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THE GLASS INDUSTRY: FIROZABAD

DP/IND/90/010

Report of the terminal evaluation mission*

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1. EXPLANATORY NOTES

CDGI	CENTRE FOR DEVELOPMENT OF GLASS INDUSTRY
DC(SSI)	DEVELOPMENT COMMISSIONER, (SMALL SCALE INDUSTRIES)
GOI	GOVERNMENT OF INDIA
GOUP	GOVERNMENT OF UTTAR PRADESH
M[SSI & ARIs]	MINISTRY OF SMALL SCALE INDUSTRIES AND AGRO AND RURAL INDUSTRIES, GOVT. OF INDIA.
SIDO	SMALL INDUSTRIES DEVELOPMENT ORGANISATION
SIDBI	SMALL INDUSTRIES DEVELOPMENT BANK OF INDIA
SSI	SMALL SCALE INDUSTRIES
UNDP	UNITED NATIONS' DEVELOPMENT PROGRAMME
UNIDO	UNITED NATIONS' INDUSTRIAL DEVELOPMENT ORGANISATION
CGCRI	CENTRE FOR GLASS AND CERAMICS RESEARCH INSTITUTE
TERI	TATA ENERGY RESEARCH INSTITUTE
GAIL	GAS AUTHORITY OF INDIA LIMITED
Rs	INDIAN RUPEES
PTDU	PRODUCT AND TECHNOLOGY DEVELOPMENT UNIT
US \$	US DOLLAR (Exchange Rate Rs 45 per Dollar as of September, 2000).
kcal	kilocalories

2. SUMMARY

1. The terminal evaluation team comprised of the following members; Sheela Bhide, UNDP Expert and Team Leader, Gary Hardware, UNIDO Expert, M P Singh, Government of India Expert,

2. The Team had briefing meetings at UNDP/UNIDO offices, New Delhi and at the offices of the DC(SSl), New Delhi on 18 September 2000. The Team was in Firozabad from 19 to 24 September 2000 and had meetings and visits there with staff of CDGI, glass manufacturers and secondary processors such as decorated ware, bangle makers and bead makers, members of Industry Associations and a showroom. A de-briefing meeting was held at UNDP/UNDO offices, New Delhi, on 25 September 2000.

3. Firozabad glass industry is a backwater of glass making and of working practices. The industry needs to urgently address and resolve the problems of poor utilization of resources, poor working conditions, health hazards and pollution of the environment.

4. The guidance of the Centre for the Development of the Glass Industry (CDGI) is vital if the changes in the industry are to be achieved and it is considered that the objectives as set out in Phase I and in Phase II of the project are valid and relevant to the needs of the small-scale glass industry of India.

5. The project was delayed, partly due to the absence of a Principal Director until November 1997 and the late setting up of the PTDU in March 1999. The Centre can be considered to have been fully operational only from March 1999 and as a result the objectives have not been fully met. The Team recommends that the project be extended for at least another five years.

6. The project was planned and executed on the basis of a transfer of technology to the glass industry but does not seem to have given sufficient weight to the socio-economic problems in bringing about the change. Resistance from glass plant owners and from workers has been part of the problem of implementation of the aims of the project. The involvement of owners and of workers in the early stages may have made the services of the Centre more acceptable.

7. The location and facilities of the Centre has also been a barrier to developing a working relationship with owners. The Centre is some 4 km from the main road along a poorly constructed roadway. At the Centre the power supply is erratic, the telephones unreliable. These factors may also be part of the problem of recruiting staff to work at the Centre.

8. The need to improve the infrastructure and to provide Natural Gas to the Centre and the adjacent industrial site will enhance the effectiveness of the Centre. The provision of Natural Gas to the industrial site will encourage glass plant owners to move.

9. The aim of making the Centre self sufficient in three years time makes it essential to adopt a business orientated approach to running it. An appropriate Business Plan is required to meet the technical and social needs of the small-scale glass industry whilst maintaining a viable financial operation. The Principal Director should organize the Centre as a business by developing with the staff a Mission Statement, agreeing a strategy and delegating, with responsibility for achieving targets, to members of the staff.

10. To assist in the development of business a consultant can be employed to market the services of the Centre assisted by a cost accountant to carry out cost analysis in the plant operations and to advise the industry on the viability of investments.

11. A part of the Business Plan should be to view the glass industry by market sector because the needs of one sector are likely to be quite different from another. Knowledge of the

global market and how it is developing will assist CDGI in advising clients of technological changes that will help their industry.

12. The socio-economic culture is causing a resistance to change, which should be addressed as a priority. The reasons must be sought and solutions advanced to remove that resistance. A first step may be to involve owners and workers in the selection of projects, method of action and monitoring the progress. It is considered that specific people need to be targeted and to use them as "change agents".

13. The Centre should adopt, with the involvement of the owners, an integrated strategy towards technical improvements in the process and recognize the interdependence of each part of the process in maximizing the benefits. The most important element is the establishing of a permanent core of well-trained staff within each company. Without this the benefits of any technical improvement will not be optimised and may not be long lasting.

14. The continued support of the DC(SSl) and of the Government of Uttar Pradesh is vital to the success of the project. The Governing Council should also encourage the local industry owners to find representation and to take part in sub-Committees.

15. CDGI needs to be more pro-active by working in the glass plants on specific projects relating to energy and material resources, safe working practices and environmental health. These will be practical demonstrations of the usefulness of the Centre to the industry. It will also give staff from the Centre "hands on" exposure to the workings of the glass plant. Priority should be given to eliminating the health hazards associated with the use of kerosene in bangle production, cullet (broken glass) sorting and silvering of beads.

16. The successes of CDGI such as the pot manufacture and the day tank have to be translated into viable full-scale plants. The investment needed may be outside the ability of an individual owner and a development fund controlled by CDGI will be available to assist. It can be used as part of a guarantee of success or as a loan.

17. The Centre needs to have a structure to work to and which can be used to measure its effect on the industry and to monitor the trends. Setting up a database of all customers and potential clients will be a part of this. This will contain technical data and historical developments.

18. The Centre should set down specifications for all raw materials, glasses, fuels, etc., and creating benchmarks for industry to achieve, using base line conditions as the measure of success and best industry practice as the target.

19. It is essential that CDGI keep abreast of developments in the glass industry, particularly in those market sectors pertinent to Firozabad. The setting up of a web page, sponsored by CDGI and for the use of members will be an important link to the outside world. The staff will require access to technical journals, attendance at seminars and visits to glass plants. The CDGI should be a dynamic institution, keeping pace with the developments in the glass industry, globally in both technical operations and market conditions. The structure of the Centre should be flexible so that it can adjust to changing needs of the industry. Staff should be appointed on a contract basis.

3. INTRODUCTION

1. The Programme for the Improvement of the Glass Industry in Firozabad was executed by UNIDO between July 1992 and June 2000. The programme was implemented by the Office of the Development Commissioner (Small Scale Industries), New Delhi through the Centre for Development of Glass Industry, Firozabad. The programme was taken up for the development of the glass industry in India.

2. The terminal evaluation of the project was authorized by the UNDP, Delhi in August 2000. The terms of reference of the evaluation are given in the ANNEX 1. The evaluation team comprised of the following members:

Sheela Bhide, UNDP Expert and Team Leader

Gary Hardware, UNIDO Expert

M P Singh, Government of India Expert

3. The evaluation team met in the UNDP office in New Delhi on 18th September 2000 for a briefing session with the UNDP officials. The team also had preliminary discussions with DC(SSl). The team proceeded to Firozabad on 19 September 2000. During its stay in Firozabad from the 19 to 24 September 2000, the team members interacted with the representatives of the Firozabad industry. The list of the industry representatives is given at ANNEX 2. The team also had meetings with the staff of CDGI and the officials of the State Government. The team members also met some of the raw material suppliers and representatives of various Industry Associations and some individual entrepreneurs from the small and cottage industry sector. The team members visited a number of small scale factories and small and cottage units representing different sectors of the industry such as glass decorative items, bangle making, bead making, tumbler manufacturing, glass decoration (screen printing, sand etching, glass cutting). The team visited some units that were targeting the export markets. It also examined different types of furnace, viz. open pot, closed pot, continuous and day tank furnaces. The team also visited a unit which had a modern furnace set up by Tata Energy Research Institute, (TERI), New Delhi. The team also visited a pot manufacturer to evaluate the CDGI technology for the manufacture of improved pots. The above visits were undertaken with a view to ascertain from different sections of the industry the interaction they have been having with CDGI and the effectiveness of the services provided by the Centre to them.

4. The funding of the evaluation has been done by UNDP.

4. PROJECT CONCEPT AND DESIGN

4.1 Socio-Economic context

Firozabad has developed as a natural cluster of a diverse range of small-scale glass manufacturers involved in labour intensive production and decoration of bangles, beads, hand-made tumblers, tableware and decorative ware. There are also a few medium scale units using semi-automatic equipment to manufacture industrial glass products such as automobile headlight lenses, glass bulbs, shells and consumer products such as tumblers, bowls and ashtrays.

