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ECONOMIC AND ENERGY AUDIT OF TEXTILE FOAM
PROCESSING

By
Raymond Machacek

June 1983

Work Performed Under Contract No. AC06-76RL01830

Arthur D. Little, Inc.
Cambridge, Massachusetts

U. S. DEPARTMENT OF ENERGY

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the U.S. Department of Energy
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TABLE OF CONTENTS

	Page
List of Figures	v
List of Tables	vii
1.0 EXECUTIVE SUMMARY	1
1.1 BACKGROUND	1
1.2 FINDINGS	1
2.0 OBJECTIVE AND GOALS	3
3.0 SCOPE AND APPROACH	5
3.1 EVALUATION OF EXISTING PROCESSES	5
3.2 REVIEW AND EVALUATION OF FOAM FINISHING	9
3.3 REVIEW AND EVALUATION OF DATA REQUIREMENTS	12
3.4 REVIEW OF DATA SAMPLING PROCEDURE AND DATA COLLECTION	12
4.0 FINDINGS	15
4.1 COMPARISON OF PROCESS ENERGY USE	15
4.2 COMPARISON OF ECONOMICS	20
5.0 CONCLUSIONS AND RECOMMENDATIONS	33
APPENDIX A -- HEAT AND WATER BALANCES TO CHECK ACCURACY OF MONITORING EQUIPMENT	A-1
APPENDIX B -- SUMMARIZED DATA	B-1
APPENDIX C -- RESULTS OF COMPUTERIZED PAYBACK-PERIOD CALCULATIONS	C-1

LIST OF FIGURES

Figure No.		Page
3.1	Schematic — Finishing Process for Wet Pickup of Chemicals Tubular Knits and Broad-Woven Fabrics	6
3.2	Schematic — Carpet Dyeing Conventional Beck Process	7
3.3	Schematic — Wet Continuous Dyeing and Drying of Carpets	8
3.4	Schematic — Finishing Process for Foam Pickup of Chemicals Tubular Knits and Broad-Woven Fabrics	10
3.5	Schematic — Continuous Foam Dyeing and Air Drying of Carpets	11

LIST OF TABLES

Table No.		Page
3.1	Foam Finishing Test Results	13
3.2	Wet Continuous Dyeing of Carpets	14
4.1	Moisture Pickup Wet vs Foam Finishing	15
4.2	Energy Used to Finish Fabrics	16
4.3	Dryer Efficiencies	17
4.4	Annual Energy Consumption for Finishing Tubular Knits	18
4.5	Annual Energy Consumption for Finishing Broad Wovens	19
4.6	Annual Energy Consumption for Beck Dyeing of Carpets Compared with Foam Dyeing	19
4.7	Annual Energy Consumption for Wet Continuous Dyeing of Carpets Compared with Foam Dyeing	20
4.8	Operating Costs of Finishing Operations	20
4.9	Tubular Knits – Conventional Finishing	22
4.10	Tubular Knits – Foam Finishing	23
4.11	Broad Wovens – Conventional Finishing	24
4.12	Broad Wovens – Foam Finishing	25
4.13	Beck Dyeing and Continuous Drying of Carpets	26
4.14	Continuous Wet Dyeing and Drying of Carpets	27
4.15	Continuous Foam Dyeing and Air Drying of Carpets	28
4.16	Annual Operating Cost Savings – Tubular Knits	29
4.17	Annual Operating Cost Savings – Broad Wovens	29
4.18	Annual Operating Cost Savings – Beck Carpet Dyeing	30
4.19	Annual Operating Cost Savings – Continuous Carpet Dyeing	30
4.20	Summary of Economic Incentives for Retrofit Foam Finishing into Existing Processes	31

1.0 EXECUTIVE SUMMARY

1.1 BACKGROUND

Conventional wet processing of textiles – dyeing, or application of such surface finishes as soil and water repellents, antistatic agents, fire retardants, permanent press agents, and starch – consumes about 0.19 quadrillion Btu's of energy per year, the equivalent of 30 million barrels of oil. Because wet processing involves immersion of the fabric in a water bath, most of the energy used is in the form of heat for drying.

In the newer foam finishing approach, the chemicals for surface finishes are dispersed in a mixture of water and air. The chemicals are concentrated in a relatively small amount of water, and air is injected to form a thick, stable foam. Because little water is involved, drying time and temperature may be drastically reduced.

Arthur D. Little, Inc., conducted an economic and energy audit of foam processing that considered the technical feasibility, reliability, energy savings, and economic incentives for using foam finishing. We monitored four plants that finish textiles (carpets, broad-woven fabrics, and tubular knits). The plants were selected by the developer of the foaming process (United Merchants and Manufacturers, Inc.) to represent a wide range of textile finishing applications.

1.2 FINDINGS

The results of the Arthur D. Little audit are favorable from the technical, energy, and economic standpoints. At all sites, foam finishing or foam dyeing performed as well as or better than conventional wet processing. We audited foam processing in textiles as diverse as light tubular knits and heavy carpets. In the plants studied, foam finishing required 37-57% less energy than conventional wet processing. The only site that did not show energy savings, one processing broad-woven textiles, did not take advantage of the lower moisture pickup inherent in foam finishing when it failed to increase line speed or reduce dryer temperature.

The economic benefits accruing from retrofitting foam finishing on existing dryers are reflected in the increased productivity; the discounted cash flow (dcf) internal rate of return varied from 42 to 140%. Considering energy savings alone, the dcf internal rate of return varied from 14 to 140%. The capital investment for retrofitting foam processing on existing finishing lines varied from \$45,000 for the lighter fabrics to \$120,000 for the carpets.

For new mills, foam processing is even more attractive, since all the increased productivity of foam finishing can be designed into the plant. The equipment designed specifically for foam finishing will be smaller and will cost less than a

dryer designed for wet finishing. Lower operating costs at lower capital cost present an overwhelming case for foam finishing in all new mills.

Even with retrofitting foam finishing on existing dryers, substantial benefits can accrue. In the mill producing tubular knits, the 60% increase in production rate on the two existing dryers made it possible to eliminate a planned new finishing line yet still attain a major expansion of capacity. Another favorable note is that as plant personnel become more familiar with the capabilities of their foam processing installations, they will save even more energy. For example, one finisher of broad-woven goods reduced its oven temperature by an additional 20% over most of its foam finishing runs, (a malfunction of the energy monitoring equipment did not allow us to document the additional energy savings). The goods finished at the lower temperature still met all the customer's requirements, however. In carpet dyeing plants, substantial energy savings can be achieved, since foam dyeing can provide better control of dye, and the second washing step, necessary with conventional dyeing, can be eliminated.

2.0 OBJECTIVE AND GOALS

An objective of the U.S. Department of Energy's (DOE) Office of Industrial Programs (OIP) was to expeditiously achieve maximum implementation of existing and new energy conservation technologies. To aid in achieving this goal, the OIP created an "Acceleration Program." The Program's objective was to encourage industry adoption and use of energy-conserving technologies sooner than under normal market conditions. Conservation and Renewable Energy has undertaken several means to promote use of energy conservation technologies. In one such "accelerated acceptance" program, the OIP worked with the equipment suppliers to find users, i.e., host plant operators, to demonstrate the merits of the textile foam process. This technology was made available to users on a cost-sharing basis under the DOE Contract Number DE-FC01-80CS-40334 with United Merchants and Manufacturers, Inc. As participants in the Acceleration Program, the vendor's (in this instance United Merchants and Manufacturers, Inc.) responsibility was to install the process, find users, and publicize the merits of the energy-saving product. The responsibility of the users (the four companies) was to implement the process in their respective plants and to collect operating data for the vendor and DOE. The data collected was to describe the operation of the process including costs, energy consumption, and reliability. Arthur D. Little, Inc., audited the operating performance and economic attractiveness of foam finishing of three types of textiles and prepared this report based upon plant visits and upon data collected at the four plants.

The goal of this project was to provide an independent, third-party technical review (audit) of the technology, operating data, and energy-saving potential of the textile foam process. This report also provides an evaluation of the economic attractiveness of foam finishing, based upon the operating data from all the plants studied.

3.0 SCOPE AND APPROACH

Arthur D. Little monitored four plants:

- Dyeing of Carpets – Galaxy Carpets, Inc., Chatsworth, GA.
- Finishing of Tubular Knits – Health-tex, Inc., Cumberland, RI.
- Finishing of Broad-Woven Fabrics – Harodite Finishing Company, Inc., North Dighton, MA.
- Finishing and Tinting of Broad-Woven Fabrics – Wansona Manufacturing Corporation, Wadesboro, NC.

The audit involved verifying the economic, technological, and energy-conserving factors involved in converting from conventional textile finishing processes to foam finishing. The detailed scope of work involves four items.

3.1 EVALUATION OF EXISTING PROCESSES

We prepared a description and evaluation of the existing finishing processes and the modifications necessary for foam finishing. This description is sufficiently detailed to serve as a basis for comparing operating results before and after installing foam finishing.

Figure 3.1 shows a schematic of the conventional finishing of lightweight goods, such as tubular knits, or broad-woven fabrics. The fabric is dipped into a water bath containing the desired chemicals, squeezed between a pair of rolls to remove the excess liquid, and passed through a series of dryers. Even after being squeezed by the padding rolls, the wet-finished goods averaged a pickup of 0.6 to 0.8 pound of water per pound of fabric, all of which had to be removed in the dryers. Evaporation of water from the dryers is energy-intensive, requiring 1,000 to 12,000 Btu per pound of water evaporated. Most dryers in the textile industry require 2,000 to 5,000 Btu per pound of water evaporated.

We evaluated two conventional wet processes for dyeing heavyweight goods such as carpets. The first process, shown in Figure 3.2, is a batch process with an open Beck tank to dye and wash rolls of carpets followed by continuous drying of the carpets on a dryer. The second wet-dyeing process, shown in Figure 3.3, involves a continuous dyeing, steaming, washing, and drying operation. The host plant for carpet dyeing used both wet methods to dye and finish its carpets.

Figures 3.1, 3.2, and 3.3 detail the forms of energy used for wet finishing and the locations of sensors used for monitoring. The major use of energy, about 85%, is in the form of natural gas or steam to provide heat to the dryers. The only other use of energy is to power the electric motors of the dryers and to activate the process

FIGURE 3.1 SCHEMATIC — FINISHING PROCESS FOR WET PICKUP OF CHEMICALS TUBULAR KNITS AND BROAD-WOVEN FABRICS

FIGURE 3.2

SCHEMATIC – CARPET DYEING
CONVENTIONAL BECK PROCESS

FIGURE 3.3 SCHEMATIC – WET CONTINUOUS DYEING AND DRYING OF CARPETS

control system. For the audit, the vendor installed at each site a sensor for measuring natural gas or steam use in the dryers, a wattmeter on the line that supplies electric energy to the dryers, and a monitor (manufactured by the J.W. Sweet Company of Columbia, SC), that recorded total energy consumption, both thermal and electric. Personnel at each plant recorded, from meters already installed, total yardage produced and fabric types.

3.2 REVIEW AND EVALUATION OF FOAM FINISHING

To ensure the fairest comparison between foam finishing and conventional technology, the same finishing line and a similar product mix were used for both processes in the respective plants. Thus, the audit measured the same type of energy consumption on the same dryer with the same sensors and recorders for both processes. The order of scheduling foam or wet processing was randomized, so any operating improvements would apply equally to both processes. Every possible step was taken to ensure that the only substantive changes in operating procedures were related to the method of application of the finish to the goods.

Figures 3.4 and 3.5 present a schematic view of the finishing operations for modified foam processing of lightweight and heavyweight goods. The major changes relate to the application of the foam finish and the elimination of the water bath. The goods typically picked up only half as much moisture as in wet finishing and dried much more readily. The operators at one host plant found that they could increase the speed of the line by 60% (from 25 yd/minute to 40 yd/minute) and still dry the goods to the same final dryness. Other plants combined increased line speed with lower oven temperatures. In this manner, the host plants not only reaped significant energy savings, but substantial cost savings on labor and annualized capital charges by increasing production rates.

The unique feature of foam finishing is to replace most of the water in the finish solution with air, and thus save on energy needed to dry the goods. The foam, similar in consistency to shaving cream, typically has five parts of air to each part of liquid. On a volume basis, however, the foam is formulated to have the same amount of finishing chemicals as the wet finishes. Thus, the fabric picks up the same amount of chemicals as with wet finishing, but much less water.

The vendor chose to use a foam generator manufactured by the Textile, Rubber and Chemical Company of Dalton, GA. A number of other companies manufacture foam generators including the following:

- Eze, Inc., Dalton, GA.
- Latex Equipment Systems, Dalton, GA.
- SKG Industries, Reading, PA.
- Mondo (European)
- Eurofoamer (European)
- Capin Machinery (European)

FIGURE 3.4 SCHEMATIC – FINISHING PROCESS FOR FOAM PICKUP OF CHEMICALS
TUBULAR KNITS AND BROAD-WOVEN FABRICS

FIGURE 3.5 SCHEMATIC – CONTINUOUS FOAM DYEING AND AIR DRYING OF CARPETS

3.3 REVIEW AND EVALUATION OF DATA REQUIREMENTS

Before the start of the audit, the Arthur D. Little team met with personnel from the vendor and the host plants to review the data requirements to ensure that all appropriate data would be collected. We wanted enough data to be able to run a water and energy balance on several runs to confirm the accuracy of the sensing and monitoring equipment and ensure the accuracy of the audit. A typical balance is shown in Appendix A. As a result of this meeting, we adopted the data logging forms shown in Tables 3.1 and 3.2. We also obtained the information necessary to conduct the operating cost analysis for each of the processes.

3.4 REVIEW OF DATA SAMPLING PROCEDURE AND DATA COLLECTION

We reviewed the data sampling procedure to ensure that adequate data were collected, i.e., data that were statistically significant and gave results that provided convincing conclusions. The host plants provided 180 sets of data on the conventional technology (wet finishing) and 125 sets of data on foam finishing. The data for both processes provided a statistically adequate sample of energy and cost information from which we could compare the processes and estimate energy savings. A summary of the data collected at the host plants is presented in Appendix B.

