



UNEP IE

United Nations Environment Programme
Industry and Environment

Cleaner Production

A Training Resource Package



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UNEP

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**Industry and
Environment
Environmental
Training Unit**

Cleaner Production

A Training Resource Package

This package is one of a series that provides practical support material to teachers and trainers wishing to commence or enrich their curriculum with up-to-date approaches in environmental management.

It is based on extended experience with training workshops by UNEP and other agencies, and is now being made available for wider use in all regions throughout the world.

Acknowledgements

The first version of this training resource package was prepared in 1994 by F. Balkau and J.W. Scheijgrond for UNEP IE.

It was subsequently trialled in workshops and courses in several places, leading to subsequent revisions to produce this current document.

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Evaluation Form

Cleaner Production

As part of the continuing review of this trainers package, we would appreciate your cooperation in answering the following questions. Please return the completed evaluation form to:

UNEP IE, Tour Mirabeau, 39-43 quai André Citroën, 75739 Paris Cedex 15, France
Fax 33 (1) 44 37 14 74.

- 1 Do you have any suggestions for improvement of the trainers package? How could we improve its readability, contents, practical use, and so on?

- 2 How was the package useful in preparing your own training activity?

- 3 Did the background information and the transparency set in *Parts 3* and *4* provide you with enough information? What was missing?

continued ...

- 4 What resource information was useful to you? What else should be included?

- 5 What are your experiences with the exercises in Part 5? What worked, and what didn't?

- 6 Do you have training material which could be incorporated into this workbook?

- 7 What additional topics related to cleaner production would you want to be included in the final version of this workbook?

*Thank you for taking the time to complete this evaluation form. Please return the completed form to
UNEP IE, Tour Mirabeau, 39-43 quai André Citroën, 75739 Paris Cedex 15, France.*

Users Guide

This is a trainers support package, *not* a reference book. It does not give a systematic, comprehensive overview (there is not enough room to do this); rather, it focuses on some selected aspects that are central to the subject. The structure of the document allows further sections to be easily developed and added as additional modules.

The package is written for trainers to provide them with support material and ideas, rather than as a study book for students. The average trainee will only ever see a few pages or exercises reproduced from this document.

One of the purposes of this package is to provide some case studies and situation scenarios that can be used as a basis for interactive training and simulated decision-making. However, the exercises only explore a small part of the potential of the case studies, and trainers are strongly encouraged to develop further exercises or tasks.

The package is oriented at developing insights and decision-making skills. For teaching the factual knowledge base of the subject, trainers are referred to the reading lists in the bibliography.

Work exercises are predominantly based on interactive groupwork and a team approach to

problem-solving. Such work needs to be guided by a tutor who is a recognized expert in the field. This method allows the full complexity of real decision-making to be explored.

Where calculations are required, the exercises are more oriented towards throwing light on useful approaches or management decisions than simply finding the 'correct' answer. Trainers are strongly urged not to see this package merely as a set of arithmetic exercises.

In some instances, answers are indicated. The 'correct' answer depends on the context of the question. It is here that a tutor or external resource expert is useful.

Many trainers find this disturbing. They should remember that real decision-making depends on the wider circumstances surrounding the problem, and that a numerical answer which is politically or socially unacceptable, or administratively unworkable (even though accurate), is not in effect 'correct'.

The simulation of real life situations and decision-making that is the basis of this package makes it most suitable for senior students and trainees, and especially for professional training (or retraining) courses.

In order to extend the training material into a number of industrial situations, this package is supplemented by several sector-specific *workbooks*. These include typical calculation exercises, simulation of diagnostic reviews, and examination of cleaner production options. For many training applications, it is recommended to use this package *and* one or more of the workbooks for the tanning, brewing, textile and recycling sectors.

Finally, we must stress again that this package does not cover all aspects of the subject. Its prime purpose is to lead trainers into this field, and to help and encourage them to develop their own material, appropriately tailored to their specific learning situation. UNEP is prepared to work further with trainers who wish to extend this package into new directions, or go into greater depths on some subjects.

How to start a training activity based on this package

1 *Remember that this is a starters kit*, not a complete recipe book. Remember also that the workbook aims to develop insights and decision-making skills, not to convey knowledge or facts.

2 *Understand the needs of your trainees*. What insights or skills do you intend to develop? Define your learning objectives.

3 *Refresh your memory* by reading some of the background papers and studying the overhead transparencies. Write your own notes in the spaces provided.

4 *Identify some expert resource persons* who could be invited as tutors to help you in discussion sessions.

5 *Select some of the exercises* you wish to present to trainees.

6 *Examine carefully the case study or scenario* on which they are based. Be sure that you have at least one solution to the exercise that you can explain and defend.

7 *Develop other exercises or questions* yourself.

8 *Develop your own local case study* if you can, and use this instead of the one in the package.

9 *Prepare some background questions* and preliminary exercises for trainers to carry out before they start the workshop/course.

10 *In session, summarize the issues* for trainees using the overheads given, and others you may have. Discuss the problems and difficulties decision-makers face. Discuss where factual information can be found to help in decision-making.

11 *Commence the work sessions*, preferably in small groups, and preferably guided by

a tutor. Discuss and compare results. Be open to ideas and experiences from trainees, and discuss these.

12 *Return to the learning objectives*, and check that they have been achieved.

13 *Consider how to follow up* and reinforce the learning experience by establishing some ongoing projects, or periodic reunions.

To facilitate using this package, the header of odd-numbered pages describes the contents of that particular section. This information is also repeated in the footer of even-numbered pages. You can track your progress through the package by referring to the calibrations on the bar across the bottom of odd-numbered pages:



The shading shows your current position in the text.

Abbreviations and Glossary

Abbreviations

ICPIC	International Cleaner Production Information Clearinghouse
IE/PAC	Industry and Environment Programme and Activity Centre of UNEP
ILO	International Labour Organization of the United Nations
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
US EPA	United States Environmental Protection Agency
WHO	World Health Organization

Glossary

The following definitions are taken from inhouse documents and the UNIDO Training Course *Ecologically Sustainable Industrial Development*. They should not be regarded as official, legally binding definitions, but rather working definitions for the purpose of this package. It should be realized that the rapid evolution of environmental issues and management tools has sometimes led to conflicting or inconsistent use of terminology. Readers are advised to focus on the concepts implied in the definitions rather than engage in semantic and ultimately sterile debate on definitions.

Abatement See *end-of-pipe treatment*.

Audit (environmental) is a systematic, documented, periodic and objective evaluation of an environmental situation or organizational factor. There are now many types of 'environmental' audits, including sites or facilities, of regulatory compliance or management systems, or of technical aspects such as energy use or pollution releases. As the methodology has expanded, the terminology has gradually become less precise and varied. Environmental audit can thus be a specific or a general term, often with synonyms such as cleaner production assessment or environmental assessment.

Chemical assessment A chemical assessment is an analytical tool which determines the potential of a chemical to cause harm because of its inherent toxicity and/or ecotoxicity.

Cleaner production The continuous application of an integrated preventive environmental strategy to processes and products so as to reduce the risks to humans and the environment. In international and many national programmes, 'Cleaner Production' has gradually replaced earlier and more ambiguous terms such as *pollution prevention*, *waste minimization*, or *environmental assesment*.

Cleaner Production assessment A procedure for systematically evaluating a manufacturing or production process to identify options for improvement or change so as to reduce pollution releases and other environmental impacts.

Cleaner technologies Production processes or equipment with a low rate of waste production. Treatment or recycling plants are not classed as clean technologies.

- Cradle-to-grave** The life cycle of a product, from raw material extraction to final disposal.
- Disposal** Final placement or destruction of toxic, radioactive, or other wastes.
- Eco-auditing** A management tool comprising a systematic, documented, periodic and objective evaluation of how well environmental organization, management and equipment are performing. Sometimes the expression *environmental audit* is used instead of eco-audit.
- Eco-efficiency** Maximization of industrial output from a given level of resource input, thus ensuring cleaner production and appropriate use of human, renewable and non-renewable resources.
- Eco-labelling** The use of labels to inform consumers that a labelled product is environmentally more friendly relative to other products in the same category.
- End-of-pipe treatment** Treating pollutants at the end of a process – for example, by filters, catalysts and scrubbers – instead of preventing their occurrence.
- Energy audit** Identifies the costs and physical quantities of energy inputs used, the annual and seasonal trends in energy use and cost, and the energy use per unit of output.
- Environmental accounting** An attempt to devise balance sheets to measure economic activity in terms of the cost to the environment.
- Environmental auditing** See *eco-auditing*.
- Environmental impact assessment (EIA)** An evaluation of the effects of human development activities or no-action on the various components of environment, executed during the planning phase.
- Environmental management system** A management system aimed at facilitating improved environmental performance that involves a complete review of the environmental effects produced by a company, the production of an environmental policy designed to ameliorate the identified effects and procedures to achieve the aims and objectives of the policy.
- Environmental technology assessment** An assessment which analyzes the effects on the environment of a technology, specifically on human health, ecological systems and resources.
- Improvement assessment** The most important phase of the life cycle assessment. In this phase, the manufacturer can identify opportunities for improving the environmental performance of their product.
- Life cycle** The combination of processes needed by a product to fulfil the function specified by the functional unit. Life cycle stages include production, use and processing after disposal, including the processing of the waste generated in these stages.
- Life cycle analysis** An inventory of how much energy and raw materials are being used, and how much solid, liquid and gaseous waste is generated, at each stage of a product's life.
- Materials accounting** Any analytical technique aimed at identifying and quantifying the materials which enter and exit a given production process or facility.
- Payback period** A relatively simple profitability measure, which can be used to calculate the time a Cleaner Production project (or any other capital project) will take to pay for itself.
- Reclamation** The recovery of useful products from waste materials.
- Recovery** The extraction of material from waste that may be recycled or reused. Recovery may take place at the source of waste production or as a process during waste handling.
- Recycling** The retrieval of materials or products for reuse in their original form or for reprocessing into other products. Examples include recycling of aluminium cans or paper. Recycling may be within the plant or process, in which case it becomes part of the cleaner production approach, or outside the plant, in which case it is more properly a waste management activity.
- Reuse** Retrieval of materials or products for their original purpose within the same site.
- Risk audit** A risk audit identifies all areas of vulnerability and specific hazards at site and at plant level, and examines and assesses in detail the standards of all facets of a particular activity.
- Source reduction** is a part of the cleaner production approach. It involves prevention of the generation of waste at the process origin, rather than managing it once it has been produced.
- Waste** In the context of this package, waste is taken as a broad term to cover any non-

product discharge from a process. Thus, it describes discharges in the gaseous, liquid, and solid phases.

Waste audit A waste audit is a thorough account of the wastes from an industry, a plant, a process or a unit operation. A waste audit requires the derivation of a material balance for each scale of operation. The waste audit should result in the identification of wastes, their origin, quantity, and composition, and their

potential for reduction. Other frequently used terms for the waste audit, using more or less the same approach and objectives, are *Waste and Emission Audit*, *Waste and Emission Prevention Assessment*, and *Waste Minimization Audit*. A Cleaner Production assessment is an expanded form of waste audit that focuses more heavily on evaluation of remedial and preventative options, and a plan of action..



Part 1

Introduction

1.1 This package	1:4
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1 Introduction

Many teaching institutions and individual trainers have difficulty in following the rapid evolution of environmental issues that are relevant to their courses.

This is particularly true when teaching subjects such as pollution and environmental management. And yet it is important that new graduates have a good knowledge of issues in which they may eventually provide consulting services or policy advice to governments and industry.

The fact that development and environment are interrelated means that it is more vital than ever that:

- *all professionals have a basic environmental literacy that helps them to incorporate environmental priorities into their specialized work, whatever their profession;*
- *specialized environmental courses are relevant to today's environmental agenda.*

In 1993, in response to these findings, UNEP, WHO, and ILO jointly initiated the programme on Training Approaches for Environmental

Management in Industry. The programme aims to enhance the capacity of national institutions to offer local training on topics concerned with the prevention of industrial pollution.

In this context, trainers' packages have been prepared on different areas of environmental management. These packages are intended to help educators and trainers to develop their own workshops or curricula, or to integrate some of the ideas and information into already existing teaching programmes.

It is important to keep in mind that these training resource packages merely provide a first orientation to the topic.

In practice, the trainer will need to add his/her own material, expand certain parts or delete others, and develop their own exercises for students based on whatever course they are planning to give. Accordingly, the package is more a 'starters kit' than a particular curriculum.

In no way does the package constitute a 'course' in its own right.

1.1 This package

This package focuses on the situation of cleaner production. It assists individuals who wish to teach the techniques and ethos of *cleaner production* at educational institutions, but it is also applicable to training at government and company level.

Cleaner production is a big topic, and it is unrealistic to expect that all aspects can be covered directly. Accordingly, we have focused on the most important starting point in the cleaner production (CP) approach – that of *waste audits* and *emissions* and the selection and implementation of simple cleaner production options in a factory.

Other cleaner production tools will be discussed later.

The package is not static.

As feedback is received from users and technical specialists, the material will be modified and enriched.

Users are encouraged to report on their experiences in using the package, and to send in suggestions for improvements.

Associated with this trainers package are several sector-specific workbooks. These have a more in-depth coverage of certain industries, and include detailed calculation exercises on cleaner production options. Current workbooks include:

- Cleaner Production in Leather Tanning
- Cleaner Production in Breweries
- Cleaner Production in Textile Wet Processing
- Environmental and Technological Issues related to Lead-Acid Battery Recycling.

1.2 Contents of this package

This package is conceived principally to help trainers prepare a seminar, workshop, or extended course. It is not a course per se.

The package contains:

- suggestions and hints for *effective training*;
- a *short background* to the subject, drawn from other existing publications;
- *overhead transparencies* to introduce and illustrate the main ideas;
- *case studies* and situation reports and scenarios drawn from actual experience;
- supplementary *technical information* to support some work exercises;

- *work exercises* and questions;
- *appendices* with further information about UNEP and its programmes.

The package is not able to cover all aspects of the subject, nor has it been possible to go into great depth on most topics. The package is therefore more of a 'starter's kit' than an exhaustive manual. Trainers are encouraged to extend the package by adding their own case studies and exercises, and expanding the subject coverage into new topics. For example, trainers in environmental health may wish to add some modules on occupational safety and ecotoxicity by building on the chemical information already presented.



Part 2

Organizing Effective Training Activities

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2 Organizing Effective Training Activities

2.1 Introduction

Communication and organizational skills are just as important as a technical appreciation of the subject. Professional educators already understand this point, but teaching is a very individual matter, and interactive teaching can be very demanding on a busy person.

Here, we recall some of the key aspects of the learning process.

This text contains advice on:

- *how to ensure maximum effectiveness as a trainer*
- *how to organize effective training activities and presentations.*

We have provided this advice before consideration of the technical material, so that readers can remind themselves of the importance of the advice when choosing work exercises and training projects, later in this package.

Adults learn best when they are actively engaged. They remember 20% of what they *hear*, 40% of what they *see*, and 80% of what they *discover for themselves*.

Accordingly, this package relies on interactive teaching methods, using working exercises, case

studies, and groupwork problem-solving, rather than on lecture format.

Interactive techniques are more complex to organize than simple lecture-giving, but they give better results. In particular, interactive methods are more likely to provide students with practical skills. This is important where skill development rather than factual knowledge is the objective. Lectures are better at providing factual knowledge than at developing skills.

For example, a workshop format is very effective in providing training on the effective use of management tools such as *Environmental Impact Assessment* (EIA), or audits. For high level environmental management, both knowledge and skills are required, so the appropriate mixture of techniques should be used.

The notes in this Part are based on the experiences of UNEP IE and WHO in organizing workshops and other training sessions.

Personal advice on how to be an effective trainer is also given by several experienced trainers, who all use interactive training approaches.

2.2 Notes on interactive workshop organization

2.2.1 Workshops

Workshops provide a stimulating learning environment where people with a wide range of experiences and skills can join together to address practical problems beyond the ability of an individual to resolve.

Interactive workshops use a combination of several techniques to bring about a deeper and more pragmatic learning experience than is possible with a lecture-style format.

Workshops also provide excellent opportunities for exchanging personal experiences, problem-solving through panel sessions and direct consultations with experts, and discussing some of the complex situations which surround most environmental problems.

The UNEP/WHO workshop format incorporates the following elements:

- sending out pre-workshop reading material, with some simple exercises

- preparation of a country report by each participant before the workshop
- short introductory or overview lectures on key issues
- practical problem-solving work exercises on case studies
- feedback by experts and discussions on workshop exercises
- panel sessions (that is, question-answer dialogues) with experts
- individual study sessions, computer quizzes, and so on.
- structured oral presentations of country reports leading to a regional overview
- audiovisuals such as videos, films, and slides
- field visits where appropriate
- personal action planning by participants for follow-up activity.

2.2.2 Preparation

Sessions need to be carefully prepared, with participants knowing in advance what they will do or see. A proforma report form for country reports gives a common format to these sessions. Country reports should also try to link the issues with other sessions.

It cannot be overstressed how important it is that participants should be thoroughly prepared for the workshops, and that all the pre-workshop activities have been completed.

2.2.3 Organization

The organization of working group sessions also requires care. Groups should first meet informally, elect their own chairman, and then act as a permanent team in various workshop sessions. They are guided, but not instructed, by technical experts.

It is useful to finish the workshop by preparing personal action plans. Participants should develop and present their proposals for what they can initiate immediately on their return home. Such action includes:

- what they can achieve unassisted, *and*
- what else they could achieve if some assistance were available.

The role of resource experts as advisors is crucial. They should have sufficient experience to assist in all sessions and provide general advice on all subjects in workshops, discussion or panel sessions. They should not, however, dominate the workshops.

The five day format is ideal for covering all these requirements. If less than five days is taken, you can be sure that important issues will be left out. If more time is available, consider including social events and private study sessions, along with more extensive project work for the students.

2.3 Some ideas for more effective communication

If the training is to be successful, effective communication is essential – from recognition of the training need to the final evaluation of the event.

Without good communication, all manner of things can go wrong:

- the training is too early – or too late – to make any impact on performance
- trainees do not know what the training is about or what to expect
- the course is planned for a local public holiday

- trainees who are traditionally used to lectures are suddenly required to take part in discussion groups, which might feel alien to them.

Most of these issues can be anticipated and overcome by good communication between the course designers, writers, and event organizers and presenters on the one side, and the students and their organizations on the other.

Some simple communication considerations will help to improve outputs in training and avoid disasters.

Before the learning event

Find out:

- how the learners have been taught in the past
- the real needs and situation of the learners
- whether the facilities are adequate for the envisaged training
- whether the training has the support of senior people
- how success will be measured.

Make a project plan for the organizers, giving details of how the event will be organized. Send the plan to them, with details of the key dates and needs.

During the learning

- find out how relevant the topics are to the work situation of the participants
- start with the familiar oil can – not a video of an oil spill disaster
- communicate using topics, themes and issues in the local press
- store unanswered questions, and remember to answer them before the end
- keep notes for participants to bullet-point format
- ensure the participants keep notes for future reference – few read essays, or even articles
- if you are working in a foreign language, at least translate the slides.

After the learning event

- always communicate your thanks and best wishes
- inform participants on follow-up study procedures, and how the instructor can help to analyze the evaluations and inform the organizers of the results
- communicate to colleagues the results of the training and what can be learned from these results.

2.4 Some personal suggestions for effective training

The following suggestions come from four teachers with long experience in training. They are all different in character, and therefore in teaching approaches. However, they all believe in an enthusiasm for the subject which is critical when teaching students.

To be an effective educator/teacher:

- Provide an enjoyable learning situation that expands all of the participants' network.
- Model courses and teaching styles on examples that you think are outstanding. Ask yourself about the qualities of a good instructor or a good course, and follow the answers you come up with.
- Allow the subject matter to be discussed and discovered by students – not hammered in.
- Make courses relevant and interesting by understanding your audience. Ask them what they already know, and then plan for their needs. Incorporate ideas from the group in the course.
- Remember that no amount of style will substitute for a lack of substance.

Deborah Hanlon, Environmental Scientist
Office of Environmental Engineering
and Technology Demonstration, US EPA

The outstanding educator/teacher:

- Is fully acquainted with, and believes in, the educational merit of the subject matter.
- Utilizes clear and graphic illustrations to inform and motivate the students to learn.
- Utilizes learning approaches including multi-media, projects, interviews, questionnaires, debates, and similar interactive approaches to ensure full involvement of the students.
- Reacts positively to all questions – there are no Stupid Questions, only Stupid Answers.
- Remembers that positive reinforcement is a better motivational approach than criticism.
- Is available for private discussions with individual students or groups of students.

Don Hulsingh, Environmental Consultant and Professor at
Erasmus University in Rotterdam
the Netherlands

To be efficient ('doing things right'), and effective ('doing the right things'):

- Think about helping people to learn, rather than teaching them.
- Seek learner feedback, and measure learning achieved with objective tests.
- Set learning time limits.
- Seek conscious and unconscious learning.
- Seek learning that endures, based on understanding and skills.

Bob Boland, Environmental Consultant, France

The best educator/teacher:

- Likes the learners, and has a true understanding of how they learn.
- Has the ability to communicate.
- Will change the training programme and the approach if necessary.
- Is still learning, and has recent applied experience of the subject being taught.
- Has the ability to organise events and to manage things.

Colin Sutherland, Educational Consultant, France

2.5 Resource persons guide

As this package relies heavily on interactive groupwork sessions, here are some guidelines on how to be an effective resource person.

In a case study-based training approach, the resource person serves more as a:

- facilitator of the group learning process
- technical adviser as needed,

and a

- catalyst of learning

rather than a:

- lecturer
- story-teller

or

- instructor.

Here are some guidelines on how to be an effective resource person.

1 Be sure that you have *read and understood thoroughly* the participant's notes before you meet your group. There's nothing like being prepared and more familiar with the case study scenario than the participants are!

2 Before every group work session, take time to visit your assigned meeting room and check the:

- **seating arrangements** There should be a large enough table surrounded by enough chairs for the participants and yourself
- **equipment and supplies** such as flipcharts, flipchart papers, marker pens, white/black board, board eraser, masking tape, transparency sheets, writing pads, ballpen/pencils, calculator, etc.
- **physical conditions of the room** There should be sufficient lighting, the room temperature should be comfortable, noise should be as low as possible, etc.

3 During the initial group meeting, it is important to set an *informal and friendly atmosphere*. It is suggested that you:

- **introduce yourself**, preferably asking everyone to call you by your first name, and then let everybody introduce himself/herself in a similar manner. *Do not waste time stating positions*

and respective organizations, etc., which should have been done on the first day anyway.

- then ask if the *objectives and purpose* of the exercise, which have been previously discussed in the plenary session, are clear to them.

Sample objectives are:

- identify and understand the options that SMEs can employ in their pollution prevention program
- evaluate the feasibility and suitability of these options in view of technical, environmental, financial, organizational, and social criteria and constraints.

It will be useful to know whether the majority of the group members have actually read the text provided, which states the background and the problem.

If they have not, then you will need to direct them to focus their attention first on what needs to be accomplished by the end of each part.

4 If your group gets involved in diverse issues, try to steer them back on the right track by *asking relevant questions*, rather than telling them what to do.

5 Give *technical assistance and supplementary information* as needed,

without 'spoon-feeding' the participants. However, do not lecture or dominate the group discussion process.

6 Although you need not stay with your group for 100% of the time, it is expected that you:

- *spend at least 80% of the time* with them during regular sessions. The crucial times are at the *beginning*, *middle*, and near the *end* of each groupwork session.
- If they decide to work beyond the prescribed regular time, just make sure that they are on the right track; your presence during overtime is not mandatory, but voluntary.

7 There will be *critical parts* during the identification of options, followed by technical, environmental, and economic evaluation, where your technical advice will be most needed by your group.

The best way to assist the participants is by giving only the advantages and disadvantages of the options in question. Let them weigh these pros and cons and decide for themselves whether to take or drop the option.

8 If you encounter any question about the technical content of the material that you have not been briefed on, discuss it with the Team Leader and *agree on how to tackle the situation*. It may well be that the other resource

persons need to be duly advised on the particular question.

9 See to it that you *compare notes*, *exchange hints*, and *share strategies* with other resource persons so that you can assist one another, as well as gauge your group's progress in comparison with the others.

10 If tension or heated argument arises among your group members, try your best (with a sense of humor) to *defuse* it.

11 In the case of *absenteeism*, approach the person/persons in question and encourage them to participate.

12 If one or two group members are dominating the discussions or doing all the work, intervene and *encourage everyone to get involved*. In order to do this effectively, you need to be attuned to your group's 'culture' and trend of discussion.

13 Although division of labor is a time saving group work strategy, you must ensure that it is not done to the extent that there is no peer learning and discussion occurring. It is counter-productive for group members to work individually on these exercises.

14 The most productive, meaningful and fulfilling group work is when they get to accomplish what they have to do *as a team* – and have fun in the process!

2.6 Suggestions for self study

Although this package was designed to provide resources for trainers, the potential for self-study should not be ignored.

The package does not constitute a complete course on cleaner production in leather tanning, but can be seen as an introduction to be

supplemented by further reading and additional training materials listed in the Appendices, and perhaps by site visits and discussions with professionals.

The following approach is suggested for individual study.

- Read the *introduction*, but avoid any sections on organizing training events.
- Seek out the section containing *background papers* or *subject content*. Read through the whole section as narrative.
- Work through the pages offered to the trainer for *overhead projection*, and ensure you can relate the key points of each overhead to the text you have read.
- Look at the section on *exercises*. Identify those which lend themselves to individual work, and tackle them. Those exercises clearly constructed for teamwork, or requiring research, may not be appropriate.
- Refer back to the *narrative* text as and when you need to, to complete the exercises.
- Check your *answers* against those given in this resource pack. Where there are discrepancies, check through your own working to understand why the discrepancies appeared.
- Use the *Appendices* to plan your own further development.



Part 3

Technical Background Papers

3.1	Introduction	III:3
3.2	Key learning points.....	III:4
3.3	Background paper on Cleaner Production	III:5
3.4	A Primer on Cleaner Production Tools: assessments and audits.....	III:16
3.5	Transparencies.....	III:21

3 Technical Background Papers

3.1 Introduction

Cleaner Production is an approach to environment management that has many benefits for industry. It is most successfully implemented through a systematic life-cycle approach to production that considers:

- product design
- low-waste production technologies
- efficient use of energy and raw materials
- optimization of existing technologies and
- a high standard of operational safety.

The prevention philosophy of Cleaner Production is the antithesis of the earlier end-of-pipe treatment approach, in which pollution was cleaned up after it had already been generated.

The background papers in this Part explain in simple terms what Cleaner Production is, what it achieves, and how it can be applied. There is particular emphasis on aspects which can be incorporated into teaching programmes.

Due to limited space, we can only give an overview of the key points. The material in this document is sufficient as a basis for preparing a lecture on the general principles, but it is not sufficient to develop an extended curriculum, or to carry out projects or consulting work.

For further details and more general reading on the subject, you should refer to the references in **Part 4**, which also include a list of training materials available from various sources.

3.2 Key learning points

1 The Cleaner Production approach reduces pollutant generation at every stage of the production process in order to minimize or eliminate wastes that need to be treated at the end of the process.

2 The terms *pollution prevention*, *source reduction* and *waste minimization* are often used to mean Cleaner Production.

3 Cleaner Production can be achieved through:

- improved operation and good housekeeping
- process modification
- changes in plant and equipment
- raw or toxic material substitution and
- re-design and/or reformulation of products.