Over the life of the industry and its various sectors there appears to have been little or no change in technology, working practices, product range or market techniques either through internal evolution or induced by outside influences. In terms of the technology of the processes and the working conditions, it is a backwater seemingly cut off from modern methods and marketing practices. This is surprising since Firozabad is located not far away from the national

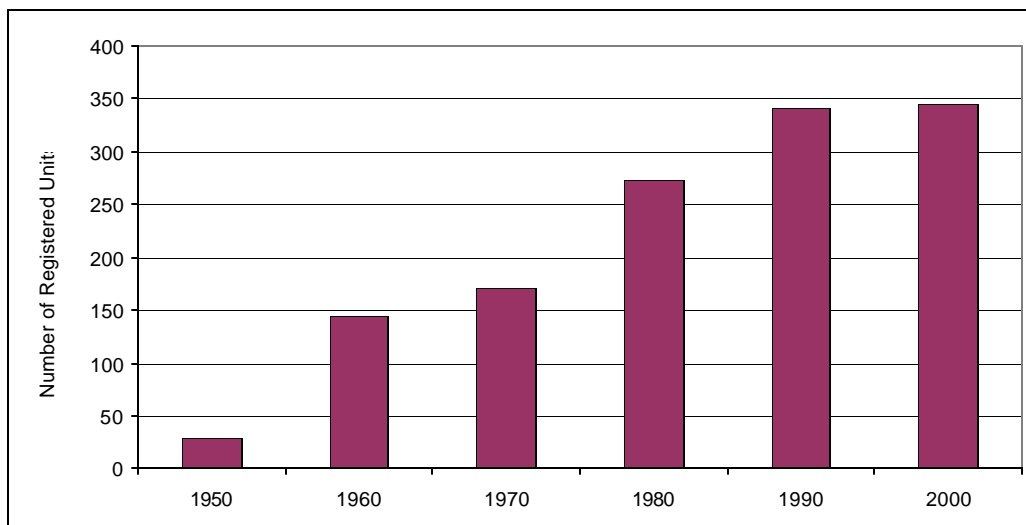
capital (250 Km) and not far away from the tourist Centre of Agra (45 Km). It is located on the national highway (Delhi-Calcutta) and is in the prosperous western part of Uttar Pradesh that is advanced in agricultural and industrial methods. Moreover, a majority of the factory owners belonged to a community that has shown tremendous entrepreneurial capabilities in other parts of the country and in other sectors of industry.

The work force is mainly on contract and few companies have permanent employees. Working practices evolved over years, a structured hierarchy within the work force and fears about job losses may all be factors that militate against change and acceptance of new technology.

4.2 Structure of industry

Glass making in Firozabad dates back more than 200 years but the small-scale industry developed about 1900. The growth since 1950 can be seen in Figure 1

Figure 1: Growth of Small Scale Glass Industry, Firozabad



The number of glass making and secondary processes that are operating is unclear. As per records there are in total 345 registered small-scale units in Firozabad but as shown in Table 1 the number of actual operating units may only be 276. This analysis of the industry is not clear nor a breakdown of the market sectors is available. The picture is further complicated by the information from one Company; Delux Glass that it works for four months making bangles and for eight months making decorated ware.

Exports are said to account for Rs crores 27 which represents only 10% of the above total value of production.

Since the setting up of CDGI the climate for change has increased with the availability of natural gas, the threatened closure due to the Supreme Court ruling on banning coal fired furnace within the Taj trapezium zone and the reduction of import duty on glassware.

Table 1: Production Units in Firozabad

Furnace Type	Registered Units	Operational Units	Production (Tonnes per annum)	Value (Rs Crore)
Bangles, Open Pot	200	64	60,000	120
Fancy Goods, Closed Pot	40	37	15,000	30
Tank Furnace	36	18	75,000	120
TOTAL	276	119	150,000	270

According to CDGI, the operational units listed in Table 1 can be broken down into the fuel type that is being used as shown in Table 2. It was reported by CDGI that in 1997, Phase I, 64 glass making units using coal were offered Natural Gas had converted. In Phase II, 204 units were offered Natural Gas and 74 responded. This suggests that the total units using coal are more than the 55 shown in Table 2.

Table 2: Furnace Type and Fuel Used

Furnace Type	Coal Fired	Oil Fired	Natural Gas Fired	TOTAL
Open Pot	40	0	24	64
Closed Pot	14		23	37
Tank Furnace	1	4	18	23
TOTAL	55	4	65	124

4.3 Objectives

The project recognized that the technology of glass making remains primitive and obsolete. The high consumption of coal, inferior product quality, poor utilization of raw materials and energy resources, hazardous working conditions, a polluting environment, poor working practices and the status of the women, are the major problem areas to be addressed.

The main objectives of the project were the following:

- ◇ Development and adoption of new glass melting and forming technology ensuring the effective utilization of raw materials and energy resources.
- ◇ Improvements in product quality and design.
- ◇ Introduction of different types of glass, other than soda lime glass.
- ◇ Improvements in the industries working practices and the technology of the process. In particular, environmental protection and working conditions that are causing severe health problems to workers and residents of Firozabad and district.
- ◇ Up-grading of skills of those working in glass manufacture and secondary processes (including women and young workers) not only to improve the present poor living standards but also to create appropriate and broader opportunities.

The process of liberalization of the economy and opening of the country to foreign imports with lower import duty has been a major policy objective to expose the local industry to greater competition and thus induce technological and productivity changes.

4.4 Institutional framework

The main agency involved in providing solutions to the problem areas was the CDGI, which was specifically set up under this project for upgrading of technology, training of manpower, product development, more efficient use of energy resources and pollution control. The other agencies involved in the problem areas outside the project are Gas Authority of India Limited (GAIL), involved in the supply of natural gas, Ministry of Petrochemical and Gas. Tata Energy Research Institute, New Delhi is involved in developing energy efficient gas furnaces. U. P. Pollution Control Board is responsible for monitoring ambient air level pollution in Firozabad. U. P. State Industrial Development Council is responsible for the development of infrastructure facilities for the industry. UNDP has also taken initiatives in collaboration with the Ministry of Environment and Forests, GOI for the Integrated Energy and Environment Programme for the glass industry in India.

The ownership of the project is with SIDO of the Ministry of SSI and ARI, GOI that is also the implementing agency

The project envisages the full support of DC(SSl), GOI, and of the GOUP both of whom are co-partners in funding the project. However, the Team members observed that there was a lack of strong linkages between CDGI and other agencies, either governmental or non-governmental in implementing the programme in the problem areas.

4.5 Relevance

The objectives of the project and the intended beneficiaries were clearly defined in the project document. After the implementation of the project, and up to the present time, the objectives remain valid since there have not been any significant changes in technology, working conditions, the skill levels of the workers or the environmental pollution levels.

The project is fully compatible with the UNIDO thematic priorities of technological upgrading, environmental protection, improvement of Workers' conditions, health and safety levels and gender issues.

4.6 Project design

The problem areas were correctly identified by the project and the setting up of the CDGI, its staff and equipment was seen as the main technical instrument to address these issues. The project did not visualize taking up any programme directly with the industry other than those that were to be taken up with CDGI.

The team members felt that the local industry representative did not seem to have been closely involved in the conceptualisation and designing of the project or in the functioning of the Centre. Moreover, there was a greater emphasis on the change of technology per se, but not on the socio economic implication of technological changes. Neither were there any adequate links between the industry and CDGI with other agencies either governmental or non-governmental involved in the problem areas. The fact that the linkage between the CDGI and the industry was weak resulted in the objectives of the project not being implemented to the desired levels.

The project does not seem to have recognized the fact that the glass industry in Firozabad is a diverse industry with a number of market sectors. Each market sector ought to have been understood and the trends, both domestic and global, to have been analysed and addressed to make the project implementation more effective.

The policy objective relating to the problem areas for either the Centre or the State is not clear. It appears that the issue of conversion from coal to gas was largely in pursuance of the supreme court directive to protect the historic monument of Taj Mahal rather than because any policy of the government to reduce environmental pollution levels to certain specified levels.

On the issue of child labour there seems to be State policy to eradicate the use of child labour in the industry. The members of the Team observed that there were practically no children below the age of 12 years of age employed in the factories visited by them. The factory owners informed them that the State Government officers visit their factories frequently to implement the policy and imposed heavy penalties (of Rs 20,000) on them in case of any violation is detected.

The baseline surveys were carried out only in 1994 and reported in 1995. The implementation of the project would have benefited from an earlier base line survey. A quantifiable assessment could have been made of the situation as it prevailed in the industry under various parameters when the project was taken up in 1992 and the situation that prevailed in the industry when the project concluded in June 2000. Notwithstanding the lateness of this report, CDGI should have taken up the base line data and continued to measure and plot trends. This would have allowed some conclusions to be reached about the effectiveness of the implementation of the project.

The Team members felt that the progress of the project implementation should have been more closely monitored so that corrective measures could have been taken up at the appropriate time. For instance, the fact that the linkages of CDGI with the industry were weak could have been identified earlier and amendments in the structure of CDGI and changes in the functioning of the staff could have been brought about during the implementation of the project itself.

Phase I of the project was to set up testing facilities, design & decoration and Phase II was the setting up of the PTDU with glass making, mould making facilities. Both Phases are almost complete; the PTDU was to have been installed in 1997 but delays meant it was not operational until March 1999. The outstanding items are a mould manufacture unit and the purchase of a bead-making machine that is pending.

5. Implementation

5.1 Budget and Expenditures

The Centre is funded by grants made by the GOI, GOUP & UNDP.

The funding pattern of the grant is as under:

GOI	Rs 24.7 million
GOUP	Rs 24.4 million
UNDP	US \$ 2.04 million (pre-revised)
	US \$ 1.76 million (revised)

GOI is providing inputs towards recurring expenditures, indigenous machinery & equipment. The grants provided by GOUP have been used towards development of land, construction of buildings and infrastructure facilities. The UNDP component of grants is utilized towards the following; training, deputation of foreign experts, non—expendable equipment, laboratory, workshop etc. The accounts of the Centre are regularly monitored as per the laid down procedure.

The firm of Chartered Accountants duly approved by the Governing Council, audits the accounts of the Centre annually. The audited statement of accounts along with the audited report is then placed before the General Body of the Centre.

