EXECUTIVE SUMMARY

0.1 World over, Toluene is produced from the three main sources viz. Catalytic Reforming of Naphtha, Steam cracking of Naphtha and Coal (Coke-oven light oil redistillation). The predominant source being the Catalytic Reforming of Naphtha, Aromatics Extraction and Splitting through an Integrated Aromatics Complex where Toluene is produced alongwith Benzene or Xylenes as a by-product. The production from coal has been on the decline.

0.2 There are two standard specifications internationally accepted for manufacture of Toluene viz. Nitration Grade Toluene (ASTM D-841-85) and Industrial Grade Toluene (ASTM-D-362-84). Nitration Grade Toluene is of high purity (>99.8%) and has more stringent product specifications.

0.3 In India only a small quantity (7 to 8 Thousand T/Yr) of Toluene is produced by samll producers and the Steel Plants, bulk of the Toluene is produced at three Refinery locations i.e., IOC, Gujarat Refinery, Baroda, BPCL Refinery at Bombay and CRL, Cochin through the Reforming of Naphtha, Aromatics Extraction and Splitting route. In the year 1992-93, total Toluene production in the country was 56,900 MT, of which 48,700 MT was produced at these three refineries and the rest from Steel Plants and other small producers.

0.4 The demand of Toluene is now increasing moderately in India at the rate of about 8%. The Toluene demand by year 2000/2001 is expected to increase to 105,000 T/yr from 1992-93 demand of about 57,000 T/yr.

0.5 The total Installed production capacity for Toluene at the three refinery locations and steel plants is approximately 55,000 T/Yr and the (actual) current capacity is of the order of 65,000 T/Yr. (Steel plants produce Toluene much below their currently stated capacities). Since no new Toluene Production Unit is presently under planning or implementation stage, it would be necessary to add additional production capacity of the order of 40,000 T/Yr between 1994 to year 2001 in a progressive manner to cope up with the domestic demand or else meet the deficits through imports.

0.6 The production of Toluene so far has been more or less matching with the consumption with marginal, occasional imports. After the new capacity additions at BPCL in 1985 and CRL in 1989 the production capacity was in excess of the demand with the result that the imports during the last few years were nil or very nominal.

0.7 With the present industrial policy and import duty reduction on Toluene, the imports of Toluene are likely to increase in the coming years.

0.8 With new regulations restructing both Benzene/Toluene content in the Motor gasoline, Toluene in future is likely to be surplus in the world market, thereby increasing the market competitiveness. The export potential is expected to be virtually nil in view of no spare capacity.

0.9 Toluene has three principle uses : (i) As a Motor spirit blending component to boost the Octane Number (ii) as a Solvent/Thinner, for production of dyes (iii) chemicals derived from Toluene. The important chemicals derived from Toluene are TNT used as Explosive, Toluene Di-Isocynate (TDI) used in Urethane Polymers; Toluene Sufonamide used as Sacchrin (sweetener); Benzyl Chloride for Plasticizer; Benzoic Acid for production of Phenol, Caprolactum and Terephthalic Acid; Chlorinated derivatives for Dyes, Pesticides, Pharmaceuticals and miscellaneous derivates used in medicines, perfumes, flavours, germicides etc.

In US, Japan and Europe a large proportion of Toluene produced is used in Motor spirit blending and conversion to Benzene through the Hydro-Dealkylation (HDA) process.

0.10 In India Toluene is mainly used as solvent/thinner, for dye manufacture, chemicals production and TNT production for Defence. Small quantities are also used for the manufacture of pharmaceuticals, pesticides, printing inks, magnetic tapes, saccharin, adhesives. Amongst chemicals are included Benzoic Acid, Benzyl Chloride, Para Toluene Sulfonic Acid (PSTA), Toluene Di-Isocynate (TDI), Toluene Sulfonamide, adhesives, plastic coatings, lacquers etc. Chlorinated derivatives, Nitrotoluene, and Pesticides do not show significant growth in India. Use of Toluene in TDI production is expected to increase.

0.11 The export of Toluene from India has been nil mainly because it is priced quite low in the international market. The domestic price of Toluene is much higher due to higher basic price of the feed stock (naphtha).

0.12 Toluene is generally produced as a co-product alongwith Benzene in a B/T production unit or in an integrated B/T/X Aromatics production unit. Therefore the economics about the scale of plant will be mainly governed by either Benzene or Xylenes production. The report of Committee on Perspective Planning of Petrochemical Industry (1986) recommended minimum economically viable production capacity of 100,000 MTPA of Benzene and 18,000 MTPA of Toluene. This would require to set up a Catalytic Reformer of about 2,00,000 MTPA (MIN) capacity, though this would depend on the feed composition and B/T precursers.