Effluent treatment, incineration, and even waste recycling outside the production process are not regarded as Cleaner Production, although they remain necessary activities to achieve low environmental impact.

4 The economic advantage of Cleaner Production is that it is more cost effective than pollution control. The systematic avoidance of waste and pollutants increases process efficiency and improves product quality. The costs of final

treatment and disposal are minimized through pollution prevention at the source.

5 The environmental advantage of Cleaner Production is that it solves the waste problem at its source. Conventional end-of-pipe treatment often only moves the pollutants from one environmental medium to another.

6 The slow acceptance of Cleaner Production is mostly due to human factors rather than technical factors.

- The end-of pipe approach is well known and accepted by industry and engineers.
- Existing government policies and regulations often favour end-of-pipe solutions.
- There is a lack of communication between those in charge of production processes and those who manage the wastes that are generated.
- Managers and workers who know that the factory is inefficient and wasteful are not rewarded for suggesting improvements.

7 Because Cleaner Production attacks the problem at several levels simultaneously, the introduction of a industry/plant level programme requires the commitment of top management and a systematic approach to waste reduction in all aspects of the production process.

Source: UNIDO/UNEP, LU 3, 1994

Table 3.1 Reasons why Cleaner Production is not adopted

		percent
Political (60%)	Bureaucratic resistance	20
	Human conservatism	10
	Uncoordinated legislation	10
	Media sensationalism	10
	Public ignorance/ misinformation	10
Financial (30%)	Disposal subsidies	10
	Scarce money	10
	Entrenched disposal industry	10
Technical (10%)	Lack of reliable centralized information	5
	Lack of assistance in applying waste minimization to individual needs	5
Total		100

Source: Don Huisingh (extract from US studies)

3.3 Background paper on Cleaner Production

3.3.1 Introduction

The production of goods and services without the concurrent production of residues and wastes has long been regarded as an ideal, but something that planners have not taken very seriously. The idea was regarded as uneconomic, and there was always enough empty space to dump unwanted materials.

With the passing of time, we have come to appreciate more fully the pressure that pollution puts on our natural resources and our health. Europe, for example, produces more than 2 000 million tonnes of solid waste each year. Twenty million tonnes of this waste is considered to be hazardous.

Traditional methods of dealing with such volumes of wastes have not always been successful, and the resulting contamination of water and land has led to pressure on industry to improve the situation.

For factory effluents and emissions, the situation is similar. The environmental impacts are increasingly regarded as unacceptable. The standards are tightening, and disposal costs are increasing. In order to escape this impasse, the authorities and industry are now more seriously trying to find a way of avoiding waste production altogether.

This re-examination is happening at a time when increased market competition is, in any case, causing companies to make improvements in production efficiency, and generally look for cost-cutting measures. Simple calculations of the market value of chemicals that have been flushed down the drain support the long-standing view of ecologists that emissions, effluents and other residues, in addition to being pollutants, are in fact a wasted resource.

Suddenly waste minimization, pollution prevention, and recycling are in all our day-to-day thoughts. In other words, we are at last thinking more seriously about producing without waste. We are thinking about *Cleaner Production*.

This change in attitude became very noticeable during the United Nations Conference on Environment and Development (UNCED) in 1992. In *Agenda 21*, UNCED gives high priority to the introduction of Cleaner Production methods and preventative and recycling technologies in order to achieve sustainable development. This priority is emphasized in *Chapters 20, 22 and 30 of Agenda 21*.

This paper outlines what UNEP understands by Cleaner Production, what is being done to promote it, and how the concept can be applied in practice.

3.3.2 What is Cleaner Production?

Cleaner Production is a general term that describes a preventative approach to industrial activity. It applies equally well to the service sector, transportation systems, and agriculture. It is neither a legal nor a scientific definition to be dissected, analyzed and subjected to pedantic disputes. It is a broad term that encompasses what some countries call waste minimization, waste avoidance, pollution prevention, and other similar names, but it is also includes something extra.

Cleaner Production refers to the mentality underlying the production of our goods and services with the minimum environmental impact under present technological and economic limits. It acknowledges that production cannot be perfectly clean. Practical reality ensures that there will be residues of some sort from many processes and obsolete products. However, we can – and must – strive to do better than in the past if our planet is to remain habitable.

Cleaner Production does not deny growth; it merely insists that growth is ecologically sustainable over a longer time span than economists have traditionally used.

It is also important that we have a clear view of what Cleaner Production is not. Some popular misconceptions – for example, that recycling and effluent treatment by themselves constitute Cleaner Production – have to be repeatedly refuted, since many vested interests try to repackage existing programmes under a new, popular title.

- For **production processes**, Cleaner Production includes the conservation of raw materials and energy, the elimination of toxic or dangerous materials, and reduction of emissions and wastes at the source.
- For **products**, the strategy focuses on reducing impacts through the entire life-cycle of the articles produced, from conception to use, to ultimate disposal.

The definition that has been adopted by UNEP is that:

"Cleaner Production is the continuous application of an integrated preventative environmental strategy to processes and products so as to reduce the risks to humans and the environment."

The main emphasis is clear. As well as prevention during the

manufacturing process, it is also important to take a life-cycle approach to the products themselves.

Cleaner Production involves applying know-how, improving technologies, and – above all – changing attitudes in many places.

3.3.3 Why Cleaner Production?

As well as achieving a lower level of pollution and environmental risk, Cleaner Production is also often a good business proposition. More efficient use of materials and process optimization results in less waste and lower operating costs. There is often an improvement in worker productivity, with less time lost through illness and accidents. For new processes, such benefits are usually built into the equipment, but even for older plant there is often an economic incentive to modify or change the existing process (see *Table*

3.2). Case studies in Europe confirm these findings. The *Landskrona* and *Prisma* projects in Sweden and the Netherlands respectively confirm the results achieved in the USA. Australia and Canada can also quote similar experiences.

Likewise, developing countries have positive experiences about the economics of this approach to environmental performance. Three case studies are shown below as an example. Further examples from all regions of the world can be found in the UNEP publication *Cleaner Production Worldwide*.

Table 3.2 Examples of Cleaner Production and payback periods in the United States

Industry	Method	Waste reduction	Payback period
Pharmaceutic production	Water-based solvent replaced organic solvent	100%	< 1 year
Equipment manufacture	Ultrafiltration	100% of solvent	2 years
Farm equipment manufacture	Proprietary process	80% of sludge	2.5 years
Automotive manufacture	Pneumatic cleaning process replaced caustic process	100% of sludge	2 years
Microelectronics	Vibratory cleaning replaced caustic process	100% of sludge	3 years
Organic chemicals production	Absorption, scrap condenser, conservation vent, floating roof	95% of cumene	1 month
Photographic film processing	Electrolytic recovery ion exchange	85% of developer; 95% of fixer, silver and solvent	< 1 year

Source: D. Huisingh 'Cleaner technologies through process modifications, materials substitutions and ecologically based ethical values' in *Industry and Environment* 12:1 [1989]

POLAND

FSM Sosnowiec manufactures car headlight reflectors, door locks and window winders. The lamp bodies are made of zinc aluminium alloy, and then copper-nickel-chromium plated. The door locks and window winders are made of steel and are zinc-plated.

The waste from the factory used to contain cyanide and the heavy metals chromium, copper, nickel and zinc. But then a new programme to reduce pollution and improve the working conditions of the factory was introduced.

New plating processes were introduced, waste from rinses was all but eliminated, and a recycling system was introduced, which allowed waste raw materials to be recovered and water reused.

This reduced the use of water and raw materials. Waste stream quantities were reduced as follows:

- chromic acid by 60%;
- copper by 95%;
- cyanide by 80%;
- nickel by 98%;
- zinc by 98%;
- wastewater by 93%.

Wastewater has been purified to the following levels:

- chromium to 0.1mg/l;
- copper to 0.1mg/l;
- nickel to 1.0mg/l; and
- cyanide to 2.0mg/l; and
- zinc to 0.9mg/l.

Capital investments in the programme was US \$36,000, resulting in total savings of US \$193,000 per year, with a payback period of two months.

INDONESIA

PT Semen Cibinong is a cement company near the Indonesian capital of Jakarta. It operates two cement kilns, each producing about 2 000 tonnes of cement per day.

The quality of the cement is determined largely by the firing temperature in the kiln. Too low a temperature, and the cement fails quality standards. Too high a temperature, and fuel is wasted, while production of nitrogen oxides (NO_x) and sulphur oxides (SO_x) also increases. Both these emissions are dangerous pollutants, the wasted fuel is an unnecessary expense and the low-quality cement is an unsalable product – in other words, an expensive waste of money.

The company introduced a sophisticated monitoring and control system to ensure optimum efficiency in the operation of the kiln, particularly in maintaining the right temperature. This system:

- reduced energy use by three percent;
- increased production capacity by nine percent;
- reduced below-standard cement production by 40 percent;
- produced cement more readily ground to powder, leading to further energy savings, and
- reduced emissions of NO_x and SO_x.

The US \$375,000 invested saved US \$350,000 per year in energy costs alone and, with the other benefits, paid for itself in less than a year.

INDIA

Century Textiles of India is the world's largest exporter of 100 percent cotton fabrics, and it employs 7,000 people. In 1991-92, its textile division had a turnover of US \$99.75 million.

Sulphur black is a fabric dye commonly used in India because it does not fade much from washing or sunlight, but the traditional dyeing process uses sodium sulphide and produces foul-smelling effluents containing 30 parts per million (ppm) of highly toxic sulphides. The State Pollution Control Board stipulated that the sulphides be reduced to 2 ppm.

By substituting hydrol, a cheap and non-toxic by-product of the maize starch industry, for most of the sodium sulphide, Century Textiles reduced its sulphide emissions to within the 2 ppm limit. The new system produced higher quality cloth, eliminated the need for new investment to meet the pollution standards and saved money using the cheaper hydrol.

Furthermore, hydrol produces less corrosion than sodium sulphide, meaning lower maintenance costs, and the smell of sulphide in the work place was eliminated.

Source: Our Planet 5.3 1993

3.3.4 Where is Cleaner Production applied?

Cleaner Production concepts are now gradually being incorporated into industrial operations. Nevertheless, many companies and countries have been slow to implement these concepts, which suggests that there are some obstacles to its implementation. These obstacles are, however, not absolute. Often, they tend to be more an excuse for delay than a legitimate barrier. Experience worldwide shows that the largest obstacle is human conservatism and motivation. Lack of awareness, lack of information on options, and lack of suitable new technologies can be contributing reasons. Occasionally, market constraints force a company to continue to operate an old process, or to manufacture a traditional product, even when newer, cleaner options are available.

Much is said and written about the importance of new technologies. In many instances,

technology does indeed make a major contribution to preventing pollution – but this is not the same as saying that, without new technology, nothing can be done. The US experience is that about half the pollution generated nationally could be avoided by improvements in operating practices and simple process changes.

The experience of national Cleaner Production programmes in Europe, Canada, USA, Australia – in fact, everywhere – shows that, in many cases, once manufacturers have been forced to make process changes in order to reduce pollution, they often have a more efficient and lower-cost production line. Why does industry wait for government to prompt cost reduction measures?

Clearly, there is still much to be done before the concepts of Cleaner Production are universally applied.

3.3.5 Who is responsible for Cleaner Production?

In recent years, environmental specialists have developed an impressive array of tools and skills which can help in the general implementation of Cleaner Production actions.

At the planning level, various techniques have become common in many countries. These techniques include:

- environmental impact assessment
- risk assessment and risk management
- environmental audits.

Care systems such as *Quality Care*, *Environmental Care*, *Responsible Care*, and *Total Quality Management* are also regarded as environmental management tools at the planning level. Among the more product- or process-specific skills are:

- waste auditing
- product life-cycle assessment and ecolabelling
- energy auditing
- chemical safety and
- product impact improvement.

Government personnel are increasingly using regulatory policy and standards, environmental monitoring, and economic incentives to influence industrial and consumer choice towards less polluting processes and products.

The danger in relying too much on regulatory policy and standards is that the environmental management tools are then used only to comply with regulations, not to improve performance. For instance, a certificate can be obtained when a company has implemented a quality care system according to ISO 9000 standards. The company often makes no further efforts to improve the existing quality care system, and obtaining the certificate becomes a goal in itself. When the quality care system is approached with a Cleaner Production mentality, continuous improvements are made, irrespective of any possible certificates which can be obtained along the way.

This striving for continuous improvement is characteristic of the Cleaner Production concept.

The environmental management tools which can be useful for the introduction of Cleaner

Production programmes are discussed in the primer on Cleaner Production in *Section 3.4*.

Although the environmental specialists have an important part to play, the prime responsibility for Cleaner Production does not rest with them. The main contributors are all those who are in some way involved with production, distribution or consumption of industrial products and services. Clients or suppliers need to be conscious of the implications of their decisions on products.

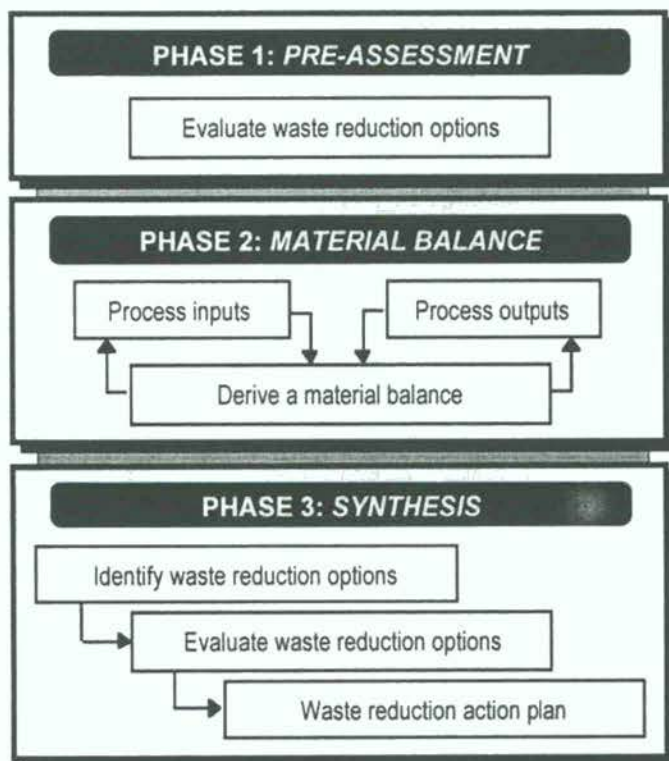
Plant operators can pay more attention to process optimization, housekeeping and safe chemicals handling. Managers need to give employees incentives to reduce waste.

In industry, many preventative actions can be taken by individuals during their normal day-to-day activities. Technical personnel can best implement the prevention concept if there is a clear policy framework, and if the assessment methodologies (for example, environmental performance criteria for industrial products) are available, and when information on environmental impacts and alternatives is known. Management must however take the initiative to enable and encourage the technical personnel to act. Accordingly, many key decisions that enable Cleaner Production are actually made at the level of corporate management, or during policy development in government.

3.3.6 Implementing Cleaner Production by industries

Figure 3.1 Waste audit procedure illustrates the process in brief. Fuller details are in *Section 5*.

Figure 3.1 Waste audit procedure



Source: UNEP/UNIDO

Auditing

The development of preventative actions can only occur when it is clear what the problem really is. Therefore, the first step is an inventory of waste that is generated in a plant. A useful diagnostic procedure has been developed by UNEP and UNIDO (*Figure 3.1*). This waste audit procedure is used to systematically identify areas of Cleaner Production so that options for potential preventative actions address the most important sources first.

Preventative options

Preventative options are identified in the synthesis phase of the audit, which is the key to successful remedial action. Accordingly, the discussion below will elaborate on the generation of options for reducing the wastes at their source. It should be noted that the same methodology is applicable for the generation of options for reducing risk, and reducing energy consumption.

Let us look at these actions in turn. A waste audit procedure is initiated after a conscious decision has been made by the management to take some action. The first phase is to form the audit team, discuss the programme with workers and supervisors (who will need to provide much of the data), and document the main processes to be studied (see *Figure 3.1*). It is important to pay attention to psychological aspects of the study, as workers will be reluctant to provide information if they believe they will be punished for process inefficiencies.

From the data provided by plant records and other information, the audit team prepares a **material balance** of chemicals, water and perhaps energy. When this material balance is of sufficient quality, it will be possible to determine where the main sources of waste are. While simple in concept, the necessary information for a good mass balance is often difficult to obtain. Many companies do not keep good records of chemicals or discharges.

The *synthesis* phase is where the material balance is studied, and appropriate measures are proposed to reduce or prevent loss of materials.

It is here that the audit team uses all means possible to identify Cleaner Production options. The ideas for options may come from:

- literature search
- personal knowledge

- discussions with suppliers
- examples in other companies
- specialized databases
- or
- further Research & Development.

As a creative intellectual environment based on the widest possible experience is often needed in order to think of all possibilities, brainstorming and group sessions are regularly used at this stage.

Depending on the circumstances, the above procedure can be further developed to a more sophisticated level. The three phases above may be extended to five or more phases, each with a larger number of steps within them. For example, the Dutch *Prisma* project uses such an expanded procedure when carrying out major plant assessments. The additional steps certainly assist in complex situations – however, the basic principles as described above are the same:

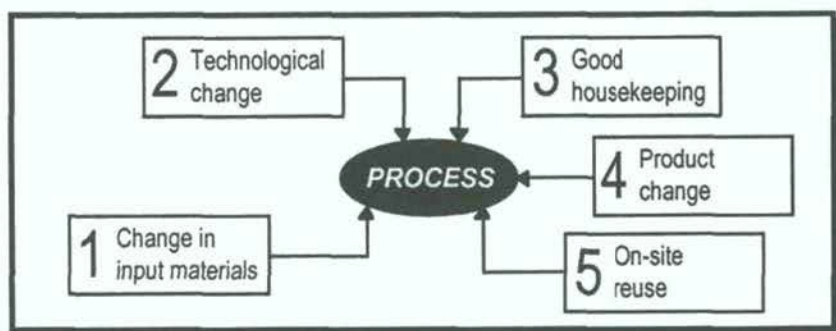
- a preparation stage
- a plant assessment stage
- and
- a synthesis stage, where options are generated.

As mentioned above, generating options is a creative process that relies more on inspiration than on logical deduction (although logic remains important). In many audits, brainstorming sessions have proven to be very effective for generating options. The brainstorming session is a combination of creativity and common sense. Before starting a brainstorming session, literature from other organisations and companies should be consulted, and a site inspection should take place so the generation of options will be more productive. One should, hereby, focus on all influences of the process that could lead to the generation of waste. Brainstorming sessions have proved to be most effective when managers, engineers, process operators and other employees, as well as some outside consultants, work together without hierarchical constraints.

It should be noted that, during the audit process, a number of obvious possibilities for immediate improvements may already have been identified (see *Figure 3.1*). In order to go further, it is often helpful to conceptually divide the process into several essential elements, as shown in *Figure 3.2*.

The option generating process then considers each element in turn.

Figure 3.2 Process elements for Cleaner Production options



Source: UNEP IE

1 Change in input materials

Input material changes accomplish Cleaner Production by reducing or eliminating the hazardous materials that enter the production process. Also, changes in input materials can be made to avoid the generation of hazardous wastes within the production processes.

Input material changes include:

- material purification
- material substitution.

2 Technological change

Technology changes are oriented toward process and equipment modifications to reduce waste, primarily in a production setting.

Technology changes can range from minor alterations that can be implemented in a matter of days at low cost, to the replacement of processes involving large capital costs.

These include the following:

- changes in the production process
- equipment, layout, or piping changes
- use of automation
- changes in process conditions
 - such as flow rates, temperatures, pressures, and residence times.

3 Good housekeeping

Good housekeeping implies procedural, administrative, or institutional measures that a company can use to minimize waste. Many of these measures are used in industry largely as efficiency improvements and good management practices. Good housekeeping practices can often be implemented with little cost. These practices can be implemented in all areas of the plant,

including production, maintenance operations, and in raw material and product storage.

Good operating practices include the following:

- Cleaner Production programmes
- management and personnel practices
- material handling and inventory practices
- loss prevention
- waste segregation
- cost accounting practices
- production scheduling.

Management and personnel practices include employee training, incentives and bonuses, and other programmes that encourage employees to conscientiously strive to reduce waste.

Material handling and inventory practices include programmes to reduce loss of input materials due to mishandling, expired shelf life of time-sensitive materials, and proper storage conditions.

Loss prevention minimizes wastes by avoiding leaks from equipment and spills.

Waste segregation practices reduce the volume of hazardous wastes by preventing the mixing of hazardous and nonhazardous wastes.

Cost accounting practices include programmes to allocate waste treatment and disposal costs directly to the department or groups that generate waste, rather than charging these costs to general company overhead accounts. In doing so, the departments or groups that generate the waste become more aware of the effects of their treatment and disposal practices, and have a financial incentive to minimise their waste.

By judicious scheduling of *batch production runs*, the frequency of equipment cleaning and the

resulting waste can be reduced. It is at this stage also that the energy efficiency of the process, and of the general plant operation, can be considered.

The UNEP IE publication *Climate Change and Energy Efficiency in Industry* discusses this topic in more detail (see *Part 4* for full references to this publication).

4 Product changes

Product changes are performed by the manufacturer of a product with the intent of reducing waste resulting from a product's use.

Product changes include:

- product substitution
- product conservation
- changes in product composition.

5 On-site reuse

Recycling via use and/or reuse involves the return of a waste material either to the originating process as a substitute for an input material, or to another process as an input material.

After the options have been generated, an initial selection should be made, considering:

- availability
- suitability
- environmental effects and
- economical feasibility.

This initial selection should take place before the Cleaner Production option is submitted to more thorough evaluation.

During the *feasibility phase*, the evaluation will result in a selection of options for implementation. Some examples of Cleaner Production techniques are given in *Figure 3.3*.

The *implementation phase* of the options has to be followed by monitoring of the changes, and – inherent to the concept of Cleaner Production – followed by a new audit, which will be used to identify new options for Cleaner Production.

This last step closes the chain of continuous improvement.

The procedure outlined above can be used in the same way across the world.

We should learn from the positive results that are now coming from those companies and countries that have acquired some experience with the Cleaner Production process. In order to facilitate this learning process, UNEP has built a global programme on Cleaner Production which shares the worldwide experience, and builds a network of expertise.

3.3.7 Introducing Cleaner Production by governments

While it is industry that ultimately must implement Cleaner Production, the role of government is to lead by providing an environment that will accelerate the process and encourage industry to initiate its own Cleaner Production programme.

The range of tools available trying to catalyze industry to adopt Cleaner Production is large, and different countries will select those combinations of tools they regard as most suited to their needs.

In the UNEP IE publication *Government Strategies and Policies for Cleaner Production*, the available tools are analyzed under four different categories:

- 1 applying regulations
- 2 using economic instruments
- 3 providing support measures
- 4 obtaining external assistance.

Figure 3.4 shows this analysis.

In industrialized countries, the first three of these tools have generally been applied in the order given in *Figure 3.4*. The last tool, obtaining external assistance, is specially relevant to developing countries and those undergoing economic transition. In other words, governments have first established regulations designed to limit emissions to the air, water, and onto the land. They have then introduced economic instruments that encourage the observance of these regulations and penalize their infringement. Finally, they have provided support for industries to enable the regulations to be more easily met. In the process, developed countries have acquired extensive and complicated regulatory systems.

Regulations have not been introduced on such a massive scale in developing countries, and it is not yet clear whether they will need to do so.

They certainly do not have to be in place before launching a Cleaner Production offensive. The implementation of Cleaner Production, with its goals of zero emissions and full recycling, does not necessarily depend on the existence of an extensive regulatory system. Developing countries may well find it more feasible to depend on raising awareness of the economic

benefits implicit in Cleaner Production. Coupled with suitable support measures and the use of external assistance, this will be enough to persuade many industrial leaders to adopt Cleaner Production procedures, with regulations and economic instruments playing a less important role than they have in the industrialized countries.

For further details, readers are referred to the UNEP IE publication *Government Strategies and Policies for Cleaner Production*, included in the Annex documents.

Figure 3.3 Examples of Cleaner Production techniques

Change in input material	
<i>Printing</i>	• Substitute water-based ink for solvent-based ink
<i>Textiles</i>	• Reduce phosphorus in wastewater by reducing use of phosphate-containing chemicals
	• Use ultraviolet light instead of biocides in cooling tower
<i>Electronic components</i>	• Replace water-based film-developing system with a dry system
Technological changes	
<i>Filtration and washing</i>	• Use countercurrent washing
	• Recycle spent washwater
<i>Parts cleaning</i>	• Use mechanical cleaning devices
	• Improve parts draining before and after cleaning
	• Use plastic-bead blasting
<i>Surface coating</i>	• Use electrostatic spray-coating system
	• Use powder coating systems
	• Use airless air-assisted spray guns
Good housekeeping	
	• Reduce raw material and product loss due to leaks, spills, drag-out, and off-specification process solution
	• Schedule production to reduce equipment cleaning - for example, formulate light to dark paints so the vats do not have to be cleaned out between batches
	• Develop employee training procedures on waste reduction
Product change	
<i>Batteries</i>	• Replace mercury in batteries
<i>Spray cans</i>	• Replace volatile chemicals with water soluble formulation as aerosol
<i>Refrigerators</i>	• Replace CFCs with Ammonia
On-site reuse	
<i>Printing</i>	• Use a vapour-recovery system to recover solvents
<i>Textiles</i>	• Use ultrafiltration system to recover dye stuffs from waste water
<i>Tape measures</i>	• Recover nickel-plating solution using an ion-exchange unit

Taken from H.M. Freeman Hazardous Waste Minimization

Figure 3.4 Differences in the use of policy instruments
in the European Union and the United States

	NL	DK	SP	UK	FR	BE	GE	PO	IT	Gr	EI	LU	USA
Legislation													
Approval scheme including cleaner technology	⊙	⊙	○	⊙	○	○	○	○	○	○	⊙	⊙	⊙
Voluntary agreements	⊙	⊙	○	○	○	○	⊙	○	○	○	○	⊙	⊙
Financial instruments													
Tax, duties and fees	⊙	⊙	○	○	⊙	⊙	⊙	○	○	○	○	○	⊙
Grants and subsidies	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	○	⊙	⊙
Information and education													
Demonstration projects, processes	⊙	⊙	○	⊙	○	⊙	⊙	○	○	○	○	○	⊙
Demonstration projects, products	⊙	⊙	○	○	○	⊙	⊙	○	○	○	○	○	○
Consultant support	⊙	⊙	⊙	⊙	⊙	⊙	○	○	⊙	○	⊙	○	⊙
Centres of expertise	⊙	○	○	⊙	○	⊙	⊙	○	⊙	○	⊙	○	⊙
Newsletters	⊙	⊙	○	⊙	○	⊙	○	○	○	○	⊙	○	⊙
General manuals	⊙	⊙	○	⊙	⊙	⊙	○	○	○	○	○	○	⊙
Industry-specific manuals	⊙	⊙	○	○	○	○	○	○	○	○	○	○	⊙
Databases	⊙	⊙	⊙	○	○	⊙	○	○	○	○	○	○	⊙
Videos	⊙	⊙	○	○	○	○	○	○	○	○	○	○	⊙
Conferences and seminars	⊙	⊙	○	⊙	⊙	⊙	○	○	○	○	⊙	○	⊙
Research and development programmes	⊙	⊙	○	⊙	⊙	⊙	⊙	○	⊙	⊙	⊙	○	⊙

⊙ yes ⊙ under preparation ○ no activities or no information

Commission of the European Union, DG XI *Waste Management: Cleaner Technologies*
Update on Situations in Member States, Brussels, June 1994, draft;

and J. Hirschhorn and K. Oldenburg, *Prosperity without Pollution*, Nostrand and Reinhold, New York, 1991

3.3.8 UNEP's Cleaner Production Programme

Within UNEP, the Industry and Environment Centre (UNEP IE: formerly IEO, the Industry and Environment Office) has been concerned with reducing the environmental impact of industrial activity since its establishment in 1975. In response to a 1989 decision of UNEP's Governing Council, the activities on low-waste technologies, Cleaner Production, residue management, and industrial policy were recast to emphasize more strongly the preventative aspect of industrial environmental management.

