U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-282 072

AHL

Assessment of Industrial Hazardous Waste Practices, Rubber and Plastics Industry Rubber Products Industry

Foster D. Snell, Inc., Florham Park, N.J.

Prepared for

Environmental Protection Agency, Washington, D C

Mar 78

PB 282 072

ASSESSMENT OF INDUSTRIAL HAZARDOUS WASTE PRACTICES,

RUBBER AND PLASTICS INDUSTRY

Rubber Products Industry

This report (SW-163c.3) describes work performed for the Office of Solid Waste under contract no. 68-01-3194 and is reproduced as received from the contractor. The findings should be attributed to the contractor and not to the Office of Solid Waste.

U.S. ENVIRONMENTAL PROTECTION AGENCY

1978

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-530-SW-163C.3	2.	3. RECIPIENT'S ACCESSION NO. PB282072
4. TITLE AND SUBTITLE Assessment of Industrial Hazardous Waste Practices, Rubber & Plastics Industry		5. REPORT DATE March 1978
		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Joel M. Kushnir and Stephen F. Nagy		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Foster D. Snell, Inc. Hanover Road Florham Park, NJ 07932		10. PROGRAM ELEMENT NO.
		11. CONTRACT/GRANT NO. 68-01-3194
12. SPONSORING AGENCY NAME AND ADDRESS EPA Office of Solid Waste Management Programs Hazardous Waste Management Division 401 M Street, S.W. Washington, D.C. 20460		13. TYPE OF REPORT AND PERIOD COVERED Final; 4/75 - 4/76
		14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

16. ABSTRACT

This industry study is one of a series under the Office of Solid Waste Management Program of the Hazardous Waste Management Division, U.S. Environmental Protection Agency. The report concentrates on the rubber and plastics industry. It characterizes these industries in terms of number, location, size and age of plants, products, processes, etc.; identifies and quantifies those wastes which are or may be generated by these industries; describes current practices for treatment and disposal of potentially hazardous wastes; determines the control technologies which might be applied to reduce hazards presented by these wastes upon disposal; and estimates the cost of control technology implementations.

The information presented in the report was acquired from a review of published information; trade association participation; personal contacts; visits to various plants and corporate offices of germane companies; waste sample analysis; and the application of an econometric model to project waste loads for 1977 and 1983.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Control Costs Hazardous Wastes Industrial Wastes Plastics Industry Residues Rubber Industry Sludges Solid Wastes Waste Generation Factors	Chemical Treatment Hazard Potential Incineration Land Filling Lagooning Resin Manufacture Stream Separation Toxicity	

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS (This Report) Unclassified	21.
	20. SECURITY CLASS (This page) Unclassified	22. PRICE A11 - A01

EPA Form 2220-1 (9-73)

This report was prepared by Foster D. Shell, Inc., Florham Park, New Jersey, under Contract No. 68-01-3194.

An environmental protection publication (SW-163c.3) in the solid waste management series.

ACKNOWLEDGEMENTS

The preparation of this report was accomplished through the efforts of the staff of Foster D. Snell, Inc., a subsidiary of Booz·Allen & Hamilton Inc., Florham Park, New Jersey.

Mr. Matthew A. Straus, Staff Engineer, Hazardous Waste Management Division, was EPA Project Officer for the study. His assistance, leadership, careful review and advice made an invaluable contribution to the preparation of this final report.

Appreciation is extended to the following trade associations for assistance and cooperation in this program:

- Rubber Manufacturers Association
- International Institute of Synthetic Rubber Producers
- Manufacturing Chemists Association
- Textile Economics Bureau
- Society of the Plastics Industry

Appreciation is also extended to the many rubber products manufacturers, plastic resin, synthetic rubber and fiber producing companies, who cannot be mentioned by name due to reasons of confidentiality, without whose assistance this report could not have been written.

Acknowledgement is also made of state and Federal agencies who gave invaluable assistance and cooperation in this program.

TABLE OF CONTENTS

CHAPTER III -- RUBBER PRODUCTS INDUSTRY, SIC 30

Section			Page
1.	INTRODUCTION AND GENERAL DESCRIPTION OF THE RUBBER PRODUCTS INDUSTRY -- SIC 30		III-2
	1.1	In 1972, SIC 30 Industries Employed Over 270 Thousand Works And Produced About $10 Billion In Shipments	III-2
	1.2	With The Exception Of Reclaimed Rubber And Miscellaneous Rubber Products Fabricated From Latex Rubber, The Processing Operations Of The Rubber Products Industry Are Based On Mechanical And Dry Manufacturing Processes	III-4
	1.3	There Are Nine Major Classes Of Ingredients Which Are Used In The Manufacture Of Rubber Products	III-4
	1.4	The Nine Major Classes Of Rubber Products Ingredients Contain Hundreds Of Chemicals, Some Of Which Are Considered To Be Hazardous To Man Or His Environment	III-6
	1.5	Wastes Produced In SIC 30 Are Related To The Processes	III-15
2.	SIC 3011, TIRES AND INNER TUBES INDUSTRY		III-21
	2.1	Characterization Of SIC 3011, Tires And Inner Tubes Industry	III-23
	2.2	Detailed Process Description And Waste Stream Identification For The Tire Industry -- Group I	III-35
	2.3	Inner Tube Manufacturing Process -- Group II	III-50
	2.4	Waste Characterization For The Tire And Inner Tube Industry	III-53

TABLE OF CONTENTS (CONT'D.)

Section			Page
	2.5	Waste Quantification For The Years 1974, 1977 And 1983 -- Tire And Inner Tube Industry	III-60
3.	SIC 3021, RUBBER AND PLASTICS FOOTWEAR INDUSTRY		III-69
	3.1	Characterization Of SIC 3021, Rubber And Plastics Footwear Industry	III-69
	3.2	Detailed Process Descriptions And Waste Stream Characterization For The Rubber And Plastics Footwear Industry	III-76
	3.3	Waste Characterization For The Rubber And Plastics Footwear Industry	III-85
	3.4	Waste Quantification For The Years 1974, 1977 And 1983, Rubber And Plastics Footwear Industry	III-87
4.	SIC 3031 -- RECLAIMED RUBBER INDUSTRY		III-93
	4.1	Characterization Of SIC 3031	III-93
	4.2	Detailed Process Description And Waste Stream Characterization For The Rubber Reclaiming Industry, SIC 3031	III-94
	4.3	Waste Characterization For The Reclaimed Rubber Industry	III-104
	4.4	Waste Quanification For The Years 1974, 1977 And 1983, Reclaimed Rubber Industry	III-105
5.	SIC 3041 -- RUBBER AND PLASTICS HOSE AND BELTING INDUSTRY		III-109
	5.1	Characterization Of SIC 3041, Rubber And Plastics Hose And Belting	III-109

TABLE OF CONTENTS (CONT'D.)

Section			Page
	5.2	Detailed Process Descriptions And Waste Streams Identification For The Rubber And Plastics Belt And Hose Industry, SIC 3041	III-118
	5.3	Waste Characterization For The Rubber And Plastics Hose And Belting Industry	III-132
	5.4	Waste Quantification For The Years 1974, 1977 And 1983, Rubber And Plastic Hose And Belting Industry	III-135
6.	SIC 3069 -- FABRICATED RUBBER PRODUCTS, NOT ELSEWHERE CLASSIFIED (N.E.C.)		III-140
	6.1	Characterization Of SIC 3069, Fabricated Rubber Products, N.E.C.	III-140
	6.2	Detailed Process Descriptions And Waste Stream Identification For The Fabricated Rubber Products Industry, SIC 3069	III-152
	6.3	Waste Characterization For The Fabricated Rubber Products Industry, N.E.C.	III-172
	6.4	Waste Quantification For The Years 1974, 1977 And 1983, Rubber Products Industry, N.E.C.	III-173
7.	TREATMENT AND DISPOSAL TECHNOLOGY FOR POTENTIALLY HAZARDOUS WASTES, RUBBER PRODUCTS INDUSTRY		III-183
	7.1	Treatment And Disposal In SIC 30	III-183
	7.2	Treatment And Disposal Of Waste Devulcanizing Agents From Rubber Reclaiming	III-190
	7.3	Land Disposal Practices	III-204

TABLE OF CONTENTS (CONT'D.)

Section		Page
8.	COST ANALYSIS FOR THE TREATMENT AND DISPOSAL OF POTENTIALLY HAZARDOUS WASTES, RUBBER PRODUCTS INDUSTRY	III-209
8.1	Volume Of Waste	III-209
8.2	Contracting Fee	III-209
8.3	Long Distance Hauling Cost	III-210
8.4	Cost Of Packaging	III-211
8.5	Cost Of Upgrading A Portion Of An Existing Landfill Site	III-211
8.6	Plant Labor Costs	III-213
8.7	Definition Of Technology Levels	III-213
8.8	Typical Cases Of Potentially Hazardous Waste Disposal Costs	III-214

LIST OF TABLES

CHAPTER III -- RUBBER PRODUCTS INDUSTRY, SIC 30

Table		Page
III-1	1972 Economic Data And Relative Importance Of Subcategories Of The Rubber Products Industry, SIC 30	III-3
III-2	Distribution Of Raw Materials Consumption For The Rubber Products Industry, SIC 30	III-5
III-3	Major Classes Of Ingredients Used In The Manufacture Of Rubber Products, SIC 30	III-7
III-4	Examples Of Elastomers And Chemicals Used In Rubber Products Fabricating	III-9
III-5	Hazard Ratings For Sample Chemicals Used In Rubber Products Fabrications, SIC 30	III-19
III-6	Impact Of The Tire Industry On Other Sectors Of The Economy, SIC 3011	III-22
III-7	Geographic Distribution Of Plants In SIC 3011	III-25
III-8	Major Tire Production Facilities In The U.S. SIC 30111 And 30112	III-27
III-9	Distribution Of Tire Manufacturing By Age -- SICs 30111 And 30112 (Group I)	III-29
III-10	Geographic Distribution Of Raw Material Consumption In The Tire And Inner Tube Industry, SIC 3011	III-33
III-11	Waste Stream Characterization In Tire Manufacturing, SICs 30111 And 30112	III-39
III-12	Estimated Geographic Distribution Of Production Tire And Inner Tube Industry For 1974, SIC 3011	III-54

LIST OF TABLES (CONT'D.)

Table		Page
III-13	Examples Of Typical Recipes For Rubber Stock Used For Manufacture Of Passenger Tires	III-56
III-14	A Typical Recipe For Rubber Stock Used In The Manufacture Of Inner Tubes	III-58
III-15	Geographic Distribution Of Wastes -- Tire And Inner Tube Industry, SIC 3011	III-61
III-16	Product Shipments In Producer Prices For The Tire And Inner Tube Industry, SIC 3011	III-68
III-17	Geographic Distribution Of Plant Location And Age, SIC 3021	III-71
III-18	Employment, Raw Material Consumption And Production, SIC 3021	III-73
III-19	Waste Practices For The Plants In SIC 3021	III-80
III-20	Examples Of Typical Recipes Used For Rubber Stock In The Rubber And Plastic Footwear Industry, SIC 3021	III-86
III-21	Geographic Distribution Of Wastes, Rubber And Plastic Footwear Industry, SIC 3021	III-88
III-22	Product Shipments In Producer Prices For The Footwear, Belts And Miscellaneous Rubber Products Industries, SICs 3021 And 3069	III-90
III-23	Rubber Reclaimers, SIC 3031	III-94
III-24	Quantification Of Waste Streams For The Rubber Reclaiming Industry, SIC 3031	III-98
III-25	Total And Potentially Hazardous Wastes, Rubber Reclaimers Industry, SIC 3031	III-106

LIST OF TABLES (CONT'D.)

Table		Page
III-26	General Statistics For Establishments By Primary Product Class For The Segments Of The Rubber And Plastics Hose And Belting Industry, SIC 3041	III-112
III-27	Geographic Distribution Of Plants Employment And Distribution Of Production In The Rubber And Plastics Hose And Belting Industry, SIC 3041	III-113
III-28	Distribution Of Plant Age For Those Establishments Classified In The Rubber And Plastics Hose And Belting Industry, SIC 3041	III-116
III-29	Waste Parameters For The Plants Classified In The Rubber And Plastics Hose And Belting Industry, SIC 3041	III-124
III-30	Examples Of Typical Recipes Used For Rubber Stock In The Rubber And Plastic Hose And Belting Industry, SIC 3041	III-133
III-31	Geographic Distribution Of Wastes -- Rubber And Plastics Hose And Belting Industry, SIC 3041	III-136
III-32	Geographic Distribution Of Plant Age For Plants Using Wet Processes In The Fabricated Rubber Products Industry, N.E.C., SIC 3069	III-142
III-33	Geographic Distribution Of Plant Age For Plants Using Dry Processes In The Fabricated Rubber Products Industry, N.E.C., SIC 3069	III-144
III-34	Geographic Distribution Of Plant Age For Those Establishments Classified In The Fabricated Rubber Products Industry, N.E.C., SIC 3069	III-146
III-35	Geographic Distribution Of Plants And Employment For The Fabricated Rubber Products Industry, N.E.C., SIC 3069	III-149

LIST OF TABLES (CONT'D.)

Table		Page
III-36	Geographic Distribution Of Raw Material Consumption For The Fabricated Rubber Products Industry, SIC 3069	III-153
III-37	Geographic Distribution Of Production For The Fabricated Rubber Products Industry, N.E.C., SIC 3069	III-156
III-38	Waste Parameters For The Dry Processing Segment Of SIC 3069	III-161
III-39	Waste Parameters For The Wet Processing Segment Of SIC 3069	III-169
III-40	Geographic Distribution Of Wastes -- Fabricated Rubber Products Industry, N.E.C., Dry Process Segment, SIC 3069	III-175
III-41	Geographic Distribution Of Wastes -- Fabricated Rubber Products Industry, N.E.C., Wet Process Segment, SIC 3069	III-177
III-42	Geographic Distribution Of Wastes -- Fabricated Rubber Products Industry, N.E.C., Aggregate (Dry And Wet), SIC 3069	III-179
III-43	Summary Of Typical Plant Potentially Hazardous Wastes From Rubber Products Manufacture, SIC 30	III-184
III-44	Treatment And Disposal Technology For Powders And Dusts From The Tire And Inner Tube Industry, SIC 3011	III-192
III-45	Treatment And Disposal Technology For Powders And Dusts Feom The Rubber And Plastics Footwear Industry, SIC 3021	III-194
III-46	Treatment And Disposal Technology For Used Devulcanizing Agents, Rubber Reclaiming Industry, SIC 3031	III-196

LIST OF TABLES (CONT'D.)

Table		Page
III-47	Treatment And Disposal Technology For Powders And Dusts From The Rubber And Plastics Hose And Belting Industry, SIC 3041	III-197
III-48	Treatment And Disposal Technology For Powders And Dusts From The Rubber Products Industry, N.E.C., SIC 3069	III-199
III-49	Percent Of Production Value Allocated To Treatment And Disposal Of Potentially Hazardous Wastes In The Rubber Products Industry, SIC 30	III-215
III-50	Yearly Expenditures For Potentially Hazardous Waste Disposal In The Rubber Products Industry, SIC 30	III-216
III-51	Potentially Hazardous Waste Disposal Costs For A Typical Plant In The Tire And Inner Tube Industry, SIC 3011	III-217
III-52	Potentially Hazardous Waste Disposal Costs For A Typical Plant In The Rubber And Plastics Footwear Industry, SIC 3021	III-218
III-53	Potentially Hazardous Waste Disposal Costs For A Typical Plant In The Rubber And Plastics Hose And Belting Industry, SIC 3041	III-219
III-54	Potentially Hazardous Waste Disposal Costs For A Typical Plant In The Rubber Products Industry, N.E.C., SIC 3069	III-220

LIST OF FIGURES

Chapter III--Rubber Products, Industry SIC 30

Figure		Page
III-1	Distribution Of Plants Sizes By Employment In The Tire And Inner Tube Industry, SIC 3011	III-32
III-2	Production And Material Balance In Tire Manufacturing, SIC 3011	III-37
III-3	Waste Flow Diagram In Tire Manufacturing, SIC 3011	III-38
III-4	Process Flow Diagram For Inner Tube Manufacturing, SIC 30112	III-51
III-5	Distribution Of Plants Sizes By Employment, SIC 3021	III-75
III-6	Production And Waste Flow Diagram In The Production Of Canvas Footwear, SIC 3021	III-78
III-7	Basic Processing Steps Utilized In The Production Of Plastic Footwear, SIC 3021	III-79
III-8	Rubber Reclaiming Flow Diagram, SIC 3031	III-97
III-9	Distribution Of Plant Sizes By Employment In The Rubber And Plastic Hose And Belting Industry, SIC 3041	III-115
III-10	Process Flow Diagram For Rubber Hose Manufacturing, SIC 3041	III-119
III-11	Plastic Hose Manufacturing Flow Diagram, SIC 3041	III-120
III-12	Rubber Belt Manufacturing Flow Diagram, SIC 3041	III-121
III-13	Waste Flow Diagram For Rubber Hose Manufacturing, SIC 3041	III-122
III-14	Waste Flow Diagram For Rubber Belt Production, SIC 3041	III-123
III-15	Distribution Of Plant Sizes By Employment In SIC 3069	III-151

LIST OF FIGURES (CONT'D.)

Figure		Page
III-16	Basic Processing Steps Used In Dry Processing Of Rubber Goods In The Rubber Products Industry, N.E.C., SIC 3069	III-159
III-17	Waste Flow Diagram For Dry Processing Of Rubber Goods In The Rubber Products Industry, N.E.C., SIC 3069	III-160
III-18	Typical Wet Processing Steps In The Rubber Products Industry, N.E.C., SIC 3069	III-167
III-19	Waste Flow Diagram For Wet Processes In The Rubber Products Industry, N.E.C., SIC 3069	III-168

III. RUBBER PRODUCTS INDUSTRY -- SIC 30

This chapter characterizes and discusses industry structure, manufacturing processes, total wastes generated and treatment and disposal technologies and associated costs for potentially hazardous wastes identified for the rubber products industry portion of SIC 30.

The chapters' contents are presented as follows:

- SECTION 1 -- INTRODUCTION AND GENERAL DESCRIPTION OF THE RUBBER PRODUCTS INDUSTRY, SIC 30
- SECTION 2 -- TIRES AND INNER TUBE INDUSTRY, SIC 3011
- SECTION 3 -- RUBBER AND PLASTICS FOOTWEAR INDUSTRY, SIC 3021
- SECTION 4 -- RECLAIMED RUBBER INDUSTRY, SIC 3031
- SECTION 5 -- RUBBER AND PLASTICS HOSE AND BELTING INDUSTRY, SIC 3041
- SECTION 6 -- FABRICATED RUBBER PRODUCTS, NOT ELSEWHERE CLASSIFIED, SIC 3069
- SECTION 7 -- TREATMENT AND DISPOSAL TECHNOLOGY FOR POTENTIALLY HAZARDOUS WASTES, RUBBER PRODUCTS INDUSTRY
- SECTION 8 -- COST ANALYSIS FOR THE TREATMENT AND DISPOSAL OF POTENTIALLY HAZARDOUS WASTES, RUBBER PRODUCTS INDUSTRY

Figures and tables in each of the sections follow the first page on which they are discussed. Tables are presented first, followed by the figures.

1. INTRODUCTION AND GENERAL DESCRIPTION OF THE RUBBER PRODUCTS INDUSTRY -- SIC 30

For the purposes of this project, the industry segments of SIC 30 which were included for study are as follows:

. Tires and Inner Tubes	SIC 3011
. Rubber and Plastic Footwear	SIC 3021
. Reclaimed Rubber	SIC 3031
. Rubber and Plastic Belt and Hose	SIC 3041
. Fabricated Rubber Products, Not Elsewhere Classified (N.E.C.)	SIC 3069

Tables and figures discussed, immediately follow the text page.

1.1 In 1972, SIC 30 Industries Employed Over 270 Thousand Workers And Produced About $10 Billion In Shipments

Table III-1 shows the number of employees, value added, value of shipments, gross value of assets, approximate number of establishments, percent of all employees, percent of value added by manufacturer and an importance rating of the categories for the rubber products industry in 1972.

- These industries have approximately 1,500 establishments.

- Total gross book value of end of year depreciable assets was approximately $4 billion.

- SIC 3011 (Tires and Inner Tubes) was rated most important of the categories and represented

  - 39.7% of the SIC 30 in terms of total employment

  - 54.4% of value added by manufacturer.

- SIC 3069 (Fabricated Rubber Products (N.E.C.) employed 36.6% of the total employees.

TABLE III-1

1972 ECONOMIC DATA AND RELATIVE IMPORTANCE OF SUBCATEGORIES OF THE RUBBER PRODUCTS INDUSTRY SIC-30

Code	Industry Group and Industry	All Employees (1,000)	Percent Of All Employees	Value Added By Manufacturer (million dollars)	Percent Of Value Added By Manufacturer	Value Of Industry Shipments (million dollars)	Total Gross Book Value Of Depreciable Assets End of Year (million dollars)	Approximate Number Of Establishments	Importance Rating(3)
30	Rubber Products	270.8		5,648.5		10,227.8	4,074	1,510	--
3011	Tires and Inner Tubes	107.5	39.7	3,070.8	54.4	5,747.1	2,671 (1)	200	1
3021	Rubber and Plastics Footwear	31.5	11.6	370.3	6.5	600	177 (1)	100	2
3031	Reclaimed Rubber	0.9	0.3	15.6	0.3	29.7	24 (2)	20	3
3041	Rubber and Plastics Hose and Belting	31.9	11.8	618.7	11.0	1,020.1	316 (1)	90	2
3069	Fabricated Rubber Products, N.E.C.	99.0	36.6	1,573.1	27.8	2,830.9	885 (1)	1,100	2

(1) Estimated at 10 times annual capital expenditures, i.e. a ten year average lifetime for assets. Estimate based on a 40 year life for buildings and 7 year life for equipment

(2) Estimated on a straight line extrapolation of total gross book value of depreciable assets for the years 1968-1971

(3) Based on the relative values in "Percent of All Employees" and "Percent of Value Added by Manufacturer" columns

Source: 1972 Census of Manufactures unless otherwise indicated

1.2 With The Exception Of Reclaimed Rubber And Miscellaneous Rubber Products Fabricated From Latex Rubber, The Processing Operations Of The Rubber Products Industry Are Based On Mechanical And Dry Manufacturing Processes

The mechanical and dry manufacturing processes typically are: molding, extruding, sheeting, foaming, coating, fabrication of sections, and vulcanization. The initial manufacturing operations involve batch treatment of the stock to incorporate colorants, extenders, reinforcers, and special additives such as accelerators and antioxidants. After the batching step, the production operations can be continuous, semi-continuous, or batch-continuous.

Rubber reclaiming utilizes process technologies which differ considerably from those used by the other product areas of the study included in this report. The process includes mechanical preparation of the rubber (old tires) and physicochemical modification (devulcanization) before finishing off as a thin sheet or flakes.

Although rubber items produced from latex rubber are included in SIC 3069, the processes employed and some of the wastes produced are also different from those in other product areas of the industry. The wet processes involve latex or cement and are mainly used for the production of dipped goods such as gloves and prophylactics. The unit operations are quite simple and include compounding and mixing, dipping, drying, curing.

1.3 There Are Nine Major Classes Of Ingredients Which Are Used In The Manufacture Of Rubber Products

Table III-2 lists the components of the rubber recipes used in the production of rubber goods as a function of the total raw materials consumed by the industry. The principal raw materials are elastomers, carbon black and plastic resins.

In addition to the components listed, there are a few products of this industry which use plastic resins supplementary to elastomeric raw materials. These resins are used either in admixture (e.g. in some white rubber recipes) or singly (e.g. polyvinyl chloride for sneakers or other polymers for reinforced or unreinforced plastic hose).

TABLE III-2

DISTRIBUTION OF RAW MATERIALS CONSUMPTION FOR THE RUBBER PRODUCTS INDUSTRY
SIC 30
(% of Total Raw Materials Consumed)

Class	SIC Code 3011	3021	3041	3069
Elastomers	57.5	26.6	42.2	55.1
Carbon Black	20.6	0.3	17.1	11.0
Plasticizers	4.1	7.5	8.0	6.8
Pigments	6.1	9.9	7.2	15.0
Cord and Fabric	7.8	15.0	12.3	2.4
Plastic Resins	0.9	37.5	13.1	6.7
Chemicals	3.0	3.2	3.1	3.0

Source: Foster D. Snell, Inc. analysis of Department of Commerce data.

- For SIC's 3011, 3041 and 3069, elastomeric materials comprise the bulk of materials consumed (42-57%) on a weight basis. For SIC 3021 the industry uses more plastic resins in their products than elastomers (37.5% plastic resins versus 26.6% elastomers). Data gathered for SIC 3031 indicates that additives and devulcanizing agents (mineral acids or bases) comprise 15% of finished shipped products.

- The use of carbon black in SIC 3021 represents only a small percentage of its use in the other rubber fabricating segments. SIC 3011, 3041 and 3069 respectively use 20.6%, 17.1% and 11.0% carbon black in the rubber products industry.

  These quantities reflect the fact that SIC 3021 uses predominantly white rubber and a large amount (37.5%) of plastic resins in their products.

1.4 The Nine Major Classes Of Rubber Products Ingredients Contain Hundreds Of Chemicals, Some Of Which Are Considered To Be Hazardous To Man Or His Environment

Table III-3 lists the nine major classes of ingredients and their uses, employed in the manufacture of rubber products. These include elastomers (basic component of all rubber products), processing aids, vulcanization agents (curing aids), accelerators to aid curing, accelerator activators for maximizing the efficiency of accelerators, age resistors such as anti-oxidants, fillers, softeners, and miscellaneous ingredients such as colorants, blowing aids, etc.

Table III-4 presents a list of typical chemicals used in rubber fabricating. The list is general in nature and serves to show the wide variety of chemicals a processor has to choose from. Particular chemicals are selected on the basis of several factors, including the choice of elastomers or plastic resin, product performance requirements and processing techniques.

TABLE III-3 (1)

MAJOR CLASSES OF INGREDIENTS
USED IN THE MANUFACTURE OF
RUBBER PRODUCTS
SIC 30

I.	ELASTOMERS --	The basic component of all rubber compounds, it may be in the form of synthetic or natural rubber alone, or "masterbatches" of rubber-oil, rubber-carbon black, or rubber-oil-carbon black, or reclaimed rubber; master batches are selected in order to obtain specific physical properties in the final product.
II.	PROCESSING AIDS --	Materials used to modify the rubber during the mixing or processing steps, or to aid in a specific manner during the extrusion, calendering, or molding operations.
III.	VULCANIZATION AGENTS --	These materials are necessary for vulcanization; (process of combining rubber with sulfur or other additives under heat and pressure to eliminate tackiness when warm and brittleness when cool -- i.e. curing), since without the chemical crosslinking reactions involving these agents, no improvements in the physical properties of the rubber mixes can occur.
IV.	ACCELERATORS --	In combination with vulcanizing the agents, these materials reduce the vulcanization time (cure time) by increasing the rate of vulcanization. In most cases, the physical properties of the products are also improved.
V.	ACCELERATOR ACTIVATORS --	These compounds form chemical complexes with the accelerators, and thus aid in obtaining the maximum benefits from the acceleration system by increasing the vulcanization rates and improving the final products properties.

TABLE III-3 (2)

VI.	AGE RESISTORS --	Antioxidants, antiozonants, and other materials that are used to reduce the aging process in vulcanizates. They function by slowing down the deterioration of the rubber products. The deterioration occurs through reactions with materials that catalyze rubber failure, i.e., oxygen, ozone, light, heat, radiation, etc.
VII.	FILLERS --	These materials are used to reinforce or modify the physical properties, impact certain processing properties, or reduce costs.
VIII.	SOFTENERS --	Any material that can be added to the rubber to either aid in mixing, promote greater elasticity, produce tack or extend (or replace) a portion of the rubber hydrocarbon (without a loss in physical properties).
IX.	MISCELLANEOUS INGREDIENTS --	Materials that can be used for specific purposes but are not normally required in the majority of rubber compounds can be included in the group. It includes retarders, colors, blowing aids, abrasives, dusting agents, odorants, etc.

Source: Foster D. Snell, Inc.

TABLE III-4 (1)

EXAMPLES OF ELASTOMERS AND CHEMICALS USED IN RUBBER PRODUCTS FABRICATING

1. ELASTOMERS

- Natural rubber
- Neoprene
- Nitrile
- Polybutadiene
- Polyisoprene

2. PROCESSING AIDS

- Xylyl mercaptan (thioxylenols)
- Oil soluble sulfonic acids
- Zinc salt of penta chlorothiophenol
- Penta chlorothiophenol
- 2-naphthylenethiol
- Phenylhydrazine salts

3. VULCANIZATION AGENTS

- Elemental Vulcanization Agents
  - Rhombia sulfur
  - Amorphous sulfur
  - Selenium
  - Tellurium
- "Low Sulfur" Vulcanization Agents
  - Tetramethylthiuram disulfide
  - Dipentamethylenethiuram hexasulfide
  - Dimorpholinyl disulfide
  - Alkylphenol disulfide
- Nonsulfur Vulcanization Agents
  - Metal oxides (including ZnO, PbO, PbO/MgO, MgO/pentaerythritol)
  - Difunctional compounds -- epoxy resins, quinone dioximes and diamines or dithio compounds.

TABLE III-4 (2)

4. ACCELERATORS

Type	Example
Aldehyde-amine reaction products	Butyraldehyde-aniline condensation product
Amines	Hexamethylene tetramine
Guanidines	Diphenyl guanidine
Thioureas	Ethylenethiouria
Thiazoles	2-mercaptobenzothiazole
	Benzothiazyl disulfide
Thiurams	Tetramethylthiuram disulfide
Sulfenamides	N-cyclohexyl-2-benzothiazyl-sulfenamide
Dithiocarbamates	Zinc dimethyldithiocarbamate
Xanthates	Dibutylxanthogen disulfide

5. ACCELERATOR ACTIVATORS

Inorganic Compounds

- Zinc oxide
- Hydrated lime
- Lead oxide
- Red lead
- White lead
- Magnesium oxide
- Alkali carbonates
- Alkali hydroxides

Organic Acids (normally used in combination with metal oxides)

- Stearic
- Oleic
- Lauric
- Palmitic
- Myristic
- Hydrogenated oils from:
  - .. palm
  - .. castor
  - .. fish
  - .. linseed

Alkaline Substances

- Ammonia
- Amines
- Salts of amines with weak acids
- Reclaim rubbers made by the alkali process

TABLE III-4 (3)

6. AGE RESISTORS

Antioxidants

Chemical Type	Example
- Hindered Phenol	- Styrenated phenol
- Hindered Bis-phenol	- 2,2'-Methylene-bis-(4 methyl-6-t. butylphenol)
- Amino-phenol	- 2,6'-Di-t. butyl-α - dimethylamino-p-cresol
- Hydroquinone	- Hydroquinone mono-benzyl ether
- Phosphite	- Tri (mixed mono and di-nonylphenyl) phosphite
- Diphenylamine	- Octylated diphenylamine
- Naphthylamines	- Phenyl- β -naphthylamine
- Alkyldiamine	- N,N'-Diphenylethylene diamine
- Aldehyde-amine condensation product	- Aldol-alpha-naphthyl-amine
- Quinoline	- Polymerized 2,2,4-trimethyl-1,2-dihydroquinoline
- Phenylenediamine	- N,N'-Diphenyl-p-phenylene diamine

Antiozonants

Chemical Type	Example
- Dialkyl-phenylene	- N,N'-Bis-(1-methyl-heptyl)-p-phenylene-diamine
- Alkyl-aryl-phenylene diamine	- N-Isopropyl-N'-phenyl-p-phenylenediamine
- Carbamate	- Nickel dibutyldithio-carbamate

Physical Type	Example
- Waxes	- Blended petroleum waxes
	- Microcrystalline waxes

7. SOFTENERS (PHYSICAL PLASTICIZERS)

- Fatty Acids
  - Cotton Seed
  - Rincinoleic
  - Lauric

- Vegetable Oils
  - Gelled Oils
  - Solid Soya
  - Tall Oil
  - Soya Polyester

- Petroelum Products
  - Unsaturated
  - Mineral Oils
  - Unsaturated Asphalt
  - Certain Asphalts

- Coal Tar Products
  - Coal Tar Pitch
  - Soft Cumars-Tars
  - Soft Coal Tar
  - Cumar Resins

- Resins
  - Shellac

- Pine Products
  - Crude Gum Turpentine
  - Rosin Oil
  - Rosin
  - Pine Tar
  - Dipentene
  - Certain Rosins

- Esters
  - Dicapryl Phthalate
  - Butyl Cuminate
  - Dibutyl Phthalate
  - Butyl Lactate
  - Glycerol Chlorobenzoate
  - Chlorodibutyl Carbonate
  - Methyl Ricinoleate

- Miscellaneous
  - Amines
  - Wool Grease
  - Pitches
  - Diphenyl oxide
  - Benzoic acid
  - Benzyl Polysulfide
  - Waxes
  - Fatty Acids

8. MISCELLANEOUS INGREDIENTS

Type	Purpose	Example
. Abrasives	. For erasers, grinders and polishing wheel products.	. Ground silica and pumice
. Blowing agents	. A gas-generating chemical necessary for preparing blown sponge and micro-porous rubber. Suitable agents must be capable of releasing the gas during the vulcanization period.	. Azo compounds and carbonates -- azo dicarbonamide

7. MISCELLANEOUS INGREDIENTS (continued)

Type	Purpose	Example
. Colorants	. Materials used for coloring the elastomers. They are usually either inorganic pigments or organic dyes.	. Titanium dioxide (white) and cadmium oxide (red) . Organic dye
. Flame retardants	. Chemicals added to reduce flammability.	. Chlorinated hydrocarbons, phosphate and antimony compounds (antimony oxide)
. Internal lubricants	. Provide good mold release and fidelity.	. Amines (primary tallow amine), amides and waxy materials.
. Odorants	. Used to screen out or mask odors from rubber compounds. These compounds are normally used for wearing apparel and drug sundries. Some are effective as germicides.	. Aromatic compounds such as methyl salicylate
. Promoters	. Promote improved reinforcement where added to certain rubber-carbon black mixtures during mastication under controlled conditions.	. Nitroso (p-di-nitrosobenzene) and dioxime compounds.

7. MISCELLANEOUS INGREDIENTS (continued)

Type	Purpose	Example
. Retarders	. These materials reduce the accelerator activity during processing and storage. Their purpose is to prevent scorch during processing and prevulcanization during storage. They should either decompose or not interfere with the accelerator during normal curing at elevated temperatures. These materials function by lowering the pH of the mixture thus retarding vulcanization.	. Organic acids such as salicylic acid.

Source: Foster D. Snell, Inc.

1.5 Wastes Produced In SIC 30 Are Related To The Processes

Waste production in SIC 30 is related to the processes and chemicals involved in these processes. The eight major steps or operations for the production of fabricated rubber goods are as follows:

- Raw materials receiving
- Raw materials storing
- Compounding
- Mixing
- Forming
- Curing
- Finishing and inspection
- Shipping

The first four steps are receiving, storing, compounding and mixing. These steps involve the handling of process chemicals, many of which are in the form of dusts and powders in a free, uncombined state. As pointed out in paragraph 1.4 above, some of the chemicals are toxic materials.

- The materials handled in the operations generate wastes from sources such as:
  - floor sweepings consisting of material from broken bags, fiber packs, etc. and spillage in receiving, storage, compounding and milling areas
  - dusts and powders from the bag houses of dust collection equipment operating in the compounding and mixing areas
  - dusts and powders generated from general plant maintenance and equipment clean-out
  - oils used to lubricate the seals of Banbury mixers become contaminated with "oozings" containing process chemicals from the material being mixed. Contaminated oils themselves are collected in drums and must be disposed of.

- From the forming through shipping steps, these chemicals are entrapped within a water insoluble rubber matrix. Indeed, after curing, many of the chemicals such as the accelerators are not only entrapped in a matrix, but have also undergone reaction. These wastes may also include various solid materials such as rubber stock and fibers.

For the entire SIC 30 industry, including the wet process used by a part of SIC 3063, it was found that the wastes were essentially water free. This means that the figures on a "wet basis" would be identical with those on a "dry basis". The wastes for this industry are reported on a "dry basis" only, being understood that these same figures can be used to describe the wastes of SIC 30 on a "wet basis".

1.5.1 <u>Wastes From The Manufacture Of Rubber Products In Which The Toxic Or Otherwise Hazardous Materials Have Been Entrapped In The Rubber Matrix Are Not Considered To Be Potentially Hazardous</u>

This class of wastes consists of various solid materials generated in the subsequent unit operations. These wastes are typified by either:

- Cured or uncured compounded rubber stock
- Cured or uncured rubber stock physically bound to a fiber substrate
- Rubber free fiber substrate.

In these wastes, the potentially hazardous materials are either absent or have been compounded into the rubber matrix and are strongly bound or reacted.

Studies have been performed[1,2,3,4] on the ability for substances to leach out from rubber matrices, and their possible subsequent entry into the human food chain. The results of these studies have pointed in the direction of concluding that once the processing chemicals are incorporated into the matrix, there is little likelihood of their leaching out in significant quantities.

For example, toxic substances, such as substituted p-phenylenediamines, which are used as antiozonates and antioxidants in fabricated rubber products react with substances such as ozone, oxygen and vulcanization fragments[2,3]. These reactions occur during manufacture, storage and use of the product. Inert polymer compounds are apparently formed by these reactions. This results either in the formation of protective fibers that are chemically bound to the elastomer surface, or in the formation of the reaction products that are chemically attached or physically retained within the matrix.

General plant trash, such as pallets, packaging materials, etc. will likewise not be considered potentially hazardous. The compounded and cured rubber materials and general plant trash account for the great majority of materials disposed of by the industries.

1.5.2 Rubber Products Industry Wastes Containing Processing Chemicals In An Unbound Form Are Considered To Be Potentially Hazardous For The Purposes Of The Study

Potentially hazardous wastes refers to any wastes or combination of wastes that may pose a hazard (known or potential) to human health or living organisms because such wastes may be suspected of being

- Toxic (including carcinogenic)
- Flammable or explosive
- Corrosive or reactive
- Biologically magnified or persistent.

(1) Henry C. Hollifield, "Alteration Products of Substituted p-Phenylenediamines", FDA Internal Report, 31 references, 1975.

(2) Otto Lorenz and Carl R. Parks, "Mechanism of Antiozonant Action. I. Consumption of p-Phenylenediamines in Rubber Vulcanizates During Ozonization, "Rubb. Chem. Technol., Vol. 36 (1963), p. 194.

(3) K.B. Piotrovskii and Yu.A.L'vov, "Relationship Between the Chemical Reactions of Rubber-Like Polymers and those of p-Phenylenediamine Derivatives During Inhibited Oxidation, "Dokl. Akad. Nauk., USSR, Vol. 198 (1971), p. 122.

(4) E.J. Latos and A. K. Sparks, "Water Leaching of Antiozonants", Rubb. Journal, No. 6 (1969), p. 18.

Toxicological information on selected chemicals used in rubber processing is presented in Table III-5. This listing is provided to show that some of the chemicals used in SIC 30 have the potential for being classified as "hazardous" in the free state.

Wastes classified as potentially hazardous will be those arising from such unit operations as receiving, storing, compounding and mixing, and in special cases the on-site sewerage treatment of plant processing effluents.

- Unit operational wastes are classified as being potentially hazardous because they are likely to contain known toxic substances in an unbound and unreacted state. These may consist of such materials as pigments, antioxidants, accelerators, promoters, etc. For information concerning further in-depth questions such as minimum concentrations to be classified as hazardous, please refer to references cited at the end of Table III-5.

- The seal oils from the Banbury mixers (greases and lubricating oils) contaminated with the processing chemicals constitutes another group of potentially hazardous wastes.

- Finally, sludges from on-site sewerage treatment plants constitute another group of potentially hazardous materials. These sludges can contain significant amounts of heavy metals. This may be especially significant for sludges generated by SIC 3041 -- Rubber and Plastic Belt and Hosing, where lead from molds used during hose curing operations finds its way to on-site sewerage treatment plants.

* * *

This section of Chapter III presented a general introduction to SIC 30 -- Rubber Products Industry including classes of wastes which many be considered to be potentially hazardous. The next sections discuss in detail each of the four digit SIC's within SIC 30 which are included in the study. The final section discusses treatment and disposal technologies for the potentially hazardous wastes and their associated costs.

TABLE III-5 (1)

HAZARD RATINGS FOR SAMPLE CHEMICALS USED IN RUBBER PRODUCTS FABRICATION [1]
SIC 30

Use Class	Chemical	Hazard Rating	Source	Comments
. Processing Aids	Phenylhydrazine	3	(a)(c)	Based on acute systemic effects from ingestion. LD_{50} orally (rats) 188 mg/kg.
	Pentachlorothiophenol	3	(a)	Based on acute systemic effects from ingestion of pentachlorophenol.
. Vulcanization Agents	Tetramethylthiuram and disulfide	3	(a)	Based on acute systemic effects from ingestion.
	Alkyl phenol disulfide	U	(a)	Limited information based mainly on animal experiments, suggests that these compounds are dangerous and may cause hemolytic anemia.
	Lead Oxide	4	(b)(c)	LD_{50} in guinea pigs 200 mg/kg.
. Accelerators	Diphenyl guanidine	U	(a)(b)(c)	Details unknown. Animal experiments suggest high toxicity. MLD_{sc} rats 50 mg/kg.
	Ethylenethiourea	U	(a)	A suspected carcinogen.
	Benzothiazyl disulfide (Benzothiazole)	U	(a)(b)	LD_{50} orally in mice 100 mg/kg.
	Zinc dimethyl dithiocarbamate	4	(b)	Poorly absorbed in absence of oils.
. Age Resistors				
- Antioxidants	Hydroquinone	4	(b)	Systemic actions like phenols, but in addition tremors and convulsions are prominent. LD_{50} orally in rats 320 mg/kg.
	Diphenylamine	3	(b)	When ingested by laboratory animals, it causes persistent anorexia, diarrhea, emaciation, hypothermia and general debility. Less toxic than aniline (LD_{50} orally in rats 440 mg/kg).
	Phenylenediamine	4	(b)	Suspected as a cuase of bladder tumors in "aniline" workers.
- Antiozonates	Nickel dibutyl dithiocarbamate	4	(b)	Based on nickel salts.

TABLE III-5 (2)

Use Class	Chemical	Hazard Rating	Source	Comments
. Softeners	Coal tars and pitch	U	(a)	Recognized carcinogen of the skin, scrotum, lip, larynx and lungs. Also an experimental carcinogen of the bladder.
. Fillers	Carbon black (soot)	U		Carbon black is an obstructive and irritating dust, which is carcinogenic. It has caused cancer of nasal sinuses and lungs.
. Miscellaneous Ingredients - Colorants	Cadmium oxide	5	(b)	As little as 10 mg. of cadmium salts have often produced severe toxic symptoms when ingested.
- Flame Retardants	Chlorinated hydrocarbons		(a)	Many of these substances are suspected of being carcinogenic. When heated to decomposition, they emit highly toxic fumes of phosgene.
	Antimony compounds	5	(b)	Tolerance to antimony compounds has been denied.
- Promoters	p-di-nitroso benzene	U	(a)	Many nitroso compounds are suspected carcinogens.

Notes:

(1) This list is not meant to be exhaustive. It is presented only to point out the toxicological properties of selected rubber processing chemicals.

Sources:

a. Dangerous Properties of Industrial Materials, (4th Ed.), N. Irving Sax, Van Nostrand Reinhold Company, New York, 1974.

b. Clinical Toxicology of Commercial Products (3rd Ed.), Gleason, Gosselin, Hodge and Smith, The Williams & Wilkins Co., Baltimore, 1969.

c. Merck Index, 9th Edition.

2. SIC 3011, TIRES AND INNER TUBES INDUSTRY

This section includes geographic and capacity distributions for tire and inner tube manufacturing. Descriptions of processes for the manufacture of tires and inner tubes are included in addition to waste characterization and waste quantification in SIC 3011.

