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FINAL

**TECHNO-ECONOMIC INVESTMENT PROFILE
ON**

**RUBBER HOSES FOR AUTOMOTIVE
REPLACEMENT MARKET**

prepared for

**THE GULF ORGANIZATION FOR
INDUSTRIAL CONSULTING**

22

**Industrial Investment Division
Vienna, February 1991**

TECHNO-ECONOMIC INVESTMENT PROFILE

ON

RUBBER HOSES FOR AUTOMOTIVE REPLACEMENT MARKET

1.0 EXECUTIVE SUMMARY

A modern vehicle may have as many as 10 flexible rubber hoses, each of different lengths and diameter. There is a growing trend for most hoses to be customised for each particular vehicle application although there is still a general requirement for standard straight hoses. It is recommended that a manufacturing plant should be capable of manufacturing both types and particularly the customised hoses manufactured in silicone rubber which are now commonly fitted to Mercedes trucks and commercial vehicles.

An initial annual production of 387,000 hoses is recommended, representing an annual turnover of US\$ 4,970,000 by the end of Year 3. The projected return would be US\$ 1,491,000 gross profit.

The investment in machines, installation and commissioning is estimated at US\$ 1,118,600 plus site, building and local costs.

2.0 PRODUCT DEFINITION

2.1 Product Range

Automotive hoses are flexible rubber pipes manufactured in either plain rubber or rubber with integral textile reinforcement. There can be over 10 different rubber hoses on each type of vehicle. The hoses may carry many different fluids such as water, air, oils, fuel and refrigerants, often under arduous pressure and temperature conditions which are typically found in a vehicle engine compartment.

Typical shapes and sizes of hoses are shown in Figure 1. There are two distinct market areas:-

2.1.1 Standard Shapes

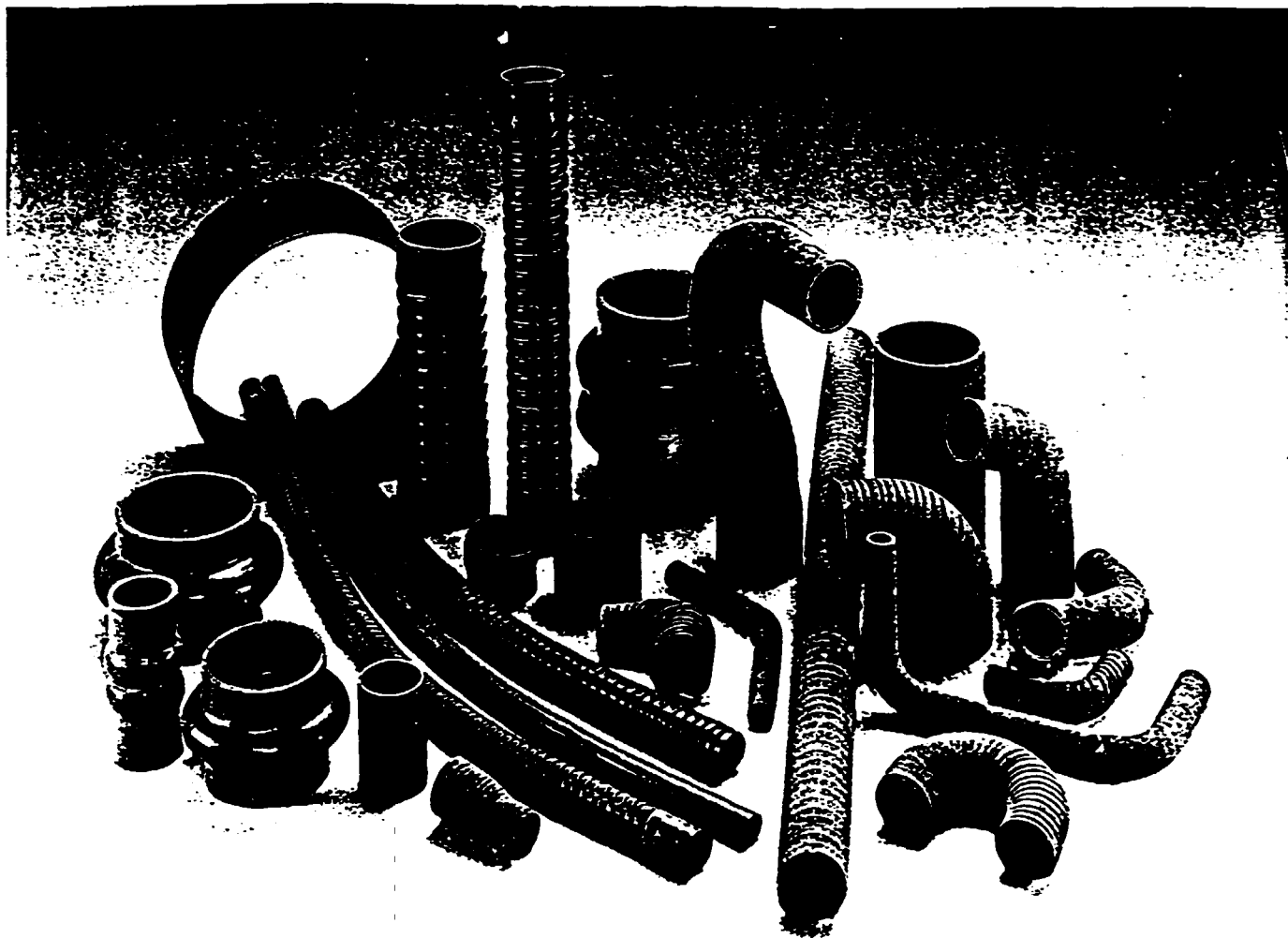
- a) straight hoses with parallel sides, constant cross section and bore range 6mm to 314mm; and
- b) reducers and elbows compatible for use with a straight hose.