In keeping with UNEP's role as a catalytic, coordinating agency, the function of UNEP IE is to promote the adoption and implementation of the Cleaner Production concept by industries and

governments around the world. Subsequently the concept is applied, implemented and monitored in each country by national initiatives. **Figure 3.5** gives a list of different arenas in which Cleaner Production could be promoted, and how it could be done.

The objectives of the UNEP Cleaner Production Programme are:

- to increase worldwide awareness of the preventative environmental protection strategy embodied in the Cleaner Production concept
- to assist governments and industries to develop actual Cleaner Production programmes and activities that will result in the adoption of Cleaner Production know-how, technology and approaches.

These objectives are addressed through a series of programme activities such as:

- a computerized International Cleaner Production Information Clearinghouse (ICPIC)
- working groups in key industry sectors and management tools
- publication of technical guides and bulletins

- training and education activities, and technical assistance in key areas.

Activities are coordinated by the UNEP IE Centre in Paris. However, much of the field work is carried out by associated experts in various parts of the world.

Figure 3.5 Different arenas for the promotion of Cleaner Production

	Arenas	Topic
1	The company	Problem analysis and solution
	• employers • employees	• responsibility and internal control • prevention teams and organization • change in work routines • participation and influence
2	The network of the company	Reduction of 'aspect blindness'
	• consultants • suppliers • educational institutions • trade unions	• cleaner working procedures • cleaner process technologies • changes in design and construction • clean technologies • learn prevention strategies • new courses and further training • working conditions versus environment • 'cleaner' wage-bargaining system • diffusion of knowledge about prevention
3	The authorities	Dynamic regulation
	• municipality • county • state	• green wastewater plan • health and safety • environmental certification • trade agreements/action plans • initiate the innovation of clean technologies
4	The public	Enlightenment and democratic debate
	• citizen • media	• motivation to prevention • change of consumer behaviour • information and debate

Source: D. Huisingh

3.3.9 Summary

Cleaner Production of industrial goods and services is now essential if the concept of sustainable development is to become a reality.

In most cases, cleaner Production has an economic as well as an ecological advantage over traditional methods of environmental control. The major barrier to date remains human conservatism and motivation, but improved means of information dissemination and the adoption of lower-waste technologies and products also remain important contributors to Cleaner Production.

The Cleaner Production approach requires contributions from industrial production and

operational personnel and service sectors, as much as from environmental specialists. The target audience for a Cleaner Production programme is therefore very broad, and the programme must adapt its message and its advice according to the particular audience or event under consideration.

UNEP's Industry and Environment Centre – UNEP IE – is pursuing an active programme of information exchange, awareness raising and technical assistance designed to help developing countries in particular to implement Cleaner Production policies and activities.

3.4 A Primer on Cleaner Production Tools: assessments and audits

It was mentioned earlier that intervention on Cleaner Production can take place at many points in the life-cycle of a product or a process. Many different professions and functions can contribute, but each necessarily has different options for intervention. Each contributor also uses different tools to diagnose, assess and intervene. We have already seen how one of these tools, the waste audit, can be applied.

It is not possible here to give a comprehensive description of all the Cleaner Production tools that could be used. However, because assessments and audits are often central to effective decision-making, we give a brief summary of some of the key procedures that can assist those wanting to launch Cleaner Production initiatives.

It should be understood that some of these (such as life-cycle assessment) are still evolving, and readers are encouraged to keep up to date with developments in this field.

For the same reason, the definitions are neither formal nor definitive. We have merely attempted to give a practical working description of each tool to help readers understand how they may be applied.

The key procedures we shall examine are:

- *Environmental Impact Assessment (EIA)*
- *Life Cycle Assessment (LCA)*
- *Environmental Technology Assessment (ETA)*
- *Chemical Assessment* • *Environmental Audit*
- *Waste Audit* and
- *Energy Audit* • *Risk Audit.*

3.4.1 Environmental Impact Assessment

Environmental Impact Assessment (EIA) is a comprehensive evaluation of the effects of human development activities or non-action on the various components of environment, executed during the planning phase. It is most commonly applied to assess the impact of proposed major development projects.

Application

The objectives for applying EIA in developing countries are as follows:

- to identify adverse environmental problems that may be expected to occur
- to incorporate action appropriate mitigation measures into the development
- to identify the environmental benefits and disadvantages of the project, as well as its economic and environmental acceptability to the community
- to identify critical environmental problems which require further studies and/or monitoring
- to examine and select the optimal alternative from the relevant available options
- to involve the public in the decision-making process related to the environment
- to assist all parties involved in development and environmental affairs to understand their roles,

responsibilities, and overall relationships with one another.

An Environmental Impact Assessment is often applied to large scale projects and major plants. The preference resulting from the Environmental Impact Statement (EIS) must be the result of an explicit weighing of the pros and cons of all the alternatives.

Further reading

Environmental Impact Assessment: basic procedures for developing countries [1988]
Regional Office for Asia and the Pacific.

United Nations Environment Programme.

Environmental Impact Assessment: The Netherlands – fit for future life. Leidschendam, The Netherlands: Ministry of Housing, Physical Planning and Environment, Directorate General for Environmental Protection, Directorate for Administrative Affairs, Environmental Impact Assessment Section.

3.4.2 Life Cycle Assessment

Life Cycle Assessment (LCA) is a systematic inventory and comprehensive assessment of the environmental effects of two or more alternative activities. The assessment involves a defined space and time, including all steps and co-products in the activity's life cycle, from the cradle to the grave.

LCA does not *make* decisions – rather, it *helps* people to make a decision.

Application

Life-Cycle Assessment is a continuously developing tool that has various applications, but primarily aimed at products. It can be used to develop criteria for environmental labelling schemes, and can also point to environmental improvements by product (re)design or by choice of raw materials, suppliers, and processes or machines. In addition, it can point to those processes in the life cycle where a more in-depth waste audit would be of greatest importance.

In principle, a Life Cycle Assessment is composed of four components:

- 1 *Goal definition and scoping*
- 2 *Inventory analysis*
- 3 *Impact assessment*
- 4 *Improvement assessment.*

1 *Goal definition and scoping* consists of a screening process which will clearly define the problem and establish the objectives and goals of the assessment.

2 The *inventory analysis*, also known as the life cycle analysis, is an inventory of how much energy and raw materials are being used, and

the amount of wastes released into several media, at each stage of a product's life.

3 The *impact assessment* involves analyzing the overall impacts of the environmental loadings identified in the inventory analysis.

4 During the *improvement assessment*, the manufacturer can systematically evaluate the needs and opportunities to reduce the environmental load.

Further reading

LCA in Environmental Decision-Making.

This report is being prepared for UNEP IE, and will be available in 1994. Further information from UNEP IE.

The Use of Life Cycle Assessment in

Environmental Labeling [1993] Washington, USA: US EPA (EPA/742-R-93-003). United States Environmental Protection Agency, Office of Pollution Prevention and Toxics.

Environmental Assessment of Products: a course on life cycle assessment [1993] B. Pedersen.

TEK, Finland: UETP-EEE (The Finnish Association of Graduate Engineers).

3.4.3 Environmental Technology Assessment

An **Environmental Technology Assessment** analyses the effects on the environment of a technology, specifically on human health, ecological systems and resources.

Application

The Environmental Technology Assessment is part of a Technology Assessment. It is an analytical tool used to help understand the likely impact of the use of a new technology by an industry, region, country or society.

An Environmental Technology Assessment includes:

- strategic environmental assessments, which examine the environmental implications of

policies, plans and programmes that affect technology development and use

- environmental impact assessments of specific facilities or projects
- environmental testing of the effluents or environmental releases of particular technologies
- environmental risk assessments, which express risks to human health or ecological systems by quantitative or qualitative methods
- product life cycle analyses, which evaluate the environmental impacts of a product from raw

material acquisition, through use, to ultimate disposal.

Further reading

Report of the workshop on the transfer and development of environmentally sound

technologies (ESTs) [1993] United Nations Conference on Trade and Development (UNCTAD), Palais des Nations, 1211 Geneva 10, Switzerland.

3.4.4 Chemical Assessment

A **chemical assessment** determines the potential of a chemical to cause harm because of its inherent toxicity and/or ecotoxicity.

Application

The chemical assessment makes use of information sources which give an overview of the possible inherently toxic effects of a chemical. Information from Material Safety Data Sheets (MSDS) and the International Programme on Chemical Safety (IPCS), for example, serve as the basis to evaluate and assess the hazards a chemical imposes on human health and the quality of the environment. As a result, the preference of the use of one chemical over the

other can be chosen. The Chemical Assessment is often part of a risk audit.

Further reading

The Environmental Health Criteria Series.

International Programme on Chemical Safety (IPCS). Published under joint sponsorship of UNEP, ILO, and WHO.

Managing Chemicals in the 1980s [1983] OECD, Paris.

Compendium of Environmental Exposure Assessment Methods for Chemicals [1989] OECD Environment Monographs 27. OECD.

3.4.5 Environmental Audit

Environmental auditing is a management tool comprising a systematic, documented, periodic and objective evaluation of how well environmental organization, management and equipment are performing. Sometimes, the expression **eco-audit** is used instead of environmental audit.

Application

Environmental audits should be seen as an element in a comprehensive approach to environmental management.

An environmental audit helps to safeguard the environment, by assisting with and substantiating compliance with local, regional, and national laws and regulations, and with company policy and standards. It also reduces exposure to litigation and regulatory risk (for example, penalties and additional regulations). The process ensures an independent verification, identifies

matters needing attention, and provides timely warning to management of potential problems.

The term **environmental audit** is sometimes used in a wider sense, to refer to any assessment activity which could be part of an environmental management system.

Further reading

Environmental Auditing [1990] Technical Report No. 2. Paris, France: UNEP IEO.

ICC Guide to Effective Environmental Auditing [1991] International Chamber of Commerce (ICC). Publication 483. Paris, France: ICC Publishing S.A. ISBN 92-842-1115-8.

3.4.6 Waste Audit

A **waste audit** is a thorough account of the wastes from an industry, a plant, a process or a unit operation. A waste audit requires the derivation of a material balance for each scale of operation. The waste audit should result in the identification of wastes, their origin, quantity, composition and their potential for reduction.

Other frequently used terms, using more or less the same approach and objectives, are *Waste and Emission Audit*, *Waste and Emission Prevention Assessment*, and *Waste Minimization Audit*.

Application

A good waste audit:

- defines the sources, quantities and types of waste being generated
- collects information on unit operations, raw materials, products, water usage, and wastes
- highlights process inefficiencies and areas of poor management
- helps to set targets for Cleaner Production
- permits the development of cost-effective waste management strategies
- raises awareness in the workforce regarding benefits of Cleaner Production

- increases knowledge of the process
- helps to improve process efficiencies.

Further reading

Audit and Reduction Manual for Industrial Emissions and Wastes [1991] Technical Report No. 7, UNEP IE/UNIDO, Paris, France.

Assessment of Sources of Air, Water and Land Pollution: a guide to rapid source inventory techniques and their use in formulating environmental control strategies [1993] Geneva, Switzerland: World Health Organisation.

3.4.7 Energy Audit

An **energy audit** identifies the costs and physical quantities of energy inputs used, the annual and seasonal trends in energy use and cost, and the energy use per unit of output.

Application

The energy audit should be part of an energy management programme, aimed at reducing the overall cost of energy use per unit of output. An energy audit must be conducted in line with management policy, developed as part of the energy management programme. A good energy audit:

- defines the sources, quantities, and costs of energy being used
- collects information on energy usage per unit operation
- highlights process inefficiencies and areas of poor management
- helps to set targets for energy saving
- permits the development of cost-effective energy strategies
- raises awareness in the workforce regarding costs of energy consumption.

As a result of the audit, a plan of action is formulated and implemented, followed by evaluation and continuous improvement of the energy management program. The Energy management programme follows the same lines as the procedure for a waste audit procedure as described in *Part III.3*.

Further reading

Climate Change and Energy Efficiency in Industry [1991] A joint UNEP IE-IPIECA publication, Paris, France.

The Energy Audit. Advisory Booklet 3 [1983] National Energy Conservation Programme. Canberra: Australian Government Publishing Service.

Energy Audits for Industry [1993] Oxon, UK: Energy Efficiency Enquiries Bureau, Energy Technology Support Unit (ETSU).

3.4.8 Risk Audit

A risk audit identifies all areas of vulnerability and specific hazards at site and plant level, and examines and assesses, in detail, the standards of all facets of a particular activity.

Application

The risk audit is a tool within a risk management program. The audit is conducted systematically, and has five main elements:

- identification of possible materials loss producing situations
- assessment of potential losses associated with these risks
- selection of measures to minimize materials losses
- implementation of these measures within the organization
- monitoring of the changes effected.

As a result of the audit, a plan of action is formulated and implemented, followed by evaluation and continuous improvement of the risk management program.

The risk management programme follows the same lines as the procedure for a waste audit procedure as described in *Part III.3*.

Further reading

Hazard Identification and Evaluation in a Local Community [1992] UNEP IE Technical Report No. 12. UNEP IE/PAC.

Loss Prevention in the Process Industries [1991] P. Lees. Essex, UK: Butterworth-Heinemann.

Methodologies for Risk and Safety Assessment in Chemical Process Industries: A Manual [1990] Dr K.V. Raghaven & Dr A.A. Khan. London, Great Britain: Commonwealth Science Council, The Commonwealth Secretariat.

3.5 Transparencies

This set of transparencies is designed to introduce an audience to Cleaner Production, and to explain how the waste audit procedure works. They are taken from a much bigger package of transparencies, available from UNEP IE in Paris. The transparencies are best used in the order presented. Every transparency is provided with a note to the trainer, explaining in what context the transparency should be used.

Sustainable Development is ...

**“Development that
meets the needs of the
present generation
without compromising
the ability of future
generations to meet
their own needs”**

Our Common Future
World Commission on Environment and Development [1987]

There are many different definitions of sustainable development. This one is used by the United Nations.

- Another definition which has become common is, *“Improving the quality of human life while living within the carrying capacity of supporting ecosystems”* (IUCN/UNEP/WWF 1991).
- *Agenda 21* is a guidebook showing the road to sustainable development.
- Cleaner Production is recognized as an important approach to reducing environmental impact on the world, and leading industrial developments in the direction of sustainable development.

Cleaner Production means ...

“The continuous application of an integrated preventive environmental strategy to processes and products so as to reduce risks to humans and the environment”

This definition of Cleaner Production is used by UNEP IE. It is based on the assumption that there is no such thing as clean production. Every production process results in some form of pollution. The Cleaner Production approach tries to continuously reduce the generation of pollution, at every stage of the life cycle.

There are also different definitions being used by other organizations.

Don't mistake Cleaner Production for *Waste Minimization*, *Pollution Prevention* and so on.

Cleaner Production puts a heavy emphasis on attitude change!

For *processes*, this means ...

- *conserving* raw materials and energy
- *eliminating* the use of toxic raw materials
- *reducing* the quantity and toxicity of all emissions and wastes before they leave a process

For *products*, this means ...

- *reducing* impacts along the entire life cycle, from raw material extraction to disposal.

This transparency explains in more detail what Cleaner Production means.

Cleaner Production lowers the *risks* to:

- the *workers*
- the *community*
- *consumers* of
products
- *future generations*

This transparency, together with the two which follow, explains the benefits of Cleaner Production. These arguments are important to overcoming the barriers to convincing people to adopt Cleaner Production practices.

**Cleaner Production
lowers the *costs* of:**

- **production**
- **end-of-pipe
treatment**
- **health care**
- **cleaning up the
environment**

Demonstrating how Cleaner Production is cost effective, and can even reduce costs, is a powerful argument!

Cleaner Production *improves:*

- **process efficiency**
- **product quality**

**Even when investment costs
are *high*, the payback
period can be *low*.**

**There is *no* payback period on
end-of-pipe investments.**

The cost argument can be supported by the efficiency and product quality argument. Cleaner Production makes economic sense.

*Many clients are
under the
misconception that an
environmentally
sound project
will always cost more!*

*They need to be informed
that, in many cases,
the opposite is true.*

Source: Fidic 1992

The Cleaner Production approach often leads to the implementation of cost-effective measures. Indeed, many people do not understand that:

- by saving raw materials
- by being more energy efficient
- and
- by discharging less waste

— you can also save a lot of money.

Some important statistics ...

Over

50%

of *waste*

can be avoided by
*simple management
measures and minor
process changes*

Over

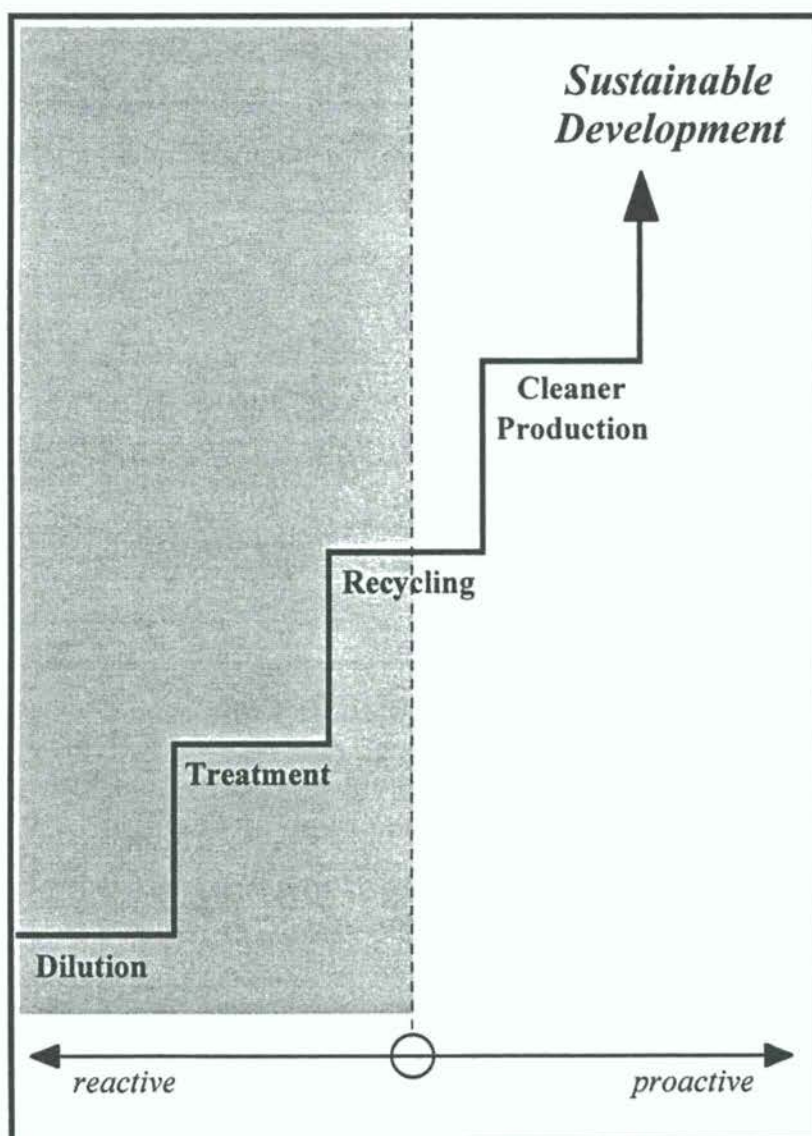
65%

of the *barriers*

to cleaner production
involve
*human motivation
and attitudes!*

See also *Table 1* in Part III.

The majority of the barriers have nothing to do with economics or cost effectiveness.



This hierarchy shows the different approaches to environmental problems which have been adopted for national strategies over the last 30 years. Cleaner Production indicates a preventive approach, which is a requirement for sustainable development.

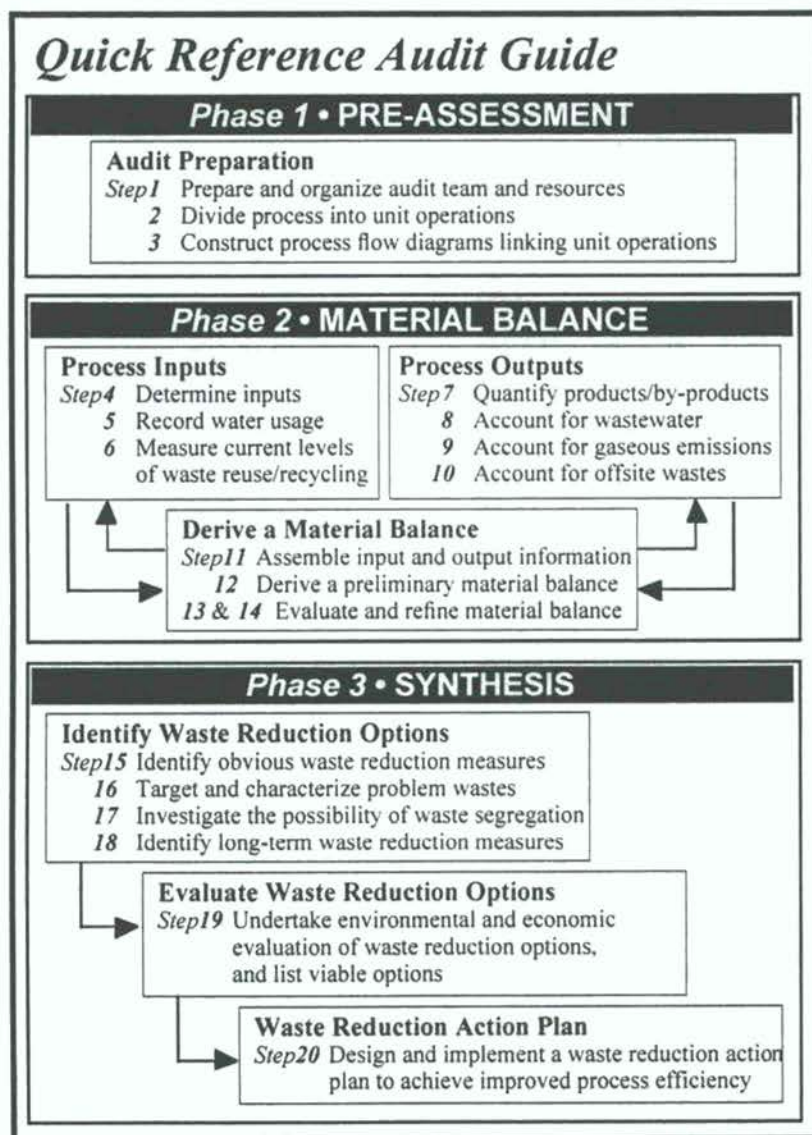
Recycling can be reactive or proactive. Under the definitions of Cleaner Production, only *on-site* recycling is seen as proactive.

What is a Waste Audit?

A Waste Audit is ...

- an *analytical tool* designed to assure industrial managers that their organization is operating in an environmentally safe and economically efficient manner
- used to *document* the types and quantities of wastes generated by the firm
- a *systematic approach* to the identification and evaluation of various Cleaner Production options

The waste audit is a systematic approach to Cleaner Production. This assessment follows a specially developed procedure which is discussed in detail in the following transparencies. For more details of how the procedure works, refer to *Part III* or to the UNEP/UNIDO Technical Report No. 7 *Audit and Reduction Manual for Industrial Emissions and Wastes*.



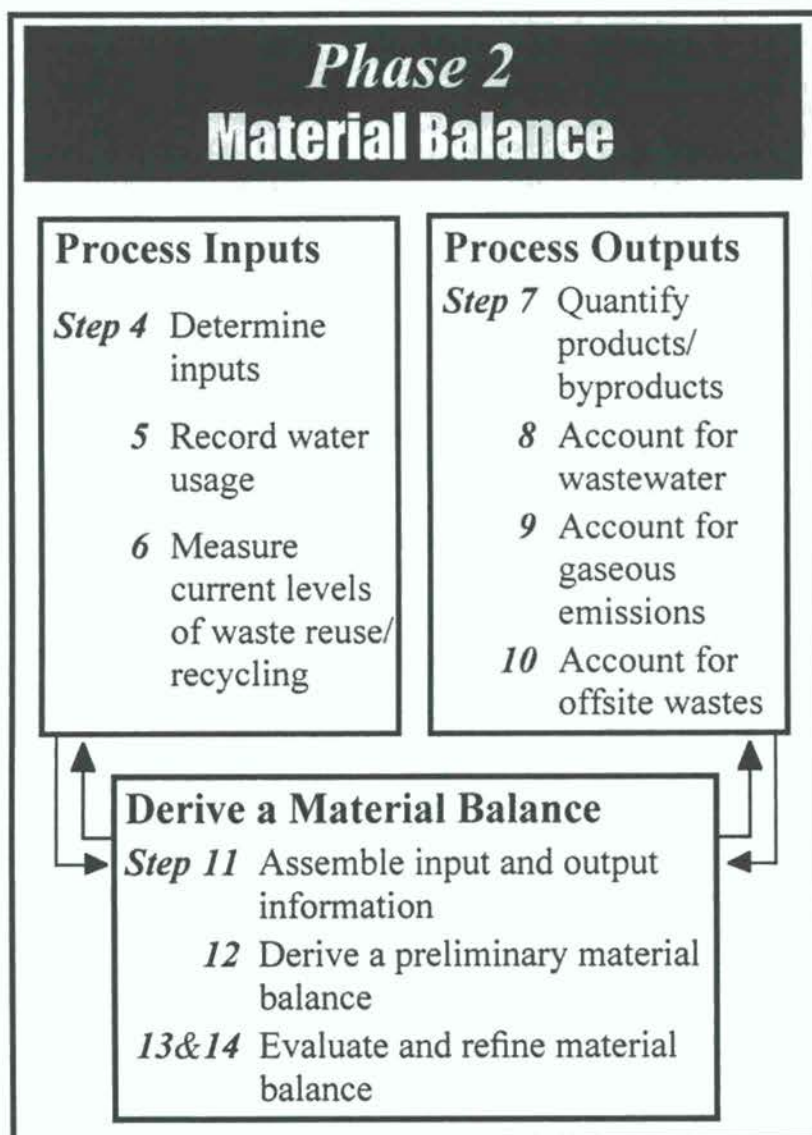
The waste audit, whose outlines are shown here, is discussed in more detail in the technical background paper and in the UNEP/UNIDO technical report *Audit and Reduction Manual for Industrial Emissions and Wastes*. There are several procedures developed for waste audits (sometimes called Waste and Emission Prevention Assessment, Source Reduction Audit, Waste Minimization Audit, or Cleaner Production Assessment). The UNEP IE publication *Government Strategies and Policies for Cleaner Production* discusses some of the alternative waste procedures.

Phase 1 **Pre-Assessment**

Audit Preparation

- Step* 1 Prepare and organize audit team and resources
- 2 Divide process into unit operations
- 3 Construct process flow diagrams linking unit operations

See background paper on Cleaner Production, *Section 3.3*.



