EXECUTIVE SUMMARY

0.1 The Seamless Steel Tube Industry is almost one century old. The prime *raison d' etre* for the development of this industry was provided by the transport sector. Towards the end of the last century, seamless steel tube plants were set-up in U.S.A. to cater to the tube requirements of the bicycle frame. Subsequently with the advent and popularisation of 4-wheelers, there was rapid development in the petroleum sector. The petroleum sector consumed large quantities of seamless steel tubes for drilling, casing, transport, etc. Since then, as of today, the petroleum sector accounts for the bulk of the usage of seamless tubes and pipes.

0.2 The major processes used for production of seamless hollows are as follows:

(i) Piercing & Rolling

(ii) Extrusion

(iii) Casting & Rolling

(iv) Powder Metallurgy

For the commercial production of seamless steel pipes, the last two processes are not important. The majority of the seamless pipes are produced by piercing and rolling or by extrusion.

0.3 Piercing of a billet which may be of round or rectangular (gothic) cross-section may be done (a) on a Piercing Press or (b) in a Press Piercing Mill or (c) in a Rotary Piercing Mill. The principle of the rotary piercing mill which contains two barrel shaped rolls positioned at skew angle was developed by Mannesmann Brothers in Germany in the last century. As a round billet is fed into this mill, it is imparted a combined rotational and axial advance motion. The stresses generated induce an opening tendency at the billet centre. By positioning a suitable mandrel, advantage of this tendency is taken to form a hollow with controlled internal and external diameters.

Several variations of the rotary piercing mill have been developed which include *Stiefel Mill, Mannesmann Piercing Mill, Diescher Piercing* Mill and the most recent Cone-type Piercing Mill.

The rotary piercing is the most commonly employed process for preparation of hollows. The press piercing mill is used less often.

0.4 The hollow bloom obtained by piercing is further elongated into a shell by adopting one of the several following processes:

(i) Plug Mill

(ii) Push Bench & CPE

(iii) Diescher Mill

(iv) Pilger Mill

(v) MPM (Multi-stand Pipe Mill)

(vi) Assel Mill

(vii) Mandrel Mill

(viii) PSW or 3-roll Planetary Mill

(ix) Extrusion Press

Among the above processes, the Plug Mill is considered out-dated. Push bench is used for commercial tubes and for cold drawing blanks. The Diescher process which had become obsolete has been revived in the recent years as a flexible, low investment process for manufacture of mechanical tubing of smaller dia. The Pilger Mill is suitable to roll tubes in the size range of 150-600mm. It is a flexible process with low initial investment. The Multi-stand Pipe Mill (MPM) has been developed for high production of medium diameter tubes at minimum cost. The process takes advantage of high scale production to reduce unit cost of production. The Floating Mandrel Mill is used for production of smaller diameter tubes. The Assel Mill process has been particularly popular for manufacture of bearing and mechanical tubes in medium capacity range. A number of developments have taken place in Asseel Mill to improve process efficiency. The Planetary Mill process has been adopted for

manufacture of tubes. Although a number of advantages are claimed, the process is complex and has not been popular.

Manufacture of seamless steel tubes by extrusion is a well established process. It has certain advantages with respect to quality. However, the production costs are higher and hence extrusion process is used generally for manufacture of stainless steel and high alloy steel tubes or nickel base alloy tubes which fetch higher prices.

0.5 The above processes are used in the hot condition. The hot formed tubes are used for majority of the applications such as OCTG, bearings, etc., after further finishing operations such as heat treatment, threading, upsetting, etc. For certain applications, tubes of smaller diameter, higher mechanical properties or better surface finish are required. Such tubes are obtained by cold processing of the above hot formed or mother tubes. The two most commonly used processes for cold processing are Pilger Mill and Cold Drawing.

The Pilger Mill is a discontinuous process in which a portion of the tube is successively subjected to rolling between two roll dies. The main advantage of the process is that very high reduction can be achieved. This is essential for certain applications such as Zircoloy and Stainless Steel Tubes used in the Nuclear Power Industry. A number of developments have taken place in the Pilger equipment whereby the process has been made an almost continuous one by using full roller dies and multiple feeding. The majority of this development work has been done by M/s Mannesmann Group of Germany.

The cold drawing of tubes is similar to wire drawing except that generally a plug or mandrel is used to control internal diameter. The equipment is relatively less complex. The tube drawing is particularly used for manufacture of smaller diameter tubes such a capillary tubes, hypodermic needle tubes, etc.