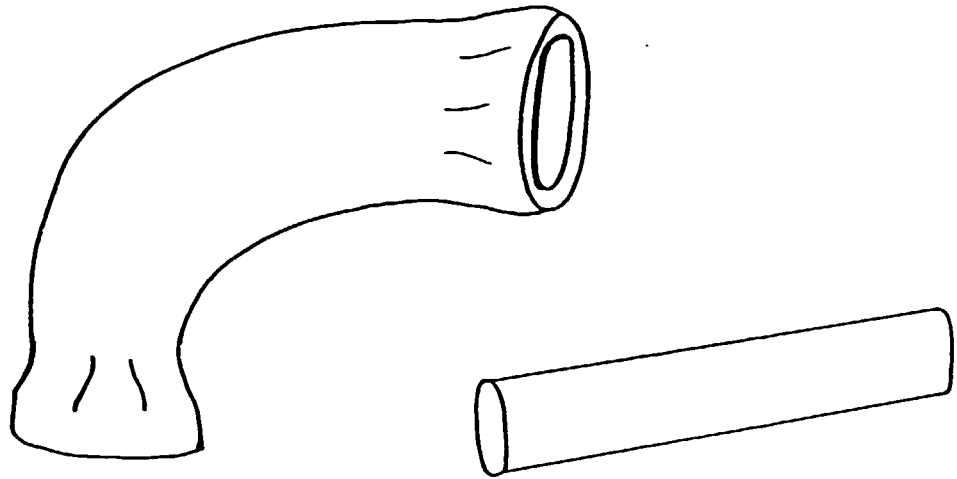
2.1.2 Customised Shapes ('Freeform')

There is an increasing trend for automobile hoses to be tailored to a particular vehicle type to minimise vehicle assembly costs and save space in the engine compartment.

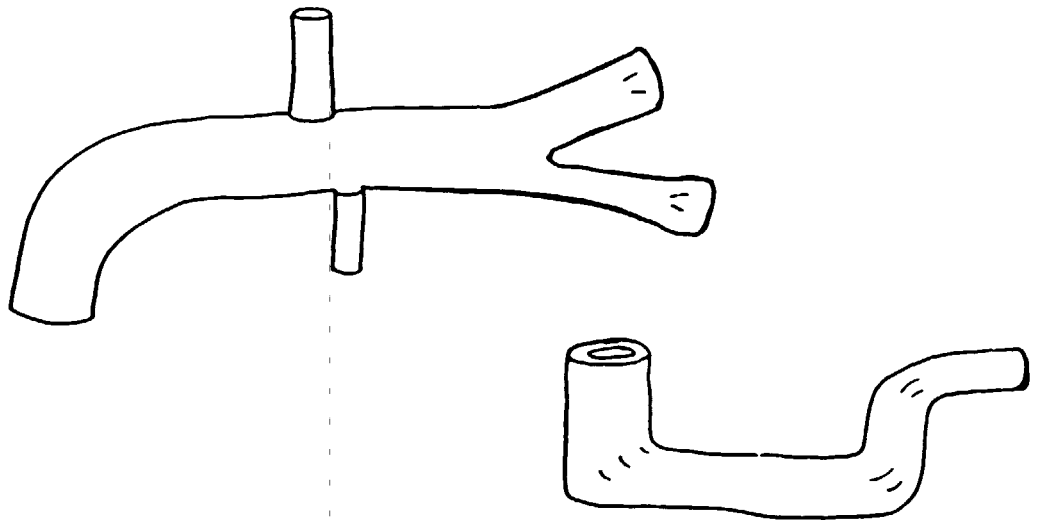
Diversity of shape and size is virtually limitless but generally takes the form of a pre-set 3-dimensional shape with variation in cross-section combined with a number of integral branch connections (see Appendix 1, Fig 2).

FIGURE 1





TYPICAL Standard Shape Hoses



TYPICAL "freeform" Shape Hoses

2.2 Specifications

It is the general industry practice for each original vehicle manufacturer to issue his own specifications for hose materials and construction. Access to these specifications is normally obtained through formalised supply agreements.

There are also national standards which are less commonly specified except in the areas of safety, for example:-

BS6784 - Specification for rubber hoses and hose assemblies for automobile power steering systems.

AU108 - Specification for plain and reinforced rubber hoses for automobiles.

The rubber/textile hose construction is typically made from the more common rubbers available:-

Natural rubber

SBR	Styrene Butadiene Rubber
EPM	Ethylene Propylene Rubber
CIIR	Chlorobutyl Rubber
CR	Polychloroprene (eg. Neoprene)
NBR	Nitrile Rubber (good oil resistance)
BU/AU	Polyurethane Rubber
Q	Silicone Rubber (for wide temperature range)

Relevant British Standards are BS903, 1154, 3227, 2751, 2752 and 6014

The textile reinforcements used are:-

Polyester	(woven, braided and knitted)
Glass	(woven)
Nomex	(knitted and woven)

3.0 TECHNOLOGY REVIEW

3.1 Review of the Options

Product Range

A prospective manufacturer of automotive hoses needs to take account of the move away from simple hoses to complex 'freeform' shapes which are customised for and unique to each vehicle model. The main options would appear to be:-

1. Reach an agreement with the major vehicle suppliers to the Arab Gulf region to permit the local manufacture of replacement 'branded' hoses.
2. Reach an agreement with an existing hose manufacturer to permit the local manufacture of hoses to an existing range of designs and thereby gain access to a number of vehicle manufacturers.
3. Produce hoses independently and sell to local distributors. These hose products would then compete on price and specification with the original equipment manufacturers' hoses but may need to be sufficiently differentiated to avoid infringing design copyright.

Manufacture

There are three basic manufacturing techniques:-

- a) Extrusion - only suitable for standard shapes.
- b) Moulding - requires expensive dedicated mould tooling and is suitable for customised hoses.
- c) Freeformed - a manually intensive process of building complex irregularly shaped multi-branched customised hoses.

3.2 A Review of Production Scale Ranges

The European market of over 100 million vehicles is served by about 10 major suppliers, most of whom also manufacture other hose products for non-automotive markets. Each may manufacture up to 10 million hoses per annum.

The Arab Gulf vehicle population is approximately 3.3 million vehicles. The indicative market for replacement automotive hoses can be estimated at 1.98 million hoses per annum on the basis of 3 relevant hoses per vehicle and one hose replacement every 5 years.

The suggested production capacity of a start-up project (to be achieved in Year 3) is 20% of this market, or 387,000 hoses per annum at single shift operation based on 240 working days per year. This capacity would provide sufficient scope for expansion to service export markets and of course the general industrial hose market. Capacity could be doubled by two shift operation.