Exhibit D-5 (Appendix D) presents a detailed industry definition. According to the 1972 Census of Manufactures, value added by manufacturers was $3,070.8 million, while the value of shipments was $4,747.1 million and the total gross book value of depreciable assets was estimated[1] at $2,671 million. The 1972 Census of Manufactures also reports that there were about 200 establishments classified in SIC 3011, with about 126 establishments having 20 or more employees.

The pneumatic tire is the characteristic product of this sector. It is the sector's most valuable product; the other products in the sector use manufacturing process steps that are quite similar to processes involved in SIC 3069, Miscellaneous Rubber Products N.E.C.

Tires are vital to the U.S. transportation business which in turn is important to nearly all production. Table III-6 illustrates the impact of the tire industry on various sectors of the economy.

Pneumatic tires are constructed from strong textiles (typically rayon, nylon, polyester) glass, or steel impregnated with polymers (synthetic and natural rubber) and overlaid with a tread of wear-resistant polymer such as styrene-butadiene rubber (SBR). These are built up individually by a skilled tire builder, and cured into the familiar toroidal shape under pressure in a heated mold. The material may also be used for tire retreading, tire repair and inner tubes on bicycles, airplanes, tractors and motorcycles.

Wastes relevant to the study are produced in virtually every processing step in the manufacturing operations of SIC 3011. It is estimated that in 1974 approximately 220,000 KKg of wastes were produced by the industry. Of this amount, approximately 30,000 KKg are considered to be potentially hazardous. These potentially hazardous wastes are produced not as side streams to the processes, but in a manner incidental to production, i.e. floor sweepings from receiving or storage areas; dusts from particulate control equipment; or contaminated seal oils from the mixing areas.

(1) Estimated at 10 times annual capital expenditures from 1972 Census of Manufacturers, i.e., a ten year average lifetime for assets. Estimates based on a 40 year life for buildings and a 7 year life for equipment.

TABLE III-6

IMPACT OF THE TIRE INDUSTRY ON OTHER SECTORS OF THE ECONOMY
SIC 3011

Sector	Tire Value per $1000 of Expenditure	Total Value ($ Millions)
Personal Consumption	$ 3.11	$ 2540
Other Final Demand		459
Motor Vehicles	18.00	1200
Auto Repair	17.79	420
Trucking	10.14	297
Farm Machinery	21.00	118
Coal Mining	10.81	62
Other Intermediate		1971
Total Output		$ 7067

Source: Rubber and Plastics News, September 24, 1973.

The following paragraphs detail industry structure, process techniques and waste generation sources and quantities for SIC 3011.

2.1 Characterization Of SIC 3011, Tires And Inner Tubes Industry

For the purposes of this study, it was only necessary to divide the industry into a subcategorization of two groups as follows:

- Group I, composed of the following SICs:
  - 30111 -- Passenger car and motorcycle pneumatic tires
  - 30112 -- Truck, bus and off-highway pneumatic tires
- Group II, composed of the following SICs:
  - 30113 -- other pneumatic tires and solid tires
  - 30114 -- All inner tubes
  - 30115 -- Tread rubber, tire sundries and repair materials.

According to the 1972 Census of Manufactures, Group I accounted for 93% of the value of shipments and 89% of the number of production workers for SIC 3011. Only Group I industries are discussed in-depth since they are responsible for the great majority of production in SIC 3011. Group II accounted for 7% of the value of shipments and 11% of the number of production workers for SIC 3011.

A detailed discussion of the methodology employed in the development of the industry characterization information is presented in Appendix A at the back of this report.

2.1.1. Georgraphic And Capacity Distribution Of Plants In SIC 3011

Table III-7 presents the geographic distribution of plants for establishments in SIC 3011 in terms of Group I and Group II plants. Capacity data for Group I plants (pneumatic tires for passenger cars, motorcycles, truck, bus and off-highway uses) is included in Table III-7. The largest concentrations of plants are located in EPA Regions IV and V with 31 and 33 establishments, respectively. The states include:

EPA Region IV -- Alabama, Georgia, Kentucky, Mississippi, No. Carolina, So. Carolina and Tennessee

EPA Region V -- Illinois, Indiana, Michigan, Ohio and Wisconsin.

Location of the establishments to potential end-users (i.e. automobile industry) appears to be a major reason of Group I plants in EPA Region V. Other factors such as economics (labor, raw materials) may have influenced the building of plants in EPA Region IV.

Table III-8 lists Group I plant locations by owner (company) with an approximate date of construction and capacity (tire production -- units/day). The largest producers included Goodyear (229,000 tires/day), Firestone (216,000 tires/day) and Uniroyal (158,000 tires/day).

2.1.2 Age And Employment Distribution Of Major SIC 3011 Plants

Table III-9 displays the distribution of plants by age, state and EPA region for Group I plants in SIC 3011. National totals are included. Forty-four percent of the Group I plants are between 11 and 29 years old. Forty-one percent of the Group I plants are 30 years or older. The majority (57%) of the Group I plants are located within EPA regions IV and V.

TABLE III-7 (1)

GEOGRAPHIC DISTRIBUTION OF PLANTS IN SIC 3011

		Total No. Plants (1)	Group I Plants (2)	Group II Plants (3)	Tire Capacity (units/day) (4)
IV	Alabama	6	4	2	94,500 (5)
X	Alaska				
IX	Arizona				
VI	Arkansas	5	2	3	23,000
IX	California	15	6	9	84,500 (5)
VIII	Colorado	2		2	
I	Connecticut	1	1		13,500
III	Delaware				
IV	Florida				
IV	Georgia	7	1	6	17,000
IX	Hawaii				
X	Idaho				
V	Illinois	6	4	2	36,000
V	Indiana	4	1	3	19,000
VII	Iowa	5	2	3	42,000
VII	Kansas	1	1		30,000
IV	Kentucky	1	1		23,000
VI	Louisiana				
I	Maine				
III	Maryland	2	1	1	20,500 (5)
I	Massachusetts	2	1	1	29,000
V	Michigan	3	3		86,000 (5)
V	Minnesota				
IV	Mississippi	3	2	1	27,100
VII	Missouri	1		1	
VIII	Montana				
VII	Nebraska				
IX	Nevada				
I	New Hampshire				
II	New Jersey				

TABLE III-7 (2)

		Total No. Plants (1)	Group I Plants (2)	Group II Plants (3)	Tire Capacity (Units/day) (4)
VI	New Mexico				
II	New York	1	1		16,000 (5)
IV	North Carolina	4	2	2	28,000 (5)
VIII	North Dakota				
V	Ohio	19	11	8	158,300 (5)
VI	Oklahoma	5	2	3	41,000
X	Oregon				
III	Pennsylvania	10	5	5	71,500 (5)
I	Rhode Island				
IV	South Carolina	1	1		30,000
VIII	South Dakota				
IV	Tennessee	9	4	5	78,000
VI	Texas	5	2	3	31,000
VIII	Utah				
I	Vermont				
III	Virginia	3	2	1	8,800
X	Washington				
III	West Virginia				
V	Wisconsin	1	1		30,000
VIII	Wyoming				
	TOTAL	122	61	61	1,037,700
Region	I	3	2	1	42,500
	II	1	1		16,000
	III	15	8	7	100,000
	IV	31	15	16	297,600
	V	33	20	13	329,300
	VI	15	6	9	95,000
	VII	7	3	4	72,000
	VIII	2		2	
	IX	15	6	9	84,500
	X				

(1) Based on plants with 20 or more employees.
(2) SIC subcategories 3011 and 30112
(3) The "other" segment of SIC 3011 encompasses the plants producing 3011 materials exclusive of the 30111 and 30112 production.
(4) Based upon Group I category (Table III-).
(5) In these states, there is one plant of unknown capacity. It is assumed to be average 16,000 tpd.

Source: Foster D. Snell, Inc. analysis of Industry and Department of Commerce data.

TABLE III-8 (1)

MAJOR TIRE PRODUCTION
FACILITIES IN THE U.S.
SIC 30111 and SIC 30112

Company	Location	Approximate Construction Date	Capacity Units/Day
Armstrong	Des Moines, IA	1944	20,000
	Hanford, CA	1961	10,000
	Madison, TN	N.A.	10,000
	Natches, MS	1938	14,600
	West Haven, CT	1920	13,500
Carlisle	Carlisle, PA	N.A.	N.A.
Cooper	Findlay, OH	1945	13,000
	Texarkana, AR	1964	13,000
Courduroy	Grand Rapids, MI	N.A.	N.A.
Denman	Warren, OH	N.A.	N.A.
Dunlop	Buffalo, NY	1923	N.A.
	Huntsville, AL	1969	N.A.
Firestone	Akron, OH	1911	27,000
	Albany, GA	1968	17,000
	Barberton, OH	1921	8,500
	Bloomington, IL	1965	50
	Dayton, OH	1945	20,700
	Decatur, IL	1963	22,000
	Des Moines, IA	1945	22,000
	Los Angeles, CA	N.A.	15,500
	Memphis, TN	N.A.	28,000
	Pottstown, PA	1947	30,000
	Salinas, CA	N.A.	15,000
	Nashville, TN	N.A.	10,000
General	Akron, OH	1945	9,050
	Byran, OH	N.A.	30
	Charlotte, NC	1967	12,000
	Mayfield, KY	1960	23,000
	Mt. Vernon, IL	N.A.	N.A.
	Waco, TX	1945	16,000

TABLE III-8 (2)

Company	Location	Approximate Construction Date	Capactity Units/Day
Goodrich	Akron, OH	N.A.	6,000
	Ft. Wayne, IN	N.A.	18,000
	Los Angeles, CA	1928	11,500
	Miami, OK	N.A.	13,000
	Oaks, PA	1937	9,000
	Tuscabosa, AL	1945	21,000
Goodyear	Akron, OH	N.A.	38,000
	Conshohocken, PA	N.A.	13,000
	Cumberland, MD	1921	20,500
	Danville, VA	1966	4,100
	Fayetteville, NC	N.A.	N.A.
	Freeport, IL	1963	14,000
	Gadsten, AL	N.A.	44,000
	Jackson, MI	1937	30,000
	Los Angeles, CA	1927	N.A.
	Topeka, KS	1945	30,000
	Tyler, TX	N.A.	15,000
	Union City, TN	1968	30,000
Mansfield	Mansfield, OH	1946	14,000
	Tupelo, MS	1959	12,500
McCreary	Indiana, PA	1951	3,500
Michelin	Greenville, SC	1975	30,000
Mohawk	Akron, OH	N.A.	6,000
	Salem, VA	N.A.	4,700
	West Helena, AR	1956	10,000
Uniroyal	Ardmore, OK	N.A.	28,000
	Chicopee Falls, MA	1965	29,000
	Detroit, MI	1906	39,700
	Eau Claire, WI	1944	30,000
	Los Angeles, CA	1931	16,500
	Opelika, AL	1964	13,500

(1) Not Available

Source: Snell update of "Rubber Reuse and Solid Waste Management", U.S. EPA, 1971 and the Rubber Red Book.

TABLE III-9 (1)

DISTRIBUTION OF TIRE MANUFACTURING BY AGE -- SICs 30111 AND 30112 (Group I)

		Number Of Plants	Age: 10	Age: 11-30	Age: More Than 30
IV	Alabama	4	1	3	
X	Alaska				
IX	Arizona				
VI	Arkansas	2		2	
IX	California	6		2	4
VIII	Colorado				
I	Connecticut	1			1
III	Delaware				
IV	Florida				
IV	Georgia	1	1		
IX	Hawaii				
X	Idaho				
V	Illinois	4 (1)		4	
V	Indiana	1		1	
VII	Iowa	2		1	1
VII	Kansas	1		1	
IV	Kentucky	1		1	
VI	Louisiana				
I	Maine				
III	Maryland	1			1
I	Massachusetts	1		1	
V	Michigan	3			3
V	Minnesota				
IV	Mississippi	2		1	1
VII	Missouri				
VIII	Montana				
VII	Nebraska				
IX	Nevada				
I	New Hampshire				
II	New Jersey				

		Number Of Plants	Age 10	Age 11-30	Age More Than 30
VI	New Mexico				
II	New York	1			1
IV	North Carolina	2	1	1	
VIII	North Dakota				
V	Ohio	11(2)	2	2	7
VI	Oklahoma	2		1	1
X	Oregon				
III	Pennsylvania	5		3	2
I	Rhode Island				
IV	South Carolina	1	1		
VIII	South Dakota				
IV	Tennessee	4	2	1	1
VI	Texas	2		2	
VIII	Utah				
I	Vermont				
III	Virginia	2	1		1
X	Washington				
III	West Virginia				
V	Wisconsin	1			1
VIII	Wyoming				
	TOTAL	61	9	27	25
	Region I	2		1	1
	II	1			1
	III	8	1	3	4
	IV	15	6	7	2
	V	20	2	7	11
	VI	6		5	1
	VII	3		2	1
	VIII				
	IX	6		2	4
	X				

(1) A plant is reported to have a 50 tires/day capacity

(2) A plant is reported to have a 30 tires/day capacity.

Source: "Rubber Reuse and Solid Waste Management", U.S. EPA, 1971.

Figure III-1, graphically presents the distribution of plant sizes for SIC 3011 based on total employment at a national level. The largest single category are plants employing 1 to 4 with about 50 plants. It is believed that these are Group II plants. However, the next largest category are plants employing between 1,000 and 2,499 employees. There are about 35 plants in this category.

2.1.3 Geographic Distribution Of Raw Material Consumption In SIC 3011

Raw materials consumed by class on a percentage of total materials consumed in SIC 3011 are as follows:

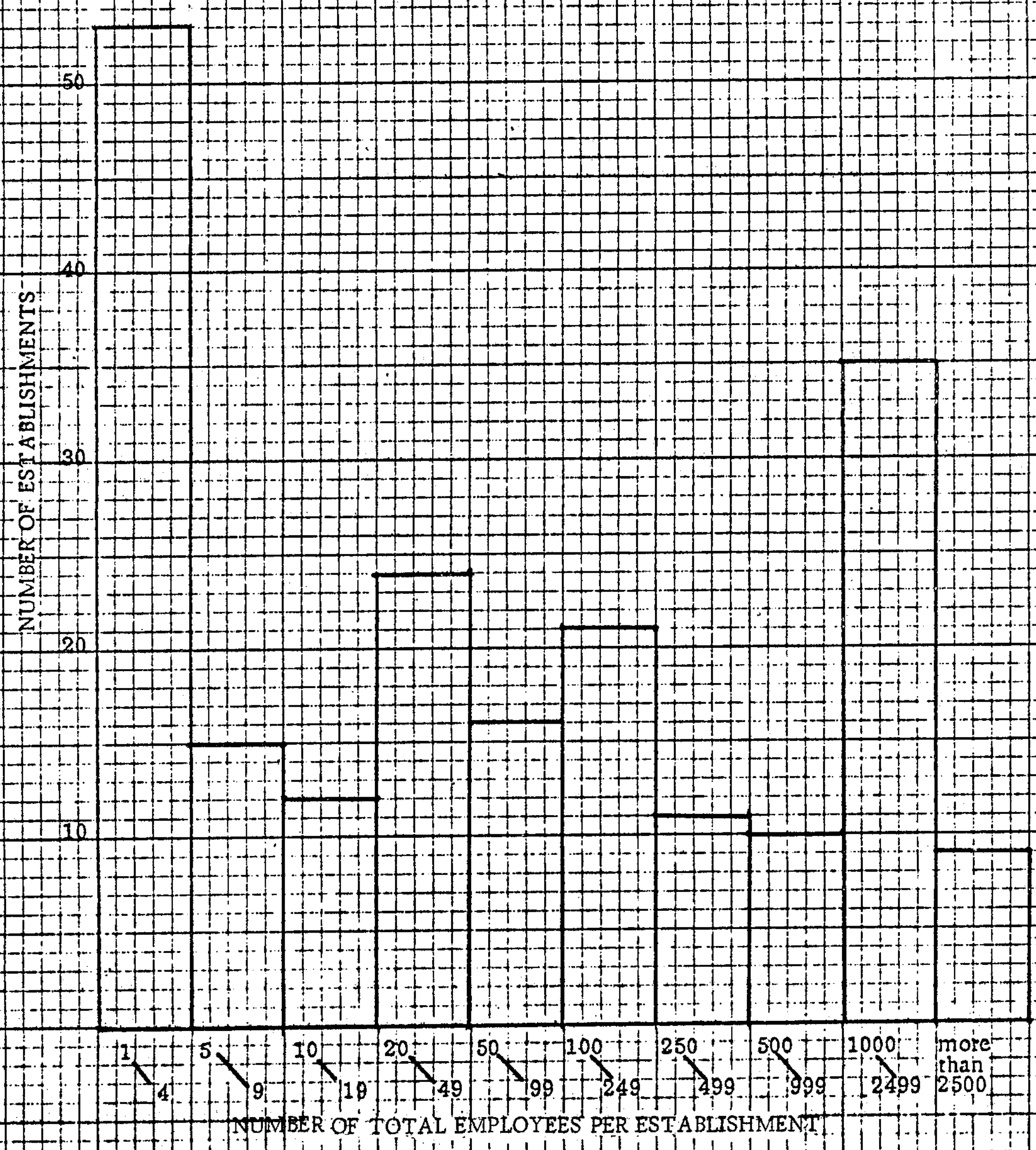
Class		Percent of Total Raw Materials Consumed in SIC 3011
Elastomers		57.5
Carbon black		20.6
Cord and fabric		7.8
Pigments		6.1
Plasticizers		4.1
Chemicals		3.0
Plastic resins		0.9
	Total	100.0 %

Source: Table III-4.

Elastomers and carbon black account for more than 75% of the total raw materials utilized in SIC 3011. Of the remaining components, fillers (such as cord and fabric) and colorants (pigments) account for 14%. Plasticizers and chemicals to aid in the process (vulcanization, accelerators, anti-oxidants) largely account for the remaining raw materials used.

Table III-10 distributes the consumption of these materials by state, EPA region and national levels for Groups I and II of SIC 3011. The figures are reported in KKKg/year. Twenty-six states account for raw material consumption and the following conclusions may be drawn from this exhibit:

FIGURE III- 1
EPA
DISTRIBUTION OF PLANTS SIZES
BY EMPLOYMENT IN THE TIRE
AND INNER TUBE INDUSTRY
SIC 3011



Source: Foster D. Snell Analysis of Department of Commerce Data (1972 -- Census of Manufacturers)

TABLE III-10 (1)

GEOGRAPHIC DISTRIBUTION
OF RAW MATERIAL CONSUMPTION
IN THE TIRE AND INNER TUBE INDUSTRY
SIC 3011

		Total Consumption of Raw Materials (KKKg/yr)	Group I[1] Raw Materials Consumption (KKKg/yr)	Group II[2] Raw Materials Consumption (KKKg/yr)
IV	Alabama	343.9	334.5	9.4
X	Alaska			
IX	Arizona			
VI	Arkansas	95.5	81.4	14.1
IX	California	341.5	299.1	42.4
VIII	Colorado	9.4		9.4
I	Connecticut	47.8	47.8	
III	Delaware			
IV	Florida			
IV	Georgia	88.5	60.2	28.3
IX	Hawaii			
X	Idaho			
V	Illinois	136.8	127.4	9.4
V	Indiana	81.4	67.3	14.1
VII	Iowa	162.8	148.7	14.1
VII	Kansas	106.2	106.2	
IV	Kentucky	81.4	81.4	
VI	Louisiana			
I	Maine			
III	Maryland	77.3	72.6	4.7
I	Massachusetts	112.4	107.7	4.7
V	Michigan	304.4	304.4	
V	Minnesota			
IV	Mississippi	100.6	95.9	4.7
VII	Missouri	4.7		4.7
VIII	Montana			
VII	Nebraska			
IX	Nevada			
I	New Hampshire			
II	New Jersey			

		Total Consumption of Raw Materials (KKKg/yr)	Group I(1) Raw Materials Consumption (KKKg/yr)	Group II(2) Raw Materials Consumption (KKKg/yr)
VI	New Mexico			
II	New York	56.6	56.6	
IV	North Carolina	108.5	99.1	9.4
VIII	North Dakota			
V	Ohio	598.1	560.4	37.7
VI	Oklahoma	159.2	145.1	14.1
X	Oregon			
III	Pennsylvania	276.7	253.1	23.6
I	Rhode Island			
IV	South Carolina	106.2	106.2	
VIII	South Dakota			
IV	Tennessee	299.7	276.1	23.6
VI	Texas	123.8	109.7	14.1
VIII	Utah			
I	Vermont			
III	Virginia	35.9	31.2	4.7
X	Washington			
III	West Virginia			
V	Wisconsin	106.2	106.2	
VIII	Wyoming			
	TOTAL	3965.5	3678.3	287.2
Region	I	160.2	155.5	4.7
	II	56.6	56.6	
	III	389.9	356.9	33.0
	IV	1128.8	1053.4	75.4
	V	1226.9	1165.7	61.2
	VI	378.5	336.2	42.3
	VII	273.7	254.9	18.8
	VIII	9.4		9.4
	IX	341.5	299.1	42.4
	X			

Notes: (1) Includes those establishments classified in SICs 30111 and 30112.
(2) Includes those establishments classified in SICs 30113, 30114 and 30115.

Source: Foster D. Snell, Inc. analysis of 1972 census data.

- The total raw materials consumed amounted to almost 4000 KKKg/year of which Group I plants used 37,000 KKKg/year or about 93% of total consumption.

- EPA regions IV and V acounted for 55% of total consumption and 60% of consumption in Group I plants.

- In Group II plants, which accounted for 7% of total raw material consumption, EPA regions IV and V acounted for 3.4% of total consumption and 47% of the raw materials consumed by Group II plants.

- The states of Ohio, California, Michigan, Tennessee and Pennsylvania were the most predominant in raw material consumption.

- In terms of consumption, Group I industries are significantly more important than Group II.

2.2 Detailed Process Description And Waste Stream Identification For The Tire Industry -- Group I

This section of the report provides a detailed processing description for the manufacture of tires, including radial and bias, and relates the waste streams of the industry to its unit operations.

The general process for tire manufacturing consists of:

- Preparation or compounding of the raw materials

- Transformation of these compounded materials into the five tire components

- The building, molding and curing of the final product.

It is important to note that the wastes generated by this industry are not generally dependent on production levels as, for instance, a waste stream in a chemical operation.

A good proportion of the wastes are in the form of accidental spills in warehouses; dust collected from conveying equipment or other material transfer operations; and off-grade products resulting from errors or production upsets. A small portion such as vent trims is a direct function of the production but is highly dependent on the particular product mix.

A flow diagram for a typical tire plant is shown in Figure III-2. Included in Figure III-2 is a material balance diagram for tire manufacturing. A similar display presenting waste streams as a function of unit operations is presented in Figure III-3. Table III-11 summarizes the wastes by type and quantities produced in kilograms of waste per 1,000 kilograms of production. The largest category of wastes produced is scrapped tires which account for approximately 22 Kg per 1000 Kg of production.

2.2.1 Materials Receiving And Storage

The storage of the raw materials received varied with the size of the operation, and the efficiency of the establishment. The materials received were kept away from the elements and stored under conditions that would not effect the physical and chemical properties of the raw materials.

Three types of rubber are used in the manufacture of tires: natural, synthetic crumb and masterbatch. These items arrive at the plant in 34 Kg (75 lbs) bales on pallets and usually wrapped with polyethylene film with cardboard overwraps.

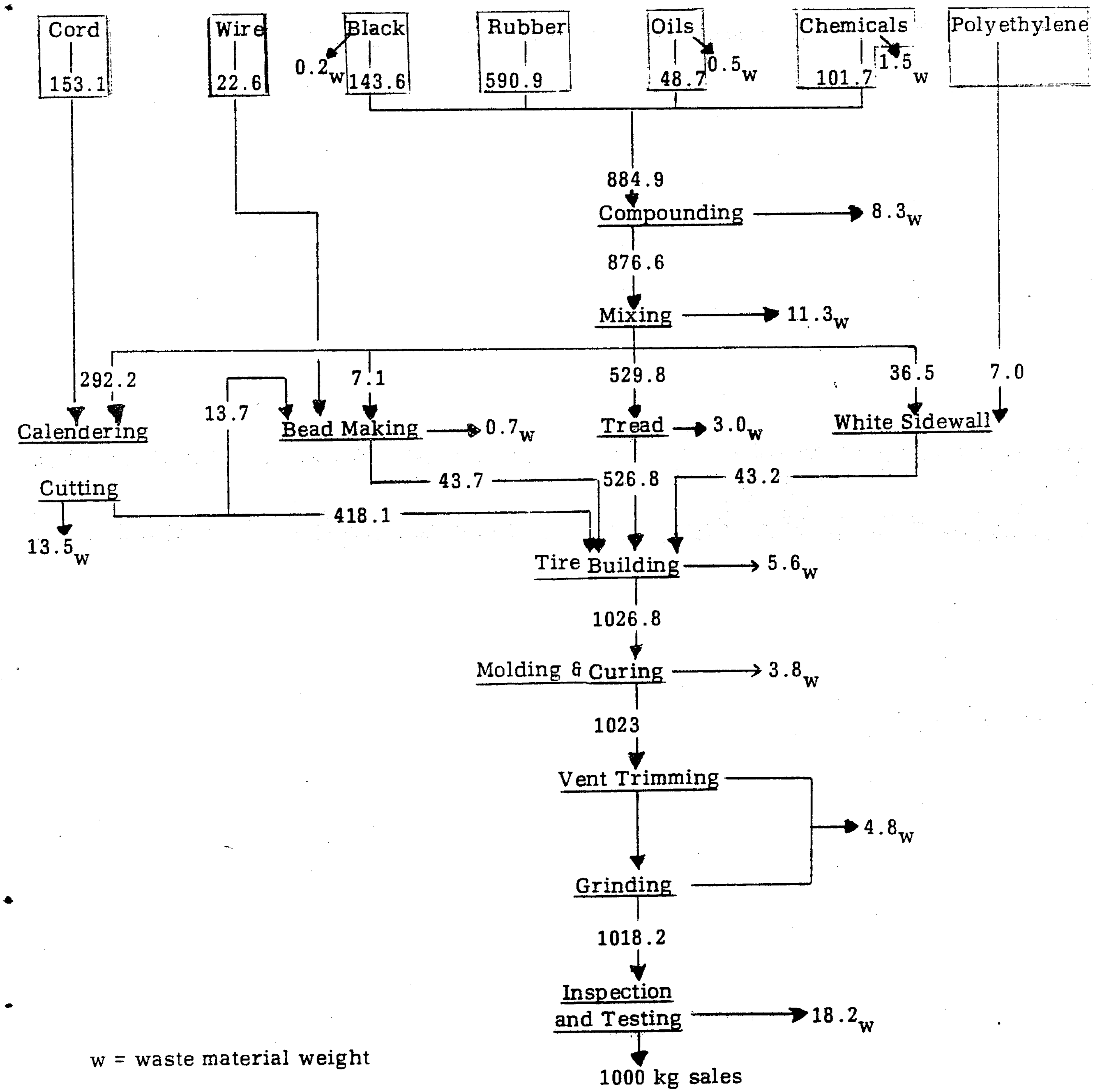
Carbon black arrives generally in bulk or semi-bulk, returnable collapsible containers. The carbon blacks are handled mechanically.

Zinc and magnesium oxides are also received in semi-bulk form or in 23 KG (50 lbs) bags, usually palletized.

Extender oils are usually received in 210 l (55 gal) drums. The remainder of the ingredients are received in bags or fiber packs of various sizes.

FIGURE III-2

PRODUCTION AND MATERIAL BALANCE IN TIRE MANUFACTURING (1)
(Kg/1000 Kg of Product)
SIC 3011



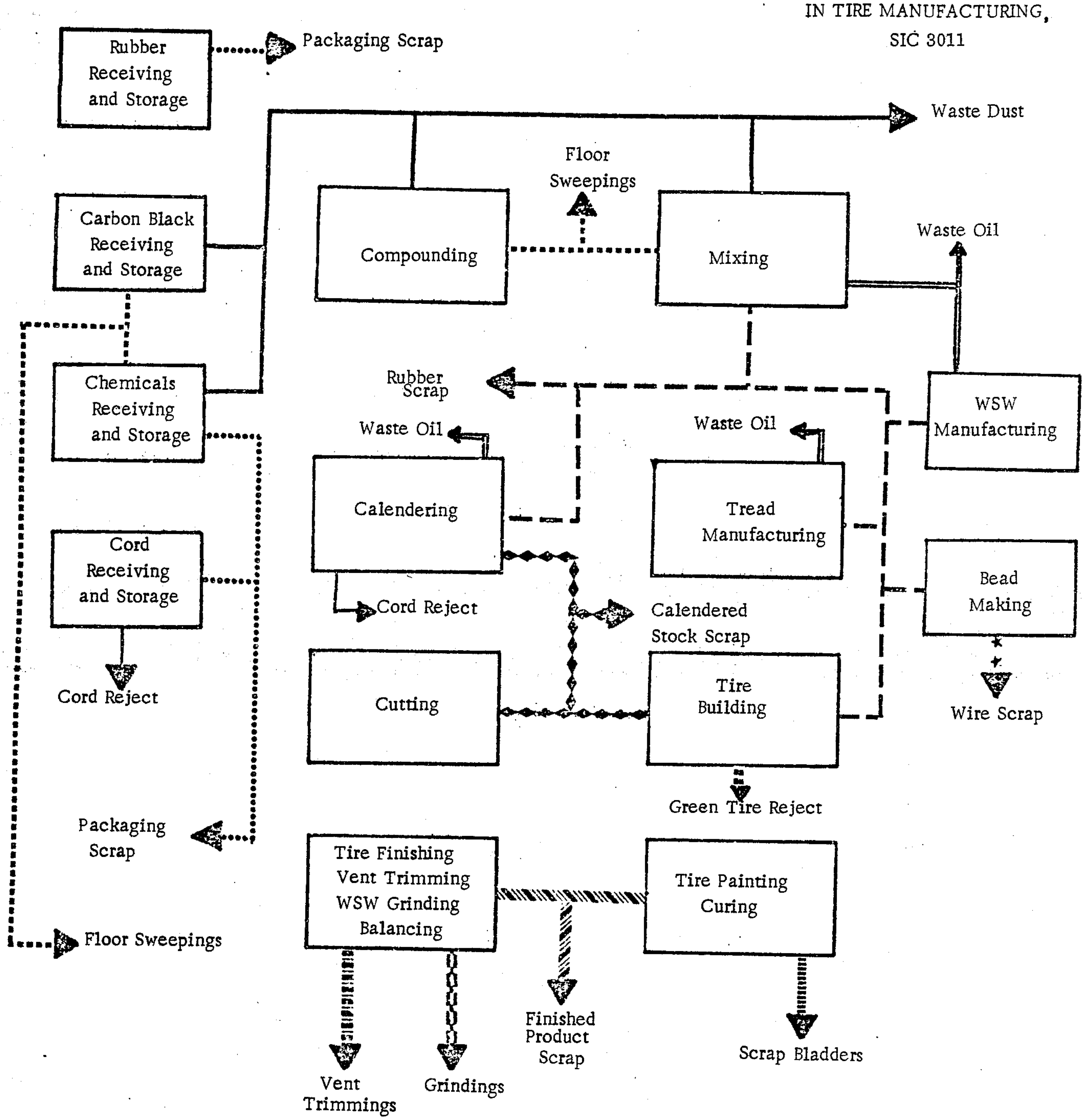
w = waste material weight

(1) This includes only those wastes which are the object of this study. For waste streams characterization see Table III-13.

Source: Foster D. Snell, Inc. analysis of industry interviews

FIGURE III-3

WASTE FLOW DIAGRAM
IN TIRE MANUFACTURING,
SIC 3011



Source: Foster D. Snell, Inc. analysis of industry interviews

TABLE III-11 (1)

WASTE STREAM CHARACTERIZATION
IN TIRE MANUFACTURING
SICs 30111 and 30112

	Source and Waste Stream	Waste Type	Quantity[1] (Kg/1000 Kg of product)	
I.	Spilled Carbon Black	Type I	0.2	
II.	Warehouse And Compounding Area Sweepings Mixtures in varying proportions of any number of about 150 different products. However, carbon black and pigments usually predominate.	Type I	1.7	
III.	Dust From Compounding And Mixing Collected From Bag Dust Collectors Mixtures in varying proportions of carbon black, pigments (eg. zinc oxide or titanium dioxide), clays, and finely powdered additives (antioxidants, promoters and accelerators), also stearic acid.	Type I	8.3	
IV.	Scrapped Stock ("Scorched" Rubber) More or less large chunks of partially cured rubber.	Type II	11.3	
V.	Other Wasted, Uncured Stock Uncured rubber stock too contaminated for reuse.	Type II	3.4	0.4 calendering 3.0 tread manufacturing
VI.	Coated And Uncoated Fabric Scraps Various pieces of cord material (polyester, rayon, nylon, fiberglass, etc.) either uncoated or rubber coated (predominantly rubber coated).	Type II	15.9	13.0 calendering 2.9 tire bldg[2]
VII.	Bead Manufacturing Scrap Mixtures of rubber, steel wire and rubber coated fabric.	Type II	0.7	
VIII.	Green Tire Scrap Tires which have been built but are not cured and which are rejected for various reasons.	Type II	2.7	

TABLE III-11 (2)

	Source and Waste Stream	Waste Type	Quantity[1] (Kg of Waste per 1000 Kg of Product)
IX.	Cured Rubber Waste (Vent Trims And Grindings) Mixture of small cylindrical pieces (vents) resulting from molding operations which are trimmed from the tire and of ground rubber resulting from the deliberate grinding of the black rubber "skin" covering the white sidewall material. Also rubber ground from the tread to dynamically balance the tire.	Type II	4.8
X.	Scrapped Tires Tires which do not pass final inspection. Also, in part, tires used in destructive testing; also curing rejects.	Type II	21.9
XI.	Oily Wastes Various mixtures of oil and rubber from Banbury seals and also waste lubricant from mechanical equipment (e.g. mills).	Type II	0.5

(1) Figures have been isolated when a stream is generated in more than one operation, except as noted below.

(2) There is some evidence that radial tire building may generate more scrap than bias tire building, so that this figure is only valid for the particular mix in this plant. However, the amount of scrap in radial tire building reflects in part the "newness" of this production.

(3) Type I wastes contain the raw materials used by this industry in a fee or uncombined state. Type II wastes are those process chemicals compounded into the rubber matrix.

Source: Foster D. Snell, Inc. analysis of industry interviews.

As discussed, the majority of the materials arriving at the plant come in bulk, semi-bulk bags or fiber packs. Spillages resulting in the wasting of a portion of these materials may occur due to such factors as:

- Inadvertent breaking of the bags and fiber packs by dropping or puncturing by fork lift trucks

- Leaks in the conveyor systems used for bulk materials transport

- Spillage of the materials at the plant site from the hopper type rail cars or trailers.

Also, dust collection equipment may be employed at the receiving or storage areas adding to the quantity of materials which must be disposed of.

2.2.2 Compounding (Figure III-2)

Compounding consists of measuring the ingredients which constitute a batch. The batch size of which is determined by the capacity of the Banbury mixers. Minor ingredients are usually weighed out into Kraft paperbags and collected in trays corresponding to each of the batches.

The major ingredients are:

- Extender oils are usually metered directly into the Banbury

- Rubber and masterbatched rubber to be used is added directly in bale quantities. Weight being adjusted by dividing the bales and saving the excess for subsequent batches. The rubber and master batch is often fed to an intermediate mill called a plasticator. Sometimes a portion of the extender oil is introduced at this time.

- Carbon black can be metered directly to the Banbury mixer by automatic scales. In some facilities carbon black is metered into front-end loaders or similar equipment and then dumped into the Banbury mixer.

Compounding of the rubber stock is a batchwise operation. Waste streams originating from the operation compounding are essentially associated with two sources:

- Handling of the carbon blacks and major pigments such as oxides of zinc, magnesium and titanium.

- Other dusting ingredients such as antioxidants, curing agents, catalysts and promoters.

All of these non-rubber solids used in the rubber stock recipes are extremely fine powders and very easily airborne. These materials may fall to the floor and must be swept up. Conveying equipment used to bring ingredients into the compounding area are usually vented by suction to air pollution control equipment (electrostatic precipitators and/or bag houses). Tailings collected by this equipment must also be disposed of.

2.2.3 Mixing (Figure III-2)

The bulk of the mixing is carried out in Banbury mixers. A Banbury mixer essentially is a closed vessel that my be controlled for temperature, pressure and rate of mixing speed. A small portion is sometimes hand mixed on roller mills.

Several passes through the Banbury are usually required. When it is desired to stock large amounts of a recipe, the curing agents are added at the last pass. The material coming out of the Banbury mixer is usually extruded as a continuous sheet which is cooled by passing it through a slurry of talc or soapstone in water. The talc or soapstone acts as an anti-tack agent on the surface of prepared stock.

White sidewall material is prepared in a similar fashion but obviously does not contain blacks and is handled on much smaller scale equipment.

Rubber stocks thus prepared are usually palletized and then transported to the other work stations where extrusion or calendaring take place.

The three waste streams produced by the mixing operation are:

- Dusts
- Oils
- "Scorched" stock

The Banbury mixers are vented through the dust collection equipment. Since a certain amount of "puffing" takes place in the mixer upon the addition of the compounded ingredients, some dust is contributed at this point to the wastes which must be disposed of.

A Banbury mixer consists of two counter-rotating mixing blades which impart a considerable energy to the extremely viscous mass constituted by the raw rubber stock. The seals around the shafts of the blades are subjected to considerable pressures. By the operation of these mixers, lubricating oils "ooze" out of the seals. These oils are highly contaminated with some of the components of the mix, and are collected in drums and must be disposed of.

In addition to oils "oozing" from the mixers, used reducing gear oil is another waste that requires disposal. It must be borne in mind that rubber processing involves the softening of a very tough thermoplastic material. The best method devised to make this material plastic enough for most applications is the shearing action of two smooth cylinders revolving at a small differential velocity, with a suitable interstitial space. Very high torques are required to insure the proper rotation of the cylinders at comparatively low speeds. A typical rubber mill has a motor in the 100 to 300 horse power range and a very large reducing gear. The reducing gear oil has to be periodically drained and replaced.

The third waste stream identified in the mixing operation is "scorched" rubber. This is rubber stock which, due to a variety of causes, usually a compounding error, becomes partly cured during the mixing operation. Therefore this stock is too hard for further processing and has to be discarded.

2.2.4 <u>White Sidewall (WSW) Manufacturing</u>
(Figure III-2)

This step is essentially an extrusion operation. The operation can typically be carried out by the following methods:

- Encasing of the white rubber stock in a special black rubber envelope via a co-extrusion process (extruding of two or more materials simultaneously.
- A "laminating" step in which the white stock is coated on a black rubber backing.

The product of both of these operation types is a continuous strip which is rolled onto a reuseable cloth liner and is sent to the tire building work station.

The waste stream produced in this operation is uncured rubber stock arising from process start-up and shut-down. Minor amounts of lubricating waste oils may be present.

2.2.5 <u>Camelback Or Tread Manufacturing</u>
(Figure III-2)

This operation is also essentially a co-extrusion of at least two types of stock.

- Tread stock
- Sidewall stock

Camelback (used for tire retreading) comes out of the extruder as a continous strip which is cooled by a water spray. It is cut to length by a skiving operation. Cement is applied to the taper (reduced thickness) resulting from the skiving operation.

Individual camelbacks are placed on tray equipped trucks and carted to the tire building work stations.

The majority of wastes are constituted by rejected stock which is not suitable for production or recovery usually due to contamination. Waste oils are minimal.

2.2.6 Calendering (Figure III-2)

Basically two types of calendering operations are employed by the industry:

- Frictioning, which is the application of one or two layers of rubber stock to a textile base.

- Sheeting which is the production of a thin unsupported rubber sheet.

Both frictioned and sheeted stock are used in the tire building operation. They constitute the plies or carcass of the tire.

The cords and belts of the tire are made in the calendering operation.

In addition to the waste oils created by the calenders' gear boxes, this operation gives rise to off-spec calendered stock. Rubber scrap and cord rejects normally become part of the "sweepings."

2.2.7 Cutting [1]

The calendering operation produces a roll in which the main orientation of the cord is parallel to the longitudinal axis of the material. The cutting operation permits the reorientation of the cord. The bias cut pieces are cemented together to form a continuous strip in which the cord is oriented at a 40^{o} to 60^{o} angle from the longitudinal axis of the strip. The strips are wound on a roll together with a reusable cloth liner for separation. The rolls are then conveyed to the tire building work stations.

The wastes generated in this operation are mainly calendered stock cuttings.

2.2.8 Bead Manufacturing (Figure III-2)

The bead is essentially a rubber covered metallic ring. It is produced by coiling an appropriate length of bead wire, usually brass covered steel, to the desired diameter. At the same time, rubber stock is extruded onto the coil. In certain cases, the bead is also wrapped in a ribbon of calendered stock.

The completed beads are put on racks and conveyed to the tire building operations.

The wastes generated in this operation are wire scrap, some calendered stock and some scrap rubber.

(1) The operation described here is for the manufacture of conventional bias tire. There are substantial differences in the operations involved in the manufacture of radial tires. These operations are of a highly confidential nature. However, the waste streams produced are reported not to be materially different.

2.2.9 Tire Building[1] (Figure III-2)

This operation is the assembly of the components, the production of which has been described above. It is essentially a mechanically assisted hand operation, requiring a high degree of skill.

The tire is built up as a cylinder on a collapsible, round rotating drum. The inner liner is applied first. Then, the bias cut plies are placed so that they overlap the beads, alternating the bias angle with each ply. The overlap is then rolled around the bead and the belt(s) are then applied. Finally, the tread is wrapped around the carcass with the cemented slanted ends firmly pressed together. The cylinder is then collapsed and the green tires are placed on caster-mounted racks for transfer to the next work station.

Three kinds of scrap are generated at this step: green tire rejects, end cuts of calendered stock and scrap rubber.

2.2.10 Tire Painting (Figure III-2)

Before molding and curing, the green tire is sprayed with proprietary release agents, possibly silicone oil. These agents aid in the release of air from the tire during molding and from the mold of the tire after curing. Both water- and solvent-based sprays are used. Excess spray is released to the atmosphere. In most plants the tires are placed in a hood during spraying to reduce atmospheric contamination.

(1) The operation described here is for the manufacture of conventional bias tire. There are substantial differences in the operations involved in the manufacture of radial tires. These operations are of a highly confidential nature. However, the waste streams produced are reported not to be materially different.

2.2.11 Molding And Curing (Figure III-2)

The tire is molded and cured in an automatic press. Here an inflatable rubber bladder bag is inflated inside the tire, causing the tire to take its characteristic doughnut shape. The mold is simultaneously closed over the shaped tire. Heat is applied by steam via the mold and bladder bag. Excess rubber and trapped air escape through weepholes. After a time and temperature controlled cure, the press is cooled, the bladder is deflated via a vacuum, and the tire is removed. The tire is then inflated with air and left to cool in the atmosphere. This last inflation insures product quality and uniformity by allowing the tire to "set up" or achieve the final limits of its cure under controlled conditions.

A significant quantity of waste associated with this operation consists of worn out bladders. The bladders are rubber bags used to apply pressure to the tire during the curing operation. It is included in the weight of scrap tires from this and other operations.

2.2.12 Tire Finishing (Figure III-2)

The tire comes out from the curing mold with cylindrical rubber protrusions usually about 3 mm (1/8") by 10 mm (1/2") literally bristling from the tread surface. These correspond to some rubber flow into the vent holes of the mold. They are shaved off on a finishing machine and constitute a significant quantity of rubber waste. In addition, there are two grinding operations which also generate rubber waste: one is the grinding out of the black rubber cover of the white sidewall and the other is used to dynamically balance the tire.

In the course of these operations a tire inspection is carried out. This causes the rejection of a certain amount of tires. These have been discussed in a preceding section (2.2.9).

* * *

The discussion thus far has described a typical tire plant, and applied most readily to the production of passenger tires. There are, however, several variations.

The first of these is the production of truck and industrial tires. Truck tires tend to have a greater amount of natural rubber in their treads. Natural rubber, as received in the plant, is much harder to handle than synthetic. Additional roller mills are needed to break up and soften the rubber before it enters the Banbury mixer.

There are also major differences in the building and molding of the tires as the larger sizes are approached. The building of a "giant off-the-road tire" requires the services of two men each for a half a day, whereas the passenger tire can be built in less than 5 minutes. Larger tires are cured in giant molds which are not automatically operated.

