Environmental Technology Assessment (EnTA)

Manila, Republic of the Philippines
22 - 25 February 2000

Workshop Report

UNEP

United Nations
Environment Programme
Division of Technology,
Industry and Economics

ILMC

The International
Lead Management
Center

CDG

Carl Duisberg
Gesellschaft

WORKSHOP REPORT

This document reports on the conduct and outcome of an International Workshop on Environmental Technology Assessment (EnTA), held in Manila, Republic of the Philippines, 22-25 February 2000.

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Sponsors:

- International Lead Management Center (ILMC), USA;
- Carl Duisberg Gesellschaft (CDG), Germany;
- Philippine Recyclers Inc., Republic of the Philippines;
- Technicas Reunidas (Torrejón), Spain; and
- UNCTAD – International Trade and Commodities Division, Trade, Environment and Development Section, Geneva Office, Switzerland.

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EXECUTIVE SUMMARY

The United Nations Environment Programme (UNEP), in conjunction with the International Lead Management Centre (ILMC) and the Carl Duisberg Gesellschaft (CDG), convened a participatory training workshop designed to familiarise participants with the Environmental Technology Assessment (EnTA) process and to develop their understanding by engaging them in a practical application of the EnTA methodology, using automotive battery recycling as a case study. UNEP viewed the workshop as part of its efforts to encourage the uptake of EnTA, including training in, and evaluation of, its new environmental technology assessment (EnTA) Manual, *Anticipating the Environmental Effects of Technology*.

The 46 workshop delegates and other participants were drawn from a pool of government environmental officials, industrial process and environmental managers, and representatives of educational institutions and non-governmental organisations (NGOs) from the ASEAN region, and from selected countries in transition. Importantly, the workshop organisers achieved an appropriate mix of participants from the private sector, regulatory bodies, policy makers, educators and NGOs.

The workshop programme included presentations and discussions on environmental assessment techniques, the economics of sustainable environmentally sound battery recycling, construction and design of the modern recyclable lead acid battery, principles of hydro-metallurgical and pyro-metallurgical battery recycling, and the methods and practices of EnTA, as well as a practical, field-based assessment exercise in EnTA. Personal follow-up action plans were prepared by the trainees.

As a result of the workshop, 40 participants are now trained in the use of EnTA. Considerable progress was also made towards publication of an evaluated and revised EnTA Manual, ready for worldwide use by Governments and industry as a selection tool for sound environmental management of recycling and other processes, preparation of a model workshop, and publication of a trainers' manual. The workshop thus contributed to international advanced training, to dialogue and to human resources development, including international know-how transfer between North and South, and East and West.

Various aspects of the workshop were subject to a combination of formal and non-formal reviews and evaluations. Based on their knowledge and practical experience with EnTA (acquired both during and, in some cases, prior to the workshop), participants recognised the benefits of having an environmental management tool that is technology focussed. Importantly, EnTA identifies if more sophisticated assessment tools, such as environmental risk assessment and cost-benefit analysis, need be used to ensure that the appropriate environmental outcomes can indeed be achieved. Participants considered the draft EnTA Manual to be comprehensive and thought it provided an understandable and useful introduction to EnTA and to the specific assessment procedures. However, the Manual needs to include a simple economic assessment. Some trainees expressed concerns about the subjective nature of EnTA, the lack of specific weighting procedures for aggregating impacts and explicit acknowledgement of uncertainties. However, most participants were comfortable that EnTA uses concepts and procedures consistent with

the need to reflect diverse human values, expert opinion and incomplete information and understanding.

A number of follow-up activities were identified in the personal action plans and in a post workshop review conducted by the organisers. EnTA will be further evaluated and applied in the various national situations, including different applications and approaches such as treatments, adaptation and innovation. Multi-sector training and consultation will also be undertaken and the policy environment for the implementation of EnTA will be developed in participating countries. Finally, EnTA will be refined in order to improve precision, and include financial and economic analyses.

The workshop, along with the similar workshop convened in South Africa, has provided substantial guidance for the revision of the EnTA Manual. While the preparation of the revised Manual in conventional form is already supported by UNEP, the goal of worldwide distribution and use of the Manual will come about only if more EnTA trainers are available and modern information dissemination methods such as CD ROM and the Internet are employed.

The experience acquired in implementing the Manila and South African workshops has resulted in identification of a number of ways in which the workshop structure, approach, content and methods might be modified in order to produce optimal outcomes. The stage is now set for the development of a “model workshop” and for the preparation of a trainers’ manual, but further action is contingent on identifying, briefing and resourcing those who have the ability to complete such a task.

Finally, as a result of the workshop a series of important recommendations have been prepared:

Recommendation 1:

UNEP, in conjunction with its substantive partners such as ILMC, CDG and UNCTAD, continue to develop EnTA as a key environmental management tool, and facilitate the application of EnTA through the dissemination of information, including the revised Manual, and through the implementation of further training and other capacity building activities.

Recommendation 2:

Relevant international, regional and national organisations and institutions provide substantive and sustained support to the Manila workshop participants, in ways that will facilitate implementation of their personal action plans and ensure sustainable and measurable impacts from the workshop, including facilitating their involvement in building regional and national capacities in EnTA.

Recommendation 3:

Appropriate organisations and institutions are encouraged to participate and collaborate in studies that will lead to a scientifically rigorous and operational definition of "environmentally sound and sustainable", and to the identification and application of measures (targets and indicators) to be used to quantify the increased uptake of environmentally sound technologies, and the benefits that arise;

Recommendation 4:

Build on the successful strategic alliances that were established and strengthened during the planning and implementation of the Manila workshop in order to:

- prepare, and disseminate worldwide, the revised and improved EnTA training materials, including case studies on:
  - lead acid battery recycling;
  - disposal of medical wastes; and
  - comprehensive comparison of existing and emerging lead acid battery processing technologies;
- support the work of regional and national centres engaged in environmental technology assessment and transfer; and
- replicate the EnTA training workshop approach in other institutions, countries and regions, and with reference to other process technologies.

Recommendation 5:

UNEP and its strategic partners to facilitate and coordinate a study of the implications on trade, and on sustainable development, of the increased use of environmentally sound technologies for the recycling of hazardous wastes.

INTRODUCTION

The United Nations Environment Programme (UNEP), in conjunction with the International Lead Management Centre (ILMC) and the Carl Duisberg Gesellschaft (CDG), convened a participatory training workshop designed to familiarise participants with the Environmental Technology Assessment (EnTA) process and to develop their understanding by engaging them in a practical application of the EnTA methodology, using automotive battery recycling as a case study. UNEP viewed the workshop as part of its efforts to encourage the uptake of an emerging methodology for assessing the environmental and related impacts of industrial process, and other, technologies. To facilitate this uptake of EnTA, UNEP has prepared an environmental technology assessment (EnTA) Manual*, Anticipating the Environmental Effects of Technology.*

Part of the workshop programme was devoted to characterising and illustrating the importance of macro and micro economic factors in establishing the parameters for a viable and thereby sustainable industrial process.

EnTA is well suited to developing countries and those in transition as it facilitates selection of the "appropriate" technology, to suit the environmental (including social and economic) circumstances and priorities of the country or region. Hence there was particular value in conducting the workshop in South East Asia, and including several participants from other regions and countries in transition.

The Workshop targeted those working in industry, Governmental environmental, regulatory and trade agencies, and in non-governmental organisations. Such people are among those often required to assess the environmental impact of a range of technologies, or make discerning choices between various competing processes.

FOCUS, OBJECTIVES AND OUTPUTS OF THE TRAINING WORKSHOP

The focus of the workshop was to assess the environmental and related performances of current and emerging technologies used in automotive battery collection and recycling sectors in Southeast Asia, particularly in the Philippines, including measures that enhance collection rates and avoid used batteries entering the waste stream.

The objectives of the workshop were to ensure that participants would:

- Understand the principles of economically viable and environmentally sound lead acid battery collection and recycling;
- Be able to use the methodology described in the Environmental Technology Assessment (EnTA) Manual, *Anticipating the Environmental Effects of Technology*, as a tool with which to evaluate the environmental soundness of technologies and of procedures in the secondary lead industry, with a special focus on used automotive lead acid battery collection and recycling; and

- Be capable of applying the lessons learned to assess the environmental impacts of a wider range of technologies.

Consistent with the above objectives, the outputs of the workshop were:

- 36 delegates and 4 other participants trained in the use of EnTA to evaluate the environmental impacts of process technologies, especially those related to recycling used lead acid batteries;
- Publication of an evaluated and revised EnTA Manual, ready for worldwide use by Governments and industry as a selection tool for sound environmental management of recycling and other processes; and
- Preparation of a model workshop, and publication of a trainers' manual that would facilitate replication of the workshop in other countries and regions, and focus on a range of process technologies.

To achieve these objectives extensive use was made of the simplified Environmental Technology Assessment (EnTA) Manual, *Anticipating the Environmental Effects of Technology*, prepared jointly by UNEP's Production and Consumption Unit and its International Environmental Technology Centre, both of UNEP's Division of Technology, Industry and Economics (DTIE).

Participants from governmental environmental and other agencies, from industry, educational institutions and non-governmental organisations, were trained in the use and application of EnTA, with battery recycling used as a case study. The newly acquired knowledge and skills were intended to provide the basis for participants to make valid assessments of the real and potential environmental performances of the chosen battery recycling processes and, where applicable, make recommendations regarding procedural and technology improvements to the industrial sector, in order to achieve higher levels of health and environmental protection. The workshop was also intended to give participants the opportunity to equip themselves with the methods, tools and materials they could use to conduct EnTA training courses in their domestic institutions and national organisations.

BACKGROUND TO THE WORKSHOP

The potentially serious health and environmental impacts of inappropriate and uncontrolled practices in collection and recycling of lead-acid batteries are well documented. All stages of the used battery collection and re-processing operations are associated with potentially adverse human health and environmental risks, for both small-scale operators and major plants.

UNEP's technical report *Recyclage des Batteries Plomb-Acide et Environnement*, published in 1999, provides a global review of many of the technological options for improving the performance of the secondary lead industry. A report, in English, outlining the principles of sound battery recycling will be prepared in 2000, as a joint initiative of UNEP and ILMC. This report will contain information about the appropriate management of battery recycling operations, including best practices and cost effective environmental options for developing countries.

As part of the United Nations Conference on Trade and Development (UNCTAD) project on the impact of the proposed Basel Ban Amendment, ILMC and UNCTAD have undertaken an extensive study of automotive battery collection and recycling in the Philippines, focusing on the need to restructure the formal and informal sectors, and taking into account relevant Filipino social, economic and environmental needs and priorities. The Manila Office of UNDP and the Philippine Government's Department of Trade and Industry and Environmental Management Bureau (EMB) also support this study, and compliance with the resulting recommendations.

The export-import of automotive batteries has become an element of the work of the Basel Convention, especially the procedures to regulate the trade in recyclable hazardous wastes. The use of environmentally sound technologies for recycling is one of the key elements in the global debate on this issue. However, the definition of "environmentally sound" needs to be expressed in operational and scientific terms that facilitate the selection of appropriate recycling technologies and procedures, by both the private sector and governments.

In order to encourage the wider use of EnTA, UNEP has simplified the procedure, as described in the new Environmental Technology Assessment Manual, *Anticipating the Environmental Effects of Technology*. The revised Manual is for use by government officials, consultants and company process and environmental managers, to identify the health, environmental and social implications of any technology through application of EnTA.

The workshop combined all the above elements into a training format that lead to the practical application of the EnTA methodology by the delegates. The workshop also provided an opportunity for UNEP to review and evaluate the EnTA Manual and to share policy advice.

WORKSHOP PROGRAMME

The workshop programme is presented in Annex 1. The interactive and participatory workshop comprised the following major components:

- Opening;
- Summaries of national reports on lead acid battery recycling and environmental management;
- Review and discussion of environmental assessment techniques, with a focus on EnTA;
- Technical presentations and discussions related to:
  - Economics of sustainable environmentally sound battery recycling;
  - Construction and design of the modern recyclable lead acid battery;
  - Principles of hydro-metallurgical battery recycling; and
  - Principles of pyro-metallurgical battery recycling;
  - The methods and practices of EnTA;
- Practical, field-based assessment exercises in EnTA;
- Preparation and presentation of reports of practical working groups;

- Preparation of personal action plans;
- Review and evaluation of:
  - EnTA as an environmental management tool;
  - The EnTA manual;
  - The workshop; and
- Close

WORKSHOP PARTICIPANTS

The 46 workshop delegates and other participants were drawn from a pool of government environmental officials, industrial process and environmental managers, and representatives of non-governmental organisations (NGOs) from the ASEAN region, and from selected countries in transition. Importantly, the workshop organisers achieved an appropriate mix of participants from the private sector, regulatory bodies, policy makers, educators and NGOs.

Details of all experts and participants are provided in Annex 2.
A workshop moderator (Brian Wilson of ILMC) and a team of nine resource personnel, including two facilitators, helped implement the workshop. The large number of resource persons and facilitators, relative to the total number of workshop participants, was necessitated by the interactive, participatory and, at times, highly technical nature of the workshop.

The Workshop team comprised the following:

- Lilia Casanova, Deputy Director, UNEP's International Environmental Technology Center, Osaka, Japan;
- Olivia la O'Castillo, Asia Pacific Roundtable on Cleaner Production, Pasig City, Philippines;
- Teofila Echavia Remotigue, Partnerships Coordinator, GTZ Family Health Management Project, Pasay City, Philippines;
- Carlos Frias, Project Manager, R&D Centre, Técnicas Reunidas, S.A.,Madrid, Spain;
- Ulrich Hoffmann, Trade, Environment and Development Section, UNCTAD, Geneva, Switzerland;
- Edmundo Esguerra, Environmental Engineer, Philippine Recyclers Inc., Manila, Philippines;
- Reinhard Gleis, Regional Coordinator for ASEAN, Carl Duisberg Gesellschaft e. V., Manila, Philippines;
- Niclas Svenningsen, UNEP Regional Office for Asia and the Pacific, Bangkok, Thailand;
- Brian Wilson, Program Manager, ILMC, USA; and
- John Hay, John E. Hay & Associates, Auckland, New Zealand,

SUMMARY OF THE WORKSHOP SESSIONS

A. Opening

The workshop was formally opened by Ms. Lilia Casonova, Deputy Director of UNEP's International Environmental Technology Center, in Osaka, Japan. Ms. Casonova acknowledged that the importance of applying the right technologies in the national development process is clear to everyone, but sometimes the environmental and health impacts are overlooked by purchasers and by managers. The concept of "cleaner technologies" has been adopted by many national agencies, but the challenge is how to recognise a "cleaner" technology in the first place. Without some method to evaluate the environmental impact of technologies, the process of technology transfer remains uncertain. In response, the tool for Environmental Technology Assessment (EnTA) was created. EnTA is a joint programme of the Production and Consumption Unit (PCU) of UNEP's DTIE, and of the International Environmental Technology Center (IETC). The PCU focuses on EnTA for process technologies used by industry, while IETC focuses on EnTA for environmentally sound technologies for urban environmental and freshwater management, whether by governments, civil society or industry.

Ms. Casonova stressed the importance of using EnTA to make the right decisions on technology choice, be they commercial decisions of what to import, government decisions on what processes to license, decisions on what environmental technology to adopt and apply, regulatory decisions on how to write a permit, or even decisions by exporters on how to market their new processes or environmentally sound technologies. EnTA is thus for everyone. It applies to local processes and technologies as much as to imported ones, and can be used at small scale units and larger industrial plants. It is just as useful for industry as it is to environmental organisations, since it reveals aspects of efficiency and effectiveness, infrastructure needs and supply chains.

In her opening remarks Ms. Casonova also thanked the numerous sponsors and other contributors whose inputs would help ensure the success of the workshop.

The full text of the Opening Speech is provided in Annex 3.

Mr. Reinhard Gleis, Regional Coordinator for ASEAN, Carl Duisberg Gesellschaft e. V. (CDG), Manila, Philippines, also made some opening comments. He highlighted the importance of sound and sustainable management by industry and also the major efforts being made by Germany, and specifically the industrial organizations, the German State and the European Union who are partners in CDG. CDG is dedicated to international advanced training, dialogue and human resources development, including international know-how transfer between North and South, and East and West.

Mr. Brian Wilson also presented some opening remarks in which he outlined the commitment of ILMC to EnTA and to the workshop. He also thanked the other workshop sponsors and contributors for their significant inputs.

B. Summaries of National Reports on Lead Acid Battery Recycling and Environmental Management

The National summaries presented by the participants provided a useful insight into the state of battery recycling and environmental management in the ASEAN and other countries represented at the workshop.

Copies of national reports provided by participants are available as part of the workshop report accessible via the ILMC home page: http://www.ILMC.org. Only key comments are given below.

In Brunei the private sector undertakes the collection of batteries, which are then exported to other ASEAN countries.

In Cambodia, increasing interaction with, and investment from other countries, has resulted in rapid development of industry and agriculture. The result is serious degradation of environmental quality.

China has a policy of discontinuing the use of out of date technologies – there is a list of such technologies. With respect to batteries, China is drafting a policy to regulate the management of battery recycling.

Battery recycling regulations are in place in Indonesia. Batteries are separated into dry and acid categories. For the latter there are three main recycling plants. These have regulatory approvals, but there are also smaller plants that do not yet have approvals. They are not meeting requirements.

All batteries are imported into Laos – there is no local manufacturing. The main uses are in automobiles and for domestic power supply. There is no formal recycling programme in Laos. The informal sector is very involved in recycling. Lead is recovered and the cases are reused.

Malaysia is gearing up for achievement of fully industrialised status by the year 2020. As a result, matters pertaining to environmental quality have gained prominence in recent years. The need to integrate environmental considerations into project planning and development is leading to an emphasis on prevention of environmental degradation. This is in contrast to the traditional end of pipe solutions that involve curative actions.

Environmental impact assessments have been undertaken in the Philippines since 1982. The main instrument is the environmental compliance certificate. These are issued for environmentally critical projects and for projects in environmentally sensitive areas.

The Russian Federation has no legislation for battery management. While the current collection level is around 30%, the target figure is 85%.

In Singapore there are no recycling facilities for used lead acid batteries. All such batteries are exported.

Sri Lanka has industries engaged in recycling lead and in the manufacturing of batteries. There are regulations covering environmental impact assessment. In addition, an individual has a right to go to court if they believe their rights are infringed. An environmental protection license is required in order to operate an industry. The license in turn involves an assessment. But not all factories have licenses. An important issue in this respect is the need to gain an appropriate balance between protecting the environment for the future and sacrificing the present, for example through the loss of jobs due to the closure of non-complying enterprises.

In addition to the benefits that arise from industrialisation, Vietnam is experiencing a lowering of environmental quality as a result of the discharge of untreated wastes into the environment. To prevent, minimise and limit environmental damage, and contribute to sustainable development, Vietnam established the Environmental Protection Strategy

2010 and the Environmental Protection Plan 2001-2005. Part of the strategy is to build up and develop environmental science and technology, especially through the application of cleaner production to the entire country.

C. Review and Discussion of Environmental Assessment Techniques, with a Focus on EnTA

John Hay presented an overview of environmental assessment techniques, thereby providing a context for environmental technology assessment. He noted that environmental assessments address three core values:

i) environmental sustainability, by building in environmental safeguards;
ii) integrity, by having the assessments conform to agreed standards; and
iii) utility, by providing balanced and credible information for decision making.

Environmental assessments, including environmental technology assessment, facilitate improved environmental outcomes by:

i) recognising that the "environment" is wider than ecosystems and living resources, for it includes economic, social, aesthetic and cultural conditions and amenity values;
ii) adopting proactive management approaches that emphasise problem prevention rather than problem correction;
iii) adopting an adaptive management approach due to uncertainties in initial identification of potentially adverse environmental impacts;
iv) considering the wider technological system, rather than the technology itself, in isolation; and
v) identifying and assessing alternative technology options.

D. Economics of Battery Recycling

Ulrich Hoffman reviewed the likely environmental impact on different economies arising from the economic effects of the Basel Ban Amendment. While not yet in force, the Amendment is being imposed voluntarily by many countries, including the Republic of the Philippines. The Amendment bans the export of hazardous wastes, including lead acid batteries and lead wastes, from OECD countries to non-OECD countries. Under prevailing conditions in the Philippines, the Basel Ban Amendment effectively encourages the importing of primary lead in order to bridge the domestic supply-demand gap because primary lead is nearly as cheap as secondary lead. A comprehensive national strategy is therefore required to reduce waste generation, enhance access to domestic sources of lead scrap and make recycling environmentally sound and economically viable and efficient.