These production quantities are too low to consider local manufacture of the rubber sheet, or the textile reinforcement. The scale of the plant is governed by the rubber sheet reinforcing build machine. A single machine will have a capacity to produce about 4 million hoses. That part of the plant will be somewhat oversized for the immediate market.

3.3 Recommended Production Technology

The scale suggests that one extrusion machine and one freeform silicone hose production section would provide a flexible plant able to produce both large runs of constant diameter hose and smaller runs of hoses of almost any configuration. In both cases the complete range of rubber and reinforcing materials could be offered to customers.

A moulded hose production facility bears heavy tool costs for each variety of hose and needs long production runs to be economic.

Our recommendations are influenced by the high share of Mercedes in the commercial vehicle and truck markets within the Arab Gulf region. Mercedes are moving across to freeform reinforced silicone rubber hoses. That manufacturer believes they offer much longer life, and are much better able to endure elevated temperatures. That aspect seems relevant given the Arab Gulf climates where ambient temperature ranges are wide.

3.4 Sources of Technology

JAMES DAWSON & SONS LIMITED (especially for the silicone free forming technology)

A Fenner Group Company, Boultham Works, Lincoln, England LN6 7AF
Tel: 0522 53 1821 Fax: 0522 5 10029 Tlx: 56357

HESTON CODAN RUBBER LIMITED

18-20 Union Road, London, England SW4 6JP

Tel: 071 720 3751 Factory Tel: 0536 20 010 Tlx: 919045

DUNLOP INDUSTRIAL HOSE LIMITED

Bassington Drive, Bassington Industrial Estate, Cramlington, Northumberland, England, NE23 8AT

Tel: 0670 7 13451 Fax: 0670 736724

PIRELLI

Via e Piaaggio, 28, 66013 Chieti Scala, Italy

Tel: 0871 5091 Fax: 0871 509703 Tlx: 310135

AC FLEXFRANCE

9 Rue de la Paix, 93100 Montreuil, France

Tel: 1 48550195 Tlx: 214154

BAGGERMAN BV

Postbus 155, 6040 AD Roermond, Netherlands

Tel: 4750 235 23 Tlx: 36897

4.0 THE PRODUCTION PROCESS

4.1 Description and Flow Sheet for Recommended Technology

4.1.1 'Freeform' Rubber Hoses (see Fig 2)

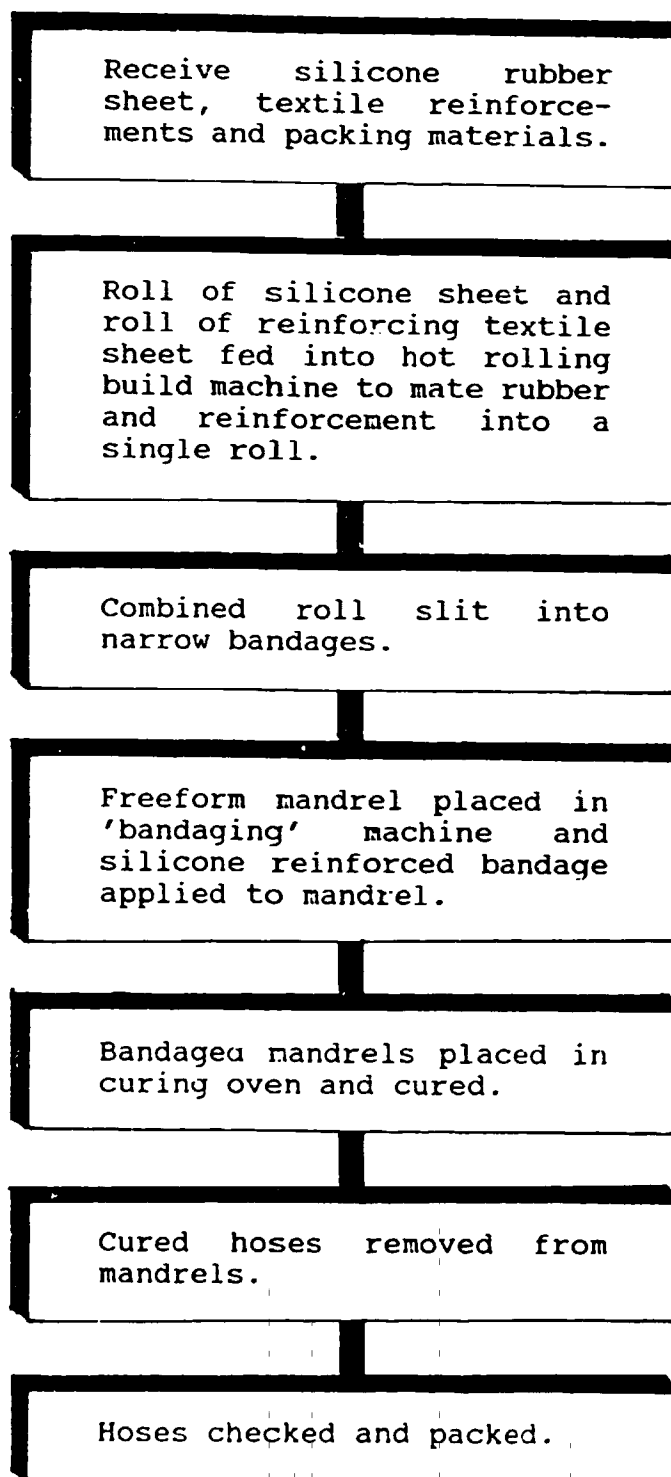
1. PREPARATION OF RUBBER

Receive and unpack silicone rubber sheet (quantities too small for purchasing and mixing raw rubber).

2. PREPARATION OF TEXTILE REINFORCEMENT

3 ply knitted polyester blankets are bought in ready for use (quantities too small for own manufacture).

PRODUCTION FLOW CHART FOR
'FREEFORM' AUTOMOTIVE RUBBER HOSES



3. MATING OF RUBBER AND REINFORCEMENT

The roll of silicone rubber has to be mated to the reinforcing blanket. This is done in a build machine (see Appendix 1) which passes the silicone sheet around the top half of a roller to make it pliable. The reinforcing fabric is fed onto the underside of the hot roller where the rubber and the reinforcement are pressed together to form a single blanket.

