The Occupational Health Aspects of Waste Collection and Recycling

A survey of the literature

UWEP Working Document 4, Part I

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Cover photo: The photo on the cover was made by WASTE in Brazil.

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FOREWORD

Working conditions in waste collection and recycling had already my attention during my study. For my graduation on Human Geography at the University of Amsterdam, within the research project 'Approaches to urban solid waste management, linkages between formal and informal systems of source separation and recycling', I did field research in wholesale enterprises dealing in cullets, paper and bottles in Bangalore, India.
Because the topic on occupational health aspects of working with waste is relatively unexplored, and the opinions differ on the risks of the work, the offer from WASTE to do a desktop study on this subject I gladly accepted.

Although not many studies have been undertaken, a lot of organisations in the South responded enthusiastically to the questionnaire that was sent to them. It became clear that there is interest in the topic and it underlines the importance of further research and initiating projects in the field.

I must thank many people for their contribution to this report: firstly the colleagues at WASTE for giving me the opportunity to do this study and for the pleasant working environment. Special thanks go to Inge Lardinois for her helpful comments, support and cooperation, and to Anne-Lies Risseeuw for editing the text. I would like to thank Dick Heederik of Wageningen Agricultural University for reading and correcting the draft report. Several persons have been very helpful in providing me with useful information, in particular Gerrit Eckhart of the Cleansing Group of the Municipality of The Hague and Philip Rushbrook of the WHO in France. I would like to thank Hapee de Groot of Both ENDS for providing me with a list of organisations working in the field in India.
A word of special thanks goes to the Society for Participatory Research in Asia - PRIA - in New Delhi, the Forum of Communities United in Service - FOCUS - in Calcutta, the Self Employed Women's Association - SEWA - in Ahmedabad, and Clean Ahmedabad Abhiyan. Also, I am very grateful to all the persons who responded enthusiastically to the mailing that was sent to them.

Gouda, December 1996

SUMMARY

This desktop study on the occupational health aspects of waste collection and recycling has been conducted on behalf of WASTE, Gouda, as part of their Urban Waste Expertise Programme (UWEP). The aim of this report has been to analyse existing information and to give an overview of the state of the art on occupational health aspects in waste management.

Literature studies on working conditions and occupational health in general and case-study researches on occupational health aspects of handling waste were analysed. A questionnaire was sent to organizations active in the field of health and waste.

Risks associated with waste collection and recycling can be divided into:

1. Occupational accidents
2. Physical risks
3. Chemical risks
4. Ergonomic risks
5. Psychological risks
6. Biological risks
7. Others

In identifying the health impact of chemical and biological agents several problems can be encountered:

1. The long period before the effect becomes manifest
2. The multiplicity of causes of diseases, which makes it difficult to distinguish occupational diseases from diseases caused by for instance unhygienic living conditions
3. There is a lack of knowledge on mechanisms involved in the pathogenesis of human chronic diseases
4. Diseases are wrongly classified

In controlling occupational exposure a nine-step plan is advised (Boleij *et al.*, 1995) which may lead to an effective and efficient reduction of exposure:

1. Define problem
2. Agree on aims
3. Rank sources
4. Identify mechanisms
5. Devise strategy
6. Select programme
7. Implement controls
8. Evaluate effect
9. Maintain situation

A four level strategy that is used in the Netherlands by the Labour Inspection has been applied to the waste recycling entrepreneurs involved in used oil, household batteries and

photo chemicals by van der Meer (1994). This strategy, which is similar to step 5 mentioned above is as follows:

1. Measures at source
2. Ventilation
3. Separation of men and source
4. Personal protection

The micro-organisms that in certain concentrations and under specific conditions can be detrimental to the health are: bacteria, fungi, protozoa, viruses and other agents.

In the Netherlands there are few specific regulations for biological agents at the workplace which can be detrimental to health. Internationally too, legislation concerning most substances does not exist. Only for dust MAC values have been formulated.

The case-studies focused on waste water, plastic, paper, mixed wastes and compost. From the studies that had been investigated it appeared to be difficult to draw straightforward conclusions on the health effects of working with waste, mainly due to methodological problems and lack of scientific information. Also the number of studies are limited, so conclusions are difficult to draw.