He went on to identify the elements of a national strategy that included optimizing collection, enhancing the environmental performance of the formal sector, and the downsizing and integration of the informal sector into the regulated sector. Packages of policy measures include those that involve significant government intervention with respect to collection, research and development for prolonged battery life, production of a low cost battery line and facilitating the use of environmentally sound technologies. Another package of policy measures would promote high capacity utilization of licensed recyclers through supplementary regulation and public financial support for collection, private sector investment in new technology and research and development for prolonged battery life, public financial support for easing sales conditions of an inexpensive battery line and allowing battery scrap imports by licensed secondary recyclers. Major determining factors as to which policy measures should be used are the international lead price and the foreign and domestic supplies of used lead acid batteries.

E. Construction and Design of the Modern Recyclable Lead Acid Battery

Brian Wilson described the make up and design of the modern recyclable lead acid battery. The major components are the electrodes (typically pure lead oxide and lead sulfate for the cathode, with the anode being a grid of metallic lead alloy with various elemental additives that might include antimony, calcium, arsenic, copper, tin and selenium), the electrolyte (dilute sulfuric acid), the separators, lead terminals and the plastic or rubber casing. The typical lead battery consists of 17% metallic lead, 50% lead oxide/sulfate, 24% electrolyte, 5% plastics and 4% (and reducing) inert residuals.

F. Principles of Hydro-Metallurgical Battery Recycling

Carlos Frias discussed the environmental effects of hydro-metallurgical processing of used lead acid batteries. In addition to the treatment of battery pastes, he reviewed current and best practices with respect to the treatment of the drained electrolyte, metallic grids and connectors. He noted that efficient separation of the various battery components facilitates further treatment, and that most of the negative environmental impacts arise from the composition of the battery pastes, especially the 20% sulfur content.

Hydro-metallurgical contributions to lead acid battery processing include treatment of the drainage acids, battery paste desulfurisation, treatment of the pastes, recycling of baghouse fumes, ashes, slags and old slag deposits and contaminated soils, and treatment of the lead sulfide concentrates. Of all the hydro-metallurgical options for the treatment of pastes, only the PLACID process has demonstrated complete technical viability. Whilst PLACID technology can completely replace traditional pyro-metallurgical recycling, partial hydro-metallurgical recycling can complement rather than substitute conventional furnace technology. A brine/acid solution is used for lead dissolution and electrowinning. There are no liquid effluents, just inert leaching residues. All slags, ashes and drosses are recycled to the PLACID line and the acid used in the process regenerates. Sulfurous gases are eliminated and gaseous emissions are eliminated in the hydro-metallurgical process and are minimal in the combined hydro-metallurgical and traditional furnace technology. This is because the lead compound produced can be melted at low temperature.

The PLINT process is advocated for the treatment of pastes, and is also appropriate for re-treating old slag deposits and contaminated soils. The process is similar to the PLACID process, but it produces a pure lead oxide instead of electrolytic lead.

G. Principles of Pyro-Metallurgical Battery Recycling

Edmundo Esguerrra, Environmental Engineer with Philippine Recyclers Inc. (PRI), described the high temperature extraction of lead from used lead acid batteries. The technology involves pre-treament (including crushing, screening and sorting), desulfurization, smelting and refining. He reviewed the various furnace configurations used in smelting lead, and the secondary lead refining process. Environmental controls, such as afterburning, the use of baghouse filtration systems, wet gas scrubbers, ventilation hoods and the treatment of wastewater were also described.

H. The Methods and Practices of EnTA

John Hay provided a comprehensive description of the EnTA methodology and the associated best practices. He noted that, to help ensure the success of EnTA, it is appropriate to develop an action plan for undertaking the assessment. EnTA is best divided into five linked steps, in addition to preparation, reporting and follow-up activities (Figure 1).

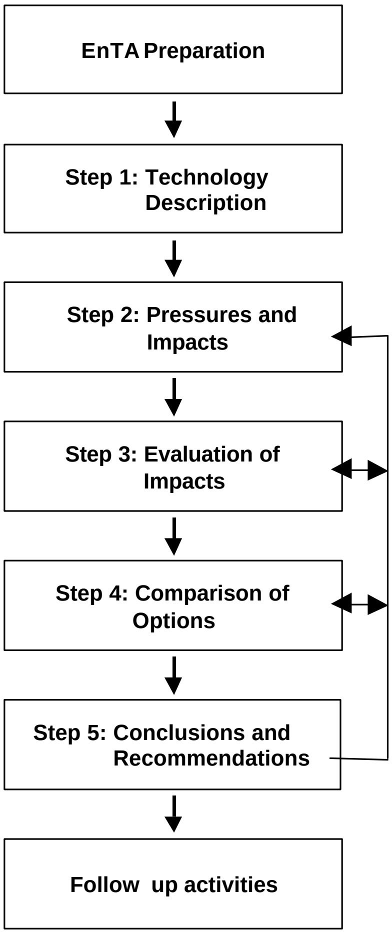

Figure 1. Overview of the EnTA Process

The start of any EnTA requires the evaluation team to establish the assessment framework, goals, commitment, and resources available. In this phase the tasks, responsibilities, timetable and budget for the project should also be established.

Step 1 includes describing the proposed technology by defining the technology being considered, identifying the goals the technology is intended to satisfy, identifying the stakeholders and by characterising the operation and development of the technology. The next step (Step 2) involves identifying the raw materials, land, energy, labour, infrastructure and supporting technologies required for the technology to operate, and the wastes and hazardous products produced by the technology. The potential environmental and related impacts associated with each of these components are also characterised in this step. The inputs and outputs are considered over the lifecycle of the technology.

The significance of the potential impacts identified in Step 2 are elaborated in Step 3, leading to an overall assessment of the environmental risks. Information gaps and uncertainties are also identified, contributing to the decision as to whether there is sufficient information to reach a consensus regarding the impacts.

An important part of EnTA is consideration of alternative technologies that may also achieve the same goals as the proposed technology. Other technologies are considered in Step 4, in order to determine if they are likely to achieve the same goals, but with lower overall environmental impact.

The fifth step is to combine all of the previously acquired information in order to reach a consensus as to the suitability of the proposed technology, and any alternatives. This step also involves identification of any gaps and uncertainties in the assessment process that may prevent development of consensus-based recommendations.

Important actions after the completion of the preceding five steps include reporting the findings and recommendations to the interested parties. Completion of the steps in the EnTA Manual should not be considered the end of the assessment. Follow-up activities include monitoring of the use of the findings and identifying where subsequent assessments might be strengthened.

Although Figure 1 suggests that the five steps of the EnTA process are sequential, this is not necessarily the case. In many instances the various steps in the technology evaluation can be undertaken simultaneously or in a different order, depending upon the timeframe and resources available to the assessment team. Also, EnTA can be an incremental and circular process (as Figure 1 implies), continually incorporating new information, understanding and assumptions as they become available.

I. Practical, Field-Based Exercises in EnTA

The practical nature of the workshop was facilitated by participants being given the opportunity to visit and assess the PRI secondary lead plant at Bulacan, close to Manila. In 1995 PRI commissioned state of the art US designed and sourced lead recycling (battery breaking and desulfurizing) equipment. But the company is always seeking new technology developments that will further improve its environmental performance, productivity and product quality. The company has teamed up with local universities and lead industry bodies, such as the Battery Council International and the ILMC, to test and develop cleaner and more robust processes. The plant complies with the Philippine's environmental legislation for emissions, discharges and occupational exposure and was awarded ISO 14001 accreditation in November 1999.

PRI has been a focus of the UNCTAD-ILMC Study on Lead Acid Battery Recycling in the Republic of the Philippines and it has been actively involved in the Private Sector Participation in Managing the Environment (PRIME) Project of the Philippine's Department of Trade and Industry and Department of Environment and Natural Resources. PRI is the largest government licenced battery recovery and secondary lead smelting facility in the Philippines, and the company plays a leading role in the protection and preservation of the environment.

Thus the Bulacan facility of PRI made an excellent case study, consistent with the workshop objectives.

i) Preparations for EnTA Assessment

Prior to the field trip participants were briefed on the recycling operations of the Bulacan plant, including personal health and safety requirements.

Participants were also divided into three working teams, based on criteria that resulted in teams having a mix of technical, policy, environmental, regulatory and national backgrounds and expertise.

Each team was asked to appoint a facilitator to ensure that best use was made of the expertise in the group, that all members can and do contribute and that all tasks were completed, with appropriate allocation of time to each. Each team also appointed a rapporteur, to ensure that the results of discussions were recorded, and to communicate the findings of the team to other workshop participants.

One team was tasked to initiate an EnTA related to the collection, transport and storage of used lead acid batteries at the plant . They were also asked to develop a set of goals for the assessment, with these goals being clear, achievable and measurable. In addition, the team was asked to identify potential stakeholders and report back to the full group.

A second team was asked to initiate an EnTA related to the hydro-metallurgical reprocessing of used lead acid batteries and therefore develop a set of goals for the assessment, with the goals again being clear, achievable and measurable. A preliminary checklist of potential environmental impacts was to be developed, and potential stakeholders identified. All findings were to be reported to all workshop participants.

The third team was given similar tasks to the second team, except the focus was on enhanced pyro-metallurgical recycling of used lead acid batteries.

The teams were advised of the time allocation for their activities, such that approximately 15 minutes were to be allocated to self introductions that described current employment and responsibilities and identified the expertise being brought to group. The group exercise was to take some 60 minutes and reporting back around 30 minutes.

The teams used the EnTA Manual to guide them in their preparatory work. Given the fact that the plant was already in operation, the EnTA procedures adopted by the teams involved an assessment of the existing plant (to provide a baseline for environmental and related impacts), identifying specific new or incremental technologies, and subsequently assessing their environmental performance relative to the baseline.

ii) Field-Based Assessment

After further briefings at the plant, related to plant operations and health and safety requirements, each assessment team was divided into two groups (to keep group sizes manageable) and all participants were issued with the required safety clothing and respiratory equipment.

Team members then toured the plant, accompanied by knowledgeable members of the PRI staff. In addition to gaining an oversight of the plant’s operations, the groups gathered the information required to complete the relevant worksheets in the EnTA Manual, with each team focusing their assessment on the tasks assigned during the preparatory activities. Information gathering was undertaken by a combination of visual inspection, questioning of appropriately experienced team members and PRI staff and by inspection of relevant documentation held at the plant.

The assessment required approximately four hours on site. This would be a minimum amount of time required for an assessment of the type undertaken in the present case study, and also assumes considerable preparation has been undertaken prior to the site visit.

J. Preparation and Presentation of Reports of Practical Working Groups

On their return to the main workshop venue each team completed the worksheets in the EnTA Manual and prepared their presentations.

The first team noted many shortcomings in the current system for the collection, transport and storage of used lead acid batteries at the plant, and identified several new technologies that could be employed to improve environmental performance, both off- and on-site. These options included a railway system for battery transportation, a well informed system for collection and transportation, short term fixes to problems plus a "just in time" approach, and a zero discharge wastewater treatment plant. Each of these options was subjected to an environmental assessment, resulting in recommendations as to which options might be considered for adoption by plant management.

The second team considered the environmental benefits that might arise from the incorporation of the PLACID and/or PLINT processes at the plant, leading to a recommendation that plant management consider such technological improvements.

Feedback from the group included:

- The goal of the assessment and the goal of the technology are two different things;
- The preferred option might be different if cost is, or is not, a factor;
- An issue is whether to consider costs implicitly or explicitly; but if there are serious concerns about the economics of the technology, a return on investment (ROI) and a cost-benefit analysis should be recommended, over and above the EnTA;
- EnTA can lead into, and facilitate economic analysis, more detailed environmental analysis and government policy analysis;
- If economic aspects are integrated into the assessment, questions such as "can wastes be turned into a by-product?" will more likely be addressed;
- There is a need to internalise all the environmental costs;
- Government assistance might be required to support a technology, or else it might fail;
- While it is appropriate for the assessment to focus on the technology, it is important to realise that the technology will be a success only if it is supported by an integrated strategy;
- The Manual should include a preface to explain that a technology assessment decision is not made in a vacuum – while the private sector can make an effort, the added support of government is often needed; and
- The team recommended a further case study based on PRI, in which the current technology is compared to the PLACID technology; the technology and the engineering would have to be on a comparable basis, with the same capacity for the

plant and the same social and other conditions; these would serve as inputs to the EnTA process.

The third team identified several ways in which the environmental performance of the existing plant could be improved through the introduction of technologies that build on the currently employed pyro-metallurgical processes. Thus the current operation provided the benchmark.

Feedback from the group included the following:

- There is confusion over whether the goals are of, or for, the technology – this can be clarified by thinking of the goals as the outcomes the technology is intended to achieve;
- EnTA is not always the end of the assessment – for example, it might highlight the need for more information, such as the undertaking of an economic analysis;
- The assessment is subjective, suggesting the need for more information; but more information may not reduce the subjectivity, or the uncertainties;
- If there are issues of concern, more detailed, rigorous and quantitative analyses may well be warranted;
- Despite the presence of a number of technical experts in the team, there was still insufficient information on which to base judgements – this highlights the need for more consultation, leading to more information being available;
- Step 4 calls for differentiation of subjective judgements, such as identifying the difference between a slight impact with high level of certainty and a major impact with a low level of certainty;
- Given that the goal is to optimize the recovery of lead, with maximum efficiency, the Manual does little to identify the pressures and levers related to the industry – for example, there is no reflection of the importance of different price factors, such as the difference in cost between primary and secondary lead; the cost pressure on the technology to be selected is not reflected in the assessment tool; and
- EnTA should also consider the impact of trade liberalization – for example, cheap battery imports increase the pressure on the secondary lead industry.

Following the presentations by the three teams, the resource persons participating in the workshop provided constructive feedback to the working groups. The feedback was a mix of additional technical information that the teams might have included in their assessment, and guidance as to how their assessment might have been improved by consideration of key information.

The teams were also urged to reflect on the adoption of different approaches and suggestions, and how a more rigorous assessment might be undertaken outside the training environment. It was also pointed out that no one person has all the expertise and knowledge needed in an EnTA – a multidisciplinary team approach was required to guarantee the best results. The comment was also made that EnTA does have a role in encouraging the use of environmentally friendly technologies. It is a tool that helps make decisions at enterprise level, in consultation with regulators and community representatives. EnTA also facilitates a comparative analysis.

But with respect to the case study it was pointed out that lead metal prices are at their lowest ebb since systematic recording of prices began at the end of the 19th century. As a result, the competitive position of primary materials, versus recovered materials, has increased. Also, pyro-metallurgically produced secondary lead products have difficulty competing on the basis of purity. Overall, certain secondary materials can be at a competitive disadvantage. Tightening of the environmental requirements can increase the used battery recovery rates, but it can also reduce profit margins and discourage investment. Reflecting the costs of environmental damage in the product costs adds to the problem. So governments have a key role to play, in that they can encourage implementation of technologies that are drastically cost cutting. Governments may thus need to assist the private sector. One way would be to tax the primary material so that secondary lead becomes more cost competitive. Any action requires development of a plan that is comprehensive and provides a mix of incentives, restrictions and even penalties.

Thus while EnTA is useful at enterprise level, there is also a need for national policy analysis to ensure that policy is supportive of achieving the identified national environmental and other goals. There is also a need to involve the government in any follow-up activities after the EnTA. In that way everyone will benefit from the EnTA being undertaken.

However, EnTA is not a “silver bullet” – it is one of many tools. The workshop is an important opportunity to learn how to improve EnTA as a tool. As a tool, EnTA makes an assumption – that there is an enlightened government and industry. EnTA is a “process tool”, so some are comfortable with the process, while others will be uncomfortable. This raises questions as to who are the target audience for EnTA and does there need to be specialised training for EnTA – does a company need to hire an EnTA specialist?

The target audience needs to be more clearly identified – different information is required and expertise needed if the target audience is the enterprise or the regulator. Another issue is the ideal composition of the assessment team.

There is a need to clarify the relationship between EIA and EnTA – for example, in the Philippines the priority for industry and the regulator is the EIA, so what is the role for EnTA? It is important to recognise that, in general, the EIA is obligatory while EnTA is voluntary. Perhaps EnTA can best be used to prevent the enterprise from reaching the stage of doing an EIA on an unfeasible technology or other proposal.

EnTA needs to be flexible. In this respect an advantage comes from the fact that the worksheets in the Manual are in electronic form, so they can be expanded and modified, as the situation requires.

Again in the context of the case study, a challenge for EnTA is that in its present form it does not give rise to a framework for developing a strategy for improving the environmental outcomes associated with the activities of the informal sector, other than emphasising that many of the current practices are unacceptable.

The field trip was considered to be an excellent opportunity to evaluate a real world activity, rather than engage in EnTA on a theoretical basis.

K. Preparation of Personal Action Plans

In the concluding stages of the workshop all participants were invited to prepare and share their personal actions plans for follow-up activities related to EnTA and the tools and experience they had acquired at the workshop.

They were asked to develop their action plans under two headings:

- Actions that can be undertaken without assistance in addition to that already available in the course of current employment; and
- Actions that can be undertaken only if additional assistance is available.

Participants were also advised to provide a timetable for the planned actions.

The resulting personal action plans are presented in Annex 4.

In general, most action plans included aspects of the following:

- EnTA will be further evaluated and applied in the domestic situation, with different applications and approaches – e.g. treatments, adaptation, innovation;
- Multi-sector training and consultation will be undertaken;
- The policy environment for the implementation of EnTA will be developed in the home country; and
- The tool will be refined (e.g. improve precision, and include financial and economic analyses).

L. Reviews and Evaluations

Various aspects of the workshop were subject to a combination of formal and non-formal reviews and evaluations. The findings are summarised below.

i) EnTA as an Environmental Management Tool

Based on their knowledge and practical experience with EnTA (acquired both during and, in some cases, prior to the workshop), participants recognised the benefits of having an environmental management tool that is technology focussed.

EnTA is already being undertaken by industry, by regulators and by NGOs etc, but the approaches, methods and techniques being used are informal and ad hoc. Until the Manual was prepared there were no established procedures. The Manual is an attempt to give some structure and consistency to the EnTA process and will facilitate discussion, consultation and the development of best practices.

EnTA is considered to be useful at the project and enterprise level, and less valuable at the national policy level.

EnTA is viewed as a "scoping tool", to be used at the "idea stage", rather than after development of a formal or full project proposal. EnTA is largely qualitative. This has advantages in that it identifies the data required to complete the assessment and is more likely to be used than are assessment methods that require large amounts of detailed, quantitative information.

There is merit in having a tool that considers technology alternatives in an explicit manner, and can also involve and reflect the interests of multiple stakeholders. Indeed, most participants considered one of the main benefits of EnTA to be its use as an instrument that encourages a dialogue between stakeholders, possibly aiding in any possible conflict resolution through a sharing and an appreciation of divergent values and goals, and the use of a common language. EnTA was also considered to be an appropriate, proactive environmental management tool that facilitates a multidisciplinary and multi-sector approach to environmental management. While it is useful in simplifying the environmental management issues and options of concern, EnTA also fosters a comprehensive and integrated approach, especially with regard to the implications of the technology system.

Importantly, EnTA identifies if more sophisticated assessment tools, such as environmental risk assessment and cost-benefit analysis, need be used to ensure that the appropriate environmental outcomes can indeed be achieved.

For any process to be truly environmentally sound it must be sustainable. It is therefore imperative that some elementary financial assessment be included in the revised Manual, in order to determine process viability.

Finally, it was acknowledged that EnTA is not a “recipe” that has to be followed on a rigorous basis – rather the procedures can be modified and supplemented, and they should evolve in response to the process itself, and experience, so that the assessment reflects local, national and regional circumstances.

ii) The EnTA Manual

Towards the conclusion of the workshop the participants (including the resource persons) provided feedback on the EnTA Manual. Their comments were based on a reading of the Manual and on the use of the Manual in the practical assessment case study.