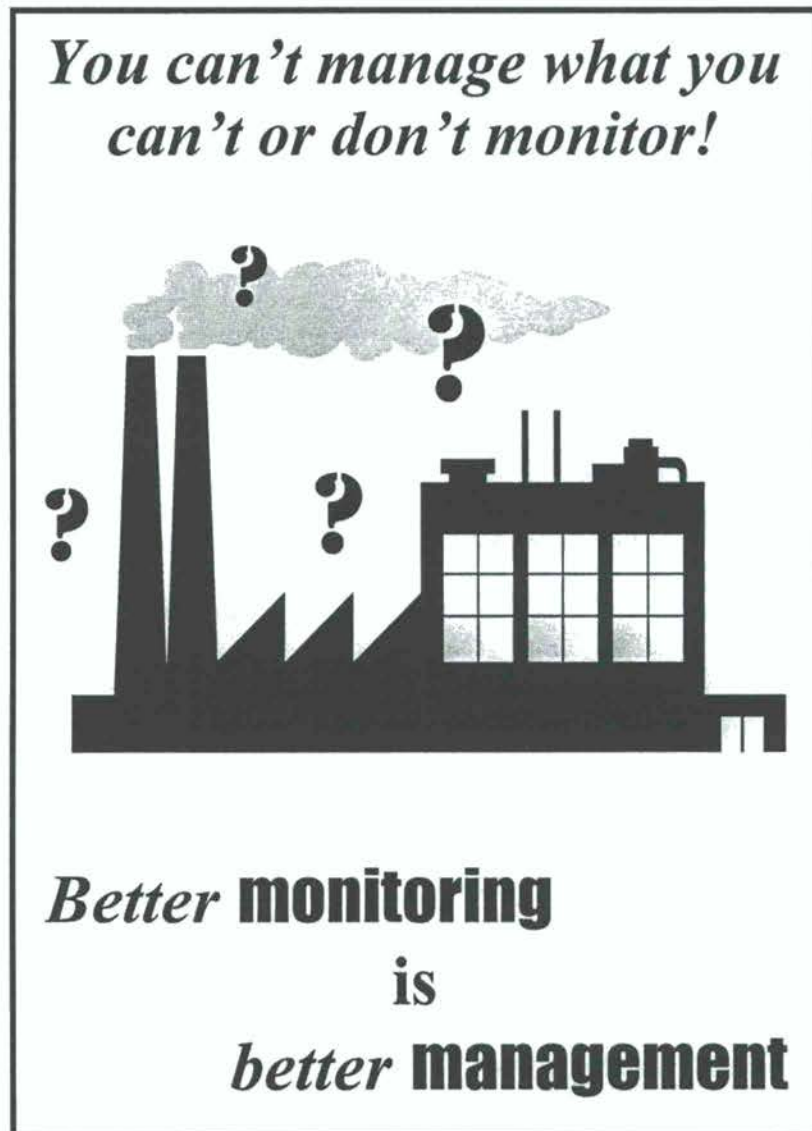
See background paper on Cleaner Production, *Section 3.3*.

Ten Barriers to Creativity

Fear of ...

- 1 making mistakes
- 2 being seen as a fool
- 3 being criticized
- 4 being misused
- 5 being alone
- 6 disturbing tradition
and making changes
- 7 being associated with
taboos
- 8 losing the security of
habit
- 9 losing the group's love
- 10 being an *individual*

These barriers have been found to be real, and therefore they deserve serious attention. When creativity is blocked, the Cleaner Production programme might cease to exist, or may even not see the light of existence at all. Creativity is especially crucial when options for Cleaner Production have to be generated.



The second phase of the waste audit consists of making a material balance of the processes/site operation, depending on the scope of the audit. Monitoring is also necessary to gain evidence for the success of the Cleaner Production programme, and thus the continuous improvement of the environmental performance of the company.

Company Data for a Waste Audit

General Information

- Company environmental policy documents
- Standard procedures
- Organization charts

Raw Materials/Product Information

- Product composition and batch sheets
- Overviews of raw materials and input material applications (including energy)
- Fact sheets on product safety aspects
- Product and raw material inventory records
- Operator data logs
- Operating procedures
- Production schedules

This transparency, together with the two which follow, gives a checklist of the information you need when preparing the assessment of waste streams. Depending on your audience, it may be interesting to go into more detail about these sources of information.

Company Data for a Waste Audit *continued ...*

Process Information

- Production process flow diagrams
- Materials and heat balances (both in theory and in practice) for:
 - production processes
 - waste treatment processes
- Manuals and descriptions of the production process
- Installation overviews
- Specifications of installation and data sheets
- Diagrams of pipes and instruments
- Site and buildings drawings
- Installation layout and logistics

See previous transparency for comment.

Company Data for a Waste Audit *continued ...***Environmental Data**

- Emission records
- Analyses of waste materials
- Environmental audit reports
- Licences and/or licence applications

Financial Data

- The cost of waste treatment, waste removal, and effluent costs
- Product, utility and raw material costs/cost price composition of products
- Operating and maintenance costs
- Financial reports

See previous transparency for comment.

Searching for Cleaner Production Options

1 Brainstorming Session

- New ideas and insights emerge
- Cleaner Production techniques emerge as points of action
- Knowledge of products, processes, and how the processes are carried out
- Combination of creativity and common sense

2 Consult organizations

3 Scrutinize recent specialist literature

The information sources mentioned in the previous transparencies play an important role in the brainstorming session. Brainstorming has proven to be the most effective tool for generating Cleaner Production options for the selected assessment targets. The consultant organizations can play a role when the brainstorming session doesn't produce ideas, or when the solutions have to be evaluated by an outside expert. As a result of the brainstorming session, specialist literature and other information sources may need to be scrutinized again.

The logo for ICPIC features the text "ICPIC has ..." in a bold, sans-serif font. Below the text is a large, empty rectangular box, likely intended for a graphic or image.

ICPIC has ...

- over 300 cleaner technology and programme case studies
- a bibliography of over 600 pertinent publications
- a directory of international contact points

The International Cleaner Production Information Clearinghouse

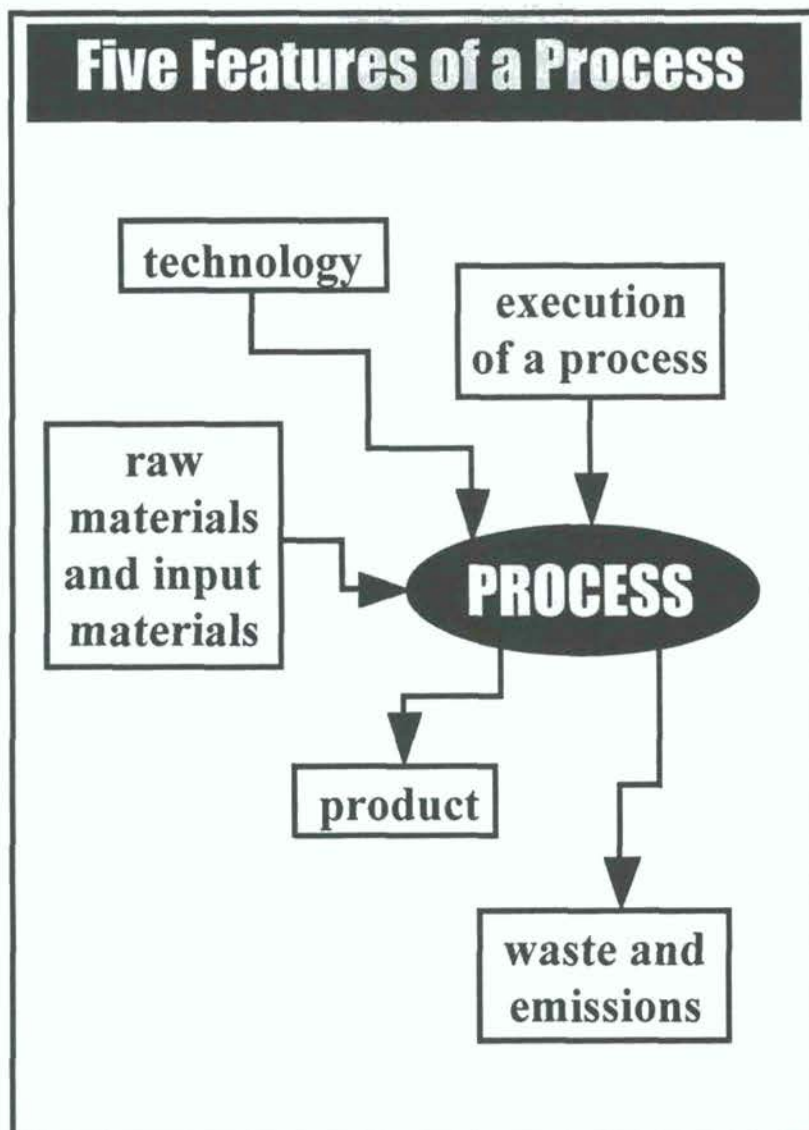
The International Cleaner Production Information Clearinghouse (ICPIC) consists of:

- diskette of CP database
- Internet link
- direct query service
- publications available for distribution.

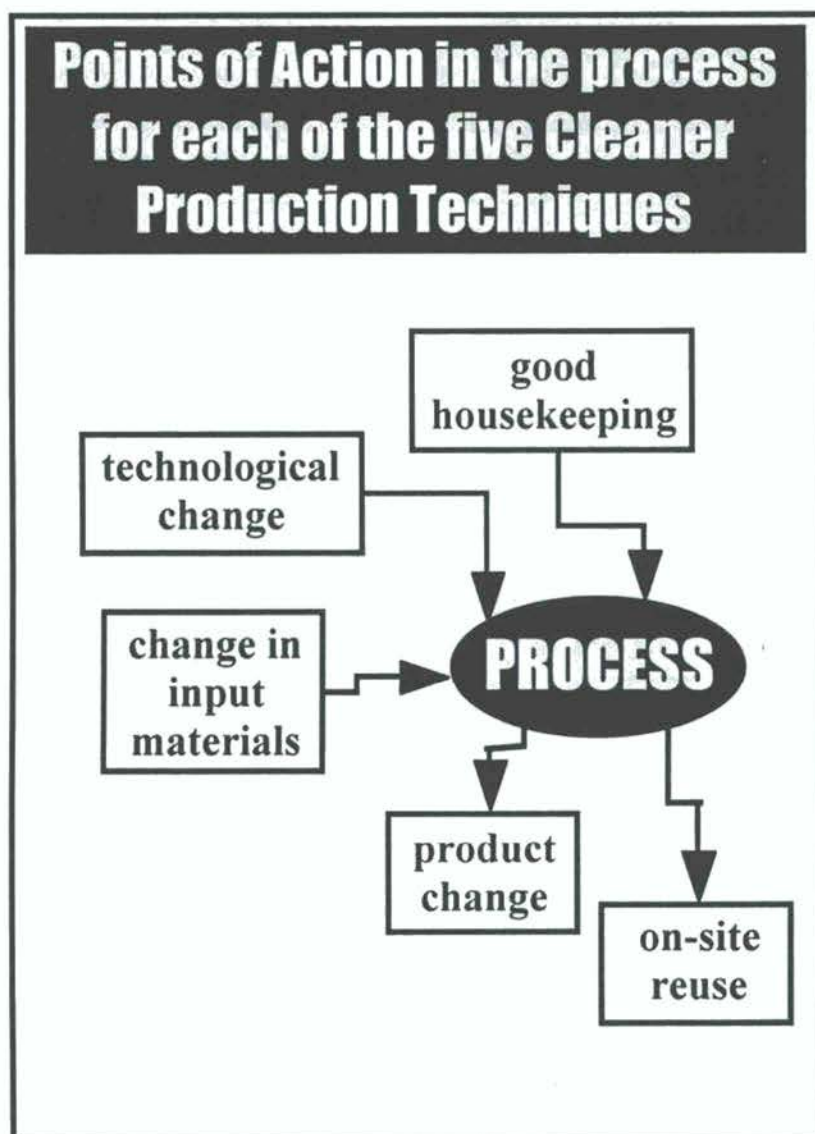
***Use of technical literature and
personal contacts
for generating options***

- **Trade and Business Associations**
- **Plant Engineers
*and Operators***
- **Environment Protection
Authority *and*
Water Boards**
- **Equipment Suppliers**
- **Consultants**

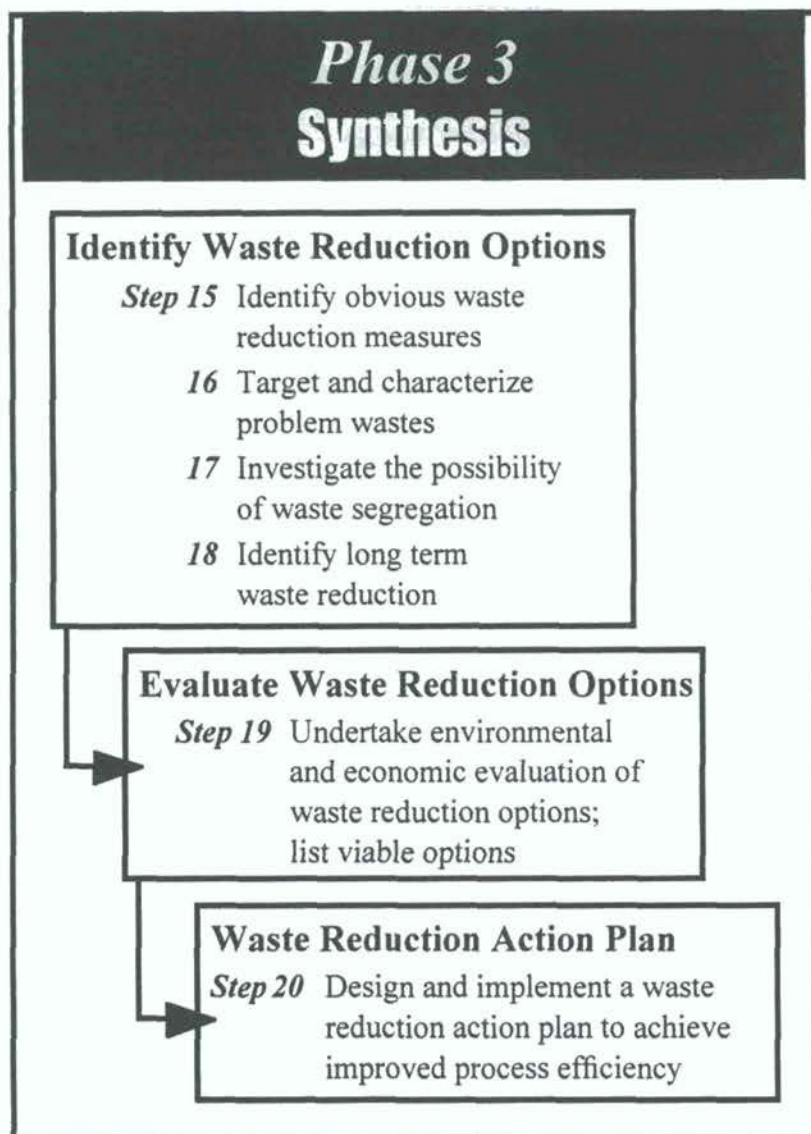
Before Cleaner Production options are generated during a brainstorming session, it is useful to collect as much information as possible from different sources, which can provide you with options for the assessment of your wastes and emissions.



In Phase 3 of the waste audit, you will have to generate Cleaner Production options. It is important to keep in mind that there are five features which influence the process, and which can serve as focus points for generating options.



Based on the five features that influence the environmental performance of a process, these points of action can be taken to improve the environmental performance of the process.



See background paper on Cleaner Production, *Section 3.3*.

Important questions to answer when making the initial selection of options

Availability

- Is the Cleaner Production option available?
- Can you find a supplier who can provide the installation or input material?
- Do you know an advisor who can help you to develop an alternative?
- Has the Cleaner Production option already been applied elsewhere?
- If so, what are the results and experiences?

The initial selection of Cleaner Production options is the last step of the Assessment phase. In this step, the options are screened and selected for further study. These questions are useful when making the initial selection.

Important questions to answer when making the initial selection of options

Suitability

- Does the Cleaner Production option fit in with the way your company is run?
- Is the Cleaner Production option in line with your company's products?
- What are the consequences of the Cleaner Production options for your internal logistics, throughput time, and production planning?
- Does the Cleaner Production option require adjustments to be carried out in other parts of the company?
- If so, what adjustments, and how radical?

The initial selection of Cleaner Production options is the last step of the Assessment phase. In this step, the options are screened and selected for further study. These questions are useful when making the initial selection.

Important questions to answer when making the initial selection of options

Environmental Effect

- What is the anticipated environmental effect of the Cleaner Production option?
- How big is the estimated reduction in the waste stream or emission?
- Are there any other potentially adverse effects on the environment?
- If so, what is the magnitude of these effects, and how hazardous are they?

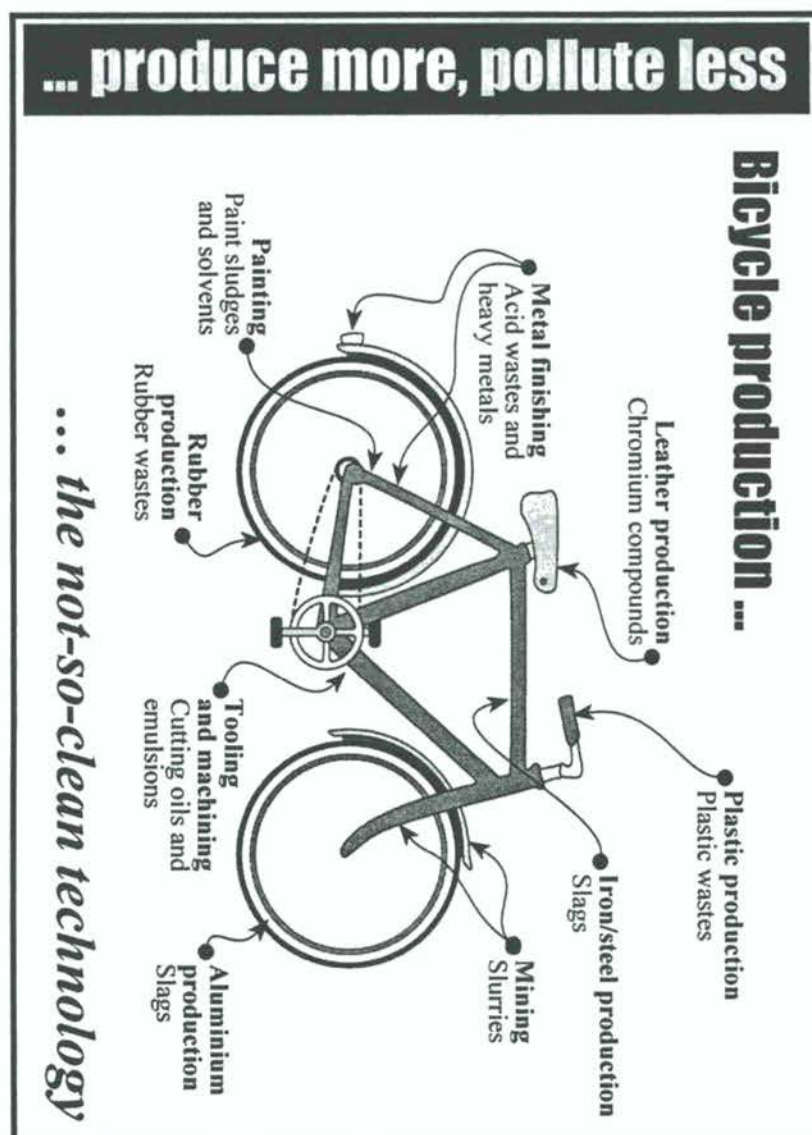
See previous transparency.

Important questions to answer when making the initial selection of options

Economic Feasibility

- What are the anticipated costs and benefits from implementing the Cleaner Production option?
- Can you estimate the required investment?
- Can you make an estimate of the benefits, such as reduction of environmental costs, reduction in wastage, and/or improving the quality of the product?

See previous transparency.



The example of the bicycle gives an impression of how a perceived environmentally friendly product can have many negative environmental impacts. It is not suggested that the bike is banned – rather, this example emphasises the fact that each product and process needs to be studied closely in order to identify areas of improvement.



Cleaner Production does not only lead to a reduced impact on the environment, but it also enhances improvements in all aspects of a company's performance.



Part 4

Training Courses, Information Sources and Background Material

4.1	Introduction	IV:3
4.2	Directories for education in Cleaner Production and environmental management	IV:4
4.3	Background material on Cleaner Production.....	IV:6
4.4	Existing training courses and institutes in Cleaner Production	IV:13
4.5	Examples of existing training courses on Cleaner Production	IV:15
4.6	Training support material	IV:19
4.7	Cleaner Production centres	IV:21

4 Training Courses, Information Sources and Background Material

4.1 Introduction

Part IV contains:

- a list of directories
- a short inventory of existing training courses
- references to training support material and
- references to background material on Cleaner Production.

The purpose is to give the trainer an idea of the education sources and materials available on Cleaner Production. Hence, a list of addresses of universities and institutes is provided. The directories give information on courses in environmental management, some specifically aimed at Cleaner Production. The background

material provides more information and access to exercises and case studies on Cleaner Production. It also contains a section with general background on environmental issues.

The inventory of training courses does not aim to be complete. The UNEP Cleaner Production Working Group on Education has recently completed a survey of Cleaner Production training courses and university courses. Information about teaching materials, their contents, where they are available and how to obtain them has been assembled and is now available to a wide audience through UNEP IE (see below).

42 Directories for education in Cleaner Production and environmental management

Inventory on Cleaner Production Education and Training [1996]

UNEP / UETP-EEE / IACEE / TEK / DTU

This book is the result of a worldwide survey of courses and training opportunities on this subject. It helps those interested in starting a course or training programme to locate others

working in the same field, and to activate networks and wider contacts.

ISBN: 952-5005-11-9.

EC Study Guide to Environment-Related Courses [1993]

This publication of the European Communities, Directorate-General Environment, Nuclear Safety and Civil Protection provides an overview of the environment-related courses available at institutes of higher education in all EC Member States.

The information given for courses includes:

- field of study

- title of qualification/degree
- objective
- length of course
- tuition fees
- contents
- admission requirements
- employment prospects.

Further information

Office for Official Publications of the European Communities, L-2985, Luxembourg, or any EC sales and subscription address.

Massachusetts Environmental Industry/Education Resource Directory: a guide to schools, careers, and environmental companies [1992]

This directory is intended to serve the information needs of a number of different parties: environmental companies, educators, students, guidance and career counsellors, government agencies, and support services to the environmental industry.

The directory gives information on:

- education programs
- careers in the environmental industry

- environmental companies
- environmental industry/education resources
- Massachusetts State resources.

Available from:

Bay State Skills Corporation, 101 Summer Street, Boston, MA 02110.

Tel (1 617) 292 5100.

Price: US \$25 for students, schools, and public libraries, plus US \$3 for postage and handling.

Reference Guide to Pollution Prevention Resources [1993]

This guide is an annual publication. It contains information about pollution prevention resources and training opportunities available across the USA.

The publication provides information on:

- where to obtain pollution prevention training, or who might be able to share experiences about establishing a new training opportunity
- publications and videos
- contact points at the State and Federal levels

- university centres that are conducting pollution prevention research and training
- Federal, State, and non-profit organizations providing additional pollution prevention information and technical assistance.

Available from:

US EPA, Office of Prevention, Pesticides and Toxic Substances, 401 M Street, SW (7409), Washington, DC 20460.

USA Document number: EPA/742/B-93-001.

Directory of Pollution Prevention in Higher Education: Facility and Programs

This survey reports the state of development of pollution prevention education at Universities in the United States, based on a national survey conducted between December 1991 and February 1992. Fifty-nine institutes provide information on their pollution prevention education efforts. This directory is regularly updated.

Available from:

National Pollution Prevention Centre for Higher Education, University of Michigan, Dana Building, #2540, 430 East University Avenue, Ann Arbor, MI 48109-1115.

Tel (1 313) 764 1412; Fax (1 313) 936 2195.

Guide for Engineers: Information and environmental field

How and where to obtain information to protect the environment in an industrial process (C. Kuzucuoglu)

This guide aims to help engineers gain information in three ways:

- by helping them to situate and analyze their own case, the conditions under which the problem is presented and the aims which determine their information requirements
- by proposing a method to characterize and seek useful information

- by proposing a list of information means or suppliers likely to be consulted.

Published by:

World Federation of Engineering Organizations (WFEO), and UNEP IE [1990]; WFEO, Committee of Engineering Information c/o CNIF, 7 rue Lamennais 75008, Paris, France.

4.3 Background material on Cleaner Production

Obtaining information on cleaner production can be a challenging task of sifting through a seemingly endless amount of resources presently available. What is available, accessible, and relevant depends greatly on the purpose of your search and your physical location.

This section lists a number of information sources, cleaner production centres and more general programmes on projects, publications, databases, institutions etc. that can assist you in obtaining further information about cleaner production. Please contact UNEP IE if you require additional information on the entries contained below.

4.3.1 Publications available from UNEP

Audit and Reduction Manual for Industrial Emissions and Wastes [1991]

UNEP IE and UNIDO. Technical Report No. 7. The manual is a practical working document intended for use within industry. It can be used by factory personnel at all levels interested in upgrading their own processes; consultants reporting to an industrial client; and government personnel reviewing existing factory operations.

127pp. Price: FF200/US\$40.

The Industry and Environment Review: Cleaner Production [1994] Vol. 17:4.

This highlights the findings of the Third UNEP High Level Advisory Seminar on Cleaner Production (Warsaw, Poland: October 1994), and includes a selection of written contributions.

Price: FF100/US\$20.

Cleaner Production Worldwide [1993]

This publication aims to show through examples that by applying cleaner production, industry and consumers anywhere in the world can gain environmental benefits while reducing costs.

Price: FF200/US\$40.

Cleaner Production in the Asia Pacific Economic Cooperation Region [1995]

This is a regional issue of the popular Cleaner Production Worldwide series, and includes 18 case studies from the APEC region, prepared under the sponsorship of the United States Environmental Protection Agency. Price: FF200/US\$40.

Cleaner Production Worldwide Volume 2 [1995]

In addition to 'production process' examples, this publication contains case studies on product development and descriptions of several innovative programmes which promote cleaner production.

Price: FF100/US\$20.

Government Strategies and Policies for Cleaner Production [1994]

Provides guidance and information on the strategies and policies that governments can use to stimulate cleaner production in developing countries and economies in transition. This primer describes an effective overall strategy for starting a cleaner production programme.

32pp. Free of charge.

Life Cycle Assessment: what it is and how to do it [1996]

UNEP. 91pp.

Monitoring Industrial Emissions and Wastes [1996]

Technical Report No. 27. 188pp.

Climate Change and Energy Efficiency in Industry [1991]

A joint UNEP IE-IPCECA publication.

64pp. Free of charge.

Environmental Aspects of the Metal Finishing Industry [1989]

Technical Report No. 1. 91pp. Price: FF200/US\$40.

The Textile Industry and the Environment [1994]

Technical Report No. 16. 120pp. Price: FF175/US\$35.

Industry and Environment Review: Food Processing and the Environment Vol.18:1

Price: FF50/US\$10.

Environmental Management in the Electronics Industry: semiconductor manufacture and assembly [1995]

Technical Report No. 23. 161pp. Price: FF175/US\$35.

Tanneries and the Environment [1991]

Technical Report No. 4. 119pp. Price: FF200/US\$40.

4.3.2 Databases

International Cleaner Production Information Clearinghouse (ICPIC)

UNEP IE. Network plus databases of case studies, publication abstracts, expert institutions, and resources available from UNEP IE. For availability contact UNEP IE. An email address – icpic@unep.fr – allows users to pose questions to the Programme. UNEP IE is evaluating the feasibility of having the databases available through the World Wide Web in the future.