Another variation in the typical tire production is the manufacture of camelback. Cambelback is tread used for tire retreading. It is produced in the same manner as tread used for new tires. (See flow diagram, Figure III-2.)

Process variations associated with tread and industrial tire production and cambelback manufacture do not have a significant effect on the quantity and quality of the wastes generated when compared to those from automobile tire production on a weight basis.

Radial tires, like truck tires, contain more natural rubber, thus requiring more machinery in the compounding area. Whereas bias-ply tires are built in the form of a hollow cyliner, radial tires are built in the doughnut shape of the final product. Again, wastes will be very similar to those for typical passenger tire production on a weight basis.

2.3 Inner Tube Manufacturing Process -- Group II

Inner tube manufacturing is discussed here to provide an example of the production processes used in the Group II segment of SIC 3011. Inner tubes manufacture is very similar to tire manufacture A flow diagram for the typical process is shown in Figure III-4.

Inner tube production represents a rapidly declining segment of SIC 3011. Over 99% of the U.S. production is of tubeless tires. Indeed, the value of materials in 1972 going into tire production (and they are more expensive on a weight basis) is 1.8% of that going into tires.

A detailed description for the inner tube manufacturing process is presented below. Wastes produced are similar to those in tire production, both in terms of quantity and type, on a weight basis, per unit operation. This is previously described in Figure III-2 and Table III-11.

2.3.1 Materials Receiving And Storage (Figure III-4)

Raw materials are received and stored in a similar manner as employed in tire production. There are no major differences.

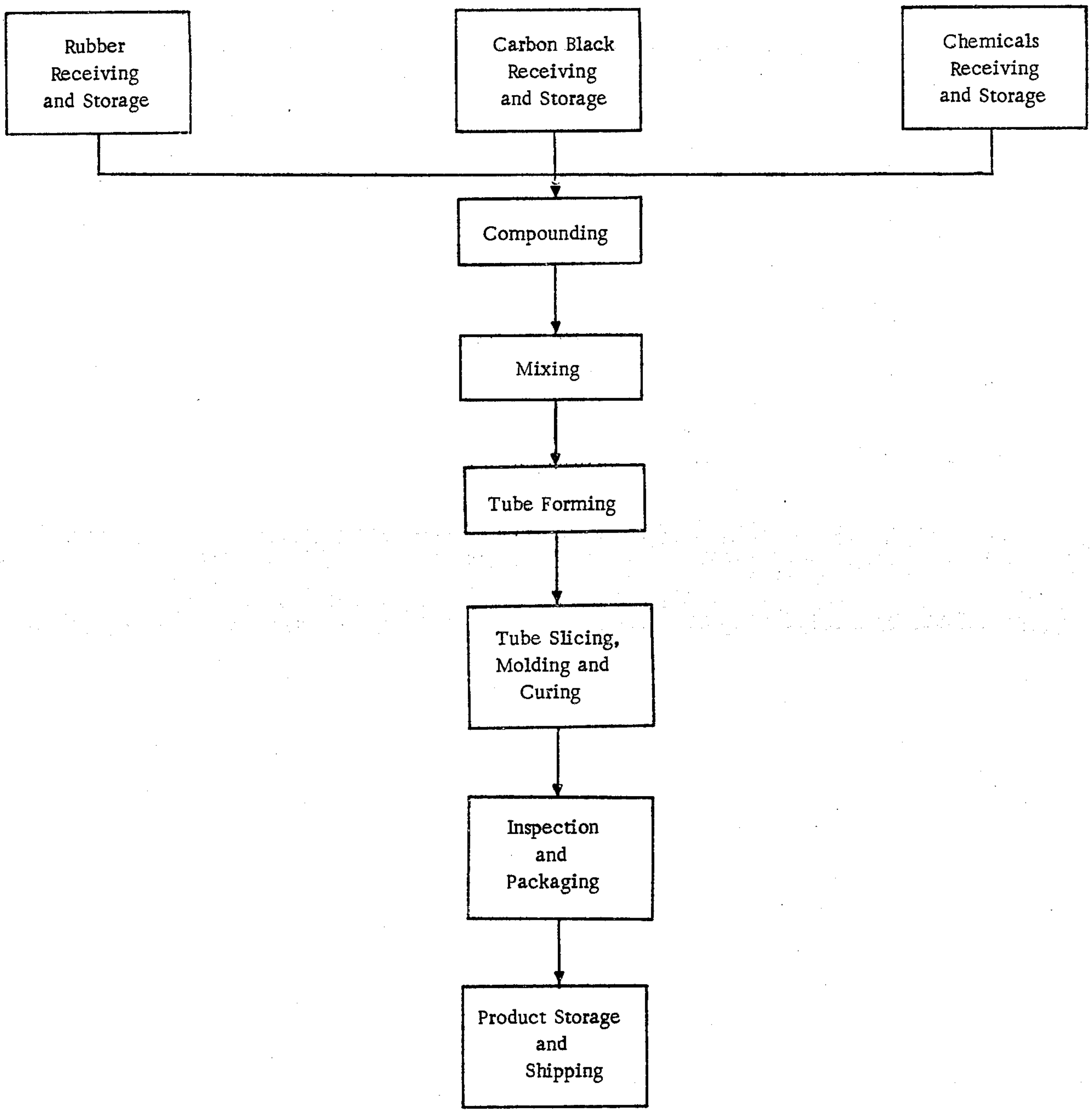
2.3.2 Compounding And Mixing (Figure III-4)

The basic machinery used in the compounding and mixing operations is similar to that used in tire manufacturing; namely, Banbury mixers and roller mills.

Two types of rubber stock are prepared. The first type consists of fillers, extenders, reinforcing agents, pigments and antioxidant agents. These compounds are added and mixed into the raw rubber stock. The resulting mixture is known as non-productive or non-reactive stock. Because no curing agents have been added, this material will have a long shelf life, thus allowing large quantities of a particular recipe to be made and stored for later use.

FIGURE III-4

PROCESS FLOW DIAGRAM FOR INNER TUBE MANUFACTURING SIC 30112



Source: Foster D. Snell, Inc.

The second type of rubber stock contains curing and accelerator agents, in addition to a small quantity of the original list of elements. This mixture, known as productive or reactive rubber stock, now meets the particular compounding requirements of its final destination. Since it contains the curing agents, this mixture has a short shelf life and will be used almost immediately.

One minor distinction of inner tube manufacture is the high usage of butyl rubbers. In addition, a soap rather than soapstone solution is sometimes used to coat the non-reactive stock.

2.3.3 Tube Forming

The process by which the tube is formed is similar to the extrusion of tire treads. The compounded rubber is fed to an extruder via a warm-up mill and strip-feed mill. Here the rubber is extruded into a continuous cylinder. To keep the inside of the tube walls from sticking to each other, a dry soapstone powder is sprayed inside the tube as it is formed in the extruder. The tube is labelled and passed through a water cooling tank. After cooling, the water is blown off the tube and soapstone powder is sprayed on the outside of the tube.

2.3.4 Tube Slicing, Molding And Curing

Once extruded, the tube is cut to length and the ends spliced together. A valve is also attached.

Once formed, the tube must be molded and cured. This operation is very similar to the process performed in tire manufacture.

2.3.5 Product Storage And Shipping

After curing, the tube is inspected for defects, packaged and sent to warehousing and shipping.

2.4 Waste Characterization For The Tire And Inner Tube Industry

The previous section described the processes used and waste streams generated by the Tire and Inner Tube Industry in order to provide a basis for discussing the industry's disposal practices for potentially hazardous wastes. This section further assesses the industry by determining which wastes may be potentially hazardous.

Essentially, there are two major waste types being generated by the industry.

- Type I -- Wastes in which raw materials used by the industry are in a free or uncombined state.

- Type II -- Wastes in which the raw materials have been reacted or trapped in a cured or uncured rubber matrix.

Type I wastes are those produced from raw material spillages in receiving, warehouse and compounding areas; dust collected in particulate emission control equipment; and the "oozing" of oils from the seals of Banbury mixers.

Type II wastes are uncured and cured rubber materials produced from operations such as mixing, calendering, extrusions, grinding (deflashing) and inspection.

Based on Table III-11 (Waste Stream Characterization in Tire Manufacturing) in Section 2.2, 11 Kg per 1,000 Kg of product may be classified as Type I wastes. This amounts to 15% of the materials disposed of by a typical plant in this industry according to KKKg/year of tire production, as described in Table III-12.

Since Type I wastes are essentially composed of raw material it is important to know what these raw materials are. Type I wastes may potentially be composed of these raw materials. Table III-13 presents the raw materials used in typical recipes for the tire manufacture of inner tubes.

TABLE III-12 (1)

ESTIMATED GEOGRAPHIC
DISTRIBUTION OF PRODUCTION
TIRE AND INNER TUBE INDUSTRY FOR 1974
SIC 3011

Region	State	Production (1) (KKKg/yr)
IV	Alabama	285.0
X	Alaska	
IX	Arizona	
VI	Arkansas	69.4
IX	California	254.8
VIII	Colorado	
I	Connecticut	40.7
III	Delaware	
IV	Florida	
IV	Georgia	51.3
IX	Hawaii	
X	Idaho	
V	Illinois	108.6
V	Indiana	57.3
VII	Iowa	126.7
VII	Kansas	90.5
IV	Kentucky	69.4
VI	Louisiana	
I	Maine	
III	Maryland	61.8
I	Massachusetts	87.4
V	Michigan	259.4
V	Minnesota	
IV	Mississippi	81.7
VII	Missouri	
VIII	Montana	
VII	Nebraska	
IX	Nevada	
I	New Hampshire	
II	New Jersey	

TABLE III-12 (2)

Region	State	Production[1] (KKKg/yr)
VI	New Mexico	
II	New York	48.2
IV	North Carolina	84.4
VIII	North Dakota	
V	Ohio	477.5
VI	Oklahoma	123.6
X	Oregon	
III	Pennsylvania	215.6
I	Rhode Island	
IV	South Carolina	90.5
VIII	South Dakota	
IV	Tennessee	235.2
VI	Texas	93.5
VIII	Utah	
I	Vermont	
III	Virginia	26.5
X	Washington	
III	West Virginia	
V	Wisconsin	90.5
VIII	Wyoming	
	TOTAL	3129.5[2]
Region	I	128.1
	II	48.2
	III	303.9
	IV	897.5
	V	993.3
	VI	286.5
	VII	217.2
	VIII	
	IX	254.8
	X	

Notes:

1. Based on tire production and allocated on the basis of state capacities and an average weight of 15 Kg per tire (the principal product of this industry).

2. Based on a 1974 production of 208,633,000 tires.

Source: Table III-11 and "Rubber Industry Facts," Rubber Manufacturers Association, Washington, D.C. (1975)

TABLE III-13 (1)

EXAMPLES OF TYPICAL RECIPES FOR RUBBER STOCK
USED FOR MANUFACTURE OF PASSENGER TIRES

Passenger Tire Treads

Component	Quantity(1)
SBR 1500	100
Oil soluble sulfonic acid of high M.W. with a high boiling hydrophyllic alcohol and a paraffin oil	2
Stearic Acid	2
Zinc Oxide	3
Phenyl- β- naphthylamine (65 parts) and diphenyl-p-phenylenediamine	1
Carbon Black	50
Para Flux	5
Sulfur	2
N-oxydiethylene benzothiazole 2-sulfenamide	1.25
Benzothiazyl disulfide	0.25

Passenger Tire Sidewalls — Black

Component	Quantity(1)
SBR 1000	80
Reclaim	40
Oil soluble sulfonic acid of high M.W. with a high boiling hydrophyllic alcohol and a paraffin oil	2
Stearic Acid	1
Zinc Oxide	3
Phenyl- β- naphthylamine (65 parts) and diphenyl-p-phenylenediamine	1
Octylated diphenylamines	1
Para Flux	4
Sunproofing Wax	3
Black	40
Carbon powder and pellets	5
Sulfur	2
N-Oxydiethylene benzothiazole 2-sulfenamide	1.25
Benzothiazyl disulfide	0.20

Passenger Tire Sidewalls — White

Component	Quantity(1)
High Modular Crepe Rubber	50
Neoprene Rubber	50
Oil soluble sulfonic acid of high M.W. with a high boiling hydrophyllic alcohol and a paraffin oil	2
Stearic Acid	0.5
Zinc Oxide	50
Titanium Dioxide	35
Ultramarine Blue	0.2
Magnesia	2
Sulfur	1
Benzothiazyl disulfide	1

TABLE III-13 (2)

Passenger Tire Carcass

Component	Inner Plies Quantity(1)	Outer Plies Quantity(1)
High Modulus Crepe	40	50
SBR	55	55
Reclaim	40	-
Oil soluble sulfonic acid of high M.W. with a high boiling hydrophyllic alcohol and a paraffin oil	3	2
Stearic Acid	1	1
Zinc Oxide	3	3
Octylated diphenylamines	1	1
Para Flux	3	5
Black	40	40
Sulfur	2.2	2.5
N-oxydiethylene benzothiazole 2-sulfenamide	1.25	1.25
Benzothiazyl disulfide	0.25	0.25

Passenger Tire Inner Liners

Component	Quantity(1)
High Modulus Crepe	40
SBR	40
Reclaim	40
Oil soluble sulfonic acid of high M.W. with a high boiling hydrophyllic alcohol and a paraffin oil	2
Stearic Acid	1
Octylated diphenylamines	2
Carbon powder and pellets	40
Hard clay	35
Para flux	5
Sulfur	2
Benzothiazyl disulfide	1
Tetramethylthiuram disulfide	0.1

Camelback Compounds

Component	Quantity(1)
SBR	70
Oil soluble sulfonic acid of high M.W. with a high boiling hydrophyllic alcohol and a paraffin oil	41.25
Stearic acid	2
Zinc oxide	2
Octylated diphenylamines	1
Black	70
Para Flux	5
Coumarone Indene resin	7
Sulfur (insoluble)	2
N-oxydiethylene benzothiazole 2-sulfenamide	0.25
Benzothiazyl disulfide	1.25

M.W. = Molecular Weight

(1) Based on 100 parts of rubber by weight.

Source: The Vanderbilt Rubber Handbook, G.G. Winspear, Ed., R. T. Vanderbilt Co., Inc., N.Y., 1958.

TABLE III-14

A TYPICAL RECIPE FOR RUBBER STOCK USED IN THE MANUFACTURE OF INNER TUBES

COMPONENT	Passenger QUANTITY(1)	Truck & Bus QUANTITY(1)
. Butyl Rubber	100	---
. High Modulus Crepe	---	100
. Zinc Oxide	5	5
. Oil Soluble Sulfuric acid of high molecular weight with a high boiling hydrophyllic alcohol and a paraffin oil	---	3
. Extender Oil	25	---
. Stearic acid	---	3
. Black	60	---
. Octylated diphenylamines	---	1
. Sulfur	2	2.2
. 2-Mercaptobenzothiazole	0.5	---
. Benzothiazyldisulfide	---	0.75
. Tetramethylthiuram-disulfide	1	0.25
. Tellurium diethyl-dithiocarbamate	0.5	---

1. Based on 100 parts of rubber by weight

Source: The Vanderbilt Rubber Handbook, G.G. Winspear, Ed., R.T. Vanderbilt Co., Inc., N.Y., 1958

From these tables it can be seen that aside from such ingredients as rubber and extender oils, there are many other substances used in varying amounts including:

- Carbon black
- Diamines
- Phenylamines
- Benzothiazyl disulfide
- Dithiocarbamates

These chemicals are regarded as toxic or potential carcinogenic agents.

In view of the above discussion, the next paragraphs segregate SIC 3011 wastes into potentially hazardous and non-potentially hazardous categories.

2.4.1 Potentially Hazardous Wastes

Type I wastes contain the raw materials used by this industry in a free or uncombined state. Since these wastes are generated, for the most part, by spillages from bags of raw materials, "fluffing" of ingredients upon addition to the Banbury mixers, particulate control equipment, etc., they may be contaminated with quantities of raw materials which are toxic or possibly carcinogenic, as discussed in Section 1.5.1. Approximately 16% of the wastes may be classified as Type I.

For the purposes of this study, therefore, Type I wastes will be considered to be potentially hazardous to man and/or his environment.

2.4.2 Non-Hazardous Wastes

It has been shown (see discussion on page III-6) that once process chemicals are compounded into the rubber matrix there is a very low probability that they will ever leach out if land disposed. In addition, once the rubber matrix has been cured, some of the processing chemicals such as accelerators, accelerator activators and vulcanization agents have been destroyed through reaction. Some of these chemicals were the diamines, disulfides, dithiocarbamates, etc. which were pointed out as being possibly carcinogenic or otherwise toxic.

For the purposes of this study, therefore, Type II wastes will not be considered potentially hazardous.

2.5 Waste Quantification For The Years 1974, 1977 And 1983 Tire And Inner Tube Industry

In this portion of the report, estimated total and potentially hazardous waste quantities for the industry are presented for the year 1974 and projections made for the years 1977 and 1983. The data is based on the results of industry interviews, literature search and the analytical procedures carried out on actual waste samples obtained from industry sources.

Table III-15 presents the waste quantification for 1974, 1977 and 1983, respectively. The following paragraphs discuss the rationale used in developing the tables.

As explained on page III-16, the wastes generated by SIC 3011 are free from readily separable water, since no water is involved in production processes. Thus, the wastes can only be reported on a dry basis.

2.5.1 Total Wastes

Total wastes for the industry in 1974 were developed by multiplying the total waste factor of 71.4 Kg of waste per 1000 Kg of production by the kilograms of production in SICs 30111 and 30112 for each state. Production in the other segments of the industry -- SICs 30113, 30114 and 30115 -- was not taken into account since they were responsible for only approximately 7% of the production of the entire industry on a weight basis in 1972 and the proportion of such items has undergone further decline.

The procedure followed for the waste projections for 1977 and 1983 is discussed in Section 2.5.3.

Total wastes produced, on a dry basis (wastes contain little or no water) for the years of interest are estimated as follows:

- 1974 -- 223,446 KKg/yr
- 1977 -- 235,934 KKg/yr
- 1983 -- 243,778 KKg/yr

2.5.5 Potentially Hazardous Wastes

As pointed out in Section 2.3, wastes produced in this industry are typified by being composed of raw materials in the free and uncombined states and those which are in the form of uncured or cured rubber. These wastes may be organized as follows.

TABLE III-15 (1)

GEOGRAPHIC DISTRIBUTION OF WASTES --
TIRE AND INNER TUBE INDUSTRY, SIC 3011
(DRY WEIGHT BASIS) (1)
(KKg/yr)

		1974		1977 (2)		1983 (2)	
		Total Wastes	Potentially Hazardous Wastes	Total Wastes	Potentially Hazardous Wastes	Total Wastes	Potentially Hazardous Wastes
IV	Alabama	20349	2793	21468	2947	22201	3047
X	Alaska						
IX	Arizona						
VI	Arkansas	4956	680	5228	717	5407	742
IX	California	18193	2497	19194	2634	19848	2724
VIII	Colorado						
I	Connecticut	2906	399	3066	421	3170	435
III	Delaware						
IV	Florida						
IV	Georgia	3663	503	3864	531	3996	549
IX	Hawaii						
X	Idaho						
V	Illinois	7754	1064	8180	1122	8460	1161
V	Indiana	4091	562	4316	593	4463	613
VII	Iowa	9046	1242	9544	1310	9869	1355
VII	Kansas	6462	887	6817	936	7050	968
IV	Kentucky	4955	680	5228	717	5407	742
VI	Louisiana						
I	Maine						
III	Maryland	4412	606	4655	639	4813	666
I	Massachusetts	6240	856	6583	903	6808	934
V	Michigan	18521	2542	19540	2682	20206	2773
V	Minnesota						
IV	Mississippi	5833	801	6154	845	6364	874
VII	Missouri						
VIII	Montana						
VII	Nebraska						
IX	Nevada						
I	New Hampshire						
II	New Jersey						

		1974 Total Wastes	1974 Potentially Hazardous Wastes	1977(2) Total Wastes	1977(2) Potentially Hazardous Wastes	1983(2) Total Wastes	1983(2) Potentially Hazardous Wastes
VI	New Mexico						
II	New York	3441	472	3630	498	3754	515
IV	North Carolina	6026	827	6357	872	6574	902
VIII	North Dakota						
V	Ohio	34094	4680	35969	4937	37196	5106
VI	Oklahoma	8825	1211	9310	1278	9628	1321
X	Oregon						
III	Pennsylvania	15394	2113	16241	2229	16795	2305
I	Rhode Island						
IV	South Carolina	6462	887	6817	936	7050	968
VIII	South Dakota						
IV	Tennessee	16793	2305	17717	2432	18321	2515
VI	Texas	6676	916	7043	966	7284	999
VIII	Utah						
I	Vermont						
III	Virginia	1892	260	1996	274	2064	284
X	Washington						
III	West Virginia						
V	Wisconsin	6462	887	6817	936	7050	968
VIII	Wyoming						
	TOTAL	223446	30670	235734	32355	243778	33466
Region	I	9146	1255	9649	1324	9978	1369
	II	3441	472	3630	498	3754	515
	III	21698	2979	22892	3142	23672	3255
	IV	64081	8796	67605	9280	69912	9597
	V	70922	9735	74822	10270	77376	10621
	VI	20457	2807	21581	2961	22319	3062
	VII	15508	2129	16361	2246	16919	2323
	VIII						
	IX	18193	2497	19194	2634	19848	2724
	X						

Notes:

1. The wastes in this industry are dry.

2. Based on growth in SIC 3011 for these years as estimated from INFORUM input/output model use.

Source: Foster D. Snell, Inc.

TABLE III-15 (3)

Type I Wastes(1)

Source	Waste	Quantity (Kg of Waste per 1000 Kg of Product)
. Receiving, storage, compounding and mixing areas	.Floor sweepings containing carbon blacks, pigments, accelerators, anti-oxidants, etc.	1.9
. Air pollution control abatement equipment	.Dusts containing carbon blacks, pigments, accelerators, anti-oxidants, etc.	8.3
. Banbury mixers and other high energy mechanical equipment	.Oils from Banbury "oozings" contaminated with the same materials described above. Waste lubricants	0.5
	Total	10.7

Type II Wastes(1)(2)

Source	Waste	Quantity (Kg of Waste per 1000 Kg of Product)
.Mixing	."Scorched" rubber	11.3
.Calendering, tread manufacture and tire building	Uncured stock	3.4
	.Coated and uncoated fabric	15.9
	."Green" tires	2.7
.Bead manufacturing	.Rubber, steel wire and rubber coated fabric	0.7
.Tire finishing	.Rubber dust	4.8
.Inspection	.Scrapped tires	21.9
	Total	60.7

(1) For full definition of waste types see page III-59.

(2) Type II wastes are classified as non-hazardous.

Source: Table III-14

Type I wastes are designated as potentially hazardous while Type II wastes are non-hazardous.

Type I wastes, however, are not composed entirely of hazardous materials. These wastes are mixtures of a variety of chemicals used in the production of tires. In fact, the wastes can, in reality, be considered to be mostly innocuous material plated or contaminated with constituents in the free state which are hazardous in some form. However, since some of the contaminants such as the diamines, carbon blacks or benzene based compounds are considered to be carcinogens, even trace quantities of these compounds when not bound make this class potentially hazardous.

Type I wastes are produced in a manner which is incidental to the actual unit operations used in this industry. They are not side streams of by-products which may be quantitatively produced as a direct consequence of the process such as found, for example, in the formation of alcohol in nylon manufacture.

Instead, the potentially hazardous wastes resulting from manufacturing in SIC 3011, and indeed from SICs 3021, 3041 and 3069, generally appear as a result of spillages from bulk material handling, accidental rupture of bags and fiber packs, the collection of dusts from particulate control apparatus and "oozings" of oil contaminated with raw materials from Banbury seals.

It is impossible to predict with any degree of confidence which bags will break on a particular occasion at a plant. In any given time period, a container of an antioxidant such as phenylenediamine, an agent suspected of causing bladder tumors in humans, may rupture. For that time period, floor sweepings may contain significant amounts of the carcinogen.

On the other hand, during the next time period, only a container of titanium dioxide, an innocuous substance, may rupture, producing floor sweepings which are not considered to be potentially hazardous.

In terms of quantifying the precise potentially hazardous component of the total wastes generated, absolute amounts are not possible to arrive at due to the mixology of a particular sample obtained during the time period of observation.

Results from the physical and chemical analyses performed from spot sampling of Type I wastes generated by the tire industry are presented in Appendix B -- Analytical Results and Protocols. The data presented are illustrative in nature and does not, therefore, represent an exhaustive sampling campaign for the industries studied.

The data does, however, show the wide variability of physical and chemical properties of the samples studied belonging to SIC 3011 plants.

- The inorganic fraction (ash) varies from 96% of the sample for floor sweepings to 10% for wet dust collectors residues.

- Many metals including mercury, lead, nickel and zinc, are present in the samples with their concentrations being variable.

- Water solubility of the samples are low, but also have significant variance.

The variance of the concentrations of the wastes' constituents does show that quantification of the compounds making up Type I, or potentially hazardous wastes, is not possible with any degree of reliability. These results support the findings from the visits and interviews that the chemicals which make the wastes potentially hazardous find their way into the Type I material to be discarded in a random manner.

Therefore, due to the randomness of its composition, the amount of potentially hazardous wastes generated by SIC 3011 presented in Table III-15 are not broken down into their specific hazardous components.

From Table III-17 potentially hazardous wastes (dry basis) estimated for the years of interest are as follows:

- 1974 -- 30,670 KKg/yr

- 1977 -- 32,355 KKg/yr

- 1983 -- 33,466 KKg/yr

The methodology used for estimating potentially hazardous waste loads for 1977 and 1983 are discussed in the next subsection.

2.5.3 Projections Of Tire And Inner Tube Industry Wastes For The Years 1977 And 1983

Waste projections for the years 1977 and 1983 were made using the Interindustry Economic Research Project of the University of Maryland (INFORUM) input/output model of the U.S. economy. The model analyzes the economy into 200 industrial sectors generally corresponding with the four digit 1967 Standard Industry Classifications.

For each of the sectors, the annual value of sales in 1972 dollars is distributed in terms of:

- Materials use by each of the other 199 industries
- Capital investment by each of 90 groups of industries
- Materials used by each of 28 types of construction
- Government purchases by 9 categories
- Inventory changes
- Exports and imports of each sector
- Personal consumption

The mechanism whereby the distribution is accomplished is a collection of matrices of input/output coefficients which are measures, based on historical data, of the quantity of a given product required to produce other products.

Exogenous factors (those which are defined outside the model) determine the absolute size of the economy and include:

- Population, labor force and age segmentation forecasts
- Interest and depreciation rates
- Government policy, especially unemployment rates
- Relative international prices

The logic of the model is to determine the course of after-tax consumer income.

The waste load forecasts presented in Table III-16 also take into account the fact that according to industry sources interviewed, no increase in the wastes to be disposed of are anticipated due to the effect of the Water Effluent Guideline Regulations for 1977 and 1983.

The waste loads were projected on changes in product prices (1972 dollars) from 1974 for 1977 and 1983 as predicted by the model. Table III-16 presents the projected values for product shipments for those years and their percent change from 1974.

TABLE III-16

PRODUCT SHIPMENTS IN PRODUCER PRICES FOR THE TIRE AND INNER TUBE INDUSTRY, SIC 3011

	Product Shipments (Millions of 1972 Dollars)				
	1974	1977	% Change Over 1974	1983	% Change Over 1974
Tire and Inner Tube Industry	5,285	5,576	+ 5.5%	5,764	+ 9.1%

Source: INFORUM Input/Output model, University of Maryland, June, 1975.

3. SIC 3021, RUBBER AND PLASTICS FOOTWEAR INDUSTRY

A detailed industry definition is presented in Exhibit D-6, Appendix D. According to the 1972 Census of Manufacturers, $370.3 million was the value added by manufacture. Value of shipments totalled $600 million in 1972. The total gross book value of depreciable assets was estimated(1) at $177 million.

According to Commerce Department sources at the beginning of 1973, the industry consisted of 31 firms operating plants. (2) However, from an analysis of industry data only 44 plants were identified.

The industry is comprised of those establishments whose primary products are rubber and plastics footwear, waterproof fabric upper footwear and other fabric upper footwear (with rubber or plastic soles vulcanizing to the uppers). Shipments of rubber and plastics footwear represented 94% of the industry's total shipments.

Although wastes are produced through most of the production unit operations in this industry, approximately 86% of the total waste is produced in cutting and shoe building. This waste is not considered to be potentially hazardous. The potentially hazardous wastes are floor sweepings and dusts encountered in material handling, compounding and mixing areas. It is estimated that the industry produced approximately 45,000 KKg of wastes per year, approximately 385 KKg of which are potentially hazardous.

3.1 Characterization Of SIC 3021, Rubber And Plastics Footwear Industry

There are two characteristic products in this sector:

- SIC 302101, Rubber and Canvas Footwear
- SIC 302102, Protective Rubber Footwear

However, for the purposes of this study, it was not necessary to divide the industry in such a manner. Appendix A following the report, gives a detailed description of the methodology used in developing a characterization of this industry.

(1) Estimated at 10 times annual capital expenditures from 1972. Census of Manufacturers, i.e., a ten year average lifetime for assets. Estimates based on a 40 year life for buildings and 7 year life for equipment.

(2) Foster D. Snell, Inc. Industry Energy Study of the Plastics and Rubber Industries, SICs 282 and 30. Final Report to the Department of Commerce, Federal Energy Office, May 10, 1974.

3.1.1 Geographic Distribution Of Establishments In SIC 3021 And Plant Age

Table III-17 presents the geographic distribution of plants and plant ages in SIC 3021. EPA Region I accounts for approximately 30% of the industry with 15 plants.

There are almost no new plants in the industry. Eighty-six percent of those whose constructions dates were available are at least 10 years old. There are several plants that began manufacturing over 100 years ago.

3.1.2 Employment

Figure III-5, following the tables, graphically shows the distribution of plant sizes in SIC 3021. This industry is labor intensive, with 40% of the plants having 500 to 1,000 employees.

Table III-18 geographically distributes employment in the industry. EPA Region I accounts for 54% of the employment in the rubber and plastic footwear industry.

3.1.3 Raw Material Consumption And Production In SIC 3021

The following table shows raw materials consumed by class as a percentage of total materials by weight consumed.

Component		Percent of Total Material Consumed
Elastomers		26.6%
Carbon Black		0.3
Plasticizers		7.5
Pigments		9.9
Cord and Fabric		15.0
Plastic Resins		37.5
Chemicals		3.2
	Total	100.0 %

Source: Foster D. Snell, Inc. analysis of Department of Commerce data.

The industry consumed approximately 130 KKKg of raw material a year to produce 210 million pairs in 1972. Production is distributed geographically in Table III-21.

TABLE III-17 (1)

GEOGRAPHIC DISTRIBUTION OF
PLANT LOCATION AND AGE
SIC 3021

		No. of Plants	Plant Age (Years) Less than 10	10-25	26-50	Over 50
IV	Alabama					
X	Alaska					
IX	Arizona			1		
VI	Arkansas	1				
IX	California	1			1	
VIII	Colorado					
I	Connecticut	1		1		
III	Delaware					
IV	Florida					
IV	Georgia	3	1	1	1	
IX	Hawaii					
X	Idaho					
V	Illinois	2				2
V	Indiana	1			1	
VII	Iowa					
VII	Kansas					
IV	Kentucky					
VI	Louisiana					
I	Maine	4	2	1	1	
III	Maryland	2				2
I	Massachusetts	7	2	2		3
V	Michigan					
V	Minnesota					
IV	Mississippi					
VII	Missouri					
VIII	Montana					
VII	Nebraska					
IX	Nevada					
I	New Hampshire	1		1		
II	New Jersey	4		1	2	1

		Plant Age (Years)				
		No. of Plants	Less than 10	10-25	26-50	Over 50
VI	New Mexico					
II	New York	2	1			1
IV	North Carolina	3		2	1	
VIII	North Dakota					
V	Ohio	2			2	
VI	Oklahoma					
X	Oregon					
III	Pennsylvania	4		1	2	1
I	Rhode Island	1			1	
IV	South Carolina					
VIII	South Dakota					
IV	Tennessee	1		1		
VI	Texas					
VIII	Utah					
I	Vermont	1		1		
III	Virginia	1			1	
X	Washington					
III	West Virginia	1				1
V	Wisconsin	1				1
VIII	Wyoming					
	TOTAL	44	6	13	13	12
Region	I	15	4	6	2	3
	II	6	1	1	2	2
	III	8		1	3	4
	IV	7	1	4	2	
	V	6			3	3
	VI	1		1		
	VII					
	VIII					
	IX	1			1	
	X					

Source: Rubber Red Book

TABLE III-18 (1)

EMPLOYMENT, RAW MATERIAL CONSUMPTION AND PRODUCTION, SIC 3021

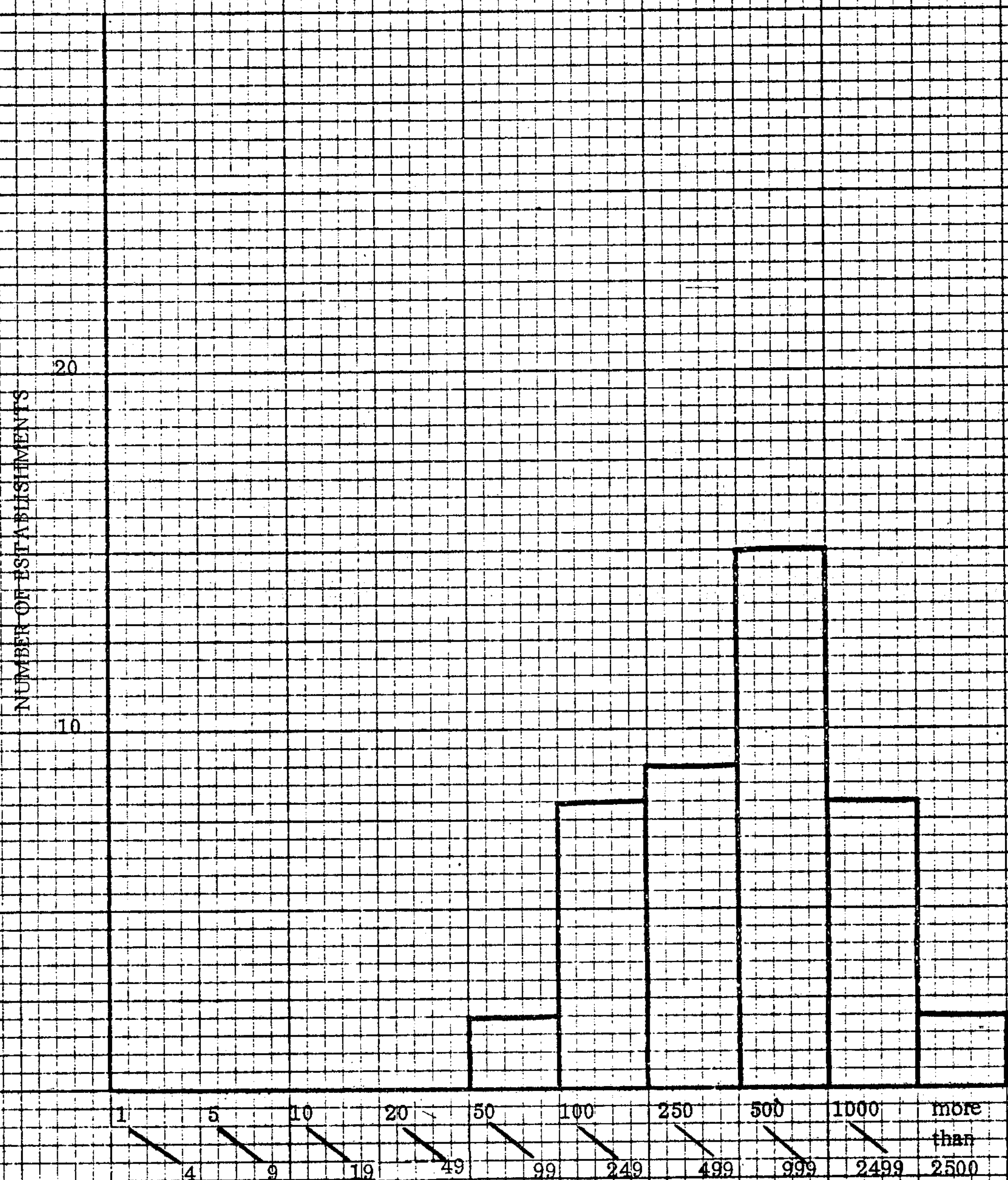
EPA Region	State	Employment	Raw Material Consumption (KKKg/yr)	Production (KKKg/yr)
IV	Alabama			
X	Alaska			
IX	Arizona			
VI	Arkansas	450	1.6	0.74
IX	California	390	1.4	0.65
VIII	Colorado			
I	Connecticut	1200	4.2	2.0
III	Delaware			
IV	Florida			
IV	Georgia	2880	10.1	4.7
IX	Hawaii			
X	Idaho			
V	Illinois	750	2.6	1.2
V	Indiana	500	1.8	0.83
VII	Iowa			
VII	Kansas			
IV	Kentucky			
VI	Louisiana			
I	Maine	2690	9.5	4.4
III	Maryland	1700	6.0	2.8
I	Massachusetts	12620	44.4	20.7
V	Michigan			
V	Minnesota			
IV	Mississippi			
VII	Missouri			
VIII	Montana			
VII	Nebraska			
IX	Nevada			
I	New Hampshire	1045	3.7	1.7
II	New Jersey	795	2.8	1.3

EPA Region	State	Employment	Raw Material Consumption (KKKg/yr)	Production (KKKg/yr)
VI	New Mexico			
II	New York	985	3.5	1.6
IV	North Carolina	3945	13.8	6.4
VIII	North Dakota			
V	Ohio	580	2.0	0.93
VI	Oklahoma			
X	Oregon			
III	Pennsylvania	2200	7.7	3.6
I	Rhode Island	1185	4.2	2.0
IV	South Carolina			
VIII	South Dakota			
IV	Tennessee	200	0.7	0.32
VI	Texas			
VIII	Utah			
I	Vermont	1000	3.5	1.6
III	Virginia	200	0.7	0.32
X	Washington			
III	West Virginia	500	1.8	0.83
V	Wisconsin	800	2.8	1.3
VIII	Wyoming			
	TOTAL	36615	128.8	60.0
	Region I	19740	69.5	32.4
	II	1780	6.3	2.9
	III	4600	16.2	7.5
	IV	7025	24.6	11.5
	V	2630	9.2	4.3
	VI	450	1.6	0.75
	VII			
	VIII			
	IX	390	1.4	0.65
	X			

Source: Foster D. Snell, Inc.

FIGURE III-5

DISTRIBUTION OF PLANT SIZES BY EMPLOYMENT, SIC 3021



Source: Foster D. Snell, Inc. analysis of data from Communication Channels, Inc. 1975 Rubber Red Book (27th Edition), New York, Palmerton Publishing Co. 1975.

3.2 Detailed Process Descriptions And Waste Stream Characterization For The Rubber And Plastics Footwear Industry

As discussed previously, the rubber and plastics footwear industry can be divided into two parts: canvas footwear and waterproof footwear. In most cases, both processes are carried out in the same plant so that information is not available to isolate the wastes generated by one production technique or the other.

This industry is undergoing changes in markets, products and raw materials, due to changing trends in consumer preferences, competitive pressures from foreign manufacturers and availability of new products and processes. For example, polyvinyl chloride based materials and thermoplastic elastomers such as Kraton are increasingly being used in the manufacture of large volume items commonly known as sneakers.

3.2.1 Canvas Footwear Production

Canvas footwear includes all footwear made of canvas and rubber or plastic, such as high and low-cut leisure, as well as sports and professional footwear, characterized by textile uppers with rubber or plastic soles, heels and trim.

An important characteristic of this industry is that the large producers are multi-plant operations; that is, some of the processing steps -- in particular, preparation of rubber stock and calendering -- are often carried out in a single facility. The product of these steps are then shipped to other plants in which the final processing steps are carried out.

In general, the basic steps are:

- Receiving and materials storage
- Compounding and mixing of rubber stocks
- Calendering
- Cutting and stitching
- Shoe building
- Curing
- Finishing and inspection
- Packaging and shipping.

Figure III-6, presents a combined production and waste flow diagram for the manufacture of canvas rubber footwear. Figure III-7 illustrates a combined production and waste flow diagram for canvas plastic footwear.

The wastes generated in these operations are summarized and quantified in Table III-19. The processing steps and the wastes generated are described in detail in the following paragraphs and Figures III-6 and III-7.

3.2.1.1 Receiving And Materials Storage

The types of materials used in this industry are similar to those used in tire production. The major difference lies in the quantities consumed.

Canvas footwear production in a given plant does not require the large quantities of raw materials needed for tire production. Instead of raw materials being brought to the plant in bulk quantities, they are received in bags, fiber-packs, drums, etc. They are usually stored in a small area of the plant.

Wastes at this stage consist essentially of floor sweepings from the warehousing areas. These wastes are usually combined with those of the next operation, except the packaging wastes.

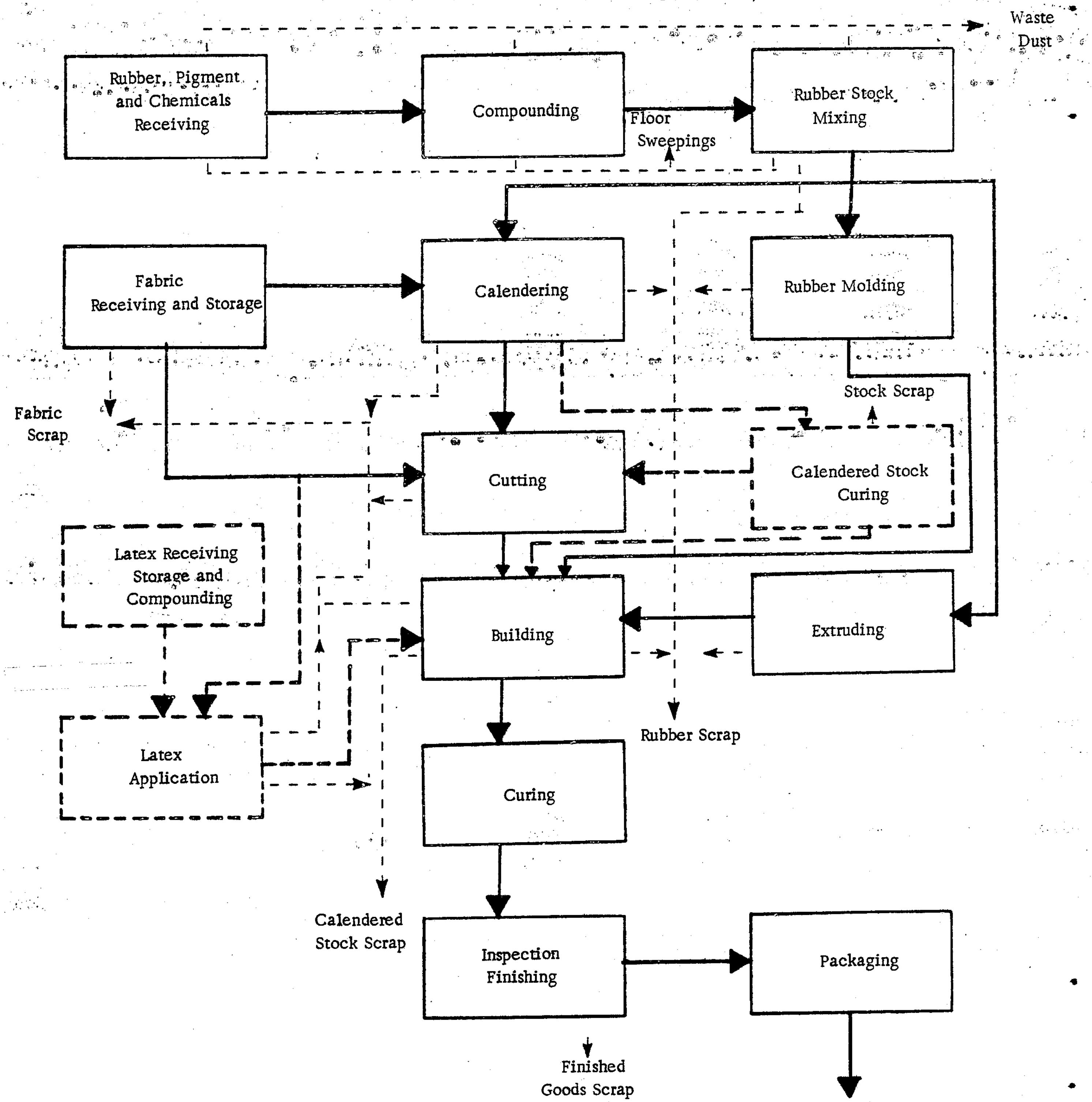
3.2.1.2 Compounding And Mixing

Compounding and mixing of stock for canvas footwear production does not differ in principle from that of other rubber products. There are, however, some important differences:

- Use of white pigments in lieu of carbon black for much of the stock. These pigments are usually zinc, titanium and magnesium oxides.
- Much greater care is taken in preventing contamination of the stock to avoid discoloration.
- Much smaller scale of operation. For example, there is no bulk handling of raw materials.