The following is a summary of the main points that were made in the feedback session:

- The Manual is comprehensive and provides an understandable and useful introduction to EnTA and to the procedures involved in conducting an assessment;
- There is a need to identify and be clear as to who are the current and potential users of EnTA; similarly, there is a need to be clear as to who are the target audience for the EnTA Manual;
- There needs to be better guidance on the composition of the assessment team;
- While the Manual goes into some detail about EnTA, there is still a lack of clarity as to what EnTA is, how it relates to other environmental management tools and under what circumstances, and when, EnTA should be used;
- Some of the expressions and terms used in the Manual could be revised in ways that would increase understanding;
- Some participants expressed concerns about the subjective nature of the EnTA procedures, including the frequent reliance on expert opinion, but most participants argued that subjectivity and judgement was a attribute of human value systems - a tool which identified and tried to accommodate the diversity of values was needed and useful; likewise, the appropriate use of expert opinion is a powerful way to incorporate the diverse views and expectations of different stakeholders;
- Similarly, some participants argued for the use of a rigorous weighting system that allowed the identified individual impacts to be aggregated in a systematic manner; however, most participants rationalized that any weighting system would be

inherently more subjective, would add complexity to the assessment process and would imply a degree of exactness that could not be justified;

- In the same vein, some participants had difficulty with the explicit acknowledgement of uncertainties in the assessment; but most participants saw such acknowledgement as a strength of the procedures described in the Manual;
- Participants noted that judgements regarding the potential severity of the environmental impacts can be aided by reference to appropriate legislation, regulations, standards and guidelines, where they are available and applicable; for example, if the impacts are likely to result in non-compliance with such requirements, the impacts should be classed as medium or large, depending on the likely level of non-compliance;
- A major shortcoming of the Manual was considered to be the lack of any economic assessment – a simple economic assessment should be conducted in the form of an analysis of the return on investment (ROI) and, if necessary, a cost-benefit analysis, just as the more detailed social assessment should be conducted as a social impact assessment, rather than as part of the EnTA; just as social factors are given some consideration in EnTA, so too should economic factors;
- Identification of negative impacts only is encouraged in the Manual – some provision should be made for taking into account positive (beneficial) impacts, because the environmental benefits of suggested alternative technologies need to be characterised;
- Attention should be given to mitigation of adverse environmental impacts;
- The goals of the assessment and the goals of the technology must be distinguished, and clarified;
- The Manual should be more explicit about early consultation with stakeholders being desirable;
- References to "health" should be changed to "health and safety";
- The ability of current infrastructure to meet the demands of the proposed technology should include consideration of whether meeting those demands is a reasonable use of the infrastructure;
- References that imply a formal assessment of risk should be avoided, as the concepts and procedures of risk assessment are not included in the Manual;
- Category names should be used to describe the overall impacts;
- There is a need to clarify the assessment of relative impacts in Step 4c;
- The concept of an environmentally "benign"' technology should be expressed using the more common expression of "environmentally sound";
- Waste characterised as "environmentally inert" should be considered in the context of whether it is dumped into landfill, which is not environmentally benign, or traded as a useful product; and
- The checklists provided for identifying potential impacts and comparing alternative options are most helpful.

It was agreed that if the Manual and worksheets were revised in ways that addressed the above concerns, they would meet the needs of most individuals and groups interested in assessing the environmental implications of a given technological intervention, and in distinguishing between the environmental merits of different technology options.

iii) The Workshop

The workshop, as a participatory training initiative designed to familiarise participants with the Environmental Technology Assessment (EnTA) process, was subject to two reviews and evaluations.

a. Participant Assessment

The assessment was undertaken by the workshop delegates, and excluded the resource persons and facilitators. It was conducted using an evaluation form that was distributed to 36 individuals. All responded.

The aggregated percentage results are presented in Table 1 and in Figure 2.

It is apparent from Table 1 that a clear majority of the participants saw considerable value in EnTA as an environmental management tool and considered the field trip an essential part of the learning experience.

The difficulty participants had in understanding the presentation and explanation of the EnTA process is thought to reflect the fact that they were not given the Manual prior to the workshop, there was little time allocated to the presentation on EnTA (relative to the complexity of the task), there was little time available for participants to absorb and reflect on the substantial material and detailed explanations were given prior to the site visit. The latter might have been best left until after the field visit. Furthermore, consensus opinion was that inadequate time had been allowed for the groups to work through the EnTA process and complete the practical exercise.

In a similar manner, responses to the technical presentations might have been different had they come after the visit to the processing plant.

Table 1. EnTA Workshop Evaluation Sheet Aggregated Responses

Number of responses is expressed as a percentage of total responses (36)

- Rate the EnTA process as a tool to assess an industrial technology:
  Not useful 3* useful 44 very useful 47 extremely useful 6

- Rate the EnTA process as a useful tool to be used by multi - stakeholder groups:
  Never 3* possibly 31 often 29 always 37

- Rate the EnTA process as a useful tool to assess a new technology:
  Not useful 6* useful 42 very useful 44 extremely useful 8

- Rate the EnTA process as a useful tool to assess alternative technologies:
  Not useful 6* useful 36 very useful 50 extremely useful 8

- The EnTA presentation and explanation of the process was:
  Unclear 25 clear 39 understood 36

- The economic, hydro- and pyro-metallurgical technical presentations were:
  Irrelevant; not understood 0 relevant; not understood 38 relevant; understood 62

- As part of the benchmarking process, the field trip was:
  Irrelevant & not essential 0 relevant, but not essential 17 relevant & essential 83

- The EnTA exercises helped me to understand the process and were:
  Irrelevant & not helpful 8 relevant, but not helpful 22 relevant & helpful 70

- The conference management, venue and accommodation were:
  Unsatisfactory 0 satisfactory 3** good 8 very good 36 excellent 53

Notes.
Number of participants other than facilitators and resource persons: 36
Number of assessment forms returned: 36

* All the participants qualified their response with the phrase "in its present form".
** A day delegate who thought he should have been accommodated at the hotel

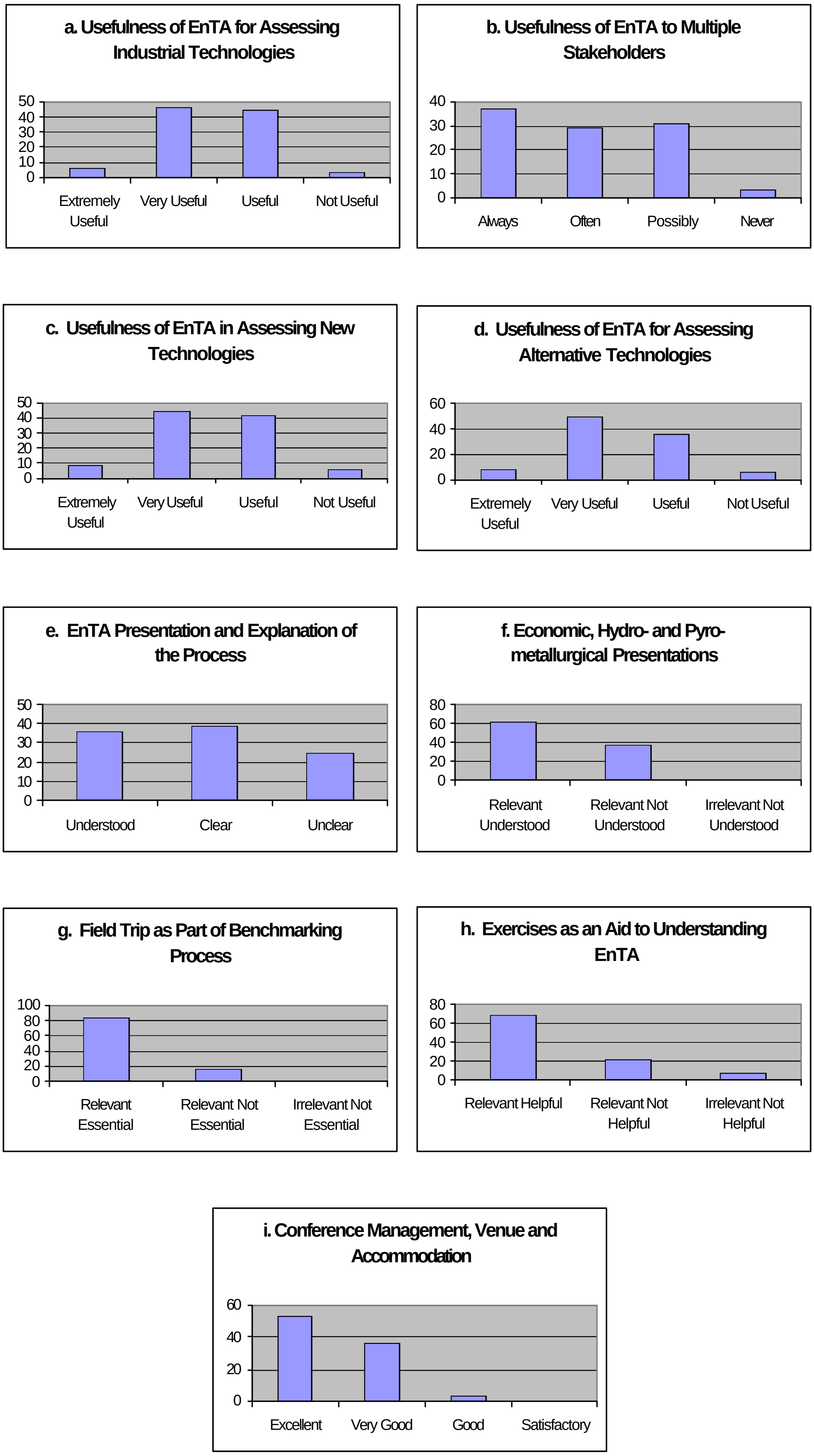

Figure 2. Results of evaluation of EnTA workshop (full details in Table 1)

Participants were also asked to provide comments or recommendations about the EnTA process. The submitted comments were as follows:

- EnTA training should continue in all regions and be linked to a local training center or institution;
- I would like to see an in depth manual of EnTA that ideally any professional could pick up and use in their work; in the event of any difficulties it would be useful to be able to go to an EnTA web site (which John Hay mentioned would be interactive) on the Internet, for information and clarification;
- Good participation, communication, socialization and networking with the EnTA delegates;
- Suggest continuous training;
- EnTA can be used as a supplementary tool of EIA at the project scoping stage;
- Need to revise some parts to make the Manual easily understood;
- Need to further improve EnTA;
- Need further training with different industrial technologies;
- Further follow up required, such as training, EnTA updates and so on;
- EnTA process has to improve and be simplified. It has to be practical and relate to the real world in terms of the economic aspects as well as the social and environmental impacts. EnTA needs weighting in terms of the aggregate checks against the EnTA specification and it needs to refer to the standards as a base line;
- A practical output with a balance of inputs and a sharing of the experiences of participants. Learning without pressure!
- Needs further refinements;
- The lack of quantitative analysis and the resulting lack of precision reduces the effectiveness of this tool;
- The EnTA process is a very useful tool to access the environmental impact of an industrial technology;
- EnTA must include “economic” aspects in its assessment process;
- Excellent! Keep up the good work;
- The assessment of social impact needs some parameters. The EnTA process must be clear for “new or fast technology”;
- EnTA needs to be polished further and the economic factors should also be considered. Do not forget to send all the participants a report of the workshop. Include also all the materials presented. Good work Brian!
- Everything about the workshop was excellent;
- Additional improvements required;
- Improve it by adding the economic aspects. Put more weight into the environmental aspects so that it can truly be called “En”TA;
- Needs more time to learn the process and needs more time to compare the old and new technologies;
- The EnTA process is the best concept now, but it is difficult to practice and it depends on economic policy/criteria/law, project proponent awareness, public acceptance etc
- Go ahead with the focus, not only on the technique itself, but also from the viewpoint of how to apply it in the current decision making system. I think that it is a very good tool for sustainable development;
- The EnTA process is very new and so we need more time to study it in detail; and

- EnTA process is appropriate with a project proposal, but will depend on the economics. In a country that has an EIA system, EnTA should be a part of the EIA process. However, the EnTA process may need to be modified for each country.

In a general discussion that sought feedback on the workshop most participants considered the workshop to be too short, given the amount of learning that was involved.

b. Assessment by Resource Persons, Facilitators and Organisers
On the day following the workshop, the resource persons, facilitators and organisers met in order to assess the participant feedback and to provide and discuss their own personal assessments of the workshop.

Comments made during the discussion included:

***Re Workshop participants and their involvement*:**

- The workshop organisers succeeded when they went out of their way to have an appropriate mix of participants from the private sector, regulators, policy makers, educators and NGOs;
- The workshop raised awareness and empowered individuals to take further action; it also identified opportunities for strengthening environmental management systems;
- There was a high level of enthusiasm and participation during the workshop – even those less competent in English seemed to benefit; they listened and assimilated, even though they did not participate as much as some others;
- The workshop participants had a committed and disciplined spirit – to the extent that had never been seen before by a resource person with long experience; the organisation and the implementation created a climate very conducive to success;
- The diversity of backgrounds, and of national circumstances, was a strength – but also a challenge; there was a spectrum from people/countries with little awareness of any environmental management tools, to those who had an entrenched EIA protocol and who had difficulty seeing where EnTA fitted in; and
- A number of CDG alumni had some difficulty understanding the relevance of aspects of the EnTA process. For them the workshop proceeded too fast, especially the field trip and the completion and interpretation of the worksheets; this allowed English speakers to dominate.

***Re EnTA as an environmental management tool*:**

- EnTA is a useful and appropriate tool to facilitate dialogue between multiple stakeholders and to gain a comprehensive appreciation of a situation; it is very good at enhancing understanding and raising awareness of technical and related issues, in ways that enables an assessment as to whether the technology would contribute to sustainability; it can aid in the identification and understanding of the issues, as a prerequisite to an effective multi-stakeholder dialogue, with the aim of bringing all stakeholders to a common level of understanding;
- But EnTA is not a decision making facilitation tool – it is too imprecise;
- Most assessments end up as (subjective) judgements even if they endeavour to be objective; but there may be value in weighting some of the categories so that there is more benefit from aggregation of the impacts;

- The subjective character of EnTA is elevated by its position as a tool in a multi-stakeholder process, with a focus on education and a comprehension of the technical aspects, rather than on decision making
- EnTA is subjective, and there is a need to either clarify the meaning of such categories as “high, medium and low”, or relate the terms to a base line;
- As a tool for informing, generating discussion and advising multiple stakeholders, the subjectivity of EnTA is not a problem;
- A key to the success of EnTA is harmonizing considerations with respect to the economy and the environment – i.e. to facilitate integration;
- There are different roles for EnTA, depending on a country’s level of development and the status of environmental management in that country; EnTA can also be used within a company, or at national level to facilitate a dialogue by raising awareness and identifying key issues;
- NGOs and regulators saw EnTA as an excellent awareness raising tool – it facilitates a dialogue between multiple stakeholders, forcing people to look at the full breadth of issues;
- In the ideal application of EnTA, one would need all the lifecycle costs reflected in prices (i.e. internalized) and all decisions could then be made on the basis of a cost-benefit analysis; but there are departures from the ideal: i) all costs are not internalised; ii) currently most technology systems are based on not all costs being internalised – to do so would make many of the present systems uneconomic and redundant and; iii) for certain emerging technologies a complete cost analysis is not available
- EnTA demonstrated how it can be used to change a viewpoint from seeing something as a waste to viewing it as a product;
- Should EnTA be compulsory/binding or optional and more a means to facilitating discussion?
- EIA is not working in many Asian countries and where it is working, it is a specialized tool in the hands of a few regulators and consultants – while EIA may allow industry to meet its regulatory requirements, only EnTA can ensure inputs from all stakeholders, and only EnTA requires all options to be considered; and
- A key concern is to identify what is wrong with EIA and identify what EnTA can achieve that EIA cannot.

***Re The EnTA Manual*:**

- There are real concerns about the lack of any requirement to consider economic assessment, as a contribution to environmental sustainability;
- The EnTA Manual needs to define the basic documentation and information required to undertake the assessment – especially when a base line is being established or a comparison is being undertaken. There is a need to have comparable information for all alternatives to be considered; thus there is a need to define the technical documents that give a description of the process, present a process diagram, provide simplified materials and energy balances, define raw material and final product amounts and their physical and chemical forms, the costs, conceptual basic engineering information, and critical points where decisions have to be made on environmental, economic and social grounds;
- The Manual should help people feel comfortable with the fact that personal understanding will vary and individual contributions will differ;

- The Manual should be as developmental unbiased and as least prescriptive as possible;
- The Manual should facilitate objective decisions based on goals that are set by the local stakeholders, not by outsiders;
- The Manual should retain the flexibility of the tool, showing that EnTA can be either a simple tool or as advanced as required;
- The Manual should ensure that EnTA is not locked into having specific information requirements – stakeholders will determine/decide the information requirements; but for training there is a need to have at hand as much of the relevant information as is possible;
- The Manual should contain advice on how to define the technology intervention – i.e. how to define the boundaries;
- The Manual needs an index; and
- p 51 of the current Manual refers to gaps and uncertainties in identifying “pressures” – the same terminology should be used elsewhere; The question “can environmental impacts be sustained?” needs to be clarified.

***Re Workshop structure and approach*:**

- Learning by doing is very appropriate for EnTA – the use of a real case study was very positive – much better than working solely in theory;
- There is a need to clarify the objectives and target group for EnTA – this will help define the process for the workshop;
- The length of the workshop was inappropriate and needs to be about half a day longer to allow sufficient time for the application of the practical exercise; the plant visit should occur on the afternoon of day 2, leaving day 3 for working up the assessment results; this might mean that the first day needs to be a longer session, or extended into the evening;
- The workshop design needs to be improved, especially given that 6 hours spent on the worksheets was insufficient; one solution might be to separate the baseline and new technology exercises into two sessions.
- In relation to the pedagogical approaches used, how much progress could participants with poor English skills make during the workshop?
- The moderator/facilitator role was a struggle – there was not sufficient opportunity to prepare; better preparation would have allowed the process to be improved;
- There is a need for better briefing and training of facilitators in a multi-stakeholder dialogue, such as that which arises in an EnTA
- There is a need to maximize/optimize the use of the four days – training the trainers (moderators/facilitators) would help in this respect; there was no chance to preview the materials;
- Often the chemistry and composition of the teams was such that they were dominated by one person – thus a team came up with results, but it was unclear if all participated in producing these results;
- The purpose of the workshop was to train the participants, but another priority was to trial the EnTA Manual and worksheets – in these respects the workshop process was excellent; but there is a need to consider the context in which EnTA is to be used – e.g. in relation to EIA, CBA, where it is used, by whom;
- Given the complexities of the science, economics, social pressures, legislation and international conventions, was lead recycling a good test of the EnTA methodology? What if the EnTA had been applied to copper recycling, for example?

- What were the expectations of the organisations that participated in the workshop (as sponsors etc) and were these expectations realised?
- The EnTA process is likely to be very suitable in a multi-stakeholder situation where parties with different views and objectives are required to discuss and consider environmental management in order to determine whether a process is environmentally sound.

The post workshop review concluded with identification of a number of follow-up activities. In the list below, those designated with an * have already been allocated funding by UNEP.

- Send participants the PowerPoint presentations on environmental management and on EnTA;
- Prepare and circulate the workshop report;
- Revise the Manual on the basis of feedback from the EnTA workshops in Manila and South Africa*
- Circulate the revised Manual to the EnTA contact group, for comment and feedback;
- Revise the Manual, as appropriate*
- Distribute revised Manual to Manila workshop participants for their comments;
- Prepare and distribute a CD containing all the workshop presentations and materials;
- Monitor implementation of the personal EnTA action plans prepared during the workshop;
- Develop and evaluate success indicators for the workshop, showing the impact of follow-up implementation and the difference the workshop has made;
- Prepare case studies using the revised Manual*:
  - Recycling of lead acid batteries – based on workshop materials;
  - Disposal of medical wastes – the Basel Convention Secretariat is active on this topic; UNCTAD has most of the information and before the last COP a technical working group drafted guidelines for disposal of such wastes;
- Prepare a comparative, comprehensive study of existing and new lead acid battery processing technologies;
- Prepare a training package in EnTA*;
- Assess and identify regional centres for capacity building in EnTA:
  - Africa;
  - South and Latin America;
  - Asia-Pacific, possibly on a sub-regional basis;
  - Eastern Europe and Russian Federation; and
  - Small Island Developing States;
- Strengthen the regional centres, through training the trainer programmes and other initiatives such as preparation of case studies and publication of the Manual in appropriate regional/national languages – use the UN Asia and Pacific Centre for Technology Transfer (APCTT) to integrate the activities in the Asia-Pacific region, in conjunction with the proposed Department of Science and Cleaner Technologies Institute (in Philippines) and national Cleaner Production Centres in Vietnam, China etc; and
- Develop and implement an interactive, computer-based training package for use and distribution via the Internet.

M. Close

On behalf of the workshop sponsors and other contributors, Mr. Niclas Svenningsen, Industry Programme Officer, UNEP/ROAP, Bangkok, Thailand, highlighted the fact that the workshop had exceeded the high expectations regarding achievement of its multiple objectives. Summing up the workshop, Mr. Svenningsen commented that the workshop had been a learning experience for the trainers and resource persons, as much as it had been for the other participants. The EnTA Manual used in the workshop is new and was being tested for the first time. He said that the workshop had been successful in providing insights into how best to use the Manual in support of the EnTA process. It also provided experience that showed how best to use the Manual in a training environment and how to conduct future workshops to maximize their efficiency and value for the participants.

Mr. Svenningsen noted that EnTA is a relatively new tool. It has yet to be recognised by ISO 14000 and is yet to become part of the environmental management vocabulary, as have the terms Environmental Impact Assessment, Waste Minimization or Cleaner Production. But EnTA is a tool of growing importance. Mr. Svenningsen said he was personally convinced that it will not be long before EnTA is a very common and widely applied tool, maybe even more so than EIA and life cycle analysis, as EnTA is a much more convenient and an easy-to-use tool.

