Thermometers (Upto 150°C)

PRODUCT CODE	:	N. A.
QUALITY AND STANDARDS	:	IS 2480:1973 General purpose solid stem glass thermometers IS 2627:1979 Glossary of terms relating to liquid in glass thermometers IS 4610:1968 Glass tubes for general purpose and reference thermometers IS 4825:1968 Laboratory and reference thermometers IS 5681:1970 General meteorological liquid in glass thermometers IS 6274:1971 Method of calibrating liquid in glass thermometers IS 6592:1972 Soil thermometers
PRODUCTION CAPACITY	:	Quantity: 60,000 pieces Value : Rs.20.79 lakhs
MONTH AND YEAR OF PREPARATION	:	March, 2003
PREPARED BY	:	Small Industries Service Institute Rajajinagar, Bangalore-560 044. Phone Nos.: 3351581-82 Telex: 845-2328 Fax: 3351583/3204018 E.Mail: sisibng@bgl.vsnl.net.in

Introduction

Thermometer is a simple instrument to measure temperature accurately. The industrial thermometers proposed in the project profile are 'liquid in glass thermometers' of the solid stem type or the chemical school type having flexibility in shape and purpose. These thermometers can be developed in various ranges, sizes, shapes to cope with the diversified needs to develop various industrial horizons within the International Standards.

Market Potential

With the advent of science and technology, research and development and rapid industrialisation, educational development programmes, there is a very good scope for setting up a number of small scale units covering various ranges, sizes, shapes. The industry relies on correct estimation of temperature measurements in various processes/ reactions. Industries and research laboratories require mostly thermometers ranging between - 100°C to 500°C. Due to

expansion educational instructions with science as a basic subject being introduced from primary classes onwards, the need of thermometers between 0-110°C and 0-150°C ranges is fairly large.

This project is envisaged for the manufacture of different types of solid stem thermometers with temperature ranging from 0-50°C to 0-110°C and 0-150°C. These thermometers are expected to have a good market in the country in educational institutions, laboratories, R and D centres, industry etc.

BASIS AND PRESUMPTIONS

1. *Efficiency:* Units for the manufacture of these thermometers can be set up in any part of the country preferably in cooler climates like hill-stations. It is proposed that the unit will work 300 days a year on a single shift basis of 8 hours a day. 75% efficiency of personnel and machinery is taken for achieving the full capacity production.
2. *Time period:* Within 1 year of trial production the full capacity is expected to be achieved.
3. *Labour wages:* Labour wages is taken at minimum applicable.
4. *Interest rate:* Taken at 14% per annum.
5. *Pay back period:* About 7 years.
6. *Land cost:* Rented premises.

IMPLEMENTATION SCHEDULE

The project should be implemented within 6 months. The following is the time-schedule required for each activity for implementation:

Sl. No.	*Activity*	*Period*
1.	Project preparation and acquisition of sheds, provisional registration, Procurement of power and other licences	2 Months
2.	Procurement of machinery, equipments, and raw materials	3 Months
3.	Installation of machinery, equipment, recruitment of labour, trial run etc.	1 Month
	Total	6 Months

TECHNICAL ASPECTS

Process of Manufacture

a. Raw Materials

The principal raw materials required for thermometer manufacture are capillary tubing, glass tubes and filling liquids like pure mercury.

The capillary tubing are glass tubes with fine bores. They can be of different shapes and different colours. Thermometers require tubes from 0.02 mm to 0.1 mm bore. These bores approximately correspond to 360 mm to 20 mm spirit height. The outside dia of the capillaries ranges from 1 mm to 10 mm or so. Coloured enamel is used on the back side of capillary and also the bore is made oval for making the column visible. The prismatic capillaries in red and blue back are also used.

Pure, triple-distilled mercury is required as a filling liquid. Petroleum, coloured red or blue for better visibility is also used for lower temperature.

b. Production technique

The manufactures of these thermometers require very skilled

blowers and graduators. The quality of these thermometers depends upon the manufacturing process, the skill of the workers, use of correct machinery, following correct specifications and use of good quality raw materials.

c. Blowing Section

The capillaries received from factories are sorted out as per their spirit heights. It is then put in a dust proof cup-boards, so that the selection is easy and quick.

By knowing the range and type of a thermometer, the mercury length of the capillaries is accurately determined.

The bulb size is calculated using the formula

$$\text{Bulb size} = \frac{\text{Scale length x 10}}{\text{Mercury length}}$$

The capillaries are cut to the required sizes.