FIGURE III-6

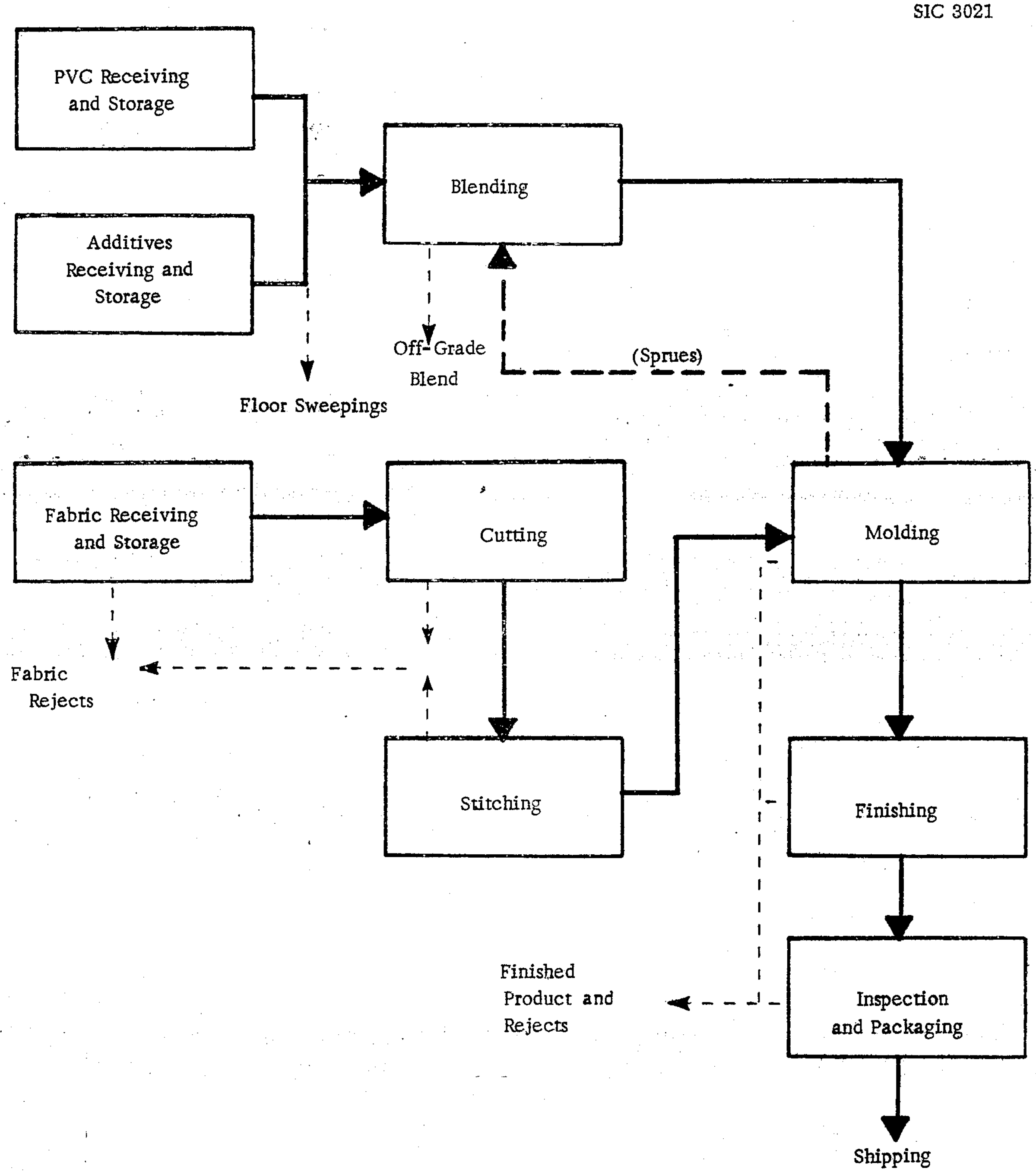
PRODUCTION AND WASTE FLOW DIAGRAM
IN THE PRODUCTION OF CANVAS
FOOTWEAR, SIC 3021



Source: Foster D. Snell, Inc.

FIGURE III-7

BASIC PROCESSING STEPS UTILIZED IN THE PRODUCTION OF PLASTIC FOOTWEAR, SIC 3021



Source: Foster D. Snell, Inc.

TABLE III-19

WASTE PRACTICES FOR THE PLANTS IN SIC 3021

	Source	Waste Stream	Quantity (Kg/100 Kg of product)
I.	Material Handling Compounding Area Mixing Area	Floor sweepings Dust from particulate emission control equipment	5
II.	Mixing, Molding Calendering, Extruding	Scrap uncured rubber stock	23.0
III.	Cutting Building	Scrap fabric Scrap calendered stock	230 230
IV.	Finished Product	Cut up shoes	46
		Total:	534

Source: Foster D. Snell, Inc.

Rubber mixing is carried out in Banbury mixers or on compounding mills. Some of the stock is directly extruded as a strip. Most of it is produced as a thin sheet which is immediately dipped in an anti-tack solution to prevent sticking during storage.

Polyvinyl chloride (PVC) utilized in plastic footwear manufacture, comes as a free flowing powder. Oils and pigments are added to the resin in ribbon type blenders with the mixture resulting in a powdery material.

Wastes at this stage consist of:

- Dust collected from the air pollution control equipment associated with transferring and mixing operations.

- Rejected product usually due to human error in compounding cross contamination between dissimilar batches, or production upsets.

- Rubber scrap and waste oil.

3.2.1.3 Calendering And Canvas Preparation

Calendering operations are similar to those used in the tire industry. The textile material to be calendered are usually of the woven or knitted type. However, this does not significantly alter the operating conditions of the calendering mills. The wastes at this step consist principally of the residual material from the stamping operations, end cuts and off-grade product (Figure III-6).

The canvas components for the footwear are made from two or three-ply fabric. The fabric is received at the plant as single sheets. Latex is applied to the plies, which are pulled together and passed over a heated drum. The sheets are stacked and the multi-layer canvas is stamped into shape.

The different canvas components making up the shoe uppers are stitched together on sewing machines. The boxing, or edging, which protects the join between the sole and the canvas uppers, is extruded as a long strip from rubber stock.

3.2.1.4 Sole And Inner Sole Production

The soles are generally produced by injection, compression or transfer molding techniques (Figure III-6). These processes are described in the section of this report dealing with SIC 3069. Injection molding is used universally in the manufacture of PVC shoes.

The molded soles are deflashed (rough edges removed), usually in a buffing machine and then coated with a latex adhesive. The latex coated soles are then dried in an oven.

Inner soles are extruded as flat sheets from special rubber stock. The extruded sheet is passed through heated presses. Blowing agents, such as sodium bicarbonate or azodicarbon amide are mixed into the rubber stock in the compounding area. These blowing agents decompose and release gases which blow the extruded sheet into cellular sponge. Finally, the inner soles are stamped out of the cellular sheet.

In addition to some off-grade product, the wastes generated in this operation are the residuals from stamping and the sprues and flashings from molding operations (Figure III-7).

3.2.1.5 Shoe Building

This is a very complex operation which can be carried out in a variety of ways. As discussed, the "uppers" may have been produced at one location and sent to another location for the building operation.

In general and in particular for high priced footwear, the shoe is built from the various components on a last.

- First the canvas upper is cemented at its edges, and placed over the last.
- The inner sole is attached to the bottom of the last.
- The outer sole, toe and heel pieces and boxing are placed on the shoe using latex as an adhesive.

The complete, uncured shoe is usually inspected at this point before being sent on to the next operation, which is curing. In this operation the wastes are the unrecoverable rejected products, end cuts and trimmings.

3.2.1.6 Curing

The curing operation (Figures III-6 and III-7) is typically carried out in tunnel ovens in which the rubber is vulcanized by application of heat and pressure. The cement portion of the shoe also undergoes vulcanization at this step.

Anhydrous ammonia is injected into the tunnel oven or autoclave to complete the cure. Curing with ammonia produces a good surface texture on the rubber and eliminates the residual tackiness associated with rubber that is cured conventionally.

Some shoes are cured without ammonia. This is done where the tackiness of the product is not very important or where the compounding recipe can be modified to eliminate the tackiness often associated with regular air curing.

Steam is not used for curing because in many cases, the steam would stain the canvas parts of the shoe. The curing cycle usually lasts about one hour, and two to five pounds of ammonia are used for every thousand pairs of shoes cured. At the end of the curing cycle, the ammonia/air mixture is vented to the atmosphere.

While production rejects may be generated at this stage, due to production upsets, they are identified in the course of the next operation.

3.2.1.7 Finishing And Inspection

Finishing may involve the attachment of labels, printing of size and other information, the painting of decorative stripes, etc.

A final inspection of the finished shoe is then carried out. The shoes are now ready to be packaged and shipped. The wastes generated in this operation consist of rejected products. In order to avoid improper distribution of off-grade products, the practice is to cut up or chop up the defective products.

3.2.2 Waterproof Footwear

The operational characteristics of waterproof footwear are usually similar to those for canvas footwear. A much greater use of molding is made so that in effect the processes are intermediate between those described above and those used in those industries belonging to SIC 3069. A detailed process description for waterproof footwear will not be presented here since it would be repetitious of the information discussed above and that which is discussed in section 6 which is devoted to SIC 3069.

3.3 Waste Characterization For The Rubber And Plastics Footwear Industry

As in the Tire and Inner Tube Industry, wastes produced in SIC 3021 can be classified into two types:

- Type I -- Wastes in which raw materials used by the industry are in a free or uncombined state.

- Type II -- Wastes in which the raw materials have been reacted or trapped in a cured or uncured rubber matrix.

These two waste types are produced in the same manner as those in SIC 3011: Type I being produced from raw material spillage, dust collected by particulate control equipment, etc.; Type II wastes are composed mainly of cured and uncured rubber.

Based on Table III-19, Type I wastes account for approximately 1% of materials disposed of by a typical plant in the industry or 5 Kg per 1000 Kg of product. Type II accounts for the remainder.

Table III-20 indicates which raw materials, quantified on a weight basis, are used in the preparation of rubber stock for footwear manufacture. From this table it can be seen that the Type I wastes may contain substances such as diamines, phenylamines, benzothiazyl disulfide and zinc dithiocarbamate, already pointed out as being regarded as toxic or even possibly carcinogenic.

As explained on page III-16, the solid wastes, both non-hazardous and potentially hazardous, created this industry, do not contain significant quantities of free water. Thus, the waste quantities reported are on a dry weight basis only.

The next paragraphs discuss SIC 3021 wastes by potentially hazardous and non-hazardous categories.

3.3.1 Potentially Hazardous Wastes

Type I (Section 2.4) wastes contain the raw materials used by this industry in a free or uncombined state. Since these wastes may be contaminated with quantities of raw materials which are toxic or possibly carcinogenic, Type I wastes will be considered to be potentially hazardous to man and/or his environment.

TABLE III-20

EXAMPLES OF TYPICAL RECIPES USED FOR RUBBER STOCK IN THE RUBBER AND PLASTIC FOOTWEAR INDUSTRY, SIC 3021

1st Grade Friction

Component	Quantity (1)
High Modulus Crepe	100
Oil Soluble Sulfonic Acid of High Molecular Weight With Paraffin Oil	2
Stearic Acid	0.5
Zinc Oxide	5
Coumarone-Indene Resin	2
Mixtures of Octylated Diphenyl-amines	1
Calcium Carbomate	25
Whiting	25
Sulfur	2
2-Mercaptobenzothiazole	0.6
Benzothiazyl disulfide	0.6
Zinc dimethyl dithiocarbamate	0.12
Total	163.82

1st Grade Black Uppers

Component	Quantity(1)
Smoked Sheet	80
SBR	20
Oil Soluble Sulfonic Acid of High Molecular Weight With Paraffin Oil	1.5
Stearic Acid	0.75
Zinc Oxide	5
Blend of Phenyl-β-naphthylamine p-isopropoxy diphenylamine and diphenyl-p-phenylene diamine	0.5
Carbon Black	75
Sulfur	2
Benzothiazyl disulfide	1.5
Zinc dimethyl dithiocarbamate	0.1
Total	186.35

Foxing

Component	Quantity(1)
High Modulus Crepe	100
Oil Soluble Sulfonic Acid of High Molecular Weight With Paraffin Oil	1
Zinc Oxide	5
Stearic Acid	0.5
Polyalkyl polyphenol	1
Whiting	100
Clay	40
Sulfur	2
2-Mercaptobenzothiazole	0.6
Benzothiazyldisulfide	0.6
Tetramethyl thiuram disulfide	0.12
Total	250.82

Lining Gum

Component	Quantity(1)
Smoked Sheet	100
Oil Soluble Sulfonic Acid of High Molecular Weight With Paraffin Oil	1
Stearic Acid	0.5
Zinc Oxide	5
Mixtures of Octylated diphenylamines	0.5
Whiting	100
Sulfur	2.25
Benzothiazyldisulfide	1.25
Zinc dimethyl dithiocarbamate	0.1
Total	210.6

Soles, Neutral

Component	Quantity(1)
High Modulus Crepe	80
SBR	20
Oil Soluble Sulfonic Acid of High Molecular Weight With Paraffin Oil	2
Stearic Acid	0.75
Zinc Oxide	5
Light Processing Oil	5
Mixtures of Octylated diphenylamines	1
Whiting	40
Clay	90
Sulfur	2.25
2-Mercaptobenzothiazole	0.6
Benzothiazyldisulfide	0.6
Zinc dimethyl dithiocarbamate	0.2
Total	247.4

(1) Based on 100 parts of rubber by weight.

Source: The Vanderbilt Rubber Handbook, G. G. Winspear, Ed., R. T. Vanderbilt Co., Inc., NY 1958. Note: although this source is about eighteen years old, recipes are still valid.

3.3.2 Non-Hazardous Wastes

Type II wastes mainly are composed of cured and uncured rubber, fabric, packaging materials, etc. These wastes will not be considered potentially hazardous.

3.4 Waste Quantification For The Years 1974, 1977 And 1983, Rubber And Plastics Footwear Industry

In this portion of the report estimated total and potentially hazardous waste quantities for the industry are presented for the year 1974 and projections made for the years 1977 and 1983. The data is based on the results of industry interviews, literature search and the analytical procedures carried out on actual waste samples obtained from industry sources.

Table III-21 presents the waste quantifications for 1974, 1977 and 1983. The following paragraphs discuss the rationale used in developing the table.

3.4.1 Total Wastes

Total wastes for the industry in 1974 were developed by multiplying the total waste factor of 534 Kg of waste per 1000 Kg of production from Table III-19 by the kilograms of production in SIC 3021 for each state based on Table III-18.

The procedure followed for the 1977 and 1983 waste projections is identical to that used in SIC 3011 where the INFORUM econometric input/output model was used. The model is described in Appendix A at the back of this report. Waste loads were projected on changes in product shipments in producer prices (1972 dollars) for 1977 and 1983 as predicted by the model for an aggregate of SICs 2031, 3041 and 3069. Table III-22 presents projected values for product shipments for those years and their percent change from 1974.

The waste load forecasts presented in Table III-23 also take into account the fact that based on industry interviews, no increase in solid wastes are anticipated due to the effect of the 1977 and 1983 Water Effluent Guideline Regulations.

TABLE III-21 (1)

GEOGRAPHIC DISTRIBUTION OF WASTES, RUBBER AND PLASTIC FOOTWEAR INDUSTRY, SIC 3021 (DRY OR WET BASIS) (KKg/yr)

		1974 (1)		1977 (2)		1983 (2)	
		Total Waste (3)	Potentially Hazardous Wastes	Total Wastes	Potentially Hazardous Wastes	Total Wastes	Potentially Hazardous Wastes
IV	Alabama						
X	Alaska						
IX	Arizona						
VI	Arkansas	401	4	447	4	465	5
IX	California	347	3	387	3	403	4
VIII	Colorado						
I	Connecticut	1,068	10	1,191	11	1,239	12
III	Delaware						
IV	Florida						
IV	Georgia	2,510	23	2,799	26	2,912	27
IX	Hawaii						
X	Idaho						
V	Illinois	641	6	715	7	743	7
V	Indiana	443	4	494	4	514	5
VII	Iowa						
VII	Kansas						
IV	Kentucky						
VI	Louisiana						
I	Maine	2,350	22	2,620	25	2,726	25
III	Maryland	1,495	14	1,667	16	1,734	16
I	Massachusetts	11,054	103	12,325	115	12,823	119
V	Michigan						
V	Minnesota						
IV	Mississippi						
VII	Missouri						
VIII	Montana						
VII	Nebraska						
IX	Nevada						
I	New Hampshire	908	8	1,012	9	1,053	9
II	New Jersey	694	7	774	8	805	8

TABLE III-21 (2)

		1974 (1) Total Wastes (3)	1974 (1) Potentially Hazardous Wastes	1977 (2) Total Wastes	1977 (2) Potentially Hazardous Wastes	1983 (2) Total Wastes	1983 (2) Potentially Hazardous Wastes
VI	New Mexico						
II	New York	854	8	952	9	991	9
IV	North Carolina	3,418	32	3,811	36	3,965	37
VIII	North Dakota						
V	Ohio	497	5	554	5	577	6
VI	Oklahoma						
X	Oregon						
III	Pennsylvania	1,922	18	2,143	20	2,229	21
I	Rhode Island	1,068	10	1,191	11	1,239	12
IV	South Carolina						
VIII	South Dakota						
IV	Tennessee	171	2	191	2	198	2
VI	Texas						
VIII	Utah						
I	Vermont	854	8	952	9	991	9
III	Virginia	171	2	191	2	198	2
X	Washington						
III	West Virginia	443	4	494	4	514	5
V	Wisconsin	694	7	774	8	805	8
VIII	Wyoming						
	TOTAL	32,003	300	35,684	334	37,124	348
	Region I	17,302	161	19,291	180	20,071	186
	II	1,548	15	1,726	17	1,796	17
	III	4,031	38	4,495	42	4,675	44
	IV	6,099	57	6,801	64	7,075	66
	V	2,275	22	2,537	24	2,639	26
	VI	401	4	447	4	465	5
	VII						
	VIII						
	IX	347	3	387	3	403	4
	X						

Notes: (1) Based on Tables III-19 and III-20.

(2) Based on growth in SIC 3021 for these years as estimated from INFORUM input/output model use.

(3) Reported on a dry weight basis -- SIC 3021 industry wastes do not contain significant quantities of water.

Source: Foster D. Snell, Inc.

TABLE III-22

PRODUCT SHIPMENTS IN PRODUCER PRICES FOR THE FOOTWEAR, BELTS AND MISCELLANEOUS RUBBER PRODUCTS INDUSTRIES, SICs 3021, 3041 AND 3069

	Product Shipments (Millions of 1972 Dollars)				
	1974	1977	% Change Over 1974	1983	% Change Over 1974
Aggregate of SICs 3021, 3041 and 3069	4,342	4,840	+ 11.5%	5,036	16.0%

Source: INFORUM Input/Output Model, University of Maryland, June, 1975.

As can be seen from Table III-23, total wastes produced on a dry basis for the years of interest are estimated as follows:

- 1974 -- 32,003KKg/yr
- 1977 -- 35,684KKg/yr
- 1983 -- 37,124KKg/yr

3.4.2 Potentially Hazardous Wastes

As in the Tire and Inner Tube Industry, Type I wastes are designated as being potentially hazardous. These wastes are not composed entirely of hazardous materials but are mixtures of a variety of chemicals used in the production of footwear. This type of waste can, in reality, be considered to be mostly innocuous material plated or contaminated with constituents in the free state which are hazardous in some form.

In terms of quantifying the precise potentially hazardous components of the total wastes generated, absolute amounts are not possible to arrive at due to the mixology of a particular sample obtained during the time period of observation.

Results from the physical and chemical analyses performed from spot sampling of Type I wastes generated by SIC 3021 are presented in Appendix B -- Analytical Results and Protocols. The data presented are illustrative in nature and do not, therefore, represent an exhaustive sampling campaign for the industries studied.

The data does show, however, that for samples of Type I wastes obtained from SIC 3021:

- The inorganic fraction (ash) is about 55% of sample weight.
- Many metals are present in the samples including lead, zinc, tin and copper. In fact, for one sample (sweepings from compounding room) the lead content in the ash was 72 parts per million. These wastes may pose a potential hazard.

- Water solubility under neutral pH was in the range of 1% to 5%.

Due to the randomness of the wastes' composition. the amount of potentially hazardous wastes generated by SIC 3021 presented in Table III-21 are not broken down into their specific hazardous components.

From Table III-22 potentially hazardous wastes (dry basis) estimated for the years of interest are as follows:

- 1974 -- 300KKg/yr
- 1977 -- 334KKg/yr
- 1983 -- 348KKg/yr

In this industry, wastes do not normally contain water and are, therefore, reported on a dry basis only.

4. SIC 3031, RECLAIMED RUBBER INDUSTRY

SIC 3031 comprises establishments engaged in reclaiming rubber from scrap tires, tubes and other rubber articles. The end product is used as a raw material for rubber goods. Exhibit D-7 (Appendix) provides a detailed industry definition.

Value of shipments in 1972 was $29.7 million. Value added by manufacture according to the 1972 Census of Manufacturers was $15.6 million. The gross book value of depreciable assets was estimated (1) at $7 million. There were 20 establishments, 9 with 20 or more employees. Since then, many of the smaller firms have closed, leaving only 9 plants at present.

Wastes in this industry are estimated at 38,888 KKg/yr for 1974. Of this 135 KKg are considered to be potentially hazardous (as discussed in Section 2.4).

4.1 Characterization Of SIC 3031

This is a small industry with only 9 establishments. Table III-23 lists the firms, locations, nameplate capacities and general processes used by each firm. This listing accounts for a production capacity of 114.5 KKKg/yr which is 85% of the 1974[1] production.

Table III-23 also shows the geographic distribution of plants and their capacities in this industry. Other information such as plant age and size by employment is not provided in order to prevent disclosure.

Total industry employment is between 800 and 900 workers. In terms of production capacity, 66% is in EPA Region V. Most plants have been substantially modified during the past 5 to 7 years in order to meet Clean Air Act and other regulatory requirements.

Census information does not present data for raw materials consumed in this industry. However, one source indicates[2] that additives and devulcanizing agents represent about 10% of initial raw materials consumed and as much as 15% of the shipped products.

---

(1) Foster D. Snell Inc. Industrial Energy Study of the Plastics and Rubber Industries, SICs 282 and 30, Final Report to the Department of Commerce, Federal Energy Office, May 10, 1974, Exhibit X-5.

(2) "Solid Waste Management in the Fabricated Rubber Products Industry, 1968," "Rubber Re-Use And Solid Waste Management Part I, U.S. Environmental Protection Agency, 1971.

TABLE III-23

RUBBER RECLAIMERS
SIC 3031

Firm	Location	Capacity (KKKg/yr.)	Process Used
Atlos	Los Angeles, CA	10.1	Grinds only
Centrex	Findlay, OH	15	Devulcanizes, some grinding
Goodyear	Akron, OH	27.5	100% capture, devulcanized and digested
Laurie Rubber	New Brunswick, NJ	Neg.	Primarily devulcanizes, specialty work
Midwest Rubber	E. St. Louis, IL	25	Fine grinding, devulcanizing, digesting
Nearpara Rubber	Trenton, NJ	5.5	Digested
Ohio Rubber Co.	Willoughby, OH	11.5	100% capture, digested and devulcanized
U.S. Rubber Reclaiming	Vicksburg, MS	30	"Reclaimator" and fine grinding
A. R. Lakin	Chicago, IL	10.1(1)	Fine grinding, cuts parts from tires

(1) Estimated based on FEO X-5

Source: Rubber Reclaimers Association

4.2 Detailed Process Description And Waste Stream Characterization For The Rubber Reclaiming Industry, SIC 3031

Rubber reclaiming operations depend to some extent on the nature of the raw materials utilized. At present, practically all reclaiming now carried out in the United States is performed on old tires.

The processing of old tires basically involves a two step operation:

- Mechanical preparation of the rubber
- Physico-chemical modification, usually called devulcanization.

Traditionally, there were three basic processes used in the industry:

- The mechanical process
- The pan process
- The digester process

It is reported that one plant is left operating using the mechanical process. Operations in the other plants have so significantly been modified that in fact a new process classification is required. There are:

- The reclaimator process
- The dynamic devulcanization process

However, both of these processes have a common mechanical unit operation which differs only in some operational details which do not affect the generation of wastes.

The physico-chemical portion of the two processes in wide use today are also quite similar. These processes basically differ only in the method for providing heat energy for reclamation.

Processing steps for rubber reclaiming are discussed in detail below. A general process flow diagram is presented in Figure III-8. This diagram also presents the waste streams generated by the process.

It is very important to note that rubber reclaiming is the only segment in the rubber fabrication industry where generation of wastes is an intrinsic part of the operations. In the other segments the wastes are incidental to the production process and do not necessarily have a direct relationship to production volumes. In the rubber reclaiming segment, however, a quantitative relationship exists between the production volume and the quantities of wastes generated.

An examination of this relationship is provided by the wastes generated due to the removal of wire and fiber components from the tires to be processed. These components must be removed to permit reclaiming of the rubber. Since wire and fiber constitute a fairly constant proportion of the entire mass of the tire, the waste stream that they constitute will be proportional to the production volume. Given the same tire mix, the proportion will be constant from plant to plant.

The quantification of waste streams generated by the rubber reclaiming industry are presented in Table III-24.

4.2.1 Mechanical Preparation Of The Rubber

One of the most important factors in the successful reclamation of rubber from old tires is the separation of the rubber stock from the considerable amount of metallic wire and fibrous material constituting a significant portion of the total weight of the tire carcass.

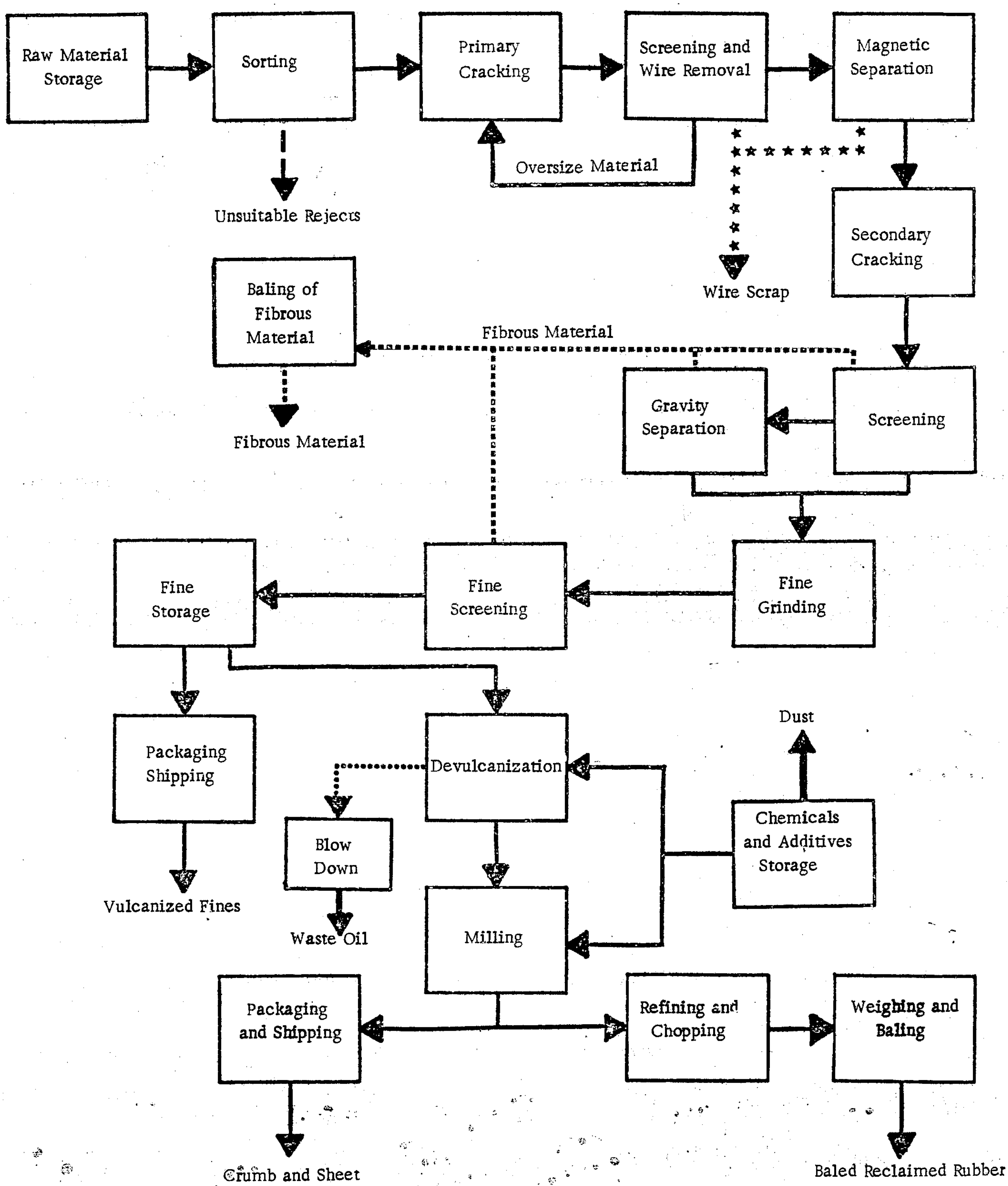
Mechanical preparation has several unit operations.

4.2.1.1 Sorting

This is a simple selection of the material appropriate for further operations. This operation is required because grinding equipment used in subsequent steps cannot handle studded or steel-belted tires. Usually, electronic devices select out from a feed conveyor those tires which are unsuitable for further processing due to their high metal content. Thus, basically, the waste stream from this operation consists of rejected tires.

FIGURE III-8

RUBBER RECLAIMING FLOW DIAGRAM
SIC 3031



Source: Foster D. Snell, Inc.

TABLE III-24

QUANTIFICATION OF WASTE STREAMS FOR THE RUBBER RECLAIMING INDUSTRY -- SIC 3031

	Source	Waste Stream	Quantity of Waste (Kg/1000 Kg of product)
I.	Warehouse and Compounding Area	Dusts and floor sweepings	1
II.	Sorting	Unsuitable tires	75
III.	Primary Size Reduction	Wire scrap	75
IV.	Secondary Size Reduction	Fiber and rubber dust	3
V.	Fiber Separation	Separated fiber	115
VI.	Fine Grinding	Fine ground fibers	4
VII.	Devulcanization	Oils and contaminated devulcanized agents	12
VIII.	Finishing	Strainer cleanings (additives and pigments in rubber matrix)	3
		Total	288

Source: Foster D. Snell, Inc. analysis of industry interviews.

4.2.1.2 Primary Size Reduction

This step is accomplished by a powerful grinder or cracker whose principal components are two corrugated cylinders. The purpose of the grinder is to tear the tire into pieces and separate off the bead wire.

The bead wire is manually removed after a first pass through the cracker. Oversized pieces are separated out by a coarse screen and returned for a second pass over the cracker.

The bead wire constitutes the waste stream produced by this operation.

4.2.1.3 Secondary Size Reduction

The material passing through the primary screening devices is subjected to a further size reduction in a secondary cracker of a design similar to the primary cracker.

The ground stock is again screened. Fine dust and airborne fiber are removed at this stage by aspiration. Magnetic separators are used to segregate the metallic particles which had escaped the first manual separation.

Secondary size reduction produces material ground to about 6.5 mm (0.25 in) to 9.5 mm (0.375 in) in size. The waste streams from the secondary size reduction are the metallic material retained by the magnetic separators and the rubber and fiber dust streams.

4.2.1.4 Fiber Separation

Material produced from secondary cracking is sent at a constant rate through a three way sieve.

- Fluffy fiber material is retained on the top screen and is conveyed to the fiber collection system.

- The middle stream is conveyed to separators of the gravity type in which fiber rich lighter particles are separated from denser, rubber rich particles by a stream of air.

- The finer stream from screening along with the heavy stream from the air separators is air conveyed to storage equipment ahead of the next operation, fine grinding.

The waste stream from fiber separation is, of course, constituted by fibers.

4.2.1.5 Fine Grinding

This unit operation reduces the rubber rich feed material from fiber separation to an essentially fiber-free, fine 20 to 30 mesh material. Air classification is also used between passes through the fine grinder.

After the material is down to the proper mesh size, it is stored for further physico-chemical treatment, or for sale as vulcanized, ground reclaimed rubber. Fine ground fibrous material represents the waste streams generated by this step.

4.2.2 Devulcanization

Once the rubber to be reclaimed has been mechanically prepared, it is ready to be devulcanized or depolymerized by physical or chemical processes. Devulcanization may be accomplished by application of heat, solvents and in some cases, mechanical energy.

Devulcanizing agents are added to the prepared rubber together with the conventional oil extenders to provide a workable stock. These agents are traditionally mineral acids or mineral bases. Newer rubber compositions dictated the use of other chemicals, however. At present, while the actual compositions of the agents are proprietary, they are said to be free acids from tall oil, naval store oils and some petroleum derivatives. The devulcanizing agents are used in a proportion of 10% to 15% by weight of the total material acted upon during devulcanization.

As mentioned previously, there are only two devulcanization processes in broad use:

- Reclaimator process
- Dynamic devulcanization process.

A preliminary mixing operation is common to both processes and is described first in the following paragraph. Then, the two processes are separately described in detail.

4.2.2.1 Mixing

This is an operation not unlike that of compounding/mixing used to prepare rubber stock in the other segments of SIC 30. However, since the rubber in this stage of reclaiming is in a dispersed granular form, mixing requires far less energy and is usually accomplished in conventional ribbon blenders rather than Banbury mixers. Additives at this stage include extender oils, devulcanizing agents and various pigments, clays and chemicals. The exact composition of these mixtures is highly proprietary. Typical rubber plant warehouse sweepings and dusts constitute the wastes generated.

At this point, the rubber mixture may be devulcanized by either of the two processes as follows.

4.2.2.2 Reclaimator Process

The Reclaimator Process is a continuous operation in which the rubber mixture is fed into a complex piece of equipment called the Reclaimator. The Reclaimator combines the features of a high strength mixer with those of an extruder.

The heat required for depolymerization is essentially produced by internal friction within the Reclaimator. Residence time is of the order of a few seconds. Stack gases are generated which have to be cooled and scrubbed to meet air emission standards. Oil is recovered from this stream. In at least one establishment, this oil is being recycled to the process.

Therefore, the waste stream produced by the Reclaimator process is constituted by the oil which is separated from the wastewater stream. The oil may be reused in subsequent batches where formulation permits, or, where this is not feasible, it must be disposed of.

4.2.2.3 Dynamic Devulcanization

In this devulcanization process, heat is supplied by addition of high pressure steam to a batch in a suitably designed mixing autoclave. Steam pressures of 500 to 1000 psi are used. "Cooking" time is on the order of a few minutes. Steam pressure is relieved through air pollution control equipment which is essentially a venturi scrubber discharging to a barometric condenser.

The wastes produced by Dynamic Devulcanization are constituted by the overflow of the barometric condenser. The overflow may go directly to a joint municipal-industrial wastewater treatment plant or the oils and muds in the overflow may be separated out.

4.2.3 Reclaimed Rubber Finishing

The product material from the two devulcanization processes are finished in different ways.

4.2.3.1 Dynamic Devulcanization Product Finishing

The material produced by the Dynamic Devulcanizer is further compounded on a mixing strainer, passed through a primary mill and then through a secondary mill.

The secondary mill produces a very thin sheet (a few mils thick -- 0.5 mm) which is worked on by a chopper blower, sent to a weigh hopper and finally to a baler. Most of the finished product is sold in bales, identical in size and weight to those of synthetic rubber.

The waste stream produced at this step in the operation consists of cleanings from the strainers. It is a rubber matrix containing solid particles.

4.2.3.2 Reclaimator Process Product Finishing

The material produced from the Reclaimator is in the form of thin flakes. These flakes can be processed to sheet or crumb form on conventional equipment. The finished product is sold either as a sheet or as a crumb.

4.3 Waste Characterization For The Reclaimed Rubber Industry

Wastes generated by SIC 3031 can be categorized into two types as was done for the other industries studied:

- Type I -- Wastes produced from the devulcanization process which are composed of oils and contaminated reclaiming agents.

- Type II -- All other wastes produced by this industry (see Table III-24).

Based on Table III-24, Type I wastes account for approximately 4% of materials disposed of by a typical plant in this industry of 12 Kg per 1000 Kg of product. Type II accounts for the remainder.

The reclaiming agents which constitute Type I wastes may originally have been added to the rubber to be reclaimed in proportions from 0.5 to 20 percent of the weight of scrap. Examples of reclaiming agents are naval stores such as dipentene, coal tar products such as solvent naphtha, and petroleum products such as the chemically unsaturated resin oil obtained in the refining of gasoline. There are also various chemical agents such as alkylated phenolsulfides, aliphatic and aromatic mercaptans, alkyl- and arylamines. At least one of these devulcanizing agents, solvent naphtha, is reported to be a recognized carcinogen.[1]

The following paragraphs segregate SIC 3031 wastes into potentially hazardous and non-potentially hazardous categories.

4.3.1 Potentially Hazardous Wastes

Since Type I wastes may contain

- some materials which have been reported to be toxic and/or carcinogenic

- other substances of unknown composition due to the proprietary nature of devulcanizing oils

(1) Sax, I.N., Dangerous Properties of Industrial Materials, 4th Ed., Van Nostrand Reinhold Co., N.Y., 1975.

other unknown constituents which may be in solution due to the action of the devulcanizing agents on the scrap rubber.

These wastes will be considered to be potentially hazardous.

4.3.2 Non-Hazardous Wastes

The three largest constituents of Type II wastes generated by SIC 3031 are scrap fiber, scrap wire and tires unsuitable for reclaiming. These three wastes account for over 90% of the materials to be disposed of by this industry as shown in Table III-24.

In a departure from the other segments of SIC 30, dusts from pollution control equipment and floor sweepings from receiving and compounding areas are not considered to be potentially hazardous. These wastes were so classified here because plants categorized in this industry generally only add extenders or fillers such as clays to the rubber once it has been reclaimed. For this industry, the dusts and sweepings only contribute approximately 1 Kg of waste per 1000 Kg of product produced or 0.004% of the total waste load.

4.4 Waste Quantification For The Years 1974, 1977 And 1983, Reclaimed Rubber Industry

The data presented below is based on the results of industry interviews, literature search and the analytical procedures carried out on actual samples obtained from industry sources.

Table III-25 presents the waste quantification for 1974, 1977, and 1983. The following paragraphs discuss these tables and the rationale used in their development. The data in the table are on a national basis, only to prevent disclosures due to the small size of this industry.

4.4.1 Total Wastes

Total wastes for the industry in 1974 were developed by multiplying the total waste factor of 288 Kg of waste per 1000 Kg of production from Table III-25 by the production bolume in Kg (Table III-23).

TABLE III-25

TOTAL AND POTENTIALLY HAZARDOUS WASTES, RUBBER RECLAIMERS INDUSTRY, SIC 3031 (DRY OR WET BASIS)

NATIONAL BASIS

Year	Estimated Production	Estimated Total Wastes	Estimated Potentially Hazardous Wastes
	(KKKg/yr)	(KKg/yr)	(KKg/yr)
1974	135	38,888	135
1977	156	44,928	156
1983	209	60,192	209

Source: Foster D. Snell, Inc. analysis of literature and industry interview data.

The U.S. Department of Commerce[1] has projected a 5.1% increase in value of shipments for this industry through 1980. This projected increase is based on the 1974 occurrence of shortages and escalating prices of new rubber, causing a renewed interest in reclaimed rubber. In addition, rubber reclaimers are attempting to develop new markets, such as for road surfacing.

However, based on such factors as the declining use of reclaim in tires caused by the increased production of radial tires, it is estimated that the growth rate for reclaim will be approximately 3% per year.

The waste load forecasts presented in Table III-25 also take into account the fact that based on industry interviews, no increase in solid wastes are anticipated due to the effect of the 1977 and 1983 Water Effluent Guideline Regulations.

As can be seen from Table III-25, total wastes produced on a dry basis (waste products are essentially "dry") for the years of interest are estimated as follows:

- 1974 -- 38,888 KKg/yr
- 1977 -- 44,928 KKg/yr
- 1983 -- 60,192 KKg/yr

4.4.2 Potentially Hazardous Wastes

Only the waste oils from devulcanization have been designated as potentially hazardous wastes as generated by this industry.

Precise identification and quantification of the chemical constituents found in the potentially hazardous waste stream is not possible due to the complexity of the mixture.

Results from the waste sampling and analysis program presented in Appendix B indicated that for the material analyzed:

- The total quantity of inorganic material did not exceed 4%
- Silicon, magnesium, aluminum and calcium were the only metals contained in the ash in significant quantities (> 10% of the ash content)
- Lead was present in a concentration of 3.8 mg per Kg of sample (3.8 parts per million).

From Table III-29, potentially hazardous wastes (dry basis) estimated for the years of interest are as follows:

- 1974 -- 135 KKg/yr
- 1977 -- 156 KKg/yr
- 1983 -- 209 KKg/yr

5. SIC 3041, RUBBER AND PLASTICS HOSE AND BELTING INDUSTRY

Exhibit D-8 (Appendix D), provides a detailed definition of this industry. The value added by manufacture was $618.7 million according to the 1972 Department of Commerce Census of Manufacturers. The industry had shipments valued at $1,020.1 million. The gross book value of depreciable assets was estimated (1) to be $316 million. In 1972, there were 92 establishments, 73 of which had twenty or more employees.

The industry is comprised of manufacturers whose primary product is rubber and plastics hose and belting. This represented 85% of the industry's product shipments. Secondary products in this industry in 1972 consisted mainly of fabricated rubber.

Production of rubber and plastic hoses and belts vary, but in general the processes consist of mixing, calendering, reinforcing with yarn or wire, extrusion, vulcanizing the rubber products and finishing.

Wastes occur throughout the entire process. The bulk wastes are produced by building, finishing and rejects. In 1974, 46,950.2 KKg of wastes were produced by this industry, 3,386.7 KKg of which may be potentially hazardous. These hazardous wastes are found mainly in floor sweepings and dust emissions. There is a unique potentially hazardous material in the form of lead oxide in the sludges produced by on-site wastewater treatment facilities.

5.1 Characterization Of SIC 3041, Rubber And Plastics Hose And Belting

This industry can be disaggregated into six segments:

- 30411 -- Rubber and Plastics Belts and Belting, Flat
- 30412 -- Rubber and Plastics Blets and Belting, Other Than Flat
- 30413 -- Rubber and Plastics Hose, Horizontal Reinforced
- 30414 -- Rubber and Plastics Hose, Continuous Molded, Non-Hazardous
- 30415 -- Rubber and Plastics Garden Hose
- 30416 -- Rubber and Plastics Hose, N.E.C.

(1) Estimated at 10 times annual capital expenditures from 1972 Census of Manufacturers, i.e., a ten year average lifetime for assets. Estimates based on a 40 year life for buildings and 7 year life for equipment.