He concluded by again acknowledging and thanking the workshop sponsors and contributors, expressing his appreciation to the workshop participants for their commitment and enthusiasm and by wishing all participants a safe journey to their homes and success in their follow-up activities with EnTA.

The full text of the closing speech is provided in Annex 5.

N. Post Workshop Media Release

Subsequent to the workshop a media release was prepared and distributed. It is reproduced in Annex 6. Annex 7 presents the media release for a similar workshop held contemporaneously in South Africa.

O. Recommendations

The following recommendations are based on:

- the experience gained through conducting the workshop;
- the results of the evaluations and reviews reported above;
- the findings of a similar workshop help contemporaneously in South Africa (see Annex 8); and on
- a general understanding of the emerging needs for strengthening of the capacity to make environmentally sound choices when developing, transferring and assimilating technologies.

In framing the recommendations below, consideration has also been given to the intended workshop outputs, and the extent to which they have been met. Thus:

***Intended Output**:* Over 40 participants trained in the use of EnTA in the evaluation of the environmental impact of process technologies, especially those related to the recycling of used lead acid batteries;

Result: The information presented above confirms that this output has been achieved. However, there is now a need to monitor implementation of the personal EnTA action plans prepared during the workshop, develop and evaluate success indicators for the workshop, showing the impact of follow-up implementation and the difference the workshop has made and seek to remove any barriers the workshop participants may experience in implementing their personal action plans.

Intended Output: Publication of an evaluated and revised EnTA Manual, ready for worldwide use by Governments and industry as a selection tool for sound environmental management of recycling processes;

Result: The Manila workshop, along with the similar workshop convened in South Africa, has provided substantial guidance for the revision of the EnTA Manual. While the preparation of the revised Manual in conventional form is already supported by UNEP, the goal of worldwide distribution and use of the Manual will come about only if more EnTA trainers are available and modern information dissemination methods such as CD ROM and the Internet are employed, as signaled in the follow-up activities identified above.

Intended Output: Preparation of a model workshop, and publication of a trainers' manual that would facilitate replication of the workshop in other countries and regions, and focussing on other process technologies.

Result: The experience acquired in implementing the Manila and South African workshops has resulted in identification of a number of ways in which the workshop structure, approach, content and methods might be modified in order to produce optimal outcomes. The stage is now set for the development of a "model workshop" and for the preparation of a trainers' manual, but further action is contingent on identifying, briefing and resourcing those who have the ability to complete such a task.

The recommendations, which logically encapsulate many of the detailed suggestions documented in preceding sections of this report, are:

Recommendation 1:
UNEP, in conjunction with its substantive partners such as ILMC, CDG and UNCTAD, continue to develop EnTA as a key environmental management tool, and facilitate the application of EnTA through the dissemination of information, including the revised Manual, and through the implementation of further training and other capacity building activities.

Recommendation 2:
Relevant international, regional and national organisations and institutions provide substantive and sustained support to the Manila workshop participants, in ways that will facilitate implementation of their personal action plans and ensure sustainable and measurable impacts from the workshop, including facilitating their involvement in building regional and national capacities in EnTA.

Recommendation 3:
Appropriate organisations and institutions are encouraged to participate and collaborate in studies that will lead to a scientifically rigorous and operational definition of

"environmentally sound and sustainable", and to the identification and application of measures (targets and indicators) to be used to quantify the increased uptake of environmentally sound technologies, and the benefits that arise;

Recommendation 4:
Build on the successful strategic alliances that were established and strengthened during the planning and implementation of the Manila workshop in order to:

- prepare, and disseminate worldwide, the revised and improved EnTA training materials, including case studies on:
  - lead acid battery recycling;
  - disposal of medical wastes; and
  - comprehensive comparison of existing and emerging lead acid battery processing technologies;
- support the work of regional and national centres engaged in environmental technology assessment and transfer; and
- replicate the EnTA training workshop approach in other institutions, countries and regions, and with reference to other process technologies.

Recommendation 5:
UNEP and its strategic partners to facilitate and coordinate a study of the implications on trade, and on sustainable development, of the increased use of environmentally sound technologies for the recycling of hazardous wastes.

Annex 1
Environmental Technology Assessment (EnTA) Workshop Programme

Day 1

09:00	Welcome by UNEP IETC	Lilia Casonova
09:20	Introduction to the Workshop by ILMC	Brian Wilson
09:40	Opening of the workshop by CDG	Reinhard Gleis
10:00	*Break*	
10:20	Summary of national reports	Participants
11:30	Overview of the economics of battery recycling	Ulrich Hoffman
13:00	*Lunch Break*	
14:00	Overview of assessment techniques	John Hay
15:30	*Break*	
15:45	Needs assessment exercise	(Working Groups)
16:45	Short "start up" EnTA exercise	John Hay
18:00	*Finish*	

Day 2

08:30	Environmental Technology Assessment (EnTA) Overview of EnTA manual and of assessment procedures	John Hay
10:30	*Break*	
10:45	Construction of the modern lead acid battery	Brian Wilson
11:00	Principles of hydrometallurgical battery recycling	Carlos Frias
12:30	*Lunch Break*	
13:30	Principles of pyrometallurgical recycling	Edmundo Esguerra
15:00	*Break*	
15:45	Workgroup Briefings for the EnTA Field Trip Collection, transport and storage of used lead acid batteries used lead acid battery re-processing	Brian Wilson
16:45	Interim report by working group chairs	(Working Groups)
17:00	*Finish*	

Day 3

07:00	Depart for Field Trip (Coach)	(Working Groups)
08:30	Plant Safety Briefing and Process Introduction	PRI
09:00	*Break*	
09:20	EnTA Field Assessment Exercise	(Working Groups)
12:00	*Lunch*	
13:00	Depart PRI and return to workshop venue	
15:00	*Break*	
15:20	Completion of EnTA worksheets and reports	(Working Groups)
17:00	*Finish*	

Day 4

09:00	Report of working groups.	(Working Groups)
09:01	Collection, transport & storage of used lead acid batteries	WG 1
09:30	Battery recycling – pyro-metallurgical processes	WG 2
10:00	Battery recycling – hydro-metallurgical processes	WG 3
10:30	*Break*	
11:00	Review Panel - Discussion of the EnTA findings	
12:00	*Lunch*	
13:00	Preparation of Personal Action Plans	(Working Groups)
13:30	Discussion forum for Action Plans	(Working Groups)
14:30	*Break*	
15:00	Review and discussion of the EnTA, EIA and EMS	John Hay
16:00	Closure by hosts, sponsors & participants	Niclas Svenningsen

Annex 2

Workshop Participants

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Annex 3

Welcome Remarks - Opening Session

International Workshop on Environmental Technology Assessment

Organized by UNEP in collaboration with ILMC and CDG

22-24 February 2000, Manila

Presented by Lilia Casanova
Deputy Director of UNEP/IETC

Good morning, ladies and gentlemen. It is my pleasure, on behalf of UNEP, in particular, of the Division of Technology, Industry and Economics (DTIE), to welcome you all, but most especially the participants from developing countries, to this workshop on Environmental Technology Assessment. UNEP also expresses its gratitude to all those who have worked to ensure that this Workshop becomes a successful event. UNEP is represented here today by the IETC office in Japan and the ROAP in Bangkok. We particularly want to thank our partner organisations - the International Lead Management Center (ILMC) of the U.S.A. and the Carl Duisburg Gesselschaft (CDG) of the Federal Republic of Germany, the Tecnicas Reunidas (TR) of Spain, the United Nations Conference on Trade and Development (UNCTAD), the Philippine Recyclers Inc. (PRI)- and the local counterparts here in the Philippines who are providing assistance to this event. We know also that much work has been done by others who are not here, including the UNEP Production and Consumption Unit, based in Paris, who developed the idea of the workshop in the first place and gave practical guidance to the organisers.

The importance of applying the right technologies in the national development process is clear to everyone, but sometimes the environmental and health impacts are overlooked by the technology promoters. The idea of “clean technologies” – actually ‘cleaner’ technologies, since nothing is perfectly clean – came to be adopted by many national agencies, but the issue is how to recognise a “clean” technology in the first place? Without some method for evaluating technologies for their environmental impact, the business of technology transfer remains a chancy affair.

Thus the notion of “Environmental Technology Assessment” – or EnTA for short – was born. EnTA is a joint programme of the former Industry and Economics Programme Action Center (IE/PAC) of UNEP in Paris, whose work related to cleaner production is now largely taken care of by the Production and Consumption Unit (PCU) of the DTIE, and of the International Environmental Technology Center (IETC). The PCU focuses on EnTA for process technologies by industries while IETC focuses on EnTA of environmentally sound technologies for urban environmental and freshwater management, whether by governments, civil societies or industries.

But you will hear much more about EnTA shortly, from people who are more knowledgeable about it than I. Right now I want just to stress the importance of using EnTA to make the right decisions on technology choice. It can be commercial decisions of what to import, government decisions on what processes to license, decisions on what environmental technology to adopt and apply, on regulatory decisions on how to write a permit, and even decisions by exporters on how to market their new processes or environmental technologies. EnTA is for everyone. It applies to local processes and technologies as much as imported ones, and can be used at small scale and for big industrial plants. It is just as useful for industry departments as it is to environmental organizations, since it reveals aspects of efficiency and effectiveness, infrastructure needs and supply chains. We will see all this shortly.

This early part of the workshop would be the right moment to explain why UNEP is involved. Well, UNEP is involved for two interconnected reasons. On one hand, from the production or industry side, if we have a polluting process it is easy to buy a treatment plant to fix this problem. But treatment plants are expensive to buy, expensive to run, and make no return on the investment. In many cases the treatment is not as effective as we want anyway. The cleaner production approach sidesteps this by using better production technologies, and more efficient operation. The result is less pollution, AND a more productive factory. We call this a win-win situation. But it is sometimes hard to persuade people to adopt this approach. UNEP has been promoting the cleaner production approach in the region for over 10 years now, and we are pleased by the uptake within governments and industry. But the greater the uptake, the greater becomes the need to identify cleaner and safer technology alternatives. We cannot always believe the sales agents – we need to work out ourselves if the alternative is better on all criteria, and if it does not after all have a down-side somewhere. And as cleaner production becomes a household word, we need a method like EnTA to help us along.

On the other hand, from the consumption side, households will always produce waste, i.e., solid waste or wastewater. Waste can be reduced but not totally avoided. Waste avoidance is ideal but it is not yet popular. Waste avoidance and reduction are value laden practices that require a lot of value orientation or reorientation in societies for them to be accepted. And much of the responsibility to make people and individuals aware of the right kind of values and 'soft' technologies to apply – e.g., the management systems and procedures and sound practices to avoid waste, reduce waste or reuse or recycle waste - still belongs to Municipal governments. EnTA is a method that will help Municipal governments and communities identify and select which technology, 'hard' or 'soft', will be more appropriate to adopt and use.

We hope that this workshop starts a chain reaction of other agencies, institutions and organisations using and promoting and doing training on EnTA. I note a number of important regional organisations represented here this week, as for example the Asia Pacific Roundtable on Cleaner Production which can I am sure do a lot to give the EnTA idea a push. Several of you are from institutes concerned with technology transfer. Well, knowing how to recognize a good technology is an essential first step, and teaching this step to decision-makers can do a lot to put the development process on a better track. Many of you will therefore have a double role of using EnTA, and promoting EnTA to others. UNEP is ready to help you to organize similar events in your countries, and in fact one of the goals of this workshop is to compile a good set of training material for you all to use back home.

Of course many of you are also concerned with improving the performance of the lead industry, and the practical material and knowledge you will gain here will I am sure be of immense use to you. UNEP and ILMC are ready to help you to apply this knowledge in practical situations.

I should also say a few words about how the EnTA process relates to the other work of UNEP. The DTIE, based in Paris, regroups several Units concerned with sustainable industrial and urban development. The individual programmes of the Division include such diverse items as Cleaner Production, industrial accident prevention (APELL), safe chemicals management, urban technologies, freshwater management technologies, phase-out of ozone-depleting substances, more energy efficient processes and polices, among others. Together these allow industries, governments and civil societies to plan a better and more sustainable development path ahead. All of them have a technology component somewhere.

The partners in this workshop do not see this as being a single event lasting a mere 4 days. This workshop is the beginning of a change in decision-making by you, and your colleagues in your own organizations. There may be a need to follow up this meeting with others in your country. All of us are committed to helping you apply this knowledge, and we will do what we can to assist you as you proceed.

So let me once again thank our partners, especially the ILMC and the CDG, for their organisational and financial support, the Philippine Recyclers Inc. and the Government of the Philippines as generous hosts, UNCTAD and Tecnicas Reunidas as supporting organisations, our hard-working consultants and advisers, and others who have supported the idea, but cannot be here.

Most especially, I thank all of you for your enthusiasm in coming here. I wish you hard work and a good output at the end.

Finally, on behalf of the Executive Director of UNEP, Mr. Klaus Töpfer, I thank the organizers and sponsors, and wish you all a very successful workshop.

Annex 4
Personal Action Plans

Sirirat Kongmon

1. Increase the capacity of trainers to know and understand the environmental technology assessment concept 6 months by professional

2. Increase awareness and consciousness, including promoting the EnTA concept in order to make it acceptable to main 3 groups - Government, project proponents and NGOs and the public

3. Continuously by Government

4. Improve the guidelines for preparing the Environmental Impact Assessment report for development projects, by addition of the EnTA concept to the report, as part of the project assessment 1 year by Government

5. Adopt EnTA concept in practical assessments of all development projects 3 years by Environmental Policy/ Environmental Law

Prachai Rorkyhila

Follow-up EnTA Activities	Time Frame	W/out Additional Resources	With Additional Resources	Remark
Provide the criteria in order for decision impact assessment to depend on regulation	1-3 years Formal may be about 5-7 years	X		Informal - I agree with the principle EnTA Worksheets but not clearly understand the criteria in relation to local demand, identify consequences of concern etc.
Evaluate the technique in Thailand (all) in order to produce user friendly environment database (Revise)	2 years or 3 years		Expert, Information	Because of the economic crisis I can't begin the new project (fixed budget)

Hong Nareth

Activities Follow up (After workshop)	Time Frame	Without additional resources	With additional resources
Introduce EnTA into country create a mechanism for inter-agency collaborations in implementing of EnTA	1 year		Technical assistance and financial support and expertise
Conduct training course on EnTA for the relevant institutions	3 months		Technical assistance and financial support

Li Jishir

Follow-up activities	Time frame	Without additional resources	With additional resources
1. Organizing national workshop on EnTA	7-12, 2000		
2. Organizing Asia-Pacific Regional Workshop on EnTA	7-12, 2000 or 1-12, 2001		
3. Introducing EnTA into China through publications in Chinese (Compiling or translation)	3-12, 2000		
4. Enhancing research projects on EnTA	2000, 2001, 2003		
5. Improving capacity of myself on EnTA	2000, 2001, 2002		
6. Ready to be trained in future programs	2000, 2001		

Sun Qihong

Activities	Time Frame	Without additional resources	With additional resources
1. Fully understanding the EnTA and have a feasibility study on how it can be introduced into China (technically and managerially)	3 months	X	
2. Translate the Final Manual and methodologies into Chinese	2 months	X	Maybe Chinese methodology required
3. Under UN programme on EnTA, disseminate country wide through China NCPC network	4-6 months		X
4. Integrate EnTA with other tools, eg. EIA and esp. CP Technology Evaluation			Methodology development required

T.R C. Frias

1. To collaborate with UNEP and ILMC in improving the EnTA Manual by including economic, local, and financial aspects in the assessment.

2. If required, to prepare “Pre-feasibility studies or conceptual basic engineering” documents on selected base cases of TR technologies such as PLACID or PLINT.

3. To maintain a collaborative approach with UNEP and ILMC, to help them with information dissemination and training activities.

4. Provide ongoing and current information with both UNEP and ILMC, to keep them aware of the latest and new developments in clean and eco-efficient technologies applied to secondary lead industries.

Mariva Solclafeuko

1. To share new experience in anticipating the environmental effects of technology, especially with our Planning and National Environment Protection Committee - 3 months

2. To try and evaluate existing technologies using the full method of evaluation of the environmental consequences

3. To use my new experience in the evaluation of projects and technologies

Edcesite I. Dael

Activities	Time Frame	Without additional resources	With additional resources
1. Do consultation with UNDP, DENR, LCD and LMCHA for possible inclusion of EnTA as a tool of SCP	April	X	
2. Conduct orientation briefing to ESPB	May		X
3. Conduct orientation briefing to SM of ecosystems	May		X
4. Passage of ordinary cc or res from ESPB	June		X
5. Conduct training to SM of ecosystems	June	X	
6. Replication to demo cities			

Personal Action Plan

Follow-up Activities	Time Frame	Without additional resources	With additional resources
1. Submit comments to UNEP on EnTA	2 weeks after workshop	X	
2. Obtain copy of revised EnTA	1 months after workshop	X	
3. Implement EnTA at plant level a. Training on EnTA for personnel b. Implementation and integration	6 months after workshop		X
4. Updating of knowledge of other tools	1 year after workshop		X
5. Continuous networking with EnTA participants to exchange information on EnTA implementation	Continuous	X	

Lim Cheng Sang

Follow-up action without additional resources

1. To use the present EnTA forms, with some modifications, to study and assess the environment/economic feasibility of our choice of selected technologies. Time frame: 3 months (Purpose is to find out if the conclusions would be different with and without the use of EnTA)

Follow-up action with additional resources.

2. To use the present EnTA forms or the revised EnTA forms, if available in time, to study the environment/economic feasibility of using a dry separation technology for the treatment of aluminum dross – a new project currently under evaluation. Time frame: 3-6 months

Leonard Ho

1. Coordinate with Carlos Frias about details of hydro-metallurgical processes – within one month - With additional resources

2. Undertake feasibility study (preliminary) of a project or maybe in improved EnTA study – one month - Without additional resources

3. Seek funding to undertake assessment of options that will look at payback on basis of project successfully generating revenue – one year - With additional resources

Olivia L. Castillo

Follow up activities	Time Frame	Without additional resources	With additional resources
1. On receipt of final draft, link with Dept. of Science Technology to have future EnTA workshop in Manila DOST/DENR/DTI - DENR = Dept. of Environment & Natural resources - DTI = Dept. of Trade & Industry	March 30 to May 30, 2000		With the help of ADB/CDG/US-AEP & industry association + UNEP+ILMC
2. Keeps lines of communication open with Brian Wilson, John Hay, Ulrich Hoffman for future workshop	April 30 to June 30, 2000		Same as above - P.3 R (Phil Pollution Prevention Roundtable) - APRCP (Asia Pacific Roundtable for Cleaner Production
3. Link PRI with the Development Bank of the Phil or Land Bank of the Philippines for financial support for environmentally driven intended upgrades of technology	6-31 March 2000		As ADB-RETA local Consultant, I will introduce the PRI to the Filipino Banks for CP Financial Support
4. 4. Put EnTA in APRCP Roundtable in February 28 – March 2, 2001	March 8 to May 31, 2000		With APRCP organizing members

Personal Action Plan

Activities	Without additional resources	Time frame
1. Integrate EnTA into our existing technology assessment instrument. Present tool focuses too much on technical/financial aspects with little consideration of areas covered by EnTA (i.e. social issues)		
2. Fill in areas not adequately covered by EnTA (i.e. economics)		
3. Assess the practicality of quantification of ratings, to improve precision.	Cross disciplinary	
4. Re-convene the team to review the revised EnTA	Original team	Upon completion of EnTA tool

Li Tongyuann

Activity 1: To draw up the EnTA guidelines, workbooks and manuals and establish EnTA infrastructure suitable for China.