Enviro\$en\$e

US Environmental Protection Agency and the Strategic Environmental Research and Development Program. Contains information on cleaner production (pollution prevention), such as descriptions of state and federal (US) programmes, technical case studies, and information on related national and international initiatives.

The system is accessible on the WWW: <http://wastenot.inel.gov:80/envirosense/> It is also accessible via a Bulletin Board System (BBS).

Further information: contact Kevin E. Twitchell at (1 208) 526 6956, or twi@inel.gov.

Industrial and Technological Information Bank (INTIB)

INTIB is the United Nations Industry and Development Organization's clearinghouse. Its main task is to provide industry in developing countries with the necessary background for sound technological and business decisions. Amongst others, it contains information on clean technology and industrial energy saving.

Further information: Chief, Industrial and Technological Information Bank, UNIDO, PO Box 300, A-1400, Vienna, Austria.

Information can be also accessed on the World Wide Web. To access the Web, one needs a subscription with an Internet service provider, and the use of a searching programme such as *Netsearch*, *Yahoo* or *Lycos* (all available on the Web itself). There are more than 700 servers dealing with environmental issues, and new 'pages' and sites are set up every week.

Below are some examples of servers that contain cleaner production information:

Envirolink

<http://www.envirolink.org/index1.html>

A major source of information on environmental issues including sustainable development. Provides access to various databases and clearinghouses. Full publications are also available.

National Cleaner Production Database Australia

<http://kaos.erin.gov.au/portfolio/epa/ncpd/ncpd.html>

Provides case studies from various Australian industry sectors.

International Institute for Sustainable Development

<http://www.iisd.ca/linkages/>

Information about conventions, conferences, and activities. Publications. Virtual Policy Dialogue.

Global Environment Centre

<http://sakura.unep.or.jp/gec/index.html>

International Environment Technology Centre. Case studies from Japanese industry are provided, with a list of contacts.

Additional information about UNEP in general:

UNEP Headquarters

<http://www.unep.org>

The main source of information about UNEP.

UNEP Geneva Center

<http://www.unep.ch>

A reference for publications and convention. Full documents and user statistics available.

UNEP Collaborating Centre on Energy and Environment

<http://www.risoe.dk/sys/syshom3.html>

4.3.3 Journals and newsletters

Because many cleaner production programmes publish newsletters to disseminate information about their activities, you may wish to inquire about publications available from the centres listed above.

Below is a limited selection of newsletters and journals.

Cleaner Production Newsletter

The Newsletter of the UNEP IE network dedicated to promoting cleaner production, containing information on cleaner production initiatives from all parts of the world. Distributed twice a year in English, French and Spanish. Subscription free.

For subscription, write to UNEP IE, Paris, France.

EIA Newsletter

Newsletter on activities and development in the field of Environmental Impact Assessment. It is written for, and by, participants in an EIA network which covers 72 countries.

Subscription information: EIA Centre, Department of Planning and Landscape, University of Manchester, Manchester M13 9PL, United Kingdom.

Environmental Pollution Prevention Project News

Newsletter of the US AID-US EPA Environmental Pollution Prevention Project, providing updates on the EP3 centres and information on the overall program.

Subscription information: EP3, 1530 Wilson Boulevard, Suite 900, Arlington, VA, 22209-2406, USA.
Tel (1 703) 351 4004; *Fax* (1 703) 351 6166.

Environmental Technology Assessment

Newsletter of the Environmental Technology Assessment (EnTA) Programme of UNEP IE. The newsletter is produced twice a year.

Further information: UNEP IE, Paris, France.

Green Product Design

Newsletter of the Section for Environmental Product Development, Faculty of Industrial Design Engineering, Delft University of Technology.

Subscription information: Green Product Design, Jaffalaan 9, 2628 BX, Delft, The Netherlands.
Tel (31 15) 782 738; *Fax* (31 15) 782 956.

Industry and Environment

Quarterly review, which provides a forum for the exchange of research and experience, presenting articles written by and for industry managers, government officials and researchers in the field of sustainable development.

Subscription: US\$45/year (surface mail), US\$60/year (airmail). UNEP IE.

For subscription, write to UN Bookshop/Sales Unit, Palais des Nations, CH-1211 Geneva 10, Switzerland.

Journal of Cleaner Production

A quarterly journal devoted to technologies, concepts, and policies and educational advances in cleaner production and industrial ecology, pollution prevention, and waste minimization.

Subscription: £125 (Europe), £135 (rest of world).

Further information: Elsevier Science Ltd, The Boulevard, Langford Lane, Kidlington, Oxford OX5 1GB, United Kingdom.

Tel (44) 1865 843479 / 843781;

Fax (44) 1865 843952..

Journal of Clean Technology and Environmental Sciences

A quarterly international journal devoted to pollution prevention and clean technology. Published by the International Association for Clean Technology, which aims to promote the research and application of clean technologies and methodologies. Annual membership of IACT includes a subscription to the *Journal of Clean Technology and Environmental Science*, the *IACT Newsletter*, and access to the IACT Information Network (US\$85 to US\$250).

Further information: IACT Secretariat, Rechte Wienzeile 29/3, A 1040 Vienna, Austria.
Tel (43 1) 567 487; *Fax* (43 1) 314 182.

Loss Prevention Bulletin

Appears six times per year. Contains articles and case histories from process industries throughout the world. Subscription £50 per year for universities.

Subscription information: The Editor, Loss Prevention Bulletin, Institute of Chemical Engineers, 165-171 Railway Terrace, Rugby, CV21 3HQ, England.

Pollution Prevention

European Edition. A journal for the protection of the environment, published seven times a year.

Published by: MacDonald Communications, Inc.
Subscription US\$90/year.

Further information: Pollution Prevention,
90 Long Lane, Rickmansworth, Herts WD3 2YG,
United Kingdom.

Pollution Prevention News

Quarterly newsletter of the US Environmental Protection Agency. To be added on the mailing list, write: Pollution Prevention News, US EPA, 401 M Street SW (MC 7409), Washington, DC 20460, United States of America.

Pollution Prevention Review

Quarterly journal aimed at a wide range of readers. Each issue contains topics of current interest in pollution prevention, covering such areas as education, model programs, implementation techniques, and regulatory developments.

Subscription information: Executive Enterprises Publications Co., Inc., 22 West 21st Street, 10th Floor, New York NY 10010 6904.
Tel (1 212) 645 7880, extension 208.

The Hazardous Solid Waste

Minimization & Recycling Report

Monthly newsletter on pollution prevention published by Government Institutes, Inc.
Subscription US\$252/year.

Subscription information: Government Institutes, Inc., 4 Research Place, Suite 200, Rockville, MD 20850, USA.

UNIDO-UNEP National Cleaner Production Centre Newsletter (NCPC Newsletter)

Quarterly newsletter that contains updates from centres operated under the NCPC programme. For those involved or interested in similar capacity building programmes for cleaner production. To receive a copy, contact UNEP IE, Paris, France.

Waste Notes

A publication of the Centre for Waste Reduction Technologies (CWRT) of the American Institute of Chemical Engineers.

Subscription information: Centre for Waste Reduction Technologies, 345 East 47th Street, New York, NY 10017-2395.
Fax (1 212) 752 3297.

Waste Reduction Bulletin

A monthly periodical for industry promoting hazardous waste reduction.

Subscription information: Ontario Waste Management Corporation (OWMC), 2 Bloor St. West, 11th Floor, Toronto, ON, M4W 3E2, Canada.

4.3.4 Contact organizations

Some are also listed above.

World Business Council for Sustainable Development (WBCSD)

The council's current work programme includes the examination of policy and development of projects, with the focus on eco-efficiency and technology cooperation.

160 route de Florissant, CH-1231 Conches, Geneva, Switzerland. *Fax* (41-22) 839 3131.

Preventative Environmental Protection Approaches in Europe (PREPARE)

The PREPARE Secretariat follows the activities of this European working group on international industrial research and development on cleaner processes and cleaner product systems.

PREPARE Secretariat, TME, Grote Markstraat 24, 2511 BJ The Hague, The Netherlands.

Tel (31 70) 363 4422; *Fax* (31 70) 362 3469.
Email tria@knoware.nl

Central European Environmental Data Request Facility (CEDAR)

International Society for Environmental Protection. CEDAR provides the environmental and scientific community in Central and Eastern Europe (CEE) with state-of-the-art access to environmental information located throughout the world.

Marxergasse 3/20, A-1030, Vienna, Austria.
Tel (43-1) 715 5879; *Fax* (43-1) 715 2829.

The Centre for Environmental Management and Planning (CEMP)

Undertakes research, training, consultancy and the provision of environmental information services on many aspects of environmental management and impact assessment.

CEMP, AURIS Environmental Division, 23 St Machar Drive, Old Aberdeen AB2 1RY, Scotland, United Kingdom.

Tel (44 274) 272483; *Fax* (44 274) 487658.

Environmental Impact Assessment Centre (EIA Centre)

The Centre's functions are to undertake research and other studies relating to EIA; to undertake, and assist others in undertaking, EIA educational and training programmes; to provide advice to those engaged in implementing EIA.

EIA Centre, Department of Town and Country Planning, University of Manchester, Manchester M13 9PL.

The Global Environmental Technology Network (GETNET)

GETNET is a network established by the World Health Organization (WHO). The activities of the network include information exchange; development of training activities; research promotion; intersectoral cooperation.

Environmental Technology Division of Environmental Health, World Health Organization, 1211 Geneva 27, Switzerland.

Tel (41-22) 791 3754; Fax (41-22) 791 0746.

International Association for Impact Assessment (IAIA)

IAIA Executive Office, PO Box 70, Bellhaven, NC27810, USA.

Tel (1 919) 964 2338; Fax (1 919) 964 2211.

International Network for Environmental Management (INEM)

INEM is a global federation of non-profit national and regional industry associations which promote and foster environmental management and sustainable development. INEM activities include collection and dissemination of information and facilitation of technical exchange.

INEM Main Secretariat, Bahnhofstraße 36, D-22880 Wedel (Holstein), Federal Republic of Germany.

Tel (49) 4103 84019; Fax (49) 4103 13699.

International Register of Potentially Toxic Chemicals (UNEP-IRPTC)

IRPTC is an international clearinghouse for scientific, technical and regulatory information for assessment and control of chemical hazards.

The Director, UNEP-IRPTC, Palais des Nations, 1211 Geneva 10, Switzerland.

Tel (41-22) 979 9183;

Fax (41-22) 787 3460.

Organization for Economic Cooperation and Development (OECD)

OECD is active in environment economics, management and research, and has many publications. It has a programme on technology and the environment that focuses on the promotion of cleaner technology.

OECD, 2 rue André Pascal, F-75775 Paris, Cedex 16, France.

Tel (33-1) 45 24 82 00; Fax (33-1) 45 24 85 00.

4.3.5 Audiovisuals

There are a number of videos on cleaner production and waste prevention available today. Most of these have been produced to introduce national programmes, such as those in Canada, The Netherlands, the USA, the United Kingdom, and elsewhere. Their use in general programmes on cleaner production must take these national origins into account.

Films marked with an asterisk () are available for viewing only at UNEP IE in Paris.
To obtain copies, please contact the producer/distributor.*

Cleaner Production: the bottom line

Language: English Year: 1994

Length: 15 minutes

Produced by: the Australian National University, Instructional Resources Unit for the Commonwealth Environmental Protection Agency.

Distributed by: Public Affairs & Education Section, 40 Backall Street, Barton ACT 2600, PO Box E305, Queen Victoria Terrace, ACT 2600 Australia.

Tel (63-06) 274 1999; Fax (63-06) 274 1666.

Cleaner Production: the green line

Length: 15 minutes

See *Cleaner Production: the bottom line*.

Cleaner Technology: the way to a better environment*Language:* English *Year:* 1992*Produced by:* Lars Brydesen Film*Distributed by:* Lars Brydesen Film,
Lochersvej 15, 3100 Hornbaek, Danmark.*Tel* (45-45) 22 002 84; *Fax* (45-45) 87 27 05.**Money Down the Drain (* Nos 83 & 138)***Language:* English *Year:* 1986*Length:* 17 minutes*Produced and distributed by:* Ontario Waste
Management Corporation (OWMC),
2 Bloor St. West, 11th Floor, Toronto, ON,
M4W 3E2, Canada.*Summary:* This video presents four examples of
cleaner production initiatives that reduce
costs, too. Suitable for a technical audience.**Pollution Prevention (* No 162)***a) PPRB Research Programmes**b) Less is More: pollution prevention is good business**c) In Partnership with Earth: the future of the environment**d) Beyond Business As Usual: meeting the challenge
of hazardous waste**e) Rinsing Process Modifications for Metal Finishers**Language:* English *Year:* 1993*Length:* a) 23 minutes; b) 23 minutes;

c) 60 minutes; d) 28 minutes 30 seconds;

e) 30 minutes

Produced and distributed by: USEPA,
Cincinnati, Ohio 45268*Summary:* This videotape contains five
pollution prevention films produced byvarious EPA organizations, and was put
together by the Pollution Prevention Research
Branch (PPRB) of the EPA's Office of
Research and Development. The films
promote pollution prevention by highlighting
selected success stories from both industry
and the public sector.**The Competitive Edge (* No 84)***Language:* English*Length:* 17 minutes*Produced by:* OWMC Canada*Distributed by:* Ontario Waste Management
Corporation (OWMC), 2 Bloor St. West,
11th Floor, Toronto, ON, M4W 3E2, Canada.*Summary:* This video explains the purpose of
and the major steps in a waste audit. Good
teaching material. Specialist audience.**Waste Minimization***Language:* English *Year:* 1994*Length:* 22 minutes*Produced and distributed by:* Andrew Bailey
and Cinewessex. Copies can be obtained
from: Dr N. Johnson, CEST, 5 Berners Road,
Islington, London N1 OPW.*Fax* 44 171 354 4301.*Summary:* This video shows the results of the
world's largest waste minimization initiatives:
Project Catalyst and the Aire and Calder
Project.**For further film information, contact:**The Film Librarian, Audio Visual Unit, Information & Public Affairs (IPA),
UNEP PO Box 30552, Nairobi, Kenya
Tel: (254-2) 23 00 84/23 08 00

or

UNEP IE, Tour Mirabeau, 39-43 Quai André Citroën,
75739 Paris Cedex 15, France.*Tel:* (33) 01 44 37 14 50 *Fax:* (33) 01 44 37 14 74;*Email:* unepie@unep.fr *WWW:* <http://www.unepie.org/home.html>

4.3.6 Environmental packages from IChemE



IChemE has an international reputation for providing high quality, effective safety and environmental training solutions using video, slide, open learning and computer-based techniques. We draw on experts throughout industry, the regulatory bodies, the legal profession and academia to ensure that our training packages are both high quality and relevant.

ENVIRONMENTAL AWARENESS

Package E02

Understanding is the key to effective environmental improvements - both through certified standards and effective policy implementation. This package gives a thorough grounding in environmental awareness. The case studies cover: environmental law; global issues; corporate issues; and waste minimization.

AQUEOUS EFFLUENTS

Volume 1: awareness and treatment strategies

Package E01

Engineers learn how to assess and deal with effluent problems; senior management gain a sound technical and legal grounding; and operators learn why compliance is important. Seven case studies demonstrate how effective treatment strategies save money whilst benefiting the environment. And the technical guidance covers: characterisation of effluents; treatment strategy; safety; unit operations; and costs.

Volume 2: measurement and monitoring

Package E013

Trainees learn how to measure and monitor effluents, ensuring compliance and reducing treatment costs.

AIR EMISSIONS

Volume 1: key issues

Package E03

This package provides comprehensive coverage of generic air pollution issues and technologies, backed up with detailed sections on sources and types of emissions, atmospheric chemistry, standards and legislation (UK and European).

Volume 2: monitoring and control

Package E012

This package follows on from AE Vol. 1: key issues, and provides detailed information on measurement and monitoring and control techniques, illustrated with comprehensive case studies. Sections on ambient monitoring, meteorology and air dispersion modelling help to provide a thorough grounding in the technical issues associated with air emissions.

ENERGY MANAGEMENT

Package E011

Energy efficiency affects the bottom line. Trainees learn the basic tools and techniques for effective energy management.

ENVIRONMENTAL AUDITING

Package E04

Trainees learn how to make audits more effective. In clearly defined sections, the package explains how to go about auditing a site, from defining the scope and objectives through on-site activities to reporting and follow-up work. Thirteen case studies and exercises, supported by over 120 slides, include: setting up an EMS; auditing for waste disposal, due diligence and effluent compliance; reporting audit findings; and discussion of photographs of bad practice.

ENVIRONMENTAL MANAGEMENT SYSTEMS

Package E05

If you already have an environmental management system, this package will help you gain commitment from your staff. If you are just developing a system, not only will you benefit from the training, but also benchmarking from the detailed case studies will save you time. And if you have still not decided which system to go for (if any), this package will help you make an informed decision.

ENVIRONMENTAL IMPACT ASSESSMENT

Package E06

This training package gives you a thorough grounding in the EIA process and techniques. Produced in conjunction with the Institute of Environmental Assessment, the package provides an effective means of training all staff concerned with EIAs. There are nine case studies provided by leading environmental consultancies. These introduce the practical aspects of the EIA process by examining projects involving a food processing plant, a sewage treatment works, a coastal defence scheme, a pipeline proposal, an oil refinery and a power station.

WASTE MINIMIZATION

Package E07

Approaches in the package vary from good housekeeping to complex techniques such as life cycle analysis. This training package shows how to go about it, from defining a strategy through to making sure it happens.

CONTAMINATED LAND

Package E08

Trainees learn why contaminated land is important, how and why a company should avoid contamination, and the pros and cons of the key remediation techniques. You will also learn how to use this knowledge to get the most out of the consultants you use.

For order form contact:

Mark Smith

Safety Health and Environment Department • Institution of Chemical Engineers

165-189 Railway Terrace • Rugby CV21 3HQ, UK

Tel +44 1788 578214 • Fax +44 1788 560833

4.4 Existing training courses and institutes in Cleaner Production

Only a few training institutes are listed in this section. Additional listings from the trainer are welcome. The publication *Inventory of Cleaner Production Education and Training*, published by UNEP's working group on education, contains an extensive list of university and institutional courses from around the world. *Section IV.5* lists four programmes in more detail.

UNEP Cleaner Production Programme

One of the activities of this UNEP IE programme is training and technical assistance. Workshops and seminars for government, industry, and academia have the following objectives:

- increasing awareness and prompting action
- educating people, and
- helping to develop cleaner production programmes.

Erasmus Centre for Environmental Studies

This centre has an international PhD programme in cleaner production and sustainability. It also organizes a course on cleaner production (see *Section IV.5*).

Further information: Erasmus University, Erasmus Centre for Environmental Studies, PO Box 1738, Burgermeester Oudlaan 50, 3000 DR Rotterdam, Netherlands.
Tel (31-10) 408 2050; Fax (31-10) 212 0834.

European Postgraduate Course in Environmental Management (EPCEM)

The EPCEM is a one-year full-time course. It is organized by the inter-disciplinary departments of Environmental Science at the Agricultural University of Wageningen, Leiden University, the Free University of Amsterdam, and the University of Amsterdam. The EPCEM provides its participants with knowledge and insight in the different interests and aspects which play a role in the development and evaluation of potential solutions for environmental problems.

Further information: EPCEM Secretariat, IVAM, Interfaculty Department of Environmental Science, University of Amsterdam, Nieuwe Prinsengracht 130, 1018 VZ, Amsterdam, Netherlands.
Tel (31-20) 525 6232/6206;
Fax (31-20) 525 6272.

International Institute of Industrial

Environmental Economics: Lund University

Masters and PhD programmes in cleaner production and related subjects for Swedish and foreign students.

Further information: V. Martensgatan 1, S-22351 Lund, Sweden.

Email: env_econ@gemini-ldc.lu.se

RMIT Faculty of Engineering

A three year part-time course, leading to the title of Master of Engineering in Cleaner Production, is provided at the RMIT.

Further information: Faculty of Engineering, RMIT, GPO Box 2476V, Melbourne 3000, Australia. Tel (61 3) 660 3261;
Fax (61 3) 663 7873.

The Continuing Education Centre of the Asian Institute of Technology (AIT)

The Continuing Education Centre conducts short-term training programmes for career professionals, academics and executives of public and private organizations. One of the courses that they organize is entitled Waste Avoidance and Minimization in Industry (Clean Technologies). This course aims to help the participants relate the concept of and introduce clean technologies to industrial waste management.

Further information: Continuing Education Centre, Asian Institute of Technology, GPO Box 2754, Bangkok 10501, Thailand. Tel (662) 524 5244/5270;
Fax (662) 516 1418/2126.

World Health Organization

WHO can assist in finding expert resource persons for national workshops and courses as required.

The Global Environmental Technology Network (GETNET) has as one of its principal activities the development of training activities.

Further information: Environmental Technology Division of Environmental Health, World Health

Organization (WHO), 1211 Geneva 27,
Switzerland. *Tel* (41-22) 791 37 54;
Fax (41-22) 791 07 46.

**WRITAR: Waste Reduction Institute
for Training and Application Research**

WRITAR is a non-profit waste reduction
research and training organization. It has a training
centre dedicated to the dissemination of pollution

prevention information and techniques. They offer
training in 'train-the-trainers' techniques.

Further information: Writar, Centre for
Excellence in Pollution Prevention Training,
1313 5th Street SE, STE 325, Minneapolis,
MN 55414-4503. *Tel* (1-612) 379 5995;
Fax (1-612) 379 5996.

4.5 Examples of existing training courses on Cleaner Production

This section contains four examples of training courses in the field of Cleaner Production. The examples given are taken from:

- the Royal Melbourne Institute of Technology (RMIT)
- UNIDO
- Lund University
- Erasmus University.

4.5.1 Masters of Engineering in Cleaner Production [RMIT]

Master of Engineering in Cleaner Production

Master of Engineering in Cleaner Production is a three-year part-time (or equivalent full-time) course. The content will be modularized so that the units can be easily taken to industry or government for in-house training. Such units will have credit points that can be used at a later stage for credit towards the Master's degree.

Course Structure		
Year 1	Semester 1	SE110 Systems Engineering
		SE120 Data Analysis and Statistic Modelling
		MS511 Total Quality Management Principles
	Semester 2	MS514 Total Quality Management Tools
		CP200 Cleaner Production Principles
		CP210 Cleaner Production Computing
		CP220 Environmental Quality Monitoring + one elective from the list below
Year 2	Semester 1	CP310 Cleaner Production Technologies I
		CP311 Environmental Law
		CP312 Toxicology
		CP313 Eco-Design: Products and Processes + one elective
	Semester 2	CP420 Cleaner Production Technology II
		SE160 Management of Public Issues
		+ two electives
Year 3	Semester 1	CP510 Cleaner Production Case Studies
		CP511 Cleaner Production Thesis/Project + one elective
	Semester 2	CP611 Cleaner Production Thesis/Project
		+ one elective

Course Aims

To help students understand the environmental, economic and social benefits of Cleaner Production. To help students develop expertise in the implementation of Cleaner Production approaches throughout industry and society in order to achieve Sustainable Development.

Exemptions

Students may be permitted to substitute advanced studies from other institutions or from other courses at RMIT. Assessment will be made by the course leader. No exemptions will be allowed for subjects in the final year.

Off-Campus Options

Where industry demand is sufficient, subjects will be offered via intensive workshops and where applicable they will be offered in-house. Students who have completed relevant industry training programs may apply for exemptions or sit for special examinations in order to achieve credit into the courses.

Graduate Certificate of Engineering in Cleaner Production

Graduate Certificate in Cleaner Production is a one-year part-time (or equivalent full-time) course. The content will be modularized so that the units can be easily taken to industry or government for in-house training. Such units will have credit points that can be used at a later stage for credit towards the Graduate Certificate or Master's degree.

Course Structure	
Semester 1	MS511 Total Quality Management Principles
	CP310 Cleaner Production Technologies I
	CP311 Environmental Law
	CP312 Toxicology
Semester 2	MS514 Total Quality Management Tools
	CP200 Cleaner Production Principles
	CP220 Environmental Quality Monitoring
Two elective subjects are also to be taken during the course	

Course Aims

To introduce students to the environmental, economic and social benefits of Cleaner Production. To help students develop some expertise in the implementation of Cleaner Production approaches throughout industry and society in order to achieve Sustainable Development.

Contact address: Faculty of Engineering, RMIT, GPO Box 2476V, Melbourne 3000, Australia.
Tel (61 3) 660 3261; Fax (61 3) 663 7873.

4.5.2 Ecologically Sustainable Industrial Development [UNIDO]



This training course is designed primarily for UNIDO field staff, but is suitable for all staff of the United Nations as well as for anyone interested in industrial development.

The objectives of the course are as follows:

- To examine the environmental impacts of industrial development.
- To understand ecologically sustainable industrial development (ESID) as an appropriate response to past and future trends in industrial development and the environment.
- To introduce Cleaner Production as a practical approach for achieving ESID.
- To become informed about the analytical tools that can be used to identify Cleaner Production opportunities.
- To become familiar with the economic analysis techniques that can be used to justify investments in Cleaner Production.
- To examine the potential role of Governments in encouraging the adoption of Cleaner Production.
- To recognize and use sources of information about Cleaner Production.
- To develop skills in incorporating environmental considerations into industrial development projects.
- To motivate further study.

Contact UNIDO, Box 300, A-1400 Vienna, Austria.

4.5.3 International Institute of Industrial Environmental Economics at Lund University, Sweden

The International Institute of Industrial Environmental Economics provides courses covering a range of subjects such as:

- industrial environmental economics
- pollution prevention
- environmental policy
- environmental management
- cleaner production
- life cycle assessment.

The *M.Sc. in Environmental Management and Policy* prepares decision makers in business, governments and other organisations to act in an environmentally proactive way in general policy, production and environmental issues. The overall focus is on cleaner production.

The programme consists of four parts:

- preparatory course
- basic block
- advanced block
- and
- theses.

The *preparatory* block contains language studies, guidance for information searching, use

of computer and other similar issues. The *basic* block provides general information on related issues, and covers natural ecosystems, environmental economics and policy, environmental technology, introduction to cleaner production, environmental information and communication. *Advanced* block subjects include environmental policy and law to promote cleaner production, economics and sustainable development, environmental management, cleaner products, and cleaner technologies.

The programme is targeted at Scandinavia, OECD and Eastern European and developing countries. The programme is offered free of charge and the institute is prepared to assist students from Central and Eastern Europe and developing countries in finding sources of funding for other expenses.

Doctoral studies in cleaner production will be arranged on a more individual basis than the Master's programme and will reflect students' past experiences and present interests.

Contact address: V. Martensgatan 1, S-22351 Lund, Sweden. Email: env_econ@gemini-ldc.lu.se

4.5.4 Cleaner Production: theories, concepts, and practice [Erasmus University, the Netherlands]

This interdisciplinary course, offered at Erasmus University during the spring semester, has the following objectives:

- | | |
|---|--|
| <p><i>a</i> To examine the historical context of our contemporary environmental problems.</p> <p><i>b</i> To examine the fundamental differences between the theories, concepts and definitions of the new Cleaner Production approach to environmental protection and those of the Pollution Control approaches, commonly practised today.</p> <p><i>c</i> To explore, using concrete examples drawn from industries and other organizations from around the world, how Cleaner Production is being implemented in all branches of industry and in other sectors of society.</p> | <p><i>d</i> To learn about the environmental and economic benefits of Cleaner Production.</p> <p><i>e</i> To learn about the technical dimensions of Cleaner Production.</p> <p><i>f</i> To learn how most governmental policies and programs, currently in effect around the world, foster the End-of-Pipe pollution control approaches.</p> <p><i>g</i> To learn how new governmental policies and programs that foster and support Cleaner Production are being designed and implemented. Illustrative governmental</p> |
|---|--|

programs from global, regional, national and local levels are evaluated.