Table III-26 provides information on the relative size of each of the six industry segments in terms of the number of establishments, employment, value added by manufacturer and value of shipments. From Table III-26, it can be seen that:

- The belts and hose segments have about the same number of plants, 43 and 47, respectively
- There are almost twice the number of employees in the segments producing belts and belting than in the production of hose (20,000 vs. 11,900).
- Plastic and rubber belt and belting accounted for about 65% of the value added by manufacture and the value of shipments of SIC 3041, while plastic and rubber hose products accounted for 35%.

However, based on our assessment of waste streams produced by SIC 3041, it will be unnecessary to divide the industry into its segments for the study, since most plants manufacture both rubber and plastic belts and hose, and waste produced by both products types are similar in type and quantities.

A detailed discussion of the methodology used to develop this industry characterization can be found in Appendix A at the end of the report.

5.1.1 Geographic Distribution Of Plants, Employment And Distribution Of Production In SIC 3041

There are plants in 28 states, Ohio with 15 establishments being the state with the greatest number of plants. Otherwise, there is a fairly even geographic distribution. Employment is highest in EPA Region V due to Ohio's large employment figures. This data is shown in Table III-27.

Raw materials consumed by class as a percentage of total materials consumed are as follows:

Class	Percent of Total Raw Materials Consumed in SIC 3041
Rubber	40.9
Carbon Black	16.6
Plasticizers	7.8
Pigments	7.1
Cord and Fabric	11.9
Synthetic Resins	12.7
Chemicals	3.0
Total	100.0

Source: Foster D. Snell, Inc. analysis of Department of Commerce Data.

As can be seen from the above data, synthetic resins of plastics account for about 13% of the raw materials consumed.

Production is highest in EPA Region V, mainly due to the high concentration of establishments in Ohio. Table III-27 geographically distributes the quantities of products produced in this industry on a weight basis.

Figure III-9, following Table III-27, graphically distributes the size of plants in this industry according to employment. There are 19 plants with 100-249 employees, 15 with 20 to 49, and 11 with 500 to 999. Although plants in this SIC range in size from less than 5 to several thousand employees, most appear to have employment in the median range.

5.1.2 Plant Age Distribution In SIC 3041

Plant ages were directly available for about 53% of the establishments in this industry. However, based on the number of known plant ages, estimates were made for the remainder of the establishments. This data is presented in Table III-28, following Figure III-9. Based on these estimates, only 4 of the plants are less than 10 years old. The rest are fairly evenly distributed between 10 years and more than 50 years.

TABLE III-26

GENERAL STATISTICS FOR ESTABLISHMENTS BY PRIMARY PRODUCT CLASS FOR THE SEGMENTS OF THE RUBBER AND PLASTICS HOSE AND BELTING INDUSTRY, SIC 3041

Industry or Product Class Code	Industry or Product Class	Number Of Establishments	Number of Employees (1,000)	Value Added By Manufacture (Million Dollars)	Value of Shipments (Million Dollars)
3041	Rubber, Plastics Hose and Belting	90	31.9	618.7	1,120.1
	Totals for Rubber and Plastics Belts and Belting	43	20.0	392.5	728.5
30411	Rubber and Plastics Belts and Belting, Flat	29	10.1	150.5	381.6
30412	Rubber and Plastics Belts and Belting, Not Flat	14	9.9	242.0	346.9
	Totals for Rubber and Plastics Hose	47	11.9	226.2	391.6
30413	Rubber and Plastics Hose, Horizontal Reinforced	12	3.6	78.2	128.5
30414	Rubber, Plastics Hose, Continuous Molded Nonhydraulic	4	1.9	34.1	60.5
30415	Rubber and Plastics Garden Hose	7	0.5	13.6	24.0
30416	All Other Rubber and Plastics Hose, N.E.C.	24	5.9	100.4	178.6

Source: Foster D. Snell, Inc. analysis of 1972 Census of Manufacturers, U.S. Department of Commerce.

TABLE III-27 (1)

GEOGRAPHIC DISTRIBUTION OF PLANTS EMPLOYMENT AND DISTRIBUTION OF PRODUCTION IN THE RUBBER AND PLASTICS HOSE AND BELTING INDUSTRY, SIC 3041

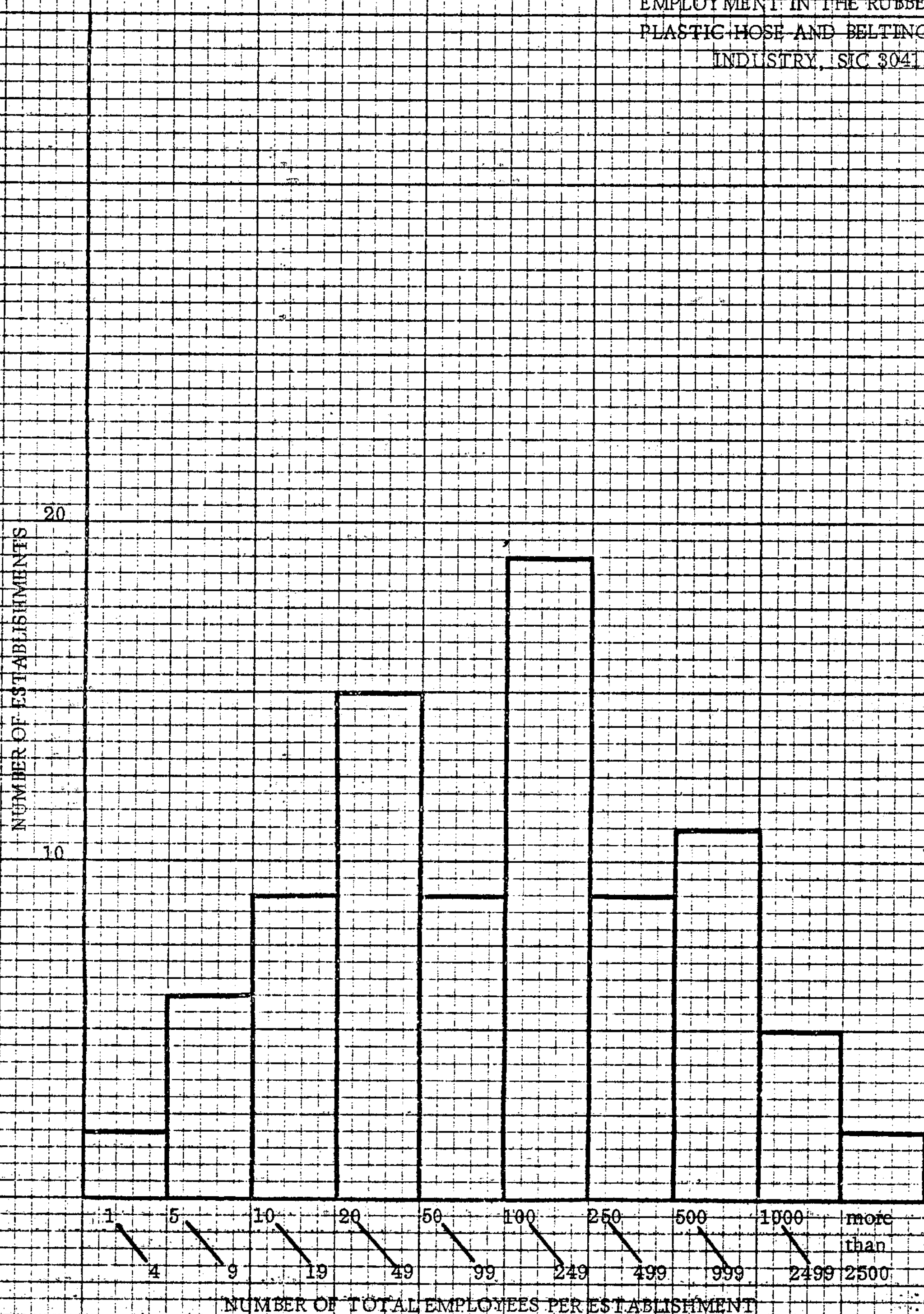
		Number of Plants	Employment	Production (KKKg/yr)
IV	Alabama			
X	Alaska			
IX	Arizona			
VI	Arkansas	1	500	6.2
IX	California	10	630	7.7
VIII	Colorado	1	5000	61.5
I	Connecticut	4	845	10.3
III	Delaware			17.8
IV	Florida			
IV	Georgia			
IX	Hawaii			
X	Idaho			
V	Illinois	4	2515	30.9
V	Indiana	2	425	5.2
VII	Iowa	2	1110	13.6
VII	Kansas	2	315	3.9
IV	Kentucky	1	1000	12.3
VI	Louisiana			
I	Maine			
III	Maryland			
I	Massachusetts	4	1125	13.8
V	Michigan	1	450	5.5
V	Minnesota	4	565	6.9
IV	Mississippi			
VII	Missouri	4	2210	27.2
VIII	Montana			
VII	Nebraska	2	1250	15.4
IX	Nevada			
I	New Hampshire	1	150	1.8
II	New Jersey	6	1685	20.7

		Number of Plants	Employment	Production (KKKg/yr)
VI	New Mexico			
II	New York	4	1200	14.8
IV	North Carolina	3	1900	23.4
VIII	North Dakota			
V	Ohio	15	9305	114.5
VI	Oklahoma	1	500	6.2
X	Oregon			
III	Pennsylvania	5	1315	16.2
I	Rhode Island	1	450	5.5
IV	South Carolina	3	1100	13.5
VIII	South Dakota			
IV	Tennessee	2	460	5.6
VI	Texas			
VIII	Utah	1	300	3.7
I	Vermont			
III	Virginia			
X	Washington	1	10	0.1
III	West Virginia			
V	Wisconsin	1	500	6.2
VIII	Wyoming			
	TOTAL	87	38255	470.4
	Region I	10	2560	31.4
	II	10	2885	35.5
	III	6	2765	34.0
	IV	9	4460	54.8
	V	27	13760	169.2
	VI	2	1000	12.4
	VII	10	4885	60.1
	VIII	2	5300	65.2
	IX	10	630	7.7
	X	1	10	0.1

Source: Foster D. Snell, Inc. analysis of Department of Commerce, Census of Manufacturers and industry data.

FIGURE III-9

DISTRIBUTION OF PLANT SIZES BY EMPLOYMENT IN THE RUBBER AND PLASTIC HOSE AND BELTING INDUSTRY, SIC 3041



Source: Foster D. Snell, Inc. analysis of data from Communication Channels, Inc. 1975 Rubber Red Book (27th Edition), New York, Palmerton Publishing Co. 1975.

TABLE III-28 (1)

DISTRIBUTION OF PLANT AGE FOR THOSE ESTABLISHMENTS CLASSIFIED IN THE RUBBER AND PLASTICS HOSE AND BELTING INDUSTRY, SIC 3041

EPA Region	State	No. of Plants	Less than 10 yrs.	10-25 yrs.	26-30 yrs.	over 50 yrs.
IV	Alabama					
X	Alaska					
IX	Arizona					1
VI	Arkansas	1				
IX	California	10		5	3	2
VIII	Colorado	1				1
I	Connecticut	4		2	1	1
III	Delaware	1				1
IV	Florida					
IV	Georgia					
IX	Hawaii					
X	Idaho					
V	Illinois	4		2	1	1
V	Indiana	2			2	
VII	Iowa	2		2		
VII	Kansas	2			2	
IV	Kentucky	1		1		
VI	Louisiana					
I	Maine					
III	Maryland	4		1	1	2
I	Massachusetts	1				1
V	Michigan	4		1	1	2
V	Minnesota					
IV	Mississippi					
VII	Missouri	4	1	1	1	1
VIII	Montana					
VII	Nebraska	2			2	
IX	Nevada					
I	New Hampshire	1				1
II	New Jersey	6		2	2	2

TABLE III-28 (2)

EPA Region	State	No. of Plants	PLANT AGE (Years) Less than 10 yrs.	10-25 yrs.	26-30 yrs.	over 50 yrs.
VI	New Mexico					
II	New York	4		2		2
IV	North Carolina	3			1	2
VIII	North Dakota					
V	Ohio	15	2	5	6	2
VI	Oklahoma	1		1		
X	Oregon					
III	Pennsylvania	5		2		3
I	Rhode Island	1				1
IV	South Carolina	3		1	1	1
VIII	South Dakota					
IV	Tennessee	2				2
VI	Texas					
VIII	Utah	1	1			
I	Vermont					
III	Virginia					
X	Washington	1			1	
III	West Virginia					
V	Wisconsin	1				1
VIII	Wyoming					
	TOTAL	87	4	28	25	30
	Region I	10		3	2	5
	II	10		4	2	4
	III	6		2		4
	IV	9		2	2	5
	V	27	2	8	10	7
	VI	2		1		1
	VII	10	1	3	5	1
	VIII	2	1			1
	IX	10		5	3	2
	X	1			1	

Source: Snell analysis of information from Rubber Red Book, Palmerton Publishing Company, Inc., 1975.

5.2 Detailed Process Descriptions And Waste Streams Identification For The Rubber And Plastics Belt And Hose Industry, SIC 3041

Unit operations used in this industry present some variations. However, these variations do not seem to significantly affect the amounts or types of wastes generated. Except for the fabrication of plastic hose, the compounding, mixing and, where applicable, calendering, steps for the manufacture of belts and hose are identical. Indeed, these steps are often carried out on the same pieces of equipment in the same facility.

Figures III-10, III-11 and III-12, are flow diagrams for the processes described. Figures III-13 and III-14 show the waste streams generated as a function of unit operation. Finally, Table III-29, quantifies the waste streams for plants classified in SIC 3041.

5.2.1 Common Processing Steps

These processing steps, common to both rubber belt and hose manufacture, Figures III-10, III-12, produce the required rubber stocks used in subsequent unit operations.

As in the tire and footwear industries, previously described, dozens of recipes are prepared corresponding to the various rubber components required to build the finished products.

5.2.1.1 Receiving And Compounding

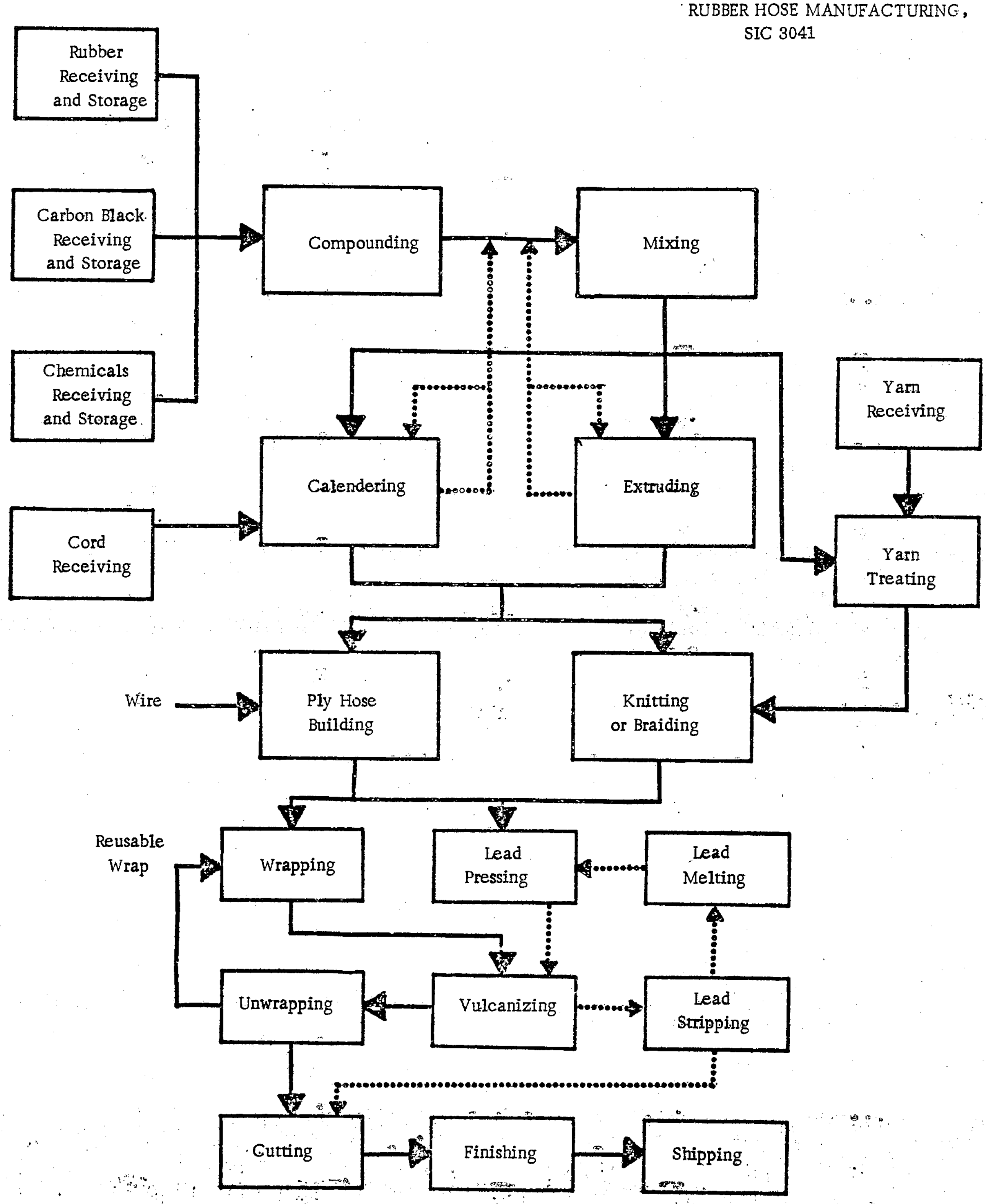
As in tire and footwear fabrication, the receiving of materials for use in the manufacture of belts and hose generates the usual empty containers and packaging materials in which the raw materials were shipped. These solid wastes include:

- Fiber drums
- Cardboard
- Paper
- Metal straps
- Metal drum lids
- Broken pallets
- Wood crating (particularly from imported natural gums).

Also, there are floor sweepings generated from inadvertant breaking of bags, fiber packs, etc. and from general materials handling.

FIGURE III- 10

PROCESS FLOW DIAGRAM FOR RUBBER HOSE MANUFACTURING, SIC 3041

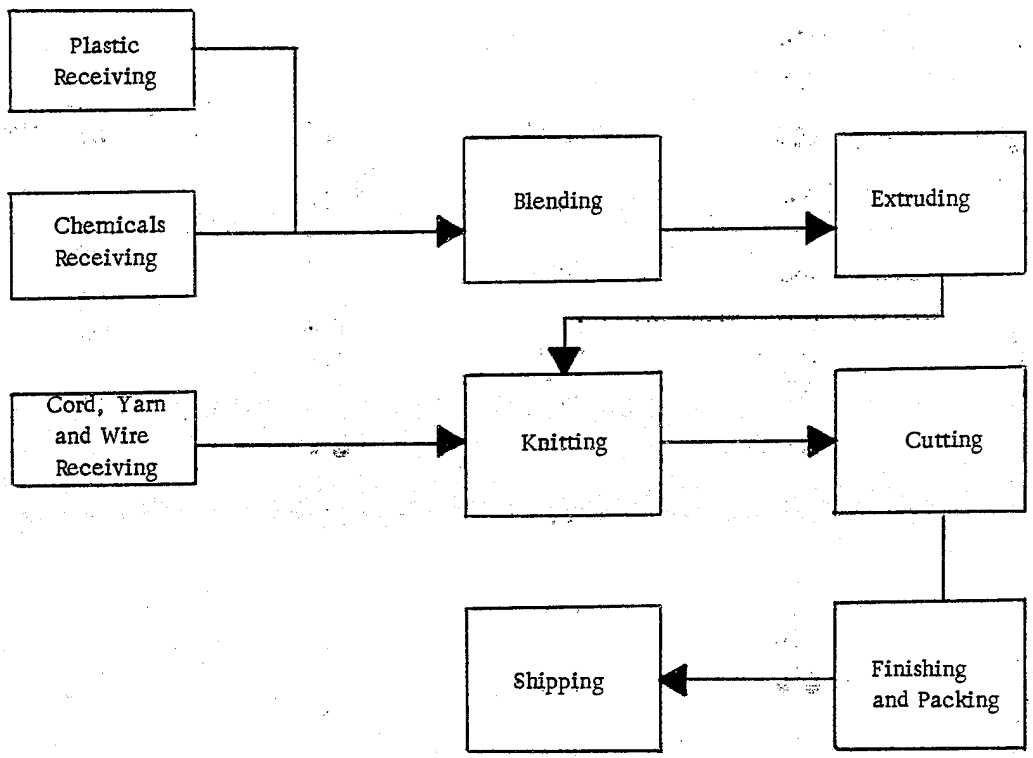


••••••Represents alternate paths.

Source: Foster D. Snell, Inc.

FIGURE III-11

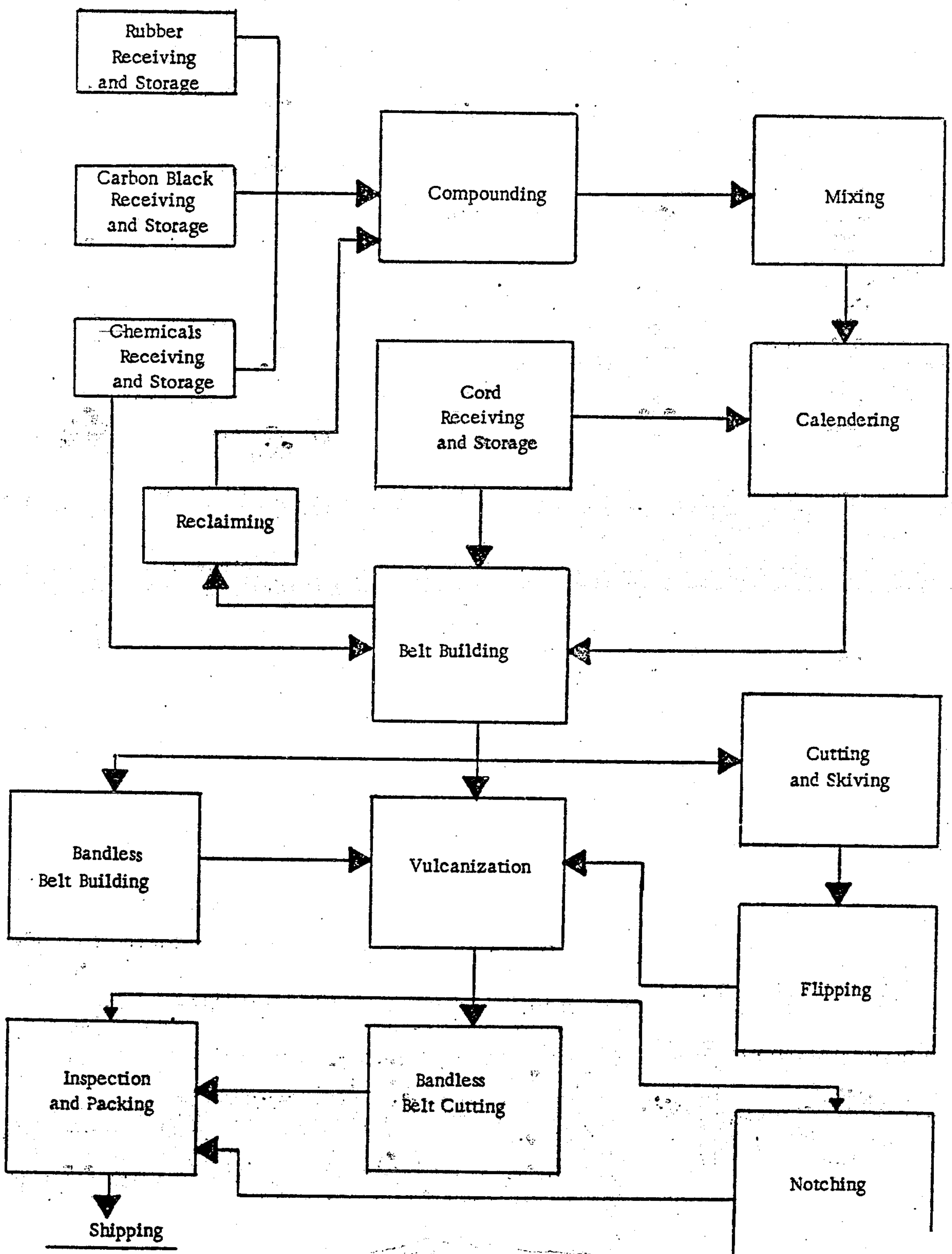
PLASTIC HOSE MANUFACTURING FLOW DIAGRAM, SIC 3041



Source: Foster D. Snell, Inc.

FIGURE III-12

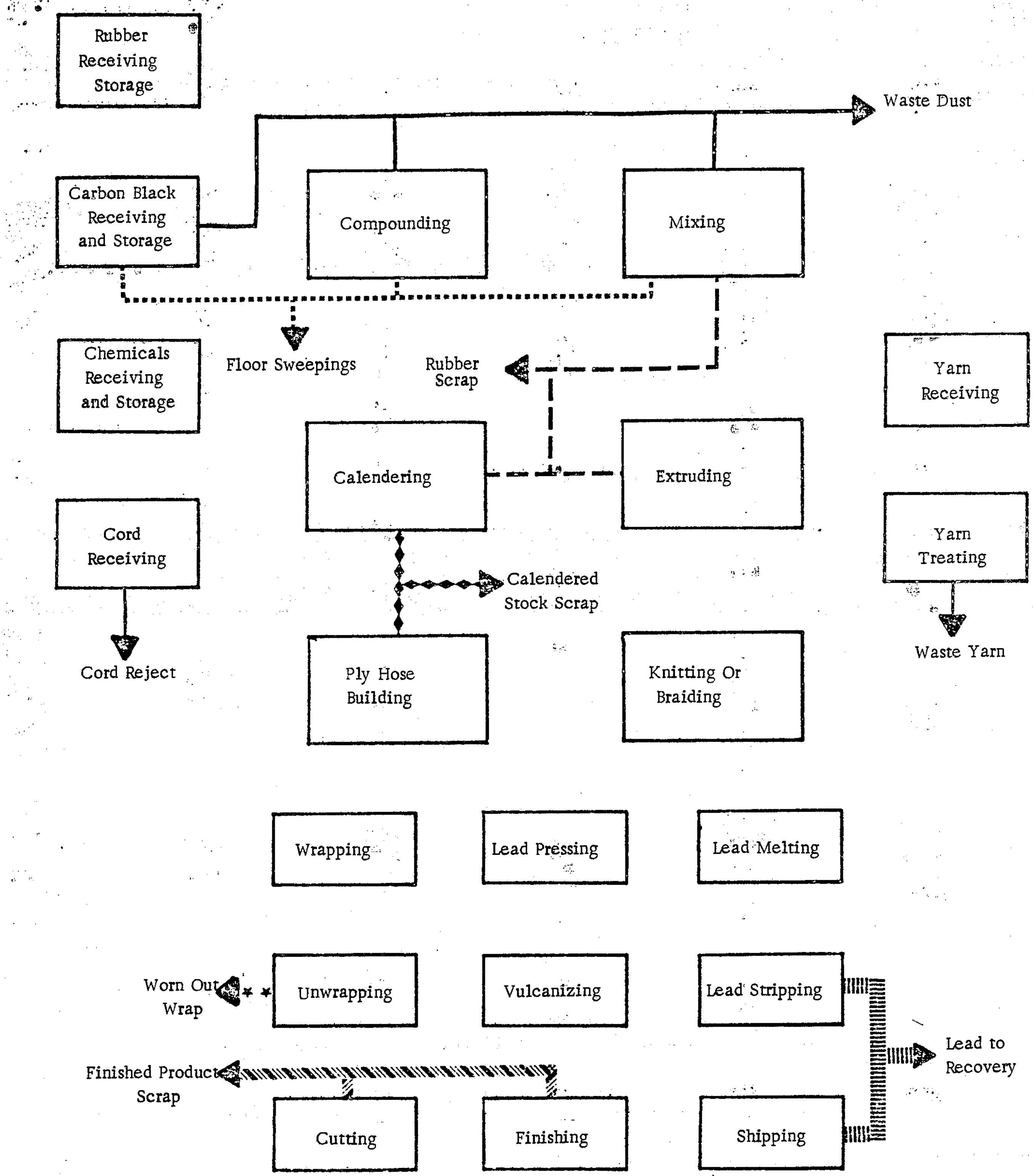
RUBBER BELT MANUFACTURING
FLOW DIAGRAM,
SIC 3041



Source: Foster D. Snell, Inc.

FIGURE III-13

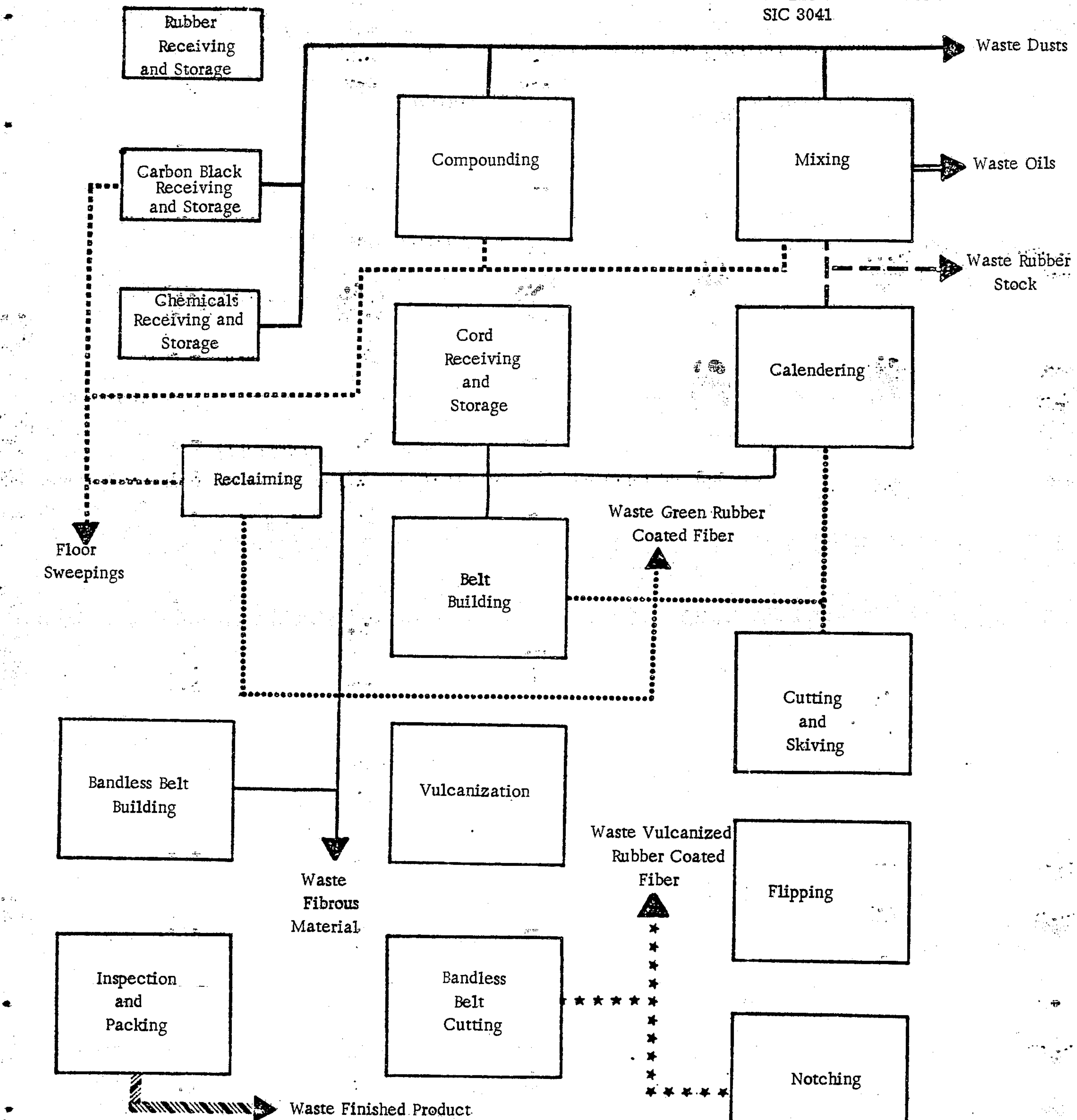
WASTE FLOW DIAGRAM FOR RUBBER HOSE MANUFACTURE, SIC 3041



Source: Foster D. Snell, Inc.

FIGURE III-14

WASTE FLOW DIAGRAM IN RUBBER BELT PRODUCTION, SIC 3041



Source: Foster D. Snell, Inc.

TABLE III-29

WASTE PARAMETERS FOR THE PLANTS CLASSIFIED IN THE RUBBER AND PLASTICS HOSE AND BELTING INDUSTRY, SIC 3041

	Source	Waste Stream	Quantity (Kg per 1000 Kg of raw material)
I.	Material Handling Compounding Area Mixing Area	Floor sweepings Dust from particulate emission control equipment	8.3 (1)
II.	Mixing Area Forming (Calendering)	Scrap rubber stock (uncured)	22
III.	Calendering Forming	Cord rejects	2.8
IV.	Building Finishing Rejects	Cured miscellaneous ends, pieces, wire, calendered stock, cured stock.	80
		TOTAL	113.1 (2)

(1) For this industry there is a unique potentially hazardous waste in the sludges generated from water treatment: lead oxides from those processes in which lead is used as a mold for hose production. However, the amount of lead released is insignificant in the units used in this study on a national basis.

(2) No significant difference was found in the levels of wastes reported between the belt and hose manufacturing.

Source: Foster D. Snell, Inc. analysis of industry interviews.

Materials used in the manufacture of belts and hose are again very similar to those used in the other segments of SIC 30. The fillers and chemicals are usually in the form of micron size powders.

Compounding operations involving these dusty materials are carried out under appropriate hooding connected to dust collection equipment. Due to the uncertain composition of the dusts then generated and collected, it is seldom feasible to reuse it. Often, this dust is not segregated from that generated in the next operation, mixing.

5.2.1.2 Mixing (Figures III-10, III-12)

This operation is similar to that which has previously been described for SIC 3011 and 3021. As pointed out in the sections of the report dealing with those SICs, several types of waste streams are generated:

- Dusts. Generated from either the Banbury or the open roll mixer. This dust is usually collected through a ventilation system equipped with some dust collection device. In the smaller installations, the dust collection system from the compounding and mixing steps are not segregated. Dust from this operation is generally of uncertain composition, mostly carbon black.

- Scorched materials. Due to the intense frictional heat generated in this operation, upon addition of curing ingredients, the stock in process may become unworkable. This is caused by premature curing and is called "scorching". Scorched stock is generally unusable and is disposed of.

- Unusable stock. Compounding errors may also result in a material which cannot be recovered.

- "Oozings". Due to the very high pressures generated in the Banbury, in some installations there is a small amount of stock which literally oozes off the seals around the rotor shafts. Being contaminated with grease and oils and of uncertain composition, this material is generally unusable.

The Banbury stock is treated further on refining mills, tubers or other equipment, the main purpose of which is to shape the mixed stock into a form suitable for further processing. Often the stock is coated at this stage with soapstone powder, either applied dry or as a slurry. While most of this material becomes incorporated in the stock during subsequent processing, a varying amount may find its way into the plant sweepings.

5.2.2 <u>Rubber Hose Manufacturing</u> (Figure III-10)

There are several different processes used depending on the type and diameter of the final product. These processes are:

- Machine wrapping
- Hand wrapping
- Lead sheath process

In addition, there are minor variants to each of these processes.

5.2.2.1 <u>Machine Wrapped Ply Hose</u>

In this type of construction, a calendering operation, followed by bias cutting, identical to those processing steps found for bias tire manufacturing, are used.

The next step is the building of the hose. In general, the hose is built by wrapping the required number of plies generated by calendering and bias cutting around an extruded rubber tube. This rubber tube is itself mounted on a rubber mandrel to provide internal support. Finally, the plies are covered by a calendered rubber sheet. The assembled hose is then wrapped in a reusable cotton or nylon wrap which provides pressure during the next unit operation, curing.

Curing is carried out in a direct steam autoclave. Afterwards, the cotton or nylon wrap is unwound and rolled up for further use.

The hose is then separated from the mandrel by the injection of compressed air in the interstitial space. The injection of the compressed air also serves as a check on the integrity of the hose.

Lengths of up to 50 meters (150 ft.) are currently manufactured by this process in diameters of 5 to 75 millimeters (0.2 to 3 inches).

Wastes produced in these operations include:

- Calendered and uncalendered scrap rubber from process startups, shutdowns, and bad batches.

- Uncured and cured finished hose.

5.2.2.2 Hand Built Hose (Figure III-10)

For this type of hose, a chuck driven steel mandrel is used for support. The inner tube is produced by extrusion and slipped over the mandrel for sizes up to 100 millimeters (4 inches). For larger diameter rubber hose, the tube is constructed by wrapping layers of unsupported calendered rubber sheets to the desired thickness. The plies are then wrapped around the hose by rotating the mandrel. Afterwards, a rubber cover is applied in the same manner as for the machine wrapped hose. Before the hose is cured, several crisscrossed reusable nylon or cotton wrap is applied under tension to provide pressure during curing.

Hoses made by this process can also be wire reinforced. The position of the wire in relation to the plies is dictated by the desired service. That is, the wire may act to prevent collapse in vacuum service or to provide reinforcement in pressure service, or both.

- In the case of vacuum applications, the wire is located under the plies.

- For use under pressure, the wire is positioned over the main plies.

- If a hose is to be used in both vacuum and pressure applications, the wire is positioned mid-way.

The wire, usually made of brass covered steel, is spiralled clockwise and counterclockwise at an approximate angle of 45^{o} to the longitudinal axis.

Hand built hose is cured in the same manner as the machine wrapped hose. Solid wastes generated by this process are similar to those from machine wrapped ply hose. The only addition is some wire scrap.

5.2.2.3 Lead Sheathed Hose (Figure III-10)

In this process, strands of reinforcing wire or fiber are braided or spiralled around an unsupported inner tube. The rubber stock from which this tube is made is of such composition that it can go through the braiding or spiralling process without collapsing in the unvulcanized state.

After the braiding or spiralling operation, the hose is passed through a crosshead extruder which applies a seamless outer cover. The hose is then encased in lead (molten or forced) as it is passed through a lead press.

Before the next step, which is vulcanization, the hose is coiled and water under high pressure is pumped inside the hose. The purpose of the water is to press the hose against the lead sheath during vulcanization.

Vulcanization is carried out in autoclaves. After vulcanization, the lead is stripped from the hose and the water released. The lead is remelted for subsequent reuse.

The lead sheathed process produces hose in lengths greather than 50 feet. It is usually employed for diameters ranging from 5 to 50 millimeters (0.2 to 2 inches).

Wastes produced from this process are similar to those produced in the other two. A major difference occurs, however, if a plant manufacturing lead sheathed hose has an on-site water treatment plant (Figure III-16). The sludges produced will contain lead oxides. Since few plants have such facilities, the total amount of lead disposed to landfill is insignificant compared to other wastes from this industry on a weight basis.

5.2.3 Plastic Hose Manufacturing (Figure III-11)

Two types of plastic hose are produced:

- Unreinforced
- Reinforced

The hoses are made by extrusion of thermoplastics with or without plasticizers.

Unreinforced hose is produced from a formula which is usually compounded at the plastic manufacturing plant. The formulation consists of the plastic itself, pigments, additives and sometimes plasticizers. Ingredients can be added in a mixer similar to a Banbury. The mixer can be externally heated or the heat may be generated by friction.

Reinforced plastic hose is manufactured on equipment similar or even identical to that used for braided or spiralled rubber hose.

An important characteristic of plastic hose fabrication is the possibility of remelting and subsequent reuse of any uncontaminated waste material used in its production. There is no equivalent to the irreversible curing process used in rubber hose manufacture since curing does not allow for the reuse of the rubber without recourse to the reclaiming processes described in the previous section.

Waste production is insignificant.

5.2.4 Belts (Figure III-12)

There are two basic types of rubber belts:

- Flat belts
- V-belts.

Flat belts are primarily used for conveying equipment and are generally reinforced longitudinally and sometimes laterally. V-belts are generally used to drive power equipment.

Compounding, mixing and calendering operations are identical to those for the manufacture of previously described rubber products. Flat belts are made by calendering type operations followed by curing.

Since many of the operations required for belt production are similar to those described for other products within SIC 30, only a brief description is provided here for V-belt manufacture. Waste streams in terms of waste types and quantities are very similar to those generated in other segments of SIC 3041.

5.2.4.1 V-Belt Building

The V-belt building operation is quite similar to tire building but much less complicated.

Layers of calendered rubber stock are wrapped around a mandrel. A reinforcing cord is spiralled around the wrapped calendered stock and additional rubber sheeting is applied to cover the reinforcing cord.

At this point, two processes may be used:

- Bandless cutting
- Cutting-Skiving and Flipping

5.2.4.2 Bandless Cutting

In this process, the tube produced on the mandrel is cured in specially designed pots. The cured tube is then fed to a machine which slices the tube into the familiar V shape. There is no further processing of bandless cut V-belts after this operation.

Wastes produced by this process are cured rubber from the post-cure cutting operation (Figure III-14).

5.2.4.3 Cutting-Skiving And Flipping

In this process the uncured tube is removed from the mandrel and sliced on a cutting machine. It is sliced to the larger width. In a second cutting, called skiving, triangular sections are sliced off from both edges of the belt.

Once the belts are skived, a narrow strip of calendered stock is wrapped around the belt in an operation called flipping which is practically identical to that used for bead wrapping in tire manufacture.

Wastes produced by this process are cuttings of uncured rubber.

5.2.4.4 Curing

Belts processed via the method described in paragraph 5.2.4.3 are placed in stacked molds and then introduced into curing autoclaves. The molds are so designed that information such as size and name of manufacturer can be imprinted on the belt during curing. There is no further processing of the flipped V-belts after this unit operation.

5.3 Waste Characterization For The Rubber And Plastics Hose And Belting Industry

Wastes produced in this industry (Figures III-13, III-14 and Table III-29) may be classified into two categories as was done for the other SIC 30 industry segments studied (Section 2.2).

- Type I -- Wastes in which raw materials used by the industry are in a free or uncombined state.

- Type II -- Wastes in which raw materials have been reacted or trapped in a cured or uncured rubber matrix.

These two waste types are produced in the same manner as those in SICs 3011 and 3021: Type I from raw material spillages, dust collected by particulate control equipment, etc.

These wastes, as indicated on page III-16 do not contain any free water with the following exception.

In one instance observed where a hose plant had an on-site water treatment facility, lead from the curing step is present in the sludge. This lead is included in, on a dry basis, the Type I category; Type II wastes are composed primarily of cured and uncured rubber.

Table I wastes account for approximately 7.4% of materials disposed by a typical plant in this industry or 8.3 Kg per 1000 Kg of product. Type II accounts for the remainder.

Table III-30 indicates which raw materials, quantified on a weight basis, are used in the preparation of rubber stock for belt and hose manufacture. It is evident from the information presented in the table that some of these substances which become incorporated in Type I wastes have been designated as being regarded as toxic or even potentially hazardous. These substances include [1] phenyl-β naphthylamine, benzothiazyl disulfide, phenylenediamines, lead dimethyldithiocarbamate, and trimethyl dihydroquinoline polymer (emits toxic fumes of cyanides when heated to dryness). The table also shows that the recipes for both rubber belts and hose are very similar.

The plastics segment of the industry is not discussed here because there are no significant wastes generated by its processes. Plastic wastes are easily recycled back into the formulations.

(1) Sax, N.I., Dangerous Properties of Industrial Materials, 4th Ed., Van Nostrand Reinhold Co., N.Y., 1975.