As per GOI grant, the grants were released on time. The original budget of GOI grant has been increased. Until to-date, GOI has released Rs. 450.76 lakh. The Centre has spent more than the grants released Rs. 430.73 lakh. The differential has been met out of the revenue generated by the Centre through its R & D activities. It has been observed that the share of GOUP had released all the budgeted grant of Rs. 243.80 lakhs. The break-up of which is given in ANNEX 3, page 35.

UNDP's contribution as per project document was US\$ 2.04 million. There have been delays by UNDP in releasing the grant during 1996. UNDP suspended its assistance due to the non-recruitment of a Production Director for two years. UNDP's budget was subsequently revised to US\$ 1.76 million. The entire amount has been released and spent as per details in the ANNEX 3.

The details of the yearly budget approved and expenditure incurred are given in the ANNEX 3(a) GOI, 3(b) GOUP, 3(c) UNDP.

5.2 Delivery of UNIDO input

UNIDO was expected to provide support to the project in terms of equipment and consultancy services and training of manpower. UNIDO has arranged for CDGI staff and some owners to visit glass plants and exhibitions in the Czech Republic, France, Germany and Italy. It has also brought to CDGI, experts in glass blowing, decoration and design, furnace design, recuperation and energy studies.

Alexander Verghese from UNIDO Vienna visited CDGI in July 2000. (Mission to Firozabad DP/IND/90/010) A detailed review of the project was conducted with the Principal Director and his colleagues. The main topics focused on pollution control and energy efficiency measures adopted by the local industry, consequences of disregard to adoption of modern technology in the glass making industry and the socio-economic impact of the project. Despite the constraints faced by CDGI, the facility is fully capable of delivering adequate and appropriate technical expertise to the local industry. The greatest challenge in Firozabad is to mobilize the local entrepreneurs to let loose their traditional hold and enable them to take bold steps in promoting and upgrading their technology. CDGI is the best catalyst to accomplish this task.

UNIDO has commissioned Prof. V K Damodaran, Director of Energy Management Centre, Kerala to carry out a study on Energy and Environmental Management. The report is now finalized, a draft copy of which was given to Gary Hardware. A copy of the Report is attached herewith. ((ANNEX 5: PROF. DAMODARAN'S REPORT)

5.3 Delivery of Client's input

5.3.1 Staff

As compared to the sanctioned staff strength of the Centre, the number of staff in position is low. (See ANNEX 4, page 38). At Group A level, which is responsible for planning the research work, implementation and monitoring, only 4 persons are in position against the sanctioned strength of 11 persons. Similarly, the supporting staffs at Group B and C level are not to full strength. Many posts are lying vacant at different levels.

The team members observed that the Principal Director contrary to what was mentioned in the project document had not assigned specific tasks in writing to the senior staff members of CDGI. There was no formal review of the performance of the staff. The academic qualifications of the staff were considered adequate but that more exposure to the practical working of the glass industry in Firozabad will be beneficial.

It was felt that the Principal Director should have developed the business administration especially if the Centre is expected to function on a self-sustaining basis

5.3.2 Infrastructure

The Team observed that the infrastructure facilities at the Centre are not adequate. The Centre is receiving electricity from the rural feeder that has an erratic and irregular power supply. The Centre has installed a diesel generator set for power generation. The telephone system is unreliable. The Centre is situated some 4 km from the main road. It is inconvenient to the industry people to reach the Centre and the approach road is in poor condition. Because of these constraints, the Centre is not able to give an optimal service the industry.

5.3.3 Governing Council

The Governing Council of the Centre was constituted in 1992 to manage the affairs of CDGI. It is the policymaking, execution, project implementing and monitoring body. The Governing Council has DC(SSl) as its chairman. The other members of the Council are the Joint Secretary (Ministry of SSI), Industrial Adviser (Chemicals) of the office of DC(SSl), Adviser (Department of Science and Technology), GOI, Commissioner of Industries GOUP, Programme Officer, UNDP, New Delhi, Commissioner, Agra Division, GOUP, General Manager, SIDBI, Kanpur, Prof. V. C. Joshi, Department of Ceramic Engineering, Institute of Technology, Banaras Hindu University, Varanasi Country Director, UNIDO, New Delhi and the Principal Director CDGI. Two representatives of the glass industry and two representatives of the industry Associations are nominated by DC(SSl) as members of the G.C. The constitution of the Governing Council was amended in April 2000 to give greater representation to industry and to expert agencies.

The Governing Council is supposed to meet every quarter. The 19th meeting of the Governing Council was held on 27 April 2000 at Firozabad. It was observed that the meetings of the Governing Council were not held regularly and in 1992/94/97/98/99 there were only two meetings per year and in 1995, there was only one meeting. The representatives of the industry hardly ever attended the meetings.

The UNIDO/UNDP representatives have been attending the Council meetings regularly.

6. RESULTS

6.1 Production of outputs

6.1.1 Implementation

The Centre was made operational with a full time Director only in November 1997 and with more or less all the equipment and facilities in place and the PTDU operational in March 1999. There were inordinate delays in implementing the project. The fact that the post of Principal Director CDGI was vacant between 1992 and 1997 and that a Director in the office of DC(SSl), New Delhi was in charge of the post, during this long period, was a major reason for the slow implementation of the project.

6.1.2 Facilities

The members of the Evaluation Team studied the facilities available at CDGI and concluded that they were adequate and would serve the needs of the Centre. The mould-making unit was under installation and the day tank was under construction. It would be helpful to industry if these projects were completed as soon as possible.

It was learned that the purchase of bead making machine was under consideration. The members of the Team felt that the purchase of such a machine would not serve its intended

purpose as beads in most developed country market are fashion items and their design would change from time to time depending on the fashion trends. They felt that it would be more useful to appoint a consultant to advise the industry on possible diversification of production into new areas that could include bead making.

6.1.3 Staff

The members of the Team interviewed the senior staff at CDGI and studied their bio-data. The staff are well qualified and, apart from Dr. Tiwari, have previous experience of working in industry. When joining CDGI they may have needed to appreciate more the requirements of the local glass industry; its level of technology and working practices. The staff need to spend more time in the glass plants and this can be achieved by giving each of them a specific project relating to the improvement of fuel efficiency, glass quality and working practices as they relate to technology.

It was said that if any one member of the senior team were absent the work would suffer in that area. Each of them should be capable of at least providing a skeleton service in each area of activity.

The Principal Director needs to apply a business and administrative structure which is essential if the Centre is expected to function on a self-sustainable basis. Initially the Centre would be advised to develop a Mission statement for the Centre which could be followed by a strategy with targets, action plans and assigning specific tasks to the senior staff with regular appraisals of progress.

There is an urgent need to publish manuals for the different activities of the Centre and for the guidance of the staff and the trainees.

6.2 Achievement of the objectives

The objectives as set out in the project have not been fully met, partly due to the lack of a Principal Director until 1997 and then the late start up of the PTDU that has only been operational for about 18 months. Consequently, the glass industry in Firozabad does not yet have confidence in the Centre and worthwhile projects have still to be taken up by a significant number of companies.

CDGI will have to gain the confidence of the glass industry in Firozabad. Its approach should be to market the Centre, as any commercial business.

Probably the most important change is the acceptance that customers will have to be visited and CDGI then demonstrate its abilities in the field. Successes will build confidence in the Centre and, through newsletters and visits, the achievements can be spread to other companies.

Until CDGI is accepted as the authority on all glass and glass related matters it will not achieve its objectives. It is unfortunate that this is not yet the case because the Centre has made some significant developments; pot furnaces, decoration, glass testing and day tanks, being good examples. The sceptical attitude of many of the owners means that they want guarantees before they will commit themselves. It would be helpful in this regard to set up a "Development Fund" with which CDGI can finance projects in customer plants. If successful, the client will pay but if not the Centre will have to bear the cost. This fund may only be required until such time that customers can be satisfied that the CDGI developments are viable.

6.2.1 Integrated approach

The services that CDGI can offer to the glass industry cover all the technical aspects of glass manufacturing and secondary processing. Each of the services; raw material and glass testing,

furnace design, fuel efficiency, pollution, etc. can be viewed as separate services but the strategy of the CDGI should be to consider them as part of an integrated approach to improvements. The owners of the glass plants should be aware of this because they will become disillusioned if a project to improve the process in one area does not give full benefit due to a weakness in another area. The success in one area is interdependent on the success in other areas and only through an integrated approach will the benefits be optimised. For example:

- ❑ Glass quality improvements do not just require that raw material specifications and batch preparation be improved but also that furnace design is improved and combustion conditions are controlled.
- ❑ Control of the combustion process will benefit furnace life and fuel efficiency as well as reduce emissions.
- ❑ Control of the batch preparation will improve glass quality and reduce emissions.

It is considered that the recruitment and training of core technical staff, as permanent employees in each plant, in **all** areas of the process is essential if any of the improvements in process control are to be most effective and long lasting.

6.2.2 Performance Indices

Since the establishment of the Centre took an unusually long time and was effectively operational only after March 1999, the impact of the services offered by the Centre can be assessed only over the last one year. As soon as possible CDGI should create, measure and monitor a set of Performance Indices in the following suggested categories:

Technical performance:	Glass quality, fuel efficiency, production efficiency, pot and furnace life, number of analyses
Environmental conditions:	Overall pollution levels, chimney emissions, plant dust analysis
Social conditions:	Number of full-time employees. Number of trainees, medical condition of workers.
Economic conditions:	Cost of batch, cost of glass. Exports in value and as a percentage of total sales

Most of the outputs from CDGI can be measured; raw material quality, pollution levels, fuel efficiency, glass quality, production efficiency. It is therefore surprising that the Centre has not developed a set of benchmarks and an understanding of the best industry practice in that area. Such data can be used by industry to set performance targets and to measure the progress. The base line data produced in the Report "Base Line Survey cum Diagnostic Study of Firozabad Glass Industry" in 1995 set out the conditions, as they existed in the glass industry in Firozabad. To chart the progress of CDGI and its impact on the glass industry is an essential part of its duties and although this work has not been done, it is not too late to start.

