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**ENVIROSCIENCE, INC. (ESI) ELECTRIC ARC
FURNACE DUST RECYCLING TECHNOLOGY ASSESSMENT**

**Taiwan
April 5-9, 1994**

Prepared for:

US - ASIA ENVIRONMENTAL PARTNERSHIP



WORLD ENVIRONMENT CENTER

DISCLAIMER

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TABLE OF CONTENTS

I. EXECUTIVE SUMMARY 1

II. INTRODUCTION 2

III. SUMMARY OF MEETINGS 3

IV. CONCLUSIONS AND RECOMMENDATIONS 5

APPENDICES

- A. ITINERARY
- B. CURRICULUM VITAE

I. EXECUTIVE SUMMARY

Two representatives of Envirosience, Inc. (ESI), C.T. Philipp, President and B.H. Sims, Chief Engineer and their consultant, Mr. Don Werner visited Taipei and Kaohsiung from April 5th to April 9th, 1994. The purpose of the trip was to introduce ESI technology used to recycle Electric Arc Furnace (EAF) dust, a hazardous waste, into value added commercial products.

The steel industry in Taiwan produces approximately 120,000 million tons per year of EAF dust with the bulk of this dust is being buried in municipal landfills. Ground water contamination caused by leachate from these landfills is becoming a serious problem. In 1992, Taiwan Environmental Protection Agency (EPA) launched a five year (7/92 - 12/96) Green Plan for a healthy environment. This plan provides free import duties, investment tax credits and low interest loans to encourage private firms to improve the environment and to recycle wastes. The ESI technology has been selected by Carnegie Mellon University and China Technical Consultants, Inc. as the most cost effective technology in the world to recycle inorganic wastes.

The main purpose of this exchange was to discuss the ESI technology, develop a preliminary proposal for services, and to assist in developing markets for products to be produced from the recycle technology.

Mary Ann Wo of the Arkansas Industrial Development Commission (AIDC) has been the primary liaison between ESI and Park Liou (E. Chang Steel). On April 11th, a Memorandum of Agreement was signed between ESI and Shiao-Kang Enterprises Company, Ltd. (owned by Mr. Park Liou). This agreement has been submitted to the Industrial Bureau so that Mr. Liou can acquire government land set aside for recycling.

The next step for ESI is to negotiate the following:

- A. An exclusive country license
- B. A design/construction supervision contract
- C. A royalty agreement based upon tonnage of dust recycled

It is anticipated that more discussion will be required to facilitate negotiations and to sign agreements with the Taiwanese partners

II. INTRODUCTION

The purpose of this exchange was to introduce Enviroscience, Inc. (ESI) recycling technology to the Taiwan EPA, China Technical Consultants, Inc., a leading environmental consultant, and E. Chang Iron and Steel Company. The names and affiliations of the exchange participants are:

<u>Person</u>	<u>Company</u>
C. T. Philipp, P. E., President	Enviroscience, Inc.
B. H. Sims, Chief Engineer	Enviroscience, Inc.
Don Werner, Consultant	Engineering & Construction, Inc.

(Appendix A is a list of the organizations visited along with copies of appropriate business cards.)

ESI was advised that six Taiwan steel and iron companies had established a fund to build an EAF dust recycling facility. The six companies were: E. Chang Iron and Steel Works, Co., Ltd.; Tung Ho Steel Enterprise Corp.; Hai Kwang Enterprise Corporation; Chin Tai Steel Enterprise Co., Ltd.; Shyeh Sheng Fuat Steel & Iron Works, Co., Ltd.; and Lung Ching Steel Enterprise Co., Ltd. This EAF dust recycling facility would try to reduce the amount of EAF dust generated in Taiwan. The current load is approximately 120,000 tons/year.