What can be concluded from the literature review is that:

- Health effects may differ very much per type of activity (e.g. risks are different for waste pickers at dumpsites and itinerant waste buyers) and per type of material used.
- The list of risks as well as the four level strategy provide tools to define possible improvements.

The following recommendations are made:

- Literature research and interviewing resource persons in India.
- To organize an international workshop.
- Based on the available information financial and technical assistance is advised for small-scale waste entrepreneurs and there is need for awareness raising.

CHAPTER 1 INTRODUCTION

1.1 Historical background

In 1989 WASTE started the so-called WAREN project to assess the possibilities of recycling to become a source of income for people in the low-income areas of Nairobi, Kenya, on request of the Undugu Society of Kenya, an NGO. Rather than `reinventing the wheel' and trying to develop recycling activities, WASTE decided to involve local consultants from five cities where resource recovery activities efforts were better developed than in Nairobi. The consultants investigated the technologies used, the products made and the markets covered by micro-entrepreneurs recovering urban solid waste materials in Cairo, Bamako, Accra, Manila and Calcutta.

Ten waste materials were identified: rubber, plastic, motor oil, cooking oil, tin cans, photochemicals, broken glass, bone and horn, household batteries and organic waste. Four publications were made to disseminate the knowledge to other interested parties. These books are: "Organic Waste", "Plastic Waste", "Rubber Waste" and "Hazardous Wastes" (household batteries, photographic materials and used motor oil).

In 1995, WASTE started the Urban Waste Expertise Programme (UWEP). For more information on UWEP is referred to Appendix V. The UWEP programme builds on the results and experiences gained from the WAREN project. One of the activities of UWEP is an in-depth analysis into *plastic recycling* (UWEP 4) focusing on the economic setting, working conditions and on-site pollution. Since not much is known about working conditions nor about on-site pollution of recycling activities, it was decided to start an inventory study into this topic. Because of time constraints this study has been limited to working conditions and in particular to occupational health aspects.

1.2 Problem description and research question

Resource recovery has many benefits, such as the creation of jobs, reducing the volume of waste to be disposed of by municipal authorities, savings on foreign currency, and conservation of natural resources. The recovery methods themselves, however, are often not environmentally sound and may pose health hazards for workers. Some of these are described in the previously mentioned books. However, not much information is available on the topic nor has a thorough analysis of the existing information been made.

Another problem is that different views on the importance and the seriousness of the problem exist and that sometimes opinions are ventilated that are based on presumptions instead of on scientific facts. An example of this is the commotion that rose at a plastic recycling project in Kenya. In a pilot setting, used polypropylene (PP) was melted into long bars. Outsiders then claimed that dioxins were formed and that the site should be closed down. After consultation with plastic experts it became clear that dioxins cannot be formed from PP (dioxins can only be formed from PVC) and secondly that temperatures during the melting process were not high enough for dioxin generation.

The aim of this report is to analyse existing information and to give an overview of the state of the art on occupational health aspects in waste management. The research

question of the study is: **What are the occupational health aspects of waste collection and recycling?**

1.3 Methodology

Although UWEP deals in particular with small and micro- enterprises and communities involved in waste management in economically less developed countries, it was decided to include studies that link occupational health to waste management in economically less developed countries as well as in industrialized countries. One reason is the limited information available, another is that although situations in economically less developed countries and in industrialized countries are often not directly comparable, conclusions can give an indication of possible health effects of handling waste materials.

The literature that consisted of studies in English and Dutch mostly deals with cases in Europe and Asia. Most of the information comes from the libraries of WASTE, the University of Amsterdam, the Dutch Ministry of Public Health, Environment and Planning, the Dutch Ministry of Social Affairs and Employment, the Dutch Royal Institute for the Tropics, the University of Utrecht, the Agricultural University of Wageningen and the Catholic University of Nijmegen. Also resource persons were consulted.

A selection was made of international organizations and researchers working in the field of occupational health. A request for information was sent to these organizations containing queries on the following subjects:

1. Occupational health aspects of waste collection and recycling.
2. Methods to assess working conditions and environmental pollution.
3. Strategies to improve the working conditions and reduce the environmental pollution.

Some persons responded enthusiastically and sent details on a couple of studies. The general observation was that not much information was available on occupational health aspects of waste collection and recycling in economically less developed countries.