Activity 2: Based on the EnTA evaluation, recommend procedural and technology improvement in distiller's grains in transformation to protein by solid state fermentation, to achieve higher levels environmental protection and the appropriate use environmental resources

Activity 3: To build capability for EnTA in China

Activity 4: To establish the database required by EnTA system

R.M.D. Banclars

Activities	Time Frame	Stakeholder
1. Introducing EnTA to Central Environment Authority	By 31-7-2000	
2. Introducing EnTA to Board of Investment	By 30-6-2000	
3. Studying the feasibility of organizing a seminar to introduce the EnTA, in association with CEA & BOI		
4. Undertake EnTA in relation to purchase of a heading machine for our country	31-3-2000	Community workers Environment

Personal Action Plan

Activities	Time Frame	Without additional resources	With additional resources
1. Establish quantitative criteria on the local demands, and develop impacts by evaluation of options	One month	X	
2. Review EnTA process	Two months	X	
3. Incorporate established quantitative criteria into the EnTA Process	One month	X	
4. Expand the scope of the EnTA process to include capacity assessment for environment/economics of the project			X
5. Involve selected companies in the EnTA process			X
6. Establish relationship between EnTA and EIA and give feedback			X

Marco Carlos

Activity	Time Frame	Stakeholder
Undertake further studies on - EIA tools, formulation - ERA tools, formulation - EnTA tools, formulation - Economic Analysis	March –June 2000	Me
Attend activities related to EnTA	To be announced	me
Form a TWG to assess the EnTA exercise - Consultation - Pilot studies - Viability of incorporation	3rd quarter of 2000	Mixed discipline
Decision/decide on whether EnTA should be used	2001 up	Policy makers

Gieorginia M. Pascual – Sison

1. To go through the completed worksheets again & try it with other technology examples. To look for items where providing supplemental data can help clarify uncertainties	Output: Comments, recommendations for revision WHO: Participant/integrate in the Greening Procedures' of EnTA Time Frame: 1 year to institutionalize
2. Take applicable parts of the EnTA process and assessment and identify points to be included in the project study format being used by the BOI Environment Unit (This will supplement the feasibility aspect that usually gets evaluated in projects.) 3. Use it in evaluating technology transfer projects being offered to the BOI (only the applicable parts), complementing the assessment	Output: Project Assessment Procedures Resources: can't assess yet
4. Propose another workshop with the R&D and academe and imporve understanding they may have and seek other comments/ suggestions that can help revise the EnTA.	The organizers can look into having this sometime within the year The same goes for the other proposals
5. Proposed support activities that can come with the EnTA: 6. CD roms: database of alternative technologies that can be conceded options to traditional process 7. Program CD ROM version of the EnTA sheets that can generate summaries and assess technology for all information inputted	Can be disseminated and the need for training will also be evaluated

Personal Action Plan

Activities	Whose resources	Time Frame
1. Revising the existing assessment and preparation of strategies	Government	3 months
2. Consider EIA Report	Government	3 months
3. Adapting the Technology	Government	2 months
4. Providing EnTA guidelines	Government	2 months
5. Put EnTA strategy to lesson of study	Government	3 months
6. Provide technical assessment	Government	1 month
7. Build the capacity of EnTA	Government	3 months

Personal Action Plan

Activities	Time Frame	Without additional resources	With additional resources
1. Apply EnTA to present industry	By March 2000	X	
2. Inform and have project manager understand the EnTA goals		X	
3. Consider & improve EnTA with respect to economic aspect		X	
4. Corporate EnTA with EIA (Environment Impact Assessment) and include economic aspect			X
5. Provide specification as bench mark and refer to standard to assess with aggregate percentage & recommendation	2 weeks		X
6. Asses EnTA with present and future impact together with processes by product			X

Personal Action Plan

Activities	Time Frame	Who are involved	Without additional resources	With additional resources
Revising the environmental technology assessment product industry	3 months	Employee, Government	X	
Transfer technology to the factories	6 months	Employee, Government	X	
Adapting the appropriate technology	3 months	Employee, Government	X	
Providing EnTA guidelines	3 months	Government	X	
Monitoring and assessing impacts on policy	6 months	Employee, Government		X
Public awareness on EnTA	6 months	Employee, Government		X
Select appropriate technology for factory by using EnTA	2 months	Government Factory		X
Transfer EnTA to Local Government	2 months	Government Factory		X

Personal Action Plan

Main Purpose: To further understand the potential of EnTA as an assessment tool

Activity	Time Frame	Resources requirement
1. Use the tool in a service related technology	Six months Q1-Q2	Existing
2. Assess use of the assessment	Q3	Experts
3. Write up result of application	Q4	Existing

Personal Action Plan

Activities	Who are involved	Time Frame	Without additional resources	With additional resources
Revising the existing assessment and preparation of strategies	Government	3 months	X	
Consider EIA reports and put EnTA into EIA system	Government	2 months	X	
Technology transfer to factories and other enterprises	Government, factory	3 months	X	
Adapting the technology and give information to people	Government, people	3 months	X	
Providing EnTA guidelines	Government	2 months	X	
Put EnTA strategy in student curricula	Government	3 months		X
Monitoring and assessment relevant technology transfer and development, implement	Government	2 months		X
Select appropriate technologies for factory, using EnTA	Government, Factory	3 months		X
Adjust method for use of EnTA, based on results for each factory	Government	2 months		X
Transfer EnTA to Local Government	Government	2 months		X

Geri Geronimo R. Sanes

Activity	Time Frame	Resources requirement
1. Revising/Finalizing the EnTA checklist/questionnaire (consultation meeting)	3rd Quarter 2000	Experts and Financial Support
2. Presentation of draft final document to beneficiaries and stakeholders (Forum)	4th Quarter 2000	Financial Support (logistics)
3. Evaluation of other technology assessment documents, locally and international available	4th Quarter 2000	
4. Integration – Workshop on the Implementation of Assessment Documents	1st Quarter 2001	Experts and Financial Support

Anuda Tawatsin

Activities	Time Frame	Without additional resources	With additional resources
1. Comprehensive reading of workshop materials	28-29 February 2000	X	
2. Workshop Summary Report to MOSTE via Director General of Pollution Control Department (PCD)	Next week	X	
3. Comprehensive report and 4. Presentation of EnTA 5. Discussion of possible application in our work at PTECH-PCD (Institute of Pollution Central Technology Development)	Mid April 2000	X	
6. Departmental (and possibly other agencies) presentation of EnTA with the revised material from UNEP	June		X
7. Send EnTA materials to other concerned agencies	June		X
8. Organize or joint training course with other environment agencies, TEI, UNEP etc.	2001 onwards		X

Suqeng Priyanto

Follow up activities after EnTA workshop

1. Make report (Summary) for Ministry Environment, Head of Environmental Impact Management Agency

2. Propose the EnTA Workbook for consideration in Environmental Technology Assessment

3. Socialization and Dissemination of EnTA Workbook to internal Institutions and stakeholders

4. To analyse and examine the EnTA Workbook with reference to the Environment Impact Assessment Government Regulations

5. Developing Environmental Policy

Pongvipa Lohsonloon

Activities	Time Frame
1. Report the summary to the Director of TEI	March 2000
2. Investigate applications of the EnTA (Final version) with various groups of stakeholders, especially the Industry through TEI channels (direct contact questionnaire surveying existing training)	June – September 2000
3. If yes introduce the EnTA to the Thai Industry as a tool of technology assessment with regard to the environmental impacts (training with the help from experts & UNEP & CDC)	June – March 2001

Somphong Soulivanh

1. Understand that the EnTA is very useful for my country. Because there are many obsolete technologies and much second hand machinery in Laos we need to undertake environment technology assessment.

For personal action plan I would like to:

- Report on EnTA to government (one month)
- Organize a workshop for government staff which concern with environmental management, and for investors (In 2000)
- Propose to UNEP to organize training workshops in my country (In 2001)
- Try to use EnTA system in some factories.

Michael E. Nunez

A. Follow up to the Workshop from the academic point of view:

Short term action: Introduce EnTA to the graduate class who are enrolled in the subject Environmental Impact Assessment (EIA) & OSH Class. The students are Industry leaders and local government units coming from the Visayas and Mindanao Area. This can be used as an additional tool for their specific case study and can be incorporated in their final report.

In this way I can get an immediate feedback on how they respond to EnTA.

TIME FRAME: * One-month result
* Five month Result

Long term action: Base on the result of the Short-Term action. With some modification of EnTA, a training program be developed on the professorial level, and then introduce EnTA into the curriculum on the graduate level program in Environmental Management. – Need Resources

TIME FRAME: * Six months results – Professional Training
* One Year results – Curriculum

B. As a Professional Practitioner on EIA

ACTION: Use EnTA immediately as an additional tool in my present work

TIME FRAME: Immediate (one week)

Norazian

A. Using available resources:

1. Action: prepare a summary report of this workshop; explain what I received from this Workshop, that is of benefit to me, and to my country. Time Frame: within one month

2. Action: Distribute the EnTA information to other DOE's officers by having a colloquium and presentations. Time Frame: Two months

3. Action: Use EnTA as a supplementary tool wherever it is applicable for use in my daily work (receiving an EIA report). Time Frame: as soon as I get back to my country

B. Using Additional Resources:

1. Action: Organize EnTA Workshop in Malaysia. Time Frame: One – two years

Eng. Darrell A. Palabrica

Activities	Time Frame	Persons Involved	Status with Resources
1. Prepare report for the Regional Executive Director about the advantage of EnTA process	One week after the workshop	Participant	Dependent on the existing resources
2. Evaluate the draft version of EnTA and relate the process with the EIA	Two week after the workshop		
3. Apply EnTA process to one or two projects (major) that have submitted an Environmental Impact Statement	Within a period of one year		
4. Review EnTA process with the EIA Division/EIA Review Committee	After one year After the process has been tested for its usefulness	Participant/ EIA personnel/ EIA Review Committee members	Need other resources for implementation (for reference only)
5. If Implementation becomes successful, replicate process at the Community & Provincial Levels	After one year After the process has been tested for its usefulness	EMB-DENR/ Region VI PENROS/ CENROS	

Dang Kim Chi

A. March – August 2000

1. Present results of the workshop in Philippines to all colleagues

2. Documentary collection on the EnTA, for understanding benefits, advantages and advantages to application of EnTA in Vietnam

3. Understanding the technology which is in Hanoi (Textile, Food processing, Chemical)

B. September 2000 - February 2001

4. To find case study

5. Training for Trainer on EnTA

6. Organise training course on EnTA, for Environmental Management, Environmental Expert in NEA DOSTE, for technical staff and management staff in the factories in Hanoi; when it is possible, training course on EnTA in South and North Viet Nam

C. March – August 2001

7. National Workshop on EnTA; Invite international expert (for example John Hay) to workshop and presentation on EnTA, and work in coordination with a national expert to undertake some case studies

D. September 2001

8. Application of EnTA in some factories in Hanoi (Textile, Food processing, Chemical)

Liu Zhiguan

A. I will try to carry out the following action plan after returning to China:

1. 1. To organize a small group to carry out research concerning EnTA Assessment. Research content: - review the strategy of EnTA; The role and importantance of EnTA Assessment; The difference between EnTA, EIA and ISO 14000; also verification of environmental technology using EnTA and how to apply this system in Chinese environmental management feasibility analysis

2. To carry out awareness raising through media, workshops etc., and then try to influence some high-level decisions

3. To draw up EnTA guidelines, workbook and manuals suitable to China (industry technical specification etc.)

4. To carry out the EnTA demonstration in different industrial sectors

5. To include EnTA as a part of environmental management

6. To carry out training

B. Using available resources

UNEP EIA research academy and Institute, as well as university management methods of screening, evaluating and transferring environmental technologies

C. Time: 1-2 years

Husi Koh Choy

A. Using available resources

1. Do a presentation of what I learnt about EnTA to my colleagues in my Department/ Ministry: Within 1 month

2. Study in depth the whole EnTA process and if necessary suggest changes/amendments/modifications to the worksheets: Within 3 months
3. Production of EnTA manual

4. Submit a report on the EnTA workshop to my Department: Within 1 month

5. Networking with new friends/participants of EnTA: Immediate

B. Using additional resources

6. Send draft EnTA worksheets to other organisations and educational institutions related to the environment field, for their comments on usefulness and applicability of EnTA in their work areas. When we receive revised draft EnTA primer/worksheets from UNEP/ILMC, within one month

7. Recommend my office send officers to future EnTA workshops and training to learn/gain first-hand experience of this planning tool: Immediate

Annex 5
Closing Remarks

Niclas Svenningsen
Industry Programme Officer
UNEP/ROAP, Bangkok, Thailand

Over the last four days we have together discovered the shape, form and function of a tool that we call Environmental Technology Assessment. Under the excellent guidance of Brian Wilson and John Hay we have found out WHAT an EnTA is, HOW an EnTA works, WHEN it can be used and WHY it should be APPLIED.

For us, the trainers and resource persons, this workshop has been as much a learning experience as it has been for you. The workbook and primer we used are both new and were tested for the first time in this workshop. I think we have been successful in drawing important experience from how to use the training material and how to form future workshops to maximize their efficiency and value for the participants. This we completely owe you, the participants and resource persons, our sincere appreciation.

EnTA is in many ways a new tool. It does not belong to the buzz-words of “ISO 14000, Environmental Impact Assessments, Waste Minimization or Cleaner Production”. But it is nevertheless an important tool and I am personally convinced that it will not be long before it is a very common and widely applied tool - maybe even more so than e.g. EIA and ISO 14000, since EnTA is a much more convenient and easy-to-use tool.

But it is also important to remember that the EnTA is just that – a tool. You can not build a house only with the help of a hammer, and you cannot make an investment decision only based on an EnTA. You need other tools. You need to know a bit more about the economics of the investment, and you need to know about other implications that may not be included in the EnTA. What the EnTA tool does provide, however, is a wide array of information and means of comparing the information of different alternatives. And as you cannot build a house only with a hammer, you cannot either build a house without the hammer. The EnTA is essential and I hope you will all use and promote the use of EnTA when you come back home after this workshop.

I would also like to take the opportunity to extend UNEP’s thanks to all those that have made this workshop a success: to our two trainers: Brain Wilson and John Hay, to our resource persons Ulrich Hoffman, Carlos Frias, Olivia de o’Castillo, Teofila Echavia Remotigue, Reinhard Gleis and Edmundo Esguerra. On a more institutional level I, of course, want to extend our thanks to the International Lead Management Center and to Carl Duisberg Gesellschaft. They provided the main part of the budget for this workshop and made this not only a training event but a training event in a comfortable context. I think you will also all join me in thanking the Philippine Recyclers Inc., their staff and especially their president Mr. Jacob Tagorda and the General manager, Mr. Irving C. Guerrero, who showed us such a truly Philippine fashion hospitality during our visit to their recycling plant. Finally I would like to thank the most important persons at this workshop: you, the participants! Without you there would have been no workshop and without this particular group of participants the workshop would not have been as successful as it was. To all of you I extend UNEP’s and my personal thanks!

Annex 6
Media Release

Environmental Technology Assessment (EnTA) Workshop
Manila, 22 – 25 February, 2000

Significant Progress with Environmental Technology Assessment

Technology transfer is an essential element for national development, but a key issue is how to recognise the most environmentally sound options among existing and emerging technologies. For example, some of the industrial processes now available for recycling used lead-acid batteries produce considerably less pollution and reduce exposure of workers and the community to health risks.

In order to improve national capacity to choose appropriate technologies, the first regional workshop on Environmental Technology Assessment (EnTA) applied to industrial technologies was held in Manila, 22 – 25 February. The workshop was held under the joint sponsorship of UNEP, the Carl Duisberg Gesellschaft (CDG), and the International Lead Management Center (ILMC).

This workshop had the dual objective of studying the health risks and environmental consequences of current and emerging battery recycling processes, and evaluating the application of EnTA to industrial technology generally.

EnTA is used for comparing environmental, social, safety and other aspects of different technology options. Based on the methodology outlined in UNEP's new EnTA Manual, the workshop was able to provide a systematic overview of the technical aspects of battery recycling, examine the potential environmental impacts of various technologies, and review the wider economic and societal implications. Alternative technologies were examined from the point of view of identifying options that produce less pollution and avoid other adverse impacts. Current legislation around the world restricting the export of batteries for recycling provided an international context for the workshop.

During the workshop 45 participants from industry, governments, NGOs and technical institutes in Southeast and other parts of Asia received hands-on training on how to use EnTA. A practical focus of the exercise was kindly provided by Philippine Recyclers Inc, who made available their battery recycling facility in Bulacan for a case study.

The workshop participants agreed that EnTA should apply early in the development trajectory of a technology so that environmental, economic, social and health consequences can be predicted well in advanced and appropriate action taken. Participants indicated their intention to apply the EnTA methodology in future in their own national contexts, including further training in other countries in the region.

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Annex 7
Media Release

Workshop on Environmental Technology Assessment (EnTA) of Cyanide Technology
Johannesburg, South Africa, 21 to 25 February, 2000

Successful conclusion of Regional Workshop on Environmental Technology Assessment of Cyanide Processing

The recent mining accident in Baia Mare, Romania, has focussed world attention on the safe use of cyanide. In its closing statement to a recent workshop on "Environmental Technology Assessment (EnTA) of Cyanide Technology", UNEP drew attention again to the need to more systematically evaluate environmental consequences of technology options before they pass into widespread use.

The workshop held in Johannesburg, South Africa, 21 to 25 February, brought together 35 officials and experts from the SADC region representing government, academic institutions, NGOs, industry and consultants. The workshop was a collaborative effort between the Carl Duisberg Gesellschaft (CDG), the University of the Witwatersrand and UNEP, using in particular a new Manual developed by UNEP and other technical documents concerning environmental safety at mines.

This workshop had the dual objective of studying the safety risks and environmental consequences of current cyanide processes, and evaluating the application of EnTA to mining technology.

Based on the methodology outlined in UNEP's new EnTA Manual, the workshop was able to provide a systematic overview of the technical aspects of cyanide use and supporting technologies, examine the potential environmental impacts, and review the wider economic and societal implications. Alternative technologies were examined from the point of view of providing other options that use less hazardous substances for metals extraction. The Baia Mare accident provided a compelling context for the examination of all aspects of continued use of cyanide in the mining industry.

The methodological aspects of the EnTA procedure were examined by the workshop, including the timing of EnTA and EIA at different points in the project cycle. The workshop agreed that EnTA should apply early in the development trajectory of a technology so that environmental consequences can be predicted. Participants indicated their intention to apply the EnTA methodology in future in their own national contexts.

The workshop provided decision-makers in the mining sector with improved skills in environmental technology assessment. It also helped to encourage the wider use of other assessment methodologies such as life-cycle assessment (LCA) and Environment Impact Assessment (EIA) for industrial projects, and chemical risk assessment (CRA) for processing chemicals. These methodologies are already in use in other industries, and now need to be more widely applied in the mining sector.

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For information on the Baia Mare incident:
http://mineralresourcesforum. unep.ch/Baiamare

Annex 8

Feedback from Workshop on Environmental Technology Assessment (EnTA) of Cyanide Technology

Johannesburg, South Africa, 21 to 25 February, 2000

The following comments were provided by the workshop convenors:

- The workshop went most satisfactorily; most participants seemed to feel that they could, and were keen to, put EnTA into practice in their own contexts;
- It seems important to demonstrate that EnTA is applicable to the widest possible range of environmental questions, so that people take the concept and run with it; one of our participants has already indicated that he wants to apply EnTA in connection with mercury;
- The Manual proceeds clearly and systematically – the participants at the workshop felt that a useful addition would be a table showing the differences between TA, EIA and EnTA;
- The Manual, once a final draft is produced, needs to be subject to rigorous language and style editing;
- The Manual works well in conjunction with the worksheets, and the latter met with a favourable reception on the whole;
- EnTA is considered to be the first step in the TA process, but nowhere in the Manual is the reader informed what this process is, nor is the reader enabled to perform/organise a TA process;
- According to Agenda 21, EnTA should have a participatory element, intrinsic to the idea of sustainable development; this is nowhere found in the EnTA Manual as it exists now;
- The economic aspects (costs) of, for example, determining the feasibility of alternatives should be part of a comprehensive EnTA;
- The ICE (Pressures/Impacts/Evaluate) model is to a degree adequate, but it lacks the possibility of addressing possible responses (mitigating strategies, policy implications etc); the model used by OECD (Pressure, Impacts, Responses) could serve as an example to broaden EnTA;
- The idea of introducing the concept of a "technology system" is confusing because it is not operationalised systematically in the Manual; the only place it can be used is in Step 1 for the description of the technology; the fact that a technology should not be regarded as a static system, but as an holistic entity, is valuable and should be maintained; a technology can, however, also be defined as a "cycle"- initiation, implementation, operation, regulation, utilization, disposal; this has consequences for doing an EnTA;

- Step 1, sections (e) and (f) – participants found it difficult to distinguish between the requirements of the two worksheets; we had to compare wording in the two worksheets carefully before we were clear as to the difference; while this may not be a problem in an actual use of EnTA, in a workshop situation it is not desirable; there is also the possibility this may be a second-language problem, but it should be addressed; possibly some labelled steps on the two pages would be of assistance;
- Step 2 was well received, but participants found Step 3 repetitive; maybe it could be made clearer to them why it is desirable to do a cursory survey first and then a more elaborate one;
- Stef 3 (f) – participants reacted well to the encouragement of the reiterative process here, and elsewhere;
- We found Steps 3, 4 and 5 to be comprehensive, detailed, and easy to complete under workshop conditions;
- A Step 6 should be introduced – "communication on the EnTA"; the validation and use of an EnTA depend to a large degree on the way its results are communicated; this should be integrated in the Manual
- Some criticism was made of the fact that the cost factor was not really discussed – this is probably a very important consideration, especially in developing economies; and
- The EnTA Manual will be a valuable tool in undergraduate teaching.