III. SUMMARY OF MEETINGS

A. E. Chang Iron Steel Works Co. - Park Liou

Mr. Park Liou is President and Owner of E. Chang Iron and E. Shenz Steel Iron Company. He is responsible for an EAF dust recycling project sponsored by the following six (6) steel companies:

E. Chang Iron Steel Works Co.
Tung Ho Steel Enterprise Corp.
Hai Kwang Enterprises Corp.
Chin Tai Steel Enterprise Co.
Shyeh Sheng Friat Steel & Iron Works
Lung Ching Steel Enterprises Co.

Mr. Liou contacted ESI on January 26, 1994. He requested a price for a 60,000 tons per year recycle facility which was later expanded to a design capacity of 120,000 million tons per year of Electric Arc Furnace (EAF) dust. The technology was presented and many technical and economic questions were answered in the course of discussion. The market to recycle EAF dust will develop this year as the Taiwan EPA plans to prohibit the current practice of landfill disposal. Taiwan EPA essentially plans to adopt U.S. EPA regulations.

At this time, no EAF dust is being recycled in Taiwan and Taiwan EPA has only approved one method for treatment. This chemical treatment method was developed in the U.S. by Chemfix Technologies Inc. which was represented in Taiwan by Mr. Ho of Taiwan Logistics Services Co., Ltd. Mr. Ho has been working on a process to mix 40% EAF dust with 60% additives (primarily cement) to make bricks for the construction industry. This chemical stabilization process does not recover zinc and iron units. Also, the long-term integrity of the brick is unknown, similar attempts to make bricks in the U.S. have not been successful.

Mr. Liou concluded that the ESI process is the most cost effective EAF dust recycle technology in the world. Mr. Paul Ong of Alpa Enterprises Co., Ltd., a friend and business associate of Mr. Liou who has experience in the uses and markets for mineral wool fiber, introduced this process with fiber is the primary product.

Mary Ann Wo completed a brief market survey on mineral wool used in Taiwan, noting that there is one Japanese producer in Taiwan. Current market prices in Taiwan are:

<u>Source</u>	<u>Price, U. S.</u>
Mainland China	\$336/ton
Korea	\$509/ton
Japan	\$682 - 1027/ton

The current market price in the USA is \$200 - \$240/ton.

The participants believed the meetings with Mr. Liou to be very productive. On April 11, 1994 a Memorandum of Agreement was signed between ESI and Shiao-Kang Enterprises Company, Ltd. (a new company owned by Mr. Liou). The agreement was certified by the Coordination Council for North American Affairs - Houston Office. The Council will assist Mr. Liou with the acquisition of some very valuable government land that has been set aside for recycling. Once the land has been acquired, ESI anticipates signing an exclusive Taiwan licensing agreement with Mr. Liou.

B. China Technical Consultants, Inc. (CTCI)

ESI gave CTCI a technical presentation to Mr. Huang, ESI's main contact. In 1993, CTCI was awarded a \$10 million contract from Taiwan EPA to evaluate all the EAF recycle technologies worldwide. CTCI selected the ESI process since it produces only products and no waste residues.

ESI will continue to keep CTCI informed on the project and anticipates that Mr. Liou or ESI will subcontract some environmental work to CTCI. Their relationship with Taiwan EPA to this point has been quite valuable.

C. Taiwan EPA

The participants determined that Taiwan EPA regulations are 3-5 years behind U. S. EPA. Taiwan EPA is actively promoting Pollution Prevention and Recycling and with the assistance of CTCI, problems obtaining permits does not appear to be a major problem for the ESI project.

IV. CONCLUSIONS AND RECOMMENDATIONS

It appears that ESI's trip will lead to a commercial EAF dust recycle facility in Kaohsiung, Taiwan. Regulations are being written by Taiwan EPA to force the steel industry to recycle EAF dust when a commercial facility becomes available. It is anticipated that Mr. Park Liou will be the major stockholder in the recycle company (Shiao-Kang Enterprises Company, Ltd.) with a decision on the acquisition of the land anticipated in the near future. The total installed cost for the recycle facility cannot be determined until a licensing agreement is secured and preliminary engineering is completed. A 120,000 million ton per year recycle system would cost about \$25-\$30 million in the U.S.