TABLE 3.1

FOAM FINISHING TEST RESULTS

PLANT Tubular Knits (Health-tex) DATE 9-15

SHIFT First TIME: Start 1335 Finish 1437

FRAME SPECIFICATION AND LAYOUT FABRIC SPECIFICATIONS

Make Tubular Textile Corp. Construction 50/Poly 50/Cotton Jersey
 No. Zones Three Weight 1.062
 Heat Recovery None Width 28"
 Type Heat Natural Gas

	WET PROCESS	FOAM PROCESS
A. Frame Temperature		
Zone #1	<u>310°</u>	
Zone #2	<u>330°</u>	
Zone #3	<u>330°</u>	
B. Frame Speed	<u>25 Y.P.M.</u>	
C. Steam Consumed	<u>—</u>	
D. Gas Consumed	<u>33.37 S.C.F.H.</u>	
E. A.C. Power Consumed	<u>2.71 KW.</u>	
F. Total Energy	<u>36.01 Therms</u>	
G. Moisture - Before Pad	<u>.03%</u>	
H. Moisture - After Pad	<u>59%</u>	
J. Moisture - Leaving Frame	<u>0%</u>	
K. Type of Finish	<u>P-3</u>	
L. Volume of Finish Consumed	<u>55.7 Gals.</u>	
M. Yards Processed	<u>2024 Yds.</u>	
Meter Yds: End <u>8035</u>		
Meter Yds: Start <u>6011</u>		

N. Exhaust Stacks

No. 1
 No. 2
 No. 3
 No. 4
 Ambient
 Surface
 Misc:

Vol. CFM	Temp. OF	Dew Point OF	Vol. CFM	Temp. OF	Dew Point OF
3850	315°				
3900	320°				
3900	320°				
	124°				

WET CONTINUOUS DYEING OF CARPETS

Plant Galaxy Carpet Mills, Inc. Date 7-22-82

Shift 3rd, 1st & 2nd Time: Start 11:00 p.m. - Finish 11:00 p.m. -
7/21 7/22

Yds. Dyed 117,450 lbs.
48,453 s.y.

Shade All

Carpet Specifications

Construction Cut & Loop

Weight Avg. 37.78 ozs./sq. yd.

Width 12'

Energy Consumption (B.T.U. Equivalents)
 Process

	Beck	Wet Continuous	Foam Continuous
A. Dyeing			
1. Water Usage		0.62 gals./lb. 2.27 gals./s.y.	
2. Steam Usage		5,552 BTUs/lb. 13,458 BTUs/s.y.	
3. Electricity*		130 BTUs/lb. 315 BTUs/s.y.	
4. Fuel (Lift truck usage)		18.17 BTUs/lb. 45.07 BTUs/s.y.	
B Drying			
1. Water Usage Wet Out Box			
2. Steam (Radiators) (Steam Fixation)	N/A		
3. Electricity			
Total Energy Consumption			

*Should include where applicable:

a. Beck reel		j. Dye make-up mixers	*
b. Exhaust fans		k. Backbeater	*
c. Pull reel		l. Traverse mechanism	
d. Straightening frame		m. Foam machine	
e. U-box	*	n. Tenter track	
f. Production line	*	o. Backbeater and lint collector	
g. Steamer exhaust fans	*	p. Roll up	*
h. Vacuum extractors	*		
i. Cut down	*		

4.0 FINDINGS

4.1 COMPARISON OF PROCESS ENERGY USE

The primary advantage of foam finishing over wet finishing is that the fabrics pick up much less water when being coated with the finishing chemicals. Foam finishing does not add as much water to the fabric since some of the diluting agent in the foam is air. Table 4.1 details the average water pickup; the foam-finished fabrics picked up 48 to 53% less water than the wet-finished fabrics. The difference in water pickup in dyeing and finishing carpets is even more pronounced, because with foam processing, color can be more precisely controlled and a second bath to wash out excess dye is not necessary. With careful control, this lower water pickup can be transferred directly to lower energy consumption in the dryer. To ensure the addition of an equal amount of finish chemicals to the goods, the finishing solution before foaming contains twice to three times the concentration of chemicals as in wet processing. The air in the foam gives it greater bulk, thus assuring even distribution of chemicals in the fabric for a high quality finish.

TABLE 4.1
MOISTURE PICKUP WET VS FOAM FINISHING

Type of Textile	Water Picked Up Per Lb Dry Goods (Lb)		Reduction in Water Pickup By Foam Finishing	
	Wet Finished	Foam Finished	(Lb)	(%)
Tubular Knits	0.52	0.25	0.27	52
Broad Woven (Harodite)	0.77	0.36	0.41	53
Broad Woven (Wansona)	0.87	0.45	0.42	48
Carpets (Beck Process)	7.00	1.7	5.30	76
Carpets (Continuous Process)	7.91	1.7	6.21	79

Table 4.2 summarizes how well the reduction in moisture content achieved through foam finishing correlates with lower energy consumption. Energy savings ranged from 37 to 57% for plants where some dryer adjustments were made. The only site that did not achieve energy savings did foam finish their goods, but did not lower the temperature setting on the dryers to take advantage of the lower moisture content of the incoming fabric. Because this plant neither lowered the dryer temperature nor increased the finishing line speed, it alone failed to achieve energy savings. Even though the energy savings for the lighter goods ranged from 37 to 42%, the savings were lower than the decrease in moisture content of the wet fabrics. These data indicate that with further careful adjustments, plants could realize higher energy savings in the dryers by using a combination of:

TABLE 4.2
ENERGY USED TO FINISH FABRICS

Type of Textile	Wet Finishing Btu/lb Finished Fabric	Foam Finishing Btu/lb Finished Fabric	Energy Saving Btu/lb Finished Fabric	Percent Reduction	
				Energy Consumption	Water Pickup
Tubular Knits	3,750	2,370	1,380	37	52
Broad Woven (Harodite)*	850	490	360	42	53
Broad Woven (Wansona)**	12,200	12,200	0	0	48
Carpets (Beck Process)	13,600	8,600	5,000	37	76
Carpets (Continuous Process)	20,200	8,600	11,600	57	79

*The Harodite finishing line has been well adjusted for a uniform product, and is very efficient.

**The Wansona finishing line handles a wide variety of textile widths and weights. The dryers have been set up for the heaviest weight material, so energy consumption for lighter materials is high.

1. Further lowering the temperature in the dryer, and
2. Further increasing the speed of fabric passing through the dryer.

One plant processing broad-woven goods (Harodite) lowered the air temperature in its dryer from 300°F for wet finishing to 220°F for foam finishing in test runs documented by the monitoring equipment. In further trials with foam finishing, plant personnel lowered the dryer temperature to 190°F and dried the fabric to the same final moisture levels. Although we could not document the additional energy savings because the monitoring equipment malfunctioned during these runs, it appears that further energy savings were achieved.

The site finishing tubular knits (Health-tex) increased the speed of the finishing line by 60% from 25 yd/minute with wet finishing to 40 yd/minute for foam finishing. This increase in speed resulted in an energy saving of 37%; had the host plant also lowered the air temperature in the dryer, the percent energy savings might well have approached the percent reduction in moisture.

The average efficiencies of the various dryers varied from 7 to 78% during the drying of wet-finished goods, as is shown in Table 4.3. The plants with very low average dryer efficiencies are probably overdrying many of their goods. For example, the dryer efficiencies for tubular knits varied from 12% for the lighter weight goods to 55% for the heaviest weight goods, with an average of 18% on the overall product mix. (See Appendix B for dryer efficiency on individual runs.) It appears that plants set the dryer for their heaviest-weight goods and did not lower the temperature settings for the lighter-weight goods that account for most of their production. The plant with the 78% average dryer efficiency (Harodite) finishes only one weight of goods and has carefully set the dryer conditions for this one product. The knowledge gained and attention given to energy consumption during this program should help the plants schedule their finishing runs to achieve even lower energy consumption in the future.

TABLE 4.3
DRYER EFFICIENCIES*

Type of Textile	Average Dryer Efficiency* During Wet Finishing (%)
Tubular Knits	18
Broad Woven (Harodite)	7
Broad Woven (Wansona)	78
Carpets (Beck Process)	35
Carpet (Continuous Process)	35

*Efficiency is defined as the thermal energy required to evaporate the water from the fabric, divided by the total thermal energy supplied to the dryer.

Table 4.4 details the potential annual energy savings if all production were done by foam finishing at each plant. The table gives a breakdown of energy use and the percentage reduction for both thermal energy and electric energy as well as the total energy savings reported in Table 4.2. The plant that achieved its energy savings by increasing the finishing line speed by 60% achieved similar percentage reductions of both its thermal and electric energy consumption. The plant that achieved energy savings by a combination of increased finishing line speeds and reduced dryer temperatures (shown in Table 4.5) showed a larger percentage of thermal savings than savings in electric energy. The site that converted from a batch process (Beck carpet dyeing) to continuous foam dyeing (shown in Table 4.6) actually increased electric energy consumption because of the continuous handling of the carpet rolls, but still had a 37% reduction in overall energy use because less heat was required. Conversion of the wet continuous dyeing operation to foam continuous dyeing (Table 4.7) showed a lower electric energy consumption because the washing step after steam setting was eliminated. This conversion also showed the most striking overall energy reduction (57%) largely because foam dyeing can provide better control of the amount of dye added to the carpets. The dye can be fixed in the steaming step, eliminating the need for washing the carpets after the steaming step and then redrying the washed carpets.

TABLE 4.4
ANNUAL ENERGY CONSUMPTION FOR FINISHING TUBULAR KNITS

Basis: 10,671,774 Yards Processed in 1982

Item	Natural Gas 10 ⁹ Btu's	Electric Energy Megawatt Hours	Total Energy* 10 ⁹ Btu's
Conventional Wet Finishing	18.8	484	23.1
Foam Finishing	11.9	259	14.6
Reduction in Energy Use	6.9	225	8.5
Percent Reduction in Energy Use	37	36	37

* Conversion of 1 kilowatt-hour into the 10,500 Btu's of thermal energy required to generate it.

TABLE 4.5

ANNUAL ENERGY CONSUMPTION FOR FINISHING BROAD WOVENS

Basis: 14,000,000 Yards Processed in 1982

Item	Natural Gas 10 ⁹ Btu's	Electric Energy Megawatt Hours	Total Energy* 10 ⁹ Btu's
Conventional Wet Finishing	3.70	26.9	3.98
Foam Finishing	2.06	22.8	2.30
Reduction in Energy Use	1.64	4.1	1.69
Percent Reduction in Energy Use	44	15	42

*Conversion of 1 kilowatt-hour into the 10,500 Btu's of thermal energy required to generate it.

TABLE 4.6

ANNUAL ENERGY CONSUMPTION FOR BECK DYEING OF CARPETS
COMPARED WITH FOAM DYEING

Basis: 15,840,000 Square Yards Processed in 1982

Item	Steam Use 10 ⁹ Btu's	Electric Energy Megawatt Hours	Total Energy* 10 ⁹ Btu's
Beck Dyeing	186	2,851	216
Foam Dyeing	99.6	3,484	136
Reduction in Energy Use	86.4	(633)	80
Percent Reduction in Energy Use	47	(22)	37

*Conversion of 1 kilowatt-hour into the 10,500 Btu's of thermal energy required to generate it.

TABLE 4.7

**ANNUAL ENERGY CONSUMPTION FOR WET CONTINUOUS DYEING OF
CARPETS COMPARED WITH FOAM DYEING**

Basis: 15,840,000 Square Yards Processed in 1982

Item	Steam Use 10 ⁹ Btu's	Electric Energy Megawatt Hours	Total Energy* 10 ⁹ Btu's
Wet Continuous Dyeing	277	4,229	321
Foam Dyeing	99.6	3,484	136
Reduction in Energy Use	177.4	745	185
Percent Reduction in Energy Use	64	18	58

*Conversion of 1 kilowatt-hour into the 10,500 Btu's of thermal energy required to generate it.

4.2 COMPARISON OF ECONOMICS

The economics of the conversion of existing wet-finishing lines to foam-finishing lines are extremely attractive. Production cost savings in labor and energy as well as annualized capital costs were included in the analysis. Although not documented, additional savings appeared to have occurred through reduced use of chemicals. Table 4.8 summarizes the operating cost savings that result from the retrofitting of foam finishing on existing finishing lines. The savings on operating costs on lighter-weight goods vary from 16 to 36%. The plant finishing tubular knits showed the largest reduction in operating costs (36%) because it took advantage of the lower energy requirements during drying by increasing the finishing line speed by 60%. Table 4.8 also summarizes the operating cost savings that result from retrofitting foam dyeing on existing dyeing lines for carpets. The savings on operating costs ranged from 28 to 38%.

TABLE 4.8

OPERATING COSTS OF FINISHING OPERATIONS

Type of Textile	Operating Costs — \$/1000 Yds		Reduction by Using Foam Finishing	
	Wet Finishing	Foam Finishing	(\$)	(%)
Tubular Knits	\$ 71.67	\$45.27	\$26.40	36
Broad Wovens	13.40	11.20	2.20	16
Carpets (Beck Process)	137.63	98.88	38.75	28
Carpets (Continuous Process)	158.84	98.88	59.96	38

Tables 4.9 and 4.10 detail the operating costs for the wet and foam finishing of tubular knits. This plant achieved its energy savings solely by increasing the speed of its finishing line. The plant finishing broad-woven fabrics gained most of its energy savings by reducing the dryer temperature. It could increase the line speed by only 18% because of drive mechanism limitations. Even though it achieved a 42% reduction in energy use, it lowered its overall operating costs by only 16%. This example shows that it is highly advantageous to use the extra capacity of the dryer that foam finishing offers by increasing the finishing line speed. Tables 4.11 and 4.12 detail these operating costs for wet and foam finishing of broad-woven fabrics.

In comparing the batch process Beck dyeing (Table 4.13) with retrofitting foam dyeing on an existing continuous dyeing line, we found an operating cost saving of 28%. This saving was largely due to a reduction in energy use, but carpet dyeing is so energy-intensive that a saving in this one category results in dramatic overall savings. The other comparison is between a continuous line set up for either wet dyeing or foam dyeing of carpets. In this case, the energy savings were even more dramatic; the overall operating cost reduction reached 38%. The major reasons for the dramatic reduction in energy use with foam dyeing centered on the more controlled application of the dye before the carpets were steamed to fix the dye. When the dye was applied by foam, the carpets did not have to be washed afterward (adding new water that must be removed), and the hot carpets from the steamer could simply be cool-air dried. When the dye was applied by dipping in a dye bath, excess dye solution had to be washed from the carpet after steam setting. The washed carpet then required hot air drying that dramatically increased energy consumption. Tables 4.14 and 4.15 present the detailed breakdown for operating costs on wet-continuous and foam-continuous dyeing. Details of the runs are shown in Appendix B.

Looking at the capital investments required to reap this saving, we find two different investments required for the lightweight and heavyweight goods. The capital requirement for the light goods retrofit was \$30,000. Even though it was difficult to estimate installation costs, we chose a relatively low installation factor of 50% additional investment to bring the installed cost to \$45,000. The installation estimate is low because most of the retrofit equipment is assembled before delivery to the plant. The foamer requires little installation and requires only normal service electric power and low-pressure compressed air if available (a small compressor can be part of the foamer cart if compressed air is not available). For the carpet installation, the investment is higher (\$80,000) largely because of the larger rolls required. Installation of larger rolls should bring the installed cost to \$120,000, using the 50% factor for installation.

These capital investments produce the annual savings in operating costs summarized in Tables 4.16 through 4.19. These savings ranged from \$30,400 for broad wovens to \$949,700 for continuous dyeing of carpets. In all cases except continuous dyeing of carpets, the largest savings were in labor and energy costs. With continuous dyeing of carpets, no labor was saved since the line speed was not increased, but carpet dyeing is so energy-intensive that the energy savings alone produced the largest savings at any plant.