4. PREPARATION OF BANDAGES

The single blanket is slit into narrow bandages, typically 40mm in width.

5. FORMING AND CURING OF HOSE

The bandages are wrapped around the hose mandrel. These are batch cured in an oven.

6. STRIPPING OFF

The cured hoses are stripped off the mandrels. Complex mandrels will separate into two or more pieces to free the completed hose.

7. INSPECTION AND PACK

Simple visual inspection, box and carton pack. Bulk supplies are carton packed only.

4.1.2 Extruded Rubber Hose (see Fig 3)

1. PREPARATION OF RUBBER

Receive and unpack pre-mixed rubber extrusion compound (quantities too small for purchasing and mixing raw rubber).

2. PREPARATION OF TEXTILE REINFORCEMENT

Polyester reinforcing yarn is bought in ready for use.

3. **LOADING OF EXTRUSION MACHINE (see Appendix 2)**

Extrusion is a hot process and benefits from continuous operation. Once stopped, the cleaning down and restarting time can be several hours.

The raw rubber compound is loaded into two hoppers. Reels of polyester yarn are loaded onto the braiding machine. Here again, the longer a particular set-up can be left to run, the more efficient the overall process time.

4. **LOADING THE TOOLING**

It is normal to set up the tooling at the start of a shift when the machine is cool. With most extrusion machines changing tools in mid-shift can be a very disruptive and costly operation. One aims therefore for a complete shift on one tool if possible.

5. **FORMING AND CURING OF HOSE**

The extruded hose is formed hot and no further curing is required.

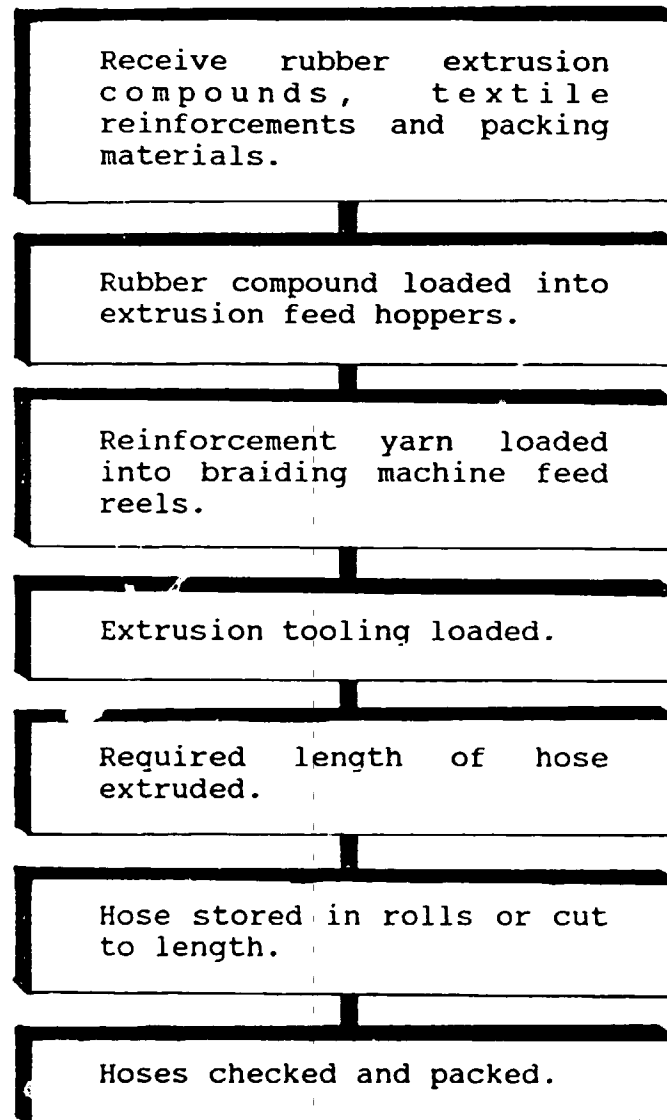
6. **STRIPPING OFF**

The complete hose is either fed onto a reel or may be cut to length by a flying saw as the extrusion process proceeds. At the start and end of a run there will be malformed hose to be cut off and scrapped.

7. **INSPECTION AND PACK**

Simple visual inspection, box and carton pack. Bulk supplies are carton pack only.

PRODUCTION FLOW CHART
FOR 'EXTRUDED' AUTOMOTIVE RUBBER HOSE



4.2 Outline List of Machinery and Equipment

Hot rolling build machine	US\$	113,750
Rubber slitting machine	US\$	087,500
Mandrels	US\$	017,500
Mandrel holding machines	US\$	035,000
Curing oven	US\$	35,000
Air compressor	US\$	17,500
Steam generator	US\$	17,500
Pallet trucks, racking, work surfaces packing equipment and small tools	US\$	35,000
Extrusion machine	US\$	96,250
Braiding machine	US\$	35,000
Extrusion tooling	US\$	17,500
Hose cutter and reeler	US\$	12,250
Toolroom	US\$	175,000

An initial set of spare parts which may be treated as working capital inventory is costed at 7½% of the new machinery and equipment cost.

US\$ 52,100

4.3 Budget Costs Estimate for Machinery

Machine	US\$	694,750
Carriage	US\$	56,000

4.4 Budget Costs for Erection of Machinery

This assumes two specialists are sent to site from the equipment vendors, and anticipates an adequate supply of local labour and tradesmen. Local accommodation of specialists is not included:-

Specialist installers	USS	49.000
Flights	USS	12.600

4.5 Site Requirements (see Appendix 3)

A level site with mains electricity, water and sewage connections is required, with reasonable access for heavy road transport. The site should be not less than 1.5 times the floor area of the buildings, ie, 1500 square metres (30m x 50m) for the site including 1000 square metres for the building. If finances permit, one would favour a site 2.5 times the floor area (50m x 50m) to allow for some expansion without moving site.

The site layout is shown in Appendix 3 and comprises:-

Production area	:	630m ²
Warehouse area	:	220m ²
Office area	:	150m ²
Hardstanding area	:	500m ²

Total land		1500m ²

4.6 Buildings and Civil Works

The main building should be weatherproof and appropriate to local climatic conditions. There will be no abnormal floor loads.