Recommendations for future actions include:

1. Sign an exclusive Taiwan licensing agreement with Shiao-Kang.
2. Sign an engineering design and construction supervision contract.
3. Prepare a list of U.S. equipment to be used.
4. Subcontract environmental work to China Technical Consultants, Inc.
5. Continue to coordinate project developments with WEC, AIDC, AIT, U. S. AEP and ASEAN Environmental Improvement Project.
6. Solicit interim project funding.

APPENDIX A
ITINERARY

ITINERARY

<u>DATE</u>	<u>ORGANIZATION</u>	<u>PERSON</u>
4/5/94	American Institute In Taiwan	Nancy Charles-Parker
4/6/94	E. Chang Iron Steel Works Co. Majetek Enterprises Co., Ltd. AIDC American Institute in Taiwan	Park Liou Y. C. Fang Mary Ann Wo Jeff Miller
4/7/94	E. Chang Iron Steel Works Co. Alpa Enterprises Co., LTD Taiwan Logistics Services - Chemfix AIDC American Institute in Taiwan	Park Liou Paul Ong Lin Jui Ho Mary Ann Wo Jeff Miller
4/7/94	American Institute in Taiwan American Institute in Taiwan	Daphine J. H. Fan Robert H. Strotman
4/8/94	AIDC China Technical Consultants, Inc. China Technical Consultants, Inc.	Mary Ann Wo Shung-Min Huang T. Y. Yu
4/8/94	Taiwan EPA Taiwan EPA AIDC	Peter Ing-Jyh Lai K. S. F. Lin Mary Ann Wo
4/8/94	American Institute In Taiwan American Institute In Taiwan	Nancy Charles-Parker Jeff Miller
4/8/94	E. Chang Iron Steel Works Co. China Technical Consultants AIDC	Park Liou Shung-Ming Huang Mary Ann Wo
4/9/94	Siemens	Rainald Strauss

APPENDIX B
CURRICULUM VITAE

RONALD J. WERNER

Telephone: [REDACTED]
Facsimile: (412) 257-1730

EXPERIENCE JONES CAPITAL CORPORATION, Charlotte, NC (1989-1992)

Marketing/Project Development

Consultant to project development and finance subsidiary of major international construction group. Responsible for development and implementation of marketing strategy and project development.

- * Initiated marketing program for new company ranging from sales literature to project development
- * Contacted engineering firms, project development companies, and Fortune 500 companies to develop prospects for power generation projects
- * Major involvement in independent power field including power generation technology, fuel selection, and power sales

PROSTEEL TECHNOLOGIES, Charlotte, NC (1988-1989)

Partner

Formed technology and equipment sales company with U. S. and European partners. Responsible for marketing, sales, contract negotiations, and day-to-day company operations.

- * Negotiated three exclusive technology and equipment supply agreements with European companies
- * Sold profitable equipment and construction project in competition with established competitors; drafted and negotiated contract

MIDREX CORPORATION, Charlotte, NC (1973-1987)

Vice President Sales/Marketing (1983-1987)

Responsible for worldwide project sales, market development and technology licensing. Member of president's staff for setting company strategic direction and operating policy.

- * Developed strategy and departmental organization to lead company's technology in new direction related to major market change and instituted comprehensive customer service program
- * Negotiated \$45 million engineering and equipment contract and technology license in Venezuela
- * Worked with Japanese and German engineering/construction companies in sale of projects in Middle East and in Africa

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RESUME DONALD J. WERNER, page 2

Director, Sales and Licensing (1980-1983)

Responsible for plant sales (Western Hemisphere), proposals, contract and license negotiations, and collaboration with international marketing with engineering and construction licensees.