TABLE 4.9

TUBULAR KNITS – CONVENTIONAL FINISHING

Basis: Line Speed – 25 Yards/Minute
 (Raw Materials are the Same as Foam Finishing –
 Same Pickup of Finishing Chemicals)

Item	Units Used in Cost Basis	\$/Unit	Units Consumed Per 1000 Yds. of Product	\$ Per 1000 Yards of Product
Variable Costs				
Direct Labor (3 persons – 3 shifts)	Hours	\$11.60	2.00	\$23.20
Supervisory (1/4 person* – 1 shift)	Hours	16.00	0.0555	0.89
Maintenance (1/2 person* – 1 shift)	Hours	11.60	0.1111	1.29
Labor Overhead (40% of labor)				10.15
TOTAL LABOR				35.53
Energy				
Natural Gas	Millions Btu	6.22	1.765	10.98
Electrical Energy	Kilowatt hours	0.066	45.41	3.00
TOTAL ENERGY				<u>13.98</u>
TOTAL VARIABLE				49.51
Fixed Costs				
Dryer Leasing	Months	430.00	0.002249**	0.97
Plant Overhead (60% of labor costs)				21.20
TOTAL FIXED				<u>22.17</u>
TOTAL OPERATING COSTS WITHOUT CHEMICALS				\$71.68

*Personnel have other duties.

**Based on 1981 production of 5,335,887 yards of finished fabric per finishing line.

TABLE 4.10

TUBULAR KNITS – FOAM FINISHING

Basis: Line Speed 40 Yards/Minute
(Raw Materials are the Same as Wet Finishing –
Same Pickup of Finishing Chemicals)

Item	Units Used in Cost Basis	\$/Unit	Units Consumed Per 1000 Yds. of Product	\$ Per 1000 Yards of Product
Variable Costs				
Direct Labor (3 persons – 3 shifts)	Hours	\$11.60	1.25	\$14.50
Supervisory (1/4 person ** – 1 shift)	Hours	16.00	0.03472	0.56
Maintenance (1/2 person ** – 1 shift)	Hours	11.60	0.06944	0.81
Labor Overhead (40% of labor)				6.34
TOTAL LABOR				22.21
Energy				
Natural Gas	Millions of Btu	6.22	1.12	6.97
Electrical Energy	Kilowatt hours	0.066	24.32	1.60
TOTAL ENERGY				8.57
TOTAL VARIABLE				30.78
Fixed Costs				
Foaming Equipment (10% of Capital Cost/ Year) ***		375./ month	0.001406***	0.53
Dryer Leasing	Months	430.00	0.001406***	0.60
Plant Overhead (60% of labor costs)				13.32
TOTAL FIXED				14.45
TOTAL OPERATING COSTS WITHOUT CHEMICALS				\$45.23

*Personnel have other duties.

**\$45,000 for conversion costs including foamers, controls, horizontal pad rolls, and installation.

***Based on an increased speed from 25 yd/minute to 40 yd/minute.

TABLE 4.11

BROAD WOVENS – CONVENTIONAL FINISHING

Basis: Line Speed – 85 Yards/Minute
 (Raw Materials are the Same as Foam Finishing –
 Same Pickup of Finishing Chemicals)

Item	Units Used in Cost Basis	\$/Unit	Units Consumed Per 1000 Yds. of Product	\$ Per 1000 Yards of Product
Variable Costs				
Direct Labor (2 persons – 3 shifts)	Hours	\$11.60	0.392	4.55
Supervisory (1/4 person* – 1 shift)	Hours	16.00	0.0163	0.26
Maintenance (1/2 person* – 1 shift)	Hours	11.60	0.0327	0.38
Labor Overhead (40% of labor)				2.08
TOTAL LABOR				7.27
Energy				
Natural Gas	Millions Btu	6.22	0.264	1.64
Electrical	Kilowatt hours	0.066	1.92	0.13
TOTAL ENERGY				<u>1.77</u>
TOTAL VARIABLE				9.04
Fixed Costs				
Plant Overhead (60% of labor costs)				4.36
TOTAL FIXED				<u>4.36</u>
TOTAL OPERATING COSTS WITHOUT CHEMICALS				\$13.40

*Personnel have other duties.

TABLE 4.12

BROAD WOVENS – FOAM FINISHING

Basis: Line Speed 100 Yards/Minute
 (Raw Materials are the Same as Wet Finishing –
 Same Pickup of Finishing Chemicals)

Item	Units Used in Cost Basis	\$/Units	Units Consumed Per 1000 Yards of Product	\$ Per 1000 Yards of Product
Variable Costs				
Direct Labor (2 persons – 3 shifts)	Hours	\$11.60	0.333	\$3.86
Supervisory (1/4 person* – 1 shift)	Hours	16.00	0.0139	0.22
Maintenance (1/2 person* – 1 shift)	Hours	11.60	0.0278	0.32
Labor Overhead (40% of labor)				1.76
TOTAL LABOR				6.16
Energy				
Natural Gas	Millions of Btu	6.22	0.147	0.91
Electrical Energy	Kilowatt hours	0.066	1.63	0.11
TOTAL ENERGY				1.02
TOTAL VARIABLE				7.18
Fixed Costs				
Foaming Equipment (10% of Capital Cost/Year)**		\$375./ month	0.000857***	0.32
Plant Overhead (60% of labor costs)				3.70
TOTAL FIXED				4.02
TOTAL OPERATING COSTS WITHOUT CHEMICALS				\$11.20

*Personnel have other duties.

**\$45,000 for conversion costs including foamers, controls, horizontal pad rolls, and installation.

***Based on foaming of 14,000,000 yards per year of fabric.

TABLE 4.13

BECK DYEING AND CONTINUOUS DRYING OF CARPETS

Basis: 2000 Square Yards/Hour Dyed and Dried
 Beck Dyeing and Continuous Drying
 (This Capacity Might Require 5 to 10 Beck
 Dyers and 1 Dryer)
 Raw Material Usage Same as for Foam Dyeing

Item	Units Used In Cost Basis	\$/Unit	Units Consumed Per 1000 Yds. of Product	\$ Per 1000 Yards of Product
Variable Costs				
Direct Labor (4 persons – 3 shifts, 1 person on Beck & forklift, 2 persons on drier)	Hours	\$11.60	2.00	\$23.20
Supervisory (1/2 person) *	Hours	16.00	0.250	4.00
Maintenance (1/2 person) *	Hours	11.60	0.250	2.90
Labor Overhead (40% of labor)	Hours	11.60		12.04
TOTAL LABOR				42.14
Energy				
Fuel for Forklift	Millions Btu	10.20	0.119	1.21
Steam	Millions Btu	5.30	11.76	62.32
Electrical Energy	Kilowatt hours	0.040	180.	6.68
TOTAL ENERGY				<u>70.21</u>
TOTAL VARIABLE				112.35
Fixed Costs				
Plant Overhead (60% of labor costs)				25.28
TOTAL FIXED				<u>25.28</u>
TOTAL OPERATING COSTS				\$137.63

*Personnel have other duties.

TABLE 4.14

CONTINUOUS WET DYEING AND DRYING OF CARPETS

Basis: 2000 Square Yards/Hour

Continuous Wet Dyeing, Steaming, Washing
and Drying

Raw Materials are the Same as for Foam Dyeing

Item	Units Used in Cost Basis	\$/Unit	Units Consumed Per 1000 Yds. of Product	\$ Per 1000 Yards of Product
Variable Costs				
Direct Labor (3 persons — 3 shifts 2 persons on dryer, 1 person on forklift)	Hours	\$11.60	1.5	\$17.40
Supervisory (1/2 person)*	Hours	16.00	0.25	4.00
Maintenance (1/2 person)*	Hours	11.60	0.25	2.90
Labor Overhead (40% of labor)				9.72
TOTAL LABOR				34.02
Energy				
Fuel for Forklift	Millions Btu	\$10.20	0.101	1.03
Steam	Millions Btu	5.30	17.49	92.70
Electrical Energy	Kilowatt hours	0.04	267.	10.68
TOTAL ENERGY				104.41
TOTAL VARIABLE				138.43
Fixed Costs				
Plant Overhead (60% of labor costs)				20.41
TOTAL FIXED				20.41
TOTAL OPERATING COSTS				\$158.84

*Personnel have other duties.

TABLE 4.15

CONTINUOUS FOAM DYEING AND AIR DRYING OF CARPETS

Basis: 2000 Square Yards/Hour
Continuous Wet Dyeing, Steaming, and Air Drying

Item	Units Used in Cost Basis	\$/Unit	Units Consumed Per 1000 Yds. of Product	\$ Per 1000 Yards of Product
Variable Costs				
Direct Labor (3 persons – 3 shifts, 2 persons on equipment, 1 person on forklift)	Hours	\$11.60	1.5	\$17.40
Supervisory (1/2 person)*	Hours	16.00	0.25	4.00
Maintenance (1/2 person)*	Hours	11.60	0.25	2.90
Labor Overhead (40% of labor)				9.72
TOTAL LABOR				34.02
Energy				
Fuel for Forklift	Millions Btu	10.20	0.101	1.03
Steam	Millions Btu	5.30	6.29	33.34
Electrical Energy	Kilowatt hours	0.04	220.	8.80
TOTAL ENERGY				43.17
TOTAL VARIABLE				77.19
Fixed Costs				
Foaming Equipment (10% of Capital Cost/Year)**		\$1000/ month	0.00069	0.69
Plant Overhead (60% of labor costs)				20.41
TOTAL FIXED				21.10
TOTAL OPERATING COSTS				\$ 98.29

*Personnel have other duties.

**\$120,000 for conversion costs including foamers, controls and knife-over roll.

TABLE 4.16

ANNUAL OPERATING COST SAVINGS – TUBULAR KNITS

Basis: 5,335,887 Yards Per Year in Each Finishing Line

Item	Conventional Finishing	Foam Finishing	Annual Savings
Labor Related Costs	\$189,600	\$118,500	\$ 71,100
Energy Related Costs	74,600	45,700	28,900
Fixed Costs	<u>118,000</u>	<u>77,100</u>	<u>40,900</u>
Totals	\$382,200	\$241,300	\$140,900

TABLE 4.17

ANNUAL OPERATING COST SAVINGS –
BROAD WOVENS*

Basis: 14,000,000 Yards Finished Per Year

Item	Conventional Finishing	Foam Finishing	Annual Savings
Labor Related Costs	\$101,400	\$ 86,200	\$15,200
Energy Related Costs	24,800	14,300	10,500
Fixed Costs	<u>61,000</u>	<u>56,300</u>	<u>4,700</u>
Totals	\$187,200	\$156,800	\$30,400

*Harodite

TABLE 4.18

**ANNUAL OPERATING COST SAVINGS
BECK CARPET DYEING**

Basis: 15,840,000 Square Yards Dyed

Item	Beck Dyeing	Foam Dyeing	Annual Savings
Labor Related Costs	\$ 667,500	\$ 538,900	\$128,600
Energy Related Costs	1,112,000	683,800	428,200
Fixed Costs	<u>400,400</u>	<u>343,600</u>	<u>56,800</u>
Totals	\$2,179,900	\$1,566,300	\$613,600

TABLE 4.19

**ANNUAL OPERATING COST SAVINGS
CONTINUOUS CARPET DYEING**

Basis: 15,840,000 Square Yards Dyed

Item	Wet Dyeing	Foam Dyeing	Annual Savings
Labor Related Costs	\$ 538,900	\$ 538,900	\$ 0
Energy Related Costs	1,653,800	683,800	970,000
Fixed Costs	<u>323,300</u>	<u>343,600</u>	<u>(20,300)</u>
Totals	\$2,516,000	\$1,566,300	\$949,700

In trying to relate these savings in annual operating costs to the capital investment necessary for retrofitting, we performed a computerized dcf analysis and payback period analysis (shown in Appendix C) and found the dcf internal rate of return presented in Table 4.20. The dcf internal rate of return after taxes for the lighter-weight fabrics ranged from 42 to 125%, while the dcf internal rate of return for the carpets ranged from an outstanding 136 to 140%. If the extra capacity of the finishing line cannot be used, credit can be taken only for the energy savings. In this case, the dcf internal rate of return varied from 14 to 40% for the lighter-weight fabrics and 130 to 140% for the carpets. In all cases, the dcf internal rate of return is attractive. The details of the analysis are presented in Appendix C.

TABLE 4.20
SUMMARY OF ECONOMIC INCENTIVES
FOR RETROFIT FOAM FINISHING INTO
EXISTING PROCESSES

Type of Textile	Discounted Cash Flow-Internal Rate of Return (%)	
	Based on Total Savings	Based on Energy Savings Only
Tubular Knits	125	40
Broad Wovens	42	14
Carpets — Beck	136	130
Carpets — Continuous	140	140

To put foam finishing instead of wet finishing into a new mill takes no additional capital investment. All of the operating savings found with the retrofits will accrue to the new plant, and the capital investment will be lower because smaller dryers are needed. Few of the problems normally associated with the introduction of a new technology into any process have been encountered. For example — what effect will foam finishing have on the quality of the finished fabric? The host plants reported excellent finish quality and very low scrap rates. In fact, several other mills, not covered in this audit, have already reported favorable results on the quality of the product with foam finishing. The equipment and know-how are available from at least five sources:

- United Merchants and Manufacturers, Langley, SC.
- Gaston County Dyeing Machine Company, Mount Holly, NC.
- Textile Rubber and Chemical Co., Dalton, GA.
- Eze, Inc., Dalton, GA.
- Latex Equipment Systems, Inc., Dalton, GA.

Another question is whether the retrofitting for foam finishing will disrupt production schedules on the finishing lines. At the host plants, the workers installed all equipment during the normal annual shutdown periods for scheduled maintenance. Furthermore, after modification the dryers can still process fabric by wet finishing if any problems should arise in the foam-finishing equipment. The host plants generally finished fabrics successfully on their first trials, however.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The audit confirmed that foam finishing of tubular knits, broad wovens, and carpets is a technically sound and economically attractive process that reduces energy consumption. The host sites retrofitted foam finishing into the existing lines without production upsets and with no adverse effects on quality or scrap rates. The plants were able to add drying capacity to their finishing lines by either increasing the speed of finishing or lowering the temperature of the dryers.

Investments for retrofitting of the foam finishing at the host plant had a dcf internal rate of return varying from 42 to 140% when energy savings and increased capacity were considered. Even if the extra production capacity could not be used, the retrofitting would have a dcf internal rate of return varying from 14 to 140% on energy savings alone. Our analysis indicates that several host plants could realize further energy savings because many of the lighter grades of goods may be dried more than is necessary.

Arthur D. Little believes that the strong economic incentives identified in this study should induce mill managers to adopt foam finishing in all new and existing textile finishing lines. This conversion will occur as managers more fully understand all the technical, energy, and economic benefits of this process.