- h* To learn the management and leadership concepts and skills necessary to help companies plan and implement policies and programs designed to actualize Cleaner Production within their organizations.
- i* To learn about and gain experience with tools, such as Waste Minimization Audits and Product Life-Cycle Analyses that are being found to be useful for helping organizations implement cleaner Production within their facilities.
- j* To explore the implications of Cleaner Production for the design and production of Cleaner Products, and for the provision of Cleaner Services.
- k* To examine the roles of labor unions, employer organizations, branch organizations, environmentalist groups, consumer groups, the media, financial institutions, the legal infrastructure, the insurance infrastructure and other societal sectors in helping and/or in hindering organizational transition to Cleaner Production.
- l* To explore the functions and dynamics of liability issues in stimulating the transition to Cleaner Production.

m To examine the role of Product Labelling in stimulating the transition to Cleaner Production.

n To assess the importance and roles of corporate environmental ethics in accelerating the transition to Cleaner Production.

o To reflect upon the philosophical, psychological, sociological, religious and political dimensions of the changes that are essential for sustainable societies in our common future!!

The course addresses environmental quality, species diversity, and societal sustainability problems and opportunities. Illustrative examples are drawn from experiences within many countries of the world. The examples illustrate the inter-disciplinary relationships between improvements within the outer environment, the worker's and consumer's environments and the social-political-economic dimensions of society.

The overall goal of the course is to help students understand the environmental and economic benefits that can be achieved through industrial and governmental implementation of the preventive approach throughout all facets of society.

Erasmus University, Erasmus Centre for Environmental Studies, PO Box 1738,
Burgermeester Oudlaan 50, 3000 DR Rotterdam, Netherlands.
Tel (31-10) 408 2050; Fax (31-10) 212 0834.

4.6 Training support material

Trainers Workbooks for Cleaner Production in Leather Tanning, Textile Manufacture, Breweries, and Battery Recycling.

UNEP [1996]

See *Appendix II* for more details.

Cleaner Production: theories, concepts and practice Reader [1992]

Editor Prof. Dr. D. Huisingh.

Published by: Stichting Syllabi, Erasmus Universiteit [1993]; Burgermeester Oudlaan 50, 3062 PA Rotterdam, The Netherlands.

Curriculum for toxics use reduction Planners [1994]

Sixth edition. The curriculum is designed to encourage participants to re-examine conventional approaches to production management and environmental protection.

The manual is intended to serve as the basis for an advanced educational program for the training of Toxics Use Reduction Planners. The targeted audience are technically experienced professionals and production managers.

Published by: The Toxic Use Reduction Institute, University of Massachusetts at Lowell, One University Ave., Lowell, Massachusetts 01854.

Environmental Assessment of Products: a course on life cycle assessment [1993]

Editor Bo Pedersen. This book is an introduction to the practical application of product life cycle assessment to be used for the education of engineers and other practitioners in training courses and institutes of higher education.

Published by: UETP-EEE, The Finnish Association of Graduate Engineers, TEK Ratvartijankatu 2, SF-00520 Helsinki, Finland. ISBN 951-9110-83-6.

Facility Pollution Prevention Guide [1992]

The guide is written for those who are responsible for implementing pollution prevention in their facilities. It is intended to help small- to medium-sized production facilities develop broad-based, multimedia pollution prevention programmes. It describes how to identify, assess, and implement opportunities for preventing pollution and how to stimulate the ongoing search for such opportunities.

Published by: US Environmental Protection Agency, Office of Research and Development, Washington, DC 20460.

Document number: EPA/600/R-92/088.

Hazardous Waste Minimization [1990]

H.M. Freeman. This book is designed to assist individuals in private companies and public agencies in identifying and pursuing options for waste minimization.

Published by: McGraw-Hill Publishing Company. IChemE

The Institution of Chemical Engineers has developed slide training packages on various themes. See Section IV.3.6.

Eco-Efficiency and Cleaner Production [1996]

World Business Council for Sustainable Development (WBCSD) and UNEP IE.

This publication explains the relationship between these two concepts, and their relevance to industrial environmental management.

Published by: WBCSD, 160 rte de Florissant, CH-1231 Geneva, Switzerland.

Pollution Prevention: homework and design problems for engineering curricula [1992]

D. T. Allen, N. Bakshani, K. Sinclair Rosselot. The book is designed to be integrated into existing courses leading to chemical and other undergraduate engineering degrees. However, the manual has proved useful to others in industry and environmental fields, as well.

Published by: American Institute of Chemical Engineers Centre for Waste Reduction Technologies. ISBN 0-8169-058-1-9. Copies can be ordered through the AIChExpress Service Centre, 2345 East 47th Street, New York, NY 10017-2395, ALChemE; Fax 212 705 8400.

Pollution Prevention Implementation in Developing Countries

J.S. Hirschhorn. Duke University Centre for Tropical Conservation, PO Box 90381, Durham, NC 27708-0381, USA.

Tel (1 919) 490 9081; *Fax* (1 919) 419 1433.

Prepare [1991]

Editors S. de Hoo, H. Brezet, M. Crul, and H. Dieleman. The PREPARE box includes a video, a manual, worksheets, and the PREPARE

Experience binder. The package focuses on exploring the opportunities to prevent waste and emissions that are present within existing companies. It is a source of ideas for the development and introduction of a waste and emission prevention programme.

Published by: the Dutch Ministry of Economic Affairs. ISBN 90 346 2565 6. Available from SDU/DOP, Rooseveltstraat 52-56, 2321 BM Leiden, The Netherlands. Tel (31 71) 352 500.

Project Casework on Waste Minimization in Textile Dyeing Industry [1993]

This training material has been developed to support the Project on Industrial Pollution Control Applications for Small and Medium Scale Industries (IPCA) in Bangkok, Thailand, and to find suitable case material that can illustrate to factory owners the benefits and incentives of waste reduction, reuse, and recycling in their own workplaces.

Further information: Carl Duisberg Gesellschaft, South East Asia Program Office, Bangkok, Thailand.

Prosperity without Pollution: the prevention strategy for industry and consumers [1991]

J.S. Hirschhorn, K.I. Oldenburg. This book explains why only the preventive environmental strategy can work, because growing population, consumption, and industrialization cripple current remedial efforts.

Published by: Van Rostrand Reinhold, 115 Fifth Avenue, New York NY 10003. ISBN 0 442 00225 4.

Teaching those Humans to Learn: creative approaches to pollution prevention training [1991]

The manual contains descriptions of interactive pollution prevention problem solving exercises. These can be used to train public policy staff and/or regulators about the concepts of pollution prevention and at the same time heighten participants' awareness of the challenges of implementing prevention activities in industry.

Published by: US EPA, Office of Pollution Prevention, 401 M Street SW, Washington DC 20460.

Training Course: Ecologically Sustainable Industrial Development

This training kit contains 10 separately bound Learning Units, a video cassette with seven films, two floppy discs, an audio cassette and, for supplementary reading, two booklets and a manual. The training course is designed for UNIDO staff, but it is suitable for all staff of the United Nations as well as for anyone interested in industrial development.

Available from: UNIDO, Environment Coordination Group, PO Box 300, A-1400 Vienna, Austria.

4.6.1 Others

Industrial Relations and the Environment: ten countries under the microscope (Volumes I and II) [1994]

Contains reports from ten country studies in the Member States of the European Community. Information on the legal framework, voluntary measures, and policy issues are researched in each country, providing a basis of comparison. The status of cleaner production is also researched.

Published by: Loughlinstown House, Shankill, Co. Dublin, Ireland.

Price: ECU30 (Vol.I); ECU25 (Vol.II).

The United States Environmental Protection Agency (US EPA) has published many cleaner production (US EPA uses the term *pollution prevention*) documents.

Further information available from:

Pollution Prevention Information Clearinghouse, US EPA,
401 M Street, SW. PM-211A, Washington, DC 20460. USA.

Tel: 1 202 260 1023; Fax 1 202 260 0178.

4.7 Cleaner Production centres

Cleaner Production centres have been established in various countries, independently or with outside assistance. In general, they are set up to develop national or regional capacity to implement cleaner production, and are open to the public. All of these centres list information collection and dissemination as one of their main activities to promote cleaner production.

Below are brief descriptions of some of the international efforts underway followed by a listing of cleaner production centres themselves, divided by region.

UNIDO-UNEP National Cleaner Production Centres (NCPCs)

NCPCs have been established in seven countries, and will ultimately support twenty over a five year period. The centres will promote cleaner production at the national level through:

- conducting in-plant demonstration and various training programmes for governments and industry to show cleaner production at work
- analyzing policy initiatives in the country and making recommendations to improve the policy framework for cleaner production
- acting as a focal point for cleaner production through information collection, analysis and dissemination activities.

The centres have an information management system with key documentation on cleaner production and various information sources, and provide information services. Interested individuals and organizations are encouraged to contact the centres to obtain information.

Further information

UNIDO: Industrial Sectors and Environment Division, PO Box 300, A-1400, Vienna, Austria.
Tel (43 1) 211310; Fax (43 1) 230 7449.

UNEP: Industry and Environment

39-43 quai André Citroën, 75739 Paris, Cedex 15, France.

Tel (33 1) 44 37 14 50; Fax (33 1) 44 37 14 74;
email unepie@unep.fr;

WWW: <http://www.unepie.org/home.html>

Environmental Pollution Prevention Project (EP3)

EP3 is a five-year programme sponsored by the US Agency for International Development (USAID) to address urban and industrial pollution and environmental quality in developing countries. The programme was established with the following three objectives:

- to establish sustainable pollution prevention programs in developing countries
- to transfer urban and industrial pollution prevention expertise and information
- to support efforts to improve environmental quality.

Since its inception in 1993, the EP3 programme has established centres in five countries (Tunisia, Chile, Ecuador, Egypt, and Indonesia).

Information clearinghouses have been (or will be) set up to disseminate pollution prevention related information. These national clearinghouses are supported by the EP3 headquarters clearinghouse, which responds to information requests from industrial facilities and governments in EP3 countries and from USAID missions throughout the world. In 1995, the Tunisia Centre became an independent organization, and in the future will become associated with the UNIDO/UNEP NCPCs.

Further information

USAID EP3 Headquarters Clearinghouse,
RCG/Hagler Bailey, Inc., 1530 Wilson Blvd.,
Ste. 900, Arlington, VA 22209-2409, USA.
Tel (1 703) 351 4004; Fax (1 703) 351 6166;
email apenderg@habaco.com.

World Environment Center's

Waste Minimization Program

Funded by the US Agency for International Development (USAID), this program has introduced the concepts of waste minimization in nine countries of Central and Eastern Europe through a series of demonstration projects.

Further information

World Environment Center

419 Park Avenue South, Suite 1800,
New York, NY 10016, USA.

Tel (1 212) 683 4700; Fax (1 212) 683 4745.

ASEAN Environmental Improvement Project

Funded by the US Agency for International Development (USAID), and part of the US Asia Environmental Partnership. The individual country programmes provide information and assistance on how to incorporate pollution prevention approaches into industrial management.

Norwegian Chartered Engineers (NIF)

NIF has established a number of cleaner production centres in central and eastern Europe, which conduct training programmes for industries. Centres are located in Poland, China, the Slovak Republic, the Czech Republic, and Russia.



Part 5

Training Material

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5 Training Material

5.1 Introduction

This Part contains exercises that can be used in actual teaching sessions, especially projects, workshops, and discussion groups. Some exercises could also be presented in modified form during seminars and meetings.

The present collection of exercises and case studies is quite diverse, illustrating the various aspects of cleaner production that may be found in practice. In its entirety, the material is a resource kit from which trainers may choose whatever most suits their needs.

The exercises are not ready for handing out as they are presented here. This decision remains with the trainer. In particular, the trainer should first attempt the exercises, so that they are not confronted with unexpected problems or questions when the participants do the exercise!

Because learning is a gradual process, some of the exercises are intended to be carried out before a formal course or workshop actually

commences. Therefore, these preliminary exercises constitute preliminary tasks that familiarize students with some key aspects of the subject, but they can also be done in class.

Every exercise contains a paragraph describing the objective of the exercise. Some books containing further exercises on cleaner production are listed in *Section 4.3*.

The purpose of these exercises is to stimulate a positive way of thinking among the participants which makes them see the challenges and opportunities available when applying cleaner production. It also develops analytical and problem-solving skills.

The current set of exercises should be seen only as a starting point. Trainers are encouraged to adapt the given exercises to suit the target audiences, and to develop additional exercises to extend the learning experience.

5.2 Preliminary exercises

5.2.1 Introduction

Before starting a learning activity, you can ask the participants to prepare by giving them some preliminary exercises to do. Some ideas for this preliminary work appear in this section. Depending on the purpose of the course and the detail in which you want to address Cleaner Production, you may want to adapt these preliminary exercises or develop others. You may also want to ask the students to do some of the background reading in *Part 3* before attending the learning activity.

Most of these preliminary exercises require the student to collect information from a number of

sources. A list of possible sources is given below, in order to give the students an idea of where they can find information. You can give this checklist to the students in advance. Ask them to mark the information sources they used. In some countries the information requested in the exercises is not available for public disclosure.

***I**t is essential that the trainer first explores the possibilities of access to the requested information before asking the students to conduct this exercise, in order to avoid disappointment and demotivation of the students.*

Information Sources	
☐ Newspaper	☐ University Library
☐ International Organizations	☐ Public Library
☐ Ministries	☐ Local Authorities
☐ Interviews	☐ Patent Office
☐ Information Hotlines	☐ Yellow Pages/Phone Book
☐ CD-ROM	☐ Wholesalers
☐ Labour Unions	☐ Industrial Organizations
☐ Chamber of Commerce	☐ Non Governmental Organizations
☐ Consumer Organizations	☐ (International) Databases
☐ Magazines and Journals	☐ Industries
☐ Service Sector	☐ Other

5.2.2 Some ideas for preliminary exercises

1 Depending on the subject of the learning activity, you can ask participants to collect newspaper articles, or articles from journals, related to the central training issues.

2 Participants from industry can be asked to make a global inventory of the waste streams in their company.

At the end of the training activity, you can ask the participants if they are able to identify more waste streams in their company after what they have learned. The inventory made by the participants may serve as a starting point for a waste audit in their company. This exercise can be combined with the exercise on ICPIC.

3 A similar exercise could be done concerning pollution releases and the general environmental impact of their company's activity. Ask the participants to make an estimate of the environmental impacts of their emissions on the local, regional and global level. Also take into consideration the socio-cultural consequences of these impacts.

4 For participants from government administration or institutes, 'country reports' – using a specific format or a checklist – will help them to appreciate their national situation, and identify the issues relevant to the workshop.

5 Send the participants a quiz which they submit before the training activity starts. The participants should do the same quiz at the end of the training activity. The questions can be chosen to be specific to the learning objectives, or to general environmental awareness, or to both.

This test can be used as a tool to measure the degree of learning achieved during the training activity. It also serves as an evaluation tool for the trainer to see if he/she succeeded in achieving the objectives of the learning activity. The quiz from UNIDO (see the *quiz* on the next page) may very well be used for such purpose.

6 Some very simple exercises, similar to what will be done in the workshop, are useful in familiarizing participants with the programme ahead. Use exercises like the preliminary exercise on the anodizing plant.

5.2.3 Preliminary exercise: Quiz

The quiz on the following page can be extended by adding more questions from the *UNIDO Training Course on Ecologically Sustainable Industrial Development* (see Section 4.4). The complete quiz contains 80 questions, and is available on diskette from UNIDO or UNEP. This quiz can function as a preliminary exercise, after a short introduction on cleaner production, or during a workshop.

Complete the quiz* below by ticking the most appropriate response.

1 Agenda 21 suggests that Environment and Development:	
a	☐ must be clearly distinguished
b	☐ cannot be separated
c	☐ have the same objectives
d	☐ do not have the same objectives
2 Environmental policies for pollution have gone through three phases, covering:	
a	☐ abatement to prevention to dilution
b	☐ prevention to dilution to abatement
c	☐ dilution to prevention to abatement
d	☐ dilution to abatement to prevention
3 The most effective management choice for handling pollution in the 1990s is:	
a	☐ prevention
b	☐ dilution
c	☐ abatement
d	☐ control
4 Cleaner Production eliminates waste:	
a	☐ at the end of the process
b	☐ at every phase of production
c	☐ only at the design stage of the product
d	☐ at the most polluting stage of the process
5 From the practical business viewpoint, Cleaner Production:	
a	☐ often pays
b	☐ does not pay
c	☐ requires up-front investment
d	☐ is not economic in developing countries
6 The key focus of the UNEP Cleaner Production programme is to:	
a	☐ act as a catalyst and network with the key players for Cleaner Production
b	☐ collect and disseminate confidential information on Cleaner Production policies, strategies, technologies and management tools
c	☐ finance manufacturing projects in developing countries
d	☐ provide an environmental monitoring service.

* Extract from complete set of 80 questions.

5.2.4 Preliminary exercise: Mass balance calculation in an anodizing plant

This exercise was developed by the Interfaculty Department of Environmental Science of the University of Amsterdam. The exercise is suitable for individuals to work through in advance of a workshop. The results should be brought to the workshop and compared with the results of other exercises performed during the workshop.

The exercise derives a mass balance in an anodizing plant. Mass balance calculations are essential to understand the flow of process

chemicals in a plant, and hence to understand where waste originates. This understanding does not lead to Cleaner Production in itself, but it does pinpoint trouble-spots, and so identify priority areas for action. The reduction options follow from an understanding of the process, and where low-waste process modifications can be made.

Examine the case study of an anodizing plant, presented on the following pages. Answer the simple questions first, before looking at the details of the assignment which follows.

Note: this question may require some intuition about the process. The case study itself will provide the basis for some informed guesswork.

CALCULATING THE VOLUME AND COMPOSITION OF WASTEWATER EFFLUENTS FROM AN ANODIZING PLANT

Introduction

Anodizing consists of applying an oxide layer to aluminium by means of an electrochemical process. This oxide layer has a decorative function, while at the same time providing protection against corrosion.

The aluminium object is dipped into an electrolytic bath (salt solution), after which a direct current is passed between the object (which functions as an anode) and a cathode. This results in electrolysis of water, and the oxygen thus formed reacts with the aluminium, creating an aluminium oxide layer.

To obtain a good anodizing layer, the object must undergo a number of pre- and post-treatment steps:

- the *pre-treatment* consists of degreasing and staining, and
- the *post-treatment* consists of sealing.

After each of these treatments, the batch of objects must be rinsed. This results in pollution of the rinse water with acids, bases, aluminium, and heavy metals. This water pollution, together with the high energy consumption and the use of large quantities of cooling water, are the major environmental problems associated with anodizing plants. This assignment is concerned with a fictitious medium-sized anodizing plant. On the basis of process and product data, mass balances are used to calculate the volume and composition of the various rinse water flows.

Sample plant

The plant has a production line consisting of eight baths.

Each bath has a capacity of 20m^3 , and is 8m long, 1.25m wide, and 2m deep.

The batches of metal parts are introduced into each bath by means of a hoist.

The anodizing rate is 100m^2 per hour, and the plant is in operation for 5 500 hours per year.

Bath 1: Degreasing

Degreasing is necessary in order to remove contaminants (oil, grease, dust, etc.) from the objects to be anodized. This takes place in a dilute lye solution at a temperature of 80°C . The bath contains 25g of degreasing salt per litre; this salt is a commercial product consisting of caustic soda, silicates, phosphates, detergents, wetting agents, and emulsifiers.

When a batch is removed from the degreasing bath, a certain amount of degreasing liquid is 'dragged over': i.e. left behind on the surface and in the crevices of the various objects.

To compensate for this, and the inevitable evaporation, enough water is added to maintain the bath at the proper level. In addition, 24kg of degreasing salt is added daily, to keep the solution up to strength.

Bath 2: Rinsing

After degreasing, the objects go on to the second bath, where they are rinsed in tap water; a rinsing factor of 100 is achieved (i.e. the concentration of pollutants in the rinse water is 1% of the concentration of those same components in the previous bath, the degreasing bath).

Bath 3: Staining

The purpose of staining is to remove old or faulty anodizing layers, to mask scratches and streaks, and to activate the surface so that a semi-mat finish is formed. The stain bath consists of a concentrated caustic soda solution (70g of caustic soda per litre) with 15g per litre of stain additives (gluconates and polyalcohols). During staining, a certain amount of aluminium is dissolved (80g/m²) through the action of the lye on the aluminium surface. Through the drag over of stain solution to the rinsing bath, the aluminium concentration in the stain bath never exceeds 50g/l (this is known as the 'never dump' system). Caustic soda and stain additives are

added daily, to keep the stain solution at the correct strength.

Bath 4: Rinsing

After staining, the objects are rinsed with tap water in Bath 4, whereby a rinsing factor of 100 is achieved.

Bath 5: Anodizing

The anodizing fluid contains 200g of sulphuric acid per litre. Through the action of the sulphuric acid, the aluminium is dissolved (20g/m²), which leads to a gradual increase in the aluminium concentration.

When the concentration of aluminium reaches 15g/l, the entire anodizing bath is dumped and replaced. In addition, sulphuric acid is added daily, in order to keep the anodizing liquid up to strength.

Bath 6: Rinsing

Following the anodizing process, the objects are rinsed with tap water in Bath 6, whereby a rinsing factor of 1000 is achieved.

Bath 7: Sealing

Sealing is the process whereby the pores of the objects are closed through the formation of böhmites on the surface of the aluminium. To achieve this, the objects are dipped in a liquid containing 5g of nickel acetate per litre.

Bath 8: Final rinsing

Following the sealing process, the objects are rinsed with demineralized water in Bath 8, whereby a rinsing factor of 100 is achieved.

ASSIGNMENTS

- 1 On the basis of the information given above, draw up an **aluminium balance** for the production line. How much aluminium does this plant discharge per year?
- 2 The **drag over** is expressed in terms of the volume of processing liquid that is dragged over to the rinsing bath per time unit. For the purpose of the remaining calculations, assume that the drag over for the anodizing bath and the sealing bath is the same as the drag over for the degreasing bath. Calculate the volume of the drag over from:
 - a the degreasing bath
 - b the stain bath.
- 3 Calculate the total amount of rinse water used for each of the four rinsing baths.
- 4 The standing time is the interval between two consecutive dumps of the anodizing bath. Calculate the standing time of the anodizing bath.
- 5 Indicate for each rinse water flow:
 - a the pollutants which are present in the rinse water
 - b the volume of each of these pollutants discharged annually (the 'load').

The details of the assignments in brief

1 Aluminium enters the process flow line in the form of the metal parts to be anodized. In this production line, there are two places where a portion of the object passes into a dissolved state – namely, during *staining* (80g/m²) and during *anodizing* (20g/m²).

The aluminium balance is:

outgoing aluminium objects = incoming aluminium objects less loss during staining less loss during anodizing
The annual production is 100m²/hour multiplied by 5 500 hours/year = 550 000m²/year.
This results in:

$$\begin{aligned}\text{weight loss of objects} &= [550\,000\text{m}^2/\text{year} \times 80\text{g/m}^2] + [550\,000\text{m}^2/\text{year} \times 20\text{g/m}^2] \\ &= 55\,000\text{kg aluminium per year}\end{aligned}$$

This means that some 55 tons of dissolved aluminium is discharged each year. Of this, some 44 tons is discharged together with the rinse water from *Bath 4* (after staining).

The remaining 11 tons, the distributions of which is unknown, is released together with the spent anodizing bath and the rinse water from *Bath 6*, which follows the anodizing bath.

2 Calculating the volume of drag over from the degreasing bath and the stain bath

a Degreasing bath

In order to maintain the concentration of degreasing salt, 24kg of salt is added daily. On the basis of a 24-hour average, the amount of degreasing salt is maintained at a constant level. The balance for the degreasing salt is:

$$\begin{aligned}\text{degreasing salt added} &= \text{amount of degreasing salt dragged over} \\ &\text{or} \\ 24\text{ kg/day} &= \text{drag over volume} \times \text{concentration of degreasing salt in the bath} \times 24\text{ hours/day}\end{aligned}$$

If we fill this in,
we get:

$$\begin{aligned}\text{drag over volume} &= 24\text{kg/day} [24\text{ hours/day} \times 25\text{g/l}] \\ &= 40\text{ litres/hour}\end{aligned}$$

b Stain bath

The concentration of aluminium is kept at a constant level (50g/l) in the stain bath. This means that the weight loss of the object must be equal to the drag over.

$$\begin{aligned}\text{weight loss of objects} &= \text{aluminium drag over} \\ 80\text{g/m}^2 \times 100\text{m}^2/\text{hour} &= \text{volume of drag over} \times 50\text{g/l} \\ \text{Thus the volume of drag over during staining is } &160\text{ litres/hour}.\end{aligned}$$

3 The consumption of rinse water is equal to the drag over volume multiplied by the rinsing factor.

Consumption of rinse water for Bath 2	40 l/hour	x	100	=	4m ³ /hour
Consumption of rinse water for Bath 4	160 l/hour	x	100	=	16m ³ /hour
Consumption of rinse water for Bath 6	40 l/hour	x	1000	=	40m ³ /hour
Consumption of rinse water for Bath 8	40 l/hour	x	100	=	4m ³ /hour

The total consumption of rinse water is 330 000m³ of tap water per year,
and 22 000m³ of demineralized water per year.

4 The following aluminium balance can be drawn up for the anodizing bath:

$\text{weight loss of objects} = \text{aluminium accumulation in anodizing bath} \\ \text{plus carry over to rinsing bath}$

At the end of the standing time, the anodizing bath contains the maximum concentration of aluminium (15g/l). The aluminium accumulation in the anodizing bath is then $20\text{m}^3 \times 15\text{g/l} = 300\text{kg}$.

The drag over to the rinsing bath is equal to the aluminium concentration in the anodizing bath multiplied by the drag over volume.

However, the concentration of the aluminium gradually rises.

Assuming that the concentration increases linearly in the course of time, the average concentration will always be half of the maximum concentration (i.e. 7.5g/l).

If we fill this in, we get:

$20\text{g/m}^2 \times 100\text{m}^2/\text{hour} \times \text{standing time} = 300\text{kg less } [40\text{ l/hour} \times 7.5\text{ g/l} \times \text{standing time}]$ So the standing time is 176 hours.