6.2.3 Specifications

CDGI needs to establish a set of specifications for glass making raw materials, glasses, and fuels. Such specifications can be used to approve raw material suppliers and advise the glass plant owners of deviations from the specification. The specifications will be based upon the best industry practice and provide suppliers with a target to achieve and to the customers of glass plants with confidence that the glass plant is meeting agreed standards.

The specifications will form an essential part of the move towards achieving an ISO 9000 certificate by the Centre and by the glass industry and its suppliers.

6.2.4 Energy efficiency

The ability to improve fuel efficiency depends upon the type of fuel, good furnace design (including the use of insulation), burner efficiency, temperature control metering and control of the gas usage, furnace pressure control and heat recovery systems.

The use of natural gas by some of the plants has resulted in a cleaner fuel with greater control over the combustion conditions when compared with coal. The introduction of natural gas would have taken place even if CDGI was not in existence and it does not seem that its contribution has been very significant. Companies have merely exchanged coal for natural gas without changing furnace design or by introducing control systems that would allow a reduction in the fuel requirement. This is illustrated in Table 3.

Only in one plant was an insulated crown seen in which CDGI was instrumental in its application. This should have reduced the fuel consumption but no data was available.

Table 3: Fuel Efficiencies

TYPE OF FURNACE	FUEL	MELTING CAPACITY (kg)	FUEL CONSUMPTION	SPECIFIC CONSUMPTION (kcal/kg)
Open Pot Furnace	Coal	4800	5000 kg	5833
	Natural Gas	4800	2800 m ³	5250
Closed Pot Furnace	Coal	3000	4000 kg	7500
	Natural Gas	3000	2150 m ³	6450
Day Tank in industry	Natural Gas	1200	850 m ³	6160

The fuel efficiency improvement when converting from coal to gas is disappointing small and suggests that no other changes were made in furnace design or operation.

It may be useful to study the energy consumption when melting in single pot furnaces and comparing this with the energy consumption for a series of multi pot configurations. The seeming logic that more pots will give greater fuel efficiency may not be valid. The 12-pot furnace has a lot of empty space in its centre that has to be heated, whereas a smaller group would fit more tightly into the space. A single pot with good insulation may be in terms of investment, furnace and pot life and flexibility of types of glass, quality of glass and fuel efficiency a better option than the industry has thought. This type of study using data from other industry sources would be beneficial to the industry in Firozabad.

It was said that to purchase a meter to measure the gas consumption was too costly for each company. It is suggested that CDGI could purchase one meter and by arranging to fit by-pass lines in each plant, install the meter, carry out measurements during trials and then remove the meter and move to another plant. The fuel consumption in each plant should be broken down into the component parts of the energy required for the process, e.g. batch feed on and melting, glass working, re-heat, annealing, secondary working such as the coating of loams, re-heating and drawing in bangle manufacture. This will identify the most energy consuming parts of the process and help to target changes in working practices or design of equipment. This is an example of CDGI being pro-active and demonstrating their service to the industry.

The work of TERI in one bangle manufacturing plant illustrates what industry needs; an up-dated design using a modern, closed burner with gas filters, pressure control, metering, emergency shut off valve and a recuperator.

The experimental day tank at the Centre is a significant development that may be taken up by industry (one plant is planning to install a unit). The day tank is said to have a lesser fuel consumption per tonne of glass melted when compared with a multi-pot furnace, a longer life and a greater utilization of the melted glass. A success with the day tank will boost the standing of CDGI in the industry. The day tank in the Centre has fusion cast glass contact blocks. Whilst these are suitable for a continuous furnace, the temperature cycling in the day tank may be injurious. Sillimanite may be a better choice.

Bangle manufacturers use a high soda glass with Na_2O content in the glass being about 20%, which is about 7% more than other typical glass products. The high soda makes the glass easier to melt and fuel efficiency should be lower than for other glasses using the same melting chamber.

Indirectly the development of a pot with a longer life will improve fuel efficiency, as less fuel will be required, (because heat transfer is improved when using open pots compared with closed pots), fewer pots will break prematurely and the new pots have a longer life. Again, a study by CDGI of gas consumption in a plant over a long period will establish these facts.

In summary, there is a need to apply energy management practices for the different kinds of furnaces, fuels and secondary processes. The energy management practices would be based upon a thorough energy audit of each type of plant, trials and equipment developments to improve the energy consumption and a best practice established for others to copy. The best plant practice will include heat recovery systems, pollution control, control of the batch preparation and use automated process control equipment to monitor and control temperatures, flows and pressures. The aim will be to demonstrate to other owners that by controlling the process and investing in new equipment they can achieve good quality glass, improve the environment and reduce the cost of operations.

CDGI could enlist the support from UNIDO/UNDP and other recognized energy management institutes in the Country to design the necessary computer software based control systems for better energy management.

6.2.5 Technology transfer

The transfer of technology to the industry has been slow, mainly because of the slow start up of CDGI, the failure of the open pot furnace and the consequential low esteem by the industry towards the abilities of its staff. All the owners that were met acknowledged the need to improve the assistance from the Centre. The fact that insufficient of them have taken up the services may be because they want a free service or as expressed by one owner that he was too busy to attend. This emphasizes the need for CDGI to visit the plants.

There is also the problem of the team leaders of the work force (are these the equivalent of Union representatives?) not accepting changes in working practices that will undermine their authority and reduce labour numbers. In some cases, owners seemed willing to accept changes but foresaw problems in their implementation. It is probable that the problem at New Bright Glass in which an open pot furnace designed by CDGI was rejected because the working conditions were too hot was in fact a resistance to accept new working practices by the team leaders. If further technology transfer is to be achieved, which involves changes in working practice or conditions then the team leaders as well as the owners will need to be persuaded. This may be achieved by involving all these interested parties at an early stage in the development process.

Until cooperation is achieved between all parties, CDGI, owners and workers, then many of the projects will fail. For example, glass quality has been cited as the drawback to exporting goods and to improve it experiments will be necessary with the batch composition, refining agents, etc. However, if the batch mixers are unwilling to change then experimentation is not possible.

In the case of pot furnace technology and day tank technology, new initiatives have been taken up by CDGI and so far the response seems to be positive, though it is too early to state categorically whether the transfer of the new technology in these areas is successful or not.

6.2.5.1 Pot manufacturing

The use of closed pots was necessary because the combustion conditions using coal firing affected the glass quality and colour. The closed pot relies on heat conduction that is less effective than conduction and radiation that applies with the open pot.

The introduction of natural gas, a cleaner flame, allows the use of open pots and thus a possibility to save fuel. This, coupled with the development of a pot with a longer life (using better quality of clays and grog), has significant opportunities for the industry to improve its operations. Trials to date have shown that the pot life increases from some 15 days to 60 days and that pot breakage in the initial warming up stage and transfer are reduced. One Company, Delux Glass, reported that on average they were replacing one broken pot per day.

As with the day tank this development will enhance the standing of CDGI. The next step is to encourage the start up of a full-scale manufacturing unit that will require a large area for manufacturing and curing with controlled temperature and humidity. The capital costs and working capital required may be beyond the capability of the present pot manufacturers and CDGI can help through a development fund.

6.2.5.2 Decoration

The setting up of the Decorating department and the use of, for Firozabad, novel techniques of decorating such as the sand etching, has been taken up by the industry. Trial work should continue on design and technique that can be passed on to industry through contact either with owners or through training programmes.

This department, which can experiment with designs and shapes, may assist the development of the bead industry for tourism and export. The use of imported beads for the assembly of chandeliers in Firozabad is an opportunity for the Centre to investigate the manufacture of these beads as it has the glass quality that is required. A demonstration of the production of the beads can be shown to the industry. Similarly, the tourist industry may be interested in glass articles that reflect Indian tourist attractions such as tumblers showing the Taj Mahal.

The practice of silvering beads by manually sucking a silver nitrate mixture into the column of beads must cease and CDGI has an obligation to find a solution to this problem.

6.2.6 Pollution and health risks

On environmental issues the most important initiative taken seems to be the conversion of coal fired furnaces to gas fired ones in pursuance of the Supreme Court orders banning the use of coal in the furnaces. In 1997, 64 units were offered gas connections out of which 61 have taken the connection. In the second phase, 204 units were short-listed for connections out of which so far 74 units have responded and completed all the formalities. The complaint of the small units has been that they are unable to meet the conditions of the Gas Authority of India Ltd. (GAIL) to provide a bank guarantee of Rs 6 lakh and a deposit of Rs 2 lakh. They also complained that the pricing policy of GAIL was unfair since the consumers in Baroda pay much less than the consumers in Firozabad. They felt that a price equalization scheme on the lines of the scheme prevailing for coal and petrol should be introduced for natural gas.

The U P Pollution Control Board appointed the CDGI in 1996 to monitor ambient air quality in three places in Firozabad. The data collected up to March 1999 did not indicate any significant change in the environment since 61 units converted to gas in 1999. However, it is too early to come to any conclusions as the number of units converted into gas is few and the period of observation (less than one year) is too short. The work of CDGI stopped in March 1999 since the U P Pollution control Board did not provide further funds. The funding was resumed and the work started once again on 10 October 1999.

GAIL needs to be pursued to provide gas connection to the remaining industries and reduce the financial rates for the deposit bank guarantee for the small units.