APPENDIX A

HEAT AND WATER BALANCES
TO CHECK ACCURACY OF
MONITORING EQUIPMENT

Heat Balance on Run of 9/15/81

Finish 1457

Data:

Run Time = 82 minutes
Finish Used = 55.7 gallons
Natural Gas Used = 3.60 million BTU
Exhaust Gas B = 3850 cubic feet per minute at 315⁰F
Exhaust Gas C = 3900 cubic feet per minute at 320⁰F
Exhaust Gas D = 3900 cubic feet per minute at 320⁰F
Heat Capacity of Exhaust Gas = 0.0185 BTU per standard cubic foot ⁰F

Heat Balance: (Ambient Temperature of 68⁰F is Used As the Zero Enthalpy)

Heat In

Stream E (Chemical Heat in Natural Gas) = 3.60 million BTU

Heat Out

Sensible Heat Out in Exhaust Gas

Stream B = (Volume Flow) · (Time) · (Heat Capacity) · (Temperature Rise)

$$= (3850 \text{ cfm}) \left(\frac{520^{\circ}\text{R}}{775^{\circ}\text{R}} \right) (82 \text{ minutes}) \left(0.0185 \frac{\text{BTU}}{\text{scf}} \right) (315^{\circ}\text{F} - 68^{\circ}\text{F})$$

Stream B = 0.968 million BTU
Similarly Stream C = 0.994 million BTU
Stream D = 0.994 million BTU

Heat to Vaporize Water

Water = (55.7 gallons)(8.39 lbs/gal) (1023 BTU/lb) =

Water = 0.475 million BTU

Total Heat Out = 3.43 million BTU

$$\text{Heat Not Accounted} = \left(\frac{3.60 - 3.43}{3.60} \right) \times 100\% = 4.4\%$$

The flow sensor on Stream E is working properly since the agreement is within 5% and the agreement would be even closer if the small amount of heat losses through the walls of the oven were added to the calculated heat out.

Water Balance

Water In

$$\text{Finish Evaporated} = (55.7 \text{ gallons})(8.33 \text{ lbs/gallon}) \left(\frac{21.1 \text{ scf}}{1 \text{ lb}} \right)$$

$$\text{Finish Evaporated} = \underline{9,770 \text{ scf water vapor}}$$

Note: One scf of methane burned produces two scf water vapor

$$\text{Water from methane} = 3.6 \text{ million BTU} \left(\frac{1 \text{ scf}}{1000 \text{ BTU}} \right) \cdot 2$$

$$\text{Water from methane} = \underline{72,000 \text{ scf water vapor}}$$

$$\underline{\text{Total Water In}} = 81,770 \text{ scf}$$

Water Out

Exhaust Gas

$$\text{Relative Humidity Out} = 2\% \text{ at } 320^{\circ}\text{F}$$

$$\text{or Humidity} = 0.083 \text{ lb water/lb gas}$$

$$\text{Dry Gas Out} = [\text{Stream B+C+D}]$$

$$\text{Stream B} = [(3850 \text{ cfm}) \cdot \left(\frac{520^{\circ}\text{R}}{775^{\circ}\text{R}} \right) \cdot (82 \text{ minutes}) \cdot \left(\frac{28 \text{ lbs}}{379 \text{ cubic feet}} \right)]$$

$$\text{Stream B} = 15,650 \text{ lbs}$$

$$\text{Stream C} = 15,750 \text{ lbs}$$

$$\text{Stream D} = 15,750 \text{ lbs}$$

$$\text{Total Dry Air Out} = \underline{47,150 \text{ lbs}}$$

$$\text{Water Out} = (0.083 \text{ lb water/lb air}) (47,150 \text{ lbs air}) =$$

$$\text{Water Out} = 3,905 \text{ lbs water}$$

$$\text{Water Out} = 3,905 \text{ lb} \cdot \left(\frac{379 \text{ scf}}{18 \text{ lbs}} \right)$$

$$\text{Water Out} = 82,200 \text{ scf vapor}$$

$$\text{Difference} = \left(\frac{82,200 - 81,770}{82,200} \right) \times 100\%$$

$$\text{Difference} = \underline{\underline{0.5\%}}$$

The balance checks well.

APPENDIX B

SUMMARIZED DATA

WET FINISHING OF TUBULAR KNITS

<u>Run Number</u>	<u>Total Yards Finished</u>	<u>Percent Water Pickup After Finishing</u>	<u>Total Energy Required Btu/lb</u>	<u>Dryer Efficiency Percent</u>
9-15-81	2024	59	3391	16.9
9-21-81	439	54	2990	17.5
9-21-81	1331	68	3601	18.3
9-22-81	7848	52	3555	14.2
9-25-81	6565	58	3597	15.6
9-28-81	2988	45	3193	13.7
9-28-81	943	59	3124	18.3
9-29-81	1615	67	3244	20.0
9-29-81	1789	61	3421	17.3
10-5-81	4599	60	3874	15.0
10-5-81	1703	61	2966	19.9
10-6-81	3411	55	3461	15.4
10-6-81	1546	49	3493	13.6
10-6-81	961	64	3508	17.7
10-7-81	3664	68	3333	19.8
10-7-81	1122	67	2973	21.9
10-9-81	854	54	2818	18.6
10-9-81	3736	66	3240	19.7
10-9-81	2584	66	2508	25.5
10-13-81	6927	61	3083	19.2
10-13-81	1673	65	4098	15.4
10-14-81	4228	60	3641	16.0
10-14-81	1545	49	3174	15.0
10-16-81	3910	63	2816	21.7
10-16-81	1827	63	2866	21.3
10-23-81	1265	59	3744	15.3
10-23-81	1444	-	2848	-
10-23-81	1216	58	2550	22.1
10-23-81	622	56	3230	16.8
4-5-82	1499	37	2400	15.0
4-5-82	1758	35	2353	14.4
4-6-82	1770	38	3104	11.9
4-6-82	2083	34	2874	11.5

WET FINISHING OF TUBULAR KNITS - Continued

<u>Run Number</u>	<u>Total Yards Finished</u>	<u>Percent Water Pickup After Finishing</u>	<u>Total Energy Required Btu/lb</u>	<u>Dryer Efficiency Percent</u>
4-7-82	2076	36	3723	9.4
4-7-82	673	39	3404	11.1
4-7-82	1022	30	3662	7.9
4-7-82	727	36	2611	13.4
4-8-82	1362	36	2991	11.7
4-12-82	4674	44	2857	14.9
4-12-82	708	34	2395	13.7
4-13-82	3609	38	2984	12.4
4-14-82	1773	32	3562	8.7
4-14-82	1426	36	3313	10.5
4-15-82	1489	44	3255	13.1
4-15-82	2536	38	2938	12.5
4-15-82	757	39	2360	16.0
4-16-82	1705	35	3428	9.9
4-16-82	3033	33.5	3174	10.2
4-16-82	897	39	2394	15.8
4-20-82	4524	40	2382	16.3
4-21-82	3109	35	3303	10.3
4-21-82	761	30	2587	11.2
4-22-82	2610	36	3363	10.4
4-22-82	1155	42	2171	18.8
4-26-82	4963	39	3331	11.4
4-26-82	3752	36	2780	12.6
4-27-82	2109	36	2912	12.0
4-27-82	1173	39	3379	11.2
4-27-82	3337	38	2206	16.7
4-28-82	2811	35	2991	11.4
4-28-82	1788	42	4070	10.0
4-29-82	1959	39	2441	15.5
4-29-82	2534	38	2491	14.8
4-30-82	4198	35	3269	10.4
4-30-82	1015	37	3219	11.2

WET FINISHING OF TUBULAR KNITS - Continued

<u>Run Number</u>	<u>Total Yards Finished</u>	<u>Percent Water Pickup After Finishing</u>	<u>Total Energy Required Btu/lb</u>	<u>Dryer Efficiency Percent</u>
4-30-82	1230	39	3613	10.5
5-3-82	877	36	2459	14.2
5-3-82	2961	34	2436	13.5
5-3-82	1235	37	2991	12.0
5-4-82	1394	38	3265	11.3
5-4-82	1833	30	3391	8.6
5-5-82	2769	30	3410	8.5
5-5-82	1844	37	2350	15.3
5-10-82	1586	38	2579	14.3
5-12-82	2688	35	2431	14.0
5-14-82	5241	36	2496	14.0
6-8-82	4762	32	2976	10.4
6-8-82	4579	36	2730	12.8
6-10-82	1630	57	2351	23.5
6-10-82	3512	28	2582	10.5
6-11-82	1284	32	2829	11.0
6-11-82	2501	54	2138	24.5
8-4-82	1880	47	3530	12.9
8-5-82	1824	47	2772	16.4
8-5-82	1477	50	2800	17.3
8-5-82	863	46	3046	14.6
8-6-82	1589	54	2702	19.4
8-6-82	5972	45	2757	15.8
8-10-82	1084	50	3099	15.7
8-10-82	1223	-	3227	-
8-10-82	4536	54	2811	18.6
8-12-82	2363	57	2668	20.7
8-16-82	2589	47	3660	12.5
8-17-82	6099	45	3179	13.7
8-18-82	9138	40	2948	13.2
8-19-82	1484	45	3901	11.2
8-19-82	5087	44	3312	12.9
8-20-82	1527	50	3292	14.7

WET FINISHING OF TUBULAR KNITS - Continued

<u>Run Number</u>	<u>Total Yards Finished</u>	<u>Percent Water Pickup After Finishing</u>	<u>Total Energy Required Btu/lb</u>	<u>Dryer Efficiency Percent</u>
8-20-82	3702	52	3145	16.0
8-20-82	936	43	2647	15.8
8-24-82	6295	52	2627	19.2
8-27-82	1379	32	2529	12.3
8-27-82	4095	50	3106	15.6
8-31-82	1153	55	4150	12.9

FOAM FINISHING OF TUBULAR KNITS

<u>Run Number</u>	<u>Total Yards Finished</u>	<u>Percent Water Pickup After Finishing</u>	<u>Total Energy Required Btu/lb</u>	<u>Dryer Efficiency Percent</u>
9-16-81	5491	31	2067	14.5
9-16-81	1870	24	1934	12.0
9-16-81	5438	29	1791	15.7
9-17-81	2065	32	2037	15.2
9-18-81	2422	33	1927	16.6
9-18-81	6961	-	1841	-
9-23-81	3998	-	2344	-
9-23-81	4430	-	1907	-
9-24-81	1049	43	2268	34.7
9-24-81	4510	-	1473	-
9-30-81	5129	21	2503	8.1
10-1-81	967	50	3275	14.8
10-1-81	1118	45	1740	25.1
10-1-81	1442	35	1738	19.5
10-8-81	1337	38	1894	19.4
10-8-81	2375	-	2053	-
10-15-81	15094	28	20.62	13.2
10-19-81	1807	43	17.02	24.5
10-19-81	1010	-	1433	-
10-19-81	1949	19	1882	9.8
10-21-81	6386	29	1953	14.4
10-21-81	1206	24	1635	14.2
10-22-81	2462	-	1985	-
10-22-81	1333	27	1971	13.2
10-22-81	1450	-	1533	-
10-26-81	3189	29	2111	13.3
10-26-81	4350	32	1572	19.8
10-26-81	445	51	1308	37.9
10-27-81	1093	-	2054	-
10-27-81	2612	23	2047	10.9
10-28-81	1217	23	1550	14.4
10-28-81	2122	19	2051	9.0
10-28-81	2044	49	1514	31.4

FOAM FINISHING OF TUBULAR KNITS - Continued

<u>Run Number</u>	<u>Total Yards Finished</u>	<u>Percent Water Pickup After Finising</u>	<u>Total Energy Required Btu/lb</u>	<u>Dryer Efficiency Percent</u>
10-30-81	5578	27	1911	13.7
10-30-81	4014	34	2343	14.1
10-30-81	1768	26	1812	13.9
3-29-82	1205	22	2491	8.5
3-29-82	1066	23	2053	10.8
3-29-82	1485	35	1589	21.4
3-29-82	1048	30	2160	13.5
3-30-82	4244	16	1913	8.1
3-30-82	2103	17	1772	9.3
3-30-82	1170	22	1692	12.6
3-31-82	1597	23	1804	12.4
3-31-82	1423	21	1684	12.1
4-1-82	6330	17	1470	11.2
4-1-82	2354	23	2027	11.0
4-1-82	2017	19	1609	11.5
4-2-82	1019	26	1708	14.8
4-2-82	1377	29	1903	14.8
4-2-82	1856	15	1323	11.0
4-5-82	685	20	1766	11.0
4-5-82	1451	23	1946	11.5
4-5-82	879	21	1823	11.2
4-19-82	6275	18	2278	7.7
4-23-82	3330	25	1504	16.1
4-23-82	5057	31	1739	17.3
4-29-82	3670	28	1901	14.3
4-30-82	2784	26	1736	14.5
5-5-82	1056	35	2029	16.7
5-7-82	1317	19	1776	10.4
5-7-82	3077	23	1651	13.5
5-11-82	1855	23	1621	13.7
5-11-82	2811	30	1621	15.5
5-12-82	2528	36	1793	19.5
5-13-82	5258	23	2155	10.4

FOAM FINISHING OF TUBULAR KNITS - Continued

<u>Run Number</u>	<u>Total Yards Finished</u>	<u>Percent Water Pickup After Finishing</u>	<u>Total Energy Required Btu/lb</u>	<u>Dryer Efficiency Percent</u>
5-14-82	738	19	2124	8.7
5-17-82	1348	20	1609	12.1
5-17 to 19-82	2282/11997/1307	26/22/20	1859/1601/1871	33.6/13.3/10.4
5-21-82	1809	35	1820	18.7
5-21-82	240	23	1678	13.1
5-21-82	921	18	1899	9.2
5-25-82	2491	23	1443	15.4
5-25-82	2824	19	2094	8.8
5-25-82	3884	20	1722	11.3
5-27-82	1789	24	1650	14.1
5-27-82	4271	18	1922	9.1
6-1-82	3722	31	1622	12.0
6-3-82	2839	29	1927	14.6
6-4-82	1958	17	2214	7.5
6-7-82	1918	27	1653	15.8
6-7-82	1800	35	1797	18.9
6-7-82	3276	24	1876	12.4
6-7-82	1350	22	1836	11.6
6-9-82	6812	32	1590	19.5
6-15-82	3234	22	1801	11.8
7-29-82	1859	23	1515	14.7
7-29-82	2041	19	1542	11.9
7-29-82	4040	18	1788	9.8
7-30-82	5675	19	2089	8.8
7-30-82	732	20	1395	13.9
7-30-82	4151	18	1904	9.2
8-2-82	3967	29	1696	16.6
8-2-82	2745	27	1911	13.7
8-2-82	1849	20	1484	13.1
8-2-82	1103	24	1434	16.2
8-3-82	1894	22	1819	11.7
8-3-82	1609	19	1900	9.7
8-4-82	2527	23	1629	13.7