5 The annual load of each type of rinse water for each component of the previous process bath can be calculated as follows:

$\text{production hours multiplied by drag over volume multiplied by concentration in the bath}$
--

- The rinse water from **Bath 2** is polluted with **degreasing salt**. The annual load is:

$$5\,500\text{ hours/year} \times 40\text{ litres/hour} \times 25\text{g/litre} = 5\,500\text{kg/year}.$$
- The rinse water from **Bath 4** is polluted with caustic soda, stain additives, and aluminium.
 The annual load of **caustic soda** is:

$$5\,500\text{ hours/year} \times 160\text{ litres/hour} \times 70\text{g/litre} = 61\,600\text{kg/year}.$$
 The annual load of **stain additives** is:

$$5\,500\text{ hours/year} \times 160\text{ litres/hour} \times 15\text{g/litre} = 13\,200\text{kg/year}.$$
 The annual **aluminium** load is:

$$44\,000\text{kg/year}$$
 (see 'Details' [2]).
- The rinse water from **Bath 6** is polluted with sulphuric acid and aluminium.
 The **sulphuric acid** load is:

$$5\,500\text{ hours/year} \times 40\text{ litres/hour} \times 200\text{g/litre} = 44\,000\text{kg/year}.$$
 For the **aluminium** load, we use the average aluminium concentration in the anodizing bath (see also 'Details' [4]):

$$5\,500\text{ hours/year} \times 40\text{ litres/hour} \times 7.5\text{g/litre} = 1\,650\text{kg}.$$
- The rinsing water from **Bath 8** is polluted with **nickel acetate**.
 The annual load is:

$$5\,500\text{ hours/year} \times 40\text{ litres/hour} \times 5\text{g/litre} = 1\,100\text{kg}.$$

5.2.5 Preliminary exercise: Identifying alternative processes

This preliminary exercise is best done individually, so each participant learns where to find information on issues related to cleaner production. In this exercise, some techniques to reduce the generation of waste are discovered. The exercise requires a library search.

The objective is to develop some insights for identifying cleaner production options. These insights will be needed for further exercises, in which options for cleaner production have to be generated.

This exercise will require some literature research.

When identifying options for Cleaner Production one can think of changes in input materials, technology changes, operational changes, product changes, and opportunities for on-site recycling. This exercise focuses on technological changes and opportunities for on-site recycling.

Question 1

Many industrial processes are batch processes, as for example in rinsing.

These rinsing processes can be substituted by counter current rinsing.

Identify journal and reference articles which explain the advantages in efficiency of counter-current rinsing versus batch rinsing.

Question 2

Heavy metals in wastewater form a major problem for industries.

The heavy metals can be separated in the sludge of a wastewater treatment, but they cannot be recovered from the sludge. The sludge has to be treated as a hazardous waste.

One way of solving this problem is to recover the heavy metals, and reuse them.

How many technologies can you find which are designed to recover heavy metals from effluents?

5.3 Work exercises

5.3.1 Elements for discussion

This exercise can be done either during plenary sessions, or in small groups.
Small groups should report the outcomes of their discussions during a plenary session.

Discussion is important, so that learners are involved in the subject matter of a presentation. In particular, it allows participants to clarify points on which they are not clear, and to raise other questions that were not covered in final presentations.

One way of initiating a discussion is by answering questions from the participants. Another approach involves the presenter asking questions of the participants. These questions

should be well prepared, and they should result in the involvement of participants, recalling and using the information they have been given.

Some ideas for discussion are given here.

They are very general, and should be adapted to your audience.

It may be useful to write down your audience's opinions and answers on a blackboard, so that you can easily compare the different viewpoints of various participants.

Some possible points for 'free' discussion

- What are the major obstacles in your company to adopting a cleaner production approach? How could they be overcome?
- What are the advantages that your country may enjoy when adopting a cleaner production approach?
- What cleaner production goals could you achieve without external assistance? What could you achieve if some assistance were available? What information on alternatives would be essential to achieve the goals without external assistance? Where would you get this information?
- Which of the tools discussed in the primer could be relevant in achieving the cleaner production goals you set for your company?

Panel session

The use of panel sessions in workshops is often very useful. A small panel of invited experts answers questions that have been submitted in written form beforehand (either signed or anonymous). This exposes the audience to different points of view and approaches of the experts.

Of course, 'free' questions and dialogue with the audience can be part of each panel session.

5.3.2 Corporate environmental action plan

This exercise requires group work and discussion. The different action plans are presented during a plenary session, which may lead to (further) discussion. This exercise follows the lines of the waste audit procedure, discussed in Section 3.3.

Zo Wat is a company which produces pesticides, and employs 3000 people. The company has to invest in end-of-pipe treatment to comply with upcoming environmental regulations.

You are responsible for all the environmental affairs of the company.

Instead of installing end-of-pipe treatment facilities, you have been advised to tackle the environmental problems at their source, so you

have decided to develop a cleaner production programme. You want to do a waste audit and implement cleaner production options in order to comply with the regulations, and, in the future, be ahead of the regulations.

A list of 11 general and specific actions, which are needed to implement a cleaner production programme, is given below. Put the actions in order of priority and explain your choice.

	Order of priority
1 Reward employees who discover and report environmental problems and who recommend ways of solving them	
2 Visit the facilities selected for the implementation of Cleaner Production options	
3 Check if the options for Cleaner Production comply with the government regulations	
4 Select criteria for the evaluation of Cleaner Production options	
5 Estimate the payback period for generated Cleaner Production options	
6 Select people for an assessment team	
7 Evaluate the results of the implemented Cleaner Production options	
8 Derive mass balances for existing unit operations	
9 Get management commitment	
10 Start training programmes for the employees about Cleaner Production and environmental awareness	
11 Set Cleaner Production goals	

5.3.3 Waste audit and reduction options in a tannery

This exercise is taken from the *Cleaner Production in Leather Tanning* training resource package. The full training resource package is available from UNEP IE. The exercise is best done in small groups, although it can also be done individually.

It is a long exercise, so the trainer may want to concentrate on only a few simple questions for a short session. At the end of the exercise, a group discussion can be initiated to identify cleaner production options.

The preliminary exercise on the identification of alternative technologies should give some insights into identifying these options.

Introduction

This exercise examines a tannery which processes 40 tonnes of hides a day using a chrome-tan process. In order to meet new effluent regulations, the tannery has to upgrade several aspects of its operation. This exercise will focus on the chrome effluent problem. The new regulations require an effluent standard of:

- less than *5mg/l* for *discharge to sewer and*
- less than *1mg/l* for *discharge to local streams*.

The upgrading also provides an opportunity to reduce operating costs at the tannery. By reducing the wastage of chrome in the effluent, the tannery hopes to reduce the US\$2 000 a day it currently spends on chrome tanning agent. Chrome accounts for a large proportion of total chemicals cost in the plant, and represents 16% of the cost of finished leather.

This exercise will follow the waste audit procedure given in the UNEP/UNIDO *Audit and Reduction Manual for Industrial Emissions and*

Wastes. Technical information on cleaner production options for the tannery can be found in UNEP/UNIDO's Technical Report No. 4 *Tanneries and the Environment*.

The exercise follows the audit steps recommended in the Manual.

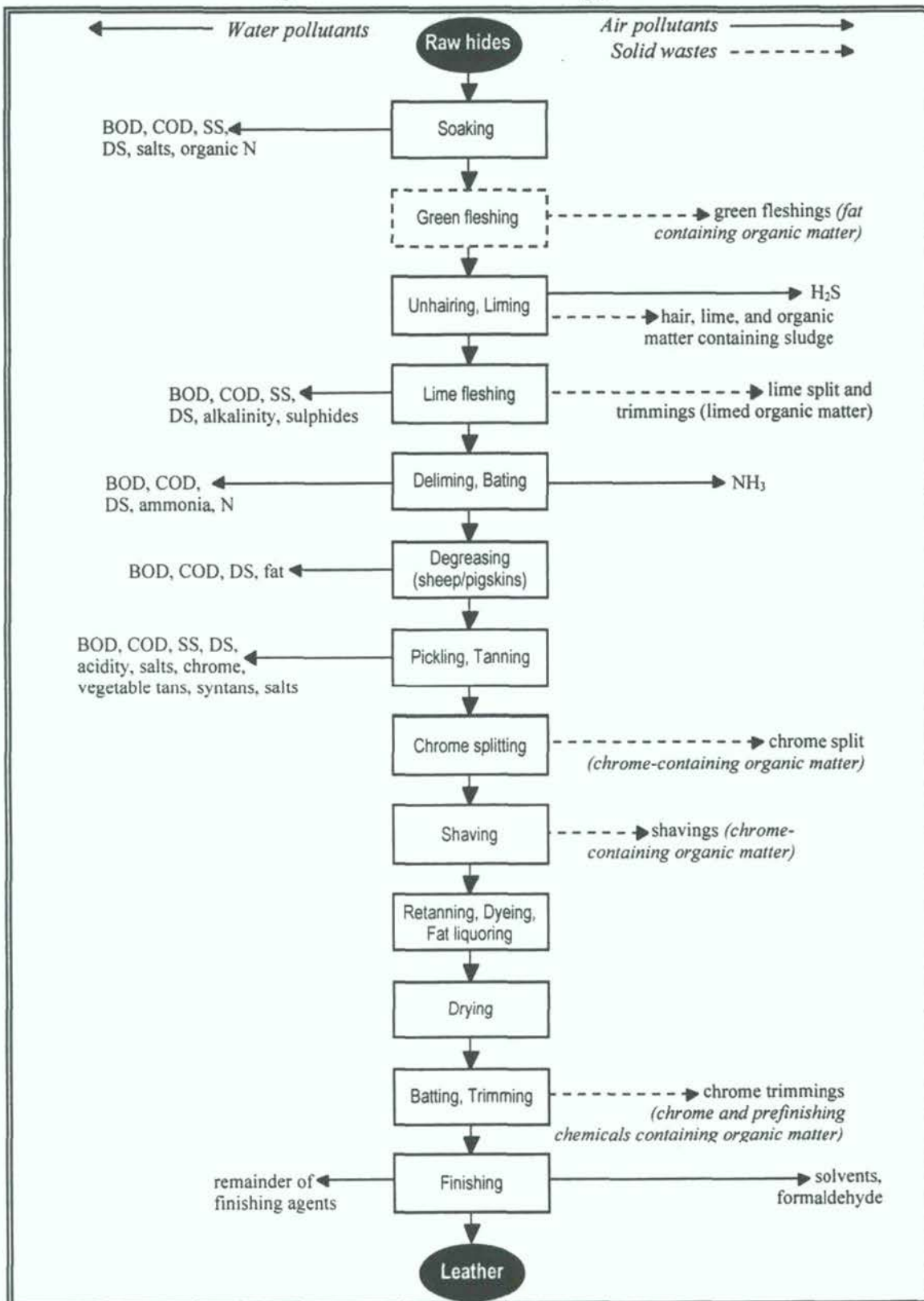
First, we examine the consumption of chrome tanning agent in the plant.

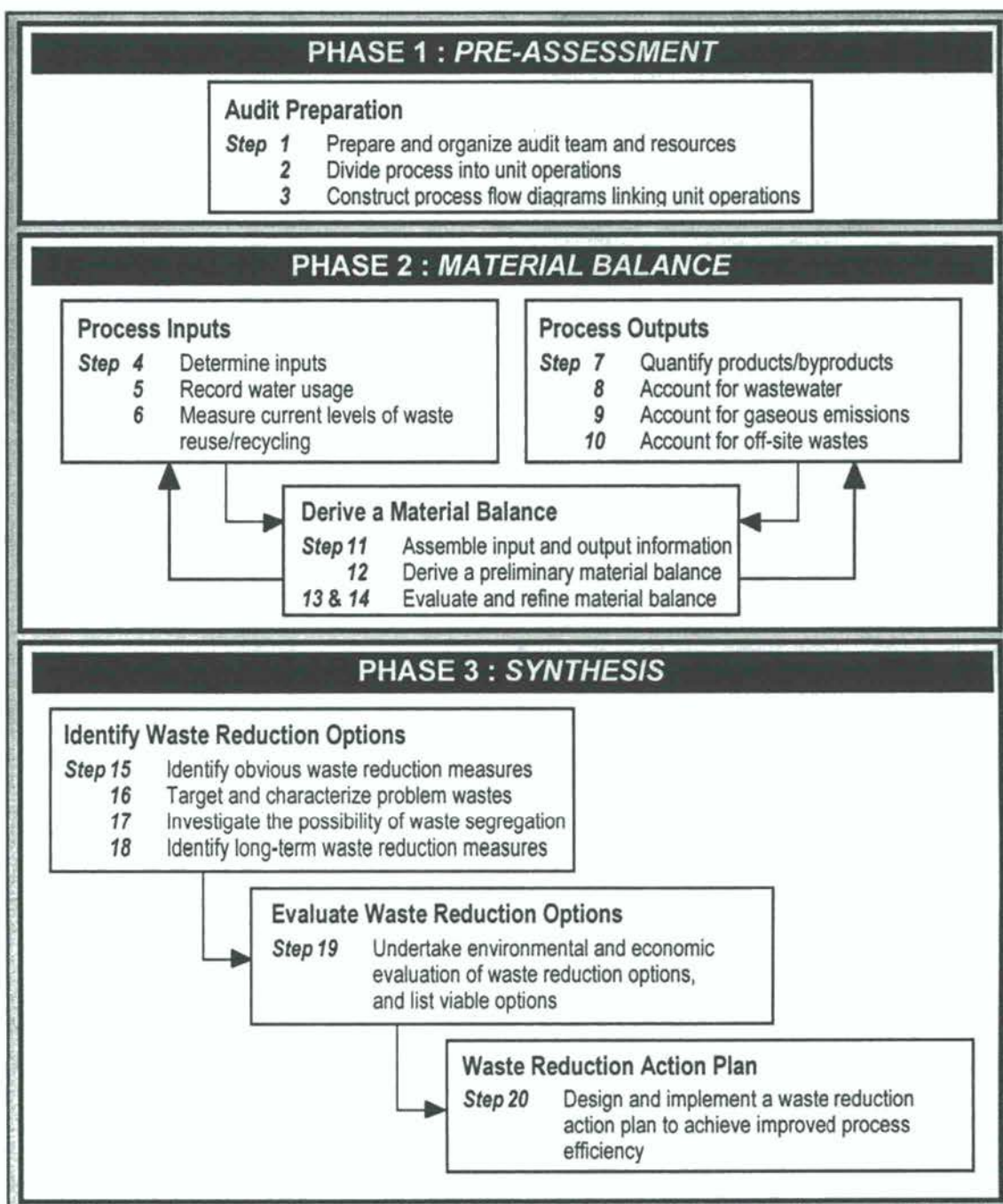
A number of alternatives – such as modified tanning agents, recycling, and chrome recovery – are then studied, and relative cost saving and effectiveness in meeting effluent standards are calculated.

These options are then compared to the cost of a treatment plant.

Please note that the figures used in this exercise do not represent an actual situation. They are ballpark figures drawn from various documents, and have been adjusted to make the calculations easier. Actual figures are, in any case, highly situation-specific.

Figure 5.1 Schematic of the tanning process





PART I: PRE-ASSESSMENT AND MATERIAL BALANCE**Step 1:****Audit team**

Assume this has been done. You are it!

Steps 2 & 3:**Unit operations and process diagram**

Refer to page 60 of the Manual. The diagram is reproduced here as Figure 1 Schematic of the Tanning Process on page 38. Note where chrome chemicals enter the process, and where they leave.

- Refer to the diagram on page 123 of the *Audit Manual*.
- Refer to pages 69-74 of the Manual for plant specific details
- Refer to Chapters 3 and 5.2 of the *Tannery Guide*.

PART II: MATERIAL BALANCE**Steps 4, 5 & 6:****Process inputs (Cr)**

- Refer to pages 61, 62, 64 and 70 of the *Audit Manual*, and pages 21-27 of the *Tannery Guide*.

The key figures to note are:

- Hides processed 40 tonnes/day fresh hides
..... 35 tonnes/day fleshed hide
- Process water (tannage) 30 m³/day
- Rinse water (tannage) 100 m³/day
- Total plant water 1800 m³/day
- Tanolin (16% Cr) 2076 kg/day
..... (ca 322kg Cr/day)
..... (ca 8kg Cr/tonne of fresh hides)

There is no recycling of waters or solids.

Cost of materials:

- Water for tanning (10 c/m³) \$17/day
- Tanolin (\$1000/t) \$2000/day
@ 16% Cr (ca \$ 7/kg of Cr)

Expected absorption rate of tanolin is 70% (i.e. 30% is wasted)

Steps 7, 8, 9 & 10:**Process outputs**

- Refer to pages 65, 66, 69 & 70 of *Audit Manual*, and pages 22-25 of *Tannery Guide*.

The key figures to note are:

- Chrome leather 7 tonnes/day
- Trimmings and shavings 7 tonnes/day
(after Cr tannage) refer to p69 Audit Manual and p25 of Tannery Guide
- Containing together 225 kg/day of Cr
- Tanning liquors 90 kg/day of Cr
..... (33m³/day @ 2 500 mg/l)
- Tanning rinsewaters 7 kg/day of Cr
..... (2 000 m³/day @ 1.5 mg/l)
- Total plant wastewater 1 800 m³/day

* These waste streams account for the 30% of tanolin that is not 'taken up' by the hide and hence is releasor and washwater.



1 What is the concentration of chrome in:

(i) the spent tanning liquor?

(ii) the effluent from the tanning stage (liquor and rinsewater)?

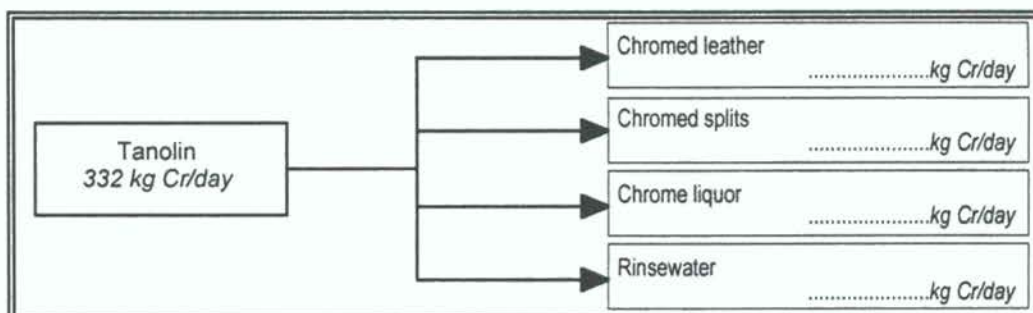
(iii) the total combined plant wastewater discharge?

The answers to this question are on page V:33.

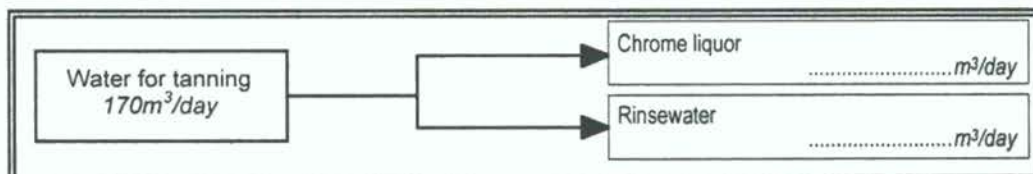
Steps 11, 12, & 13: Materials balance

Some simple flow charts for the process are shown below.

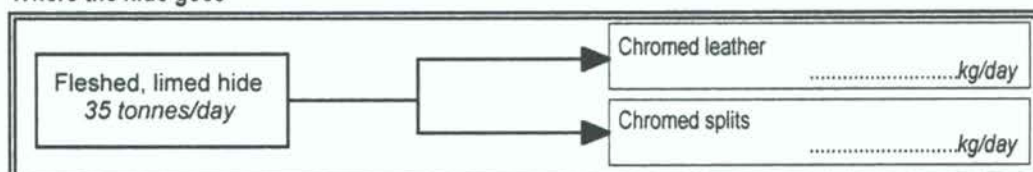
(i) Where the chrome goes



(ii) Where the water goes in the tanning stage



(iii) Where the hide goes



Check that the input/output balances correctly.

PART III: SYNTHESIS

Step 15:
Obvious waste reduction measures

• Refer to page 72 of the *Audit Manual*, and pages 36 and 37 of the *Tannery Guide*.

One of the simplest measures is reduction in water use. In many plants, a great deal of water is wasted with no process benefit. More efficient rinsing can also save a lot of water.



- 2 If a 50% reduction in rinsewater can be achieved with a batch rinsing system, how much water would be saved in the tanning process?

m³/day

The answer to this question is on page V:33.

- 3 How would this affect the concentration of chrome in:

(i) the rinsewater?

(ii) the plant's combined wastewater stream?

(iii) What is the direct cost saving achieved?

The answers to this question are on page V:33.

Other obvious reduction measures include:

- reduced use of washwater in the factory and, importantly,
- action to reduce chemical spills
- ensuring containers are completely empty and
- rinsing of containers to recover chemicals.

However, we will not calculate these here.

Step 16:
Identify problem wastes



4 From Steps 11-14, identify and give figures for:

(i) significant economic losses of chrome:

(ii) important sources of chromium wastewater that lead to difficulties with regulatory standards:

(iii) the most significant loss of water:

Some suggestions about how you might answer this question are on page V:34.

Step 17:
Waste segregation

At the moment all wastewaters enter the same drain for discharge.



5 (i) What are the possibilities for waste segregation?

(ii) What benefit would segregation have?

Suggestions for responses to this question are on page V:34.

Steps 18 & 19: Waste reduction measures

• From Chapter 5.2, page 39-42, we learn that a number of options exist to reduce the chrome problem (apart from treatment, which is expensive).

Simply stated, these options are:

Option A

Use high exhaustion chrome formulation instead of Tanolin.

This allows 90% chrome fixation in the leather, instead of the present 70.



- 6 (i) What is the cost saving to the tannery? (Assume here the same price for this formulation*)

\$/day

To what level will this reduce the chrome in:

- (ii) the total effluent from the plant?

.....mg/l

- (iii) the effluent from the tanning stage?

.....mg/l

- (iv) the spent tanning liquor?

.....mg/l

**In fact, the high fixation formulation is about 30% more expensive.*

The answers to this question are on page V:34.

Note that high exhaustion tanning agents have the chrome in complexed form. Any remaining liquors are difficult to treat by normal precipitation, and you should assume that unused complexed chrome is completely discharged to drain.

Option B

Recover spent chrome by collecting relevant effluents, and precipitating unused chrome for subsequent re-use (see page 40 of the *Tannery Guide*). Assume a 95% recovery rate. Assume the cost of this process is 30% of the cost of buying new Tanolin (on a chrome content basis). Ignore the capital cost of recovery plant for this exercise.



7 (i) What is the cost saving to the company?

\$...../day

To what level will this reduce the chrome in:

(ii) the effluent from the tanning stage?

.....mg/l

(iii) the total effluent from the plant?

.....mg/l

The answers to this question are on page V:35.

Option C

Recycle the spent tanning liquor to pickle or as make-up for subsequent tannage. Assume 67% of liquor can be recycled like this (see page 40 of the *Tannery Guide*). Assume capital costs for replumbing and pumps is negligible.



8 (i) What is the cost saving to the company?

\$...../day

To what level will this reduce the chrome in:

(ii) the remaining tanning liquors discharged?

.....mg/l

(iii) the entire effluent from the tanning stage?

.....mg/l

(iv) the total effluent from the plant?

.....mg/l

The answers to this question are on page V:35.

Option D

Solid waste

Here, we quickly look at solid waste.

A lot of chrome goes into trimmings and shavings when the tanned leather is cut to size. If the leather could be cut to size before tanning, then this chrome would be saved. However, fresh untanned hide is difficult to cut and trim.

A compromise is to give hide a *pre-tan* with, say, an aluminium tanning agent, to stabilize the hide. It is then trimmed and split.

The cut sheets (minus wastage) are then chrome tanned.



Why not use aluminium tanning all the way through?

For the answer to this question, see page 44 of the Tannery Guide.

To investigate this option, recall that – in Steps 7-10 – we found that:

- for 7 tonnes of leather/day, as much as 7 tonnes/day of trimmings and shavings are produced.



The chrome content is the same, at:

.....kg/t

The answer is 7kg/t.

A further aspect is that chrome shavings cannot be re-used as fertilizer or animal feed ...



Why not?

... and have to be dumped.

Now we will look at the effects of this option.



- 9 (i) What is the cost saving of this option, assuming process costs are the same?

\$/day

- (ii) What cost recovery is made if the non-chrome shavings are sold as animal feed for 10c/kg?

\$/day

- (iii) What is the effect on the amount of chrome in the tanning wastewater?

- (iv) What is the effect on the amount of chrome in the combined plant effluent?

Suggestions for responses to this question are on page v:35.

Step 20:
Action plan

Some of the above options could be combined to achieve even greater cost savings and reduced chrome levels in effluent.



10 (i) Propose the best combination of the above, assuming that no treatment of effluent occurs:

Option Calculate cost savings and final effluent level of chrome

\$...../daymg/l Cr

(ii) Assuming that some treatment will probably still be necessary, what combination would you propose?

(iii) Use of 2 000 kg/day of Tanolin results in the release of 14 000kg of Na_2SO_4 . How does this influence your decision about the best option?

Our suggestions about how you might answer these questions are on page V:36.

Finally, we will quickly compare the reduction options with the conventional alternative of an effluent treatment plant.

Some notional figures for a chrome removal plant are:

- **Capital cost** \$20 000 with 100m³/d capacity (minimum \$50 000)
- **Operating cost** \$1 500/tonne of Cr removed (including transport and disposal costs of sludge)

A number of calculations are possible. Amortizing the capital cost requires a guess at interest rates, repayment periods and so on, which is too complicated here.

However, if you do want to include this calculation, assume that the loan is over 1 000 days, and interest doubles the capital cost.



- 11 (i) What is the cost of chrome removal from the tannery in its original condition (i.e. no reduction measures), assuming no flow segregation occurs?

Capital cost	\$
Operating cost	\$/day

- (ii) What is the cost of treating just the chrome liquor?

Capital cost	\$
Operating cost	\$/day

- (iii) What is the operating cost for treating the remaining high strength liquors from:

Option A	\$/day
Option B	\$/day
Option C	\$/day

The answers to these questions are on page V:36.

5.4 Further work exercises

A number of companion workbooks give more extensive work exercises in various industrial sectors. These can be used for in-depth or prolonged work on cleaner production options.

In 1995, companion manuals were available on:

- **Leather Tanning** (beamhouse, tanning, and finishing)

- **Textile Manufacture** (wet processing) and
- **Breweries.**

The work exercises in these sectors include simulated audits, cleaner production options, pollution management, and other environmental issues.

For further information, contact UNEP IE.

5.4.1 Using the International Cleaner Production Information Clearinghouse (ICPIC)

What you need

For this exercise, you will need a personal computer and the diskette version of ICPIC.

If you do not have the diskette version, contact UNEP IE.

The exercise can be done individually or in small groups, depending on the time available.

What you need to do

In this exercise, the same tannery case study is used as in the technical exercise on the waste audit and reduction options in a tannery.

Assume that the waste audit has been conducted and that you now need to develop options for cleaner production applications. You will install the ICPIC database on a personal computer and see what advice it can provide for you.

Instructions for installing ICPIC follow.

Once you have identified cleaner production options, compare them with the suggested options provided in the UNEP/UNIDO *Tannery Guide*.

Instructions

- 1 Download the ICPIC diskette to a personal computer and run the demonstration programme to get a quick overview of how to search the databases.
- 2 Search the *Case Study* database using the keywords you have already chosen: 'leather', 'tanning', 'chrome' etc. Note any case study which provides alternatives to chrome tanning. Comment on their relevance to the current problem.
- 3 Consult the list of *expert institutions* to see which organisations could provide assistance with chrome reduction options. Which organizations would you contact first? Why?
- 4 Consult the *Publication Abstract* database for useful reference. How would you go about obtaining the documents?
- 5 How would you use the '*Resources Available from UNEP*' database?
- 6 If you have access to *email*, contact the Cleaner Production Programme (icpic@unep.fr) and request assistance. How would you phrase your request?

Installing the ICPIC database: Overview and general instructions

Purpose

The *International Cleaner Production Information Clearinghouse: Diskette Version* (ICPIC-DV) was developed by the UNEP IE Cleaner Production Programme to assist you with researching and answering technical and policy questions about cleaner production, the preventive environmental management strategy.