0.6 There are processes on the horizon such as Hydrostatic Extrusion, Continuous Casting and Rolling, Powder Metallurgy, etc., which could

be used in special cases for manufacture of seamless tubes. However, for commercial manufacture of seamless steel tubes in bulk quantities, these processes do not have much relevance at present.

0.7 The Indian Seamless Steel Tube Industry is about 35 years old. The first plant was set-up as a Joint Venture between TISCO & Stewart-Lloyds of U.K. at Jamshedpur. Presently, after dis-investment by Stewart-Lloyds, this facility forms part of the TISCO operations. The plant has an installed capacity of 55,000 TPY and produces about 30,000 TPY of hot and cold finished tubes. This includes about 10,000 TPY of casing pipes for ONGC/OIL. The plant uses Press Piercing-Elongator-Hot Pilger-SRM- process for hot forming and cold drawing for cold finishing. The equipment is old and out-dated and the plant is now due for major modernisation and technology up-dating.

After the another seamless tube facility was established by BHEL at Tiruchirapalli to manufacture mechanical tubing required for boilers and heat exchangers. The plant has installed capacity of 40,000 TPY and produces about 14,000 TPY of tubes. BHEL plant uses piercing press followed by elongation. The hollow is further drawn by Push Bench Process.

The third commercial venture in the field of seamless tubes was of M/s Indian Seamless Metal Tubes Ltd., who set up a plant at Ahmednagar, Maharashtra with a licensed capacity of 15,000 TPY, which has now been increased to 50,000 TPY. The production in 1991-92 was about 19,800 T. The plant is undergoing major modernisation which includes increasing installed capacity to 50,000 TPY and corresponding production to about 35,000 TPY by the year 1995. They are also setting up a melting and continuous casting unit to produce round billets for captive consumption by adopting Planetary Process for the first time in the country.

0.8 M/s. Nuclear Fuel Complex (NFC), an undertaking of the Dept. of Atomic Energy, set-up a 3,700 tonnes extrusion press with various ancillary equipment such as Pilger Mill, tube draw benches, etc., at Hyderabad to manufacture zircoloy and stainless steel tubes for nuclear power reactors. Since substantial spare capacity was available, the unit

set up additional facilities for manufacture of bearing tubes and commercial grade stainless steel tubes. However, these operations were found to be economically non-viable and currently the unit is producing zircoloy and stainless steel tubes only for captive use.

0.9 Thus, there are only three commercial units with installed capacity of 132,000 Tonnes producing (1990-91) about 70760 Tonnes of tubes at a capacity utilisation of about 53.6%. This is against the total demand (1990-91) of 232,000 TPY. Thus, the present production is able to meet barley 30.5% of the domestic demand.

0.10 Because of the substantial demand-supply gap, a number of new entrepreneurs have sought to set up seamless tube plants. However, out of the more than 15 registrations/LOIs issued, only three have made substantial progress.

M/s. Maharashtra Seamless Tubes Ltd., a company in BC Jindal Group is setting up a project near Bombay with licensed capacity of 50,000 TPY at a cost of Rs. 65.0 crores. The project was undergoing trial production in June 1992 and has now embarked upon commercial production. M/s. Kalyani Steels Ltd., are setting up a seamless tube project at Baramati near Pune, Maharashtra with licensed capacity of 60,000 TPY at a cost of Rs. 156.0 crores. Their cold finishing line was scheduled to go into production by Dec. 1991 and hot finishing line by March 1993. However, the schedule is delayed and it is opined that the project costs have also escalated considerably. M/s. Remi Metals Ltd., a company in the Remi Group, is setting up a seamless tube plant near Ankaleshwar, Gujarat, with licensed capacity of 70,000 TPY. The plant will use pre-owned 2,500 Tonnes vertical extrusion press. The technology support will be provided by M/s. Intertec of Germany. The implementation schedule of this project is also reportedly delayed. Two more seamless tube projects have been announced by M/s. Jindal Seamless at Nasik and M/s. Ratnamani Tubes at Ahmedabad. Both the projects are presently in conceptual stage.

0.11 The major user sectors of seamless tubes are as follows:

(i) Oil Country Tubular Goods (OCTG)

(ii) Bearings

(iii) Automobiles

(iv) Boilers and Heat Exchangers

(v) Refineries, Fertilizers and other chemical plants.

(vi) Mechanical tubing used for applications such as Gas Cylinders, Hydraulic Cylinders, Power Transmissions, Structural applications, etc.