The study is divided into a literature review of working conditions and occupational health in general, and a case study analysis on the occupational health aspects of handling waste materials. These case-studies were selected based on the following criteria: they were executed in the field (no desktop studies), and contain a description on the research methodology used.

The majority of case-studies focus on biological agents, hardly any information was found on the health effects of other waste materials. In the economically less developed countries most studies were done among waste pickers at dumpsites. Most of the studies that were used from industrialized countries were undertaken in composting installations and paper mills. Also a few studies have been included that were done not on recycling activities but focus on the processing of virgin materials (e.g. paper, plastics). The technologies used in those activities are similar to the ones used in recycling enterprises.

It should be realized that although efforts have been made to obtain and use as much information as possible, the literature is not exhaustive due to time constraints. New

information was received while finalizing the study and studies from Latin America have been excluded.

Each case-study was analysed on the following aspects:

1. The type of materials being studied.
2. The kind of activities taking place.
3. The objectives of the study and the research questions.
4. The research methodology being used.
5. The number of respondents and whether a differentiation was made into male and female respondents and children.
6. The health effects.
7. Conclusions and recommendations.

As the majority of the case-studies in Chapter 4 focus on the health aspects of composting and waste picking, Chapter 3 only deals with the biological agents that can be found in organic materials and which may be detrimental to the health of the workers involved.

1.4 Outline

Chapter 2 evaluates general information on the terminology on 'health', 'occupational health' and 'working conditions', defined by the International Labour Organization and the World Health Organization. Also strategies used in industrialized countries and economically less developed countries on how to control occupational exposures are listed.

Chapter 3 presents the biological agents that can be found in organic materials and which may be detrimental to the health of the worker. A summary of laws on the allowable concentrations of gases and dust in composting installations in the Netherlands is given.

Chapter 4 presents an analysis of the literature gathered on occupational health aspects of working with waste. The chapter is divided into case-studies from industrialized countries and economically less developed countries and differentiates between the following waste materials: waste water, plastic, paper, mixed wastes and compost.

Chapter 5 deals with the major conclusions from this study.

Appendix I presents a list of studies used for Chapter 4. In **Appendix II** skin diseases are listed. **Appendix III** presents an explanation of terms and diseases used in Chapter 4. In **Appendix IV** the names and addresses of persons and organizations that responded to the mailing are listed. Information on the Urban Waste Expertise (UWEP) is presented in **Appendix V**. **Appendix VI** presents some commonly used tests, which are mentioned in the literature studies, to determine certain health effects from micro-organisms.

At the end of the book the reader will find a list of **references**.

CHAPTER 2 HEALTH AND WORK

This chapter contains general information on the terminology on `health' and `occupational health', as formulated by the International Labour Organization and the World Health Organization. Also, it deals with occupational health in small-scale enterprises, problems concerning the identification of health impacts in the workplace, and it relates the workplace to the general environment. Strategies used in industrialized countries and economically less developed countries on how to control occupational exposures are also listed.

2.1 Health

The World Health Organization (WHO, 1992, p. 6) defines health as:

"A state of complete physical, mental and social well-being and not merely the absence of disease or infirmity."[1]

Health is only possible where resources are available to meet human needs and the living and working environment is protected from life-threatening and health-threatening pollutants, pathogens and physical hazards. But health also includes a sense of well-being and security. Deficient living and working environments are associated with both physical and psychological health problems. Violence and alienation are associated not only with poor job prospects but also with overcrowded, poor quality housing, deficient services and inadequate provision for leisure, recreation and children's play and development. Health is no longer the responsibility only of doctors, nurses, midwives, and other health professionals seeking to prevent or cure diseases or of those seeking to remove pathogens from the human environment and reduce accidents. It is also the responsibility of planners, architects, teachers, employers, and all others who influence the physical or social environment (WHO, 1992, pp. 5-6).

2.2 Occupational health

Ever since the International Labour Organization was set up in 1919, it has been concerned with problems affecting the workers' safety and health: in fact the ILO was established largely to deal with those problems (ILO, 1983, p. 21). During the present century concern with regard to the health of the worker has evolved from the identification of industrial disease to the much broader concept of the promotion of occupational health.

The International Labour Office and the World Health Organization in 1950 defined occupational health as:
"The promotion and maintenance of the highest degree of physical, mental and social well-being of workers in all occupations."