Surface drainage should be adequate to minimise the chance of flooding the factory area.

There are no other special civil works or structural features required.

The front office section of the building should contain:-

- General Manager's office.
- Production Control office.
- Sales and Administration office.

The total office space is likely to be 15% of the total building, ie, 150 square metres and should be serviced with:-

- 3 phase electrical supply (200 kVA).
- Water (general washing and cleaning only).
- Sewage (no special effluents).

4.7 Raw Materials

The basic raw materials required are:-

- | | | | |
|----|----------------------------------|-----|---|
| a) | Rubber | NBR | Acrylonitrile-butadiene
(pre-prepared as copolymer.
extruder feedstock) |
| | or | SBR | Styrene butadiene copolymer. |
| | or | | Other available good extruding
rubber compound. |
| b) | Rubber | Q | Silicone rubber sheet. |
| c) | 3 ply polyester
reinforcement | | In roll form. |
| d) | Polyester yarn | | For reinforcement braiding. |
| e) | Packing materials | | Boxes and cartons. |
| f) | Release agents
and lubricants | | For use in both extrusion
machine and on mandrels. |
| g) | Steel or
aluminium | | For tooling manufacture. |

Total weight of raw materials for the specified Year 3 nominal production level is 166,000 kg per annum or 3,500 kg per week. The rubber comprises about 85% of the weight, the textile 5% and packing 10%.

Anticipated scrap and rejection rate is 3% which cannot be salvaged easily.

4.8 Raw Material and Consumable Items Prices

Typical input costs per automotive hose are:-

Freeform silicon hose

Silicone rubber	US\$ 9.98
Textile	US\$ 0.35
Packing	US\$ 0.35
Consumables and scrap	US\$ 0.21

Extruded parallel hose

Rubber	US\$ 2.24
Textile	US\$ 0.09
Packing	US\$ 0.35
Consumables and scrap	US\$ 0.05

Prices for the major raw materials are likely to be:

<u>Material</u>	<u>US\$/Kg</u>
Rubber compounds as pre-prepared extruder feedstock	13.50
Silicone sheet	25.20
Polyester yarn	3.70
Packing boxes and cartons	3.60

Release agents 12.00

The input/output ratio aim should be less than 1.03 once production is routine i.e. scrap rates of under 3%.

4.9 Utility Requirements

(Typical European prices per hose)

Electricity (ovens and machines) USS 0.09

Water USS 0.009

Electrical requirements based on 200 kW hour loading.

Water requirements should not exceed 400 litres per shift.

4.10 Annual Maintenance Costs

These should be low in Year 1, rising to a steady rate in Year 3. Typically these will be under 10% of the overhead costs. ie, under US \$0.11 per hose based on Year 3 potential output.

These annual maintenance costs include sub-contract local manpower costs and do not include costs of personnel already employed at the factory.

4.11 Manpower Requirements

General Manager

Will have production engineering, financial and person-management skills. Chartered Engineer with 5 years industrial experience.

Sales Manager

Basically a working salesman. Three years' experience in selling to the motor distribution trade.

Accountant/Book-keeper

General understanding of book-keeping, debtors and creditors. To work in co-operation with company auditors. Five years' experience in similar work.

Office Staff (2)

Internal sales duties. GCSE or equivalent. One of the two should have 3 years' experience of internal sales.

Production Engineer

Qualified and experienced in continuous production work. Technician Engineer Status.

Foreman

Must have engineering trade skills and have served formal craft apprenticeship. Experience of supervising staff desirable.

Toolmaker

Must have engineering trade skills.

Maintenance Fitter

Must have engineering trade skills, and have served formal craft apprenticeship.

Operators (14)

General factory skills, but not trade skills.

These numbers can be increased as volume production builds up but this skeleton workforce is all that the business can support in the formative years.

Summarising the skill requirements of the above personnel:-

Skilled tradesmen	3
Semi-skilled tradesmen	2
Unskilled	12

4.12 Pre-Production Costs

It is assumed that this operation will be set up either as a licence operation or a know-how operation.

A typical licence and know-how fee would be US\$ 306.250 plus 5% of ex-works selling price. This fee should include the direct costs of:-

- Plant commissioning.
- Management staff training.
- Operator training.
- Initial production trouble-shooting.

Royalty is clearly a matter of negotiation. One would expect a 5% Royalty to cover travel and visit costs of the technology supplier for all routine matters.

4.13 Initial Production Levels

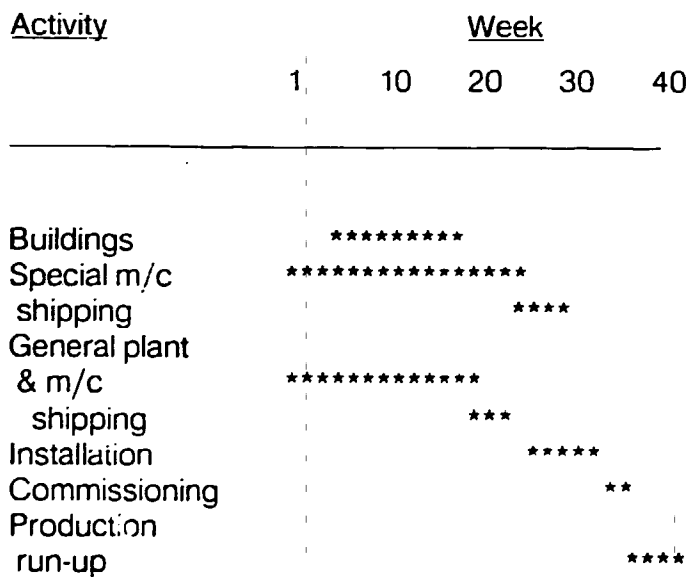
The following is a typical early years production profile for a new plant:-

Year 1	75.000 hoses
Year 2	231.000 hoses
Year 3	387.000 hoses (full production, single shift)

4.14 Construction Period

Buildings	16 weeks
Special machines	
Hot rolling build machine	26 weeks
Shipping	6 weeks
General plant and machinery	20 weeks
Shipping	6 weeks
Installation	8 weeks
Commissioning	4 weeks
Production run-up	4 weeks

Construction period:-



4.15 Environmental Aspects

There should be no abnormal environmental problems. Conventional waste tips should be satisfactory.