Pollution of the atmosphere is either through working practices in the plant, such as raw material handling, batch mixing, secondary heating of glass, or through emissions from the chimney. Workers in the Firozabad glass industry are exposed to many potential hazards. The extent of pollutants and their effect on the workers can only be measured by a comprehensive study involving a sampling of factory air and by medical examination, including blood samples. Some of the areas of hazard noted during the visit are:

1. The use of lead, arsenic, barium, cadmium, fluorides in the batch.
2. Quartz particles.
3. The fumes of fired decorated ware may contain lead or cadmium.
4. The silvering of beads.
5. The frosting of glass using hydrofluoric acid.

Chimney emissions as experienced in the areas around Firozabad will be mainly oxides of nitrogen, sulphur and carbon, particulate matter, fluorides, boron compounds and lead compounds.

The chimney emissions from coal-fired furnaces are the major problem that should be much reduced because of the conversion of furnaces to gas. The work of CDGI in conjunction with the U P Pollution Control Board will be a useful guide to the extent of the improvement.

No information seems to be available on legislation relating to the limits of pollution or dangerous substances. Information was obtained from CDGI on emission standards issued by the Pollution Control Board, which quantifies particulate matter and sulphur dioxide but it is not clear if this is legislation or guidelines. It would be in the interests of the small-scale glass industry if CDGI was to obtain benchmark data from other countries in which legislation has been passed and use this to compare progress in the local industry.

Waste gas analysis of chimney emissions is routinely carried out and although some of the information gathered is more useful to the plant operations, it is a basis for gathering information on pollution levels in general. The work should be extended to include all possible harmful substances, including those generated within the plant.

6.2.7 Industry linkages

After interviewing a cross section of the glass industry, the members of the Team concluded that the Centre has not yet established sufficient links with the industry. All the glass manufacturers including those who have used the services of the Centre were quite emphatic in stating that the Centre was not able to provide them the required assistance in upgrading their technologies. In addition, that the staff of the Centre tended to be too theoretical and not aware of the field problems and the solutions offered by them were not cost effective. The Team members felt that the staff needed to make a more concerted effort to ascertain the problems of the industry and to work along with the glass manufacturers to overcome them. Since most of the manufacturers are small scale and do not have support system they have not found time to

approach the Centre on their own. The failure of the CDGI design of an open pot furnace sent a wrong message throughout the industry that the technology developed at CDGI was not 'appropriate'. The manufacturers during the interaction with the members of the Team frequently brought up the issue of CDGI offering a 'guarantee' for their new technology, as they did not have the financial strength to bear the risks of failures. This was particularly so in the case of furnace technology.

The lack of confidence in CDGI has to be reversed by the Centre becoming pro-active in its dealings with industry. Visits to plants, experiments, audits, and tests carried out as far as possible in the glass plants, involving plant staff in the work should be taken up. Selected plants, up to five, should be used for specific work such as improvements in fuel efficiency and improvements in glass composition control. An example of the type of service that can be offered is in the manufacture of tumblers. During the visit to Durgesh Glass, the owner asked how their tumblers could be improved to match those imported. A tour of the plant immediately highlighted a number of areas for improvement; poor quality of raw materials, poor storage conditions, manually weighing and mixing of batch and a low standard of mould polishing. A report from CDGI to the owner on these matters and a suggested programme of follow up would be appropriate particularly as this is probably one of the most threatened industries in Firozabad. Receptive plants would be given the opportunity to nominate members to the Management Board of CDGI and make trips to other glass plants and trade fairs at home and abroad.

The project was founded based on assistance to the small-scale glass industry but it seems without recognizing the different sectors within the industry. Each sector such as beads and bangles, decorated tableware, tumblers, headlamp lenses, etc. has a different market and hence a different path to follow. CDGI should recognize this and create a database of each company showing its market sector, size of company, types of furnace, fuel, glass composition, etc. A file on each company should be created in which historical data are maintained. Each market sector, at home and abroad, should be known and understood by CDGI. Trends in the development of these market sectors can be researched by CDGI and the information used to guide the specific industry.

There are only two glass manufacturers in Firozabad known to the Team that are actually manufacturing for exports. A few others (about ten in number) are selling some of the items to the exporters in Moradabad, Delhi and other places. They are doing product development for the export market in-house. Some of them have visited foreign countries especially, Italy, France and UK and have collected samples of glassware. They stated that the export market required very high quality standards that they are unable to meet. They stated that CDGI had facilities for value addition on glass such as hand cutting, sand etching, hand painting etc. which could be useful to them for developing the export market but the quality of glass manufactured by them would have to improve.

The appointment of a commercial manager with PR experience may be necessary to develop the links between the Centre and industry.

The location of CDGI has been cited as a reason for not using its facilities. It is not remote but the poor roadway does make the journey difficult and time consuming. The roadway along with a supply of natural gas and a stable electricity and telephone supply will enhance the work of the Centre.

6.2.8 Women

The gender issue has hardly been addressed by the project. There is only one lady working in the Centre in the glass decoration section. Women workers in the industry are found mainly in bangle straightening and joining activities, which is mainly a cottage industry. Women are paid Rs 2 for a bundle of 160 bangles and they earn, on an average, Rs 25 to Rs 30 per day. The work is attended to intermittently throughout the day in addition to the household chores.

The bangle straightening and joining is done with kerosene lamps. To prevent the wick from flickering the doors and windows are shut. The carbon and carbon monoxide released by the kerosene burner in badly ventilated rooms is highly injurious to the health of the workers. The CDGI has yet to address this very important issue.

Women are also engaged in cullet (broken glass) gathering and sorting. They are paid about Rs 65 per day but normally find work only for about 2 hours a day. The women were not provided with any protection for their hands while handling the broken bangle pieces.

6.2.9 Testing

CDGI has extensive facilities for the chemical and physical testing of glass making raw materials, glass, and to a lesser extent refractory materials. Glass compositions can be produced in small-scale melts and the clients assisted with all aspects of control for the glass composition.

To date a significant number of chemical and physical analyses have been carried out although the trend is not known. The use of logbooks to record analyses, dates carried out and suggested action is a usual practice in an analytical laboratory but not seen at CDGI. In the future the need is for analysis that is more rapid than an x-ray spectrometer will be necessary.

So far, the testing facilities of the Centre have been the most used service by the industry. During 1999-2000, the testing laboratories out of total revenue of Rs 8.26 lakh generated Rs 3.56 lakh of revenue. Thus, the laboratory contributed as much as 43% of the Centre's revenue.

Since none of the factories in Firozabad has similar testing facilities and manufacturers wish to get value for their money in the purchase of raw material and desire to improve the quality of their product, there is scope to increase the revenue of the testing laboratories. The staff needs to be pro-active and explain to the manufacturers the benefits of the testing of raw material and the final products by their personal contacts. The glass manufacturers complained that the testing fee is high. The CDGI staff refuted this stating that the fees were low compared to the rates of other governmental laboratories. They felt that the glass manufacturers want all the services to be free since CDGI is a Government agency.

The glass manufacturers also complained that the test reports are given after 4 or 5 days and with vague replies given by the staff when they inquire whether the reports are ready. The glass manufacturers want the reports quickly since they have to decide whether to unload the raw material from the trucks and make payments to the suppliers. The CDGI staff felt that the testing procedures cannot be shortened and with the given staff, they were doing their best in providing the test reports in the shortest possible time. The manufacturers also pointed out that the standard specification for the raw material was not indicated in the report and a comparison made between the actual result and that in the specification.

An examination of the results of glass analyses for a number of companies showed that successive analysis had a differences in the chemical composition that would be unacceptable in modern glass making and confirms that there is a poor control of the process. For example, Pooja Glass sample 1710-A, gives Na_2O content of 15.25% and for sample 1717-A, a Na_2O content of 14.26%. This swing of almost 1% in Na_2O will have a dramatic effect on the cost of the batch, the ease of melting and on glass working.

The ability to formulate batches, carry out test melts in the Centre can be better used to demonstrate to the industry the benefits of changes, particularly in the use of refining agents and decolourisers for flint glass. These tests can be expanded to full scale trials in the client's plant by taking a portable weigh scale and batch mixer from the Centre, using them in the glass plant, and demonstrating the benefits by melting a good quality glass. Again, a base line condition is essential to measure the improvement. The base line would have a measure of cord and seed levels, glass colour and the glass density all taken over a period of at least one week.

The use of specifications for raw materials, glass, fuel, etc. is not being used by CDGI. This is surprising as without a benchmark to judge the suitability of a material or a glass or to advise a raw material supplier if the materials are within specification is not possible. During a meeting with a raw material supplier, it was said that they supplied four grades of sand of different quality and two grades of feldspar. Thus, the industry appears to be using a specification which is seemingly not known by CDGI.

A specification for each raw material can be used as the criteria for issuing a supplier with a certificate of conformance and which would be compulsory if the supplier is to be on a preferred supplier list. Such a list would be available to the industry to allow them to choose reliable suppliers. A specification for the glass will give manufactures a target to work to and CDGI a base upon which any work carried out to improve glass quality can be used to measure progress.

6.2.10 Production capability

Control of the production process is vital if consistent glass quality, glass processing and fuel efficiency is to be achieved. CDGI is able to provide advice on these issues but to-date that does not seem to be happening. CDGI can select a number of companies to carry out trials.

CDGI has the use of heat recovery systems (metallic recuperators), which are hardly used in the local industry. The use of the recuperator to improve fuel efficiency should be demonstrated.

The introduction of mould making will be a useful addition to the Centre although it is considered that the expertise of cast iron mould making will be beyond the scope of the Centre. It is in the areas of mould design and in mould repair that CDGI can best serve the industry. For example, during a visit to a tumbler producer it was clear that the poor appearance of the tumblers was due to a poor surface finish of the moulds. This may be caused by an inferior quality of material or to the incorrect polishing of the surface of the mould. CDGI can obtain materials and techniques on mould repair and pass these on to industry.

A spinning mould demonstrated by CDGI has been taken up by industry and is an example of forming techniques that can be developed.