In 1981 the International Labour Conference (ILO, 1983, p. 22) adopted a comprehensive Convention on occupational health and safety on the general subject. The convention (no. 155) and the accompanying Recommendation (no. 164) concerning occupational safety

[1] This is a very general definition which, according to experts, is difficult to operationalize.

and health and the working environment laid down a new principle: governments should have a national policy on occupational safety, occupational health and the working environment. The objective of the convention is to make workplaces safe and healthy.

The convention and the recommendation cover:

- The design of factories and of all machinery and equipment used.
- The training of people involved in the protection of safety and health.
- The adoption and enforcement of appropriate laws.
- The keeping of proper statistics and associated measures.

The principles of the ILO concerning working conditions, as formulated in the ILO medium-term plan for 1990-1995 (ILO, 1988b, p. 65), are:

- Work should take place in a safe and healthy environment.
- Working conditions should be consistent with workers' well-being and human dignity.
- Work should offer real possibilities for personal achievement, self-fulfilment and service to society.

These principles lead to the following objectives, as formulated by the ILO (1988b, p. 65):

- A reduction in the incidence of occupational accidents and work-related diseases.
- Improvements in the working environment and in the work organization.
- The protection of workers against excessive working hours and the promotion of measures concerning the length and the organization of working time which respond both to workers' need and to the requirements of enterprises.
- Access to work-related welfare facilities and services.
- Abolition of child labour.
- Improvement in the conditions of workers in difficult work situations.

A problem is that the ratification and implementation of these ILO instruments are limited and particularly low in economically less developed countries, because eventually, the ILO cannot interfere in the internal policy of a member country. On the basis of experience from the industrialized countries, it is likely that without special actions nor support from government authorities the implementation of the ILO principles will not take place in economically less developed countries.

An occupational disease according to the ILO (ILO, 1983, p. 18) is:
"Any undesirable condition directly arising from a person's employment."

The World Health Organization (in its global medium-term programme 1984-1989), aims at the development of occupational health programmes as an integral part of the health service infrastructure.

Estimates based on the current occupational injury rates in a number of countries suggest that all over the world there are 32.7 million occupational injuries per year and 146,000 deaths (WHO, 1992, p. 177).

2.3 Occupational health in small-scale enterprises

According to Rantanen *et al.,* (1994, p. 37) the working conditions, including occupational health and safety, vary as much as the other aspects of small-scale enterprises[2], according to the general nature of the enterprise, the type of production, the ownership and location. In the economically less developed countries and newly industrialized countries the occurrence of hazards, and also their severity, in small-scale enterprises may be exceptionally high compared to larger enterprises (Rantanen *et al.,* 1994, p. 37).

The health risks to many workers in small workshops or rooms in houses pose special problems, as such workers are usually not covered by regulatory systems. For instance in Jamaica the recycling and repair of lead acid batteries in informal enterprises had led to the exposure of both workers and the community to lead (WHO, 1992, p. 177[3]).

Hazards that can occur in those small-scale enterprises are (Rantanen *et al.,* 1994, pp. 39-44):

1. Occupational hazards: falling objects, cuts, accidents with machinery and fire risks.
2. Physical hazards: noise, hand-arm vibration in the use of powered hand tools.
3. Chemical hazards: organic solvents, other gases and vapours, lead, other smoke and fumes, silica dust, asbestos, cotton and other fibres, chemical explosions and lack of labelling of chemicals.
4. Ergonomic hazards: the problem of ergonomics in small-scale undertakings are related to the high occurrence of musculo-manual work, use of low-technology working methods and, in economically less developed countries, obsolete machinery and tools, inadequate design of work rooms often constructed originally for totally different purposes, and problems of economy preventing the use of occupational health and safety experts and giving little room for efforts to improve working conditions. Symptoms related to ergonomics and physical workload are neck complaints and back pain.
5. Psychological hazards: stress.

The common factors that undermine workplace safety in these enterprises are[4]:

1. Low levels of capital, use of primitive tools and techniques and a tendency to innovate or take shortcuts in production that, while necessary for economic survival, may pose serious hazards to the worker.
2. Poor working conditions, poorly regulated by labour or health and safety laws and poorly monitored by unions, employers' organizations and the state.
3. Poor access to information, lack of knowledge about hazards.