0.13 Toluene produced from the Reforming of Naphtha is the most predominant source of its production world over. This involves Naphtha Hydro-Treatment (NHT) for desulfurisation of Naphtha and Catalytic Reforming Process for conversion of Paraffin and Naphthenes to Aromatics. A Solvent Extraction Process is then employed for extraction of Aromatics, which are further separated to Benzene, Toluene and Xylenes, as required.

0.14 Naphtha Hydrotreatment section is designed to remove harmful compounds from feed Naphtha stock like Sulfur, Nitrogen and Metals which takes place over a Co-Mo or Ni-Mo Catalyst at elevated temperature and pressure in the presence of Hydrogen. Main processes marketed are those developed by IFP, UOP, Engelhard, Shell, Esso, Standard Oil, IFP/IIP etc.which reduce the sulfur content of Naphtha from 200 to 1000 PPM to 0.5 - 0.1 PPM level.

0.15 A number of catalytic reforming processes have been licensed for both semi-regenerative and cyclic regenerative (swing reactor type) reformers. Over the years Mono-metallic Catalysts have been gradually replaced by

Bi-metallic or Multi-metallic catalysts for higher severity operations and better catalyst stability. Many processes implemented today include : Platforming (UOP), Powerforming (ESSO), Houdriforming (HOUDRY), Magnaforming (Engelhard, ARCO) Rheniforming (Chevron), Cat. Reforming (IFP, Engelhard, Kellog etc.). Variants obtained by combining with other processes or intended for specific applications being ISO-Plus Houdriforming (HOUDRY), Selectoforming (Mobil) Aromizing (IFP), Aromatic Reforming (Chevron) etc.

The recent developments in technology of Catalytic Reforming has been the Continuous Catalyst Regenerative Reforming processes developed by UOP (CCR Platforming) and IFP (Octanizing Technology), which operate on continuous withdrawal and regeneration of catalyst from the system. This technology is specifically suited for production of Aromatics as more severe operating conditions can be applied for higher conversion of Paraffins and Naphthenes to aromatics. Future trend would be to go in for such type of units.

In India two CCR type Reformers are being planned at IOC, Mathura and Panipat Refineries.

0.16 A number of Solvents and Solvent Extraction Process have been used for extraction of aromatics from aromatic rich streams. Most commonly used and popular process is the "Shell Sulfolane Extraction" employing Sulfolane as the solvent. Because of lower Solvent: Feed ratios and the resultant lower utilities cost involved, this process finds favour. Other Solvent Extraction Processes that have been used are Udex Process employing Diethylene/Triethylene or Mixed Glycols as the solvents (originally developed by Dow and licensed by UOP); the LURGI Arosolvan process employing 'NMP' as the solvent; IFP Aromatics Extraction Process employing 'DMSO' as the solvent.

0.17 The EIL/IIP Sulfolane Extraction Process jointly developed by Engineers India Ltd. and Indian Institute of Petroleum has been successfully used both at BPC and CRL with very good performance results. This is a shining example where indigenously developed technology in Aromatics Extraction has been found at par with the similar technologies currently used in the industrialised countries of the West.

0.18 Splitting of Aromatics to individual compounds i.e., Benzene, Toluene, Xylenes is carried out through a series of splitting columns using conventional design procedures for distillation columns for the desired purity levels. No special Process Licensing or Technology Selection is involved therein.

0.19 Toluene is also produced in Steel Plants, where coal carbonisation in Coke Ovens yields light-oil rich in Aromatics. Toluene yield from light oil being in the range of 12 to 14 % volume. Light oil is recovered from coal gases either by adsorption on solids like activated carbon or by counter-current absorption in a high boiling liquid, which is stripped by steam distillation. Fixed bed catalytic processes "LITOL" for purification of Light Oil to produce high purity Benzene/Toluene has been developed by Houdry Process and chemical co.

0.20 Substantial quantity of Toluene is present in the pyrolysis gasoline obtained as a by-product in steam cracking of naphtha for olefins production. The pyrolysis gasoline is selectively hydrogenated to remove olefins/di-olefins and then catalytically treated to desulfurize the stock. Thereafter the normal extraction of Aromatics by Solvent Extraction and Splitting is carried out for separation to B/T/X.