6.2.11 Training

The Centre needs to fix annual targets for the training of persons in different aspects of glass manufacture, as without targets the level of achievement could not be judged. However, the members of the Team have the impression that there is tremendous scope to enlarge the training activities of the Centre.

The employment of workers on contract basis is widely prevalent in the industry. Therefore, the factory owners do not exhibit much enthusiasm to invest in the training of the workers because there was no guarantee that the workers would continue to work for them on a permanent basis. On the part of the workers, since they are daily wage earners, they are not willing to go for training for fear of losing their daily earnings.

It was noted that there are two labour contractors who enter into agreement with the factory owners. The workers come from the Firozabad town and from neighbouring villages. The skill is imparted on the job and in almost all cases, there is no formal training.

Since inception, the following numbers of persons have been trained:

Chemical Laboratory Practices	66
Physical Laboratory practices	6
Glass Cutting	117

Screen printing	100
Toy making	30
Scientific Glass Making	42
PTDU TRAINING	
Glass engraving	2
Hand painting on glass	10
Sand blasting	1
Acid polishing	1
Glass Forming	7
Glass production	2

The links with the small-scale glass industry are only now beginning to be developed. Training programmes are being offered which should develop the links further although the lack of permanent staff and the use of contract labour are a barrier to making significant inroads into the industry. It may be that CDGI has to compensate contract workers for time lost whilst on the training course. Alternatively, the staff of the Centre can go to the factories to train the workers on the shop floor. Peripatetic training centres can be set up by CDGI.

The local college may be a source of future workers in the glass industry and CDGI should approach the college to determine the feasibility of sponsoring students and for them to learn an aspect of glass technology or manufacture as an addition to their course.

CDGI is experimenting with a gas burner that can replace the kerosene lamps used by the cottage industry to seal and straighten bangles. When it has been developed, the Centre can use it to train groups of cottage workers in the City Centre building, firstly on the advantages in speed of operation but importantly on the reduced health hazard of the gas burner.

Courses are being advertised and a brochure produced. One owner was not aware of the brochure, which illustrates the need to market the Centre and its activities.

6.2.12 Information & consultancy

CDGI needs to demonstrate that it has the required knowledge and expertise on all aspects of glass making, as they exist in the small-scale industries. The staff will require regular exposure to the literature on technological advances, visit other glass plants, and attend seminars, trade fairs and exhibitions.

An important source of information is the Internet, which can also be used to develop a "Glass Industry of Firozabad", web page sponsored by the Centre and containing information on each glass producer and the work of CDGI. It is noted that some of the glassmakers in Firozabad already have a web page.

All such knowledge gained will be available to members and where necessary CDGI will provide a consultancy service to carry out specific work. The development of confidence in the Centre will create joint projects in which a number of members agree to carry out research into a specific topic which if successful will benefit all. Now this service is limited by the lack of confidence in the staff by industry.

7. Contribution to the development objectives

Tangible contributions to the glass industry by CDGI have been in pot manufacture, the day tank concept, decoration, spinning mould and the ability to test materials and glass on behalf of clients. These contributions are relatively new and at present can be said to be developments and not a standard practice. Trends away from a base line will help to quantify the benefits and it again emphasizes the need to create base standards and targets based upon industry best practice so allowing a quantifiable trend to be established.

The Centre has also carried out training but it is not possible to quantify the benefits although included in this are the visits by owners to plants abroad which has given an insight into the extent of competition and the competitors.

The availability of natural gas has been a significant development in Firozabad but this cannot be ascribed to the work of CDGI. Similarly, the improved fuel efficiency obtained by the use of an overhead burner and recuperator is work carried out under the sponsorship of TERI.

8. Sustainability

The present level of technology and working practices prevalent in the glass industry in Firozabad are at least fifty years behind the modern equivalent of the respective industries. The task of CDGI to bring the industry up-to-date is an enormous one and the usefulness of the Centre will continue for the near future.

The Centre should aim to become self-sustaining over a period of 3 years i.e. by March 2003 and show surpluses for reinvestment within a period of 5 years i.e. by March 2005.

The revenues earned by the Centre have so far not been satisfactory. The revenues as a percentage of the total recurring expenditure have been about 12% as can be seen from Table 4. If the Centre had been more service oriented its earnings from services could have been much higher.

The Centre charges a registration fee of Rs. 5000/= for medium and small-scale units and Rs. 2500/= for tiny and cottage units. So far, only 45 units have become members of the Centre. The manufacturers stated that they were reluctant to become members, as they were not sure they would draw any benefits from the membership.

The Centre should ensure that members receive tangible benefits from their membership such as receipt of complimentary copies of the house magazine "Kanch Vikas" (which should be to a high standard and be available on purchase to non-members) and a reduction in training fees. The Centre should improve the quality of its services and then launch an aggressive campaign to increase its membership. The registration fees selected should be put into a corpus fund, which can be built up over the next 3 to 5 years. The interest on the corpus fund alone should be used for revenue expenditure. The fund should be managed judiciously to earn maximum possible interest with minimum risk.

The Centre could consider the feasibility of introducing a dual fee structure for the testing facilities; a higher one for the medium and small-scale units and lower one for the small and cottage units. The representative of the Glass Manufacturers' Associations offered to canvas their members for more samples for testing if the fees were lowered.

The Centre could start long-term training programmes for students leading to a degree or diploma. This will ensure a steady income for the Centre. It could also offer training to students from other developing countries as this will enhance the revenues substantially and improve its image as a National Training Institute. There is a need to appoint a consultant for increasing the Centre's business activities and strengthening its links with the industry. There is also a need to

appoint a cost accountant on a contract basis to study and analyse the costing in the various departments of the Centre. The costing of the product produced by the PTDU especially needs to be done carefully so that they can be priced correctly. Permanent marketing avenues need to be explored for selling these products through recognized agents. The consultant for business development could assist the Centre in this regard. This is potentially a good source of income if managed well.

Table 4: Expenditure & Revenue

Year	Grants Received [Rs in lakh]	Expenditure [Rs in lakh]			Revenue [Rs in lakh]	% of Revenue on Recurring [Rs in lakh]
		Non-Rec	Rec	Total		
1992-93	20.00	13.72	3.03	16.75	0.05	1.65
1993-94	38.70	26.72	11.64	37.91	0.66	5.67
1994-95	51.40	33.34	20.39	53.73	2.06	10.10
1995-96	63.00	38.46	26.91	65.37	2.20	8.18
1996-97	48.00	17.79	34.00	51.79	4.20	12.35
1997-98	52.66	16.20	40.25	56.45	4.92	12.22
1998-99	98.00	51.92	42.68	94.60	5.51	12.91
1999-00	76.00	17.50	76.63	94.13	8.43	11.00
TOTAL:	450.76	215.20	255.53	470.73	28.03	

If the Centre is to become more business-oriented, there is a need to provide greater flexibility in its financial transaction. More power can be delegated to the Principal Director in approving expenditures. At present he has the powers to approve an expenditure up to Rs. 2500/= for direct purchase of consumables and up to Rs. 1 Lakhs for capital investment. The Principal Director should be authorized to incur recurring expenditure that is anticipated and provided for in the budget without any limit. Over and above this, an imprest amount of Rs. 50000/= should be made available to him for incurring unexpected expenditure. However, to prevent any misuse of these powers a concurrent audit by a reputed Chartered Accountant (as against post facto audit) may be required.

The Centre should be required to send monthly audited statements of income of expenditure to the DC(SSl) which should be scrutinized carefully.

The Glass manufacturers in Firozabad have a mistaken notion that the services of a Government Institution should be free and that they are too poor to be able to invest in manpower development, improved practices and equipment or in better quality raw materials. To widen their horizons and expose them to new ways of thinking, a few of them can be taken in groups to similar institutions in other parts of the country. For example, the Institute for Machine Tools Technology in Batala and Institute for Autoparts Technology in Ludhiana where industry has paid registration fees and is availing of the services by paying the charges.

The role of the Centre is likely to change over the years as the industry develops. There is a need to provide flexibility to it in terms of manpower. Instead of appointing permanent persons, it would be advisable to appoint consultants on a contract basis. The fees of the consultant should be such that the best talent can be drawn from the market. In the end, there will be savings

since there will be no commitment on pensions etc. without the comfort and security of a permanent government job, the contract employees will be spurred to perform better.

9. CONCLUSIONS

The main conclusions of the evaluation team are as follows:

1. The objectives as set out in Phase I and in Phase II of the project are considered valid and germane to the needs of the small-scale glass industry, particularly in Firozabad.
2. The growth of the glass industry in Firozabad has been slow over the last 50 years in terms of technology upgrading, scale of operations, product range, quality and workers' conditions. The number of units has increased from 30 in 1950 to 345 in 2000. However, they are all small-scale units competing with each other in a limited market with low value products often cutting prices to retain their market shares and compromising on quality. The industry consists of a diverse range of glass products all produced using out of date technology and working practices. Consequently, there is a waste of material resources, pollution of the atmosphere, low quality products and unhealthy working conditions and practices.
3. The products are not competitive in the world's markets especially for mass-produced, machine-made ware such as tumblers. Growth is felt to lie with labour intensive processes such as decorated ware and artistic glass especially for the export market. The technology for improving the processes, product quality and the working conditions is available. The work force engaged in glass blowing, bangle making and those involved in the secondary processes of engraving, cutting, decorating have good skills and it is these skills which can be used to add value to the products.
4. The project implementation was unduly delayed. The Centre should have been fully set up and the objectives of the project achieved during the 5-year project implementation period from 1992 to 1997. However, most of the facilities were in place only by March 1999. The Principal Director's post was vacant for a long time and a full-time Director was appointed only in August 1997.
5. There appears to have been inadequate monitoring of the project implementation by the Office of DC(SS)I Ministry of Small Scale Industries, GOI and by UNIDO and UNDP. The feasibility study taken up prior to the project clearly brought out the problem areas and, in part, the solutions. However, it did not anticipate fully the likely constraints in implementing the project since technology changes often have wide socio-economic ramifications that need to be addressed. It is reported that there was no Mid-Term appraisal of the project since effective steps had not been taken to implement the project until September 1997. In fact, UNDP withheld its assistance for two years in protest against the delay in posting a regular Director for the CDGI.
6. The Government of UP had hardly any role in implementing the project. Even today, the support of the State Government to the Centre is negligible, especially in infrastructure.
7. The Centre can be said to have become fully operational only by March 1999 with the commissioning of the Product and Technology Development Unit (PTDU), which is the most crucial and demonstrative part of the Centre's facilities. The staff have not had enough time to deliver the goods. The capacity utilization of the facilities is quite low even today.
8. The Centre's links with the glass industry are at best tenuous. The staff expected the glass manufacturers to come to them to solve their problems. They did not feel the necessity to reach out to the industry. CDGI has not been sufficiently active in seeking clients, carrying out trials, audits, etc. at customer premises and building confidence in the ability of the

Centre. It has not applied business methods to its operations nor considered itself as a commercial enterprise. The Centre should have re-oriented its way of thinking and become pro-active and emphasized more on problem solving through a “bottom –up approach” rather than a “top –down” approach.