Kogi (1985) suggested relatively inexpensive measures to improve the working conditions and occupational safety in small-scale enterprises. Examples are for instance to

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[2] The most widely accepted upper size limit for small-scale enterprises is 50 labourers. From: Rantanen *et al.,* 1994, p. 32, in: *The Promotion of Small and Medium-Sized Enterprises*. Report VI. International Labour Conference, 72nd Session. Geneva, International Labour Office, 1986, p. 104.

[3] From: Matte, T.D. *et al*. Lead Poisoning Among Household Members Exposed to Lead-Acid Battery Repair Shops in Kingston, Jamaica. *International Journal of Epidemiology,* 1989, 18: pp. 874-881.

[4] From: Occupational Health in Small-scale Industries in Africa, *African Newsletter on Occupational Health and Safety*, 1995, No. 5. pp. 32-34.

improve the lightning in a workplace by painting the walls and the ceilings white, to enable a proper reflection of the light. And in blacksmith shops, where workers are working close to the heat source, he suggested to use long tongs.

But although these measures are very inexpensive, it is still the question whether they are applicable in small enterprises, where profit margins usually are very limited. Also, there are cases known in which an employer is willing to provide gloves in the sorting of cullets, but where the labourers refuse these due to the fact they work on piece-rate and while using these gloves they work slower (van Eerd, 1995).

2.4 Identifying the health impact

It is in the workplace that the health impact of chemical and biological agents is best understood (WHO, 1992). But most manifestations of diseases, such as lung cancer or chronic obstructive pulmonary disease, which are associated with environmental factors are not caused by exposure to one specific factor. It is therefore difficult to determine the extent to which exposure to environmental agents has contributed. For instance, the health effect from being exposed to a particular chemical must be separated from that from other occupational exposures. These include noise, vibration, and psychological stress, or ill health deriving from diet or pathogens in the home.

The difficulty of identifying the effect on health of particular pollutants is even greater outside the workplace, than in the workplace. Clear-cut examples of diseases caused by exposure to chemicals in the population are few. Very large numbers of people are exposed to lower concentrations, which are often so low that they do not differ much from background concentrations.

Concern about the potential effects of long-term exposure to a number of chemical and biological agents is widespread, but verifying the effects is difficult for several reasons (WHO, 1992, p. 183):

- The long-term period before the effect becomes manifest complicates epidemiological studies, especially when populations are mobile and population and exposure records inadequate.
- Chronic diseases have a multiplicity of causes and it is often difficult to determine the extent to which a particular agent or process is responsible.
- There is a poor understanding of the basic mechanisms involved in the pathogenesis of human chronic disease.
- Diseases are wrongly classified.

In addition, there is virtually no information concerning the levels, trends, and causes of chronic diseases in economically less developed countries (WHO, 1992, p. 183).

2.5 The workplace in relation to the general environment

A safe working place is of great importance, but another very important component of the working life according to the ILO is the environment in which the worker spends the greater part of his time. They regard the **`working environment and the general environment as forming a single whole whose separate elements interact'** (ILO, 1983,

p. 12) including travelling time from and to the workplace and the housing facilities of the workers.

At the personal level, the individual worker may carry infection or contamination acquired at work back to his home or social environment such as lead and asbestos brought home on workers' clothing or acquired by making regular visits to the workplace, to the detriment of their families' health. However, diseases present in the general environment may have an important impact on health in the workplace, as in areas where malaria or water-borne parasitic diseases are endemic. The interaction between the working environment and that of the region may also occur on a large scale, like for example the disaster in Bhopal, where industrial pollutants were accidentally released, whereupon they contaminated the area around the plant. Similar disasters may also affect very large parts of the world, as for instance has happened with the Tsjernobyl disaster. It is therefore often difficult to relate diseases to the workplace only.