A bulb is blown at one end of the capillary by closing the other end with sealing wax. A small piece of glass tube is attached to the capillary and finally by heating a bulb is drawn neatly. The exact quantity of mercury as per the bulb size is poured into the bulb and the bulb size is marked. The mercury is then removed, the bulb is closed at the marked point.

A funnel is attached to the other end of the capillary. The bulb of the thermometer is slightly warmed to expel the air out of the bulb and the capillary. The end of the funnel with a jet is immersed in a cup of pure mercury. The mercury rises into the funnel and then the jet is sealed.

The thermometer is heated over a ribbon burner by which all the air and moisture trapped in the bulb and the capillary is driven into the funnel. By heating the funnel, a vacuum chamber is provided at the top, above the range of the thermometer. After it is made sure that the air is removed, the thermometers are put inside a bath of ice for about 10 minutes, and when the contraction of mercury is complete, the mercury thread is broken at the measured distance from the bulb. The thermometer is roughly checked at any two points in the range. The vacuum bulb is cut and top is sealed.

In vacuum process filling, the funnel need not be attached to the thermometer. By using rotary oil pump and the mercury diffusion pump, the thermometers are filled up.

Now the thermometer is ready to be sent to graduation section.

d. Graduation Section

The thermometers are first cleaned with clean rag and the oily substance is removed with sprit.

The thermometers are then put in different temperature baths (according to the range and sub-division) from higher temperatures to lower temperatures and adjusted avoiding parallax error.

The thermometers are then given a fine and thin coating of wax mixture leaving no space.

They are then graduated with the help of graduating machine neatly and etched with Hydrofluoric acid of 80-85% strength. The time of etching range from 60-90 seconds depending upon the type of glass and season and depth of etching needed. After etching is over, they are immersed in hot water and dewaxed thoroughly.

The graduated thermometers are then pantographed carefully after waxing again. Trade marks etc., are also pantographed. It is finally dewaxed and

then a mixture of printing ink and turpentine oil is applied to the graduated portion, cleaned with a soft paper and allowed to dry.

The thermometers are finally checked at different temperatures to know the accuracy of graduation and, if found to be giving erroneous readings, rejected.

They are then packed either in wooden covers or cardboard covers and sent to the market.

The general procedure for any stem thermometer is the same. If, however, there is any special design or range or construction, it is accordingly made and finally adjusted and completed.

Quality Control and Standards

IS 2480:1973	General purpose solid stem glass thermometers
IS 2627:1979	Glossary of terms relating to liquid in glass thermometers
IS 4610:1968	Glass tubes for general purpose and reference thermometers
IS 4825:1968	Laboratory and reference thermometers
IS 5681:1970	General meteorological liquid in glass thermometers
IS 6274:1971	Method of calibrating liquid in glass thermometers
IS 6592:1972	Soil thermometers

Production Capacity (per annum)

Quantity : 54,000 Pcs. of Thermometers after 6000 Pcs rejections.

Value : Rs.20.79 lakhs.

Motive Power 5 HP.

Pollution Control

Exhaust fans.

FINANCIAL ASPECTS

A. Fixed Capital

(i) Land and building		
Covered area of 2000 sq.ft. including blowing section, graduation section, adjusting room, etching room, store room for raw materials and finished goods, show-room and office block		Rented 3,000 per month
	Total	36,000

(ii) Machinery and Equipments

Description	Ind/ Imp.	Qty.	Price (Rs.)
Production unit			
Thermometer filling plant (mercury) with Hg.diffusion pump and pharma pump, tubular base frame with right and left hand fitted table top and vacuum retentive ground metal plate vacuum bell of 750 mm ht. with container 350 mm ht.	Imp.	1	2,50,000
Graduating m/c, hand operated with ball bearing carriage rack drive for vertical and horizontal fine adjustment carriage with about 150 mm width and 5 mm height with ball bearing cursor and adjusting mechanical line length for finer operation, complete with 2 boards graduating area and master scale holder	Imp.	3	25,000