It was designed to help organizations – in developing as well as developed countries, from the public and private sectors – to understand the concept of cleaner production and its practical application. It will also further expand and solidify the worldwide network of cleaner production practitioners.

UNEP IE encourages industry, research institutions, government, and academics to network with one another to find their appropriate cleaner production solutions.

The ICPIC-DV can help you:

- by answering technical questions
- by formulating cleaner production programmes or projects
- by providing information about the different policy approaches

- by supporting workshops and information campaigns
- by providing sources of assistance.

Description

The ICPIC-DV diskette is a collection of key databases related to cleaner production.

Please refer to the enclosed *Table of Contents* for specific descriptions. It is a handy electronic reference tool that is easily searchable by specific keywords or any word(s) you specify, and from which printouts are quickly produced.

Operation

The diskette is a self-contained database system that can be run on any IBM-compatible computer using DOS 3.3 or later versions, with a minimum of 3MB of free space on the hard drive, a 3.5 inch floppy disk drive, and 1MB of RAM.

The installation procedure is simple. However, we recommend that, before you install ICPIC-DV, you call up the 'readme' file on the diskette using your normal word processing software. It contains detailed installation procedures and background information that will help you to avoid making errors. It is an ASCII file that can be read by any word processor or text editor.

To install ICPIC-DV on your personal computer, follow these instructions:

- 1 Place the ICPIC-DV diskette in the floppy disk drive.
- 2 Change the default drive, as appropriate, to A: or B: by typing "A:" or "B:" at the C> prompt, followed by return/enter.
- 3 Type 'install' and follow the on-screen instructions.
- 4 The ICPIC-DV will install itself on your hard drive in a directory of the same name.

Demonstration feature

To access the demonstration feature, from the ICPIC-DV> prompt, type "cp /d". The demonstration takes you step by step through the process of finding answers to example questions, and shows you various search and printing features.

Caution As with any software that is freely exchanged, you should be careful to avoid introducing software viruses into your computer. UNEP IE strongly recommends that you use a virus checking program on any software you receive from outside your organization. UNEP IE assumes no responsibility for damage or problems caused by viruses that may accompany this software.

5.4.2 Information search on cleaner production

Options for chrome tanning

This exercise can be done individually or in small groups.

The previous exercise was aimed at finding references in literature about cleaner production options through ICPIC. When access to ICPIC is not possible, literature research has to be done in a library.

This exercise is designed to help you in finding information sources through literature research, which can help you identify options to reduce the emissions of the tanning process.

The context

You are the manager of a small leather tanning company. Your company uses chrome for

tanning. There is no recycling of waters or solids, and untreated wastewater, containing considerable amounts of chrome, is discharged into the local streams.

You want to reduce the amount of chrome in the wastewater.

Your task is to identify the options for reducing the amount of chrome discharged into the sewer by using cleaner technologies.

Since your focus is on cleaner production, wastewater treatment is not considered an option on its own!

One way to identify options is to do literature research in a library.



Question 1

Go to the library and look for information sources which you could consult to find the options to reduce the amount of chrome in the wastewater. Divide the information sources into two groups: *institutions* and *documentation*.

Give the names of the institutions, and the countries where they are located. Be specific! For example, 'UN, France' is not specific enough – in this case, the answer should be: 'United Nations Environment Programme, Industry and Environment Centre, France'.

Make a bibliography of books, manuals, journals, brochures, videos and databases, which may provide you with information on Cleaner Production technologies in leather industry.

N.B. References used within documents can help you find information sources which might not be present in your library.

Question 2

Choose one or two technical journals from the bibliography you produced in *Question 1* for further detailed study.

Study all issues contained in the last five volumes.

Find as many technologies as you can in these issues, which aim to reduce the amount of chrome in wastewater.

Make an abstract of the three most feasible options, in your opinion. Then compare your list of options with the lists produced by other students, and identify the differences.

5.4.3 Selecting criteria for an ecolabel

This exercise requires group work.

Good product design can do much to reduce environmental impact. It is becoming more common for countries to give an 'ecolabel' to such products.

This exercise aims to stimulate discussion and bring to the surface the complexity of the environmental impacts of a product, and the difficulties of choosing criteria for an ecolabel.

The context

An ecolabel informs the customer that a labelled product is environmentally more friendly than other products in the same category. Some countries have a system for government

approved ecolabels. The award of an ecolabel calls for an overall assessment of the ecological impact of a product during its life cycle, including the production phase.

Your task

You should assume that your government intends to introduce ecolabels for product categories in your country.

These products include:

- bikes
- bottles
- writing paper
- paints
- toilet soap
- batteries
- shoes
- domestic refrigerators
- spray cans (e.g. for deodorants, nose sprays, hair sprays).

For the purpose of this exercise, assume that the use of ecolabels aims to support national policies on the protection of the ozone layer, desertification, climate change, land use, and hazardous waste.

The development of criteria for ecolabels requires a thorough evaluation of the impact of products on the environment throughout their life cycles. Therefore, the government has assigned a jury to select a set of the most important criteria

to use when evaluating the impacts of products. These criteria will then be further developed and used when deciding which product, within its category, to award with an ecolabel.

You are the jury responsible for the selection of the criteria for toilet paper. A second jury is considering batteries (dry cells). Discuss in class or in small groups the criteria for the impact on the environment of the product with which you are dealing.

When discussing the different criteria, you need to consider the following:

- why is the criterion *important*?
- is there a *difference* between the environmental impacts of the different toilet papers (or batteries) for the selected criterion?
- what *information* about the product do you need in order to test the product on the chosen criterion?

5.4.4 Role-play: Cafe Reducto

This is an interactive exercise, which looks at the process of making coffee. The purpose of the exercise is to demonstrate how to perform a waste audit, and to demonstrate through a role play the importance of teambuilding.

An introduction for the trainer

This role-play needs audience interaction. You will need to:

- provide specific guidance to your audience on what their roles entail and
- give them a few minutes to think before you start the exercise.

The possible role descriptions are given below.

Explain the purpose of this exercise, before you start the role-play.

The core of the waste audit is to constantly ask:

- *Why do we do it this way?*
- *What are the consequences?*

If you keep asking these questions, you will understand the process and reveal the options available to you.

STEP ONE: RECRUITING A VOLUNTEER

After describing briefly the whole process of Cafe Reducto, you should ask for a volunteer.

Ask, “Who makes bad coffee?”, and recruit the first person to put their hand up.

STEP TWO: IDENTIFYING INPUTS, PROCESSES AND OUTPUTS

Make the coffee and identify the **inputs**, **process steps**, and **outputs**. Use flipcharts labelled *input*, *process steps*, and *output*.

The selected audience member should make the coffee. As the coffee is being made, ask the audience to identify the inputs and the process steps. Then ask them to look in the waste bin and check off the outputs.

Write all of these down on the flipcharts as the coffee is being made.

Check the findings against this list:

Inputs tap water, spring water, coffee (ground in a can), unground beans, ground beans: decaffeinated/regular/flavoured.
Cream and sugar.

Processes coffee maker (electric or manual), extension cord, bleached virgin paper filters, recycled brown filters, mesh filter, silk filter, roll of paper towels, cloth rag.

Outputs paper cups, reusable mugs, thermos, dishwashing detergents, draino, waste container, packaging, drain or bucket.

Finally, serve the coffee in paper cups.

STEP THREE: IDENTIFYING OPPORTUNITIES FOR SOURCE REDUCTION

Now recap the inputs, process steps and outputs. Move the discussion to identifying source reduction opportunities, and the incentives and barriers to achieving them.

Use flipcharts to facilitate the discussion. Label the flipcharts, 'Source Reduction Opportunities' and 'Incentives and Barriers'.

Ask for ideas on how to reduce or eliminate what is ending up in the bin. Ask the audience to identify the incentives for and barriers against doing what they suggest.

For each barrier they identify, they must suggest a means to overcome it.

To start the discussion, ask about what is going into the bin:

- *How much is there?*
- *What kind of material is it?*
- *Where does it come from?*
- *How do you find out where it comes from?*
- *Who do you ask?*
- *Who do you need on your team?*
- *Who do you need as advisors?*

Discuss incentives and barriers.

Link opportunities for source reduction to the specific incentives or barriers identified.

Note Participants in the role plays should be encouraged to bring their own perspectives into the discussion.

Possible audience roles

Role	Comment
<i>Owner of Cafe Reducto</i>	The process is fine, so don't change it – it's perfect. How much will it cost?
<i>Supplier/Vendor</i>	You have a number of low-impact coffee processing products – new types of filters, water, beans and equipment which are all environmentally safe. Sure, it costs more – but Cafe Reducto customers won't object to paying a little more for 'coffee correct'.
<i>Waste handler</i>	You mutter about increasing regulations and how your costs keep going up, and how sorry you are to notify Cafe Reducto of another cost increase for your services.
<i>Competitor</i>	'Muddy-Less-Water Coffee Shop' – you are better, cheaper, and more environmentally friendly – and you advertise these facts a lot. You use low-impact everything.
<i>Dr. Coffee, an academic</i>	We have spent years perfecting the process. It is fine. We can find secondary uses for all of the valuable byproducts generated from the coffee making process. One research project is identifying ways to use the spent disposable filter-packed coffee to serve in oil spill cleanup and toxic waste spill containment. So there is an environmental benefit from these byproducts.
<i>County</i>	There are more regulations from both the state and the federal government which have to be enforced. The county is not to be blamed. We do have some resources that might help to prevent your coffee shop being subject to these regulations – I would be glad to talk about them.
<i>Customers</i>	You can think of several types of customer: environmentally aware customer, health and safety conscious customer, and cost and time conscious customer, all with their own specific wishes for the quality of the coffee, service, and so on.

STEP FOUR: IDENTIFYING THE TEAM MEMBERS

Next, identify the team members. Use a flipchart labelled *Team Members*.

Emphasize that you need to ask lots of questions:

- *how do you find out?*
- *who do you need on your team?*

- *who can advise you?*

You then use the team to generate and implement options.

From this information, and by examining your processes, you will know who to have on the team and who to have as advisors.

STEP FIVE: DERIVING A WASTE AUDIT PROCEDURE

Derive a waste audit procedure: '*How do I start?*' Use a flipchart labelled *Waste Audit Procedure*. Let the audience derive the generic audit procedure. Identify the missing points as needed. Compare your procedure with that provided in the Background Paper in *Section 3.3* of this package.

It is a descriptive approach, not prescriptive – it matters more where you end up, i.e. implementing source reduction and reaching your goals, than where you start. Begin where it makes sense to you. You need to complete each step in order to finish, but you can start where you want. Overview the audit steps to illustrate this point.

You are working toward creating a complete picture of your inputs, processes and outputs. You don't have to do this all at once – you can work towards it by completing the whole picture a piece at the time.

If you start by looking at your outputs, it may provide a perspective on where to begin waste audits. An understanding of outputs will lead to waste audits of specific activities. The question for you to answer is where to draw the line – that is, what inputs and processes do you include and what do you leave out in analyzing source reduction opportunities?

STEP SIX: CONCLUSION

Cafe Reducto serves as a model process. The audience has identified an audit procedure, so make reference the procedure they have devised. Reiterate that a process is something which generates waste, emphasizing that waste audits:

- use the knowledge of individuals
- identify who should be on the team and who should be consulted
- include all available resources, even external ones.

5.5 Answers to the work exercises

PROCESS OUTPUTS

Question 1

page V:18

(i) The concentration of chrome in the spent tanning liquor is:

$$3\,000\text{mg/l (90kg in }30\text{m}^3\text{)}$$

(ii) The concentration in the effluent from the tanning stage is *liquor plus tanning rinsewater*.

Process waste (tanning liquors) is $30\text{m}^3/\text{d}$. Effluent volume for tannage rinse is not measured, but can be calculated from water input for process minus strong liquors, i.e. $170 - 30 = 140\text{m}^3$.

Together, they contain a total of 97kg/day of chrome, as shown in the process outputs. Chrome concentration is thus:

$$97 \times 10^6 \text{ mg} / 170 \times 10^3 \text{ l} = 570\text{mg/l}$$

(iii) Chrome in total plant wastewater discharge is clearly total chrome by total volume:

$$97 \times 10^6 / 1\,800 \times 10^3 = 54\text{mg/l}$$

OBVIOUS WASTE REDUCTION MEASURES

Question 2

page V:19

With a 50% reduction in rinsewater consumption, the saving in water is clearly half the 140m^3 used for tannage rinsing as shown in the process inputs, i.e. 70m^3 .

Question 3

page V:19

(i) The concentration of chrome in the rinsewater would clearly be double the concentration produced traditionally: i.e. 100 mg/l .

(ii) The plant's overall water consumption would reduce by $70\text{m}^3/\text{d}$ if only the tanning rinses were reduced.

Accordingly, there would only be a very slight reduction in total chrome concentration – but if *all* rinses in the factory were reduced by 50%, then the water savings would be much higher.

We can assume that most of the effluent volume is due to rinsing of various stages of processing, so a saving of up to, say, 800m^3 could theoretically be achieved, although in practice, the volume would be less.

As the amount of chrome used has not changed, the chrome concentration would then be around $97\text{kg} / 1\,000\text{m}^3 = 97\text{mg/l}$, higher than before.

(iii) Direct cost savings are due to reduced water use – i.e. 70m^3 during tanning, or 800m^3 overall, giving \$7 and \$80 savings respectively per day.

Other important cost savings can be expected from downscaling recycling systems and the effluent treatment plant. Some minor savings in reduced pumping costs, etc. would also occur.

PROBLEM WASTES

Question 4
page V:20

- (i) Significant economic losses of chrome occur in the discharge of tanning liquors ($97\text{kg/d} \times \$7/\text{kg} = \$679/\text{day}$ lost chemical), and especially the $(7000 \times 1.61\%) \times \$7/\text{kg}$ of chrome lost in trimmings and shavings per day. (\$784/day equivalent).
Only a third of the chrome goes into useful leather.
- (ii) Important chrome sources that lead to regulatory problems are:
[a] the discharge of spent process liquors which are very high in chrome ($3\,000\text{mg/l}$)
and
[b] chrome rinsewaters which are less concentrated but still a problem ($7\text{kg Cr}/1\,400\text{m}^3 = 50\text{mg/l}$).
- (iii) The most significant loss of water occurs in rinsing, although this is inferred rather than stated for the entire factory. For the actual tanning process, the rinsewater discharge of 140m^3 is much higher than the process liquor at 30m^3 .

WASTE SEGREGATION

Question 5
page V:20

- (i) The possibilities of waste segregation should be good, given that the tanning stage is a discrete batch process, and the volumes are relatively low.
- (ii) The benefit would be that only a relatively small volume – around $170\text{m}^3/\text{d}$ or less – would have to be treated for chrome removal, instead of the entire $1\,800\text{m}^3/\text{d}$ of total wastewater.
More significantly, the high strength process liquor ($30\text{m}^3/\text{d}$) could be economically recovered. Accordingly, the benefits include both *lower treatment costs* and some *cost recovery*.

CLEANER PRODUCTION

Question 6
page V:21

- Option A
- (i) The cost savings depend a little on what is included. Certainly, reducing chrome loss from 30% to 10% will save 20% of $\$2\,000 = \$400/\text{day}$, if the cost of the formulation is the same. When the 30% higher cost of high exhaustion chrome is included, there will be no net cost saving if all unused chrome is discharged. This shows why many tanners prefer to recycle high exhaustion chrome.
- (ii) The chrome loss has been reduced to 10% of 322kg, i.e. $32 \times 1\,000/1\,800 = 18\text{mg/l}$, but still too high to be discharged without treatment.
- (iii) In the tanning stage, the concentration will be reduced to $32 \times 1\,000/170 = 188\text{mg/l}$.

Question 7

page V:22

Option B

(i) By recovering chrome from liquors and tanning rinses, 95% of the 97kg currently wasted can be recovered, i.e. 92kg. At 70% of new chrome cost, this represents a saving of \$450.

(ii) Chrome in the tanning-stage effluent is reduced to zero, but some chrome is instead discharged from the recovery unit. Assuming about the same volume of liquid in this unit, we can simply assume 5% of the former value of 570mg/l; i.e. 28mg/l.

(iii) Chrome in the total effluent from the plant is reduced to 2.7mg/l, acceptable for discharge to sewer (you will recall that this was 5mg/l), and nearly sufficient for discharge to surface water.

Question 8

page V:22

Option C

(i) If 67% of chrome float can be recycled to pickle, only 67% of the 90kg/d of liquor will be saved, i.e. 60kg x \$7 = \$420.

(ii) The chrome level in the tanning liquors that are discharged will remain the same, because they cannot be recycled. Only the volume is reduced.

(iii) The chrome level in the effluent from the tanning stage will be reduced to:
 $30 + 7\text{kg}/140 + 10\text{m}^3 = \text{approximately } 247\text{mg/l}.$

(iv) The effluent from the plant will be reduced to $37\text{kg}/1\,800 = 21\text{mg/l}.$

This is still too strong to be discharged under the new regulations.

Question 9

page V:23

Option D

A total aluminium tannage gives a slightly different leather quality to chrome tanned leather. Using aluminium only for a pre-tan step avoids most of this problem. Also, aluminium tanned shavings are not toxic to animals, so they have some residual value as feed.

(i) By using an aluminium pre-tan step, the saving in chrome is:

$$7\text{t} \times 16\text{kg/t} \times \$7 = \$784/\text{d}.$$

The cost of aluminium has still to be subtracted from this to calculate net savings.

(ii) The 7 tonnes of shavings can be sold for 10c/kg = \$700/d. This is perhaps somewhat utopian, but it does illustrate the possibilities.

(iii) The effect on chrome content in tannage wastewater depends partly on the reduction in the amount of chrome needed for final tannage. No data is given on this.

If we assume that the same amount is still required per m² of hide, then the chrome concentration is the same as that of the normal tannage effluent, i.e. the 570mg/l calculated earlier.

(iv) The total amount discharged by the tannery is, of course, reduced in proportion to the surface area (or mass) of hide that remains after trimming, i.e. 7/14 = 50% of the original.

Assuming that most of the plant effluent comes from beamhouse and pre-tan, then the change in total wastewater from the plant is not much changed (only 50% of 170m³ = 85m³ less, which is roughly 95%). The level of chrome in the final effluent is then reduced approximately by the amount avoided in use, i.e. 50% less, to around 27mg/l.

ACTION PLAN

Question 10
page V:24

(i) Because the cost of high-exhaustion chrome is considerable, a simple useful option is to carry out aluminium pre-tan and trim before concluding with a normal chrome tan, plus practising recovery and recycle of any remaining liquors to pickle.

This can reduce chrome consumption by ensuring none is wasted in splits, and that almost total re-use is made of strong effluents.

For the first batch, chrome consumption is reduced by 50% – i.e. to 161kg/d – thus saving \$1 000. 30% of this remaining chrome is still left as waste liquor and rinsewater, which can be recycled to 95% level, a quantity of 46kg/d.

This recovered chrome can be used for the second batch at a cost of 30% of new chrome, i.e. around \$2/kg.

For the second batch, only 115kg of new chrome at \$7/kg is needed (\$805), plus 46kg of recycled chrome at \$2 = \$92.

The total for the second and subsequent batches is thus \$897 instead of \$1 000.

So further savings are \$103/d, and the total savings are \$1 103/d. We ignore for simplicity the savings from any chrome recycled to pickle, regarding this more as avoided effluent discharge.

If recovery can be carried out indefinitely (although it cannot, because other salts build up), the final level of chrome in effluent is determined by the remaining wastage of the 5% of float and rinsewater that cannot be recovered. This amounts to 5% of the reduced chrome needed for tannage, i.e. 5% of 48kg/d = 2.4kg/d. In the final total effluent, this will be 1.3mg/l.

(ii) If treatment is still necessary, then the use of high exhaustion chrome should be avoided. The same tanning combination as above would be appropriate.

(iii) If the discharge of large quantities of sulphate is a problem (e.g. to sewer systems), then the use of tanolin should be reduced as much as possible. The above combination of aluminium pre-tan and splitting before final tan, plus chrome recovery is very helpful in reducing tanolin consumption. Maximum use of spent float liquors for recycle to pickle could further avoid some sulphate releases.

DISPOSAL OPTIONS

Question 11
page V:25

(i) The original configuration of discharges was 97kg/d of chrome to effluent. The volume of wastewater is 1 800m³/d. To treat combined wastewaters requires a huge capital cost of \$360 000, and only \$145.5/d operating cost.

(ii) If only tannage liquor (or effluent) is treated, the capital cost reduces to the minimum of \$50 000, with the same operating cost.

(iii) The cost of treating **Option A** tannage effluent is $1/3 \times \$145.5 = \$7/\text{d}$.

For treating effluents from **Option B**, the cost is $0.05 \times \$145.5 = \$7/\text{d}$.

For **Option C**, the cost is $0.33 \times \$145.5 = \$48/\text{d}$.

These cost reductions are not significant compared to capital costs for a treatment plant, nor to savings achieved by reducing chemical consumption.



Appendices

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Appendix I

Supporting Documents for this Package

During trials, the following documents were shown to be of great use in supporting the use of this package. They form an integral part of the package.

Audit and Reduction Manual for Industrial Emissions and Wastes [1991]
UNEP / UNIDO.

Cleaner Production Worldwide [1993] UNEP IE.

Government Strategies and Policies for Cleaner Production [1994] UNEP IE.

Tanneries and the Environment [1991] UNEP / UNIDO.

The training kit indicated below (see also *Sections IV.5.2 and IV.6*) can also be helpful in developing further work sessions and teaching exercises.

It can be purchased from UNIDO, Box 300, A-1400 Vienna, Austria.

Training Course: Ecologically Sustainable Industrial Development [1994] UNIDO.

This UNIDO trainer course addresses many of the issues covered in this package. It is very useful, and can easily be used in combination with this package. Available from UNIDO.

Appendix II

List of Training Resource Packages available from UNEP IE

The following training resource packages have been developed by UNEP IE. They all use interactive training methodologies to explain the subject, and are aimed at educators who, although technically skilled, may not have specialized knowledge in this particular area. The packages are available from UNEP IE.

Some trainers' packages are still under development, and users are encouraged to assist UNEP to bring these to a final stage of publication.

Due to the cost of printing of the packages (between 100 and 400 pages), the completed documents are offered for sale to most users. However, a limited number of draft packages are free of charge to users prepared to contribute to their further development through review, field testing and adding material. Assistance with translation would also be welcome.

Cleaner Production: a Training Resource Package [1996] First Edition. Contains background reading, transparencies, bibliography, and work exercises. 110 pages. Price \$120 (English, Spanish). This package can be used with the workbooks below.

Trainer's Workbook on Cleaner Production in Leather Tanning [1996] First Edition. Contains background reading, case studies, work exercises and answers. 120 pages. Price \$120.

Trainer's Workbook on Cleaner Production in the Brewing Industry [1996] First Edition. Contains background reading, case studies, work exercises and answers. 75 pages. Price \$120.

Trainer's Workbook on Cleaner Production in Textile Wet Processing [August 1995] First Edition. Contains background reading, case studies, work exercises, answers, references. 140 pages. Price \$120.

Management of Industrial Accident Prevention and Preparedness: a Training Resource Package [1996] First Edition. Contains background reading, case studies and work

exercises. 110 pages. Price \$120. This package also helps to explain the APELL programme.

Risk Management of Contaminated Industrial Land: a Training Resource Package [1996] First Edition. Contains background reading, case studies and work exercises. 110 pages. Price \$120. English, Spanish.

Hazardous Waste, Policies and Strategies: a Training Manual [December 1991] TR10. Contains background reading, case studies, work exercises, reference tables and bibliography. 250 pages. Price \$120. English, French, Spanish.

Landfill of Hazardous Industrial Wastes: a Training Resource Package [March 1994] TR17. Contains background reading, case studies, work exercises, reference tables and bibliography. 315 pages. Price \$120.

Environmental and Technological Issues related to Lead-Acid Battery Recycling: Trainers Workbook [1996] First Edition. Contains background reading, transparencies, bibliography and work exercises. 130 pages. Price \$120.

Environmental Management of Mining Sites: a Training Manual [1995] UNEP/DDSMS. Contains background reading, transparencies, case studies, work exercises and answers. 200 pages. Price \$160.

Environmental Management Systems: Training Resource Kit [1995] UNEP/ICC/FIDIC. Contains background reading, transparencies, case studies, work exercises, bibliography. 492 pages. Price \$190.

Aerosol Conversion Technology Handbook [1994] Price FF225/US\$45 for developed countries.

Training Manual on Chillers and Refrigerant Management [1994] Price FF425/US\$85 for developed countries.

Training Manual on Good Practices in Refrigeration [1994] Price FF400/US\$80 for developed countries.

Environmental Impact Assessment: a training resource manual [1996] Preliminary version. Available from UNEP Environment and Economics Department, UNEP, Nairobi.

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Appendix III

About UNEP Industry and Environment

Industry and Environment was established by UNEP in 1975 to bring industry and government together to promote environmentally sound industrial development.

UNEP IE is located in Paris and its goals are to:

- 1 encourage the incorporation of environmental criteria in industrial and development plans;
- 2 facilitate the implementation of procedures and principles for the protection of the environment;
- 3 promote the use of safe and clean technologies;
- 4 stimulate the exchange of information and experience throughout the world.

UNEP IE provides access to practical information and develops co-operative on-site action and information exchange backed by regular follow-up and assessment. To promote

the transfer of information and the sharing of knowledge and experience, UNEP IE has developed three complementary tools:

- technical reviews and guidelines;
- *Industry and Environment*: a quarterly review;
- a technical query-response service.

In keeping with its emphasis on technical cooperation, UNEP IE facilitates technology transfer and the implementation of practices to safeguard the environment through promoting awareness and interaction, training and diagnostic studies.

Some relevant UNEP IE publications

Refer to *Appendix II* for trainers' packages. For complete list, refer to publications catalogue.

Industry and Environment [quarterly] deals with issues relevant to industrial development, such as auditing, waste management, industry-specific problems, and environmental news.

Government Strategies and Policies for Cleaner Production [1994] 32pp.

Cleaner Production Worldwide Vol. I and II [1995] 48pp.

Life Cycle Assessment: what it is and how to do it [1996] 92pp.

Audit and Reduction of Industrial Emissions and Wastes: Technical Report No. 7 [1991] UNEP/UNIDO. 127pp.

Monitoring of Industrial Emissions and Wastes: Technical Report No. 27 [1996] UNEP/UNIDO. 188pp.

Energy, Efficiency and Climate Change [1991] UNEP/IPIECA. 95pp.

Hazard Identification and Evaluation in a Local Community: Technical Report No. 12 [1992] 86pp.

Health Aspects of Chemical Accidents: guidance on chemical accident awareness, preparedness and response for health professionals and emergency responders Technical Report No. 19 [1994] A joint IPCS/OECD/UNEP/WHO publication: OECD Environment Monograph No. 81. 47pp.

Environmental Aspects of Industrial Wood Preservation: a technical guide Technical Report No. 20 [1994] 105pp.

The Textile Industry and the Environment Technical Report No. 16 [1994] 120pp.

***Environmental Management in the Brewing
Industry Technical Report No. 33 [1995] 120pps.***
***Storage of Hazardous Materials Technical
Report No. 3 [1990]***
***Companies Organization and Public
Communication on Environmental Issues
Technical Report No. 6 [1991] 130pp.***

***Company Environmental Reporting Technical
Report No. 24 [1994] 118pp.***
***From Regulations to Industry Compliance:
Building Institutional Capabilities Technical
Report No. 11 [1992] 62pp.***