1. INTRODUCTION

1.1 The lead-acid storage battery, an important energy storage device, is the most widely used secondary storage cell by automobile and other industries. Storage cells are devices which release a flow of electron throguh an external circuit as a result of reactions occurring between the active electrode materials and ions transported by the electrolyte. The cells in which the reactions are reversible are called secondary cells. In these cells the active materials can be returned to their original state by applying electrical current from an external source in the opposite direction to the flow of the cells discharge current.

In the early nineteenth century, scientists discovered that when direct current was passed between some pairs of electrodes of the same metal immersed in an electrolyte, the electrodes became polarized, i.e. when the circuit was opened a difference of potential existed between the electrodes. If they were connected together a current flowed. Based on these experiments in 1959 Gasten Plant began to investigate such cell us. g two electrodes immersed in dilute sulphuric acid. He found that appreciable currents could be obtained from the cell, after it was charged to produce a coating of lead peroxide on the positive plate. This was a major breakthrough in the field of electrochemistry.

Since then major developments have taken place in basic material of construction of lead-acid batteries. The present construction of this type of battery consists of positive electrode made up of leap peroxide, negative electrodes of lead in highly active metallic sponge. The insulating layers are made of hard rubber, PVC etc. The electrolyte is a dilute aqueous solution of sulphuric acid and container is made of plastic, glass, rubber or polypropylene.

In 1940's six volt rubber case, featuring external cell connectors were available. Ford company offered codar separators and thirteen percent (13%) antimony grid alloys. The battery had a temperature compensating, vibrating contact voltage regulator. By the end of the 50's twelve volt battery was available featuring rubber

separators and seven percent antimony in the grid alloy. Towards the end of the 60's, the typical new car battery featured, through partition connectors, one piece cover, and sealed side terminals, a rubber container and grid alloy containing four percent antimony. Some of the leading battery manufacturers also introduced polypropylene containers at that time.

During the latter half of 70's the battery industry entered the maintenance free era. Grids with 1-2% antimony and other alloya like Ca, sn and plates made by high speed continuous strip processing equipment were introduced. In place of conventional separators plates, encapsulated in plastic envelopes came as new technology. The polypropylene container became a cocoon, completely sealing the battery against entry and containing subsystems, such as build-in state of charge indicators, and flame arresting vent system. In early 80's major changes took place in the technology of manufacturing systems, like continuous automatically controlled casting, rolling, grid expansion, pasting, curing cutting and stacking of battery plates. This enhanced the production rates to a level undreamed of ten years earlier. In the modern plants up above the plate line, active material ingredients are programmed, weighed, and blended by computer controlled paste mixers, resulting in control of plate weight, thickness and chemistry, which was not possible few years ago. Control of this production system is backed up by analytical equipment, such as the atomic absorption spectrograph, florescent xray spectrometers, particle distribution counter and optical emission spectrograph. Sophisticated welding machines are common in all battery plants in USA, UK, Canada and France.

At present a great deal of emphasis is on the need of smaller and lighter batteries, for new small sized car and automobiles. The drive for improved fuel economy and the space limitations of present and planned engine compartments, are still strong factors today for the development of small, light weight, high powered batteries.

1.2 The manufacturing process of Lead Acid Batteries is largely based on imported technology and it has been observed that there has been repeatitive import of technology and further more foreign colloboration, in some

cases have been extended for unduly long times. In view of this, it was thought desirable to undertake the review of present status of this industry and to identify and analyse critical inputs required for absorption of imported technology.

The industrial enterprises having in-house R&D units are advantageously placed to absorb and improve upon the imported technology. The Technology Absorption and Adaptation Scheme (TAAS) of DSIR seeks to encourage this role by providing these units with optimum inputs for accelerated absorption and upgradation of imported technology. The support under TAAS for such R&D activities could be for :

- Support to technology absorption exercises.
- Selective support to strenghthening measures in the R&D base for technology absorption.
- Assistance in technology upgradation in selected sectors which are related to imported technology.
- Support for symposia, seminars, publications etc. in relation to technology absorption exercises for information dissemination.

1.3 The DSIR has introduced a scheme "National Register of Foreign Collaborations" which envisages review and analysis of imported technologies in the country and suggests measures for appropriate choice, acquisition and implementation of foreign know-how. The major objectives of this scheme are

- Undertake financial, economic and legal analysis of set of data on foreign collaborations.
- Carry out a technology analysis of the imported technology and provide a state of art technology in use in the country and status of implementation of collaboration.
- Provide the basis for a National Science strategy wherever possible.
- In the long run lead to unpackaging of imported technology and a national strength to competitively purchase only selected components of technology.
- Coordinate with Ministry of Industry, Commerce and Finance etc. by providing technology data input.

Facilitate more effective national participation with various organisations such as UNCTAD, UNIDO, ESCAP etc. and in the international exchange of information and cooperation with other developing countries.

The present report has been prepared under "National Register of Foreign Collaborations" to review the Lead Acid Battery industry in India.

1.4 This report attempts to review the present state of art in Lead Acid Battery industry and to assess the present level of absorption facilities and capabilities, both imported and indigenous technologies in this sector. An effort has been made to identify areas of reserves which could be pursued by Indian R&D units for upgrading the technology in the field of Lead Acid Batteries. A detailed and in-depth study has been carried out in Lead Acid Battery industry through M/s. Chemical and Metallurgical Design Co. Ltd., New Delhi.

1.5 There are 6 leading battery manufacturers in the country, however 80% of the production is accounted by the four leading manufacturers viz. Chloride India, Standard Batteries, Amco Batteries, Willard India. During 1984-85, approximately 97.3 million batteries were exported. The list of leading battery manufacturers in India and abroad is given in Annexure - II and III.