Description	Ind/ Imp.	Qty.	Price (Rs.)
Masterscales with regulator sub-divisions as follows: 400 divisions each 1.5 mm 300 divisions each 2.0 mm 200 divisions each 3.0 mm 300 divisions each 2.0 mm 180 divisions each 4.0 mm 360 divisions each 2.0 mm 150 divisions each 4.0 mm 600 divisions each 1.0 mm	Imp.	4	15,000
Adjusting and testing apparatus with electric heating and drive suitable for temps., upto 95°C, modern high precision design for accommodating 30 thermometers at a time. Diameter of the double walled brass testing vessel with intermediate heat insulation blanket 270 mm, immersion depth 500 mm design feature includes a revolving carrier springs with a maximum opening of 15 mm. The stirrer is of improved design, operates from below and driven by AC Motor 220 V, electric heating is controlled via a ring core transformer. The unit is to be mounted on a solid base which also houses the switch gear and instrument comprising ammeter, voltmeter, pilot lamps etc., and is supplied with flux ready for operation	Imp.	1	25,000
Air compressor directly joined to a motor for 440 V, sufficient for 15-20 burners with accessories	Ind.	1	40,000
Manifold for LPG for 15-20 burners	Ind.	1	30,000
Annealing furnace, electrically heated	Ind.	1	1,00,000
Graduating machine, precision type with rack and pinion type for fine adjustments	Ind.	2	20,000
Pentographing machine, including rack and drive for adjustment of the slide in support with scribber carriage tabulators etc.	Ind.	3	10,000
Mercury distillation plant	Ind.	1	10,000
Blowing burners	Ind.	12	15,000
Ribbon burners	Ind.	3	6,000
Bunsen burner	Ind.	10	2,000
Water boiling apparatus, gas heated new improved design	Ind.	2	10,000
Ice pots, double walled with good insulator	Ind.	3	3,000
Glass cutting knives	Ind.	10	1,000
Exhaust fans	Ind.	2	5,000
First aid box	Ind.	1	1,000
Tools like slide calipers, forceps, scissors etc.	Ind.		2,000
	Total		5,70,000
Testing Equipments			
Standard Thermometers 15 Nos. of different ranges imported	LS		30,000

Description	Ind/ Imp.	Qty.	Price (Rs.)
Electrification and installation charges @ 10% of cost of machines and equipments			57,000
Total cost of m/c and equipment			6,57,000
Cost of office equipment/working tables etc.			25,000
(iii) Pre-operative Expenses			8,000
Total Fixed Capital			6,90,000

B. Working Capital (Per Month)

(i) Personnel (per month)

Designation	No.	Salary (Rs.)	(Rs.)
Administrative and Supervisory			
Fully trained Expert-cum-Manager	1	5,000	5,000
Accountant-Clerk	1	3,000	3,000
Salesman	1	2,500	2,500
Peon	1	1,600	1,600
Sweeper/Watchman	1	1,600	1,600

Designation	No.	Salary (Rs.)	(Rs.)
Skilled Technical and Un-skilled			
Thermometer blowers	5	3,000	15,000
Thermometer graduators/adjustors	3	3,000	9,000
Helpers	2	1,600	3,200
	Total		40,900
+ Perquisites @ 15% of salaries			6,135
	Total		47,035
	or Say		47,000

(ii) Raw Materials (per month)

Particulars	Ind/ Imp	Qty. Kg.	Rate/Kg (Rs.)	Value (Rs.)
Thermometer capillary tubing, white enamelled, round, normal glass, 6-7 mm dia, 60-80 mm spirit height	Imp	40	375	15,000
Normal glass tubing 3-4 mm dia with 0.2-0.3 mm wall thickness for joining bulbs	Imp	5	400	2,000
Mercury purified and triple distilled	Imp	10	900	9,000
Petroleum filling (red and blue)	Imp	4 litrs.	500/lit.	2,000
Thermometer capillary tubes, white enamelled, round, ordinary glass, 6-7 mm dia, 60-80 mm spirit height	Ind	100	250	25,000
Thermometer capillary tubing, white enamelled, round, ordinary glass, 6-7 mm dia, 50-60 mm spirit height	Ind	10	250	2,500
Soda glass tubing 8-10 mm dia, with 0.5 to 0.75 wall thickness	Ind	5	200	1000
		Total		56,500
LPG cylinders (15.5 kg. Capacity each)		30 cyl.	170	5,100
Chemicals, waxes, printing machines, acids, rubber tubing, oils etc.				5,000
Packing materials for 4500 pcs. of thermometer				7,500
		Total		74,100

(iii) Utilities (per month)	(Rs.)
Power 500 units @ Rs.3/- per unit	1,500
Water	300
Total	1,800

(iv) Other Contingent Expenses (per month)	(Rs.)
Rent	3,000
Postage and stationery	300
Telephone	1,000
Consumable stores	300
Repairs and maintenance	300
Transport charges	400
Advertisement and publicity	1,000
Insurance	300
Miscellaneous expenditure	300
Total	6,900

(v) Total Working Capital (on 3 months basis) 3,89,400

C. Total Capital Investment

Fixed capital	Rs. 6,90,000
Working capital	Rs. 3,89,400
Total	Rs. 10,79,400

MACHINERY UTILISATION

No bottleneck is expected during operations and 75% utilisation of machinery and manpower has been taken into consideration.