5.0 PRODUCTION COSTS

These are indicated as cost per hose based on a factory cost price of US \$14.39 for a complex freeform silicone hose and US \$3.61 for a simple extruded hose.

	Silicone	
	<u>Freeform</u>	<u>Extruded</u>
Material	US\$ 10.89	US\$ 2.73
Labour	US\$ 1.75	US\$ 0.44
Overhead	US\$ 1.75	US\$ 0.44

Material costs include delivery to the factory of the raw materials.

Labour costs are for direct staff, which comprise production engineer, foreman, toolmaker and operators plus production staff in the offices.

6.0 INTERNATIONAL PRICES

Typical international average pricing for hoses is:-

	<u>Freeform Silicone</u>	<u>Extruded</u>
Retail price	US\$ 36.66	US\$ 9.21

Trade price	US\$ 29.35	US\$ 7.33
Ex-works price	US\$ 20.55	US\$ 5.15

Retail prices for the most common replacement items, top and bottom water hoses, (moulded rubber not silicone) are as follows:-

For popular cars up to 2 litres:

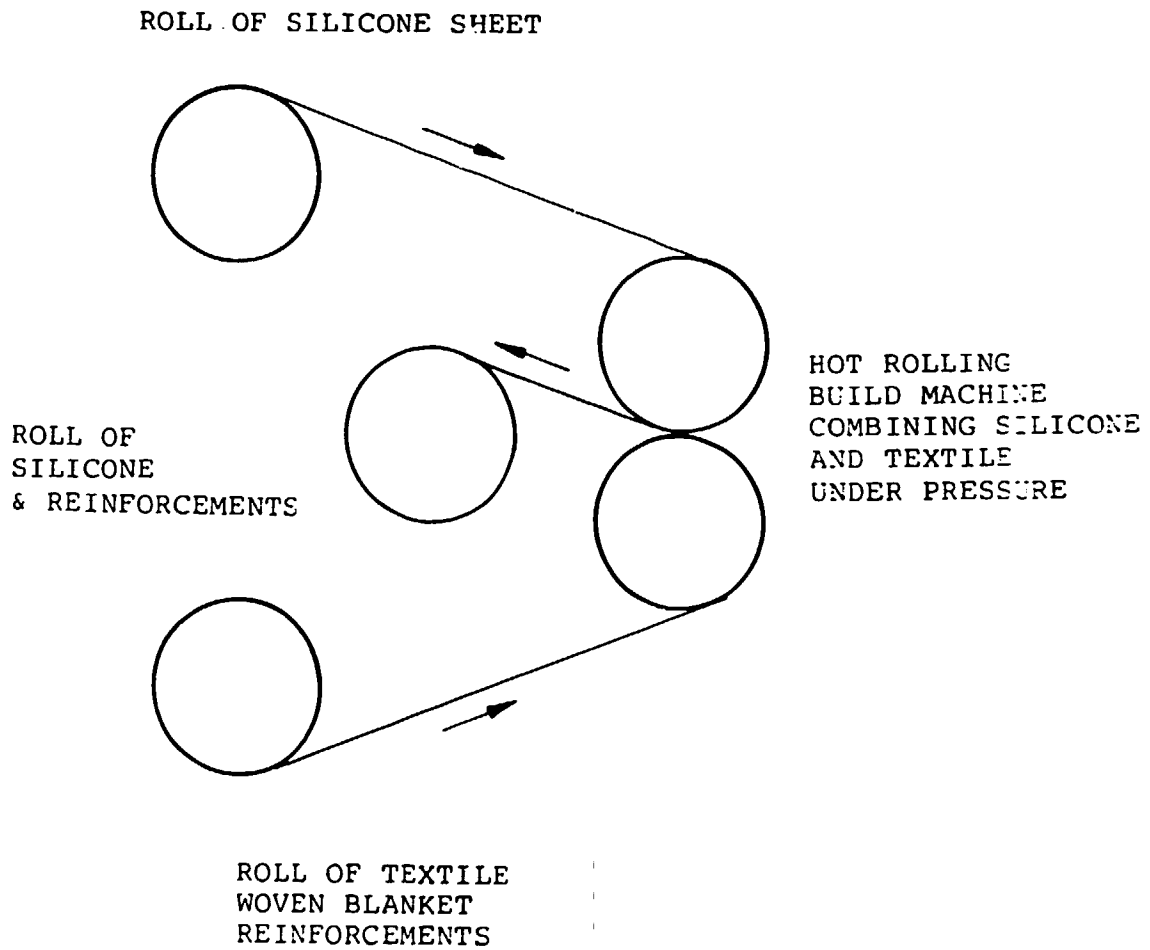
Top hose	US\$ 22.65
Bottom hose	US\$ 37.38

For small engines the prices are around 60% of the above, and for larger commercial vehicles up to 100% higher.