0.21 Production of Toluene from surplus Propane/Butane or mixed LPG is a comparatively new technology, which can be adapted if the raw material is priced cheap. BP-UOP-Cyclar Process selectively converts liquefied petroleum gas to B/T/X in a single step. A 1000 BPSD demonstration unit set up by BP is in operation at Gangmouth at Scotland since 1990. Toluene yield of about 43 wt% on Butane feed are reported.

0.22 Surplus Toluene can be converted to Benzene by the Hydro dealkylation (HDA) processes, both catalytic and thermal. The main catalytic processes were developed by Shell with the Bextol Process, UOP with the Hydeal technique, Houdry with Detol and BASF Process. The main thermal processes are those marketed by ARCO and HRI with HDA technique and Mitsubishi and Chyoda with MHC process.

0.23 Surplus Toluene can also increase the production of benzene and xylenes through the Transalkylation & Disproportionation (TADP) technique, which is of recent development. The conversion to xylenes is exploited by introduction of C-9 Aromatics alongwith Toluene in the Transalkylation step. ARCO's "Xylene Plus" process and Toyo Rayon's Totoray Process are both vapour phase Toluene TADP processes, (last one commercialised by UOP).

0.24 Naphtha cut in the distillation range of 90-110°C (TBP) are rich in Toluene precursers. All the indigenous crude oils i.e., Bombay High, Assam and South Gujarat (Ankleshwar, Gandhar) are rich in Aromatics precursers including that of Toluene (possessing high N + 2A). Main source of raw material for Benzene and Toluene production in India has been the Naphtha derived from BH Crude. It is apprehended that the Toluene production potential may come down in case of cut in supply of BH crude to refineries.

0.25 The three refineries producing Toluene viz. IOC(GR), BPCL and CRL have all used surplus/redundant capacity of their existing Catalytic Reformers and mainly added the Aromatic Extraction and Splitting facilities for the production of Benzene and Toluene. While IOC(GR) employs the Udex Process originally licensed by UOP, other two refineries adopted the EIL/IIP Sulfolane Extraction Process.

0.26 It can be said that technology for the Aromatics production has been absorbed well. All the refinery locations are producing or capable to produce Toluene in excess of the installed capacity. By sacrificing some Benzene production, the Toluene production in these three locations could be further increased.

0.27 The only Continuous Catalytic Regeneration (CCR) type reformer unit was installed at Patalganga by Reliance Industries for its xylenes complex with UOP technology. The CCR Technology is comparatively new and more of such plants are now being installed elsewhere. This is an area where R&D effort can be directed by Indian research and design Institutes. In the immediate future this technology may have to be imported.

0.32 Continuing R&D work in the refinement of reforming catalysts development of Toluene Disproportionation/Transalkylation and Hydro-dealkylation catalysts and adaption of CCR Reforming Technology through pilot plant scale-ups should remain the thrust areas for future.

0.33 RECOMMENDATIONS

).33.1 There is need to generate additional Toluene Production capacity to the tune of 40,000 MT per annum from 1993 till the year 2000-2001. This can be best done in the following ways :

- By debottlenecking the capacity of existing units producing B/T at refinery locations and by widening the feed Naphtha cut range.

- Tapping Toluene potential from Pyrolysis Gasoline produced in Naphtha crackers units and extraction of Toluene from Toluene rich streams in Aromatics Production units.

- By setting up future integrated Aromatics production units for B/T/X production. It would be difficult to justify a production unit for Toluene alone.

  By utilizing spare capacity, if any, of CAT. Reforming units being set up at Barauni and Digboi refineries and future CCR units to be set up at IOC Mathura and Panipat Refineries.

).33.2 Although organisations like EIL, IIP have developed design/engineering capabilities for process plants involved in the production of B/T/X through fixed bed Cat reforming and Solvent extraction, design/engineering capabilities need to be developed for Continuous Catalyst Regeneration (CCR) type of cat reformers. This needs to be backed up by adequate R&D developmental work.

).33.3 For self reliance, efficient catalyst development should remain a thrust area for the R&D activities. Bimetallic Catalyst already developed by IIP/IPCL for Cat Reforming should be further refined to match in performance with the best available in the world.

0.33.4 R&D efforts should be continued by IPCL/NCL for development and commercialisation of HDA Catalyst and Toluene Transalkylation and Disproportionation Catalysts. EIL should develop design/engineering capabilities for commercialization of these technologies.

0.33.5 Solvent Sulfolane now widely used in aromatic extraction is being imported. IIP, Dehradun have developed technology for its manufacture, which could be commercially exploited.