FINANCIAL ANALYSIS

(1) Cost of production (per year)	(Rs.)
Total recurring cost	15,57,600
Depreciation on machinery and equipment @ 10%	56,500
Depreciation on furnace @ 20%	20,000
Depreciation on office equipment @ 20%	5,000
Interest on total capital investment 14%	1,51,116
Total	17,90,216

(2) Turn-over (per year)	(Rs.)
Net production for sales after rejection	54,000 Pcs.

Item	Qty (Nos.)	Rate (Rs.)	Value (Rs.)
0-50°/100°C Petroleum filled ordinary glass	6000	25	1,50,000
0-50°/100°C Mercury filled normal glass	500	35	17,500
0-110°C Mercury filled ordinary glass	15,000	35	5,25,000
0-110°C Mercury filled normal glass	8000	45	3,60,000
0-150°C Mercury filled ordinary glass	19,800	40	7,92,000
0-150°C Mercury filled normal glass	4700	50	2,35,000
Total	54,000		20,79,500
Net Turnover (per year)			20,79,500

(3) Net Profit (per year)

= Turn over – Cost of production
= Rs. 20,79,500 – 17,90,216
= Rs. 2,89,284

(4) Net Profit Ratio

$$= \frac{\text{Net profit per year x 100}}{\text{Turn over per year}}$$

$$= \frac{2,89,284 \times 100}{20,79,500}$$

= 13.91%

(5) Rate of Return

$$= \frac{\text{Net profit per year x 100}}{\text{Total investment}}$$

$$= \frac{2,89,284 \times 100}{10,79,400}$$

= 26.8%

(6) Break-even Point

Fixed cost	(Rs.)
Total depreciation	81,500
Rent	36,000
Interest on total investment	1,51,116
Insurance	3,600

Fixed cost	(Rs.)
40% of salary and wages	2,25,600
40% of other contingent expenses	31,680
Total	5,29,496
Net Profit (per year)	2,89,284

$$B.E.P. = \frac{\text{Fixed cost} \times 100}{\text{Fixed cost} + \text{Profit}}$$

$$= \frac{5,29,496 \times 100}{5,29,496 + 2,89,284}$$

$$= 64.67\%$$

Addresses of Machinery and Equipment Suppliers

British

1. M/s. Brannan Thermometers
   Cleaton Moor
   Cumberland CA 225 QE.
2. M/s. Negretti and Zambia Ltd.
   Stockdale Aylesbury,
   Lbucks HP 20 IDR.
3. M/s. Taylor Instruments
   Road Gunnels, Wood Road,
   Stvenage/Herts SG Iand/EL.
4. M/s. GH Zeal Ltd.
   Loni Land, Herton,
   London SW 19300
5. M/s. L Richoux Co. (London) Ltd.
   3 Morocoo Street, South Wark
   London SEI 3 HB.

China

1. M/s. Fuxing
   Man Wai Street, Peaking.

West Germany

1. FA Armarol
   Werthien (Main),
   West Germany.
2. Fa Jucleim Thermometers
   Gabrik,
   West Germany.
3. Franz Guentner
   8593, Tirschenreuth,
   Franz-Holdmann Bawaria
   Street-19, West Germany.
4. M/s. Herbert Arnold, Glass Techn.
   Machinery and Apparatus,
   Weillrug Lahn, Weil Strasse-21,
   West Germany.
5. M/s. Beopple and Co.
   Glass Techn.
   Machinery and Apparatus,
   Giessan Lahn POB (40)
   West Germany.

For Vacuum Plant

1. M/s. Arthur Pfeiffer
   Wotzlar/Lahn,
   PO.147, West Germany.

Indigenous

1. M/s. Veer Workshop
   B-53, Naraina Indl. Area Phase II,
   New Delhi-110 028.
2. M/s. Japsin Products Inds.
   7, Netaji Subhash Marg,
   Darya Ganj, New Delhi-2.
3. M/s. Mohan Brothers
   Science Apparatus Workshop,
   Bengali Mohalla, Ambala Cantt.
   (Haryana.)
4. M/s. Thermometers and Thermomatric Appliances
   F-6A, Bhagat Singh Market,
   New Delhi-1.
5. M/s. Swastika Electric and Scientific Works ®
   Timber Market,
   Ambala Cantt-133 001.
6. M/s. Oswal Scientific Stores
   S.C.O., 4 Sector 16-D,
   Chandigarh-160 017.