Among the above sectors, OCTG, Bearings and Petroleum applications will continue to grow in the coming years. The Automobile sector which uses seamless tubes mainly in 2-wheelers has also been going through rapid expansion. Presently, the sector is passing through a period of recession which may be short-lived. In August 1992, the automobile sector was reported to be on the way to recovery.

The present total demand (1990-1991) is estimated at about 232,000 TPY out of which OCTG accounts for 138,000 tonnes or 59%. Bearings, Automobiles and Boilers account for about 9.5% each. This demand pattern will undergo only minor changes by 1994-95. The OCTG sector is expected to continue to dominate the demand. The total demand is projected to increase from 232,000 to 333,000 tonnes by 1994-95 and to 426,000 tonnes by the end of century. This corresponds to an average simple growth rate of 8.4%. Certain observers feel that this growth rate of 8.4% is too high and that a projection of 3-4% would be more realistic.

0.12 The availability of Seamless Steel Tubes from domestic production is expected to increase from 66,000 tonnes as of present (1990-91) to 176,000 tonnes by the year 1994-95 and is 283,000 tonnes by the end of the century. In-spite of the increased production, the demand-supply gap will continue to be around 170,000-180,000 tonnes per year throughout the decade. This includes about one lakh tonnes of large diameter pipes in the range of 245-400 mm for which no project has been even proposed so far.

0.13 All the existing and proposed seamless tube projects have sourced major part of the equipment and technology from abroad, as will be seen from Table-1.

TABLE 1

TECHNOLOGY & EQUIPMENT SOURCING

No.	Name of Indian Company	Supplier of main equipment	Source of Technology
1.	TISCO	Innocenti (Italy)	Stewart & Lloyd, (U.K.)
2.	BHEL	Mannesmann-Meer (Germany)	Mannesmann-Meer
3.	ISMT	-do-	-do-
4.	NFC-Extrusion Press	U.S.S.R.	U.S.S.R.
5.	Glass Lubrication	-	CEFILAC, France
6.	Maharashtra Seamless	Mannesmann-Meer	Mannesmann-Meer
7.	Kalyani Steels Ltd.	Mannesmann & U.S.S.R.	Mannesmann-Meer
8.	Remi Metals Ltd.	Intertec W. Germany	Intertec W. Germany

M/s. Mannesmann of Germany have so far been the major source of the equipment as well as technology. In the field of seamless tubes, the technology is usually euipment based except in the case of glass lubrication the technology for which is patented by M/s. Ugine Soujernet and licensed through M/s. Ceficlac of France. Erstwhile USSR has reportedly developed its own Glass Lubrication Technology which is likely to be imported by M/s. Remi Metals into India.

0.14 Technology imported by the Indian Companies has been well assimilated. There have been no repeated imports of technology by the same company. However, there has also been no parallel transfer of technology from one company to another. Since technology in this field is usually equipment based and since the major equipment is not being manufactured in India, whenever a new plant is set-up, technology is imported along with the equipment as a package.

0.15 In spite of a big demand-supply gap, the industry is not growing commensurately because of the following constraints:

(i) Non-availability of major indigenous equipment. The import of equipment is expensive and results in high project costs.

(ii) Low value added product. Thus to recover the fixed costs, high volume of production is essential. However, this is not feasible under Indian conditions because the total demand is relatively small and this demand is split up into large number of grades and sizes.

(iii) High cost of inputs such as steel, power, etc.

(iv) Global tendering practice followed by major consumers such as ONGC, OIL, etc., whose purchases are financed by international agencies such as World Bank.

0.16 On the international level, there are more than 170 major manufacturers of seamless tubes. There is a concentration of seamless tube manufacturers in U.S.A. because of the heavy domestic requirements of the oil reactor. During the last five years, Germany and Italy have emerged as the major suppliers of equipment and technology. Russia has made major investments in this sector and set up one of the largest seamless tube facilities in the world at Volzhskij. The technology to setup large integrated tube mills is giving way to the setting up of small tube mills which can concentrate on a restricted product-mix. For this purpose, some of the older processes such as Diescher Mill, Assel Mill are being revived. It is anticipated that in the international market, the seamless tube industry will face stiff competition from ERW tubes at least in certain sectors.