FOAM FINISHING OF TUBULAR KNITS - Continued

<u>Run Number</u>	<u>Total Yards Finished</u>	<u>Percent Water Pickup After Finishing</u>	<u>Total Energy Required Btu/lb</u>	<u>Dryer Efficiency Percent</u>
8-13-82	11496	22	1934	11.0
8-23-82	4692	16	1813	8.6
8-23-82	1841	22	1445	14.8
8-23-82	5044	23	1866	12.0
8-25-82	2658	27	2215	14.3
8-25-82	7786	26	1628	15.5
8-26-82	4822	-	2026	-
8-30-82	6726	58	1751	32.1
8-30-82	3077	33	1861	17.2
9-1-82	6432	26	1902	13.3
9-2-82	2651	45	1731	25.2

WET FINISHING OF BROAD WOVEN GOODS

<u>Run Number</u>	<u>Total Yards Finished</u>	<u>Percent Water Pickup After Finishing</u>	<u>Total Energy Required Btu/lb</u>	<u>Dryer Efficiency Percent</u>
9-28-81	6300	81	880.4	81
10-5-81	4790	89.2	1969.4	39
2-23-82	7644	72	794.2	78
-	7930	66	857.3	65
2-23-82	8115	75	865.5	74
2-23-82	3085	77	883.2	75
2-23-82	21140	76	824.3	79
2-23-82	2856	79	855.0	80
2-23-82	5450	72	853.5	72
2-23-82	9820	75	682.6	96
4-5-82	10560	82	748.9	103
4-5-82	5515	77	746.0	90
4-5-82	20095	72	844.8	75
4-5-82	3400	74	703.3	94
4-6-82	13000	74	790.0	82
8-19-82	6950	85.7	352.0	-
9-28-81	8500	38	489.1	-
10-15-81	19200	33.9	420.9	65
10-15-81	3325	25	456.8	42
1-12-81	6120	38	2050.3	17
2-1-82	9250	37.8	855.5	26
2-8-82	7560	38.5	813.3	37
2-8-82	7300	37.1	808.3	35

FOAM FINISHING OF BROAD WOVEN GOODS

<u>Run Number</u>	<u>Total Yards Finished</u>	<u>Percent Water Pickup After Finishing</u>	<u>Total Energy Required Btu/lb</u>	<u>Dryer Efficiency Percent</u>
2-8-82	5035	36.7	743.6	39
2-8-82	13470	39.1	799.0	36.0
2-8-82	10350	36.1	793.7	34.0
2-9-82	2273	31.0	775.0	30.41
2-9-82	4480	38.4	935.2	32.25
2-16-82	9359	35.8	613.3	45.86
2-16-82	7610	42.7	601.1	57.14
2-17-82	10000	39.7	803.5	39.33
3-30-82	5200	34.0	375.4	68.0
9-7-82	7150	37.2	93	-
9-7-82	3050	35.4	104	-
9-7-82	7375	39	83	-
9-13-82	6400	38	71	-
9-13-82	4400	34	97	-

BECK DYEING OF CARPETS

<u>Run Number</u>	<u>Pounds Dyed</u>	<u>Total Energy Required Btu/lb</u>
1-25-82	1380	4143
1-25-82	1340	1075
1-25-82	1600	1252
1-25-82	1360	5954
1-25-82	1410	3960
1-25-82	1650	4933
1-25-82	1400	5505
1-25-82	1100	7385
1-25-82	5160	780
1-25-82	5770	1271
1-27-82	1380	6151
1-27-82	2150	3227
1-27-82	1750	835
1-27-82	1550	826
1-27-82	1710	4326
1-27-82	1360	5151

WET CONTINUOUS DYEING AND STEAMING OF CARPETS

<u>Run Number</u>	<u>Total Pounds Dyed</u>	<u>Total Energy Btu/lb</u>
6-28-82	4,086	6692.5
6-29-82	66,934	7734.1
7-12-82	19,814	23,219.0
7-13-82	54,995	8271.2
7-14-82	22,513	9418.3
7-15-82	50,108	7127.0
7-16-82	69,639	8109.7
7-19-82	41,826	8756.2
7-20-82	55,028	9617.2
7-21-82	61,062	4882.2
7-22-82	117,450	5700.2
7-23-82	100,186	5271.2
7-26-82	76,287	8266.2
7-27-82	85,128	6432.2
7-28-82	105,917	4916.2

FOAM DYEING AND STEAMING OF CARPETS

<u>Run Number</u>	<u>Total Pounds Dyed</u>	<u>Total Energy Btu/lb</u>
7-21-82	3498	13,450.8
7-21-82	3623	14,050.8
7-21-82	8775	22,037.0
7-26-82	4231	3,239.3
7-26-82	4620	3,867.4

CONTINUOUS CARPET DRYING

<u>Run Number</u>	<u>Total Pounds Dried</u>	<u>Total Energy Required Btu/lb</u>
5-20-82	23,675.20	3004
5-21-82	56,865.74	1627.55
5-24-82	35,059.99	1786.47
5-25-82	45,775.77	1689.69
5-26-82	58,468.28	1329.23
5-27-82	48,497.00	1583.72
5-27/28-82	61,525.83	1814.14
5-28-82	24,339.17	1841.96
6-1-82	28,660.96	1860.49
6-1/2-82	68,236.06	1928.52
6-4-82	33,083.64	1732.73
6-7-82	28,154.56	1799.11
6-7/8-82	53,526.43	1665.66
6-8-82	66,726.56	1419.28
6-8/9-82	98,207.25	1475.44
6-9-82	46,506.92	1504.62
6-9/10-82	106,767.83	1433.82
6-10-82	54,259.79	1653.11
6-10/11-82	134,900.95	1362.84
6-11-82	64,973.26	1410.6

APPENDIX C

**RESULTS OF COMPUTERIZED
PAYBACK-PERIOD CALCULATIONS**

Table C-1

SUMMARY OF ECONOMIC INCENTIVES
FOR RETROFIT FOAM FINISHING INTO
EXISTING PROCESS WITH CONSTANT DOLLARS

<u>Type of</u> <u>Textile</u>	<u>Payback Period for Capital Investment - Years</u>	
	<u>Based on</u> <u>Total Savings</u>	<u>Based on Energy</u> <u>Savings Only</u>
Tubular Knits	0.8 years	2.4 years
Broad Wovens	2.3 years	4.2 years
Carpets - Beek	0.5 years	0.7 years
Carpets - Continuous	0.4 years	0.4 years

Table C-2

SUMMARY OF ECONOMIC INCENTIVES
FOR RETROFIT FOAM FINISHING INTO
EXISTING PROCESSES WITH 5% INFLATION

<u>Type of</u> <u>Textile</u>	<u>Payback Period for Capital Investment - Years</u>	
	<u>Based on</u> <u>Total Savings</u>	<u>Based on Energy</u> <u>Savings Only</u>
Tubular Knits	0.8 years	2.4 years
Broad Wovens	2.3 years	4.2 years
Carpets - Beck	0.5 years	0.7 years
Carpets - Continuous	0.4 years	0.4 years

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FINANCIAL ANALYSIS & PRODUCT PRICING MODEL - SEPT 1981 VERSION -

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TEXTILE FOAM PROCESSING OF TUBULAR KNITS CONSTANT DOLLARS

SALES VOLUME THOUSAND YARDS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
TUBULAR KNITS	0.0	5300.00	5300.00	5300.00	5300.00	5300.00	5300.00	5300.00	5300.00	5300.00
TOTAL VOLUME	0.0	5300.00	5300.00	5300.00	5300.00	5300.00	5300.00	5300.00	5300.00	5300.00

SALES REPORT DOLLARS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
TUBULAR KNITS	0.	140185.	140185.	140185.	140185.	140185.	140185.	140185.	140185.	140185.
TOTAL SAVINGS	0.	140185.	140185.	140185.	140185.	140185.	140185.	140185.	140185.	140185.

TEXTILE FOAM PROCESSING OF TUBULAR KNITS CONSTANT DOLLARS

INCOME STATEMENT
DOLLARS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
NET SAVINGS	0.	140185.	140185.	140185.	140185.	140185.	140185.	140185.	140185.	140185.
BOOK DEPRECIATION	0.	4500.	4500.	4500.	4500.	4500.	4500.	4500.	4500.	4500.
OPERATING PROFIT	0.	135685.	135685.	135685.	135685.	135685.	135685.	135685.	135685.	135685.
INTEREST INCOME	0.	0.	344.	1021.	1684.	2347.	2844.	3132.	3377.	3623.
INTEREST EXPENSE	0.	37.	37.	0.	0.	0.	0.	0.	0.	0.
PROFIT BEFORE TAX	0.	135648.	135993.	136706.	137369.	138032.	138529.	138817.	139062.	139308.
TAX EXPENSE	0.	57898.	62557.	62885.	63190.	63495.	63723.	63856.	63969.	64081.
PROFIT AFTER TAX	0.	77750.	73436.	73821.	74179.	74537.	74806.	74961.	75094.	75226.

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FOR TAX PURPOSE										
DEPRECIATION	0.	9000.	9000.	9000.	9000.	9000.	0.	0.	0.	0.
TAXABLE INCOME	0.	131148.	131493.	132206.	132869.	133532.	143029.	143317.	143562.	143808.
INCOME TAXES	0.	55828.	60487.	60815.	61120.	61425.	65793.	65926.	66039.	66151.

INVESTMENT CREDIT USED (BOOK AND TAX)	0.	4500.	0.	0.	0.	0.	0.	0.	0.	0.
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RETURN ON GROSS ASSETS	0.0	124.9	88.5	82.2	76.9	72.3	69.3	67.6	66.3	65.0
RETURN ON NET WORTH	0.0	146.4	120.0	120.6	121.2	121.8	122.2	122.4	122.7	122.9
RETURN ON NET OPERAT. ASSETS	0.0	129.5	100.6	107.3	114.8	123.5	133.7	145.6	159.9	177.3

PAT = PROFIT AFTER TAXES

ROGA = PAT (ADJUSTED FOR INTEREST EXPENSE) / AVERAGE BALANCE OF CURRENT ASSETS AND GROSS PLANT + EQUIPMENT

RONW = PAT / AVERAGE NET WORTH

RONA = PAT (ADJUSTED FOR INTEREST INCOME AND EXPENSE) / AVERAGE BALANCE OF NET FIXED ASSETS AND OPERATING WORKING CAPITAL (I.E.:CASH+RECEIVABLES+INVENTORIES+OTHER-PAYABLES)

EQUITY PAYBACK PERIOD
0.8 YEARS
AFTER END OF CONSTRUCTION

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FINANCIAL ANALYSIS & PRODUCT PRICING MODEL
 - SEPT 1981 VERSION -

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TEXTILE FOAM PROCESSING OF TUBULAR KNITS ENERGY ONLY

SALES VOLUME
 THOUSAND YARDS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
TUBULAR KNITS	0.0	5300.00	5300.00	5300.00	5300.00	5300.00	5300.00	5300.00	5300.00	5300.00
TOTAL VOLUME	0.0	5300.00	5300.00	5300.00	5300.00	5300.00	5300.00	5300.00	5300.00	5300.00

SALES REPORT
 DOLLARS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
TUBULAR KNITS	0.	28673.	28673.	28673.	28673.	28673.	28673.	28673.	28673.	28673.
TOTAL SAVINGS	0.	28673.	28673.	28673.	28673.	28673.	28673.	28673.	28673.	28673.

TEXTILE FOAM PROCESSING OF TUBULAR KNITS ENERGY ONLY

INCOME STATEMENT
DOLLARS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
NET SAVINGS	0.	28673.	28673.	28673.	28673.	28673.	28673.	28673.	28673.	28673.
BOOK DEPRECIATION	0.	4500.	4500.	4500.	4500.	4500.	4500.	4500.	4500.	4500.
OPERATING PROFIT	0.	24173.	24173.	24173.	24173.	24173.	24173.	24173.	24173.	24173.
INTEREST INCOME	0.	21.	417.	1124.	1787.	2450.	2947.	3235.	3480.	3726.
INTEREST EXPENSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
PROFIT BEFORE TAX	0.	24194.	24590.	25297.	25960.	26623.	27120.	27408.	27653.	27899.
TAX EXPENSE	0.	6629.	11311.	11636.	11942.	12247.	12475.	12608.	12721.	12833.
PROFIT AFTER TAX	0.	17565.	13278.	13660.	14018.	14376.	14645.	14800.	14933.	15065.

C-8

FOR TAX PURPOSE										
DEPRECIATION	0.	9000.	9000.	9000.	9000.	9000.	0.	0.	0.	0.
TAXABLE INCOME	0.	19694.	20090.	20797.	21460.	22123.	31620.	31908.	32153.	32399.
INCOME TAXES	0.	4559.	9241.	9566.	9872.	10177.	14545.	14678.	14791.	14903.
INVESTMENT CREDIT USED (BOOK AND TAX)	0.	4500.	0.	0.	0.	0.	0.	0.	0.	0.

RETURN ON GROSS ASSETS	0.0	36.0	23.6	21.6	20.0	18.8	18.0	17.5	17.2	16.9
RETURN ON NET WORTH	0.0	39.0	29.5	30.4	31.2	31.9	32.5	32.9	33.2	33.5
RETURN ON NET OPERAT. ASSETS	0.0	37.9	28.8	32.0	35.9	41.0	47.8	57.2	71.3	94.5

PAT = PROFIT AFTER TAXES

ROGA = PAT (ADJUSTED FOR INTEREST EXPENSE) / AVERAGE BALANCE OF CURRENT ASSETS AND GROSS PLANT + EQUIPMENT

RONW = PAT / AVERAGE NET WORTH

RONA = PAT (ADJUSTED FOR INTEREST INCOME AND EXPENSE) / AVERAGE BALANCE OF NET FIXED ASSETS AND OPERATING WORKING CAPITAL (I.E.:CASH+RECEIVABLES+INVENTORIES+OTHER-PAYABLES)

EQUITY PAYBACK PERIOD
2.4 YEARS
AFTER END OF CONSTRUCTION

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FINANCIAL ANALYSIS & PRODUCT PRICING MODEL - SEPT 1981 VERSION -

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TEXTILE FOAM PROCESSING OF BROAD WOVENS IN CONSTANT DOLLARS

SALES VOLUME THOUSAND YARDS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
BROAD WOVENS	0.0	14000.00	14000.00	14000.00	14000.00	14000.00	14000.00	14000.00	14000.00	14000.00
TOTAL VOLUME	0.0	14000.00	14000.00	14000.00	14000.00	14000.00	14000.00	14000.00	14000.00	14000.00

SALES REPORT DOLLARS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
BROAD WOVENS	0.	30800.	30800.	30800.	30800.	30800.	30800.	30800.	30800.	30800.
TOTAL SAVINGS	0.	30800.	30800.	30800.	30800.	30800.	30800.	30800.	30800.	30800.