TABLE III-30 (1)

EXAMPLES OF TYPICAL RECIPES USED FOR RUBBER STOCK IN THE RUBBER AND PLASTIC HOSE AND BELTING INDUSTRY, SIC 3041

V-BELT COMPOUNDS -- NON-OIL RESISTING

Base Compounds

Component	Quantity(1)
Smoked Sheet	15
SBR	85
Stearic Acid	3
Zinc Oxide	5
Blend of phenyl- β -naphthylamine and diphenyl-p-phenylenediamine	1
Polymerized trimethyldihydroquinoline	1
Paraflux	8
Carbon Black	125
Benzothiazyl disulfide	1.5
Lead dimethyl dithiocarbamate	0.2
Sulfur	2
Total	246.7

V-Belt Cushion

Component	Quantity(1)
Smoked Sheet	30
SBR	70
Oil soluble sulfonic acid of high molecular weight with paraffin oil	2
Stearic acid	1
Zinc Oxide	5
Blend of phenyl- β -naphthylamine and diphenyl-p-phenylenediamine	1
Turgum S	5
Paraflux	5
Carbon Black	90
N-oxydiethylene benzothiazole 2-sulfenamide	1
Sulfur	2
Total	213

V-Belt Skim

Component	Quantity(1)
Smoked Sheet	30
SBR	70
Stearic Acid	2
Zinc Oxide	5
Polymerized trimethyldihydroquinoline	
Blend of p-isopropoxy diphenylamine and diphenyl-p-phenylenediamine	1
Turgum S	7.5
Carbon Black	60
Benzothiazyl disulfide	1
Lead dimethyldithiocarbamate	0.15
Sulfur	2
Total	185

1st Grade Covers

Component	Quantity(1)
High Modulus Crepe	100
Oil soluble sulfonic acid of high molecular weight with paraffin oil	1
Stearic Acid	3
Zinc Oxide	5
Mixtures of octylated diphenylamines	1
Blend of p-isopropoxy diphenylamine and diphenyl-p-phenylenediamine	1
Carbon Black	45
Sunproofing Wax	0.5
Paraflux	3
Sulfur	2.5
N-oxydiethylene benzothiazole 2-sulfenamide	1.25
Tetramethylthiuram disulfide	0.15
Total	163.4

Hot Service Cover

Component	Quantity(1)
SBR	100
Oil soluble sulfonic acid of high molecular weight with paraffin oil	5
Stearic Acid	2
Zinc Oxide	5
Blend of p-isopropoxy diphenylamine and diphenyl-p-phenylenediamine	1
Blend of resinous and protective material	10
Carbon Black	45
Paraflux	3
Sulfur	0.2
Benzothiazyl disulfide	1
Tetramethylthiuram disulfides	1.5
Tetraethylthiuram disulfides	1.5
Total	175.2

1st Grade Friction and Skim Compounds(1)

Component	Quantity
SBR	75
High Modulus Crepe	25
Oil soluble sulfonic acid of high molecular weight with paraffin oil	2
Stearic Acid	1
Zinc Oxide	5
Polymerized trimethyldihydroquinoline	1
Carbon Black	45
Aromatic process oil	7
Paraflux	7
Sulfur	2.25
N-oxydiethylene benzothiazole 2-sulfenamide	1.25
Tetramethylthiuram disulfides	0.2
Total	171.7

HOSE COMPOUNDS

Rubber-Reclaim Steam Hose Tube and Cover

Component	Quantity[(1)]
High Modulus Crepe	60
Reclaim (whole tire)	80
Oil soluble sulfonic acid of high molecular weight with paraffin oil	3
Stearic Acid	1.5
Zinc Oxide	5
Polymerized trimethyldihydroquinoline	2
Coumarone-Indene Resin	2
Rosin Oil	1
Carbon Black	100
Sulfur	2
Benzothiazyl disulfide	1.25
Tetramethylthiuram disulfide	0.125
Total	257.9

Butyl Steam Hose

Component	Quantity[(1)] Tube	Cover
Butyl Rubber	100	100
Oil soluble sulfonic acid of high molecular weight with paraffin oil	10	5
Stearic Acid	1	1
Zinc Oxide	20	20
Paraffin	2	2
Carbon Black	60	60
Sulfur	2	2
2-Mercaptobenzothiazole	0.5	0.5
Tetramethylthiuram disulfide	1	1
Tellurium diethyldithiocarbamate	1	1
Totals	197.5	192.5

Washing Machine Hose

Component	Quantity[(1)]
SBR	100
Oil soluble sulfonic acid of high molecular weight with paraffin oil	2
Stearic Acid	2
Zinc Oxide	5
Blend of mixtures of octylated diphenyl-amines with refined petroleum wax	2
Coumarone-Indene Resin	20
Sunproofing Wax	7
Whiting	175
Clay	25
Titanium dioxide	5
Lithopone	10
Sulfur	3
Benzothiazyl disulfide	1.5
Zinc dimethyldithiocarbamate	0.125
Total	357.6

Acid and Beer Hose Tube

Component	Quantity[(1)]
High Modulus Crepe	100
Oil soluble sulfonic acid of high molecular weight with paraffin oil	2
Stearic Acid	2
Zinc Oxide	5
Polymerized trimethyldihydroquinoline	1
Clay	20
Sulfur	2
Tetramethylthiuram disulfide	0.25
Total	132.25

Sandblast Hose Conducting Tube

Component	Quantity[(1)]
High Modulus Crepe	100
Oil soluble sulfonic acid of high molecular weight with paraffin oil	8
Stearic Acid	3
Zinc Oxide	5
Phenyl-β-naphthylamine	1
Glycerin	2
Pine Tar	5
Carbon Black	5
Acetylene Black	25
Sulfur	2.5
Benzothiazyl disulfide	0.5
Zinc dimethyl dithiocarbamate	0.1
Total	157.1

(1) Based on 100 parts of rubber by weight.

Source: The Vanderbilt Rubber Handbook, G.G. Winspear, Ed., R. T. Vanderbilt Co., Inc., N.Y., 1958.

Note: Although this source is about eighteen years old, recipes are still valid.

The next paragraphs segregate SIC 3041 wastes into potentially hazardous and non-potentially hazardous categories. (1)

5.3.1 Potentially Hazardous Wastes

Type I wastes contain the raw materials used by this industry in a free or uncombined state. Since these wastes may be contaminated with quantities of raw materials which are toxic or possibly carcinogenic, as discussed above, Type I wastes are considered to be potentially hazardous to man and/or his environment.

5.3.2 Non-Potentially Hazardous Wastes

Type II wastes are primarily composed of cured and uncured rubber, fabric, packaging materials, etc. These wastes will not be considered potentially hazardous.

5.4 Waste Quantification For The Years 1974, 1977 And 1983, Rubber And Plastic Hose And Belting Industry

In this portion of the report, estimated total and potentially hazardous waste quantities for the industry are presented for the year 1974 and projections made for the years 1977 and 1983. The data is based on the results of industry interviews, literature search and analytical procedures carried out on actual waste samples obtained from industry sources.

Table III-31 presents the waste quantifications for 1974, 1977 and 1983. The following paragraphs discuss the rationale used in developing the table.

5.4.1 Total Wastes

Total wastes for the industry in 1974 were developed by multiplying the total waste factor of 113 Kg of waste per 1000 Kg of production from Table III-29 by the kilograms of production in SIC 3041 for each state based on Table III-27.

(2) A complete and in-depth discussion of the rationale for this segregation is presented in Section 2.4, beginning on page III-53. While this discussion is centered around the Tire and Inner Tube Industry, it is directly applicable for SIC 3041 as well, due to product and waste similarities.

TABLE III-31 (1)

GEOGRAPHIC DISTRIBUTION OF WASTES --
RUBBER AND PLASTICS HOSE AND
BELTING INDUSTRY, SIC 3041
(DRY OR WET BASIS)
(KKg/yr)

		1974 Total Wastes	1974 Potentially Hazardous Wastes	1977 (1) Total Wastes	1977 (1) Potentially Hazardous Wastes	1983 (1) Total Wastes	1983 (1) Potentially Hazardous Wastes
IV	Alabama						
X	Alaska						
IX	Arizona						
VI	Arkansas	701	51	782	57	813	59
IX	California	871	64	971	71	1,010	74
VIII	Colorado	6,956	511	7,756	569	8,070	594
I	Connecticut	1,165	85	1,299	95	1,351	99
III	Delaware	2,013	148	2,245	165	2,335	173
IV	Florida						
IV	Georgia						
IX	Hawaii						
X	Idaho						
V	Illinois	3,495	256	3,897	286	4,054	297
V	Indiana	588	43	656	48	682	50
VII	Iowa	1,538	113	1,715	126	1,784	131
VII	Kansas	441	32	492	36	511	37
IV	Kentucky	1,391	102	1,551	114	1,613	118
VI	Louisiana						
I	Maine						
III	Maryland						
I	Massachusetts	1,561	115	1,740	128	1,811	133
V	Michigan	622	46	693	51	721	53
V	Minnesota	780	57	870	64	905	66
IV	Mississippi						
VII	Missouri	3,076	226	3,430	252	3,568	262
VIII	Montana						
VII	Nebraska	1,742	128	1,942	143	2,021	148
IX	Nevada						
I	New Hampshire	204	15	227	17	237	17
II	New Jersey	2,341	172	2,610	190	2,716	199

TABLE III-31 (2)

		1974		1977 (1)		1983 (1)	
		Total Wastes	Potentially Hazardous Wastes	Total Wastes	Potentially Hazardous Wastes	Total Wastes	Potentially Hazardous Wastes
VI	New Mexico						
II	New York	1,674	123	1,866	137	1,942	143
IV	North Carolina	2,647	194	2,951	217	3,071	225
VIII	North Dakota						
V	Ohio	12,950	951	14,439	1,060	15,023	1,104
VI	Oklahoma	701	51	782	57	813	59
X	Oregon						
III	Pennsylvania	1,832	134	2,043	150	2,125	155
I	Rhode Island	622	46	693	51	721	53
IV	South Carolina	1,527	112	1,702	125	1,771	130
VIII	South Dakota						
IV	Tennessee	633	46	706	52	734	53
VI	Texas						
VIII	Utah						
I	Vermont	419	31	467	34	486	36
III	Virginia						
X	Washington	11	1	13	1	13	1
III	West Virginia						
V	Wisconsin	701	51	782	57	813	59
VIII	Wyoming						
	TOTAL	53,202	3,904	59,320	4,353	61,714	4,528
Region	I	3,552	261	3,959	291	4,120	302
	II	4,015	295	4,476	327	4,658	342
	III	3,845	282	4,288	315	4,460	328
	IV	6,198	454	6,910	508	7,189	526
	V	19,136	1,404	21,337	1,566	22,198	1,629
	VI	1,402	102	1,564	114	1,626	118
	VII	6,797	499	7,579	557	7,884	578
	VIII	7,375	542	8,223	603	8,556	630
	IX	871	64	971	71	1,010	74
	X	11	1	13	1	13	1

Note: (1) Based on growth in SIC 3041 for these years as estimated from INFORUM input/output model use.

Source: Foster D. Snell, Inc.

The procedure followed for the 1977 and 1983 waste projections is identical to that used in SICs 3011 and 3021, where the INFORUM econometric model was used. The model is described in Appendix A, at the back of this report. Waste loads were projected on changes in product shipments in producer (manufacturer) prices (1972 dollars) for 1977 and 1983 as predicted by the model for an aggregate of SICs 3021, 3041 and 3069. Table III-22, on page III-90, presents projected values for product shipments for those years and their percent change from 1974.

The waste load forecasts presented in Table III-35 also take into account the fact that based on industry interviews, no increase in solid wastes are anticipated due to the effects of the 1977 and 1983 Water Effluent Guidelines Regulations.

As can be seen from Table III-31, total wastes produced on a dry basis for the years of interest are estimated as follows:

- 1974 -- 53,202 KKg/yr
- 1977 -- 59,320 KKg/yr
- 1983 -- 61,714 KKg/yr

Wastes are reported on a dry basis only because there is no significant amount of water present in SIC 3041 wastes.

5.4.2 Potentially Hazardous Wastes

Type I wastes are designated as potentially hazardous. While these wastes are not composed entirely of hazardous materials, they are, however, plated or contaminated with constituents in the free state which are hazardous in some form. As with the potentially hazardous wastes for the other segments of SIC 30 discussed so far, quantification of the precise hazardous constituents of the total wastes generated in absolute amounts is not possible to arrive at. This is due to the mixology of a particular sample obtained during the time period of observation.

Samples of dusts from pollution abatement equipment, floor sweepings, etc. were not analyzed for SIC 3041 because there is evidence that the results would be similar to that found for SICs 3011, 3021, and 3069; that is:

- High inorganic fraction (greater than 50% of sample weight)
- Presence of a variety of metals in the ash including lead, zinc, tin and copper
- A water solubility under neutral pH in the range of 1% to 5% of the sample by weight.

Due to the randomness of the wastes' composition, the amount of potentially hazardous wastes generated by SIC 3041 presented in Table III- 35 , are not broken out into their specific hazardous components.

From Table III-35 potentially hazardous wastes, dry basis, estimated for the years of interest are as follows:

- 1974 -- 3,904 KKg/yr
- 1977 -- 4,353 KKg/yr
- 1983 -- 4,528 KKg/yr

In this industry the potentially hazardous wastes do not generally contain water and are, therefore, reported on a dry basis only.

6. SIC 3069, FABRICATED RUBBER PRODUCTS, NOT ELSEWHERE CLASSIFIED (N.E.C.)

Exhibit D-9 (Appendix D) presents a detailed definition of Fabricated Rubber Products (N.E.C.). According to the 1982 Department of Commerce Census of Manufacturers, industry shipments were valued at $2,830.9 million. The value added by manufacture was $1,573.1 million. Gross book value of depreciable assets was estimated (1) to be $885 million. Again, according to the 1972 Census of Manufacturers, there were 1,103 establishments in SIC 3069, 605 of which had 20 or more employees.

This industry produces thousands of different products. However, these products are produced by two processes basic to the industry -- dry and wet.

Wastes are generated throughout the entire dry process with most produced in the finishing steps. Potentially hazardous wastes, however, occur primarily as floor sweepings and dust from particulate emission control equipment. A nominal amount of waste oil, also considered to be potentially hazardous, are produced as a waste stream from mixing operations. Total dry process wastes are estimated to be 186.9 KKKg, 10.7 KKKg of which are considered to be potentially hazardous.

For the wet process, 6,799 KKg of wastes are estimated to be produced. Potentially hazardous wastes are again in the form of floor sweepings and dust from particulate emission control equipment. These potentially hazardous wastes are estimated to be approximately 260 KKg (dry basis).

Total wastes produced in SIC 3069 are approximately 200 KKKg of which 11.0 KKKg are considered to be potentially hazardous (dry basis).

6.1 Characterization Of SIC 3069, Fabricated Rubber Products, N.E.C.

As mentioned, this industry encompasses many different products. A breakdown of SIC 3069 into five digit SIC categories gives an indication of the types of products fabricated by the industry.

- 30693 -- Sponge and Foam Rubber Goods
- 30694 -- Rubber Floor and Wall Covering

(1) Estimated at 10 times annual capital expenditures from 1972 Census of Manufacturers, i.e. a ten year average lifetime for assets. Estimates based on a 40 year life for buildings and 7 year life for equipment.

- 30695 -- Mechanical Rubber Goods, N.E.C.
- 30696 -- Rubber Heels and Soles
- 30697 -- Druggist and Medical Sundries
- 30698 -- Other Rubber Goods, N.E.C. (for example, rubber coated fabrics, rubber clothing, stationer's sundries, toys, balloons, etc.)

In order to obtain an understanding of waste generation and disposal practices for SIC 3069, it will not, however, be necessary to divide the industry into five digit SICs. This is so because the processes involved and the wastes generated are similar in each. Instead, it is necessary to study the industry in relation to the dry and wet processes, the two processes basic to this SIC.

- The dry process comprises SICs 30694, 30696, and parts of SICs 30693, 30695, 30697 and 30698.
- The wet process is primarily used in SIC 30698, but is also used to some extent in SICs 30693, 30695 and 30697.

A detailed explanation of the methodology employed in developing the industry characterization of SIC 3069 is presented in Appendix A, at the end of this report.

6.1.1 Geographic Distribution Of Plants, Employment And Plant Ages For SIC 3069

Tables III-32 and III-33 present the geographic distribution of plants in SIC 3069 in terms of wet process and dry process plants. Table III-34 summarizes the data for the entire SIC 3069. The largest concentration of establishments is in EPA Region V, with about 400 plants (38 plants using wet process; 353 plants using the dry process).

TABLE II-32 (1)

GEOGRAPHIC DISTRIBUTION OF PLANT AGE FOR PLANTS USING WET PROCESSES IN THE FABRICATED RUBBER PRODUCTS INDUSTRY N.E.C., SIC 3069

		No. of Plants	Less Than 10 Yrs	10-25 Years	26-50 Years	Over 50 Yrs
IV	Alabama	1				1
X	Alaska					
IX	Arizona					
VI	Arkansas					
IX	California	6		4	2	
VIII	Colorado	1			1	
I	Connecticut	3		1	1	1
III	Delaware	2			2	
IV	Florida					
IV	Georgia	2	1	1		
IX	Hawaii					
X	Idaho					
V	Illinois	6	1	2	3	
V	Indiana	1		1		
VII	Iowa					
VII	Kansas					
IV	Kentucky					
VI	Louisiana					
I	Maine					
III	Maryland					
I	Massachusetts	7		1	6	
V	Michigan	6		2	3	1
V	Minnesota					
IV	Mississippi	1			1	
VII	Missouri	1				1
VIII	Montana					
VII	Nebraska	1	1			
IX	Nevada					
I	New Hampshire	1			1	
II	New Jersey	10	1	1	5	3

		No. of Plants	Less Than 10 Yrs	10-25 Years	26-50 Years	Over 50 Yrs
VI	New Mexico					
II	New York	5	1		4	
IV	North Carolina	3			1	2
VIII	North Dakota					
V	Ohio	23	2	4	9	8
VI	Oklahoma	1			1	
X	Oregon					
III	Pennsylvania	2		1	1	
I	Rhode Island	2		1		1
IV	South Carolina	2			1	1
VIII	South Dakota					
IV	Tennessee					
VI	Texas					
VIII	Utah					
I	Vermont					
III	Virginia					
X	Washington					
III	West Virginia					
V	Wisconsin	2	1		1	
VIII	Wyoming					
	TOTAL	89	8	19	43	19
	Region I	13		3	8	2
	II	15	2	1	9	3
	III	4		1	3	
	IV	9	1	1	3	4
	V	38	4	9	16	9
	VI	1			1	
	VII	2	1			1
	VIII	1			1	
	IX	6		4	2	
	X					

Source: Snell analysis of data from the 1975 Rubber Red Book, Palmerton Publishing Co., Inc.

TABLE III-33 (1)

GEOGRAPHIC DISTRIBUTION OF PLANT AGE FOR PLANTS USING DRY PROCESSES IN THE FABRICATED RUBBER PRODUCTS INDUSTRY, N.E.C., SIC 3069

		No. of Plants	Less Than 10 Yrs	10-25 Years	26-50 Years	Over 50 Years
IV	Alabama	10	1	3	3	3
X	Alaska					
IX	Arizona	5		2	1	2
VI	Arkansas	6		2	2	2
IX	California	138	6	44	40	48
VIII	Colorado					
I	Connecticut	40	2	13	11	14
III	Delaware					
IV	Florida	22	1	7	6	8
IV	Georgia	29	1	9	8	11
IX	Hawaii					
X	Idaho					
V	Illinois	55	2	18	16	19
V	Indiana	55	2	18	16	19
VII	Iowa	5		2	1	2
VII	Kansas					
IV	Kentucky	4		2		2
VI	Louisiana					
I	Maine					
III	Maryland	10	1	3	3	3
I	Massachusetts	54	2	17	16	19
V	Michigan	51	2	16	15	18
V	Minnesota	22	1	7	6	8
IV	Mississippi	12	1	4	3	4
VII	Missouri	12	1	4	3	4
VIII	Montana					
VII	Nebraska	4		2		2
IX	Nevada					
I	New Hampshire	4		2		2
II	New Jersey	58	2	19	17	20

		No. of Plants	Less Than 10 Yrs	10-25 Years	26-50 Years	Over 50 Yrs
VI	New Mexico					
II	New York	64	3	21	18	22
IV	North Carolina	15	1	5	4	5
VIII	North Dakota					
V	Ohio	148	7	48	42	51
VI	Oklahoma	6		2	2	2
X	Oregon	11	1	3	3	4
III	Pennsylvania	47	2	15	13	17
I	Rhode Island	14	1	4	4	5
IV	South Carolina	7		2	2	3
VIII	South Dakota	1				1
IV	Tennessee	13	1	4	4	4
VI	Texas	39	2	12	11	14
VIII	Utah	3		1	1	1
I	Vermont	1				
III	Virginia	13	1	4	4	4
X	Washington	5		2	1	2
III	West Virginia	8		3	2	3
V	Wisconsin	22	1	7	6	8
VIII	Wyoming					
	TOTAL	1013	45	327	284	357
	Region I	113	5	36	31	41
	II	122	5	40	35	42
	III	78	4	25	22	27
	IV	112	6	36	30	40
	V	353	15	114	101	123
	VI	51	2	16	15	18
	VII	21	1	8	4	8
	VIII	4		1	1	2
	IX	143	6	46	41	50
	X	16	1	5	4	6

Source: Snell analysis of industry data and information from the 1975 Rubber Red Book, Palmerton Publishing Company, Inc.

TABLE III-34 (1)

GEOGRAPHIC DISTRIBUTION OF PLANT AGE FOR THOSE ESTABLISHMENTS CLASSIFIED IN THE FABRICATED RUBBER PRODUCTS INDUSTRY N.E.C., SIC 3069

		No. of Plants	Less Than 10 Yrs	10-25 Yrs	26-50 Yrs	Over 50 Yrs
IV	Alabama	11	1	3	3	4
X	Alaska					
IX	Arizona	5		2	1	2
VI	Arkansas	6		2	2	2
IX	California	144	6	48	42	48
VIII	Colorado	1			1	
I	Connecticut	43	2	14	12	15
III	Delaware	2			2	
IV	Florida	22	1	7	6	8
IV	Georgia	31	2	10	8	11
IX	Hawaii					
X	Idaho					
V	Illinois	61	3	20	19	19
V	Indiana	56	2	19	16	19
VII	Iowa	5		2	1	2
VII	Kansas					
IV	Kentucky	4		2		2
VI	Louisiana					
I	Maine					
III	Maryland	10	1	3	3	3
I	Massachusetts	61	2	18	22	19
V	Michigan	57	2	18	18	19
V	Minnesota	22	1	7	6	8
IV	Mississippi	13	1	4	4	4
VII	Missouri	13	1	4	3	5
VIII	Montana					
VII	Nebraska	5	1	2		2
IX	Nevada					
I	New Hampshire	5		2	1	2
II	New Jersey	68	3	20	22	23

TABLE III-34 (2)

		No. of Plants	Less Than 10 Yrs	10-25 Yrs	26-50 Yrs	More Than 50 Yrs
VI	New Mexico					
II	New York	69	4	21	22	22
IV	North Carolina	18	1	5	5	7
VIII	North Dakota					
V	Ohio	171	9	52	51	59
VI	Oklahoma	7		2	3	2
X	Oregon	11	1	3	3	4
III	Pennsylvania	49	2	16	14	17
I	Rhode Island	16	1	5	4	6
IV	South Carolina	9		2	3	4
VIII	South Dakota	1				1
IV	Tennessee	13	1	4	4	4
VI	Texas	39	2	12	11	14
VIII	Utah	3		1	1	1
I	Vermont	1				1
III	Virginia	13	1	4	4	4
X	Washington	5		2	1	2
III	West Virginia	8		3	2	3
V	Wisconsin	24	2	7	7	8
VIII	Wyoming					
	TOTAL	1102	53	346	327	376
Region	I	126	5	39	39	43
	II	137	7	41	44	45
	III	82	4	26	25	27
	IV	121	7	37	33	44
	V	391	19	123	117	132
	VI	52	2	16	16	18
	VII	23	2	8	4	9
	VIII	5		1	2	2
	IX	149	6	50	43	50
	X	16	1	5	4	6

Source: Foster D. Snell, Inc.

Employment in this industry is also concentrated in EPA Region V. This region accounts for almost 45% of the industry employment as is shown in Table III-40, which details wet process, dry process plants and employment by state and EPA regions.

Plants in this SIC tend to have a relatively small number of employees compared to some of the other segments of SIC 30 studied. This trend is shown graphically in Figure III-15. Over 200 plants have less than 5 employees; 90% of the plants employ less than 250 people.

In the wet progress segment of SIC 3069, 48% of the plants are between 25 and 50 years old; 21% are between 10 and 25 years old; and another 21% are over 50 years old. Only 10% are less than 10 years old.

In terms of plant age, the dry process segment of SIC 3069 has a distribution similar to that found in SIC 3041. Table III-34 presents the geographical distribution of plant ages for the dry process segment of SIC 3069. Table III-35 summarizes the plant age distribution for the entire SIC 3069.

6.1.2 Raw Material Consumption And Production

Raw materials consumed in SIC 3069 by class as a percentage of total materials consumed is as follows:

Raw Material Class		Percent of Total Raw Materials Consumed
Rubber		55.1%
Carbon Black		11.0
Plasticizers		6.8
Pigments		15.0
Cord and Fabric		2.4
Synthetic Resins		6.7
Chemicals		3.0
	Total	100.0 %

As can be seen from the above list, about 45% of the materials consumed by SIC 3069 are non-rubber in nature, while 55% of the raw materials consumed is rubber. Chemicals. cord and fabric and plasticizers account for 12%. Carbon black (11.0%) and pigments (15.0%) consumption makeup the bulk of raw material used after rubber.

TABLE III-35 (1)

GEOGRAPHIC DISTRIBUTION OF PLANTS
AND EMPLOYMENT FOR THE FABRICATED
RUBBER PRODUCTS INDUSTRY, N.E.C., SIC 3069

NUMBER OF PLANTS

		All processes	Wet Process	Dry Process	Employment
IV	Alabama	11	1	10	1750
X	Alaska				
IX	Arizona	5		5	250
VI	Arkansas	6		6	1750
IX	California	144	6	138	6200
VIII	Colorado	1	1		50
I	Connecticut	43	3	40	4700
III	Delaware	2	2		1750
IV	Florida	22		22	375
IV	Georgia	31	2	29	1750
IX	Hawaii				
X	Idaho				
V	Illinois	61	6	55	3200
V	Indiana	56	1	55	11000
VII	Iowa	5		5	1310
VII	Kansas				
IV	Kentucky	4		4	375
VI	Louisiana				
I	Maine				
III	Maryland	10		10	750
I	Massachusetts	61	7	54	7700
V	Michigan	57	6	51	3600
V	Minnesota	22		22	1310
IV	Mississippi	13	1	12	1300
VII	Missouri	13	1	12	280
VIII	Montana				
VII	Nebraska	5	1	4	280
IX	Nevada				
I	New Hampshire	5	1	4	375
II	New Jersey	68	10	58	4400

		NUMBER OF PLANTS All processes	Wet Process	Dry Process	Employment
VI	New Mexico				
II	New York	69	5	64	3600
IV	North Carolina	18	3	15	1000
VIII	North Dakota				
V	Ohio	171	23	148	22600
VI	Oklahoma	7	1	6	375
X	Oregon	11		11	375
III	Pennsylvania	49	2	47	3700
I	Rhode Island	16	2	14	750
IV	South Carolina	9	2	7	750
VIII	South Dakota	1		1	150
IV	Tennessee	13		13	2100
VI	Texas	39		39	2300
VIII	Utah	3		3	250
I	Vermont	1		1	750
III	Virginia	13		13	3600
X	Washington	5		5	200
III	West Virginia	8		8	750
V	Wisconsin	24	2	22	1750
VIII	Wyoming				
	TOTAL	1102	89	1013	99455
Region	I	126	13	113	14275
	II	137	15	122	8000
	III	82	4	78	10550
	IV	121	9	112	9400
	V	391	38	353	43460
	VI	52	1	51	4425
	VII	23	2	21	1870
	VIII	5	1	4	450
	IX	149	6	143	6450
	X	16		16	575

Source: Foster D. Snell, Inc., Analysis of Department of Commerce (1972 - Census of Manufacturers) 1975 Rubber Red Book and Industry data.

FIGURE III-15

DISTRIBUTION OF PLANT SIZES BY EMPLOYMENT IN SIC 3069 (1972)

Source: Foster D. Snell Analysis of Department of Commerce Data (1972 -- Census of Manufacturers)

Table III-36 shows the geographic distribution of raw material consumption in this industry, including wet and dry processes. Dry processes account for over 75% of raw materials consumed which is estimated at 1,152.0 KKKg. EPA Region V accounts for the largest consumption at 516.7 KKKg.

Production quantities were difficult to estimate because of great dissimilarity of products and the extensive use of non-rubber materials in many of the products. Units of production in this industry vary from pounds to pairs to square yards to units.

Since it was necessary to arrive at some value for production upon which to distribute wastes produced on a geographic basis, an estimate was made. Based on raw materials consumed and the waste factors discussed in subsequent sections, it was concluded that production in SIC 3069 for the wet process was 254.6 KKKg and for the dry process was 703.6 KKKg. Table III-37 distributes SIC 3069 production geographically.

6.2 Detailed Process Descriptions And Waste Stream Identification For The Fabricated Rubber Products Industry, SIC 3069

In this section the processes used in SIC 3069 (miscellaneous fabricated rubber products) are briefly described with a view of identifying those operations which lead to the production of the wastes included in this study.

From the processing standpoint, this segment of SIC 30 can be divided into two broad categories:

- Dry processing or stock based processes
- Wet processing or latex based processes

Furthermore, the dry process can, in its turn, be subdivided into meaningful unit operations. Some are common to all processes, such as compounding and mixing, and others are characteristic of certain fabrication methods such as compression molding or extrusion.

TABLE III-36 (1)

GEOGRAPHIC DISTRIBUTION OF RAW MATERIAL CONSUMPTION FOR THE FABRICATED RUBBER PRODUCTS INDUSTRY, N.E.C., SIC 3069

		Wet Process (KKKg)	Dry Process (KKKg)	Total (KKKg)
IV	Alabama	7.0	5.8	12.8
X	Alaska			
IX	Arizona		2.7	2.7
VI	Arkansas		3.2	3.2
IX	California (3)	2.3	74.1	76.4
VIII	Colorado			
I	Connecticut	1.7	22.8	24.5
III	Delaware	57.4		57.4
IV	Florida		11.7	11.7
IV	Georgia	5.2	16.4	21.6
IX	Hawaii			
X	Idaho			
V	Illinois (3)	1.6	30.6	32.2
V	Indiana (3)	4.3	142.8	147.1
VII	Iowa		2.7	2.7
VII	Kansas			
IV	Kentucky		2.1	2.1
VI	Louisiana			
I	Maine			
III	Maryland		5.3	5.3
I	Massachusetts (3)	8.1	72.0	80.1
V	Michigan	4.6	30.2	34.8
V	Minnesota		11.7	11.7
IV	Mississippi (3)	.2	14.0	14.2
VII	Missouri	.5	6.9	7.4
VIII	Montana			
VII	Nebraska	.4	2.7	3.1
IX	Nevada			
I	New Hampshire	1.0	2.7	3.7
II	New Jersey (3)	14.3	22.6	36.9

TABLE III-36 (2)

			Wet Process (KKKg)	Dry Process (KKKg)	Total (KKKg)
VI	New Mexico				
II	New York	(3)	6.8	29.4	36.2
IV	North Carolina		43.6	9.5	53.1
VIII	North Dakota				
V	Ohio	(3)	55.9	212.5	268.4
VI	Oklahoma		2.3	3.4	6.0
X	Oregon			5.8	5.8
III	Pennsylvania	(3)	1.2	22.3	23.5
I	Rhode Island		20.1	8.5	28.6
IV	South Carolina		13.2	4.8	18.0
VIII	South Dakota		—	.5	.5
IV	Tennessee	(3)		54.6	54.6
VI	Texas	(3)		27.2	27.2
VIII	Utah			1.6	1.6
I	Vermont			.5	.5
III	Virginia			7.0	7.0
X	Washington			2.7	2.7
III	West Virginia			4.2	4.2
V	Wisconsin		9.8	12.7	22.5
VIII	Wyoming				
	TOTAL		261.5	890.5	1,152.0
	Region	I (3)	30.9	106.5	137.4
		II	21.1	52.0	73.1
		III	58.6	38.8	97.4
		IV	69.2	118.9	188.1
		V	76.2	440.5	516.7
		VI	2.3	34.	36.4
		VII	.9	12.3	13.2
		VIII		2.1	2.1
		IX	2.3	76.8	79.1
		X		8.5	8.5

TABLE III-36 (3)

NOTES:

(1) Wet Process Total Raw Material Usage, estimated from the latex usage, is 262 KKKg/year. The individual values are based on Snell's analysis of the employment figures in the plants using wet processes. (1972 census figures and current employment estimates).

(2) Dry Process Total Raw Material Usage, estimated at 830 KKKg/year. The individual values are based on the value of raw materials used in those states for which data are available and a proration of the remainder of the plants.

(3) Denotes those geographic entities for which raw material values are available.

Source: Foster D. Snell, Inc., Analysis of Department of Commerce, Rubber Red Book and Industry Interviews data.

TABLE III-37 (1)

GEOGRAPHIC DISTRIBUTION OF PRODUCTION FOR THE FABRICATED RUBBER PRODUCTS INDUSTRY, N.E.C., SIC 3069

		Production		
		Wet Process (KKKg)	Dry Process (KKKg)	Total (KKKg)
IV	Alabama	6.8	4.3	11.1
X	Alaska			
IX	Arizona		2.1	2.1
VI	Arkansas		2.5	2.5
IX	California	2.2	58.5	60.7
VIII	Colorado			
I	Connecticut	1.6	18.0	19.6
III	Delaware	55.9		55.9
IV	Florida		9.2	9.2
IV	Georgia	5.1	13.0	18.1
IX	Hawaii			
X	Idaho			
V	Illinois	1.6	24.2	25.8
V	Indiana	4.2	112.8	117.0
VII	Iowa		2.1	2.1
VII	Kansas			
IV	Kentucky		1.6	1.6
VI	Louisiana			
I	Maine			
III	Maryland		4.2	4.2
I	Massachusetts	7.9	56.9	64.8
V	Michigan	4.5	23.8	28.3
V	Minnesota		9.2	9.2
IV	Mississippi	0.2	11.1	11.3
VII	Missouri	0.5	5.4	5.9
VIII	Montana			
VII	Nebraska	0.4	2.1	2.5
IX	Nevada			
I	New Hampshire	1.0	2.1	3.1
II	New Jersey	13.9	17.8	31.7

		Production		
		Wet Process (KKKg)	Dry Process (KKKg)	Total (KKKg)
VI	New Mexico			
II	New York	6.6	23.2	29.8
IV	North Carolina	42.5	7.5	50.0
VIII	North Dakota			
V	Ohio	54.4	167.9	222.3
VI	Oklahoma	2.2	2.7	4.9
X	Oregon		4.6	4.6
III	Pennsylvania	1.2	17.6	18.8
I	Rhode Island	19.6	6.7	26.3
IV	South Carolina	12.8	3.8	16.6
VIII	South Dakota		0.4	0.4
IV	Tennessee		43.1	43.1
VI	Texas		21.5	21.5
VIII	Utah		1.3	1.3
I	Vermont		0.4	0.4
III	Virginia		5.5	5.5
X	Washington		2.1	2.1
III	West Virginia		3.3	3.3
V	Wisconsin	9.5	10.0	19.5
VIII	Wyoming			
	TOTAL	254.6	702.5	957.1
	Region I	30.1	84.1	114.2
	II	20.5	41.0	61.5
	III	57.1	30.6	87.7
	IV	67.4	93.6	161.0
	V	74.2	347.9	422.1
	VI	2.2	26.7	28.9
	VII	0.9	9.6	10.5
	VIII		1.7	1.7
	IX	2.2	60.6	62.8
	X		6.7	6.7

Source: Foster D. Snell, Inc. analysis of Department of Commerce, Rubber Red Book and industry interview data.

6.2.1 Dry Processing

The basic steps used in dry processing for the manufacture of rubber goods in SIC 3069 are similar to those used in 3011 and 3041. In most plants of SIC 3069, the receiving, compounding and mixing operations are on a much smaller scale than in the typical plants of SIC 3011 and 3041. The following steps: forming, curing and finishing are particular to this industry and present many variants, the principal ones being discussed below.

In addition, some operations involve reinforcing either during the forming operation or subsequent to it. Further, some processes combine the forming and the curing operations in one single step as in compression molding.

From the standpoint of solid waste generation, the curing operation is important since it is an irreversible process. In general, post-cure material cannot be readily recycled (see section on rubber reclaiming). Thus, in most plants, cured wastes (rejects, trimming, etc.) must be disposed of.

Figure III-16 presents a flow diagram of the processing steps, and Figure III-17 the waste streams for dry processing of rubber goods. Table III-38 summarizes and quantifies the waste streams as a function of unit operations.

6.2.1.1 Receiving, Compounding And Mixing

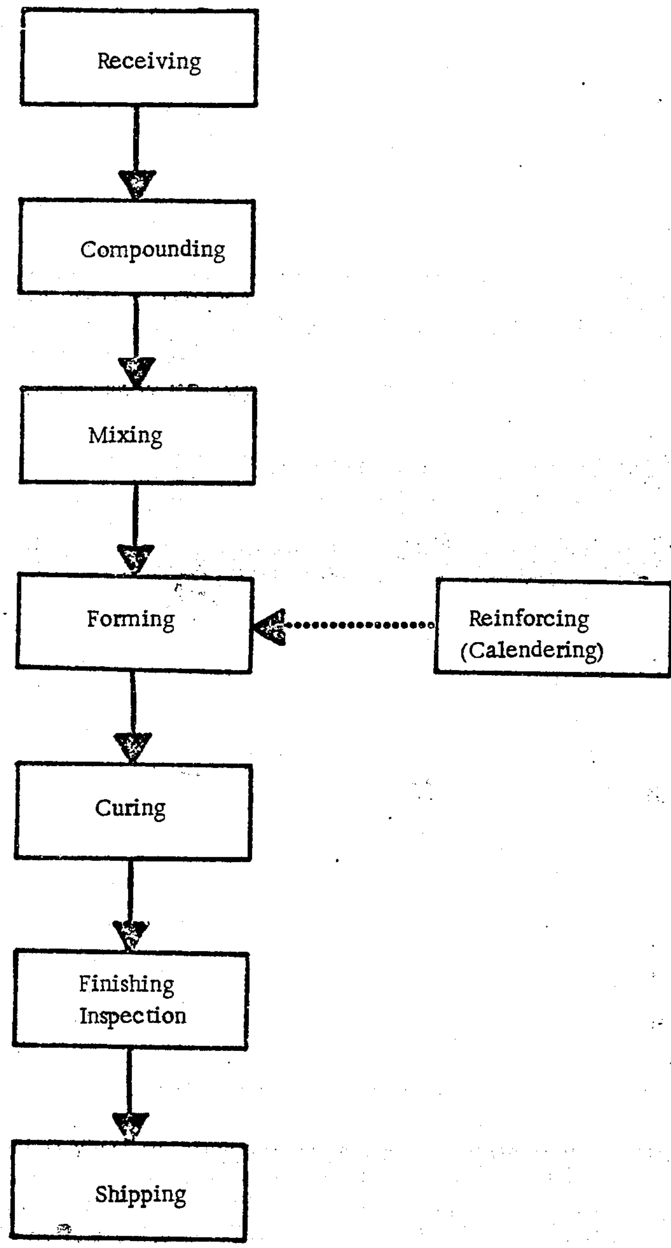
These unit operations are similar to those found in SICs 3011, 3021 and 3041 and have been previously discussed in detail. Wastes produced include:

- Floor sweepings
- Dust from particulate emission control devices
- Oils from Banbury "oozings"
- Uncured rubber
- Packaging materials, broken pallets, etc.

Once the stock is prepared it can be formed into its final shape via the next operation.

FIGURE III-16

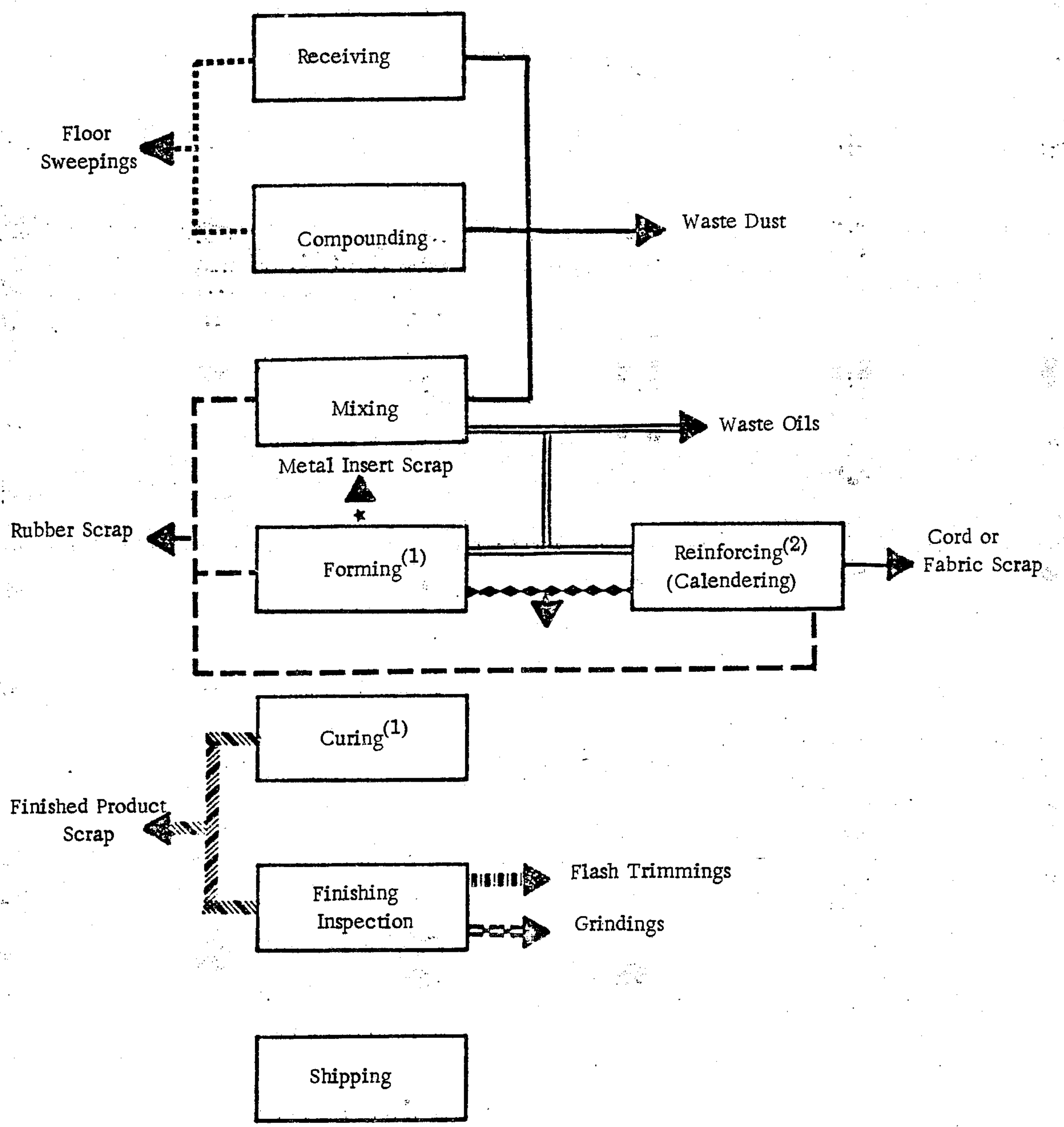
BASIC PROCESSING STEPS USED IN DRY PROCESSING OF RUBBER GOODS IN THE RUBBER PRODUCTS INDUSTRY, N.E.C., SIC 3069



Source: Foster D. Snell, Inc.

FIGURE III-17

WASTE FLOW DIAGRAM FOR DRY PROCESSING OF RUBBER GOODS IN THE RUBBER PRODUCTS INDUSTRY, N.E.C., SIC 3069



(1) In many processes these operations are combined in one step (e.g. molding)
(2) This operation is not universal in the industry.
Source: Foster D. Snell, Inc.

TABLE III-38

WASTE PARAMETERS FOR THE DRY PROCESSING SEGMENT OF SIC 3069

Source	Waste Stream	Type	Quantity (Kg/1000 Kg of product)
I. Material Handling Compounding Area Mixing Area	Floor sweepings	I	3
II. Material Handling Compounding Area Mixing Area	Dust from particulate emission control equipment	I	13
III. Mixing Area Forming (Calendering)	Scrap rubber stock (uncured)	II	42
IV. Finishing	Flash trimmings (cured rubber)	II	114
V. Finishing	Grindings (cured rubber)	II	23
VI. Curing Finishing	Rejects	II	69
VII. Calendering Forming	Cord Rejects	II	4 (1)
VIII. Forming	Metal inserts		- (2)
IX. Mixing Calendering Forming	Waste Oils		nominal (3)
		TOTAL,	268

(1) Inasmuch as only a fraction of the industry uses cord and fabric, this figure has been weighted to reflect this lower usage and can strictly be applied only if a substantial number of plants are present in any geographical distribution.