- * Collaborated with German and Austrian construction licensees in sale of major greenfield projects in Far East and Middle East and negotiated technology licenses with state-owned operating companies
- * Negotiated \$16 million contract for engineering and prototype process equipment in Malaysia and obtained Exim Bank commitment to finance

Manager Licensing (1977-1980)

Responsible for development/administration of technology licensing programs for engineering and construction companies and operating plants. Interviewed, hired, and trained personnel for this start-up group.

- * Negotiated multi-million dollar technology licenses in Nigeria, Saudi Arabia, and Iran and letter of credit with Nigerian Central Bank

International Sales and Contract Development Engineer (1973-1976)

Promoted company's technology and directed proposal and contract development for engineering, equipment, and construction services.

- * Sales engineer for major engineering, equipment, construction and start-up services contract in Caribbean

SURFACE COMBUSTION DIVISION, MIDLAND-ROSS CORPORATION (1968-1971)

Product Engineer, Environmental Control Equipment (1969-1971)

Coordinated development, design, marketing, sales, and start-up of incineration equipment. Conducted market studies for new equipment.

Development Engineer, Thermal Processing (1968-1969)

Participated in thermal process and incineration equipment development. Completed plant study resulting in 45% capacity increase.

LANGUAGE Basic German plus introductory courses in Japanese and Spanish

TRAVEL Regularly travel 120 days or more per year

EDUCATION Master of Science, University of Toledo, 1975
Major: Chemical Engineering/Environmental Technology and Economics
Environmental Protection Agency Fellowship
Graduate courses in engineering economics and legal aspects of engineering

Bachelor of Science, University of Toledo, 1968
Major: Chemical Engineering, Tau Beta Pi (Engineering Honorary)

PERSONAL Married, two children
Enjoy tennis and walking

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10

C. THOMAS PHILIPP

EDUCATION: B.S., Chemical Engineering, Tri State University, 1962
M.S., Environmental Engineering, Akron University, 1975

Years of Experience: 27

Registration: Professional Engineer: Ohio, Arkansas, Georgia, North Carolina, Texas

Organizations: Member of ASEP, MFSA, AFS

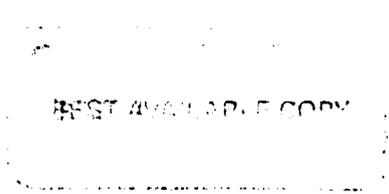
EMPLOYMENT HISTORY

Enviroscience, Inc., 1989 - President and Owner
Ensco Environmental Services, 1988-1989 - Vice President
Water Management, Inc., 1973-1987 - President and Owner
Liacon Inc., 1971-1973 - General Manager
Hytek International Corporation, 1968-1971 - Senior Chemical Engineer
NUS Corporation, C.W. Rice Division, 1965-1968 - Senior Engineer
Dow Chemical Company, 1962-1965 - Technical Services Engineer
University of Toledo, 1975-Present - Industrial Wastewater Pretreatment Seminars

APPLICABLE EXPERIENCE

Enviroscience, Inc., 1989 - President and Owner

- o Design of pyrometallurgical metals recovery systems utilizing calcium chemistry for on-site and off-site recycling.
- o Creation of engineering, marketing and service groups to develop and promote pyrometallurgical technology for recovery of metals from hazardous wastes (F, D, K series).
- o Redesign of existing 350 gpm wastewater treatment system to recover chromic acid (by ion exchange and cationic membrane technologies) and to recover copper and nickel from sludges.
- o Technical/economic evaluations of HTMR (High Temperature Metals Recovery) process to produce Ni/Fe alloy and eliminate RCRA waste generation.
- o Study of methods to remove and recover chromic acid from contaminated groundwaters.
- o Guest lecturer for University of Toledo Seminars on "Industrial Wastewater Pretreatment" since 1975.