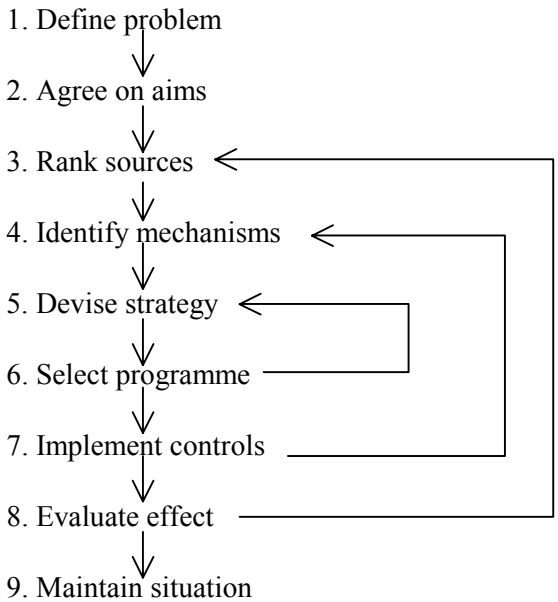
2.6 Controlling occupational exposures

Obviously, control of the working environment by restricting the source of any harmful influence is preferable to any palliative or curative measure. In some instances this is possible, as is the case with noise reduction, in other cases the worker has to be protected, for instance by using protective clothing.

2.6.1 A strategy used in industrialized countries

A hierarchy of controlling occupational exposures as is formulated by Boleij *et al.*(1995)[5] contains nine steps in which controls can be implemented systematically, as is shown in Figure 2.1. This may lead to an effective and efficient reduction of exposures, which will eventually lead to a safer and healthier workplace.

Figure 2.1 The nine steps in the process of systematically implementing control measures (Boleij *et al.*, 1995, p. 209).



[5] The following text on implementing control measures is derived from Boleij *et al.*, 1995, pp. 207-263. It focuses in particular on the USA and Europe.

Explanation of the nine steps:

1. Agreement should be obtained among all participants on the problem, and on the goals to be achieved. Also the criteria for the evaluation should already be defined at this stage in the process.

2. As a second step it is essential to formulate which aims should be reached by the implementation of control measures.

3. The identification of sources and ranking them in order of contribution to exposure is the third step. Hereby it is advised to follow the complete production cycle. By breaking down this cycle into different steps according to the material flow, source assessment becomes manageable.

In the process of quantitative source assessment four steps can be described[6]:

A. Discover all potential sources of emission.
B. Identify which sources of emission contribute to personal exposure.
C. Observe worker interaction with emission sources and existing controls.
D. Determine and rank the relative contribution to personal exposure of each source.

4. The fourth step is the collection of knowledge on the mechanisms influencing exposures, either by measurements, theory or experience. Such information on mechanisms is essential for knowing when and how to implement control.

5. A control strategy mostly consists of different alternatives:

A. In principle, elimination of a source is to be preferred. If this is not possible the source should be reduced.
B. The next step would be to isolate the source as far as possible.
C. After this phase, for airborne contaminants, ventilation is the next option.
D. Organisational measures to avoid exposure are the penultimate to be considered.
E. Personal protection should be the final piece of a control strategy.

6. The next step is to have the management adopt one of the options in the control strategy. Responsibilities of designated employees have to be clearly stated in the job description, so that afterwards results of the health and safety programme can be settled in the way as outcome of other responsibilities within the organisation. It has to be established in a control programme who is responsible for the accomplishment of which part of the programme. An important part of any control programme is training and instruction. Employees have to know how they have to use and handle the control measures, what work practices are safe and what happens when they do not work according to the instructions. The level of instruction and repetition of training are both important. As a reminder there should be written instructions for every task. The last and not least important part of the control programme are the

[6] From Boleij *et al*., 1995, p. 213, in: Piney *et al*., 1987, Controlling Airborne Contaminants in the Workplace. *Science Reviews Ltd*, pp. 33-44.

costs. The required budget for a control programme usually consists of two components:

- Investment costs: capital investment, initial training and instruction
- Operational costs: electricity, heating, maintenance, inspections, supervision, regular training

7. In order to achieve a successful implementation, commitment of the management and communication are essential elements. When the effectiveness of controls is dependent on the correct use by workers it is essential to plan a pilot phase and involve the people who have to work with the controls in their design. In ergonomics the approach of involving the future users in the process of development is called the participating approach[7]. This is essential for two reasons: firstly because it motivates and involves people, and draws up their often considerable, tacit knowledge enabling fine-tuning of controls and secondly because it is important that controls are integrated into actual work practices.