Annex 9

Case Study

Purpose and nature of the case study
The purpose of this case study is to provide an example of a practical, but fictitious application of EnTA. The case study follows the steps described in the Manual and uses the same worksheets. The completed worksheets are presented below, preceded by relevant background information.

The potentially serious health and environmental impacts of inappropriate and uncontrolled practices in the collection and recycling of lead-acid batteries are well documented. All stages of used battery collection and re-processing operations are associated with potentially adverse human health and environmental risks, for both small-scale operators and major plants.

The focus of the present case study is a private company which plans to construct and operate a secondary lead smelting plant that recycles automotive batteries. The re-processing plant is to be located in Udanax City, the capital of Udanax. The current task is to assess the environmental and related performances of the proposed technology intervention by reviewing, largely in a comparative manner, the environmental impacts of the proposed technology and some plausible alternatives.

Setting the scene

a. Udanax
Undanax is a fictitious country, created by the United Nations Environmental Programme (UNEP) for the purpose of demonstrating the applications of various environmental management tools and systems, as well as for illustrating environmental issues related to technology investments. The following is a brief overview of Udanax.

Udanax has an area of 700,000 km^2 and 1,100 km of coastline. The terrain is generally flat, with scattered hills (200 to 800 m high) in the central region of the country. There are 15 rivers with lengths over 150 km. The longest river, over 365 km in length, flows through Udanax City before reaching the ocean. The climate of Udanax is temperate to hot, with annual average maximum and minimum temperatures being 30 C and 14 C, respectively. The highest recorded temperature (41 C) was recorded in Udanax City in May, 1959. The lowest recorded temperature of 2 C was observed in January 1960, in the central region. Rainfall averages 650 mm/year in the coastal areas, and 780 mm/year in inland areas.

The population of Udanax is approximately 20 million, with six cities having populations greater than 200,000. Some 8% of the population belongs to poor minority groups. Around 50% of the population lives in the coastal areas. Udanax City has a population of 2.3 million. Udanax is not situated in an earthquake zone, but since observations began in the late 1940s one small earthquake has been recorded in the central hilly area. Frequent landslides are observed in the same area, especially during the rainy season that runs from June to September. The coastal areas experience persistent winds, typical of sea breezes.

Udanax has a limited supply of minerals, but substantial oil, gas and coal supplies. All electricity is produced by burning fossil fuels. Industry is based mainly on the energy resources, with both heavy industry and light manufacturing. Service industries are moderately well developed. There is a moderate amount of agricultural land and agriculture is reasonably extensive, with export crops based on the limited irrigated lands that produce fruit and vegetables. There is extensive livestock grazing. Tourism is a growing industry, especially in the coastal areas. Commercial fishing is an important export industry, with most fishers belonging to the largest of the ethnic minority groups.

Potable water supplies are somewhat limited, coming from both surface areas and groundwater. There is a well developed transportation network. Some 90% of Udanax City has sanitation services, although only primary treatment occurs. Trade waste from the two industrial estates located adjacent to Udanax City are not treated.

There are several high schools located in, and adjacent to, Udanax City. One of the two universities is also located in Udanax City. Some university staff members are interested in environmental pollution, and the engineering and science departments occasionally provide technical guidance to those industries that are facing pollution control problems. The majority of the population has had a primary school education and is literate, but the number of individuals with tertiary qualifications is small. Nearly 50% of the working population is employed in agriculture and fishing. Around one third are engaged in work related to government, community, social and personal services. Less that 10% of the workforce is engaged in manufacturing.

The political system is a constitutional monarchy, with a Prime Minister and parliament. Water pollution regulations are administered by four inspectors in the Ministry of Resources and Energy. To date the main emphasis has been on the quality of drinking water supplies. The Ministry of Agriculture is responsible for matters related to pesticides and groundwater. Occupational health regulations, administered and enforced by the Ministry of Health, do not yet include chemical exposure limits. Likewise, there are no regulations related to discharges of contaminants into the atmosphere.

The Ministry of Planning evaluates environmental impact assessments. Only major projects are assessed. One officer handles these assessments, and advises the Minister accordingly. An Environmental Bureau of four persons exists within the Prime Minister’s Department. It is responsible for coordinating environmental programmes, acting as international focal points and advising the Prime Minister. The Bureau has no formal links with other ministries.

The waste disposal regulations are administered by the municipalities. In most areas municipal employees collect and transport domestic wastes to one of two dumping sites located adjacent to the industrial estates. Industries employ private contractors, or company staff and vehicles are used. The dumping sites are designed, operated and controlled in ways that are likely to be successful in avoiding or limiting pollution.

The following is a summary of the current pollution and waste laws:

- Water Pollution Regulations (1981) under the Water Resources Act (1978);
  - offence to pollute both surface water bodies and ground water;
  - can set standards for discharge of effluents;
  - can order action to clean up;
- Environmental Asssessment Act (1985);
  - EIA required for all large industrial projects (over $2 million in start up costs);
  - EIA report format is prescribed;
- Waste Disposal Regulations under Public Health Act (1958);
  - wastes must be disposed of in designated locations;
  - deposit to be kept free of disease, vermin and fires;
  - only approved operators may run a waste disposal operation;
  - such operations must be safe at all times; and
  - municipalities have a duty to ensure collection of domestic solid wastes

b. The proposed technology investment

Udanax Recyclers Incorporated (URI) plan to construct and operate a secondary lead processing plant in the West Udanax Industrial Estate, some 30 km northwest of Udanax City and 5 km inland from the coast and Port Udanax. The Industrial Estate is adjacent to Udanax River and the international airport. Both formal and non-formal collection systems currently operating within Udanax will be used to ensure an adequate flow of used lead acid batteries for processing in the plant. Currently approximately half of the lead acid batteries imported into Udanax are collected and the lead smelted in small backyard enterprises. About 25% of the imported batteries are disposed of in landfills and formal dumps. The remainder are disposed of through ad hoc dumping.

When the plant is operating it is the intention that all batteries to be collected and ultimately transported to the plant by truck. The domestic supply of used batteries will be supplemented by imported batteries sourced from neighbouring countries. These batteries will come through Port Udanax and will be transported to the plant by rail. Over 20,000 tonnes of scrap vehicle batteries will be processed in an average year.

The process flow for the plant will involve pre-treatment (draining, crushing, sorting and separation) and desulfurization of the battery paste. A choice has yet to be made regarding the processing of the treated battery pastes – either a pyrometallurgical process (smelting and refining) or a hydrometallurigical process (electrowinning) will be used, or some combination thereof Frias et al., 2000).

The initial preference is to employ the hydrometallurgical process, and this will be the technology that is subjected to the full EnTA – the “long form” of the assessment. The alternatives (three smelting and refining options and no technology intervention) will be compared to the preferred choice, using the “short form” of the assessment.

Based on the processing of 20,000 tonnes of scrap batteries, and assuming the battery composition shown in Figure 1, the annual lead treatment would be:

- 10,000 tonnes battery pastes (75% lead) to the hydrometallurgical plant;
- 3,400 tonnes metallic lead (connectors, grids etc.) to low temperature melting; and
- 10,900 tonnes lead production (7,500 tonnes from the pastes and 3,400 tonnes from metallics).

The hydrometallurgical process would combine:

1) Melting of the metallic components such as the connectors and grids. This melting at 350 to 400C separates melted lead from other minor components that remain as supernatant slags or drosses. These drosses will be recycled to the hydrometallurigical treatment line. A pot or crucible will be used for this melting process. The resulting product will be alloyed lead, of similar composition to original grids and connectors. A ventilation system surrounding the melting pot will be required. Any fume captured in the ventilation bag filter will also be sent to the hydrometallurgical line. No slag or solid residue will be generated; and

2) Hydrometallurgical treatment of the battery pastes, together with a small portion of the drosses, fume, slags or imported lead sulphide. The resulting product will be 99.99% pure lead (7,100 tonnes per year) and lead cement with impurities (400 tonnes per year). The lead cement will be melted to give, for instance, lead quality for shots, or even mixed with the alloyed lead produced in the melting line.

The hydrometallurgical process offers two approaches for the gypsum product. In one instance the gypsum would not be recovered as a by-product - a residue from the leaching step would be generated containing more than 80% gypsum weight. This is an inert residue. Alternatively, battery pastes would be desulphurated by adding lime prior to the hydrometallurgical treatment. In this case a clean gypsum by-product would be produced. In addition, a small amount of leaching residue would be produced. This would also likely be classified as an inert residue.

The second option would require additional equipment and result in higher operating costs in comparison to the simpler approach. Hence the second approach will be taken only if a commercial application for the synthetic gypsum can be identified.

The plant will be designed to meet all the environmental protection regulations currently in force in Udanax. However, in anticipation of the strengthening of these regulations, including the air quality standards, the plant owners have decided to comply with much higher standards than are currently in force. It is hoped that the chosen process technology will also allow the plant to gain ISO 14001 certification.

With increasing private vehicle ownership, within both Undanax and the region, the plant owners consider the growing supply of used lead acid batteries will ensure the economic success of the enterprise. They also plan to construct and operate a battery manufacturing plant, which is to be located in an adjacent part of the Industrial Estate. They envisage considerable economic and other benefits will arise from this integration.

A preliminary assessment of the economic performance of the proposed technology intervention has been undertaken, following the methodology presented in Annex 3 of the EnTA Manual. The results are presented in Table 1.

The proposed development has been supported by both the central and municipal government authorities. They believe the technology intervention will take advantage of a resource that would otherwise be sent to a landfill, dumped inappropriately or partially recovered in the informal lead smelting sector. All three of these current recycling or disposal options have significant environmental, social and economic implications.
The initiative is also seen as an example to other industrialists, especially with respect to the desirability of improving environmental performance. The planned investment will go a long way to reducing the country's dependence on imported automotive batteries. It also signals confidence in the local economy and will hasten further development of the country's industrial sector.

Representatives of people living in residential communities adjacent to the Industrial Estate are very upset with the proposal to construct the plant. Their preference is for the plant to be built in the interior of Udanax, where other refining operations are already located. Community concerns relate principally to the pollution of the river and the groundwater, and to the release of particulates and fumes from the plant, with possible adverse impacts on the health of both children and adults living in the residential areas down wind from the plant. The community leaders are supported in this regard by national non-governmental organizations, and by two major international environmental organizations. They too wish to see the plant located in the interior. The plant owners argue that they will be using state of the art equipment and processes, and there will be no adverse effects on the environment. They also feel that if the plant had to be located some distance from Port Udanax the operation would be uneconomic, due to the increased transport costs.

This will be the first centralised lead acid battery recycling technology to be operated in Udanax. Also the proposed intervention involves a relatively unproven, but very promising process. Large amount of hazardous wastes will be received by the plant. For these reasons the owners have decided that an environmental technology assessment should be undertaken prior to the environmental impact assessment. The latter is mandatory, due to the size of the investment. They see the prior undertaking of an environmental technology assessment as an effective way to make the initial choice on process technology and to start a meaningful consultation with those people living in the neighbouring residential communities.

The costs of the environmental technology assessment will, in their opinion, be more than offset by being able to limit the more detailed environmental impact assessment to a technology option that is considered to be environmentally sound, acceptable to the community and economically viable. Thus the owners initiated the assessment with the aim of determining if the proposed technology intervention could indeed achieve these three goals.

Table 1. Preliminary Economic Assessment

	Cost ($US million)	**Net Return ($US million)**
Total installed costs	19.0	0.0
Year 1	2.3	3.6
	2.3	3.6
	2.3	3.6
	2.3	3.6
	2.3	3.6
	2.3	3.6
	2.3	3.6
	2.3	3.6
	2.3	3.6
	2.3	3.6
	2.3	3.6
	2.3	3.6
	2.3	3.6
	2.3	3.6
	2.3	3.6
	2.3	3.6
	2.3	3.6
	2.3	3.6
Year 19	2.3	3.6
Decomissioning costs	0.5	- 0.5

Discount rate	5%
Net present value	$US22.6 million
Payback period	3.2 years
Internal rate of return	18.1%

The owners have agreed to the establishment of an assessment team comprising an environmental scientist and a person with considerable expertise in economics and the social sciences. The team has been provided with limited funds which can be used to seek advice and guidance from other relevant experts, as appropriate, and to meet the costs of two public meetings, preparation and distribution of brochures and the operation of a telephone “hot line”.

Overview of lead recycling

This section provides a brief introduction to lead acid batteries and an overview of the recycling industry.

The predominant use of lead within the world is in lead acid batteries. Lead acid batteries are an essential component of the automotive industry for which there are currently no electro-chemical, economic or environmentally acceptable or competitive alternatives. World wide it is estimated that between 300 and 350 million lead acid batteries are produced each year (Angus Environmental Ltd, 1993; Behrendt & Steil; Wilson, 1993).

With the continuing growth in urbanisation and private vehicle ownership, particularly within newly industrialised countries, the steady increase in demand for automotive batteries is likely to continue, guaranteeing an international demand for lead (Angus Environmental Ltd, 1993; OECD, 1993). It is estimated that by the year 2005 approximately 74% of the total lead utilised within the western world will be in the form of lead acid batteries (Ahmed, 1996).

The average life cycle of an automotive battery is approximately 3 to 4 years. Many years ago spent lead acid batteries (batteries which fail to retain an electrical charge) were disposed of within municipal landfills, with significant adverse environmental consequences. Therefore, in many industrialised countries the recycling of lead acid batteries is seen as an appropriate response to reducing the environmental effects associated with landfill disposal, while also realising the economic potential that could be achieved through recycling. Since there is a growing world demand for lead, in particular in rapidly industrializing countries of the South, it was expected that these economic benefits would be sustained through the operational lifetime of the technology (Sancilio, 1995; UNEP, 1995).

Recycled (or secondary) lead is now estimated to constitute about 60% all the lead produced. This rate is predicted to increase to over 65% by the year 2005. Over the same period the demand for lead is also expected to increase, but the level of primary lead production will remain almost static. Therefore, battery recycling technologies are seen as an increasingly important component in the production of lead (Ahmed, 1996).

The most common lead recycling process involves the automated breaking and sorting of batteries into their components, before the lead is extracted at high temperatures (smelting). Once refined and alloyed with other metals, the extracted lead is cast into ingots and made available for use in commercial applications.

In addition to the lead content of the battery, other components and by-products can also be recycled. For example, sulfuric acid reclaimed during the breaking process can be transformed into other marketable chemical products (such as detergent additives and fertilizers). Similarly, the propylene cases of batteries can be shredded and washed to produce clean polypropylene chips suitable for reconstitution. These may then be formed into other products, including battery cases (de Feraudy, 1993; Jackson & Tansel, 1994). Some automotive batteries contain up to 70% recycled plastics and 80% secondary lead (Worden, cited in Jackson and Tansel, 1994).

However, the recycling process also has the potential for significant environmental impacts and risks to human health and safety. Generally the more notable environmental impacts include particulate (including lead and other heavy metals) and acidic (sulfur dioxide - SO_2 and possibly some hydrochloric acid in the gaseous form, HCl) discharges into the atmosphere during the smelting and refining processes, the discharge of contaminated industrial waste and the leakage of acidic electolyte during battery storage. The growing recognition of such impacts within communities, and by regulatory authorities, has been paralleled by the tightening of environmental protection standards and by higher environmental protection costs for recycling plant operators (Suttie, 1995; Wilson, 1993).

Internal costs, environmental controls and fluctuating lead prices have often impacted on the viability of any strictly profit-orientated recycling industry within western societies (Elmer, 1995; Suttie, 1995; Wilson, 1993). Although lead acid battery consumption within OECD countries continues to rise, there are few economic incentives for expansion of smelting facilities in developed nations. In contrast, lead consumption in rapidly industrializing (developing) countries has been rapidly expanding, often at rates of 10-15% per annum in volume terms. Many of these countries suffer from a domestic supply-demand gap for lead. Apart from increased imports of primary lead, this gap has also been closed by imports of scrap batteries from developed countries. Currently Asian nations such as Indonesia, India, and Thailand are the principal recipients of used lead acid batteries. (Elmer, 1995) In this regard, the fear has been expressed that such North-South shipments of scrap vehicle batteries are fuelled by lower operating costs of recycling facilities (for instance in terms of labour, health and environmental costs), which make such operations more competitive and economically viable (Greenpeace, 1994).

While not yet in force, the Basel Ban Amendment is being voluntarily implemented by many countries. The Amendment bans the export of hazardous wastes, including lead acid batteries and lead wastes, from OECD countries to non-OECD countries. Under the conditions prevailing in many developing countries, the Basel Ban Amendment effectively encourages the importation of primary lead in order to bridge the domestic supply-demand gap. Primary lead is nearly as cheap as secondary lead. In such situations a comprehensive national strategy is required to reduce waste generation, enhance access to domestic sources of lead scrap and make recycling environmentally sound and economically viable (Jha & Hoffmann, 2000).

Battery Composition

There are three general categories of lead acid batteries (see Table 2), but all operate according to the same principles. The major components of the modern recyclable lead acid battery are the electrodes (typically pure lead oxide and lead sulfate for the cathode, with the anode being a grid of metallic lead alloy with various elemental additives that might include antimony, calcium, arsenic, copper, tin and selenium), the electrolyte (dilute sulfuric acid), the separators, lead terminals and the plastic or rubber casing. The composition (by percentage weight) of a typical automotive battery is shown in Figure 3. The typical lead battery consists of 17% metallic lead, 50% lead oxide/sulfate, 24% electrolyte, 5% plastics and 4% (and reducing) inert residuals.

An average car battery weights 17.2 kg and contains approximately 6 litres of sulfuric acid (pH = 0.8) and 9.0 kg of lead – equally divided between anode and cathode (Basu et al, 1991 cited by Environment Canada 1993). The electrodes (or plates) are constructed from a grid-like lattice filled with a hardened paste containing the active material. Grids are cast from a high purity lead and alloyed with antimony, tin, arsenic and copper to improve their mechanical properties. A few manufacturers may still use small quantities of cadmium, but this is rare nowadays.

Direct electrical contact between the plates is prevented by a separator that allows electric current to flow between the plates when carried by sulfuric acid. The materials used for separators include plastic (polyvinylchloride, polyethylene), glass fibres and rubber components (Environment Canada, 1993; UNEP, 1983).
Battery casings are typically constructed from polypropylene, which is also recyclable. However, previously non-recyclable hard rubber materials (such as ebonite) were often used. As a consequence, the materials used in battery construction may vary according to their date and location of manufacture (Environment Canada, 1993).

Table 2. Types of Lead Acid Batteries

Type	Description	Life Cycle (Years)
Automotive (SLI)	Automotive batteries are constructed with thinly pasted plates and designed to supply high peak currents for brief periods of time while cranking the engine. They are not expected to be discharged to more than 75% of capacity and are recharged immediately after use. This is the most common form of lead acid battery.	2 - 5
Traction	Traction batteries are made with thickly pasted plates and have very rugged separators between the plates in order to make batteries more robust to shock and vibration. These batteries are sold for use in electric forklifts, golf carts, and marine trolling motors etc. Deep Cycle Marine batteries are of this type. They are designed for deep discharges (possibly over the course of a day), followed by deep recharges.	4 – 6
Stationary	Stationary batteries are made with thick solid plates. They are designed to be used as a standby power source and are kept in a state of nearly full charge until needed. They are able to take a deep discharge, are bigger and heavier than the other batteries and have a longer life time.	up to 10

Sources: Kantor, 1997; UNEP, 1995; Vincent, Scrosati, Lazzari, & Bonino, 1984

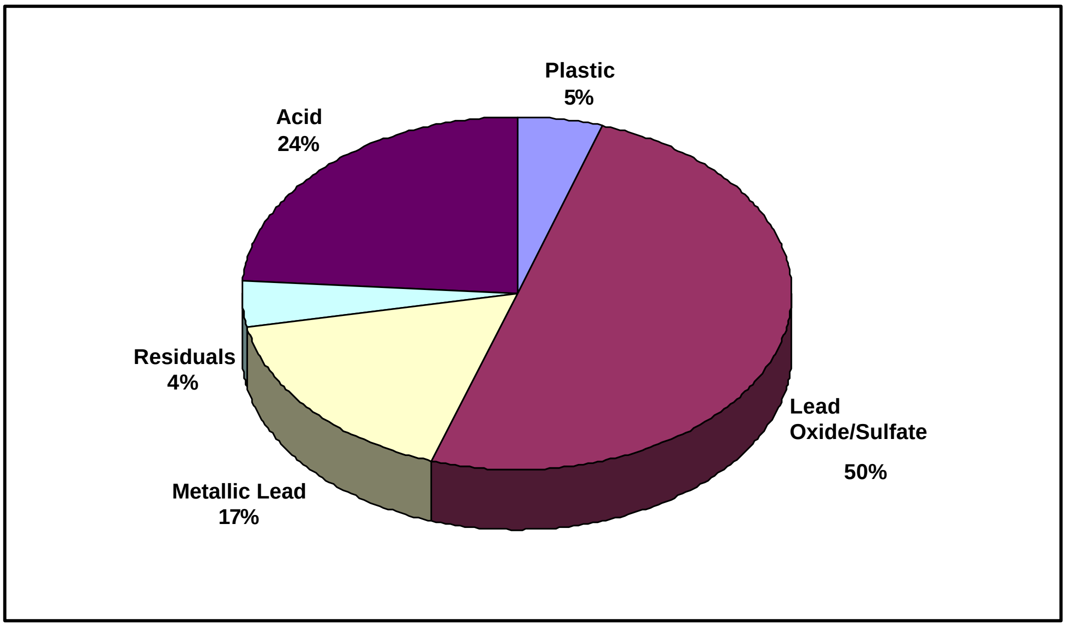


Figure 3. Constituents of Lead Acid Batteries (Percentage Weight)

Source: Environment Canada, Hazardous Waste Division, Office of Waste Management, 1993.