TEXTILE FOAM PROCESSING OF BROAD WOVENS IN CONSTANT DOLLARS

INCOME STATEMENT
DOLLARS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
NET SAVINGS	0.	30800.	30800.	30800.	30800.	30800.	30800.	30800.	30800.	30800.
BOOK DEPRECIATION	0.	4500.	4500.	4500.	4500.	4500.	4500.	4500.	4500.	4500.
OPERATING PROFIT	0.	26300.	26300.	26300.	26300.	26300.	26300.	26300.	26300.	26300.
INTEREST INCOME	0.	4.	383.	1090.	1754.	2417.	2914.	3202.	3447.	3692.
INTEREST EXPENSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
PROFIT BEFORE TAX	0.	26304.	26683.	27390.	28054.	28717.	29214.	29502.	29747.	29992.
TAX EXPENSE	0.	7600.	12274.	12600.	12905.	13210.	13438.	13571.	13684.	13796.
PROFIT AFTER TAX	0.	18704.	14409.	14791.	15149.	15507.	15775.	15931.	16063.	16196.

FOR TAX PURPOSE										
DEPRECIATION	0.	9000.	9000.	9000.	9000.	9000.	0.	0.	0.	0.
TAXABLE INCOME	0.	21804.	22183.	22890.	23554.	24217.	33714.	34002.	34247.	34492.
INCOME TAXES	0.	5530.	10204.	10530.	10835.	11140.	15508.	15641.	15754.	15866.

INVESTMENT CREDIT USED (BOOK AND TAX)	0.	4500.	0.	0.	0.	0.	0.	0.	0.	0.
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RETURN ON GROSS ASSETS	0.0	38.3	25.5	23.3	21.6	20.2	19.3	18.8	18.4	18.1
RETURN ON NET WORTH	0.0	41.6	32.0	32.9	33.7	34.5	35.1	35.4	35.7	36.0
RETURN ON NET OPERAT. ASSETS	0.0	40.2	31.0	34.4	38.5	43.9	51.0	60.8	75.4	99.0

PAT = PROFIT AFTER TAXES

ROGA = PAT (ADJUSTED FOR INTEREST EXPENSE) / AVERAGE BALANCE OF CURRENT ASSETS AND GROSS PLANT + EQUIPMENT

RONW = PAT / AVERAGE NET WORTH

RONA = PAT (ADJUSTED FOR INTEREST INCOME AND EXPENSE) / AVERAGE BALANCE OF NET FIXED ASSETS AND OPERATING WORKING CAPITAL (I.E.:CASH+RECEIVABLES+INVENTORIES+OTHER-PAYABLES)

EQUITY PAYBACK PERIOD
2.3 YEARS
AFTER END OF CONSTRUCTION

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FINANCIAL ANALYSIS & PRODUCT PRICING MODEL
 - SEPT 1981 VERSION -

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TEXTILE FOAM PROCESSING OF BROAD WOVENS ENERGY ONLY

SALES VOLUME
 THOUSAND YARDS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
BROAD WOVENS	0.0	14000.00	14000.00	14000.00	14000.00	14000.00	14000.00	14000.00	14000.00	14000.00
TOTAL VOLUME	0.0	14000.00	14000.00	14000.00	14000.00	14000.00	14000.00	14000.00	14000.00	14000.00

SALES REPORT
 DOLLARS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
BROAD WOVENS	0.	10500.	10500.	10500.	10500.	10500.	10500.	10500.	10500.	10500.
TOTAL SAVINGS	0.	10500.	10500.	10500.	10500.	10500.	10500.	10500.	10500.	10500.

TEXTILE FOAM PROCESSING OF BROAD WOVENS ENERGY ONLY

INCOME STATEMENT
DOLLARS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
NET SAVINGS	0.	10500.	10500.	10500.	10500.	10500.	10500.	10500.	10500.	10500.
BOOK DEPRECIATION	0.	4500.	4500.	4500.	4500.	4500.	4500.	4500.	4500.	4500.
OPERATING PROFIT	0.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.	6000.
INTEREST INCOME	0.	200.	729.	1386.	2044.	2717.	3228.	3518.	3764.	4009.
INTEREST EXPENSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
PROFIT BEFORE TAX	0.	6200.	6729.	7386.	8044.	8717.	9228.	9518.	9764.	10009.
TAX EXPENSE	0.	2148.	2173.	2203.	2233.	3798.	4245.	4378.	4491.	4604.
PROFIT AFTER TAX	0.	4052.	4556.	5183.	5811.	4919.	4983.	5140.	5272.	5405.

FOR TAX PURPOSE										
DEPRECIATION	0.	9000.	9000.	9000.	9000.	9000.	0.	0.	0.	0.
TAXABLE INCOME	0.	1700.	2229.	2886.	3544.	4217.	13728.	14018.	14264.	14509.
INCOME TAXES	0.	78.	103.	133.	163.	1728.	6315.	6448.	6561.	6674.

INVESTMENT CREDIT USED (BOOK AND TAX)	0.	704.	923.	1195.	1467.	212.	0.	0.	0.	0.
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RETURN ON GROSS ASSETS	0.0	8.4	8.3	8.4	8.5	6.6	6.2	6.2	6.2	6.2
RETURN ON NET WORTH	0.0	9.0	10.1	11.5	12.9	10.9	11.1	11.4	11.7	12.0
RETURN ON NET OPERAT. ASSETS	0.0	8.9	9.9	11.6	13.6	12.4	14.2	17.7	23.4	34.7

PAT = PROFIT AFTER TAXES

ROGA = PAT (ADJUSTED FOR INTEREST EXPENSE) / AVERAGE BALANCE OF CURRENT ASSETS AND GROSS PLANT + EQUIPMENT

RONW = PAT / AVERAGE NET WORTH

RONA = PAT (ADJUSTED FOR INTEREST INCOME AND EXPENSE) / AVERAGE BALANCE OF NET FIXED ASSETS AND OPERATING WORKING CAPITAL (I.E.: CASH+RECEIVABLES+INVENTORIES+OTHER-PAYABLES)

***EQUITY PAYBACK PERIOD**
4.2 YEARS
AFTER END OF CONSTRUCTION

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FINANCIAL ANALYSIS & PRODUCT PRICING MODEL
 - SEPT 1981 VERSION -

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TEXTILE FOAM DYEING OF CARPETS, BECK DYEING AS A BASE

SALES VOLUME
 THOUSAND YARDS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
CARPETS	0.0	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00
TOTAL VOLUME	0.0	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00

SALES REPORT
 DOLLARS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
CARPETS	0.	621562.	621562.	621562.	621562.	621562.	621562.	621562.	621562.	621562.
TOTAL SAVINGS	0.	621562.	621562.	621562.	621562.	621562.	621562.	621562.	621562.	621562.

TEXTILE FOAM DYEING OF CARPETS, BECK DYEING AS A BASE

INCOME STATEMENT
DOLLARS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
NET SAVINGS	0.	621562.	621562.	621562.	621562.	621562.	621562.	621562.	621562.	621562.
OPERATING EXPENSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BOOK DEPRECIATION	0.	12000.	12000.	12000.	12000.	12000.	12000.	12000.	12000.	12000.
OPERATING PROFIT	0.	609562.	609562.	609562.	609562.	609562.	609562.	609562.	609562.	609562.
INTEREST INCOME	0.	0.	900.	2684.	4453.	6221.	7546.	8314.	8968.	9622.
INTEREST EXPENSE	0.	121.	121.	0.	0.	0.	0.	0.	0.	0.
PROFIT BEFORE TAX	0.	609441.	610340.	612246.	614014.	615783.	617107.	617875.	618530.	619184.
TAX EXPENSE	0.	268343.	280757.	281633.	282447.	283260.	283869.	284223.	284524.	284825.
PROFIT AFTER TAX	0.	341098.	329584.	330613.	331568.	332523.	333238.	333653.	334006.	334359.

C-14

FOR TAX PURPOSE										
DEPRECIATION	0.	24000.	24000.	24000.	24000.	24000.	0.	0.	0.	0.
TAXABLE INCOME	0.	597441.	598340.	600246.	602014.	603783.	629107.	629875.	630530.	631184.
INCOME TAXES	0.	262823.	275237.	276113.	276927.	277740.	289389.	289743.	290044.	290345.
INVESTMENT CREDIT USED (BOOK AND TAX)	0.	12000.	0.	0.	0.	0.	0.	0.	0.	0.

RETURN ON GROSS ASSETS	0.0	173.5	116.8	110.2	104.3	99.1	95.6	93.6	92.0	90.5
RETURN ON NET WORTH	0.0	212.4	163.8	164.3	164.8	165.3	165.7	165.9	166.0	166.2
RETURN ON NET OPERAT. ASSETS	0.0	179.0	129.0	135.3	142.3	150.1	158.8	168.6	179.6	192.2

PAT = PROFIT AFTER TAX

ROGA = PAT (ADJUSTED FOR INTEREST EXPENSE) / AVERAGE BALANCE OF CURRENT ASSETS AND GROSS PLANT + EQUIPMENT

RONW = PAT / AVERAGE NET WORTH

RONA = PAT (ADJUSTED FOR INTEREST INCOME AND EXPENSE) / AVERAGE BALANCE OF NET FIXED ASSETS AND OPERATING WORKING CAPITAL (I.E.:CASH+RECEIVABLES+INVENTORIES+OTHER-PAYABLES)

EQUITY PAYBACK PERIOD
0.5 YEARS
AFTER END OF CONSTRUCTION

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FINANCIAL ANALYSIS & PRODUCT PRICING MODEL
 - SEPT 1981 VERSION -

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TEXTILE FOAM DYEING OF CARPETS, BECK DYEING AS A BASE ENERGY

SALES VOLUME
 THOUSAND YARDS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
CARPETS	0.0	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00
TOTAL VOLUME	0.0	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00

SALES REPORT
 DOLLARS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
CARPETS	0.	428313.	428313.	428313.	428313.	428313.	428313.	428313.	428313.	428313.
TOTAL SAVINGS	0.	428313.	428313.	428313.	428313.	428313.	428313.	428313.	428313.	428313.

TEXTILE FOAM DYEING OF CARPETS, BECK DYEING AS A BASE ENERGY

INCOME STATEMENT
DOLLARS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
NET SAVINGS	0.	428313.	428313.	428313.	428313.	428313.	428313.	428313.	428313.	428313.
OPERATING EXPENSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BOOK DEPRECIATION	0.	12000.	12000.	12000.	12000.	12000.	12000.	12000.	12000.	12000.
OPERATING PROFIT	0.	416313.	416313.	416313.	416313.	416313.	416313.	416313.	416313.	416313.
INTEREST INCOME	0.	0.	914.	2714.	4482.	6251.	7575.	8343.	8998.	9652.
INTEREST EXPENSE	0.	103.	103.	0.	0.	0.	0.	0.	0.	0.
PROFIT BEFORE TAX	0.	416210.	417125.	419027.	420796.	422564.	423889.	424657.	425311.	425965.
TAX EXPENSE	0.	179457.	191877.	192752.	193566.	194380.	194989.	195342.	195643.	195944.
PROFIT AFTER TAX	0.	236754.	225247.	226275.	227230.	228185.	228900.	229315.	229668.	230021.

C-16

FOR TAX PURPOSE										
DEPRECIATION	0.	24000.	24000.	24000.	24000.	24000.	0.	0.	0.	0.
TAXABLE INCOME	0.	404210.	405125.	407027.	408796.	410564.	435889.	436657.	437311.	437965.
INCOME TAXES	0.	173937.	186357.	187232.	188046.	188860.	200509.	200862.	201163.	201464.
INVESTMENT CREDIT USED (BOOK AND TAX)	0.	12000.	0.	0.	0.	0.	0.	0.	0.	0.

RETURN ON GROSS ASSETS	0.0	137.0	96.0	89.5	84.0	79.2	76.0	74.2	72.8	71.4
RETURN ON NET WORTH	0.0	162.4	131.3	131.9	132.4	133.0	133.4	133.6	133.8	134.1
RETURN ON NET OPERAT. ASSETS	0.0	142.0	108.3	114.9	122.4	131.0	140.8	152.3	165.8	181.9

PAT = PROFIT AFTER TAX

ROGA = PAT (ADJUSTED FOR INTEREST EXPENSE) / AVERAGE BALANCE OF CURRENT ASSETS AND GROSS PLANT + EQUIPMENT

RONW = PAT / AVERAGE NET WORTH

RONA = PAT (ADJUSTED FOR INTEREST INCOME AND EXPENSE) / AVERAGE BALANCE OF NET FIXED ASSETS AND OPERATING WORKING CAPITAL (I.E.:CASH+RECEIVABLES+INVENTORIES+OTHER-PAYABLES)

** EQUITY PAYBACK PERIOD **
0.7 YEARS
AFTER END OF CONSTRUCTION

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FINANCIAL ANALYSIS & PRODUCT PRICING MODEL
 - SEPT 1981 VERSION -

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TEXTILE FOAM PROCESSING OF TUBULAR KNITS 5 % INFLATION

SALES VOLUME
 THOUSAND YARDS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
TUBULAR KNITS	0.0	5300.00	5300.00	5300.00	5300.00	5300.00	5300.00	5300.00	5300.00	5300.00
TOTAL VOLUME	0.0	5300.00	5300.00	5300.00	5300.00	5300.00	5300.00	5300.00	5300.00	5300.00

SALES REPORT
 DOLLARS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
TUBULAR KNITS	0.	140185.	147181.	154548.	162286.	170395.	178915.	187860.	197253.	207115.
TOTAL SAVINGS	0.	140185.	147181.	154548.	162286.	170395.	178915.	187860.	197253.	207115.

TEXTILE FOAM PROCESSING OF TUBULAR KNITS 5 % INFLATION

INCOME STATEMENT
DOLLARS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
NET SAVINGS	0.	140185.	147181.	154548.	162286.	170395.	178915.	187860.	197253.	207115.
OPERATING EXPENSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BOOK DEPRECIATION	0.	4500.	4500.	4500.	4500.	4500.	4500.	4500.	4500.	4500.
OPERATING PROFIT	0.	135685.	142681.	150048.	157786.	165895.	174415.	183360.	192753.	202615.
INTEREST INCOME	0.	0.	290.	855.	1400.	1940.	2307.	2459.	2561.	2656.
INTEREST EXPENSE	0.	37.	37.	0.	0.	0.	0.	0.	0.	0.
PROFIT BEFORE TAX	0.	135648.	142934.	150903.	159186.	167835.	176721.	185819.	195314.	205271.
TAX EXPENSE	0.	57898.	65750.	69415.	73226.	77204.	81292.	85477.	89844.	94425.
PROFIT AFTER TAX	0.	77750.	77185.	81487.	85961.	90631.	95430.	100342.	105470.	110847.

C-18

FOR TAX PURPOSE										
DEPRECIATION	0.	9000.	9000.	9000.	9000.	9000.	0.	0.	0.	0.
TAXABLE INCOME	0.	131148.	138434.	146403.	154686.	163335.	181221.	190319.	199814.	209771.
INCOME TAXES	0.	55828.	63680.	67345.	71156.	75134.	83362.	87547.	91914.	96495.
INVESTMENT CREDIT USED (BOOK AND TAX)	0.	4500.	0.	0.	0.	0.	0.	0.	0.	0.