8. The evaluation of achievements of a control programme is the eighth step in the systematic approach to control measures. A first evaluative assessment should be done soon after the controls have been installed, the design specifications have been met, and all mechanical and electrical equipment is properly functioning. During the project sound criteria should have been developed with which workers themselves can, on a day-to-day basis, observe if controls are still working effectively and if exposures are within the desired range. Such check-ups should be done on a routine basis, at regular intervals. They are necessary because of possible changes in the processes, agents or work practices. Another reason for regular evaluation is the fact that toxicological information, control technology and MAC values are not static but dynamically. So, a situation which is presently controlled adequately, may in a few years time be in need of minor readjustments, when scientific and technological progress is taken into account.

9. The final step is the maintenance of control measures.

Why are some control measures successful and why do others fail? It seems that information is an essential element but not the decisive one. Without good information on how to adopt the controls to the specific situation, no effective controls can be implemented. But having that information does not guarantee that a successful implementation will be the outcome of the process. According to Boleij *et al*. (1995) it is advisable to consider all the elements presented in Figure 2.1.

2.6.2 Strategies applied to or used in economically less developed countries

A 'four level strategy'[8] that is used in the Netherlands by the Labour Inspection has been applied to the waste recycling entrepreneurs involved in used oil, household batteries and photo chemicals by van der Meer (1994)[9]. This 'four level strategy' is illustrated with a selection of the guidelines mentioned in the report. The most preferable option is that

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[7] From: Boleij *et al*., 1995, p. 258, in: Vink *et al*., 1992, Experiences in Participatory Ergonomics: Results of a Round Table Session During the 11th IEA Congress, Paris, July 1991. *Ergonomic*s 35, pp. 123-127.

[8] This strategy is similar to the control strategy mentioned by Boleij *et al*. (step 5).

[9] This study was executed for WASTE as a desktop study.

measures at source should be taken, so that the other options mentioned are not necessary. Step four the less preferable one:

1. Measures at source
   The basic materials of the recyclers are waste materials. They themselves have no influence on the composition of it. Measures at this level can be to change production methods such as:
   - A change in the technical part of the production process, such as closed processes instead of open processes.
   - A change in working methods, like shifting work regularly or more breaks.
   - An adjustment of the lay-out of the working place, so that dust gets less chance to settle.

2. Ventilation
   If during the process, toxic fumes or dust are formed, exhaustion should be applied. This equipment can be too expensive for entrepreneurs. A solution can be a working place with at least two open windows so natural ventilation takes place. Another option can be to do the work in the open air.

3. Separation of men and source
   The most dust or fume producing steps should take place in a separate room, or outside. By hanging wet sheets around the dust source, the spreading of dust can be prevented. If more than one person is active in the process they could shift from work regularly to spread the dose.

4. Personal protection
   Because the measures of the three levels can be too expensive or impractical, it is often needed to take measures at the fourth level. Personal protective clothing, like gloves, should be worn. The protective clothing should remain on the working place and not to be taken home.

A participatory method to assess working conditions developed by the ILO, is called ‘WISE’ (Work Improvements in Small Enterprises). It is a systematic approach to improve the working conditions and productivity in small and medium-sized manufacturing enterprises.

In the training methodology (Di Martino, 1995) six principles are followed:

1. Build on local practice
2. Focus on achievements
3. Link working conditions and other management goals
4. Use learning by doing
5. Encourage exchange of experience
6. Promote workers' involvement

Nine topics (Di Martino, 1995) have been identified as core issues:

1. Materials storage and handling
2. Workstation design
3. Productive machine safety

4. Control of hazardous substances
5. Lightning
6. Welfare facilities and services
7. Work premises
8. Work organization
9. Worker involvement

The first comprehensive WISE pilot course was implemented in Kenya in 1992 (Muchiri, 1995). Nine trainers and 17 entrepreneurs were trained on the application of the methodology. Also regional centres that were interested in the methodology attended the course.

Some improvements that were implemented as a result of the use of the WISE methodology were:

1. Provision of tool racks for easy storage and retrieval.
2. Fitting guards on machines such as those used for grinding, trimming etc.
3. Provision of suitable work benches and seats with back rests to improve work postures, reduce fatigue and boost productivity.
4. Provision of trolleys to move materials as an alternative to manual carrying.
5. Covering and labelling of chemical containers to reduce exposures, for safe use/handling and to preserve the quality.
6. Improvement of the ventilation system through the use of fans and windows.