- o Consulting engineering services to industrial clients on point source recovery, waste minimization, wastewater treatment and elimination of RCRA liability.
- o Approvals from 14 state regulatory agencies and USEPA for recycle classification for pyrometallurgical process.

Enasco Environmental Services, 1988-1992 Vice President

- o Reviewed new technologies and unit operations to increase profitability of parent corporation's TSD facility.
- o Application of state of the art technology for water conservation, chemical recovery, wastewater treatment and hazardous waste management for TSD facility and Superfund site remediation projects.
- o Completed numerous projects involving preliminary engineering reports, permit negotiations, detailed engineering, construction supervision, and projects involving waste minimization, resource recovery and groundwater remediation.
- o Prepared necessary documents for closure of hazardous waste sites together with implementation and post-closure. Preparation of hazardous waste delisting petitions and investigations for beneficial uses of listed hazardous wastes.

Water Management, Inc., 1973-1987 - President and Owner

- o Designed wastewater treatment facilities for the printed circuit, metal finishing, dairy, meat packing, aluminum smelting, rubber, automotive, foundry, anodizing, and phosphating industries.
- o Responsible for conceptual design for metal hydroxide sludge drying equipment.
- o Designed water treatment systems based on ten states' standards for municipal and industrial plants involving the following: coagulation, aeration, clarification, filtration and softening.
- o Design of chrome and nickel product recovery systems (ion exchange/reverse osmosis/ultrafiltration). Design of ultrafiltration systems for alkaline cleaner recovery and oil/water separation.
- o Water conservation projects for general industry including source reductions, waste minimization and resource recovery.
- o Design of ion exchange systems for the recovery of nitric, hydrochloric and sulfuric acids.
- o Preparation of closure plans for hazardous waste sites, implementation of closure plans and certification of closures.

- o Established engineering and fabrication facility to manufacture skid mounted, prepiped and prewired packaged wastewater treatment systems including recessed plate filter presses and sludge dryers.
- o Coordination of national trade journal advertising program.
- o In-house training programs on new technology for staff engineers.
- o Responsible for marketing and direct sales to major industrial clients.
- o Design and marketing of MSDS (mobile sludge dewatering system) unit for using a mobile filter press for pond remediation projects.

Liacon Inc., 1971-1973 - General Manager

- o Supervised process development for recovery of copper from sulfuric acid solutions via ion exchange.
- o Supervised analytical laboratory and pilot plant operations.
- o Designed recycle and recovery facilities for mercury.
- o Performed stream surveys to determine allowable pollution loadings.
- o Designed system for recovery of whey waste by reverse osmosis and evaporation.
- o Coordinated compliance with NPDES effluent limitations with plant personnel and state regulatory authorities.

Hytek International Corporation, 1968-1971 - Sr. Chemical Engineer

- o Responsible for the design of large demineralizers, deionizers and water softeners. Also designed packaged waste treatment systems for cyanide oxidation and hexavalent chrome reduction in rinse waters. Completed preliminary surveys to determine plant waste loads and necessary design parameters. Supervised installation and start-up on wastewater treatment projects. Received EPA award in 1969 for most innovative metal finishing wastewater treatment system at Bechtel-McLaughlin, Sandusky, Ohio.

NUS Corp., C.W. Rice Division, 1965-1968 - Sr. Chemical Engineer

- o Consulting engineering services to approximately 100 industrial clients. Services involved supervision of water treatment programs for large steam generating plants and industrial wastewater treatment systems. Preparation of specifications for large demineralizer systems.



Dow Chemical Company, 1962-1965, Technical Services Engineer

- o Completed laboratory evaluations and provided field supervision on use of EDTA chelant for boiler water treatment. Projects included corrosion testing programs, training of boiler plant operators, and use of chelant in boilers up to 1200 psig and 2,000,000 lb/hr. Also supervised numerous chemical cleaning projects involving chelants and acids for the removal of mill scale and deposits from industrial boilers, utility boilers, plant piping systems, and nuclear power plants.