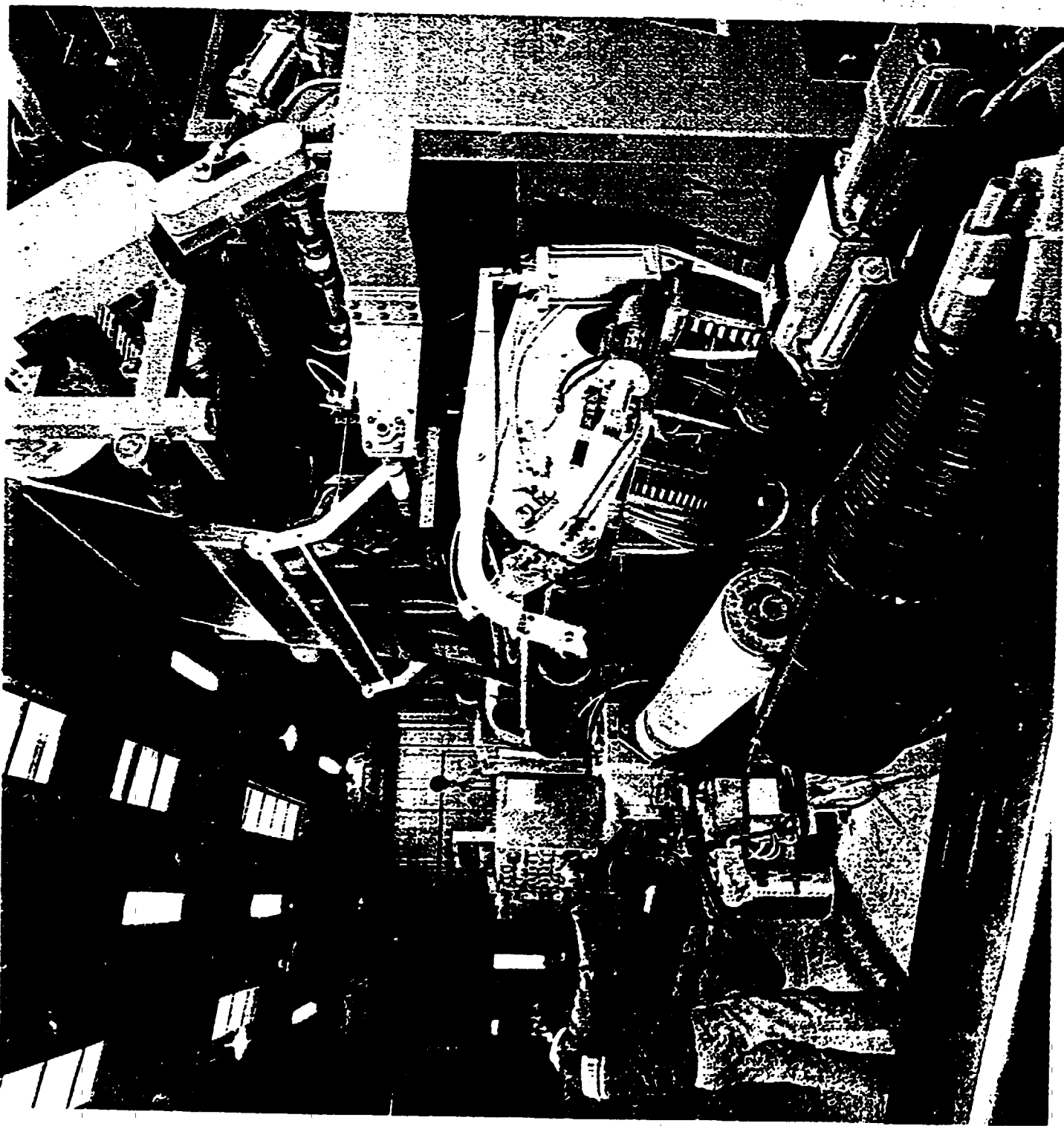
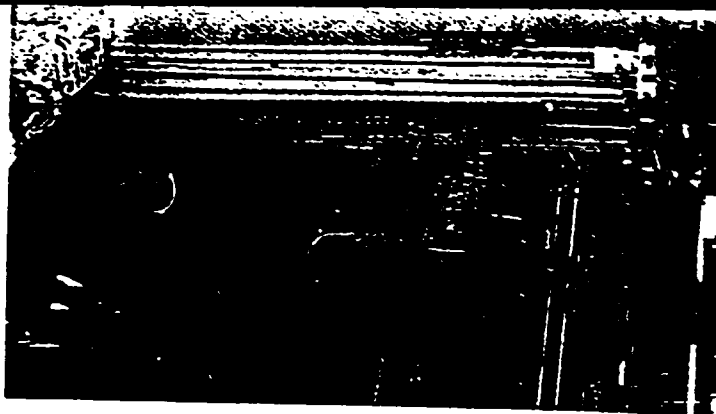
The extruded hose is extensively used in pneumatics and hydraulics in the non-passenger vehicle markets. Being relatively bulky the locally manufactured product should have an advantage over imports.

With freeform hose tooling being available at low cost (from own toolroom), small batch production should give an advantage to the local product over the manufacturers' own brand imported hose for which a premium price will be asked.

