18.84	15.42	5175.47	0.0	0.0	1.73	9.72	57.35	15174.00
E2	4	0.69	13.34	15.42	5008.55	0.0	0.0	4.80	158.76	40.71	5893.39
E2	5	1.45	21.34	15.42	5175.47	0.0	0.0	6.73	1079.75	28.61	1320.65
E2	6	1.98	26.56	15.42	5008.55	0.0	0.0	7.74	1560.72	10.43	153.29
E2	7	1.61	33.53	15.42	5175.47	0.0	0.0	7.59	2161.19	2.89	7.13
E2	8	1.92	40.87	15.42	5175.47	0.0	0.0	7.88	2673.69	0.0	0.0
E2	9	2.05	28.08	15.42	5008.55	0.0	0.0	7.88	1621.31	19.53	515.41
E2	10	1.01	13.36	15.42	5175.47	0.0	0.0	7.39	299.98	33.15	3306.42
E2	11	1.07	17.06	15.42	5008.55	0.0	0.0	4.57	27.77	66.43	12905.74
E2	12	0.93	16.60	15.42	5175.47	0.0	0.0	0.0	0.0	52.81	15096.96
E3	1	1.71	30.00	15.42	5175.47	0.0	0.0	0.0	0.0	87.61	27903.58
E3	2	1.40	22.27	15.42	4674.71	0.0	0.0	0.0	0.0	78.53	19788.64
E3	3	1.02	19.00	15.42	5175.47	0.0	0.0	1.73	9.72	57.35	15174.00
E3	4	0.69	13.43	15.42	5008.55	0.0	0.0	4.80	158.76	40.71	5893.39
E3	5	1.45	21.47	15.42	5175.47	0.0	0.0	6.73	1079.75	28.61	1320.65
E3	6	1.94	26.61	15.42	5008.55	0.0	0.0	7.74	1560.72	10.43	153.29
E3	7	1.60	33.65	15.42	5175.47	0.0	0.0	7.59	2161.19	2.89	7.13
E3	8	1.86	40.59	15.42	5175.47	0.0	0.0	7.80	2673.69	0.0	0.0
E3	9	1.98	27.81	15.42	5008.55	0.0	0.0	7.88	1621.31	19.53	515.41
E3	10	1.00	13.43	15.42	5175.47	0.0	0.0	7.39	299.98	33.15	3306.42
E3	11	1.08	17.20	15.42	5008.55	0.0	0.0	4.57	27.77	66.43	12905.74
E3	12	0.94	18.76	15.42	5175.47	0.0	0.0	0.0	0.0	52.81	15096.96

Note:

pp. 6-18 thru 6-237 illegible (computer printout tabulations)