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BOB H SIMS

EDUCATION: Arkansas Environmental Academy, Camden, AR
Garland County Community College, Hot Springs, AR

EMPLOYMENT HISTORY

Enviroscience, Inc., 1989 - Manager of Engineering
Ensco Environmental Services, 1988-1989 - Consultant
Christian Probes, 1986-1988 - President
Water Management, Inc., 1982-1986, Manager of Research & Development,
Engineering Manager
Hot Springs Village, 1974-1982 - Lead Operator

APPLICABLE EXPERIENCE

Enviroscience, Inc., 1989 - Manager of Engineering

- o Responsible for specification of furnaces, mixers, driers, air pollution control equipment to utilize the patented pyrometallurgical ^{smelt} metals recovery technology. In charge of water pollution control systems designs and supervises upgrading existing treatment systems to minimize waste and improve effluent quality. Supervising projects on oil/water separation using gravity and ultrafiltration devices. Project engineer on a Mexico City industrial wastewater system upgrade.

Ensco Environmental Services, 1988-1989 - Consultant

- o Responsible for preliminary designs of unique biologicalwaste treatment systems and exploration of new bioremediation technology for site remediation projects. Projects include ground water and surface water remediation containing oils and salts, insitu treatment of penta and creosote sludge and modular type mobile water treatment systems for both organics and heavy metals removal. Supervised operation of a 200 gpm phenol oxidation system on contract basis in Kokomo, IN.

Christian Probes, 1986-1988 - President

- o Owner of a panel shop that specialized in design and manufacture of custom controls for hazardous waste treatment systems. Responsible for bidding, overseeing building and the profit/loss of all projects; training of all employees in all areas of control panel manufacture. Provided design engineering services on contract basis to a major manufacturer of pollution control systems.

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Water Management, Inc., 1982-1986 - Manager of Research and Development, Engineering Manager

- o Chemical engineering firm primarily concerned with the disposal, reduction or recovery of hazardous waste. Started as a Field Supervisor and promoted to Engineering Manager. Responsible for the supervision of hazardous pond closures; upgrading of sanitary treatment systems; supervision of preparation of all mechanical and electrical drawings; coordination of the collection and analysis of raw water samples; conceptual treatment design; expediting all projects from field survey through final start up; development of new products.
- o Designed and assembled metal hydroxide sludge dryer; investigated new innovative spray rinse systems, liquid alum production from aluminum anodizing waste, ultra-filtration for alkaline cleaner recovery, filter press production and atmospheric evaporators.
- o Assigned to expedite all W.M.I. Hot Springs projects starting with field survey through finalization of the project; redesigned and upgraded clarifiers, clarifier plate packs and electrical components. Designed, engineered and assembled the first totally contained package waste treatment units. Set up a CAD system for electric schematics to insure standardization of controls. While in charge of Arkansas, it grew from 4 people to over 38 while becoming the hub of engineering and manufacturing all other offices.
- o Assignments have included field supervision of hazardous waste pond closures, land application of utility chemical cleaning wastes, design and construction of MSDS (Mobile Sludge Dewatering System), and upgrading of existing sanitary package treatment systems.
- o Responsible for the design of all control panels and preparation of mechanical and electrical drawings for custom and modular treatment systems. Responsible for the supervision of draftsmen. Coordinated collection of raw waste water samples and prepared conceptual treatment design based on laboratory treatability data.

Hot Springs Village, 1974-1982 - Lead Operator

- o In 1974, became Sewer Plant Operator with Class III Limited. Set up monthly stream monitoring and operated aerated lagoon and packaged systems at Hot Springs Village. Established lab for NPDES testing. Initiated a S.T.E.P. pumped effluent system. Patented a liquid level control used in the S.T.E.P. systems. Received Pollution Control Special System of the year from H.S.V. and received the Pollution Control Outstanding Achievement Award. In May of 1977, received Class III Unlimited License.