0.17 The major equipment required for setting up of seamless steel tube mills is not being presently produced in the country, although M/s. MECON have a licenced arrangement for the same with M/s. Italimplanti of Italy. Draw benches, finishing lines and other similar low value equipment, however, is being produced indigenously. Adequate consultancy services are available to provide engineering support for the setting up of new projects. For all the projects set up so far as well as those in the pipeline, consultancy services have been procured indigenously. The R&D programmes in this field are generally undertaken by the equipment manufacturers. Since there is no major equipment manufacturer in the country, there is hardly any R&D activity in the field.

The various tube making operations are amenable to mathematical modelling and computer simulation. Such work could be undertaken by the organisations such as CMERI-Durgapur, National Physical Laboratory - New Delhi, Metal Forming Institute - Hyderabad, etc.

0.18 After an in-depth review of the status of the seamless steel tube industry with a backdrop of the international situation, the following conclusions can be drawn.

(i) About 50% of the seamless tubes are used by the oil sector. Since the oil sector has reached a stagnation level, the international market for seamless tubes is also static, with no major new projects in the pipeline.

(ii) The specialised equipment for manufacture of Seamless Steel Tubes is being offered by selected companies in the world, mainly from Germany, Italy and France.

(iii) Most of the equipment manufacturers also have tube manufacturing divisions. As a result they are able to offer package of equipment and technology.

(iv) The growth of the seamless steel tubes industry in India has been constrained because of heavy investment and non-availability of indigenous equipment. The project cost for the new projects can be reduced by using pre-owned equipment or by promoting indigenous manufacture of the equipment.

(v) Presently there is a demand-supply gap of about 180,000 tonnes which even after assuming a 10% annual growth in production will still remain at the same level upto the end of this decade. If, as certain observers feel, a more realistic annual growth of production, estimated at 4% is used, the demand-supply gap will be even larger, at the end of this decade. Thus there is scope for setting up of at least two new projects of 50,000-60,000 TPY capacity.

Presently seamless pipes of more than 245mm are not being manufactured in the country. Demand for these pipes is about 1.0 lakh ton/yr. To obviate continued imports of these pipes, a new project to manufacture pipes in the range of 245mm to 355mm OD should be set up. In view of the heavy investment, it is essential to have some kind of user commitment. Hence the dominant user agencies may have to be closely associated with this project. Private entrepreneurs such as OCTL could also be associated with such a project.

(vi) There is a good scope to export seamless tubes and tube products such as OCTG. Industry needs to take note of this and avail of the benefits extended by the Govt.

(vii) The indigenous seamless tubes are expensive by 30-50% *vis-a-vis* imported products while there are several reasons for this, to some extent this disparity could be reduced by the Indian seamless industry by adopting use of concast billets as input feedstock and improving the process yields.

0.19 On the basis of the above survey, the following recommendations are offered:

(i) To bridge the demand-supply gap, at least two new seamless tube projects of 50,000-60,000 tonnes capacity each may be set up, for diameters exceeding 245mm OD.

(ii) In order to ensure user commitment, a committee consisting of representatives of the prominent users may be constituted who

may be associated with the formulation of the above projects. Representatives of private entrepreneurs such as OCTL who have plans to set up similar projects could also be members of this committee.

(iii) Steps should be taken to encourage indigenous manufacture of equipment. For this purpose an equipment designing company such as MECON and a product manufacturing company such as TISCO could collaborate so that they can offer a combined package of equipment and technology, akin to international practices.

(iv) Considerable expertise has been developed in the country to manufacture extrusion presses. However, no extrusion press for steel has been manufactured. A project to develop extrusion press for steel along with related technologies such as glass lubrication, die design etc., needs to be taken up.

Such a project could be co-ordinated by Central Metal Forming Institute, Hyderabad. Nuclear Fuel Complex, Hyderabad and Siddhartha Industries, Belgaum. DSIR could also partly fund the project.

(v) There is scope for export of seamless tubes as well as processed tube products such as OCTG.

To encourage exports, perhaps extending packing credit to deemed exporters and the procedure for evaluation of global tenders could be reviewed.

(vi) Exim Bank of India and major banks such as SBI may be encouraged to offer credit packages to foreign buyers to promote Indian exports along with Indian seamless tubes and products manufacturers.

(vii) Many aspects of seamless tube manufacture are amenable to laboratory and simulation studies. Suitable projects could be identified by Central Metal Forming Institute, Hyderabad, Central

Mechanical Engineering Research Institute, Durgapur for support by DSIR and the seamless tube industry in India.

(viii) There is a considerable interest in 'Cast and Roll' technology. Organisations such as SAIL R&D, CMFI or CMERI could be encouraged to take up projects in this field.