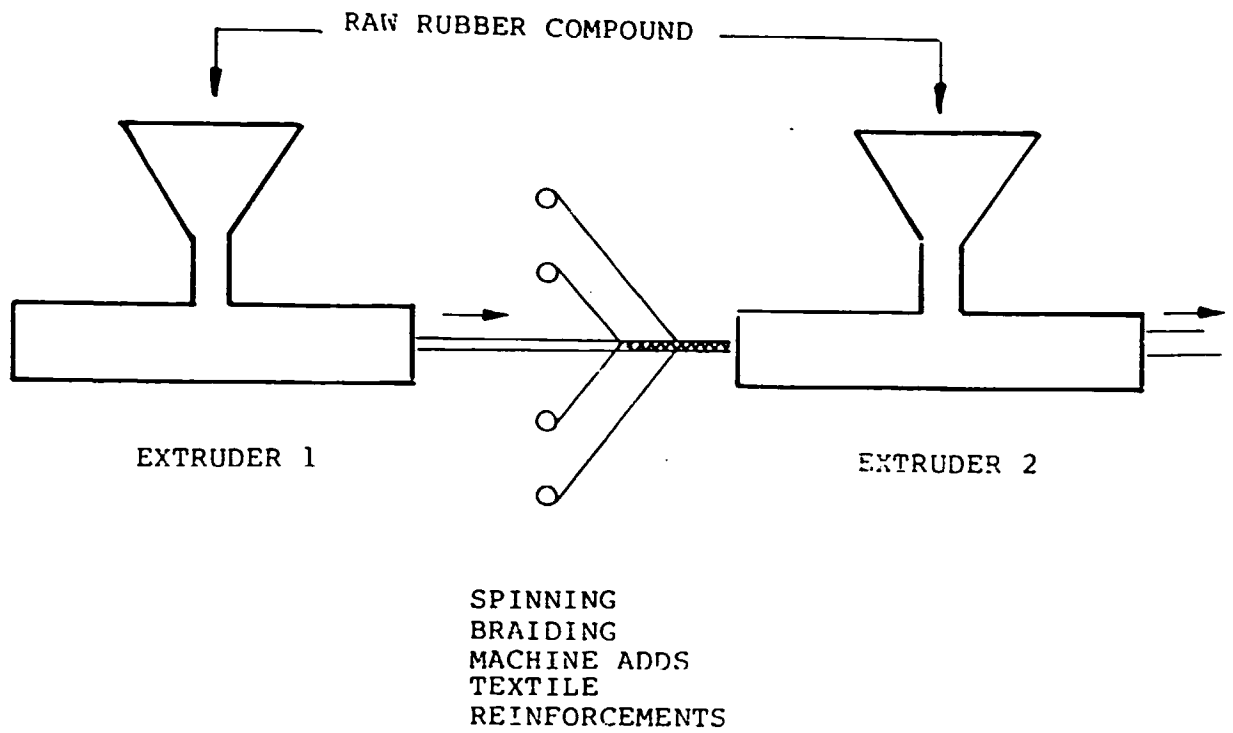
APPENDICES



HOT ROLL BUILD MACHINE



HOT ROLL BUILD MACHINE



CONTINUOUS DOUBLE EXTRUSION OF REINFORCED
RUBBER HOSE

OUTSIDE STORE

COMPRESSOR

EXTRUSION

DESPATCH

OVEN

RAW MATERIAL

FREEFORM
HOSE
BUILDING

TOOL ROOM

HOT ROLL
BUILD M/C

SLITTING

STEAM MILL

EXPANSION
SITE

OFFICES & TOILETS

AUTOMOTIVE HOSE FACTORY LAYOUT

TECHNICAL PROFILE DATA REQUIREMENTS

ASSESSMENT AND SUMMARY SHEET

Product (s) : Rubber Hose for Automotive Replacement
Market
Capacity : 387,000 hoses/year
Number of Shifts : Single Shift
Number of working days/year :
Production output by product
(incl. efficiency ratio) :

INVESTMENT - US DOLLARS [Basic Exchange Rate Used US\$1.0 = QR3.65]

-	Plant/machinery (FOB):		
*	Main production plant/machinery (1)	:	\$ 449.750
*	Storage equipment	:	\$ 30.000
*	Auxiliary equipment	:	\$ 210.000
*	Packaging equipment	:	\$ 5.000
*	Pollution control equipment	:	-
*	Engineering /Design fees (if required)	:	include in know-how fee
*	Sub-Total of Above Machine	:	<u>\$ 694.750</u>
*	Carriage	:	\$ 56.000

(1) Note. Separate detailed schedule of plant/machinery items to be attached.

-	Spare parts (1 year): (<u>initial set</u> as inventory for working capital)		
-	Erection costs: (including any technical assistance)		
	Specialist installer	:	\$ 49.000
	Flights	:	\$ 12.600
-	Freight charges (to Arab Gulf Port) (estimate)		

-	Site and building requirements (M2)		
•	Production area	:	630m ²
•	Warehouse area	:	220m ²
•	Office area	:	150m ²
•	Hardstanding area	:	500m ²

	Total site land	:	2500m ² (including 1000m ² for the floor area of the building and 1000m ² for future expansion- optional).
-	Transport equipment (if available)	:	Local purchase
-	Furniture and fixtures (if available)	:	Local purchase
-	Pre-production expenses (consultant component estimates)		
•	Training		
*	Fees	:	24,000
*	Number of persons	:	
*	Period	:	2 weeks 4 weeks
*	Location	:	UK

	Sub Total Cost	:	24,000
•	Travel expenses	:	16,250
•	Commissioning	:	26,000
•	Studies (if required)	:	40,000
•	Licence fee (if required)	:	200,000

	TOTAL	:	US\$ 306,250 + 5% of ex-works price

-	Construction programme	
	(Total in calendar months)	
	• Engineering/Design/Purchase	: 26 weeks
	• Delivery/equipment	: 6 weeks
	• Buildings	: 16 weeks
	• Installation	: 8 weeks
	• Commissioning	: 4 weeks
		<hr/>
	TOTAL	: 42 weeks from "go - ahead"

-	Production programme	
	(Production achievable after commissioning in %)	
	• First year of production	: 75.000 hoses
	• Second year of production	: 231.000 hoses
	• Third year of production	: 387.000 hoses

PRODUCTION AND OPERATION COSTS

Raw materials :

PRODUCT	QUANTITIES (**)	PRICES (USS. T)
1. <u>Freeform Silicon Hoses</u>		
Silicon rubber		25.200
Textile		3.700
Packing		3,600
2. <u>Extruded Parallel Hoses</u>		
Rubber		13.500
Textile		3.700
Packing		3.600

Consumables:

(i.e. Chemicals and other materials) 12,000

PRODUCT	QUANTITIES (**)	PRICES (US\$/T)
1. Freeform Hoses	190,000	36,000
2. Extruded Hoses	197,000	17,900

Royalties: 5% of ex-works price/year.

<u>Utilities (**)</u>	<u>US\$ per unit (excluding heating and air-conditioning)</u>
Fuel :	-
Process water :	0.009
Electricity	0.09
Steam :	-
Cooling water :	-
Compressed air :	0.01
Gas (***) :	-
Gas oil :	-

(**) Unit (Kg, T, m³, ...) per unit of product or per year.

(***) Natural, LPG etc. (please define)

Maintenance cost:

(including spare parts, excluding local manpower)

\$0.11/hose

Labour (by relevant skill and categories):

Production (a)	No./Shift			Administration	No.
	1	2	3		
Foreman	1			General Manager	1
Toolmaker	1			Sales Manager	1
Maintenance	1			Accountant	1
Operators	14			Office Staff	2
TOTAL	17			TOTAL	5

(a) Includes Maintenance Personnel.

International Sale Prices (By product) : USS

PRODUCT	EX - WORKS	RETAIL
Freeform silicon	20.55	36.66
Extruded hose	5.15	9.21

Comparative Existing Location (b) Production Cost (breakdown):

<u>Cost item</u>	<u>Freeform</u>	<u>Extruded</u>
Raw materials/consumables	\$ 10.89	\$ 2.73
Labour (direct only)	\$ 1.75	\$ 0.44
Packaging		
Royalties		
Utilities		
Maintenance)		
General expenses)	\$ 1.75	\$ 0.44
Distribution expenses)		
Depreciation)		
 TOTAL:	 \$ 14.39	 \$ 3.61

To be provided for comparison with Arabian Gulf cost breakdown.

(b) e.g. USA. W. Europe. Japan, Korea (as applicable)