7. M/s. K.G. Khosla and Co. Pvt. Ltd.
D.G. Road, New Delhi.
8. M/s. Standard Sheet Metal Works
Cross Road No.2, Ambala Cantt
(Haryana).
9. M/s. Gansons Pvt. Ltd.
207, Kalka Chamber,
Dr. Annie Besant Road, Worli,
Mumbai-400 018.
10. M/s. Narain Dass Jugal Kishore
Nicholson Road, Ambala Cantt.
11. M/s. National Physical Laboratory
Hill Side Road, New Delhi.
12. M/s. Toshniwal Bros. Pvt. Ltd.
3E/8, Jhandewalan Extn.,
New Delhi.
13. M/s. Vijay Bros.
S. Ramaswamy Street
G.T. Road, Chennai-1.

Muffle Furnace and Ovens

1. M/s. S.R. Electric Works
Staff Road, Ambala Cantt.
2. M/s. Craftsman Electric Corpn. Ltd.
Suthona Hall, Nosbit Road,
Mazhagoan, Mumbai.
3. M/s. Thermo Electric Equipment Co.
59, Commercial Chamber,
Maszid Bhunder Road,
Mumbai.
4. M/s. Hysakhi and Co.
55, Bannerjee Street,
Kolkata-6.

Raw Material Suppliers

Suppliers of Thermometer Capillary and Tubing

Japan

1. M/s. Endow Sangyo Co. Ltd.
Akamon Building, 10 Shibo
Tharmuracho, 2-Chomo
Minato-KV, Tokyo, Japan.
2. M/s. Terumo Corpn.
44-1, Hatagya, 2-Chome,
Shibuya-KU, Tokyo.
3. M/s. Japan Thermometer and
Hydrometer Inds. Co. Ltd.
9, Kanda Ta-cho 2-Chome
Chiyoda-Ku, Tokyo.
4. M/s. Sansei Medical Instruments
Co. Ltd.
10-9, Kika Wahigashi, 3-
Chkome, Yodogawa-ku,
Osaka, Japan.
5. M/s. Tajiri Industrial Co. Ltd.
19-7, Hongo 3-Chomo
Bunkyo-Ku, Tokyo, Japan.
6. M/s. Shi Batama Scientific Co. Ltd.
11-8, Minami Otsuka, 3 Chome,
Toshima-Ku, Tokyo, Japan.

Germany

1. M/s. Jennar Glass Works, Schott
and Gen Main Halternberg Strasse
West Germany.
2. M/s. Glass Workwertheim, Gerate
Fur Fissen Chaft and Technik
Wertheim Main, West Germany.
3. M/s. Web Jena Glass Work and
Schoot and Jen Jens
Postamachrift Jene Post Fach,
129, West Germany.
4. M/s. Edger Heintze
Weilburgn Lahn
P.O. Box No.94,
West Germany.
5. M/s. Branin Wartheim Main
West Germany.

U.K.

1. M/s. James A Jobling and Co. Ltd.
Wear Glass Works Sunduland SR
46 E J, Durham,
England.

2. M/s. Whitefriers Glass Ltd.
Wealdstone Harrow Middlesex,
England.
3. M/s. Grainger and Thosrelfull Ltd.
9.13, St. James St.,
Newcastte,
Upon Tyne-II, England.
4. M/s. Gallenkemps and Co. Ltd.
Christopher Street,
London EC 2 P 2 ER,
England.
5. M/s. Philip Harris Ltd.
Lynne Lane Shenstone WS 14
DEE, England.
6. M/s. Jencons (Scientific) Ltd.
Mark Road, Hemel Hampstead
Herts, England.
7. M/s. R.W. Jennings and Co. Ltd.
Scientech House Main Street,
East Bridge Ford Nr. Norringham
Notts,
England.

France

1. M/s. Cristalleries Verreries
18, Ruede Sebstopol, 18,
Cheisyrio, Sline,
France.

Indigenous

Neutral Glass Tube

1. M/s. Saraikella Glass Works P. Ltd.
PO Nagabram, Konnagharh,
Distt. Hooghly (W.B.)
2. M/s. Borosil Glass Works
19/90, Connaught Circus,
New Delhi.

Soda Lime Glass
Tube and Capillary

1. M/s. Ganga Glass Works
PO. Balawali, Distt. Bijnore (UP).

Capillary

1. M/s. Jintan Clinical
Thermometers,
Surender Nagar (Gujarat).

Soda Lime Glass
Tube and Capillary

1. M/s. India Optical and Scientific
Glass Works
S.N. Marg, Firozabad, (UP)
2. M/s. Manohar Glass Works
Railway Road, Firozabad,
Agra (UP)
3. M/s. Sun Tech Glass Works
Agra Gate, Firozabad (UP)