9. The focus of the Centre has been on developing improved technologies. However, little thought was given to the socio-economic implications of the transfer of new technologies. The staff did not anticipate opposition from any of the parties who feared that they would be adversely affected (furnace builders, pot makers, labour contractors, batch mixers). Nor did they identify “change agents” to work with them.
10. The vast majority of workers in the glass plants are on contract and few are permanent employees. This probably makes employees lack commitment to any one company and does not encourage employers to train staff. Consequently, few employees have any formal training in the technical operations of glass making and practices are passed from one generation to another.
11. The urgent problem of the health risks facing the workers involved in bangle joining, bangle straightening, cullet sorting and bead silvering have not been addressed.
12. The glass manufacturers perceive the Centre as a Government institution that should offer services free of cost to them. The “subsidy mentality” of the glass manufacturers is affecting the viability of the Centre.
13. The glass manufacturers believe that the approach of the technologists at the Centre is more theoretical and is removed from the reality of factory operations. They feel that the new or improved technologies offered by the Centre are not cost effective and that they will not succeed in the field.
14. CDGI suffers from an inadequate infrastructure such as the poor condition of the approach road, erratic electricity supply from a rural feeder, unreliable telephone connections and access to the Internet and the non-availability of natural gas.
15. The Centre suffers the disadvantage of location as it is situated away from the local industry and the town.
16. The Centre has not given adequate attention to increasing its revenues and ensuring its viability. The fact that UNDP and the Government were providing the required funds until now could have contributed to the neglect of this aspect.

10. RECOMMENDATIONS

1. The Centre can be considered to have been fully operational only by March 1999. The task of achieving the objectives is yet to be taken up in a concerted manner. It is therefore recommended that the project be extended by at least another 5 years. Any un-utilized funds of the UNIDO project should be ploughed back into CDGI to facilitate the Centre to become a more business oriented, self-sustainable institute.
2. There appears to be no need for any further major capital investments in the project. All these years the focus has been on setting up the facilities of the Centre. The task should now shift to achieving the objectives that CDGI was expected to achieve and to fully utilize the existing facilities.
3. The infrastructure of the industrial site and the services of CDGI need to be improved if the glass manufactures are to be tempted to move and for the Centre to function properly. Staff are difficult to recruit which may be due, in part, to the poor conditions and lack of facilities in the area.
4. CDGI should become a commercially oriented organization with the aim of achieving self-sufficiency within three years and the Principal Director becoming the business manager. A Consultant (Business Development) should be appointed to support the Director and his staff in selling the services of CDGI and researching the market sectors of the glass industry.
5. CDGI needs to be more pro-active in meeting the industry needs by:
 - Organizing the Centre along business lines by developing a Mission Statement, strategy, action plan, targets, job descriptions, responsibilities and appraisal of performance.
 - Creating a database of all potential clients such as raw material suppliers, equipment suppliers, glass manufacturers and secondary processes.
 - Separating and considering client needs by market sector.
 - The environmental and health problems of bangle joining and straightening, cullet sorting and manual silvering of beads to be urgently addressed by CDGI.
 - Creating programmes for the development of the main areas for technical improvement in the industry such as audits of fuel efficiency, glass quality, and production efficiency.
 - Setting up specifications for raw materials, glasses, fuels.
 - Creating benchmarks for industry to achieve, using base line conditions as the measure of success and best industry practice as the target.
6. There is a need for a complete re-orientation in the way of thinking of the staff. They should become pro-active in serving their clients. The emphasis should be more on problem solving through a "bottom-up" approach rather than a "top-down" approach.
7. The glass industry should be involved in setting the agenda for work by CDGI and as a result they seemingly "owning it". Involving owners can achieve this at the first phase of any project, identifying problems and developing solutions and associating the industry representatives with the policy-making and the funding of the Centre.
8. There is a need to apply energy management practices for the different kinds of furnaces, fuels and secondary processes. The aim will be to demonstrate to other owners that by

controlling the process and investing in new equipment they can achieve good quality glass, improve the environment and reduce the cost of operations. CDGI could enlist the support from UNIDO/UNDP and other recognized energy management institutes in the Country to design the necessary computer software based control systems for better energy management

9. CDGI should have an integrated approach to improving the technical operations of the glass industry. The interdependence of all the services and improvements must be recognized and understood by all CDGI staff and members. The most important element should be to encourage within owners the benefits of employing permanent staff who will be trained in operating the plant to the best practices introduced by CDGI.
10. It is recommended that representation on the Governing Council should be increased from the present number of 4 to at least 10. The office of the DC[SSI] should select 5 best units in each segment of the industry (decorative glass ware, beads and bangles, industrial products, tumblers etc.) on the basis of an objective criteria focusing on parameters such as quality, productivity, best practices, innovation, labour welfare. The DC[SSI] can nominate the representatives of the industry on the Governing Body for a period of 2 years. The panel can be reconstituted every 3 years. The glass manufacturers who interacted with the members of the Evaluation Team welcomed such a selection criteria.
11. The Government of Uttar Pradesh should also "own" the project and provide support to the CDGI and its activities on an on-going basis. The infrastructure facilities need immediate attention and need to be improved as a top priority and in a time-bound manner. The glass manufacturers were quite emphatic that they would not shift to the industrial estate unless the required infrastructure is in place. The investment of nearly Rs 200 crores in the estate by the State Government is till now un-productive.
12. Sub-committees of the Governing Council can be constituted under the chairmanship of an industry representative to tackle specific issues and to take decisions or whenever necessary, make recommendations to the Governing Council. The Governing Council would constitute sub-committees for issues which are considered important by the members and which need to be resolved in a time-bound manner. There should be a standing sub-committee on finance. These sub-committees can meet as frequently as is required to resolve the issues.
13. While the DC (SSI) should continue to be the Chairman of the Governing Council, an industry representative can be nominated as the Vice Chairman with a fixed tenure of a period not exceeding two years. If the Centre achieves self-sufficiency within three years, the Government could even consider appointing an industry representative as the Chairman of the Governing Council for a fixed tenure if this would be in the interest of the Centre.
14. The Centre should launch a drive to enlist the glass manufacturers as members. The registration fee of Rs. 5000/- for medium and small-scale units and Rs. 2500/- for small and cottage units seems to be reasonable for the present. It could be enhanced later if found feasible. It must be acknowledged that the quality of services offered by the Centre need to improve dramatically if the membership drive is to succeed.
15. The registration fee should be placed in a Corpus Fund and not used for revenue expenditure. The Fund should be invested judiciously to earn maximum possible interest with minimum risk. The interest earned could be used for revenue expenditure for which guidelines should be formulated. The GOI and UNDP could consider providing matching grants to the Centre over the next 3 years to build up the Corpus Fund. Similarly, the GOUP could also be requested to contribute matching funds to the Corpus. It is expected that the Corpus Fund will provide financial stability to the Centre and ensure its long-term viability.

16. The glass manufacturers who were interviewed by the Evaluation Team were unanimous in their demand for guarantees by CDGI against failures of the new technology to be experimented especially in the case of furnaces. They stated that the outlays required were substantial and their weak financial base did not permit them to take on huge risks. It is therefore recommended that a "Development Fund" be created out of which demonstration units can be set up. In case the experiment is a failure, the amount could be written off and in the event of a success the factory owner should pay the Centre the agreed amount. Third party certification of the experiment would eliminate acrimony between the Centre and the entrepreneur over the issue of whether the experiment was successful or not.
17. The Centre needs to identify activities that could enhance its revenues. It also needs to advise the industry on the scope for the business promotion and diversification. It is recommended that a consultant be appointed for a 3-year period (which could be extended on the basis of proven performance) for business development of the Centre and the industry. The Consultant should be an MBA with dual specialization in finance and marketing. His fees should be attractive to get the best possible candidate from the market. The UNDP could consider funding this post for the initial 3 years. The Consultant should be given clearly defined tasks. He should report directly to the Principal Director. A mechanism should be put in place to ensure that all senior members work with the Consultant (Business development) and that it is a team effort.
18. The consultancy wing of the Centre should be strengthened. The Centre should advise the glass manufacturers on the possibilities of business promotion and diversification based on payment of fees for the services. Organizing buyer-seller meets, participation in exhibitions, appointing experts, taking up market surveys and research projects could be some of the activities.
19. CDGI should appoint a cost accountant on a contract basis to work under the Consultant (Business Development) in the consultancy division. The cost accountant can assist the heads of the different divisions of the Centre with correct costing of their activities and correct pricing of their products (PTDU) or services (training, consultancy). The glass manufacturers, in their interaction with the members of the Team, were not able to clearly state the benefits of the new technologies provided by the CDGI. The cost accountant could assist them to take up scientifically cost benefit analysis for each experiment.
20. Each major activity of the Centre should be organized under a division. Each division should become a profit centre. Due weight should be given to developmental activities or research projects under taken which may not achieve short term revenue but are likely to serve long term benefits. The creation of profit centres will put pressure on the staff to obtain results and take on responsibilities.
21. The relocation of some of the units in the industrial estate near the Centre would increase the utilization of the CDGI facilities. The glass manufacturers stated that they were willing to move to the industrial state if gas connections were provided there and basic infrastructure provided such as a proper approach road, reliable power supply and good telephone connections. They wanted the security arrangements to be strengthened since the estate was slightly out of the town.
22. Since the provision of natural gas is a major incentive (and may be the only one) for the industries to shift to the industrial estate, the Government should take a decision immediately that in the second phase, gas connections would be given only in the industrial estate.
23. CDGI should use specifications for all glass making raw materials, glasses, fuels, etc. as feedback to the client when any analysis is carried out. The results will be compared with the specifications and advice given as to what action ought to be taken. An increase in the

demand for the testing service and a need for quicker results may justify the use of an x-ray spectrometer for rapid analyses.