RETURN ON GROSS ASSETS	0.0	124.9	92.6	92.8	87.7	86.0	85.9	87.4	89.3	91.3
RETURN ON NET WORTH	0.0	146.4	126.1	133.1	140.4	148.0	155.9	163.9	172.3	181.1
RETURN ON NET OPERAT. ASSETS	0.0	129.5	104.6	114.2	124.7	136.2	148.8	162.4	177.2	193.3

PAT = PROFIT AFTER TAX

ROGA = PAT (ADJUSTED FOR INTEREST EXPENSE) / AVERAGE BALANCE OF CURRENT ASSETS AND GROSS PLANT + EQUIPMENT

RONW = PAT / AVERAGE NET WORTH

RONA = PAT (ADJUSTED FOR INTEREST INCOME AND EXPENSE) / AVERAGE BALANCE OF NET FIXED ASSETS AND OPERATING WORKING CAPITAL (I.E.: CASH+RECEIVABLES+INVENTORIES+OTHER-PAYABLES)

EQUITY PAYBACK PERIOD

0.8 YEARS

AFTER END OF CONSTRUCTION

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FINANCIAL ANALYSIS & PRODUCT PRICING MODEL
 - SEPT 1981 VERSION -

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TEXTILE FOAM PROCESSING OF TUBULAR KNITS ENERGY ONLY 5% INFL.

SALES VOLUME
 THOUSAND YARDS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
TUBULAR KNITS	0.0	5300.00	5300.00	5300.00	5300.00	5300.00	5300.00	5300.00	5300.00	5300.00
TOTAL VOLUME	0.0	5300.00	5300.00	5300.00	5300.00	5300.00	5300.00	5300.00	5300.00	5300.00

C-19

SALES REPORT
 DOLLARS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
TUBULAR KNITS	0.	28673.	30104.	31588.	33178.	34874.	36618.	38449.	40371.	42389.
TOTAL SAVINGS	0.	28673.	30104.	31588.	33178.	34874.	36618.	38449.	40371.	42389.

TEXTILE FOAM PROCESSING OF TUBULAR KNITS ENERGY ONLY 5% INFL.

INCOME STATEMENT
DOLLARS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
NET SAVINGS	0.	28673.	30104.	31588.	33178.	34874.	36618.	38449.	40371.	42389.
OPERATING EXPENSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BOOK DEPRECIATION	0.	4500.	4500.	4500.	4500.	4500.	4500.	4500.	4500.	4500.
OPERATING PROFIT	0.	24173.	25604.	27088.	28678.	30374.	32118.	33949.	35871.	37889.
INTEREST INCOME	0.	21.	405.	1090.	1729.	2367.	2837.	3097.	3313.	3527.
INTEREST EXPENSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
PROFIT BEFORE TAX	0.	24194.	26009.	28178.	30407.	32741.	34954.	37045.	39184.	41417.
TAX EXPENSE	0.	6629.	11964.	12962.	13987.	15061.	16079.	17041.	18025.	19052.
PROFIT AFTER TAX	0.	17565.	14045.	15216.	16420.	17680.	18875.	20004.	21159.	22365.

C-20

FOR TAX PURPOSE										
DEPRECIATION	0.	9000.	9000.	9000.	9000.	9000.	0.	0.	0.	0.
TAXABLE INCOME	0.	19694.	21509.	23678.	25907.	28241.	39454.	41545.	43684.	45917.
INCOME TAXES	0.	4559.	9894.	10892.	11917.	12991.	18149.	19111.	20095.	21122.

INVESTMENT CREDIT USED (BOOK AND TAX)	0.	4500.	0.	0.	0.	0.	0.	0.	0.	0.
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RETURN ON GROSS ASSETS	0.0	36.0	24.9	24.0	23.4	22.9	23.0	23.5	24.1	24.7
RETURN ON NET WORTH	0.0	39.0	31.2	33.8	36.5	39.3	41.9	44.5	47.0	49.7
RETURN ON NET OPERAT. ASSETS	0.0	37.9	30.4	35.4	41.6	49.5	59.7	73.3	92.4	120.7

PAT = PROFIT AFTER TAX
 ROGA = PAT (ADJUSTED FOR INTEREST EXPENSE) / AVERAGE BALANCE OF CURRENT ASSETS AND GROSS PLANT + EQUIPMENT
 RONW = PAT / AVERAGE NET WORTH
 RONA = PAT (ADJUSTED FOR INTEREST INCOME AND EXPENSE) / AVERAGE BALANCE OF NET FIXED ASSETS AND OPERATING WORKING CAPITAL (I.E.:CASH+RECEIVABLES+INVENTORIES+OTHER-PAYABLES)

EQUITY PAYBACK PERIOD
 2.3 YEARS
 AFTER END OF CONSTRUCTION

FINANCIAL ANALYSIS & PRODUCT PRICING MODEL
- SEPT 1981 VERSION -

TEXTILE FOAM DYEING OF CARPETS, CONTINUOUS AS BASE CASE

CARPETS
TOTAL VOLUME

[illegible]SALES REPORT
DOLLARS

CARPETS
TOTAL SAVINGS

[illegible]

TEXTILE FOAM DYEING OF CARPETS, CONTINUOUS AS BASE CASE

INCOME STATEMENT
DOLLARS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
SALES REVENUE	0.	959112.	959112.	959112.	959112.	959112.	959112.	959112.	959112.	959112.
OPERATING EXPENSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BOOK DEPRECIATION	0.	12000.	12000.	12000.	12000.	12000.	12000.	12000.	12000.	12000.
OPERATING PROFIT	0.	947112.	947112.	947112.	947112.	947112.	947112.	947112.	947112.	947112.
INTEREST INCOME	0.	0.	874.	2632.	4401.	6169.	7494.	8262.	8916.	9570.
INTEREST EXPENSE	0.	152.	152.	0.	0.	0.	0.	0.	0.	0.
PROFIT BEFORE TAX	0.	946960.	947834.	949744.	951513.	953281.	954606.	955374.	956028.	956682.
TAX EXPENSE	0.	423602.	436004.	436882.	437696.	438509.	439119.	439472.	439773.	440074.
PROFIT AFTER TAX	0.	523359.	511830.	512862.	513817.	514772.	515487.	515902.	516255.	516609.

C-22

FOR TAX PURPOSE										
DEPRECIATION	0.	24000.	24000.	24000.	24000.	24000.	0.	0.	0.	0.
TAXABLE INCOME	0.	934960.	935834.	937744.	939513.	941281.	966606.	967374.	968028.	968682.
INCOME TAXES	0.	418082.	430484.	431362.	432176.	432989.	444639.	444992.	445293.	445594.

INVESTMENT CREDIT USED (BOOK AND TAX)	0.	12000.	0.	0.	0.	0.	0.	0.	0.	0.
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RETURN ON GROSS ASSETS	0.0	219.7	140.2	134.0	128.3	123.1	119.5	117.5	115.8	114.2
RETURN ON NET WORTH	0.0	280.7	202.4	202.8	203.2	203.6	203.9	204.1	204.2	204.3
RETURN ON NET OPERAT. ASSETS	0.0	225.4	151.1	156.6	162.6	169.1	176.1	183.6	191.9	201.0

PAT = PROFIT AFTER TAX

ROGA = PAT (ADJUSTED FOR INTEREST EXPENSE) / AVERAGE BALANCE OF CURRENT ASSETS AND GROSS PLANT + EQUIPMENT

RONW = PAT / AVERAGE NET WORTH

RONA = PAT (ADJUSTED FOR INTEREST INCOME AND EXPENSE) / AVERAGE BALANCE OF NET FIXED ASSETS AND OPERATING WORKING CAPITAL (I.E.:CASH+RECEIVABLES+INVENTORIES+OTHER-PAYABLES)

EQUITY PAYBACK PERIOD
0.4 YEARS
AFTER END OF CONSTRUCTION

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FINANCIAL ANALYSIS & PRODUCT PRICING MODEL
 - SEPT 1981 VERSION -

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TEXTILE FOAM PROCESSING OF BROAD WOVENS 5% INFLATION

SALES VOLUME
 THOUSAND YARDS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
BROAD WOVENS	0.0	14000.00	14000.00	14000.00	14000.00	14000.00	14000.00	14000.00	14000.00	14000.00
TOTAL VOLUME	0.0	14000.00	14000.00	14000.00	14000.00	14000.00	14000.00	14000.00	14000.00	14000.00

SALES REPORT
 DOLLARS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
BROAD WOVENS	0.	30800.	32340.	34020.	35700.	37380.	39249.	41211.	43272.	45435.
TOTAL SAVINGS	0.	30800.	32340.	34020.	35700.	37380.	39249.	41211.	43272.	45435.

TEXTILE FOAM PROCESSING OF BROAD WOVENS 5% INFLATION

INCOME STATEMENT
DOLLARS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
NET SAVINGS	0.	30800.	32340.	34020.	35700.	37380.	39249.	41211.	43272.	45435.
OPERATING EXPENSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BOOK DEPRECIATION	0.	4500.	4500.	4500.	4500.	4500.	4500.	4500.	4500.	4500.
OPERATING PROFIT	0.	26300.	27840.	29520.	31200.	32880.	34749.	36711.	38772.	40935.
INTEREST INCOME	0.	4.	372.	1053.	1691.	2327.	2797.	3055.	3269.	3481.
INTEREST EXPENSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
PROFIT BEFORE TAX	0.	26304.	28212.	30573.	32891.	35207.	37545.	39766.	42041.	44417.
TAX EXPENSE	0.	7600.	12977.	14064.	15130.	16195.	17271.	18292.	19339.	20432.
PROFIT AFTER TAX	0.	18704.	15234.	16510.	17761.	19012.	20275.	21474.	22702.	23985.

C-24

FOR TAX PURPOSE										
DEPRECIATION	0.	9000.	9000.	9000.	9000.	9000.	0.	0.	0.	0.
TAXABLE INCOME	0.	21804.	23712.	26073.	28391.	30707.	42045.	44266.	46541.	48917.
INCOME TAXES	0.	5530.	10907.	11994.	13060.	14125.	19341.	20362.	21409.	22502.

INVESTMENT CREDIT USED (BOOK AND TAX)	0.	4500.	0.	0.	0.	0.	0.	0.	0.	0.
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RETURN ON GROSS ASSETS	0.0	38.3	27.0	25.9	25.2	24.6	24.6	25.1	25.8	26.4
RETURN ON NET WORTH	0.0	41.6	33.9	36.7	39.5	42.2	45.1	47.7	50.4	53.3
RETURN ON NET OPERAT. ASSETS	0.0	40.2	32.7	38.0	44.5	52.6	63.2	77.2	96.6	125.0

PAT = PROFIT AFTER TAX

ROGA = PAT (ADJUSTED FOR INTEREST EXPENSE) / AVERAGE BALANCE OF CURRENT ASSETS AND GROSS PLANT + EQUIPMENT

RONW = PAT / AVERAGE NET WORTH

RONA = PAT (ADJUSTED FOR INTEREST INCOME AND EXPENSE) / AVERAGE BALANCE OF NET FIXED ASSETS AND OPERATING WORKING

***EQUITY PAYBACK PERIOD**
2.2 YEARS
AFTER END OF CONSTRUCTION

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FINANCIAL ANALYSIS & PRODUCT PRICING MODEL
 - SEPT 1981 VERSION -

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TEXTILE FOAM PROCESSING OF BROAD WOVENS ENERGY ONLY 5% INFL.

SALES VOLUME
 THOUSAND YARDS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
BROAD WOVENS	0.0	14000.00	14000.00	14000.00	14000.00	14000.00	14000.00	14000.00	14000.00	14000.00
TOTAL VOLUME	0.0	14000.00	14000.00	14000.00	14000.00	14000.00	14000.00	14000.00	14000.00	14000.00

SALES REPORT
 DOLLARS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
BROAD WOVENS	0.	10500.	11060.	11620.	12180.	12740.	13377.	14046.	14748.	15485.
TOTAL SAVINGS	0.	10500.	11060.	11620.	12180.	12740.	13377.	14046.	14748.	15485.

TEXTILE FOAM PROCESSING OF BROAD WOVENS ENERGY ONLY 5% INFL.

INCOME STATEMENT
DOLLARS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
NET SAVINGS	0.	10500.	11060.	11620.	12180.	12740.	13377.	14046.	14748.	15485.
OPERATING EXPENSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BOOK DEPRECIATION	0.	4500.	4500.	4500.	4500.	4500.	4500.	4500.	4500.	4500.
OPERATING PROFIT	0.	6000.	6560.	7120.	7680.	8240.	8877.	9546.	10248.	10985.
INTEREST INCOME	0.	200.	722.	1366.	2022.	2693.	3190.	3468.	3703.	3937.
INTEREST EXPENSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
PROFIT BEFORE TAX	0.	6200.	7282.	8486.	9702.	10933.	12067.	13014.	13951.	14923.
TAX EXPENSE	0.	2148.	2198.	2253.	3469.	5029.	5551.	5986.	6418.	6864.
PROFIT AFTER TAX	0.	4052.	5084.	6233.	6233.	5904.	6516.	7028.	7534.	8058.

FOR TAX PURPOSE										
DEPRECIATION	0.	9000.	9000.	9000.	9000.	9000.	0.	0.	0.	0.
TAXABLE INCOME	0.	1700.	2782.	3986.	5202.	6433.	16567.	17514.	18451.	19423.
INCOME TAXES	0.	78.	128.	183.	1399.	2959.	7621.	8056.	8488.	8934.

INVESTMENT CREDIT USED (BOOK AND TAX)	0.	704.	1152.	1650.	994.	0.	0.	0.	0.	0.
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RETURN ON GROSS ASSETS	0.0	8.4	9.3	10.1	9.1	7.9	8.1	8.5	8.8	9.1
RETURN ON NET WORTH	0.0	9.0	11.3	13.9	13.9	13.1	14.5	15.6	16.7	17.9
RETURN ON NET OPERAT. ASSETS	0.0	8.9	11.2	14.3	15.3	16.0	20.4	26.9	37.4	56.6

PAT = PROFIT AFTER TAX
 ROGA = PAT (ADJUSTED FOR INTEREST EXPENSE) / AVERAGE BALANCE OF CURRENT ASSETS AND GROSS PLANT + EQUIPMENT
 RONW = PAT / AVERAGE NET WORTH
 RONA = PAT (ADJUSTED FOR INTEREST INCOME AND EXPENSE) / AVERAGE BALANCE OF NET FIXED ASSETS AND OPERATING WORKING CAPITAL (I.E.:CASH+RECEIVABLES+INVENTORIES+OTHER-PAYABLES)

EQUITY PAYBACK PERIOD
 4.0 YEARS
 AFTER END OF CONSTRUCTION

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FINANCIAL ANALYSIS & PRODUCT PRICING MODEL
 - SEPT 1981 VERSION -

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TEXTILE FOAM DYEING OF CARPETS, BECK DYEING AS A BASE 5% INFL.