(2) There is no way to obtain a meaningful figure for this type of waste. Inasmuch as the metal is usually steel, it does not represent a hazardous waste.

(3) While the amount of waste oils generated is quite small, they present a difficult disposal problem and some are possibly laden with potentially hazardous materials.

Source: Foster D. Snell, Inc. analysis of industry interviews.

6.2.1.2 Forming Methods

Basically in this segment of SIC 3069, there are several forming methods which are used. From the standpoint of waste generation, these methods can be classified into two broad categories:

- Forming methods producing intermediate products requiring subsequent curing (vulcanization)

- Forming methods incorporating curing

The purpose of these classifications is to differentiate those processes in which some of the raw materials may be reused. In some instances, trimmings and other rejects from forming operations not incorporating curing may be directly recycled. On the other hand, cured material cannot, in general, be reused without going through a devulcanization process.

Extrusion and calendering are the two basic forming methods which do not incorporate curing. Forming processes incorporating curing are compression, transfer and injection molding.

6.2.1.2.1 Non-Curing Forming Methods

This paragraph discusses the two basic forming unit operations which do not incorporate curing.

- Extrusion

- Calendering

In extrusion, uncured stock produced from mixing is shaped by extrusion through a die. The extruded material can be solid or hollow. The stock may be preheated on heating mills or other heating devices before being fed to the extruder. Some extruders are designed to take cold stock.

Once extruded, the rubber product is cured in autoclaves or other curing equipment. Extruded material may also be further processed before curing such as by the addition of reinforcing material.

By and large, the extrusion process does not generate any significant amount of waste.

Non-cure forming methods involving calendering can be performed in two ways:

- Production of a continuous thin sheet of rubber

- The application of one or two thin rubber layer(s) to a fiber web.

Warm-up mills are required ahead of the calenders to impart the necessary plasticity to the rubber stock. Where a fiber web is used, it has been previously treated in a preconditioner by application of a thin coating of rubber. This preconditioning is a wet process and will be discussed in section 6.2.2. The rubber application to a fabric is called frictioning or skim coating. Calendered stock is cured in subsequent operations.

Calendering is not a waste generating operation. However, subsequent curring operations may generate sometimes hard to utilize cutting waste.

6.2.1.2.2 Forming Processes Incorporating Curing

These processes are molding operations belonging to three general categories: compression, transfer and injection molding. Choice of the forming method is dictated by economics.

Compression and transfer molding basically utilize hydraulic presses equipped with steam or electrically heated plateens.

- In compression molding the stock is enclosed between the two faces of the mold, and is then compressed and fills the mold cavities.

- In transfer molding the stock is forced out of a main cavity, the "pot", and forced to flow into and fill the cavities of the molding section.

- In injection molding, the stock is extruded directly into the mold.

Transfer molding is particularly suitable when the rubber has to be bonded to a metal support or to enclose a metallic insert. In this type of molding, there may be a higher amount of waste rubber than in other types of forming operations because it is not possible to empty the "pot" completely. This gives rise to a cured slab of waste rubber.

Injection molding, a more recent technique, obviates the problem of excess cured rubber from injection molding, because only the material in the mold cavity becomes cured. The drawback of this type of operation is that extreme care has to be used in the formulation, mixing and compounding of the stock. Generally, it also requires the use of more expensive ingredients.

Wastes directly attributable to molding operations are mold cleanings and product rejects. Products produced at the molding operation have extraneous pieces of rubber attached called flashings. These are removed in the finishing operation.

6.2.1.3 Curing

All products formed by the methods described in section 6.2.1.2.1 must be cured or vulcanized. This unit operation has been discussed in detail for other segments of SIC 30 (Section 2.2.11) and therefore, will not be covered here again. There are no wastes generated by this unit operation.

6.2.1.4 Finishing

Finishing operations may include such steps as:

- Trimming off flashings (deflashing), sprues and vents
- Cementing rubber to metal parts
- Final grinding.

In certain cases, deflashing is carried out by tumbling the parts under high refrigeration. This makes the rubber brittle causing the parts to be polished by material rubbing or by rubbing against metallic elements deliberately added to the tumbler.

Wastes produced by the finishing operation include:

- Cured rubber dusts and chunks
- Finished parts which are rejected.

6.2.2 Wet Processing

The wet processes involve latex or cement.

- A latex is an emulsion of natural or synthetic rubber in water.
- A cement is a solution of rubber in an organic solvent.

Wet processes are, at present, mainly used for the production of dipped goods such as gloves, balloons, prophylactics and clear sundries. Formerly, a large amount of foam rubber goods, used in automotive seats and pillows for example, were also made from latex. Presently most of this production has been shifted to foamed plastics, particularly polyurethanes. Foamed plastic production is classified in SIC 3079 and, therefore, does not fall within the scope of this study.

Basic wet process unit operations are quite simple:

- Receiving
- Compounding and mixing
- Dipping
- Drying-curing
- Finishing, inspection and shipping.

Production processes vary only slightly so that the steps are essentially the same for latex and cement based products. In comparison to latex products the manufacture of cement based goods is insignificant, being employed essentially for highly electrically resistant lineman's gloves.

Figure III-18 is a flow diagram and Figure III-19 is a waste stream diagram for products made via the wet processing technique. Table III-39 quantifies the waste streams as a function of unit operations.

There are few regular waste streams associated with wet process operations. When production changes occur however, the latex or cement baths must be discarded. The latex bath is usually coagulated before disposal by addition of an acid or salt.

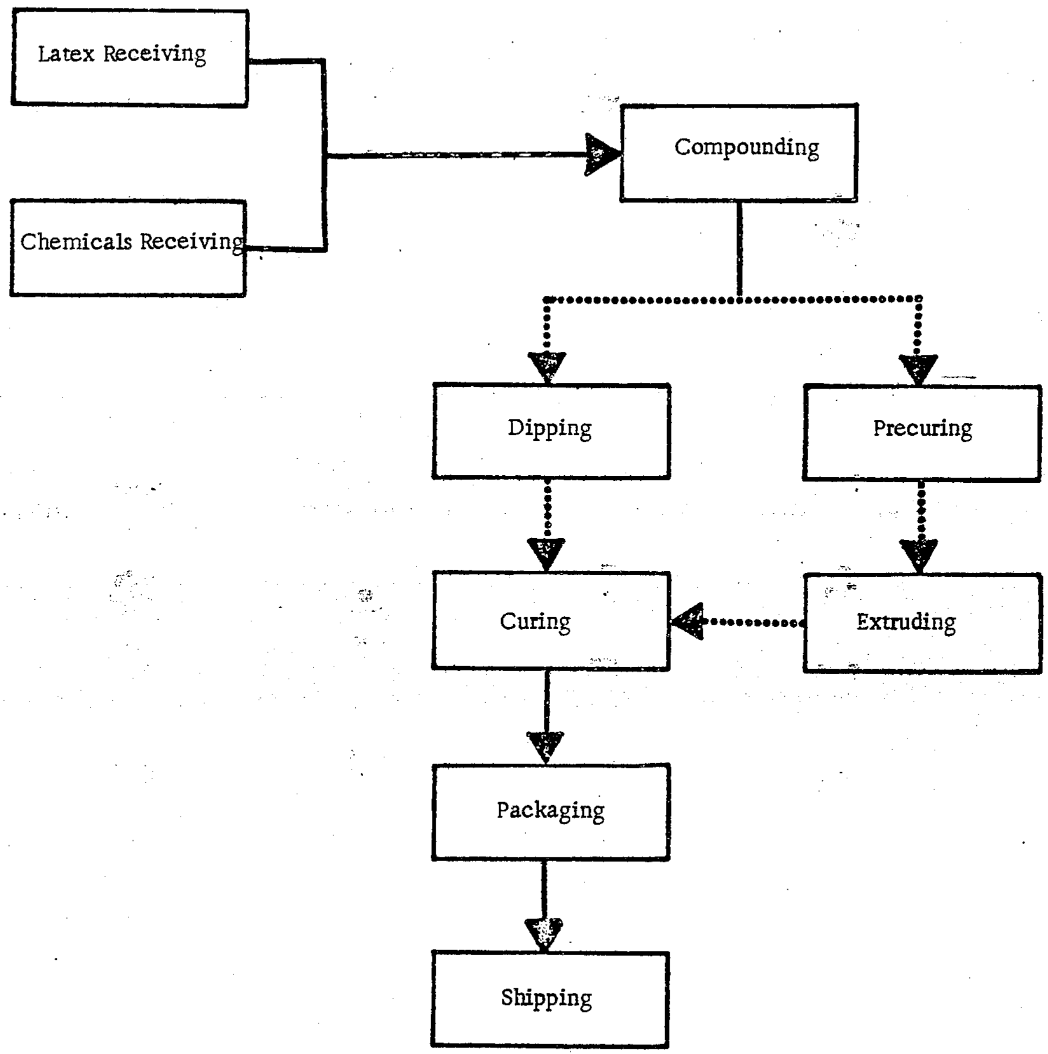
6.2.2.1 Receiving, Compounding And Mixing.

In latex operations, the majority of raw materials received are generally in the form of solutions or slurries. Very little wastes are therefore generated by this operation.

For cement operations, dry, powdery materials are added to the mix. Floor sweepings are consequently generated in the receiving area from bag breaking, bulk handling, etc. as is found in the dry processes. However, the production scales are such that only a few kilograms per week of such wastes are likely in need of disposal.

FIGURE III-18

TYPICAL WET PROCESSING STEPS IN THE RUBBER PRODUCTS INDUSTRY, N.E.C., SIC 3069

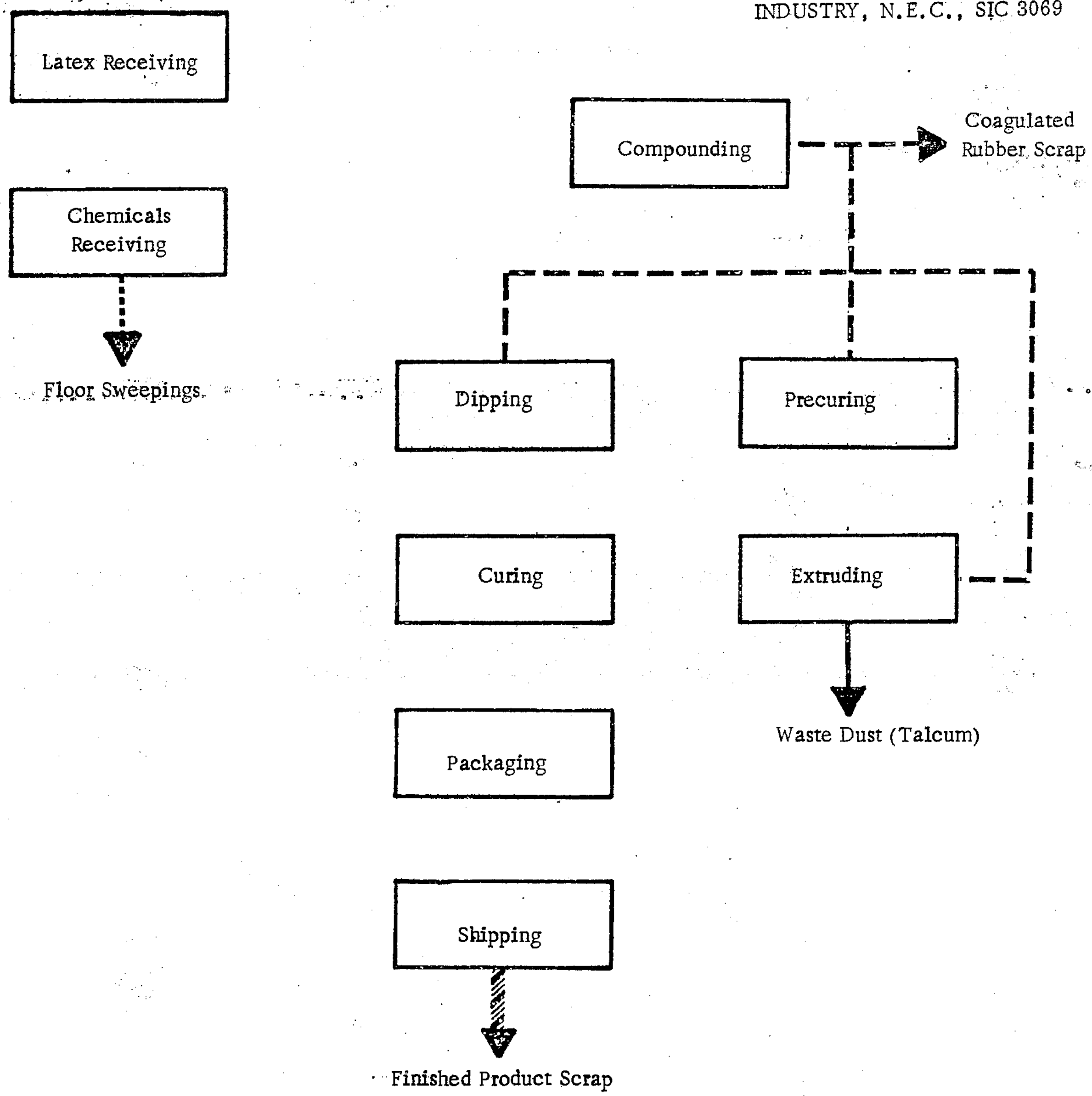


•••••• Represents alternate paths.

Source: Foster D. Snell, Inc. analysis of industry data.

FIGURE III-19

WASTE FLOW DIAGRAM FOR WET PROCESSES IN THE RUBBER PRODUCTS INDUSTRY, N.E.C., SIC 3069



Source: Foster D. Snell, Inc. analysis of industry interviews.

TABLE III-39

WASTE PARAMETERS FOR THE WET PROCESSING SEGMENT OF SIC 3069

Source	Waste Stream	Type	Quantity (Kg/1000 Kg of Product)
. Material Handling	. Floor Sweepings	I	1
. Compounding and Dipping	. Equipment Clean Outs	II	21
	. Coagulum		
. Finishing	. Polishing Dusts	II	5
	TOTAL		27

Source: Foster D. Snell analysis of industry interviews.

Compounding of latex formulation ingredients involves the measuring of solutions or slurries into agitated tanks. Spills occuring in the compounding area do not constitute a waste in terms of this study since they are usually washed down to sewers together with the wastes of the compounding tanks. These constitute an insignificant waste load and can be handled with the sanitary wastes.

In cement compounding the preparation of the starting material is quite similar to that in the dry process. However, instead of the material being sent to a forming operation, it is dissolved in an organic solvent. Since the cement compounding operation involves dry powders, particulate emission control equipment is used resulting in collected dust which must be disposed of. Again, the production scales are such that only a few kilograms per week of such wastes are generated at a typical plant.

6.2.2.2 Dipping

There are two basic dipping techniques employed by the industry:

- Straight-dip method
- Coagulation-dip method

In straight-dipping the forms are simply dipped into a latex or cement bath. After allowing for some dripping of excess rubber, the forms are rotated to insure uniform distribution of the material. The solvent is evaporated and subsequent dippings can be used to increase the thickness of the material. In the case of lineman's gloves, for example, the procedure may be repeated up to 40 times.

The coagulation-dip method involves the wetting of the forms first with a coagulant. The pre-coated forms are then dipped into the rubber containing bath. This procedure is employed where a thicker rubber coating is required.

In both cases, wastes are produced when the latex or cement baths are discarded due to production changes. The latex baths are usually coagulated with acid or salt before discarding.

6.2.2.3 Drying-Curing

For the products made by the straight-dip method there is no drying step per se. The forms or molds are usually carried through a one step drying-curing oven with the appropriate residence time.

When the caogulation-dip method is employed, the items are first dried, then washed and dried again. The washing step allows for the removal of excess latex or cement. Curing follows the second drying.

These steps are usually carried out in tunnel ovens, sometimes with variable zone heating. Heating is accomplished with hot air or infra-red.

In the case of cement goods, the organic solvent (proprietary) is sometimes recovered for reuse or simply allowed to flash out to the atmosphere.

6.2.2.4 Finishing, Inspection And Shipping

The finishing operations may include another washing and drying step. The goods are then polished by tumbling with a powder, generally talcum. For surgical gloves, starch or lycopodium powders are used. The items are then inspected and shipped. Wastes produced in these operations are usually confined to rejects of off-spec product.

6.3 Waste Characterization For The Fabricated Rubber Products Industry, N.E.C.

Wastes for SIC 3069 can also be classified into the same two categories as discussed for the other segments in SIC 30.

- Type I -- Wastes in which raw materials used by the industry are in a free or uncombined state.

- Type II -- Wastes in which the raw materials have been reacted or trapped in a cured or uncured rubber matrix.

This classification is valid for both the dry and wet process portions of SIC 3069.

Table III-38 (Section 6.2.1) shows that for the drying processing segment, Type I wastes account for approximately 6% of materials disposed of by a typical plant or 16 Kg per 1000 Kg of product. For the wet processing segment, from information presented in Table III-39, Type I wastes account for approximately 4% of materials to be disposed of or 1 Kg per 1000 Kg of product. Type II wastes account for the remainder in both cases.

Raw materials used by both the dry and wet processes are similar to those described for the other segments of the Rubber Processing Industry. The Type I wastes contain those raw materials which have been designated as being regarded as toxic or even carcinogenic. See the other SIC 30 waste characterization sections for examples of these substances.

The next paragraphs segregate SIC 3069 wastes into potentially hazardous and non-potentially hazardous categories.(1)

6.3.1 Potentially Hazardous Wastes

Type I wastes contain the raw materials used by this industry in a free or uncombined state. Since these wastes may be contaminated with quantities of raw materials which are toxic or possibly carcinogenic, as discussed above, Type I wastes are considered to be potentially hazardous to man and/or his environment.

---

(1) A complete and in-depth discussion of the rationale for this segregation is presented in Section 2.4, beginning on page III-36. While this discussion is focused on the Tire and Inner Tube Industry, it is directly applicable for SIC 3069 as well.

6.3.2 Non-Potentially Hazardous Wastes

Type II wastes are primarily composed of cured and uncured rubber, fabric, metal, packaging materials, etc. These wastes will not be considered potentially hazardous.

6.4 Waste Quantification For The Years 1974, 1977 And 1983, Rubber Products Industry, N.E.C.

In this portion of the report, estimated total and potentially hazardous waste quantities for the industry are presented for the year 1974 and projections made for the years 1977 and 1983. The data is based on the results of industry interviews, literature search and analytical procedures carried out on actual waste samples obtained from industry sources.

The waste quantification data for the years 1974, 1977 and 1983 are presented as follows, on a dry weight basis only.

- Table III-40, Waste quantification for the dry process segment of SIC 3069
- Table III-41, Waste quantification for the wet process segment of SIC 3069 (1)
- Table III-42, Waste quantification for the entire SIC 3069.

The following paragraphs discuss the rationale used in developing these tables.

6.4.1 Total Wastes

There are two factors required to determine total wastes for this industry. One corresponds to wastes generated by the dry process segment, the other to the wet. Total wastes for these segments were developed as follows.

(1) It has been found that the wastes generated by the wet process are also essentially water free, so that these wastes are also reported on a dry basis only.

6.4.1.1 Dry Process Total Wastes

Total 1974 wastes for the dry process segment of SIC 3069 were estimated by multiplying the factor 268 Kg of waste per 1000 Kg of production found in Table III-38 by the kilograms of dry process production in SIC 3069 for each state based on Table III-37.

6.4.1.2 Wet Process Total Wastes

Similarly, total 1974 wastes for wet processes (Table III-39) were estimated by multiplying the factor 27 Kg of waste per 1000 Kg of wet process production for each state based on Table III-37.

6.4.1.3 Projections Of Total Wastes For The Dry And Wet Process Segments Of SIC 3069 For The Years 1977 And 1983

The procedure followed for the 1977 and 1983 waste projections is identical to that used for SICs 3011, 3021 and 3041, where the INFORUM econometric input/output model was used. The model is described in Appendix A at the back of this report. Increases in waste loads were projected on changes in product shipments in producer (manufacturer) prices (1974 dollars) for 1977 and 1983 as predicted by the model for an aggregate of SICs 3021, 3041 and 3069. Table III-24 (Section 3.4.1) presents projected values for product shipments for those years and their percent change from 1974.

Waste load forecasts presented in Tables III-40, III-41 and III-42 also take into account the fact that based on industry interviews, no increase in solid wastes are anticipated due to the effects of the 1977 and 1983 Water Effluent Guidelines Regulations. EPA Region V accounted for 50% of total wastes in 1974 and is projected to account for 50% of total wastes in 1977 and 1983.

Wastes are reported on a dry basis because there is no significant amount of water present in SIC 3069 wastes.

TABLE III-40 (1)

GEOGRAPHIC DISTRIBUTION OF WASTES -- FABRICATED RUBBER PRODUCTS INDUSTRY, N.E.C. DRY PROCESS SEGMENT, SIC 3069 (KKg/yr)

		1974 (1)		1977 (2)		1983 (2)	
		Total Wastes	Potentially Hazardous Wastes	Total Wastes	Potentially Hazardous Wastes	Total Wastes	Potentially Hazardous Wastes
IV	Alabama	1,152	82	1,284	91	1,336	95
X	Alaska	563					
IX	Arizona	563	40	628	45	653	46
VI	Arkansas	670	47	747	52	777	60
IX	California	15,678	1,111	17,481	1,239	18,186	1,289
VIII	Colorado						
I	Connecticut	4,824	342	5,379	381	5,596	397
III	Delaware						
IV	Florida	2,466	175	2,749	195	2,861	203
IV	Georgia	3,484	247	3,885	275	4,041	287
IX	Hawaii						
X	Idaho						
V	Illinois	6,486	460	7,231	513	7,524	534
V	Indiana	30,230	2,143	33,707	2,389	35,066	2,486
VII	Iowa	563	40	628	45	653	46
VII	Kansas						
IV	Kentucky	429	30	478	33	498	35
VI	Louisiana						
I	Maine						
III	Maryland	1,126	80	1,255	89	1,306	93
I	Massachusetts	15,249	1,081	17,003	1,205	17,689	1,254
V	Michigan	6,378	452	7,111	504	7,398	524
V	Minnesota	2,466	175	2,749	195	2,861	203
IV	Mississippi	2,975	211	3,317	235	3,451	245
VII	Missouri	1,447	103	1,613	115	1,679	119
VIII	Montana						
VII	Nebraska	563	40	628	45	653	46
IX	Nevada						
I	New Hampshire	563	40	628	45	653	46
II	New Jersey	4,770	338	5,319	377	5,533	392

TABLE III-40 (2)

		1974 (1)		1977 (2)		1983 (2)	
		Total Wastes	Potentially Hazardous Wastes	Total Wastes	Potentially Hazardous Wastes	Total Wastes	Potentially Hazardous Wastes
VI	New Mexico						
II	New York	6,218	441	6,933	492	7,213	510
IV	North Carolina	2,010	143	2,241	159	2,332	166
VIII	North Dakota						
V	Ohio	44,996	3,190	50,173	3,558	52,196	3,700
VI	Oklahoma	724	51	807	57	840	59
X	Oregon	1,233	87	1,375	97	1,430	101
III	Pennsylvania	4,717	334	5,259	372	5,472	387
I	Rhode Island	1,796	127	2,003	142	2,083	147
IV	South Carolina	1,018	72	1,135	80	1,181	83
VIII	South Dakota	107	8	119	9	124	9
IV	Tennessee	11,551	819	12,879	913	13,399	950
VI	Texas	5,762	409	6,425	456	6,684	474
VIII	Utah	348	25	388	28	404	29
I	Vermont	107	8	119	9	124	9
III	Virginia	1,474	105	1,643	117	1,710	122
X	Washington	563	40	628	45	653	46
III	West Virginia	884	63	986	70	1,025	73
V	Wisconsin	2,680	190	2,988	212	3,109	220
VIII	Wyoming						
	TOTAL	188,270	13,349	209,921	14,884	218,393	15,485
Region	I	22,539	1,598	25,132	1,782	26,145	1,853
	II	10,988	779	12,252	869	12,746	902
	III	8,201	582	9,143	648	9,513	675
	IV	25,085	1,779	27,968	1,981	29,099	2,064
	V	93,236	6,610	103,959	7,371	108,154	7,667
	VI	7,156	507	7,979	565	8,301	593
	VII	2,573	183	2,869	205	2,985	211
	VIII	455	33	507	37	528	38
	IX	16,241	1,151	18,109	1,284	18,839	1,335
	X	1,796	127	2,003	142	2,083	147

(1) Based on Tables III-43 and III-44.

(2) Based on growth in SIC 3069 for these years as estimated from INFORUM input/output model use.

Source: Foster D. Snell, Inc.

TABLE III-41 (1)

GEOGRAPHIC DISTRIBUTION OF
WASTES -- FABRICATED RUBBER
PRODUCTS INDUSTRY, N.E.C.
WET PROCESS SEGMENT, SIC 3069
(KKg/yr)

		1974 (1)		1977 (2)		1983 (2)	
		Total Wastes	Potentially Hazardous Wastes	Total Wastes	Potentially Hazardous Wastes	Total Wastes	Potentially Hazardous Wastes
IV	Alabama	184	7	205	8	213	8
X	Alaska						
IX	Arizona						
VI	Arkansas						
IX	California	59	2	66	2	68	2
VIII	Colorado						
I	Connecticut	43	2	48	2	50	2
III	Delaware	1,510	56	1,684	62	1,752	65
IV	Florida						
IV	Georgia	138	5	154	6	160	6
IX	Hawaii						
X	Idaho						
V	Illinois	43	2	48	2	50	2
V	Indiana	113	4	126	5	131	5
VII	Iowa						
VII	Kansas						
IV	Kentucky						
VI	Louisiana						
I	Maine						
III	Maryland						
I	Massachusetts	213	8	237	9	247	9
V	Michigan	121	5	135	6	140	6
V	Minnesota						
IV	Mississippi	5	0.2	6	0.2	6	0.2
VII	Missouri	13	0.5	14	0.6	15	0.6
VIII	Montana						
VII	Nebraska	11	0.4	12	0.4	13	0.4
IX	Nevada						
I	New Hampshire	27	1	30	1	31	1
II	New Jersey	375	14	418	16	435	16

TABLE III-41 (2)

		1974[1]		1977[2]		1983[2]	
		Total Wastes	Potentially Hazardous Wastes	Total Wastes	Potentially Hazardous Wastes	Total Wastes	Potentially Hazardous Wastes
VI	New Mexico						
II	New York	178	7	198	8	207	8
IV	North Carolina	1,148	43	1,280	48	1,332	50
VIII	North Dakota						
V	Ohio	1,470	54	1,639	60	1,705	63
VI	Oklahoma	59	2	66	2	68	2
X	Oregon						
III	Pennsylvania	32	1	36	1	37	1
I	Rhode Island	529	20	590	22	615	23
IV	South Carolina	346	13	386	15	401	15
VIII	South Dakota						
IV	Tennessee						
VI	Texas						
VIII	Utah						
I	Vermont						
III	Virginia						
X	Washington						
III	West Virginia						
V	Wisconsin	257	9	287	10	298	10
VIII	Wyoming						
	TOTAL	6,874	256	7,665	286	7,974	295
Region	I	812	31	905	34	943	35
	II	553	21	616	24	642	24
	III	1,542	57	1,720	63	1,789	66
	IV	1,821	68	2,031	77	2,112	79
	V	2,004	74	2,235	83	2,324	86
	VI	59	2	66	2	68	2
	VII	24	1	26	1	28	1
	VIII						
	IX	59	2	66	2	68	2
	X						

(1) Based on Tables III-43 and III-45.
(2) Based on growth in SIC 3069 for these years as estimated from INFORUM input/output model use.

Source: Foster D. Snell, Inc.

TABLE III-42 (1)

GEOGRAPHIC DISTRIBUTION OF WASTES -- FABRICATED RUBBER PRODUCTS INDUSTRY, N.E.C. AGGREGATE (DRY AND WET), SIC 3069 (KKg/yr)

		1974 (1)		1977 (2)		1983 (2)	
		Total Wastes	Potentially Hazardous Wastes	Total Wastes	Potentially Hazardous Wastes	Total Wastes	Potentially Hazardous Wastes
IV	Alabama	1,336	89	1,489	99	1,549	103
X	Alaska						
IX	Arizona	536	40	628	45	653	46
VI	Arkansas	670	47	747	52	777	60
IX	California	15,737	1,113	17,547	1,241	18,254	1,291
VIII	Colorado						
I	Connecticut	4,867	344	5,427	383	5,646	399
III	Delaware	1,510	56	1,684	62	1,752	65
IV	Florida	2,466	175	2,749	195	2,861	203
IV	Georgia	3,622	252	4,039	281	4,201	293
IX	Hawaii						
X	Idaho						
V	Illinois	6,529	462	7,279	515	7,574	536
V	Indiana	30,343	2,147	33,833	2,394	35,197	2,491
VII	Iowa	563	40	628	45	653	46
VII	Kansas						
IV	Kentucky	429	30	478	33	498	35
VI	Louisiana						
I	Maine						
III	Maryland	1,126	80	1,255	89	1,306	93
I	Massachusetts	15,462	1,089	17,240	1,214	17,936	1,263
V	Michigan	6,499	457	7,246	510	7,538	530
V	Minnesota	2,466	175	2,749	195	2,861	203
IV	Mississippi	2,980	211	3,323	235	3,457	245
VII	Missouri	1,460	104	1,627	116	1,694	120
VIII	Montana						
VII	Nebraska	574	40	640	45	666	46
IX	Nevada						
I	New Hampshire	590	41	658	46	684	47
II	New Jersey	5,145	352	5,737	393	5,968	408

TABLE III-42 (2)

		1974 (1)		1977 (2)		1983 (2)	
		Total Wastes	Potentially Hazardous Wastes	Total Wastes	Potentially Hazardous Wastes	Total Wastes	Potentially Hazardous Wastes
VI	New Mexico						
II	New York	6,396	448	7,131	500	7,420	518
IV	North Carolina	3,158	186	3,521	207	3,664	216
VIII	North Dakota						
V	Ohio	45,466	3,244	51,812	3,618	53,901	3,763
VI	Oklahoma	783	53	873	59	908	61
X	Oregon	1,233	87	1,375	97	1,430	101
III	Pennsylvania	4,749	335	5,295	373	5,509	388
I	Rhode Island	2,325	147	2,593	164	2,698	170
IV	South Carolina	1,364	85	1,521	95	1,582	98
VIII	South Dakota	107	8	119	9	124	9
IV	Tennessee	11,551	819	12,879	913	13,399	950
VI	Texas	5,762	409	6,425	456	6,684	474
VIII	Utah	348	25	388	28	404	29
I	Vermont	107	8	119	9	124	9
III	Virginia	1,474	105	1,643	117	1,710	122
X	Washington	563	40	628	45	653	46
III	West Virginia	884	63	986	70	1,025	73
V	Wisconsin	2,937	199	3,275	222	3,407	230
VIII	Wyoming						
	TOTAL	195,144	13,605	217,586	15,170	226,367	15,780
Region	I	23,351	1,629	26,037	1,816	27,088	1,888
	II	11,541	800	12,868	893	13,388	926
	III	9,743	639	10,863	711	11,302	741
	IV	26,906	1,847	29,999	2,058	31,211	2,143
	V	95,240	6,684	106,194	7,454	110,478	7,753
	VI	7,215	509	8,045	567	8,369	595
	VII	2,597	184	2,895	206	3,013	212
	VIII	455	33	507	37	528	38
	IX	16,300	1,153	18,175	1,286	18,907	1,337
	X	1,796	127	2,003	142	2,083	147

(1) Based on Tables III-47 and III-48.

(2) Based on growth in SIC 3069 for these years as estimated from INFORUM input/output model use.

Source. Foster D. Snell, Inc.

As previously indicated the wastes produced by this industry are essentially water free (even those from the "wet" process). Thus, they are reported on a dry basis only.

	Total Wastes (Dry Basis)		
Year	Dry Process* (KKg/yr)	Wet Process* (KKg/yr)	Total For SIC 3069 (KKg/yr)
1974	188,270	6,874	195,144
1977	209,921	7,665	217,586
1983	218,393	7,974	226,367

* Dry Process (Stock Based Raw Materials), Wet Process Latex (Cement) Based Raw Materials

Sources: Tables III-40, III-41, and III-42.

According to these estimates, dry process wastes account for the great majority of all wastes produced in SIC 3069.

6.4.2 Potentially Hazardous Wastes

Type I wastes are designated as potentially hazardous. While these wastes are not composed entirely of hazardous materials, they are, however, plated or contaminated with constituents in the free state which are hazardous in some form. As with the potentially hazardous wastes for the other segments of SIC 30 discussed so far, quantification of the precise hazardous constituents of the wastes generated in absolute amounts is not possible to arrive at. This inability is due to the mixology of a particular sample obtained during the time period of observation.

Results from the physical and chemical analyses performed from spot sampling of Type I wastes generated by SIC 3069 are presented in Appendix B -- Analytical Results and Test Protocols. The data presented are illustrative in nature and do not, therefore, represent an exhaustive sampling campaign for the industries studied.

The results do show, however, that Type I wastes, as typified by the samples analyzed, are similar to Type I wastes analyzed for the other segments of SIC 30.

- The inorganic fraction (ash) is approximately 60% of sample weight for the floor sweepings sample and approximately 35% for dusts collected by air pollution control equipment.

- There is a variety of metals present in the samples analyzed, mostly aluminum and silicon. Other metals including lead manganese and tin are present as well but in lower concentrations, 0.0058% to 0.00058%.

- Water solubility under neutral pH was approximately 1.25%.

From Tables III-40, III-41 and III-42, potentially hazardous wastes (dry basis) estimated for the years of interest are as follows.

	Potentially Hazardous Wastes (Dry Basis)		
Year	Dry* Process (KKg/yr)	Wet* Process (KKg/yr)	Total For SIC 3069 (KKg/yr)
1974	13,349	256	13,605
1977	14,884	286	15,170
1983	15,485	295	15,780

* Dry Process (Stock Based Raw Materials), Wet Process Latex (Cement) Based Raw Materials

Sources: Tables III-40, III-41, and III-42.

As in the case of total wastes, the potentially hazardous wastes generated by the dry process segments are far greater than those generated by the wet process segment on a weight basis.

7. TREATMENT AND DISPOSAL TECHNOLOGY FOR POTENTIALLY HAZARDOUS WASTES, RUBBER PRODUCTS INDUSTRY

This section of the report discusses the methods of disposal available for potentially hazardous wastes generated by SIC 30 in relation to three levels of treatment and disposal technology.

Land-destined potentially hazardous wastes from the Rubber Products Industry originate incidentally from the manufacturing processes; that is, from housekeeping practices or from air pollution control systems. The potentially hazardous wastes from SICs 3011, 3021, 3041 and 3069 are, in general, very similar. They are predominantly fine powders composed of the raw materials consumed by this industry in the free or unbound state. The small quantity of potentially hazardous wastes generated by SIC 3031 are contaminated devulcanizing agents in the form of liquids.

The specific treatment and disposal technology used by the Rubber Products Industry are discussed in the following sections. Table III-43 summarizes the types and quantities of potentially hazardous wastes from a typical plant production standpoint.

7.1 Treatment And Disposal In SIC 30

The segments of this category having any significant land-destined potentially hazardous wastes on an industry-wide basis are the subcategories SICs 3011, 3021, 3041 and 3069. Generally, potentially hazardous wastes generated in significant quantities are restricted to landfill for disposal. Recovery of these materials is not possible, in most cases, due to the randomness of the concentrations of their constituents.

Wastes are randomly collected in the plants in containers which in turn are periodically emptied into dump trucks or directly transported to landfill. The disposal of waste oils is by storage in metallic containers.

7.1.1 Treatment And Disposal Of Dusts

As discussed, the dusts generated in plants of this industry have two major sources:

- Plant spillage
- Air cleaning equipment.

TABLE III-43 (1)

SUMMARY OF TYPICAL PLANT POTENTIALLY HAZARDOUS WASTES FROM RUBBER PRODUCTS MANUFACTURE, SIC 30

SIC	Industry	1974 Total Industry Production (KKKg/yr)	Typical Product Produced	Typical Plant Production (KKg/yr)	Significant Potentially Hazardous Waste Stream	Potentially Hazardous Typical Plant Waste Stream (Dry Basis) (KKg/yr)	Size of Typical Plant Total Waste Stream (Dry Basis) (KKg/yr)
3011	Tire and Inner Tube	3,424	Tires	59,400	(1) Floor sweepings (receiving, warehousing and compounding areas)	113	4,241
					(2) Dust from compounding and mixing collected by pollution control equipment	493	
					(3) Oily wastes	29	
3021	Rubber and Plastics Footwear Industry	81	Canvas rubber footwear	1,700	(1) Floor sweepings (receiving, warehousing and compounding areas)	1.6	907
					(2) Dust from compounding and mixing collected by pollution control equipment	6.9	
					(3) Oily wastes	Negligible	
3031	Rubber Reclaiming		Reclaimed rubber	2,500	(1) Oils contaminated with devulcanizing agents	30	720
3041	Rubber and Plastics Hose and Belting	370	Reinforced rubber hose	2,000	(1) Floor sweepings (receiving, warehousing and compounding areas)	3.5	258
					(2) Dust from compounding and mixing collected by pollution control equipment	15.5	
					(3) Oily wastes	Negligible	
					(4) Lead wastes		

TABLE III-43 (2)

SIC	Industry	1974 Total Industry Production (KKKg/yr)	Typical Product Produced	Typical Plant Production (KKg/yr)	Significant Potentially Hazardous Waste Stream	Potentially Hazardous Typical Plant Waste Stream (Dry Basis) (KKg/yr)	Size of Typical Plant Total Waste Strea (Dry Basis (KKg/yr)
3069	Rubber Products Industry, N.E.C.	890	Dry processed mixcellaneous rubber products	900	(1) Floor sweepings (receiving, warehousing and compounding areas)	2.7	241
					(2) Dust from compounding and mixing collected by pollution control equipment	11.7	
					(3) Oily wastes	Negligible	

Source: Foster D. Snell analysis of literature and industry interviews.

Spillage occurs principally in receiving, warehousing and compounding areas. They result from:

- Accidental spilling of material from containers
- Accidental ripping of bags (principally from fork lift operations)
- Poor handling at the compounding area.

Spills are swept either mechanically or by hand and are generally transferred to dust bins, dumpsters or other appropriate containers. Little attention is paid to the handling of these spills and sweepings. They eventually find their way into rubbish or trash containers which happen to be convenient.

Dust from air cleaning equipment is generated at the point where substantial amounts of light, powdery materials are discharged, particularly from bags being emptied in the compounding area. Normal practice is to provide suitable hooding and ventilation in those areas. The contaminated air is generally cleaned by bag house type dust collectors. The air purification equipment are usually cleaned in such a way that accumulated dusts are collected in hoppers at the lowest part of the cleaning equipment.

The hoppers are, in turn, discharged intermittantly in containers for reclamation or disposal. Due to the uncertain composition of the dust collected and the relatively low economic value of the materials involved, the dusts are not reused in the majority of plants, but are instead discharged to general purpose landfill.

At present, the dusts, like the spills and sweepings, are not generally segregated from the rest of the solid wastes and eventually are placed into containers holding general plant refuse.

In a few plants the dusts are segregated from the rest of the wastes. This is particularly the case in the moderately sized plants of SIC 3069. When a demand exists for fair amounts of low grade rubber, the dusts can be reused as carbon filler with no effect on the properties of the final product. This is especially true if the demand is large and the addition rate of the dust can be held sufficiently low. One example of the reuse of dusts is in the manufacture of rubber storage battery cases.

In some plants, the dusts are segregated and handled with the furnace or fly ashes to which they are physically similar.

Basically, environmentally adequate technology exists for the disposal of the dusts. Sweepings and dusts can be readily segregated from the other wastes, preferably in closed containers to reduce the chances of blowing. The dusts can then be disposed of in an approved landfill. Precautions should be taken to avoid dispersion to the atmosphere during transport to the site and while the potentially hazardous wastes are being buried.

7.1.2 Treatment And Disposal Of Banbury Waste Oils

Rubber processing requires very high power, low speed equipment -- Banbury mixers and roll mills. This equipment incorporates large, gear reducers, whose lubricants need to be replaced constituting a waste stream. These oily wastes are usually disposed of through commercial reclaimers or may be burned in plant boilers.

Another oily waste stream is constituted by a mixture of oil, rubber and processing chemicals which ooze out of Banbury mixers. This oozing arises from the great pressures generated inside these mixers causing the contaminated seal lubricating oils to bleed out.

The seal oils are collected separately from the other lubricating oils due to the presence of rubber and vulcanizing agents. If these oils are heated, they have a tendency to vulcanize; that is, the viscosity of the oil irreversibly increases with increasing temperature. It is, therefore, practicably impossible to dispose of these oils by burning in conventional boilers.

Until recently, these oils were discarded to landfill. This practice, however, has been universally discontinued. The seal oils, in most instances, are now drummed and stored in a remote area of the plant.

While the oily wastes are being stored, the curing process is proceeding at a slow rate. Eventually the material cures and has properties similar to vulcanized stock and is probably not potentially hazardous. In the "fresh" state, however, the waste is considered to be potentially hazardous due to the presence of unreacted or unbound chemicals.

At present, there is no evidence that a complete solution to the Banbury oil problem has been found. In fact, a small percentage of the plants visited claim not to generate any of these oils. These plants may simply combine the oils with other wastes and dispose of the mixture in a general purpose landfill.

On the surface the present practice of "store it and forget it" would appear grossly inadequate. However, if it is recalled that the vulcanization process has been considered in effect a chemical detoxification of the mixture of raw materials used in rubber products manufacturing, then the oily wastes which have undergone a slow (1 to 2 years) vulcanization can be considered to have lost their potentially hazardous character. The vulcanized oils may then be disposed of in a general purpose landfill without further precaution.

7.1.3 Treatment And Disposal Of Lead Wastes From Hose Production

The only other potentially hazardous waste stream identified in the rubber industry of any significance are the lead wastes from the production of lead cured hose in SIC 3041. These wastes are present in three forms:

- Pure lead scrap
- Lead dross (lead oxide)
- Lead salts in sludges from wastewater treatment

7.1.3.1 Pure Lead Scrap

The pure lead scrap waste stream is generated by the stripping of the lead molds off of the cured hose. This scrap is valuable material and in all cases observed is recycled to the process by remelting.

7.1.3.2 Lead Dross

Lead dross is the chemical substance lead oxide. It is produced as a waste stream when the lead is melted for mold fabrication. The melting of the lead causes it to react with oxygen from the atmosphere forming lead oxide or dross. The dross is skimmed from the surface of the molten lead and sold to lead processors for reclamation and reuse.

7.1.3.3 Lead Salts In Sludges From Wastewater Treatment

Large volumes of water as a coolant are used in lead cured hose production. A small amount of lead dissolves in the waste water stream as lead carbonate. It is not possible to generalize the problems associated with this waste stream for the following reasons.

- Many plants discharge their wastewaters to municipal systems with no pretreatment and the lead bearing stream is so diluted by other wastes that no significant lead concentration is detected in their waste. A typical plant reported a concentration of less than 0.01 ppm at their outfall.

- The product mix varies from plant to plant and therefore many locations may not even have a lead operation.

- There are significant process variations among the plants which use the lead press method and there are wide fluctuations in the utilization of this method in those plants that use it. One location reported the existence of a waste water treatment facility producing about 1 Kg (2 lb.) of a diatomaceous, sludge filter cake contaminated with lead per operating day. This minimal amount is disposed of by landfilling in sealed and labelled polyethylene bags. This waste stream appears too small to warrant a detailed cost analysis.

7.1.4 <u>Treatment And Disposal Of Waste Devulcanizing Agents From Rubber Reclaiming</u>

Waste devulcanizing agents are composed of naval stores such as dipentene, coal tar products such as solvent naphtha or petroleum products such as chemically unsaturated resin oil obtained from gasoline refining.