Step 1: Description of Technology

a. Identify the nature and function of the technology:

Name of the technology system: *Hydrometallurgical processing of spent lead acid batteries*
Function of the technology: *To recover high purity lead and other valuable resources from used batteries, in an environmentally sound and economically sustainable manner*

b. Identify and characterize the existing or proposed location of the technology:

Site location: *West Industrial Estate, Udanax City, Udanax*
Surrounding land use: *Industrial estate with mix of light and heavy industry*
Surrounding community: *Beyond the estate, lower middle class residences, mostly downwind from estate*
Natural environment features: *Flat land, with river adjacent to estate*
Natural hazards: *None of consequence*

c. Describe the technology (check appropriate boxes)

Existing	☑	Proposed	☐
Source of the technology		Technology indigenous to the area	☑
		Technology imported from abroad	☑
		Relatively new/unproven technology	
Type of technology		Based on the use of natural resources	☐
		Processing/manufacturing	☑
		Service/infrastructure	☐

d. In order of importance, identify the principal achievement goals for this technology and the beneficiaries and stakeholders.

What *must* the technology achieve?	Identify the beneficiaries & other stakeholders?
1. *Economic return on the investment in the plant and its operations*	*Owners, financiers, plant operators, technology developers and suppliers, central and municipal governments, plant workers*
2. *Production of lead ingots, at a cost, and to the specifications required for the efficient operation of the battery manufacturing plant*	*As above, but also owners and operators of the battery manufacturing plant*
3. *Operating a technology that can be sustained by local resources*	*As for Goal 1, but also people involved in the formal and non-formal battery collection sectors in Udanax, and the Udanax public at large*
4. *No or acceptable environmental (including community) impacts from plant operations, and improved environmental quality due to the elimination of poor environmental practices in the informal sector and the removal of used batteries from the waste stream*	*As for Goal 3, but also for other countries supplying used batteries*

What <u>other achievements</u> are desirable?	Who are the beneficiaries/stakeholders?
1. Recycling of other components of a lead acid battery	*People involved in the formal and informal battery collection sectors, users of the recycled materials, and the public at large.*
2.	
3.	
4.	

e. Description of the technology

Briefly describe the overall operation of the technology, and any changes that may need to be made to the technology during its operational lifecycle. Where possible, list the operations in sequential order, following the production of a product or service from start to finish.

Pre-treatment

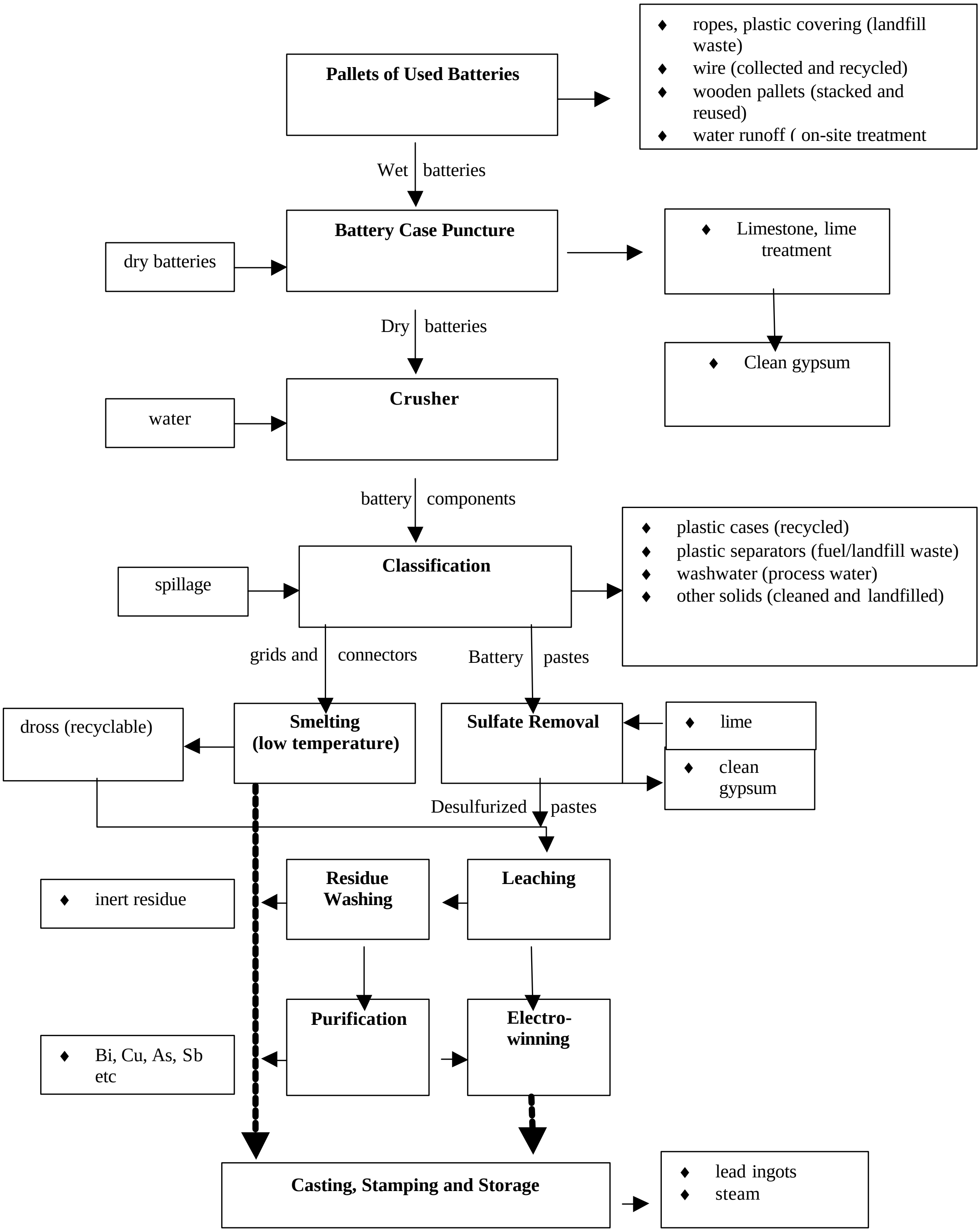
- *used batteries are taken from storage, manually removed from pallets and packing materials, and placed on breaker conveyor belt;*
- *the acid is drained from the batteries, diluted with process water, the acids is neutralised by the addition of alkali (e.g. limestone, lime, magnesia), forming gypsum – controlled neutralisation produces a clean gypsum by-product for use in some industrial applications such as plaster and cement production;*
- *batteries are broken using an automated mechanical breaking system that crushes the batteries by means of a hammermill; the separated components are classified and segregated;*
- *the grids, connectors and battery pastes are made ready for the lead re-processing while the polypropylene battery cases are chipped, washed and then fed into a standard plastic extrusion machine. The resulting plastic granulates are stored in large bags for easy handing and subsequent recycling; other plastics (polyvinyl chloride, ebonite), separators and other items are cleaned and transported to the landfill waste disposal site;*

Hydrometallurgical treatment of lead products

- *grids, connectors and other metallic components are processed by low temperature melting, producing alloyed lead and recyclable drosses; fume captured in the ventilation bad filter is sent the electrotwinning line;*
- *desulfurisation of the battery pastes is achieved by mixing with an alkaline solution regenerated through the addition of lime; clean gypsum is again the by-product; thisby-product can be used in some industrial applications such as plaster and cement production;*
- *the desulfurised battery pastes are leached with regenerated hydrochloric acid, followed by purification with lead powder, lead electrowinning and hydrochloric acid regeneration; feed materials can be battery pastes, fume, ashes, drosses, old and new slags and lead concentrate;*
- *final products are lead ingots (99.99% lead), lead cement and residual amounts of antimony, arsenic, copper, tin and selenium etc.; there are no waste liquid effluents and only inert leaching residues*

f. Flow diagram of the technology

Provide a flow diagram of the overall process or service, indicating the various sub-processes/components, showing material, energy and water inputs and output flows and identifying linkages between the different components and the external environment. Complicated and detailed sub-process/components may be drawn on additional sheets, if necessary



Step 2: Requirements of the technology intervention, and the resulting environmental pressures

a. List the raw materials, land and energy resources required by the technology, and identify where there are associated environmental pressures

Resource Demands	Relative level of demand	Identify Consequences of concern	Potentially significant pressures exist for (tick)				
			Human health and safety	Local natural environment	Global environment	Scarce /non-renewable resource use	Social systems
Material Resources							
Wet lead acid batteries	(H) M L	*Toxic, Corrosive*	✔	✔			✔
Dry lead acid batteries	H (M) L	*Lead exposure*	✔	✔			✔
Water	H (M) L	*Supply limited*				✔	
Lime	H (M) L						
Sodium hydrosulphide	H M (L)						
Lead powder	H (M) L	*Lead exposure*	✔				
Settling tank floc	H M (L)						
	H M L						
Energy Resources							
Electricity	H (M) L				✔		
Natural gas	H M (L)	*heat, explosive*	✔		✔		
	H M L						
Land Resources							
Re-processing site	H (M) L					✔	✔
Storage site – batteries; chemicals	H M (L)		✔	✔			
Storage site – ingots	H M (L)						
Processes							
Pre-treatment, processing of drained acids		*noise, acid mist*	✔	✔			
Battery paste desulfurisation			✔				
Treatment of pastes, melting and casting		*heat, fumes*	✔	✔			

b. **List the wastes and hazardous products produced by the technology, and identify where there are associated environmental pressures**

Identify the waste stream or hazardous product	Relative level of Production	Identify consequences of concern	Potentially significant pressures exist for (tick): Human health and safety	Local natural environment	Global environment	Scarce /non-renewable resource use	Social systems
Gaseous Wastes or Hazardous Products							
Fugitive emissions (melting etc)	H M (L)	*Lead exposure*	✔	✔			✔
Acid mist (from battery breaking)	H M (L)	*Burns to lungs & eyes*	✔				
Dust (from the baghouse fume)	H M (L)	*Lead exposure*	✔	✔			✔
Steam from ingot caster	H M (L)	*Burns*	✔				
	H M L						
Liquid Wastes or Hazardous Products							
Cleaning water	H M (L)	*contaminated*		✔			
Drained sulfuric acid	H M (L)	*corrosive*	✔				
Runoff from site and storage areas	H (M) L	*contaminated*		✔		✔	
	H M L						
Solid Wastes or Hazardous Products							
Bi	H M (L)						
Gypsum (only a waste if unsold)	(H) M L	*Large quantity*		✔			
As	H M (L)	*Toxic*	✔	✔			
Inert leaching residues,	H M (L)						
Recyclable drosses, Cu and Sb	H M (L)	*exposure*		✔			
Cases, separators, packing material, other	H (M) L	*Residual lead*	✔	✔			

c. List the infrastructure required by the technology, and identify where there are associated environmental pressures

Infrastructure Requirements	Current infrastructure able to meet demand in ways that are reasonable and adequate? (Y/N)	Potentially significant pressures exist for (tick)				
		Human health and safety	Local natural environment	Global environment	Scarce /non-renewable resource use	Social systems
Regional road / Main transportation corridor	*Y*					
Secondary roads and urban arterial	*Y*					
Airport access	*N/A*					
Railway access	*Y*					
Shipping / Deep water port access	*Y*					
Water supply	*Y*					
Gas supply	*Y*					
External power supply / Power lines	*Y*					
Human waste sewage and/or treatment	*Y*					
Industrial waste sewage and/or treatment	*On site treatment*	✔	✔			
Telecommunication network	*Y*					
Community services (i.e. schools, shops)	*Y*					
Public transportation	*Y*					
Local worker housing	*Y*					

d. List the supporting technologies required, and identify where there are associated environmental pressures

Supporting Technologies	**Is the technology locally available (Y/N)**	**Identify undesirable consequences of the technology**	**Potentially significant pressures exist for (tick)**				
			Human health and safety	**Local natural environment**	**Global environment**	**Scarce /non-renewable resource use**	**Social systems**
Transportation services – road	*Y*	*hazards, emissions*	✔	✔	✔		✔
Transportation services – rail	*Y*	*hazards, emissions*	✔	✔			
Transportation services – marine	*N*	*hazards, emissions*	✔	✔			
Dross disposal	*Y*						
Medical monitoring	*N*						
Training for workers	*N*						
Battery collection system	*N*	*Lead, acid*	✔				
Factory ventilation	*Y*						
Forklifts and cranes	*Y*		✔				
Environmental monitoring	*N*						

e. List the human resources demands of the technology, and identify where there are associated environmental pressures

Labour Force / Skills Required	Are these skills locally available (Y/N)	Would new workers need to be imported or local workers retrained[1]	Potentially significant pressures exist for (tick)				
			Human health and safety	Local natural environment	Global environment	Scarce /non-renewable resource use	Social systems
Engineers	*N*	I Ⓣ					
Industrial chemists	*N*	Ⓘ T					✔
Plant operators	*Y*	I T	✔				
Management and administration	*Y*	I T					
Cleaners	*Y*	I T					
Yard and warehouse workers	*Y*	I T					

[1.] I = New workers imported, T = Worker trained

f. Identify where there are environmental pressures associated with any other aspects of the technology intervention

Identify any relevant features of the technology intervention not already considered	Potentially significant pressures exist for (tick)				
	Human health and safety	Local natural environment	Global environment	Scarce /non-renewable resource use	Social systems
Decommissioning of technology	✔	✔			✔
Residual consequences of technology	✔	✔		✔	✔
Nuisance effect resulting from 24 h operation of plant		✔			✔

Step 3: Preliminary judgement

a. Assess the <u>impacts on human health and safety</u> that are likely to arise from the pressures identified in Step 2

- Describe the main human health and safety impacts associated with the technology:

Impacts related to exposure of humans to chemicals and other hazardous materials:

If new plant reduces the amount of lead smelting carried out by the informal sector, as would seem likely, there will be major benefits to human health, and safety.

Workers could be exposed to battery acids and to other corrosive chemicals used in the treatment of the pastes and the battery acids; exposure to lead and other toxic fumes possible, especially if there is a malfunction of equipment; acid mist, dust and heat may have adverse effects on worker health; dust generation would be minimal as wet processes are involved;

Impacts related to human injury:

Possibility of injuries resulting from operations in hazardous areas such as the crusher and casting room, and from equipment such as the conveyer, fork lifts, trucks, railway equipment and shipping.

Impacts related to communicable diseases:

Nil

Other impacts:

Low chance of impacts from natural gas explosion, and electrocution.

- Assess the overall impacts on human health and safety – tick the relevant boxes:

	Impacts unknown (U)	Beneficial impacts (B)	No impacts identified (N)	Slight adverse impacts (S)	Moderate adverse impacts (M)	High adverse impacts (H)
			Likely to comply with environmental standards		May not comply with environmental standards	
Exposure to chemicals	☐	☑	☐	☑	☐	☐
Risk of injury	☐	☐	☐	☑	☐	☐
Communicable diseases	☐	☐	☑	☐	☐	☐
Other	☐	☐	☐	☑	☐	☐
Overall (*transfer results to Step 4c*)	☐	☑	☐	☑	☐	☐

b. Assess the local natural environmental impacts likely to arise from the pressures identified in Step 2

- Describe the main local natural environmental impacts associated with the technology:

Impacts related to exposure to chemicals and other hazardous materials:
Natural environment will benefit from removal of used batteries from the environment (e.g. decreased illegal dumping and inappropriate storage) and from less hazardous materials going to land fills and dumps; also environmental benefits as a result of recycling, rather than use of primary lead.
Natural environment may be impacted if there are accidental releases of acids during transport and storage of the batteries, both within Udanax and from overseas. If storage areas (both at plant and as part of collection system) are inadequately designed and managed there may also be releases of acids to the natural environment.
Possibility of contaminants have adverse impacts in river ecosystem.
Contaminated water produced during battery pre-treatment will impact on environment if not controlled in an appropriate manner. Same applies to any fugitive emissions.
High amounts of gypsum are produced and if this by-product is not sold, some may have to be landfilled or disposed by other means, with attendant impacts on the natural environment. Non-recyclable components will have to be landfilled – these will have impact on the natural environment, especially if not cleaned appropriately and if landfill is not secure.
Residual chemicals after plant decommissioning could contaminate groundwater; land might have trace levels of residual lead, and other trace chemicals.
Impacts related to disturbance of ecosystems:
Impacts will occur during construction, as a result of 24 h operation (especially impact of noise on bird life) and during decommissioning. Residual impacts will also exist after decommissioning.
Other impacts:

- Assess the overall impacts on the local natural environment – tick the relevant boxes:

	Impacts unknown (U)	Beneficial impacts (B)	No impacts identified (N)	Slight adverse impacts (S)	Moderate adverse impacts (M)	High adverse impacts (H)
			Likely to comply with environmental standards		May not comply with environmental standards	
Exposure to contaminants	☐	☑	☐	☑	☑	☐
Disturbance of ecosystems	☐	☐	☐	☑	☐	☐
Other	☐	☐	☑	☐	☐	☐
Overall (*transfer this result to Step 4c)*	☑	☐	☐	☑	☐	☐

c. Assess the <u>Global Environmental Impacts</u> likely to arise from the pressures identified in Step 2

- Describe the main global environmental impacts associated with the technology:

Global Warming:

Minor contributions to global warming due to release of greenhouse gases during production of electricity used by the plant, and the burning of natural gas. Also emissions of greenhouse gases during transporting of batteries. All these emissions will be more than offset by the decreased demand for primary lead, and hence the reduced use of fossil fuels.

Ozone depletion:

None recognised.

Other:

None recognised.

- Assess the overall impacts on the global environment – tick the relevant boxes:

	Impacts unknown (U)	Beneficial impacts (B)	No impacts identified (N)	Slight adverse impacts (S)	Moderate adverse impacts (M)	High adverse impacts (H)
		Likely to comply with environmental agreements			May not comply with environmental agreements	
Global warming	☐	☑	☐	☑	☐	☐
Ozone depletion	☐	☐	☑	☐	☐	☐
Other	☐	☐	☑	☐	☐	☐
Overall (*transfer this result to Step 4c)*	☐	☑	☐	☑	☐	☐

d. Assess the impacts on the Sustainability of Resource Use likely to arise from the pressures identified in Step 2

- Describe the main impacts on the sustainability of resource use associated with the technology:

Impacts on living resources:

None recognised.

Impacts on non-living resources:

Surface and ground water supplies are under considerable pressure in Udanax; there will be added demand from the new plant.

Operations at the plant may also result in contamination of groundwater if adequate precautions are not taken; there may also be residual contamination of groundwater after the plant has been decommissioned.

Impacts on the land:

The plant will have a small impact on the availability of land, especially that which can be used for industrial purposes – both on site and as part of the collection system.

Operations at the plant may result in contamination of the land if adequate precautions are not taken; there may also be residual contamination of the land after the plant has been decommissioned.

Other:

None recognised.

- Assess the overall impacts on sustainability of resource use – tick the relevant boxes:

	Impacts unknown (U)	Beneficial impacts (B)	No impacts identified (N)	Slight adverse impacts (S)	Moderate adverse impacts (M)	High adverse impacts (H)
			Likely to be in compliance with good practice		May not be in compliance with good practice	
Impacts on living resources	☐	☐	☑	☐	☐	☐
Impacts on non-living resources	☐	☐	☐	☑	☐	☐
Impacts on land resources	☐	☐	☐	☑	☐	☐
Impacts on other resources	☐	☐	☑	☐	☐	☐
Overall (*transfer this result to Step 4c)*	☐	☐	☐	☑	☐	☐

e. Assess the <u>Social Impacts</u> likely to arise from the pressures identified in Step 2

- Describe the main social impacts associated with the technology:

Impacts on cultural values and sites:

None identified.