24. The successes in pot making and the day tank need to be translated into commercial operations. This will require capital investment and a Development Fund controlled by CDGI (see recommendation 16) can achieve this aim.
25. The skills of the glass blowers and of the decorators can be used to add significant value to the product. The bead making industry is seen by the team as having a potential for the tourism industry and for export. The beads would be of different shapes, sizes and design. An investigation into the production of chandelier beads may be useful as at the moment beads are imported and the chandeliers assembled in Firozabad. The decorated ware could be attractive to the tourist trade, particularly that based upon major tourist attractions in India and on ancient glass making in India.
26. Glass manufacturers of Firozabad appeared unaware of the rapid strides being made by the small-scale industries elsewhere. For example, hosiery units in Tirupur and diamond cutting units in Surat and at the successful functioning of certain industry-linked institutions (such as the Institute for Machine Tools Technology at Batala, Institute for Autoparts Technology, Ludhiana). Under the project, a group of industry representatives could be taken on study tours to observe such success stories. This would help to reduce their insularity, widen their horizons and forge links amongst themselves.
27. CDGI will need to keep abreast of the developments in the glass industry, its technology and markets around the world. The setting up of a web page, which is sponsored by CDGI and available to members to add their own page, will advertise the Centre and its activities. The staff will require having access to technical journals, attendance at seminars and visits to glass plants. Links with CGCRI and the India section of The Society of Glass Technology need to be maintained on a permanent basis. The CDGI should be a dynamic institution, keeping pace with the industry domestic as well as global. The structure of the Centre should be flexible so that it can adjust to changing needs of the industry. Henceforth, persons should be appointed only on contract with a fixed period. This will permit the Centre to grow along with the industry.

11. LESSONS LEARNED

1. The project objectives were correctly identified but the means by which they were to be achieved had not been given sufficient thought. Firozabad is a backwater in its glass making technology and in its working practices. The culture that pervades owners and workers is against change. The project objectives should have recognized this and launched the CDGI taking into confidence the owners and workers.
2. The long period without a Principal Director and the delay in setting up the PTDU will have reduced any enthusiasm that may have been present. This added to the inaccessibility of the Centre and the poor infrastructure has made the taking up of the services quite limited.
3. Technical staff does not always have commercial acumen and at the outset a commercial manager should have been appointed with the task of selling the Centre to the potential clients.
4. The concept of the CDGI being self-sufficient seems to be a new idea but if it had been planned from the beginning a different attitude may have prevailed.

12. (ANNEX 1: TERMS OF REFERENCE)

(not attached)

13. ANNEX 2: MEETINGS & VISITS

The following is a list of Industries and Representatives interviewed by the Team between 18 and 24 September 2000.

13.1 Industry

Company/Unit	Representative
A M Glass International	Jaya Bhawalpur, Mahesh Kumar Gupta
Durgesh Block and China Glass Works Ltd.	Devi Charan Aggrawal
Express Lites and Crafts	Faisal Khan
Akarshan Enterprises	Chakresh Jain
Coronation Glass	Pradeep Jain
Nanumal Radhakrishan	Hyan Sunder Agrawal
Delux Glass Industries	Harish Agrawal
New Bright Glass Ltd.	Hari Mohan Gupta
Shivam Glass Works	Deepak Charvedi

13.2 Industry Associations

Association	Representative
Glass Industrial syndicate	Nanumal Mittal
UP Glass Manufacturers syndicate	Devendra Gupta
Glass Chamber of Commerce	RP Chaturvedi
Minority Glass Development Society	Parsa
Glass Chamber	Sharmin Ahmad Khan

13.3 Raw Material Suppliers

Supplier	Representative
Shiva Minerals suppliers	Satish Agrawal
Associated Refractories and Minerals	Gupta

14. ANNEX 3: GRANTS & EXPENDITURES

14.1 ANNEX 3 (a): Details of GOI grants and expenditure

(CENTRE FOR THE DEVELOPMENT OF GLASS INDUSTRY)

Firozabad

(Rs. in lakhs)

Years	Grants Received	Expenditure Non -Rec	Expenditure Rec	Expenditure Total	Revenue	% of Revenue Recurring	Remark
1992 - 93	20.00	13.72	3.03	16.75	0.05	1.65	
1993 - 94	38.70	26.27	11.64	37.91	0.66	5.67	
1994 - 95	51.40	33.34	20.39	53.73	2.06	10.10	
1995 - 96	63.00	38.46	26.91	65.37	2.20	8.18	
1996 - 97	48.00	17.79	34.00	51.79	4.20	12.35	
1997 - 98	52.66	16.20	40.25	56.45	4.92	12.22	
1998 - 99	98.00	51.92	42.68	94.60	5.51	12.91	
1999 - 00	79.00	17.50	76.63	94.13	8.43	11.00	
	450.76	215.20	255.53	470.73	28.03		

Signed by RAM DULARE

Section Officer (A&A)

CDGI, FIROZABAD

14.2 ANNEX 3 (b): Details of GOUP expenditure

(CENTRE FOR THE DEVELOPMENT OF GLASS INDUSTRY, FIROZABAD)

Contribution of U. P. Government

Original Budget Allocation Rs. 243.80 Lakhs

Amt. In Rs. Lakhs

Date	1992 - 93	1993 - 94	1994 - 95	1995 - 96	1996 - 97	Total
Cost of Land	18.21					18.21
Renovation of old Building						
Shade 1	10.08					10.08
Shade 2		2.38				2.38
Construction of Boundary Wall		11.20				11.20
Cost of 4 MIG flats		14.72				14.72
Construction of Building			49.14	97.31	40.76	187.21
	28.29	28.30	49.14	97.31	40.76	243.80

14.3 ANNEX 3 (c): Details of UNDP grants and expenditures

(CENTRE FOR THE DEVELOPMENT OF GLASS INDUSTRY (FIROZABAD))

UNDP CONTRIBUTION (Net) STATEMENT (US \$)

UP TO 31.03.99

S No.	Particulars	Total Budget	1990 - 94	1995	1996	1997	1998	1999	2000	Total 1990-99
1	Project Personal	520110	167218	39006	8499	97164	112277	94596	10693	529453
2	Sub Contract	75294	31269	5075	-432	2400	21600			59912
3	Training	114650	0	75095	0	0	33006	4407		112508
4	Study Tour	84399	26624	1432	0	23806	10013	14645		76520
5	Equipments	950627	310119	19131	14569	463397	32286	49908	77020	966430
6	Misc./Sundries	14969	6251	2173	831	2796	2918	660	207	15836
		1760049	541481	141912	23467	589563	212100	164216	87920	1760659

15. ANNEX 4: STATUS OF MANPOWER

POST	As per Project	Sanctioned Post	Status (in	Group
Principal Director	1	1	1	A
CHEMICAL LAB				
Chemist	1	1	1	A
Pollution Control Officer	1	1		A
Technical Assistant	2	2	2	C
Technician	1	1		C
PHYSICAL LAB				
Glass Technologist	1	1	1	A
Technical Assistant	2	2	2	C
Technician	1			C
PILOT PLANT & DEVELOPMENT CENTRE				
Sr. Glass Technologist	1	1	1	A
Combustion Engineer	1	1		A
Technical Assistant	6	5	1	C
Operator	4	4		C
Helper	3			D
MOULD SHOP & WORKSHOP				
Mechanical Engineer	1	1		A
Technical Assistant	2			C
Technician (Maintenance)	1	1	1	C
DESIGN & DECORATION				
Industrial Designer	1	1		A
Design Asst.	2	2	2	C
LIBRARY & DOCUMENTATION				
Librarian	1	1		A
Librarian Assistant	1			C
TRAINING SCHOOL				
Asst. Glass Technologist	1	1		A
ADMINISTRATION				
Admin. Officer	1	1		A
Sr. Accountant	1	1	1	B
Asst. Auditor	2	1	1	C
Storekeeper	1	1	1	C
SPA	1			B
Stenographer - D	1			C
Stenographer - C	1	1	1	B
Typist	3	2	1	C
Telephone Operator	1			C
Driver	1	1	1	C
Watchman	3	3	2	D
Gardener	1			D
Helper	1			D
Peon	4	1	1	D
Sweeper	3			D
TOTALS:	60	39	21	

16. (ANNEX 5: PROF. DAMODARAN'S REPORT)

(not attached)