Although these materials are potentially hazardous, they do not present a problem for disposal. In most cases, these agents are directly reused in the process. In one known instance, the oily material is reprocessed for a fee by a waste oil reclaimer.

7.2 <u>Treatment And Disposal Technology Levels As Applied To Potentially Hazardous Wastes From The Manufacture Of Rubber Products</u>

The levels of treatment and disposal technology are characterized as follows:

- <u>Level I -- Technology Currently Employed By Typical Facilities</u>. This level represents the broad average treatment and disposal practice.

- <u>Level II -- Best Technology Currently Employed</u> This level represents the best practice from an environmental and health standpoint, currently in use in at least one location. Installations must be commercial scale. Pilot and bench scale installations are not suitable.

- <u>Level III -- Technology Necessary To Provide Adequate Health And Environmental Protection</u> Level III technology may be more or less sophisticated or may be identical with Level I or II technology. At this level, identified technology may include pilot or bench scale processes providing the exact stage of development is identified.

These levels of treatment and disposal technology are described for each of the five, four digit SICs that comprise the Rubber Products Industry in a series of tables as follows:

- Table III-44 -- Tire and Inner Tube Industry, SIC 3011

- Table III-45 -- Rubber and Plastics Footwear Industry, SIC 3021

- Table III-46 -- Rubber Reclaiming Industry, SIC 3031

- Table III-47 -- Rubber and Plastic Belt and Hosing Industry, SIC 3041

- Table III-48 -- Fabricated Rubber Products, N.E.C., Industry, SIC 3069.

The three levels were evaluated for each of these industries by using ten factors:

- Factor I -- Physical And Chemical Properties Of The Waste. This gives a brief description of the form of this waste and identifies the main constituents.

- Factor II -- Amount Of Waste (Kg/KKKg Of Product) This factor gives an average quantity or range of the magnitude of the total potentially hazardous qaste streams treated based upon a waste factor relating the quantity of waste (kilograms) to the quantity of production (metric tons).

- Factor III -- Factors Affecting Hazardousness Of The Waste. This gives a brief description of the possible interaction of the surrounding environment with the waste.

- Factor IV -- Adequacy Of Technology. A description of the technology with respect to environmental considerations and load regulations in terms of present and future conditions.

- Factor V -- Non-Land Environmental Impact. This describes the possible impact of the technology on non-land environmental factors such as water or air quality.

TABLE III-44 (1)

TREATMENT AND DISPOSAL TECHNOLOGY FOR POWDERS AND DUSTS FROM THE TIRE AND INNER TUBE INDUSTRY, SIC 3011

Factor	Level I, Prevalent Technology	Level II, Best Available Technology	Level III, Adequate Health And Environmental Protection
Physical and Chemical Properties of Residual Wastes	Fine solid powders contaminated with toxic materials under varying concentrations	Same as Level I	Same as Level I
Amount of Residual Wastes (Kg/KKg product)	Approximately 11	Same as Level I	Same as Level I
Factors Affecting Hazardousness	Solubility of toxic chemicals may vary with pH when disposed of in landfill, off-site	Same as Level I	Same as Level I
Treatment/Disposal Technology	Disposal in general purpose landfill, off-site	Disposal in secured landfill, off-site	1. Same as Level II 2. Encapsulation of material in steel drums with polyethylene liners and disposal as per Level I
Estimate of Number and Percent of Plants Now Using Technology	Approximately 54 plants (90%)	Approximately 6 plants (10%)	1. Same as Level II 2. None
Adequacy of Technology	Not adequate	Adequate	Adequate
Non-Land Environmental Impact	Possible ground and surface water contamination from toxic materials	None apparent	1. None apparent 2. None apparent
Problems and Comments	None	None	None
Compatibility with Existing Facilities	N.A.	. Existence and availability of sites . No process changes required except for segregation of dusts from general plant wastes.	1. Same as Level II

TABLE III-44 (2)

Factor	Level I, Prevalent Technology	Level II, Best Available Technology	Level III, Adequate Health And Environmental Protection
Monitoring and Surveillance Techniques	None	Surface and groundwater monitoring for landfill leachate.	Same as Level II
Installation Time for New Facility	Installed	Installed	No major installation envisioned
Energy Requirements	Slight -- trucks and bulldozers for landfill	Same as Level I	Same as Level I

N.A. = Not Applicable

Source: Foster D. Snell, Inc. analysis of company interviews.

TABLE III- 45 (1)

TREATMENT AND DISPOSAL TECHNOLOGY FOR POWDERS AND DUSTS FROM THE RUBBER AND PLASTICS FOOTWEAR INDUSTRY, SIC 3021

Factor	Level I, Prevalent Technology	Level II, Best Available Technology	Level III, Adequate Health And Environmental Protection
Physical and Chemical Properties of Residual Wastes	Fine solid powders contaminated with toxic materials under varying concentrations	Same as Level I	Same as Level I
Amount of Residual Wastes (Kg/KKg product)	Approximately 5	Same as Level I	Same as Level I
Factors Affecting Hazardousness	Solubility of toxic chemicals may vary with pH when disposed of in landfills	Same as Level I	Same as Level I
Treatment/Disposal Technology	Disposal in general purpose landfill, off-site	Same as Level I	1. Disposal in secure landfill 2. Encapsulation of material in steel drums which are then disposed of in general purpose landfill
Estimate of Number and Percent of Plants Now Using Technology	Approximately 44 plants (100%)	Same as Level I (100%)	1. None (0%) 2. None (0%)
Adequacy of Technology	Not adequate	Not adequate	Adequate
Non-Land Environmental Impact	Possible ground and surface water contamination from toxic materials	Same as Level I	1. None 2. None
Problems and Comments	None	None	1. Existence and availability of sites
Compatibility With Existing Facilities	N.A.	N.A.	No process changes required except for segregation of dusts from general plant wastes.

TABLE III-45 (2)

Factor	Level I, Prevalent Technology	Level II, Best Available Technology	Level III, Adequate Health And Environmental Protection
Monitoring and Surveillance Techniques	None	None	1. Surface and groundwater monitoring for landfill leachate. 2. None
Installation Time for New Facility	Installed	Installed	No major installation envisioned
Energy Requirements	Slight -- trucks and bulldozers for landfill	Same as Level I	Same as Level I

N.A. = Not Applicable

Source: Foster D. Snell, Inc. analysis of company interviews.

TABLE III-46

TREATMENT AND DISPOSAL TECHNOLOGY FOR USED DEVULCANIZING AGENTS, RUBBER RECLAIMING INDUSTRY, SIC 3031

Factor	Level I, Prevalent Technology	Level II, Best Available Technology	Level III, Adequate Health And Environmental Protection
Physical and Chemical Properties of Residual Wastes	Predominantly organic based solvents contaminated with rubber processing agents	Same as Level I	Same as Level I
Amount of Residual Wastes (Kg/KKg product)	Approximately 12	Same as Level I	Same as Level I
Factors Affecting Hazardousness	Some devulcanization agents may be toxic or possibly carcinogenic	Same as Level I	Same as Level I
Treatment/Disposal Technology	Recycle into process stream	Same as Level I	Same as Level I
Estimate of Number and Percent of Plants Now Using Technology	Approximately 90% (9 plants)	Same as Level I	Same as Level I
Adequacy of Technology	Adequate	Same as Level I	Same as Level I
Non-Land Environmental Impact	None	Same as Level I	Same as Level I
Problems and Comments	None	None	None
Compatibility with Existing Facilities	N.A.	N.A.	N.A.
Monitoring and Surveillance	None required	Same as Level I	Same as Level I
Installation Time for New Facility	Installed	Installed	Installed
Energy Requirements	Negligible	Negligible	Negligible

N.A. = Not Applicable

Source: Foster D. Snell, Inc. analysis of company interviews.

TABLE III-47 (1)

TREATMENT AND DISPOSAL TECHNOLOGY FOR POWDERS AND DUSTS FROM THE RUBBER AND PLASTICS HOSE AND BELTING INDUSTRY, SIC 3041

Factor	Level I, Prevalent Technology	Level II, Best Available Technology	Level III, Adequate Health And Environmental Protection
Physical and Chemical Properties	Fine solid powders contaminated with toxic materials under varying concentrations	Same as Level I	Same as Level I
Amount of Residual Wastes (Kg/KKg product)	Approximately 8	Same as Level I	Same as Level I
Factors Affecting Hazardousness	Solubility of toxic chemicals may vary with pH when disposed of in landfill.	Same as Level I	Same as Level I
Treatment/Disposal Technology	Disposal in general purpose landfill, off-site	Same as Level I	1. Disposal in secure landfill 2. Encapsulation of material in steel drums which are then disposed of in general purpose landfill
Estimate of Number and Percent of Plants Now Using Technology	Approximately 87 plants (100%)	Same as Level I	1. None (0%) 2. None (0%)
Adequacy of Technology	Not adequate	Not adequate	Adequate
Non-Land Environmental Impact	Possible ground and surface water contamination from toxic materials.	Same as Level I	1. None 2. None
Problems and Comments	None	None	1. Existence and availability of sites
Compatibility with Existing Facilities	N. A.	N. A.	No process changes required except for segregation of dusts from general plant wastes.

TABLE III-47 (2)

Factor	Level I, Prevalent Technology	Level II, Best Available Technology	Level III, Adequate Health And Environmental Protection
Monitoring and Surveillance Techniques	None	None	1. Surface and groundwater monitoring for landfill leachate 2. None
Installation Time for New Facility	Installed	Installed	No major installation envisioned.
Energy Requirements	Slight -- trucks and bulldozers for landfill	Same as Level I	Same as Level I

N. A. = Not applicable

Source: Foster D. Snell, Inc. analysis of company interviews.

TABLE III-48 (1)

TREATMENT AND DISPOSAL TECHNOLOGY FOR POWDERS AND DUSTS FROM THE RUBBER PRODUCTS INDUSTRY, N.E.C., SIC 3069

Factor	Level I, Prevalent Technology	Level II, Best Available Technology	Level III, Adequate Health And Environmental Protection
Physical and Chemical Properties of Residual Wastes	Fine solid powders contaminated with toxic materials under varying concentrations	Same as Level I	Same as Level I
Amount of Residual Wastes (Kg/KKg product)	Approximately 16 for dry process and 1 for wet process	Same as Level I	Same as Level I
Factors Affecting Hazardousness	Solubility of toxic chemicals may vary with pH when disposed of in general purpose landfill	Same as Level I	Same as Level I
Treatment/Disposal Technology	Disposal in general purpose landfill, off-site	Same as Level I	1. Disposal in secure landfill 2. Encapsulation of material in steel drums which are then disposed of in general purpose landfill
Estimate of Number and Percent of Plants Now Using Technology	Approximately 1,013 total dry and wet processes	Same as Level I	1. None (0%) 2. None (0%)
Adequacy of Technology	Not adequate	Not adequate	Adequate
Non-Land Environmental Impact	Possible ground and surface water contamination from toxic materials	Same as Level I	1. None 2. None
Problems and Comments	None	None	1. Existence and availability of sites
Compatibility with Existing Facilities	N.A.	N.A.	No process changes required except for segregation of dusts from general plant wastes.

TABLE III-48 (2)

Factor	Level I, Prevalent Technology	Level II, Best Available Technology	Level III, Adequate Health And Environmental Protection
Monitoring and Surveillance Techniques	None	None	1. Surface and groundwater monitoring for landfill leachate 2. None
Installation Time for New Facility	Installed	Installed	No major installation envisioned.
Energy Requirements	Slight	Same as Level I	Same as Level I

N.A. = Not Applicable

Source: Foster D. Snell, Inc. analysis of company interviews.

- Factor VI -- Problem Areas Or Comments. A brief description of problem areas encountered with the technology or important comments.

- Factor VII -- Compatibility With Existing Facilities. This evaluation factor describes whether the technology can be used by existing plants or waste disposal contractors.

- Factor VIII -- Monitoring And Surveillance Techniques This describes the type and frequency of monitoring necessary for the technology.

- Factor IX -- Installation Time For New Facility This factor provides information on whether or not the treatment and disposal technology has been installed or how long it will take to get it on-stream.

- Factor X -- Energy Requirements. This factor describes the qualitative amount of energy required for the technology.

From these tables it can be seen that the prevalent treatment and disposal practice for SIC 30 potentially hazardous wastes is the almost universal use of general landfills. Environmentally adequate disposal would be easily achieved by using approved landfills.

The following paragraphs discuss treatment and disposal technologies applicable to the Rubber Products Industry.

7.2.1 Precipitation

This technique removes water soluble compounds from a wastewater stream. Lime or caustic may be used, for example, to precipitate lead salts from the wastewater effluent of a plant manufacturing rubber hose by the lead mold process. The result of this precipitation is a sludge of high water content. The suspended solids may be further removed from solution by the use of filters, settling basins, clarifiers or thickeners.

7.2.2 Recovery And Reuse

There are some instances where some of the potentially hazardous wastes generated by SIC 30 are recovered and reused.

- For the most part, it is uneconomical to recover the constituents of the potentially hazardous dusts which is by far the largest potentially hazardous waste stream generated by SIC 30. Only in the manufacture of such products as rubber battery cases is it possible to use some of these wastes as filler material.

- Lead scrap and dross from hose manufacture is recovered and reused in all cases observed.

- Devulcanizing agents from rubber reclaiming are reused in some cases observed either directly or after they have been reprocessed by a private contractor.

7.2.3 High Temperature Processing

Smelting operations are widely used for lead dross recovery from the production of rubber hose.

7.2.4 Open Dumping

Open dumping of potentially hazardous SIC 30 wastes into gravel pits, dumps and other uncontrolled disposal areas is still a prevalent disposal practice. This was especially true until recently for Banbury waste oils which are now mostly stored on land.

The majority of industry firms contacted have become increasingly aware of their responsibility for the proper treatment and disposal of their wastes. They have related, during the course of the interviews, that they are taking an active role in investigating what is occurring at their own sites as well as those of private contractors.

7.2.5 Municipal Sewers

The only significant SIC 30 potentially hazardous waste stream going into municipal sewer systems is that of the water borne lead carbonate. The lead winds up in sewage sludge, some of which is destined for land disposal or in the effluent from the treatment plant. It is anticipated that a lesser amount of lead will be discharged in the future to sewers and that more establishments in SIC 3041 will have their own on-site sewage treatment plants.

7.2.6 Burial Operations

Major quantities of Rubber Products Industry potentially hazardous wastes are disposed of by burial. These wastes include dry solids and sludges. Burial locations include both public and private landfills.

7.2.7 Public And Private Landfills

Landfill operations are the preferred method of disposing of potentially hazardous non-flammable solids and sludges for SIC 30. A detailed discussion of landfills is given in a later section.

7.2.8 Disposal Ponds Or Lagoons

This technique provides a simple and economic approach to on-site potentially hazardous waste disposal, where applicable. However, there are some significant drawbacks.

- The pond must provide protection from both surface and groundwater contamination. In almost all areas this means a lined pond. Liners include clay, plastic, concrete and epoxy, all of which are relatively expensive.

- Except in very dry climates, ponds without discharge will overflow from rainfall accumulation.

- Ponds are prone to be "flushed out" with massive rainfall. It is difficult and expensive to provide flood protection.

Lagooning or ponding was only encountered once during the study. This disposal technique was observed at the one hose plant having on-site treatment for the lead contaminated wastewater. Lead containing sludges were deposited into lagoon.

7.3 Land Disposal Practices

This section discusses the three types of landfill available for the disposal of wastes. A description of safeguard practices required or used for the disposal of potentially hazardous wastes is provided as well.

7.3.2 Landfill Types

There are three types of landfill:

- General purpose
- Landfills approved for hazardous waste
- Secured landfills for extremely hazardous wastes.

7.3.1.1. General Purpose Landfill

This landfill type is characterized by its acceptance of a wide variety of wastes and by the absence of provisions for special containment, monitoring and leachate treatment. Well over 95% of the land-destined potentially hazardous wastes from the Rubber Products Industry are disposed of in this type of facility.

General purpose landfills will accept small quantities of hazardous wastes, particularly if they are in drums or plastic containers. Large amounts of hazardous wastes may be accepted when the degree of hazardousness is relatively low due to either the inherent characteristic of the compound or its low concentration in the overall quantity of waste.

7.3.1.2. Approved Landfills

Approved landfills are those which meet the following criteria:

- The composition and volume of each hazardous waste is known and approved for site disposal by pertinent regulatory agencies.

- The site should be suitable for hazardous wastes containment

  - geologically
  - hydrologically
  - environmentally

- Provision is made for monitoring wells, rain water diversion and if required, leachate control and treatment.

The use of an approved landfill allows many hazardous wastes to be disposed of in a controlled and environmentally safe fashion.

At present there are only a few cases where potentially hazardous wastes generated by SIC 30 are disposed of in approved landfills.

7.3.1.3. Secured Landfills

Only one establishment contacted reported that they are disposing of their wastes in a secure landfill. In this instance, the secured landfill was chosen only because of convenience reasons.

Secured landfilling involves additional safeguards beyond those described for approved landfills. These safeguards include:

- Disclosure by the landfill user of the composition and volume of each extremely hazardous waste and approval for site disposal by pertinent regulatory agencies.

- The site shall be geologically and hydrologically approved for extremely hazardous wastes. Approval would depend on the following:

  - Soil or soil/liner permeation rate of less than 10^{-7} cm. per sec.

  - Water table well below the lowest level of the landfill

  - Adequate provision for diversion and control of surface water.

- Monitoring wells are provided.

- If required, leachate control and treatment
- Records of burial coordinates to avoid any chemical interactions.
- Registration of site for a permanent record once filled.

Relatively isolated impermeable soil conditions exist in many areas of the country. If impermeable soil is not available then clay, special concrete, asphalt, plastic, and other liners and covers are available to accomplish similar containment and isolation of the hazardous wastes.

7.3.2 Safeguard Practices

Safeguard practices are those steps which are taken to ensure that hazardous wastes to be land disposed are handled in a manner which precludes their dispersement in the environment. These practices include:

- Encapsulation of wastes
- Leachate collection and treatment
- Chemical fixation

Much of the waste generated by the Rubber Products Industry is land-dumped or landfilled with little or no safeguards. When safeguards are used, they relfect efforts to regulate landfill techniques.

The following paragraphs discuss safeguard techniques which are available or practiced by those establishments classified within the Rubber Products Industry.

7.3.2.1. Direct Plastic/Concrete Encapsulation

This technique is used for small quantities of miscellaneous hazardous wastes. One company contacted in SIC 3041 encapsulates the lead bearing sludges in plastic bags prior to disposal in general purpose landfill.

7.3.2.2 Steel Drums

Steel drums used with or without plastic liners provide some long-term containment and are the most convenient storage and transportation mode for relatively small quantities of potentially hazardous wastes. The obvious problem with this method is the eventual decay of the steel drums. Unless disposed of in an appropriate landfill, future release of the contents of the drum to the environment is likely.

At present, Banbury waste oils from the Tire and Inner Tube Industry are being stored on land in steel drums. Once these oils vulcanize or set (1 to 2 years) it will be possible to dispose of the filled drums in a general landfill without the possibility of the oil's contamirants leaching out into the environment. After the setting process is complete, the contaminants are entrapped in a rubber matrix.

7.3.2.3. Clay Or Asphalt Encapsulation In Bulk

In wet climates, an impervious cover is required to protect the hazardous waste from rainfall flooding. Sections of entire landfill areas are encapsulated by adding clay or asphalt "caps" or "covers" to impervious isolation cells or landfill liners. Neutralizing or pH control ingredients such as lime, may also be used to encase or surround the hazardous waste to avoid solubility, decomposition or other change in the character of the waste to increase its potential for environmental damage.

In dry climates, there is no need to encapsulate the entire landfill since rainfall and water buildup is not a problem. Isolation cells may still be constructed, however, for specific hazardous waste containment.

7.3.2.4 Leachate Collection And Treatment

Hazardous sludges are being increasingly treated either on-site or in collection areas by mixing them with inorganic chemicals and catalysts to set up the entire mass into solid structures with low leachability and good land storage or landfill characteristics. These processes produce solids ranging from crumbly soil-like materials to concrete to ceramic slags.

The setting up of Banbury waste oils in storage drums is a form of fortuitous chemical fixation.

7.3.2.6 Coordinate Records

Landfilling of hazardous wastes can lead to undesirable chemical interactions. Acids or bases can attack slightly soluble organic and inorganic materials disposal increasing their solubility.

To guard against these interactions, some public and private landfill operations keep records of all hazardous waste burials by location and composition. By means of these record keeping systems, undesirable interactions may be avoided and potentially reactive chemicals isolated from each other.

Of course, prior knowledge of hazardous wastes coming to the landfill area is necessary so that a satisfactory disposal section may be selected. Some landfill operations require prior written requests for the disposal of specific hazardous wastes.

7.3.3 On-Site Vs. Off-Site Disposal

On the basis of interviews of companies in SIC 30, greater than 95% of the plants hire contractors or use public facilities for off-site disposal of all their potentially hazardous wastes.

In most cases, a particular contractor was chosen because it was the only one available in the area. The contractors may provide both hauling and disposal services.

8. COST ANALYSIS FOR THE TREATMENT AND DISPOSAL OF POTENTIALLY HAZARDOUS WASTES, RUBBER PRODUCTS INDUSTRY

The basis for the cost analysis presented in this report is the average values developed from the industry interviews. Since the methods used in SIC 30 for subject waste disposal do not involve chemical engineering nor any significant other form of capital investment, with the exception of the hypothetical upgrading of a landfill site discussed below, this analysis is straightforward.

The factors involved are:

- Volume of waste
- Contracting fees for disposal
- Long distance haulage -- if required
- Cost of containing the material
- Capital costs for upgrading a presently used landfill
- Labor costs at the plant.

8.1 Volume Of Waste

The solid waste of the type described in section 7.0 is expressed in terms of KKg. When it is necessary to convert this weight data into volume, such as for the determination of the required landfill excavation, a density of 500 Kg/m^3 (31.1 lb/cft.) has been assumed. This corresponds essentially to the density of the carbon black which constitutes the bulk of the waste stream.

8.2 Contracting Fee

The cost data reported by the interviewees present a considerable range of variation from \$100 to \$3 per KKg. This is due not only to the multitude of factors influencing the costs incurred, but also to the fact that a monopolistic situation exists in practically all the locations investigated. Nearly 90% of the respondents indicated that the choice of the contractor was motivated by the fact that he was the "only available".

Another reason is that the costs are based on an estimate of the tonnage of total waste hauled by a contractor, whose fee is based on the total number of trips or collection runs and that the capacity is not utilized to the same level in all plants. Indeed, this factor was found to outweigh any other consideration to such an extent that a more sophisticated analysis including such factors as the distance traveled, the presence or absence of landfill disposal fee, the type of facility utilized, did not given meaningful results. Finally, even in the most extreme situation the cost of waste disposal represents such an insignificant contribution to the total operating costs that little attention is exercised by management to the control of this cost item.

Therefore, the average calculated cost based on 28 responses in the SIC 30 is used. This is about $33 per KKg.

8.3 Long Distance Hauling Cost

Two methods are possible to evaluate this cost. One method consists of using Interstate Commerce Commission (ICC) cost data. The data presented by ICC include such factors as a distance factor, a region factor, a density factor and a load factor. However, for this particular study, the method does not seem to be completely valid, particularly to determine the additional cost of hauling the waste to a more distant site than the one presently utilized. For one thing, either the wastes have to be transported in specialized equipment or they have to be packaged. If handled by specialized equipment, the ICC rates would not apply. If packaged, the packaging could take the form of the steel drums discussed in paragraph 8.4 and thus the need for long distance haulage would disappear. A more direct calculation is thus preferred and is described below. The rationale behind this approach is that the wastes are handled in bulk in the same manner as presently utilized.

The cost of hauling the potentially hazardous waste to an acceptable landfill is taken as the additional cost of driving the truck to a site about 150 Km (approximately 100 miles) more distant. This represents a round trip of 300 Km (approximately 200 miles). The cost elements are as follows:

.	Travel Time:	300 Km at 50 Km/H (200 miles at 33 mph) 6 hours	
.	Labor Cost:	6 hours at $10	$60
.	Fuel Consumption:	300 Km at 4 Km/l. = 75 l.	
.	Fuel Cost:	75 l. at $0.15/l. (19 gal. at 0.60/gal)	$12
.	Other operating costs (amortization, oil and maintenance)	$0.10/Km ($0.16/mile)	$30
		Total	$102
.	Load:	17 KKg (approximately 35,000 lb.) Unit cost $6/KKg (approximately $6/ton)	

8.4 Cost Of Packaging

Disposal in plastic lined drums constitutes an acceptable containment method for the type of waste considered. Given the density of waste outlined in paragraph 8.1 the typical 55 gal. drum would have a capacity of about 100 Kg ($0.2\ m^3$ at $500\ Kg/m^3$). Thus, 10 drums are required per KKg of waste. The cost of a new drum is about $7.00. It is assumed that used drums are utilized at a nominal cost of $3.00. The cost of packaging is thus $30/KKg (approximately $30/ton).

8.5 Cost Of Upgrading A Portion Of An Existing Landfill Site

This cost reflects the fact that this solution should be considered as competitive economically with others more readily available. In particular, this solution is obviously applicable only to those circumstances in which a sufficient volume of waste is generated annually. The only legitimate one encountered in the industry is that of the typical tire producing plant. For validity the following assumptions are made:

- A general purpose landfill exists and is presently used.
- A portion of the site can be devoted exclusively to the disposal of the subject waste.
- No change in other disposal costs occurs.

This situation could be encountered either by those establishments who dispose of the wastes themselves or more typically through agreement with a landfill operator (private or municipal) to assume the costs of developing and upgrading a portion of the existing site. This could indeed take the form of a "pass on" cost.

The idea would be to excavate a site of say, ten year capacity, install a 3 foot clay barrier, and eventually provide periodically a plastic cover for the isolation of surface water. Over variants of this approach can be throught of, but the costs are in the same range.

Based on the previous assumptions, no cost of land is required since the site would have been utilized anyway. The cost elements are then the cost of excavating the site, and the cost of the clay liner required. In addition, the cost of the plastic covering is considered an annual cost. On the other hand, the costs of dumping and covering are considered the same as those for present practice.

The annualized capital cost is based on a 10 year capital recovery factor of 0.163 corresponding to amortization over 10 years at 10% interest. Given these assumptions, the cost for a typical tire plant producing 59,400 KKg of tires per year can be estimated as follows:

. Investment costs

- Volume to be excavated

.. Usable volume (10 years at 1,280 m^3/year) 13,000 m^3 (17,000 cu.yd.)

.. Dimensions: area 4,300 m^2 (47,000 sq.ft.)
depth 3 m (10 ft.)

.. Clay liner: depth 0.9 m (3 ft.)

.. Total volume to be excavated -- 17,000 m^3 (22,000 cu.yd.)

.. Cost of excavation $1/$m^3$ ($0.75 cu.yd.)
$17,000

.. Volume of clay 3,900 m^3 (5,200 cu.yd.)

.. Cost of clay (in place) $4.00/$m^3$ ($3.00/cy.yd.)
$16,000

Total $33,000

- Annual costs

–	Cost of capital	\$33,000 x 0.1630 =	\$ 5,500
–	Plastic cover	430 m^2 (4,700 sq.ft.) at \$5.5 m^2 (\$0.5/sq.ft.)	2,400
–	All other costs	(as per assumptions)	36,900
		Total	\$44,800

8.6 Plant Labor Costs

The collection and handling of the potentially hazardous wastes by plant personnel depends in great part on the volume at a given plant. Of all the plants considered as typical, it appears that only the volumes encountered in a tire plant would require the use of a significant amount of labor. In general, a full-time employee is handling the warehouse wastes, the bulk of which constitute the potentially hazardous waste in this industry. It is estimated that the annual cost of such an employee is \$15,000, including fringes and supplies. In addition, it is estimated that the equipment (mechanical sweepers) consumes about \$500 worth of energy per year. In all other plant instances the volumes are so small that the duties are carried out by operating personnel without significant expenditure of time or energy.

8.7 Definition Of Technology Levels

For the rubber industry the term technology as applied to hazardous waste disposal is somewhat misleading, because in no case any sophisticated technology is either used or required. The term applies more to practices which are little more than better house keeping and the use of approved landfill.

- Level I -- Technology currently employed by typical facilities. This consists of disposal to a general purpose landfill either by private contractor or by self on company property.

- Level II -- Best technology currently employed. Identified technology at this level must represent soundest practice from environmental and health standpoint currently in use in at least one location. In the particular case of the rubber industry, this level does not systematically differ from Level I. That is, it is purely fortuitous that the local landfills are secured or approved.

- Level III -- Technology necessary to provide adequate health and environmental protection. For this particular industry, the Level III corresponds to Level II where practical. Three alternatives have been considered where necessary:

  - Long distance hauling to a secured landfill site

  - Containment of the material to prevent potential leaching

  - Upgrading a landfill site to the secured level.

8.8 Typical Cases Of Potentially Hazardous Waste Disposal Costs

Based on the cost elements discussed in the previous paragraphs, the individual costs for a typical plant in each of the industry groupings have been calculated.

The results of this analysis are presented in Table III-49. These waste disposal values are not significant in terms of production costs. As shown in Table III-49, these costs amount to less than 0.06 percent of the value of the product even in the worst case and average about 0.018 percent of this value. Table III-50 provides the estimated yearly expenditures for potentially hazardous waste disposal for SIC 30.

The individual cases are presented in Tables III-51 to III-54 for the following segments of the industry:

- SIC 3011, Tire and Inner Tube Industry

- SIC 3021, Rubber and Plastics Footwear Industry

- SIC 3041, Rubber and Plastics Hose and Belting Industry

- SIC 3069, Rubber Products Industry, N.E.C.

It is to be noted that no analysis has been presented for industry segment SIC 3031, Reclaimed Rubber Industry. The reason for this omission is that no significant potentially hazardous waste has been identified for this industry to be land disposed of and furthermore, the production volume and number of operating plants is steadily decreasing. Similarly, the volumes of hazardous wastes generated by such processes as the wet processes in SIC 3069 and plastic hose in SIC 3041 are too small to warrant specific discussion.

TABLE III-49

PERCENT OF PRODUCTION VALUE ALLOCATED TO TREATMENT AND DISPOSAL OF POTENTIALLY HAZARDOUS WASTES IN THE RUBBER PRODUCTS INDUSTRY, SIC 30

Industry Subgroup	T/D Level Technology	Percent of Production Value					
		I	II	III			
				1	2	3	4
3011		0.032	0.032	0.032	0.040	0.044	0.055
3021		0.0026	0.0026	0.0026	N.A.	N.A.	0.0052
3041		0.011	0.011	0.011	N.A.	N.A.	0.022
3069		0.014	0.014	0.014	N.A.	N.A.	0.028

N.A. = Not Applicable

Treatment/Disposal Technology

Level I	Simple municipal landfill, off-site
Level II	Same as Level I, but municipal landfill is secured
Level III	1. Same as Level II
Level III	2. Ship 150 Km to a secured landfill
Level III	3. Upgrading a portion of an existing landfill to secured status with 10 year capacity
Level III	4. Simple municipal landfill, off-site, with the material disposed of in polyethylene lined steel drums.

Source: Foster D. Snell, Inc. analysis of industry interviews and literature data.

TABLE III-50

YEARLY EXPENDITURES FOR POTENTIALLY HAZARDOUS WASTE DISPOSAL IN THE RUBBER PRODUCTS INDUSTRY, SIC 30

			Dollars (1974)					
		T/D Level	I	II	III			
		Technology			1	2	3	4
SIC Code	Production (KKKg/yr)	Potentially Hazardous Waste (KKg/yr)						
3011	3,424	30,700	1,780,000	1,780,000	1,780,000	1,960,000	2,150,000	2,700,000
3021	81	390	13,000	13,000	13,000	-	-	25,000
3041	370	3,000	99,000	99,000	99,000	-	-	192,000
3069	890	10,000	353,000	353,000	353,000	-	-	663,000

Treatment/Disposal Technology

Level I	Simple municipal landfill, offsite.
Level II	Same as Level I, but the municipal landfill is secured.
Level III-1	Same as Level II
Level III-2	Ship 150 Km to a secured landfill
Level III-3	Upgrading a position of an existing landfill to secured status with 10 year capacity
Level III-4	Simple municipal landfill. Offsite but the material is disposed of in polyethylene lined steel drums.

Source: Foster D. Snell, Inc.

TABLE III-51

POTENTIALLY HAZARDOUS WASTE DISPOSAL COSTS FOR A TYPICAL PLANT IN THE TIRE AND INNER TUBE INDUSTRY, SIC 3011

Typical Plant	Production Rate	Location	Process
Tire Plant	59,400 KKg/yr	Midwest, U.S.	75% passenger tires 25% truck and bus tires

Identification of Waste Streams	Composition	Form	Amount To Treatment/Disposal
Type I waste(1)	Carbon black, organic and inorganic chemicals(2)	Powdery solids	11 Kg/KKg of production 640 KKg/yr

Dollars (1974)

T/D Level	Level 1	Level 2	Level 3			
Technology	1	1	1	2	3	4
Investment Costs						
Land	0	0	0	0	0	0
Other	0	0	0	0	33,000	0
Total Investment	0	0	0	0	39,000	0
Annual Costs						
Cost of Capital	0	0	0	0	5,500	0
Operating Costs	15,000	15,000	15,000	15,000	17,400	34,200
Energy & Power	500	500	500	500	500	500
Contractor	21,400	21,400	21,400	25,200	21,400	21,400
Total Annual Costs	36,900	36,900	36,900	40,700	44,800	56,100
Cost/KKg of Product	0.62 (3)	0.62 (3)	0.62	0.69	0.75	0.94
Cost/KKg of Waste	58	58	58	64	70	88

Treatment/Disposal Technology

Level I	Simple municipal landfill, off-site.
Level II	Same as Level I, but the municipal landfill is secured.
Level III	1. Same as Level II
Level III	2. Ship 150 Km to a secured landfill.
Level III	3. Upgrading a portion of an existing landfill to secured status with 10 year capacity.
Level III	4. Simple municipal landfill. Offsite, but the material is disposed of in polyethylene lined steel drums.

Notes: (1) Floor sweepings and dust from air pollution control equipment.
(2) Concentrations are variable.
(3) Monompolistic "Contractor" situation (Section 8.2)

Source: Foster D. Snell, Inc. analysis of industry interviews and literature data.

TABLE III-52

POTENTIALLY HAZARDOUS WASTE DISPOSAL COSTS FOR A TYPICAL PLANT IN THE RUBBER AND PLASTICS FOOTWEAR INDUSTRY, SIC 3021

Typical Plant	Production Rate	Location	Process
Canvas Rubber Footwear Plant	1,700 KKg	New England	Canvas Rubber Footwear

Identification of Waste Streams	Composition	Form	Amount To Treatment/Disposal
Type I waste(1)	Organic and inorganic chemicals(2)	Powdery solids	4.8 Kg/KKg of product 8.2 KKg/year

Dollars (1974)

T/D Level	Level 1	Level 2	Level 3			
Technology	1	1	1	2	3	4
Investment Costs						
Land	0	0	0	(3)	(3)	0
Other	0	0	0	-	-	0
Total Investment	0	0	0	-	-	0
Annual Costs						
Cost of Capital	0	0	0	-	-	0
Operating Costs	neg.	neg.	neg.	-	-	250
Energy & Power	neg.	neg.	neg.	-	-	neg.
Contractor	275	275	275	-	-	275
Total Annual Costs	275	275	275	-	-	525
Cost/KKg of Product	0.16 (4)	0.16 (4)	0.16 (4)	-	-	0.31
Cost/KKg of Waste	33	33	33	-	-	64

Treatment/Disposal Technology

Level I	Simple municipal landfill, off-site.
Level II	Same as Level I, but the municipal landfill is secured.
Level III	1. Same as Level II
Level III	2. Ship 150 Km to a secured landfill.
Level III	3. Upgrading a portionoof an existing landfill to secured status with 10 year capacity.
Level III	4. Simple municipal landfill. Offsite, but the material is disposed of in polyethylene lined steel drums.

Notes: (1) Floor sweepings and dust from air pollution control equipment
(2) Concentrations are variable.
(3) Not applicable at this scale.
(4) Monopolistic "Contractor" situation (Section 8.2).

Source: Foster D. Snell, Inc. analysis of industry interviews and literature data.

TABLE III-53

POTENTIALLY HAZARDOUS WASTE DISPOSAL COSTS FOR A TYPICAL PLANT IN THE RUBBER AND PLASTICS HOSE AND BELTING INDUSTRY, SIC 3041

Typical Plant	Production Rate	Location	Process
Reinforced Rubber Hose Plant	2,000 KKg	Midwest	Braided Rubber Hose

Identification of Waste Streams	Composition	Form	Amount To Treatment/Disposal
Type I waste(1)	Carbon black, organic and inorganic chemicals(2)	Powdery solids	8.3 Kg/KKg of product 16.5 KKg/year

Dollars (1974)

T/D Level	Level 1	Level 2	Level 3			
Technology	1	1	1	2	3	4
Investment Costs						
Land	0	0	0	(3)	(3)	0
Other	0	0	0	-	-	0
Total Investment	0	0	0	-	-	0
Annual Costs						
Cost of Capital	0	0	0	-	-	0
Operating Costs	neg.	neg.	neg.	-	-	500
Energy & Power	neg.	neg.	neg.	-	-	neg.
Contractor	550	550	550	-	-	550
Total Annual Costs	550	550	550	-	-	1050
Cost/KKg of Product	0.28 (4)	0.28 (4)	0.28 (4)		-	0.53
Cost/KKg of Waste	33	33	33	-	-	64

Treatment/Disposal Technology

Level I	Simple municipal landfill, off-site.
Level II	Same as Level I, but the municipal landfill is secured.
Level III	1. Same as Level II
Level III	2. Ship 150 Km to a secured landfill.
Level III	3. Upgrading a portion of an existing landfill to secured status with 10 year capacity.
Level III	4. Simple municipal landfill. Offiste, but the material is disposed of in polyethylene lined steel drums

Notes: (1) Floor sweepings and dust from air pollution control equipment
(2) Concentrations are variable
(3) Not applicable at this scale
(4) Monopolistic "Contractor" situation (Section 8.2).

Source: Foster D. Snell, Inc. analysis of industry interviews and literature data.

TABLE III-54

POTENTIALLY HAZARDOUS WASTE DISPOSAL COSTS FOR A TYPICAL PLANT IN THE RUBBER PRODUCTS INDUSTRY, N.E.C., SIC 3069

Typical Plant	Production Rate	Location	Process
Miscellaneous Rubber Products Plant	900 KKg/yr	Midwest	Molding

Identification of Waste Streams	Composition	Form	Amount To Treatment/Disposal
Type I waste(1)	Carbon black, organic and inorganic chemicals(2)	Powdery solids	12 Kg/KKg of product 10.7 KKg/yr.

Dollars (1974)

T/D Level	Level 1	Level 2	Level 3			
Technology	1	1	1	2	3	4
Investment Costs						
Land	0	0	0	(3)	(3)	0
Other	0	0	0	-	-	0
Total Investment	0	0	0	-	-	0
Annual Costs						
Cost of Capital	0	0	0	-	-	0
Operating Costs	neg.	neg.	neg.	-	-	300
Energy & Power	neg.	neg.	neg.	-	-	neg.
Contractor	360	360	360	-	-	360
Total Annual Costs	360	360	360	-	-	660
Cost/KKg of Product	0.40(4)	0.40(4)	0.40(4)		-	0.73
Cost/KKg of Waste	33	33	33	-	-	62

Treatment/Disposal Technology

Level I	Simple municipal landfill. Offsite.
Level II	Same as Level I, but the municipal landfill is secured.
Level III	1. Same as Level II
Level III	2. Ship 150 Km to a secured landfill.
Level III	3. Upgrading a portion of an existing landfill to secured status with 10 year capacity
Level III	4. Simple municipal landfill. Offsite, but the material is disposed of in polyethylene lined steel drums.

Notes: (1) Floor sweepings and dust from air pollution control equipment.
(2) Concentrations are variable.
(3) Not applicable at this scale.
(4) Monopolistic "Contractor" situation (Section 8.2).

Source: Foster D. Snell, Inc. analysis of industry interviews and literature data.

The individual cases are discussed below.

8.8.1 Effects Of Technology Levels On Disposal Costs

The disposal technologies are identical for all segments of SIC 30 and, therefore, there is no reason to discuss the Levels separately for each segment.

For the reasons explained in paragraphs 8.2 and 8.6, there is no systematic cost difference between Level I and Level II. For Level III, it is to be noted that three alternative technologies are envisioned for SIC 3011 only. The reason for this is that the plants of the other segments do not have the volume to justify these technologies. For instance long distance hauling cannot be contemplated for loads of less than, say 15,000 Kg (33,000 lbs). It is to be noted that it would take almost two years for a canvas rubber footwear plant to accumulate this volume. The same consideration applies to the upgrading of a landfill site. For instance, the volume of potentially hazardous waste generated by a typical reinforced rubber hose plant is 33 m^3 (40 cu.yd.) per year. This is less than the volume of clay necessary to provide the required barrier for this amount of material. On the other hand, it can be noted that the cost of drumming the waste for a tire plant is the most expensive solution for this type of operation.

8.8.2 Effects Of Plant Types On Disposal Costs

The volume of potentially hazardous wastes generated by the typical plants in the various segments of SIC 30 varies considerably for two reasons: there are extremely large differences in production volumes, and there are also large differences in the proportion of potentially hazardous waste to total production. The pertinent data are presented in Tables III-50 to III-53 and are further discussed below.

8.8.2.1 Tire Plants, SIC 3011

The characteristics of a typical fire plant are summarized in Table III-50. This plant represents the arithmetic average of the total U.S. production divided by the number of plants. Coincidentally, it also represents the most frequently encountered plant size in the industry. It is, therefore, somewhat more typical than an arithmetic average. However, none of the data are ascribable to a specific plant.

The production is a nominal 18,000 tires per day which translates to a volume of 59,400 KKg/year (131 million lbs/yr). The potentially hazardous wastes are defined in Table III-50 and amount to 640 KKg/year (1.4 million lbs/yr). This represents about 1.1% of the production volume. The various levels of technology and the elements of costs have been discussed in the previous paragraphs. The annual cost differentials to achieve Level III technology for those plants not achieving it presently are from $3,800 to $19,200 depending on the solution adopted. This compares to a product value of about $115 million. The costs are thus completely insignificant.

8.8.2.2 Rubber Canvas Footwear Plant, SIC 3021

The characteristics of a typical rubber canvas footwear plant are presented in Table III-51. It is to be noted that there are more diversity in the plants producing goods in this SIC group than in the tire plants. However, the characteristics of this plant are reasonably close to that of a good number of plants in this industry.

The production is about 1,700 KKg (3.7 million lbs/yr). This is about 3 to 4 million pairs of tennis shoes (for instance) per year. By far, the bulk of the waste in such a plant is the totally non-hazardous waste represented by the cutouts from the various fabrics used. The potentially hazardous wastes consist of some of the organic and inorganic materials used in the compounding of the rubber mixtures. These wastes amount to about 0.5% of the production volume. This figure is even lower if it is taken as a percentage of the raw materials consumed because in this industry the weight of non-hazardous waste generated amounts to more than 50% of the total product weight.

The disposal costs are truly negligible, amounting to a few hundred dollars per year, and inclusion of this segment of the industry in the economic study is essentially for the sake of completeness.

8.8.2.3 Reinforced Rubber Hose Plant, SIC 3041

The characteristics of the typical plant are summarized in Table III-52. The production volume is estimated at 2,000 KKg/year (4.4 million lbs/year). The potentially hazardous wastes are of essentially the same composition as those of a tire manufacturing plant. They amount to about 0.8% of the production volume. The disposal costs are also in the order of a few hundred dollars per year. This compares with a production value of $5 million.

8.8.2.4 Miscellaneous Rubber Products Plant, SIC 3069

The characteristics of a plant producing miscellaneous rubber products are presented in Table III-53. This industry is so diversified that there is practically no such thing as a typical plant. However, the production data represent an average derived from over 1,000 plants. They, therefore, have a certain statistical validity. The wastes are again of the same general composition as those encountered in the tire industry and amount to about 1.2% of the production volume. The disposal costs are also in the order of a few hundred dollars per year. The value of the products of such a plant is about $2.6 million.