Impacts on social systems:

Likely to be impacts on livelihoods of those currently involved in the informal sector – both collection and smelting; whether impacts are beneficial or detrimental depends on the extent to which informal sector units can be woven into the new formal collection systems will displace those in the informal sector.

The construction and ongoing presence of the plant is likely to have a social impact, if only a nuisance value; likewise for the movement of materials to and from the plant.

Employment opportunities will have positive social impacts, but the presence of young single workers in the neigbouring residential areas may stress the social system. Some professionals will move into the area – this will also increase the demand on, and for, social services.

There is the potential for significant social disruption when the plant is decommissioned, with some ongoing effects after plant closure.

Impacts on social equity:

The plant employs a range of workers (labourers to professionals). Benefits are likely to be distributed in an equitable way.

Other impacts:

None recognised.

- Assess the overall impacts on society – tick the relevant boxes:

	Impacts Unknown (U)	Beneficial impacts (B)	No impacts identified (N)	Slight adverse impacts (S)	Moderate adverse impacts (M)	High adverse impacts (H)
			Likely to be in compliance with good practice		May not be in compliance with good practice	
Impacts on cultural values and sites	☐	☐	☑	☐	☐	☐
Impacts on social systems	☐	☑	☐	☑	☐	☐
Impacts on social equity	☐	☑	☐	☐	☐	☐
Other social impacts	☐	☐	☑	☐	☐	☐
Overall (*transfer this result to Step 4c)*	☐	☑	☐	☑	☐	☐

f. Assess the impacts likely to arise from pressures not identified in Step 2

- Describe other impacts associated with the technology:

Other Impacts:
Impacts associated with plant decommissioning, and residual impacts, have been identified earlier. *There may be a nuisance effect resulting from the 24 h operation of the plant – noise, dust, vehicle and train movements.*

- Assess the overall nature of these additional impacts – identify the impacts and tick the relevant boxes:

	Beneficial impacts (B)	No impacts identified (N)	Slight adverse impacts (S)	Moderate adverse impacts (M)	High adverse impacts (H)
		Likely to be in compliance with good practice		May not be in compliance with good practice	
Impact *Decommissioning*	☐	☐	☑	☐	☐
Impact *Residual effects*	☐	☐	☑	☐	☐
Impact *Nuisance*	☐	☐	☑	☐	☐
Impact …………..	☐	☐	☐	☐	☐
Overall (*transfer this result to Step 4c)*	☐	☐	☑	☐	☐

g. Assess the economic viability of the proposed technology intervention

i) General Economics **-** the information required below is best assembled using a worksheet based on the format presented in Worksheet B, or by using a spreadsheet, financial calculator or computer software capable of calculating values of the chosen indicators.

	Value	**Units**
Payback Time	3.2	Years
Net Present Value	22.6	$US million
Internal Rate of Return	18.1	%

ii) Externalities

Component of the Life Cycle	**Describe Uninternalized Cost Elements**	**Relative Contribution to Component Cost***
Identifying the technology	*Stress on adjacent communities due to plans to construct recycling plant*	*L*
Local design and development	*As above*	*L*
Procurement		
Installation	*Disruptions and noise during construction; influx of temporary workers; stress on services*	*L*
Initial support (e.g. training)		
Operations	*Impacts on informal recycling sector; disruption due to vehicle movement; noise; uncosted waste disposal; demands on social and other services*	*M*
Maintenance	*Unplanned demands for local services, lowering normal service standards*	*L*
Ongoing support (e.g. admin, training)	*Demands on local services*	*L*
Decommissioning	*Opportunity costs regarding future land use and use of infrastructure*	*L*

* H = high; M = medium; L = low

iii) Critical Cost Elements

Component of the Life Cycle	**Describe Critical Cost Elements**	**Relative Threat to Viability of the Investment***
Identifying the technology		
Local design and development	*Compliance costs*	*L*
Procurement	*Access and royalties to patented process*	*L*
Installation		
Initial support (e.g. initial training)		
Operations	*Supply and price of used batteries; price of secondary lead*	*M*
Maintenance		
Ongoing support (e.g. admin, training)		
Decommissioning	*Price for land and infrastructure*	*L*

* H = high; M = medium; L = low

iv) Assess overall economic performance

(**H**igh, **M**odest, **L**ow, **U**neconomic)

Overall Economic Viability (*transfer this result to Step 4c)*

h. Describe information gaps and uncertainties

Information gaps and uncertainties related to assessing:

a. impacts on human health and safety:

Need more information in order to reduce uncertainties related to:

- *benefits of reduced involvement of people in the informal sector in both battery collection and back yard smelting;*
- *willingness of workers to adopt appropriate work practices to prevent exposure to toxic and corrosive chemicals and physical injury;*
- *effectiveness of measures to control any fugitive emissions;*
- *impact of plant on neighbouring residential areas; and*
- *impacts of low probability but high consequence events such as natural gas explosions.*

b. impacts on the local natural environment:

Need more information in order to reduce uncertainties related to:

- *actual environmental benefits of improving efficiency and effectiveness of the battery collection system, and of reducing backyard smelting, volume of batteries entering waste stream, and the demand for primary lead;*
- *low probability but high consequence events such as accidental spilling of battery acids during transportation;*
- *effectiveness of environmental protection measures for battery storage areas, for both collection system and on site;*
- *effectiveness of control of fugitive emissions, runoff from plant and operation of wastewater treatment system;*
- *demand for the large amounts of gypsum produced – can these be sold, or will some have to be sent to landfill?;*
- *effectiveness of cleaning and disposal measures for non-recyclable battery components;*
- *level of contamination of site after it is decommissioned; and*
- *impact of plant construction, operation and decommissioning on local ecosystems.*

c. impacts on the global environment:

Need more information in order to reduce uncertainties related to:

- *actual emissions of greenhouse gases during collection and processing of batteries; and*
- *reductions in greenhouse gas emissions as a result of decreased demand for primary lead.*

d. impacts on the sustainability of resource use:

Need more information in order to reduce uncertainties related to:

- *impacts on surface and groundwater supplies – both quality and quantity;*
- *whether amount of land required by plant is excessive given other requirements for land; and*
- *possible uses for the land after the plant is decommissioned.*

e. social impacts:

Need more information in order to reduce uncertainties related to:

- *social and economic impacts (both positive and negative) on people working in the informal sector;*
- *impacts on adjacent residential communities during both construction and operation of the plant;*
- *the advantages of increased employment, as well as impact of workers and their dependents on social services etc;*
- *impact of decommissioning plant, on economic and social life of the local community; and*
- *social equity issues – no substantive information available.*

f. other impacts (not identified above)

Need more information in order to reduce uncertainties related to:

- *environmental and social impacts of the 24 h operation of the plant, including vehicle and train movements.*

g. overall economic viability

Need more information in order to reduce uncertainties related to:

- *reliability and economic performance of this largely unproven technology;*
- *operating and maintenance costs very uncertain, as is the future selling price of lead;*

- *effect of international environmental agreements and domestic regulations on such factors as sufficient supplies of scrap batteries, need for additional environmental controls, and decommissioning costs;*
- *discount rate; and*
- *identification and evaluation of environmental externalities, including social impacts.*

i. Is there sufficient information to characterise and evaluate the environmental pressures and impacts and the overall economic viability of the technology?

Yes	☑	**- continue to the next step**
No	☐	**- take appropriate steps to reduce the gaps and uncertainties and then revise Steps 2 and 3.**

Step 4: Comparative assessment of alternative technologies

a. Identify and briefly describe alternatives to the technology being assessed.

Alternative	Description
Option 1. *Gas fired rotary furnace and refining*	*Pre-treatment as for proposed technology intervention; battery scrap, lead metal scrap, waste scrap and flue dust are charged to a gas-fired rotary furnace; coke or coal, steel scrap and sodium carbonate added; slag produced will be reprocessed; gases and dusts will be passed through secondary after-burner and bag house filters; refining will involve dedrossing and addition of metals to produce lead alloys, and then casting of the ingots; integral hoods used to contain fugitive emissions.* *As a more environmentally friendly operation some companies are now adopting the use of calcium salts to replace the sodium saltsin order to produce a non leachable slag that can be disposed of in a landfill site or used as hardcore for roads.*
Option 2. *Gas fired blast furnace and refining*	*Process is essentially the same as Option 1, apart from substitution of a blast furnace for the rotary furnace. A blast furnace is a vertical furnace that consists of a refractory lined crucible with a vertical cylinder fixed to the top. Fluxing agents would be lime based to produce a hard non leachable disposable slag. The bast furnace would also use natural gas.*
Option 3. *Diesel fuelled reverbatory furnace and gas fired blast furnace in combination, and refining*	*Process is essentially the same as Option 2, but a reverbatory furnace would be used in combination with the blast furnace. A reverbatory furnace is a rectangular refractory lined furnace operated on a continuous basis. The roof of the furnace is designed to "reverberate" heat to the molten bath. The furnace produces alow antimonial lead bullion and a slag with high antimonial lead content and few other impuritiest; this slag would be smelted in the adjacent blast furnace. The reberbatory furnace will use diesel fuel; the blast furnace will use natural gas.*
Option 4. *Used lead acid batteries will be collected and exported.*	*Used lead acid batteries will be collected using both the formal and informal sectors; initially the batteries will be placed on pallets, wrapped and stored at provincial collection centres, before being transported to and stored at Port Udanax. The batteries will be shipped overseas, in containers. All new batteries used in Udanax would have to be imported, as at present.* *There may be export restrictions for the shipment of used batteries containing acid and the electrolyte may need to be drained prior to shipping. Shipments need to comply with the PIC procedure under the Basel Convention.*

b. Evaluate the degree to which each alternative satisfies the goals that must be achieved by the technology intervention (see Step 1d).

	Alternative Option 1			Alternative Option 2			Alternative Option 3			Alternative Option 4		
	Worse	Same	Better	Worse	Same	Better	Worse	Same	Better	Worse	Same	Better
Goal 1	☑	☐	☐	☑	☐	☐	☑	☐	☐	☑	☐	☐
Goal 2	☐	☑	☐	☐	☑	☐	☐	☑	☐	☑	☐	☐
Goal 3	☑	☐	☐	☑	☐	☐	☑	☐	☐	☑	☐	☐
Goal 4	☑	☐	☐	☑	☐	☐	☑	☐	☐	☑	☐	☐
Overall	☑	☐	☐	☑	☐	☐	☑	☐	☐	☑	☐	☐

c. **For each alternative technology, compare its potential impacts and economic viability, relative to the technology being assessed (see Worksheet B for additional guidance)**

Option 1: *Gas fired rotary furnace and refining*

Assessment Endpoints	Overall impact or viability of <u>assessed</u> technology (from Step 3) (U, B, N, S, M, H)	Overall Performance of Alternative Option 1				
		Much worse	Slightly worse	Similar	Slightly better	Much better
Health	**B, S**	☑	☐	☐	☐	☐
Local Env.	*U, S*	☐	☑	☐	☐	☐
Global Env.	*B, S*	☐	☐	☑	☐	☐
Resource Use	*S*	☐	☑	☐	☐	☐
Society	*B, S*	☐	☑	☐	☐	☐
Economics	*H*	☑	☐	☐	☐	☐

Option 2: *Diesel fuelled reverbatory furnace and gas fired blast furnace in combination, and refining*

Assessment Endpoints	Overall impact or viability of <u>assessed</u> technology (from Step 3) (U, B, N, S, M, H)	Overall Performance of Alternative Option 2				
		Much worse	Slightly worse	Similar	Slightly better	Much better
Health	**B, S**	☑	☐	☐	☐	☐
Local Env.	*U, S*	☐	☑	☐	☐	☐
Global Env.	*B, S*	☐	☐	☑	☐	☐
Resource Use	*S*	☐	☑	☐	☐	☐
Society	*B, S*	☐	☑	☐	☐	☐
Economics	*H*	☑	☐	☐	☐	☐

Option 3: *Diesel fuelled reverbatory furnace and gas fired blast furnace in combination, and refining*

Assessment Endpoints	Overall impact or viability of <u>assessed</u> technology (from Step 3) (U, B, N, S, M, H)	Overall Performance of Alternative Option 3				
		Much worse	Slightly worse	Similar	Slightly better	Much better
Health	**B, S**	☑	☐	☐	☐	☐
Local Env.	*U, S*	☐	☑	☐	☐	☐
Global Env.	*B, S*	☐	☐	☑	☐	☐
Resource Use	*S*	☐	☑	☐	☐	☐
Society	*B, S*	☐	☑	☐	☐	☐
Economics	*H*	☑	☐	☐	☐	☐

Option 4: *Used lead acid batteries will be collected and exported*

Assessment Endpoints	Overall impact or viability of <u>assessed</u> technology (from Step 3) (U, B, N, S, M, H)	Overall Performance of Alternative Option 4				
		Much worse	Slightly worse	Similar	Slightly better	Much better
Health	**B, S**	☑	☐	☐	☐	☐
Local Env.	*U, S*	☑	☐	☐	☐	☐
Global Env.	*B, S*	☐	☑	☐	☐	☐
Resource Use	*S*	☑	☐	☐	☐	☐
Society	*B, S*	☑	☐	☐	☐	☐
Economics	*H*	☑	☐	☐	☐	☐

d. Conclusions regarding alternative technology interventions

i) Elaborate the information gaps and uncertainties identified in Step 4c.

Option 1 – gaps and uncertainties:
Little information on likely impacts of technology on the local environment; environmental pressures dependent on level of pollution control; high uncertainty regarding compliance with strengthened environmental regulations that may be introduced; more certainty with economic performance due to greater experience with the technology.

Option 2 – gaps and uncertainties:
As for Option 1.

Option3 – gaps and uncertainties:
As for Option 1.

Option 4 – gaps and uncertainties:
Ongoing actions of individuals in the informal sector are unclear; considerable uncertainty as ability to export batteries requires both private sector participation plus compliance with international legal agreements; implications of ongoing need to import new batteries also unclear.

ii) Is any option a viable alternative?

- ☑ No - complete Step 5, considering only the proposed technology intervention
- ☐ Yes, and the present assessment is adequate - complete Step 5
- ☐ Yes, but need to complete Steps 1 to 4 for the option
- ☐ Too many uncertainties and information gaps - need to repeat Steps 1 to 4, as appropriate

Step 5. Decide if a consensus decision can be reached

a. Can a consensus be reached with respect to the performance of the preferred technology?

	Yes	No	
Have all major pressures on the environment been <u>identified</u>?	☑	☐	- revise Step 2 o
Have the major environmental impacts of these pressures been <u>identified</u>?	☑	☐	- revise Step 2 o
Have the overall effects of these environmental impacts been <u>evaluated</u>?	☑	☐	- revise Step 3 o
Has the overall economic viability of the technology been <u>assessed</u>?	☑	☐	- revise Step 4 o
Have all reasonable alternative technologies been <u>identified</u>?	☑	☐	- revise Step 4 o
Have all important aspects of the alternative technologies been <u>identified and evaluated</u>?	☑	☐	- revise Step 4 o

b. Provide overall summary of the significant information gaps, and uncertainties that remain.

Gaps and Uncertainties in Identification of Pressures:
- ♦ *little experience with proposed technology, so actual pressures it will exert are rather unclear;*
- ♦ *uncertain as to actions of individuals and groups in informal sector, in response to introduction of the proposed technology;*
- ♦ *large amount of gypsum produced – use/disposal options unclear;*
- ♦ *lack of information on what actions will be taken to reduce fugitive emissions, and what pressures will arise.*

Gaps and Uncertainties in Identification and Evaluation of Impacts:
- ♦ *impacts on environmental and human systems not well understood – especially impacts on the informal sector;*
- ♦ *indirect environmental and social impacts of plant during construction, operation and decommissioning not well known.*

Gaps and Uncertainties in Evaluation of Alternatives:
- ♦ *difficult to compare a relatively unproven technology with well established technologies;*
- ♦ *first three alternative options that could be used should be studied more carefully if any concerns regarding the proposed technology are identified during the EIA.*

Gaps and Uncertainties in Assessing the Economic Performance
- ♦ *relatively unproven nature of the technology makes economic evaluation very difficult – from construction, through operation to decommissioning.*
- ♦ *high uncertainty regarding possible changes in domestic regulations and international environmental agreements as well as in international lead prices..*

c. Summarize the suitability of the preferred technology and the level of certainty in the assessment

i) Describe the environmental impacts of principal concern.

- ♦ *impacts on social and local natural environmental systems during construction, operation and decommissioning – especially impacts that may arise during collection, storage, and transport of the batteries, and impacts on the informal sector as a result of setting up the plant;*
- ♦ *impacts of the various use/disposal options for the gypsum by-product;*
- ♦ *occupation health and safety impacts;*
- ♦ *impacts of 24 h operation of the plant, including nuisance and safety issues;*
- ♦ *contamination of land and surface and groundwater, including after the plant is decommissioned*

ii) Identify changes that could reduce these environmental impacts and improve the acceptability of the technology, including compliance with environmental and related requirements.

- ♦ *training of staff regarding occupational health and safety issues;*
- ♦ *improved consultations with opinion leaders in informal sector, and raising awareness of opportunities to be productively involved in the battery collection and reprocessing operations;*
- ♦ *development of an effective environmental management system, including impact monitoring and preparation and implementation of impact reduction and mitigation strategies;*
- ♦ *development of a comprehensive national strategy on sustainable management of lead.*

iii) Characterise the overall level of certainty in this assessment.

Many of the potential pressures and associated impacts on environmental and human systems have been identified and described. The remaining shortcomings are primarily related to three factors: i) the proposed technology is relatively unproven, and some of its impacts and economic limitations may not yet be apparent; ii) the interactions between the technology and the environment within which it will operate are not well understood in many instances, for example the impact of particulate matter on human health; and iii) the benefits arising from the removal of used batteries from the waste stream and the reduction in backyard smelting depend on responses in the informal sector and these are difficult to predict. *Despite these and other limitations the relative merits of the proposed technology are readily apparent. Assuming that the environmental and economic performances of the technology have been characterised in an accurate manner, the technology can be judged to be environmentally sound and economically viable. There is a high level of confidence that the full environmental assessment to be undertaken in response to regulatory required will confirm this finding.*

iv) Should a more comprehensive environmental assessment be conducted for the preferred technology?

Yes ☑ **No** ☐

v) Give reasons for this decision.

Given the cost of the technology intervention, there is a regulatory requirement to undertake an environmental impact assessment. The current appraisal has demonstrated that it is appropriate to commit resources to the more comprehensive assessment. It has also highlighted the issues which should receive detailed attention and indicated which alternative technology options should be given further consideration.

vi) Based on currently available information, is the anticipated performance of the technology acceptable?

The technology is highly **disruptive to the environment**	☐
The technology is moderately **disruptive to the environment**	☐
The technology is environmentally sound	☑
The technology is economically viable	☑

vii) Is there a viable alternative technology that, overall, has a similar or lower environmental impact?

Yes ☐ No ☑

If "**Yes**", describe the alternative(s).

Not applicable.

Summarize the consensus recommendations regarding the preferred technology and the identified alternatives.

Recommendations:

- *a comprehensive environmental technology assessment of the proposed technology intervention should be undertaken, with special attention being given to the pressures and impacts of major concern, to reducing the uncertainties that have been identified and to only those alternative technology options that appear capable of meeting the goals of the technology intervention with comparable or lesser environmental impact;*
- *every reasonable effort be made to gain further information on the technical, environmental and economic performances of the proposed technology, as this is the main source of the current uncertainty;*
- *encourage the regulatory authority to provide greater certainty as to the environmental and other standards and agreements with which the plant will have to comply;*
- *encourage the development of a comprehensive national strategy on environmentally sound and economically viable management of lead, based on stakeholder involvement; and*
- *all stakeholders to be informed as to the findings of the current assessment, and an invitation extended to them to comment on the assessment procedures and its findings.*

Results of the environmental technology assessment

The findings of the assessment team are presented below.

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The mission of the UNEP Division of Technology, Industry and Economics (UNEP DTIE) is to help decision-makers in government, local authorities, and industry develop and adopt policies and practices that:

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- make efficient use of natural resources;
- ensure adequate management of chemicals;
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- reduce pollution and risks for humans and the environment.

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ABOUT ILMC

The International Lead Management Center was founded in July 1996 and is based in Research Triangle Park, North Carolina, USA. The Center was established by the international lead industry in response to the need for coordinated international action on the issue of lead risk management.

ABOUT CDG

Carl Duisberg Gesellschaft e.V. in Cologne, Germany, is a non-profit organisation dedicated to international advanced training and human resource development. Their objectives are: promoting know-how transfer between North and South, East and West, international exchange of experience, initiating development processes and global cooperation.

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MRF
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