SALES VOLUME
 THOUSAND YARDS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
CARPETS	0.0	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00
TOTAL VOLUME	0.0	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00

C-27

SALES REPORT
 DOLLARS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
CARPETS	0.	621562.	654350.	686981.	721353.	757469.	795342.	835108.	876863.	920705.
TOTAL SAVINGS	0.	621562.	654350.	686981.	721353.	757469.	795342.	835108.	876863.	920705.

TEXTILE FOAM DYEING OF CARPETS, BECK DYEING AS A BASE 5% INFL.

INCOME STATEMENT
DOLLARS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
NET SAVINGS	0.	621562.	654350.	686981.	721353.	757469.	795342.	835108.	876863.	920705.
OPERATING EXPENSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BOOK DEPRECIATION	0.	12000.	12000.	12000.	12000.	12000.	12000.	12000.	12000.	12000.
OPERATING PROFIT	0.	609562.	642350.	674981.	709353.	745469.	783342.	823108.	864863.	908705.
INTEREST INCOME	0.	0.	645.	1920.	3167.	4385.	5133.	5295.	5314.	5300.
INTEREST EXPENSE	0.	121.	121.	0.	0.	0.	0.	0.	0.	0.
PROFIT BEFORE TAX	0.	609441.	642875.	676901.	712520.	749854.	788474.	828403.	870177.	914006.
TAX EXPENSE	0.	268343.	295722.	311374.	327759.	344933.	362698.	381065.	400281.	420443.
PROFIT AFTER TAX	0.	341098.	347152.	365527.	384761.	404921.	425776.	447338.	469895.	493563.

C-28

FOR TAX PURPOSE										
DEPRECIATION	0.	24000.	24000.	24000.	24000.	24000.	0.	0.	0.	0.
TAXABLE INCOME	0.	597441.	630875.	664901.	700520.	737854.	800474.	840403.	882177.	926006.
INCOME TAXES	0.	262823.	290202.	305854.	322239.	339413.	368218.	386585.	405801.	425963.

INVESTMENT CREDIT USED (BOOK AND TAX)	0.	12000.	0.	0.	0.	0.	0.	0.	0.	0.
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RETURN ON GROSS ASSETS	0.0	173.5	122.4	120.0	118.3	117.0	117.4	119.6	122.3	125.1
RETURN ON NET WORTH	0.0	212.4	172.6	181.7	191.3	201.3	211.7	222.4	233.6	245.4
RETURN ON NET OPERAT. ASSETS	0.0	179.0	133.8	142.7	152.2	162.1	172.3	182.9	193.7	204.8

PAT = PROFIT AFTER TAX

ROGA = PAT (ADJUSTED FOR INTEREST EXPENSE) / AVERAGE BALANCE OF CURRENT ASSETS AND GROSS PLANT + EQUIPMENT

RONW = PAT / AVERAGE NET WORTH

RONA = PAT (ADJUSTED FOR INTEREST INCOME AND EXPENSE) / AVERAGE BALANCE OF NET FIXED ASSETS AND OPERATING WORKING CAPITAL (I.E.: CASH+RECEIVABLES+INVENTORIES+OTHER-PAYABLES)

EQUITY PAYBACK PERIOD
0.5 YEARS
AFTER END OF CONSTRUCTION

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FINANCIAL ANALYSIS & PRODUCT PRICING MODEL
 - SEPT 1981 VERSION -

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TEXTILE FOAM DYEING OF CARPETS, BECK DYEING AS A BASE ENERGY 5% INF

SALES VOLUME
 THOUSAND YARDS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
CARPETS	0.0	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00
TOTAL VOLUME	0.0	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00

SALES REPORT
 DOLLARS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
CARPETS	0.	428313.	449698.	472190.	495792.	520661.	546693.	574027.	602728.	632864.
TOTAL SAVINGS	0.	428313.	449698.	472190.	495792.	520661.	546693.	574027.	602728.	632864.

TEXTILE FOAM DYEING OF CARPETS, BECK DYEING AS A BASE ENERGY 5% INF

INCOME STATEMENT
DOLLARS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
NET SAVINGS	0.	428313.	449698.	472190.	495792.	520661.	546693.	574027.	602728.	632864.
OPERATING EXPENSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BOOK DEPRECIATION	0.	12000.	12000.	12000.	12000.	12000.	12000.	12000.	12000.	12000.
OPERATING PROFIT	0.	416313.	437698.	460190.	483792.	508661.	534693.	562027.	590728.	620864.
INTEREST INCOME	0.	0.	748.	2206.	3616.	5006.	5933.	6285.	6503.	6698.
INTEREST EXPENSE	0.	103.	103.	0.	0.	0.	0.	0.	0.	0.
PROFIT BEFORE TAX	0.	416210.	438343.	462396.	487408.	513666.	540627.	568312.	597231.	627562.
TAX EXPENSE	0.	179457.	201638.	212702.	224207.	236287.	248688.	261424.	274726.	288678.
PROFIT AFTER TAX	0.	236754.	236705.	249694.	263200.	277380.	291938.	306889.	322505.	338883.

C-30

FOR TAX PURPOSE										
DEPRECIATION	0.	24000.	24000.	24000.	24000.	24000.	0.	0.	0.	0.
TAXABLE INCOME	0.	404210.	426343.	450396.	475408.	501666.	552627.	580312.	609231.	639562.
INCOME TAXES	0.	173937.	196118.	207182.	218687.	230767.	254208.	266944.	280246.	294198.

INVESTMENT CREDIT USED (BOOK AND TAX)	0.	12000.	0.	0.	0.	0.	0.	0.	0.	0.
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RETURN ON GROSS ASSETS	0.0	137.0	100.4	97.6	95.5	93.9	93.9	95.6	97.7	99.9
RETURN ON NET WORTH	0.0	162.4	137.9	145.5	153.4	161.7	170.1	178.9	188.0	197.5
RETURN ON NET OPERAT. ASSETS	0.0	142.0	112.4	122.0	132.4	143.6	155.6	168.4	182.2	196.8

PAT = PROFIT AFTER TAX

ROGA = PAT (ADJUSTED FOR INTEREST EXPENSE) / AVERAGE BALANCE OF CURRENT ASSETS AND GROSS PLANT + EQUIPMENT

RONW = PAT / AVERAGE NET WORTH

RONA = PAT (ADJUSTED FOR INTEREST INCOME AND EXPENSE) / AVERAGE BALANCE OF NET FIXED ASSETS AND OPERATING WORKING CAPITAL (I.E.:CASH+RECEIVABLES+INVENTORIES+OTHER-PAYABLES)

EQUITY PAYBACK PERIOD

0.7 YEARS

AFTER END OF CONSTRUCTION

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FINANCIAL ANALYSIS & PRODUCT PRICING MODEL
 - SEPT 1981 VERSION -

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TEXTILE FOAM DYEING OF CARPETS, CONTINUOUS AS BASE CASE 5% INF

SALES VOLUME
 THOUSAND YARDS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
CARPETS	0.0	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00
TOTAL VOLUME	0.0	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00	15840.00

SALES REPORT
 DOLLARS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
CARPETS	0.	959112.	1007107.	1057320.	1110225.	1165824.	1224114.	1285318.	1349583.	1417061.
TOTAL SAVINGS	0.	959112.	1007107.	1057320.	1110225.	1165824.	1224114.	1285318.	1349583.	1417061.

2012.07.24 HVMFN: 1.2.3.4.5.6.7.8.9.10.11.12.13.14.15.16.17.18.19.20.21.22.23.24.25.26.27.28.29.30.31.32.33.34.35.36.37.38.39.40.41.42.43.44.45.46.47.48.49.50.51.52.53.54.55.56.57.58.59.60.61.62.63.64.65.66.67.68.69.70.71.72.73.74.75.76.77.78.79.80.81.82.83.84.85.86.87.88.89.90.91.92.93.94.95.96.97.98.99.100.101.102.103.104.105.106.107.108.109.110.111.112.113.114.115.116.117.118.119.120.121.122.123.124.125.126.127.128.129.130.131.132.133.134.135.136.137.138.139.140.141.142.143.144.145.146.147.148.149.150.151.152.153.154.155.156.157.158.159.160.161.162.163.164.165.166.167.168.169.170.171.172.173.174.175.176.177.178.179.180.181.182.183.184.185.186.187.188.189.190.191.192.193.194.195.196.197.198.199.200.201.202.203.204.205.206.207.208.209.210.211.212.213.214.215.216.217.218.219.220.221.222.223.224.225.226.227.228.229.230.231.232.233.234.235.236.237.238.239.240.241.242.243.244.245.246.247.248.249.250.251.252.253.254.255.256.257.258.259.260.261.262.263.264.265.266.267.268.269.270.271.272.273.274.275.276.277.278.279.280.281.282.283.284.285.286.287.288.289.290.291.292.293.294.295.296.297.298.299.300.301.302.303.304.305.306.307.308.309.310.311.312.313.314.315.316.317.318.319.320.321.322.323.324.325.326.327.328.329.330.331.332.333.334.335.336.337.338.339.340.341.342.343.344.345.346.347.348.349.350.351.352.353.354.355.356.357.358.359.360.361.362.363.364.365.366.367.368.369.370.371.372.373.374.375.376.377.378.379.380.381.382.383.384.385.386.387.388.389.390.391.392.393.394.395.396.397.398.399.400.401.402.403.404.405.406.407.408.409.410.411.412.413.414.415.416.417.418.419.420.421.422.423.424.425.426.427.428.429.430.431.432.433.434.435.436.437.438.439.440.441.442.443.444.445.446.447.448.449.450.451.452.453.454.455.456.457.458.459.460.461.462.463.464.465.466.467.468.469.470.471.472.473.474.475.476.477.478.479.480.481.482.483.484.485.486.487.488.489.490.491.492.493.494.495.496.497.498.499.500.501.502.503.504.505.506.507.508.509.510.511.512.513.514.515.516.517.518.519.520.521.522.523.524.525.526.527.528.529.530.531.532.533.534.535.536.537.538.539.540.541.542.543.544.545.546.547.548.549.550.551.552.553.554.555.556.557.558.559.560.561.562.563.564.565.566.567.568.569.570.571.572.573.574.575.576.577.578.579.580.581.582.583.584.585.586.587.588.589.590.591.592.593.594.595.596.597.598.599.600.601.602.603.604.605.606.607.608.609.610.611.612.613.614.615.616.617.618.619.620.621.622.623.624.625.626.627.628.629.630.631.632.633.634.635.636.637.638.639.640.641.642.643.644.645.646.647.648.649.650.651.652.653.654.655.656.657.658.659.660.661.662.663.664.665.666.667.668.669.670.671.672.673.674.675.676.677.678.679.680.681.682.683.684.685.686.687.688.689.690.691.692.693.694.695.696.697.698.699.700.701.702.703.704.705.706.707.708.709.710.711.712.713.714.715.716.717.718.719.720.721.722.723.724.725.726.727.728.729.730.731.732.733.734.735.736.737.738.739.740.741.742.743.744.745.746.747.748.749.750.751.752.753.754.755.756.757.758.759.760.761.762.763.764.765.766.767.768.769.770.771.772.773.774.775.776.777.778.779.780.781.782.783.784.785.786.787.788.789.790.791.792.793.794.795.796.797.798.799.800.801.802.803.804.805.806.807.808.809.810.811.812.813.814.815.816.817.818.819.820.821.822.823.824.825.826.827.828.829.830.831.832.833.834.835.836.837.838.839.840.841.842.843.844.845.846.847.848.849.850.851.852.853.854.855.856.857.858.859.860.861.862.863.864.865.866.867.868.869.870.871.872.873.874.875.876.877.878.879.880.881.882.883.884.885.886.887.888.889.890.891.892.893.894.895.896.897.898.899.900.901.902.903.904.905.906.907.908.909.910.911.912.913.914.915.916.917.918.919.920.921.922.923.924.925.926.927.928.929.930.931.932.933.934.935.936.937.938.939.940.941.942.943.944.945.946.947.948.949.950.951.952.953.954.955.956.957.958.959.960.961.962.963.964.965.966.967.968.969.970.971.972.973.974.975.976.977.978.979.980.981.982.983.984.985.986.987.988.989.990.991.992.993.994.995.996.997.998.999.1000.1001.1002.1003.1004.1005.1006.1007.1008.1009.1010.1011.1012.1013.1014.1015.1016.1017.1018.1019.1020.1021.1022.1023.1024.1025.1026.1027.1028.1029.1030.1031.1032.1033.1034.1035.1036.1037.1

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
NET SAVINGS	0.	959112.	1007107.	1057320.	1110225.	1165824.	1224114.	1285318.	1349583.	1417061.
OPERATING EXPENSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BOOK DEPRECIATION	0.	12000.	12000.	12000.	12000.	12000.	12000.	12000.	12000.	12000.
OPERATING PROFIT	0.	947112.	995107.	1045320.	1098225.	1153824.	1212114.	1273318.	1337583.	1405061.
INTEREST INCOME	0.	0.	501.	1495.	2460.	3382.	3818.	3654.	3330.	2957.
INTEREST EXPENSE	0.	152.	152.	0.	0.	0.	0.	0.	0.	0.
PROFIT BEFORE TAX	0.	946960.	995456.	1046815.	1100684.	1157205.	1215932.	1276972.	1340913.	1408017.
TAX EXPENSE	0.	423602.	457910.	481535.	506315.	532314.	559329.	587407.	616820.	647688.
PROFIT AFTER TAX	0.	523359.	537547.	565280.	594369.	624891.	656603.	689565.	724093.	760329.

	0.	24000.	24000.	24000.	24000.	24000.	0.	0.	0.	0.
DEPRECIATION	0.	24000.	24000.	24000.	24000.	24000.	0.	0.	0.	0.
TAXABLE INCOME	0.	934960.	983456.	1034815.	1088684.	1145205.	1227932.	1288972.	1352913.	1420017.
INCOME TAXES	0.	418082.	452390.	476015.	500795.	526794.	564849.	592927.	622340.	653208.

0.	12000.	0.	0.	0.	0.	0.	0.	0.	0.
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[illegible]

RETURN ON GROSS ASSETS	0.0	219.7	146.3	145.1	144.3	143.8	145.0	148.0	151.4	155.0
RETURN ON NET WORTH	0.0	280.7	212.6	223.6	235.1	247.2	259.7	272.7	286.4	300.7
RETURN ON NET OPERAT. ASSETS	0.0	225.4	156.0	163.8	171.8	179.8	187.7	195.7	203.5	211.3

RONA = PAT (ADJUSTED FOR INTEREST INCOME AND EXPENSE) / AVERAGE BALANCE OF NET FIXED ASSETS AND OPERATING WORKING CAPITAL (I.E.: CASH+RECEIVABLES+INVENTORIES+OTHER-PAYABLES)

****EQUITY PAYBACK PERIOD****
 0.4 YEARS
 AFTER END OF CONSTRUCTION