Most of the improvements were highly innovative and long lasting, and they had a tangible impact on the productivity and working conditions in these enterprises.

The Activists' Handbook of Occupational Health and Safety (1993) of the Society for Participatory Research in Asia (PRIA) mentions that monitoring the workplace is essential to protect the workers against health hazards. The monitoring can be subdivided into:

1. Environmental monitoring, which is a process of measurement and evaluation of hazardous material and processes.
2. Biological monitoring, this means the measurement of the level of substances in one's body, to detect the earliest changes at a stage when it is still reversible.
3. Medical monitoring, this deals with the clinical symptoms of a disease, and should be undertaken before a job is carried out and during working time.

In order to control health hazards PRIA developed three broad strategies:

1. Engineering controls. Dangerous machines should be made less dangerous or should be replaced by safer ones. The working place has to be ventilated, and hazardous operations should be isolated.
2. Administrative controls. They do not eliminate hazards but limit a worker's exposure to a hazard by for instance extending rest periods and introducing job rotation.
3. Personal protective equipment and clothing. This is very important in certain occupations like waste picking.

CHAPTER 3 BIOLOGICAL AGENTS[10]

This chapter deals with the biological agents that can be found in organic materials, which can be detrimental to health. The existing rules in the Netherlands concerning the allowable concentrations of gases and dust are given.
Terms with an asterisk (*) are explained in Appendix III.

3.1 Micro-organisms detrimental to health

This chapter deals with the biological micro-organisms which - in certain concentrations and under specific conditions - can be detrimental to health. These organisms can be classified as bacteria, fungi, protozoa, viruses, and other agents.

There are two groups of pathogens that may cause disease (Obeng and Wright, 1987):

1. *Primary pathogens*, which are normally present in raw waste and may cause infections in healthy individuals, include bacteria, viruses, protozoa and helminths eggs. Most of the infections they cause (such as diarrhoea and dysentery) are spread through via faecal-oral transmission routes. The micro-organisms that are the causative agents of these diseases pass from infected persons in excreta, eventually reaching other people orally (by drinking water contaminated with faeces). Another infection route is through the skin.

2. The micro-organisms (fungi and acid-producing bacteria) that grow during biological decomposition are called *secondary pathogens*. These pathogens are less important than the first group, however, they may cause primary infections or respiratory diseases, usually in people with weakened immune systems.

In Table 3.1 examples can be found of primary pathogens, in Table 3.2 examples can be found of secondary pathogens.

Table 3.1 Examples of primary pathogens spread during the composting of sewage sludge and the associated human diseases, (EPA 1981, quoted in Polprasert, 1989).

Group	Example	Disease
- Bacteria	- Salmonella enteritides	- Salmonellosis (food poisoning)
- Protozoa	- Entamoeba histolytica	- Amoebic dysentery (bloody diarrhoea)
- Helminths	- Ascaris lumbricoides	- Ascariasis (worms infecting the intestines)
- Viruses	- Hepatitis virus	- Infectious hepatitis (jaundice)

[10] The information in this chapter is mainly derived from: van Amelsfoort and Heederik, 1994, and from: van Yperen and Rutten 1996.

Table 3.2 Examples of secondary pathogens spread during the composting of sewage sludge, and the associated human diseases, (EPA, 1981, quoted in Polprasert, 1989).

Group	Example	Disease
- Fungi	- Aspergillus fumigates	- Aspergillosis
- Actinomycetes	- Micromonospora spp	- Farmer's lung (allergic response in lung tissue)

3.1.1 Bacteria and their decomposition products

Most environments contain a large variety of bacteria. Health problems only arise in the presence of specific primary and secondary pathogenic bacteria. Excessive growth can cause exposure to high levels of organisms and their excretion products.

In general, an increased risk of infection by bacteria attends professions that deal with:

- Animals or animal products
- Waste or waste water
- Micro-organisms in laboratory conditions
- Staff and/or patients in health service

The effects on health by bacteria can be classified in:

A. Specific affections
B. Toxic reactions
C. Allergic reactions

A. Specific affections
A large number of professions are subject to an increased risk of bacterial infection: for instance, foresters, cattle breeders, and workers on the sewer system. Specific affections are diseases like Legionnaire's disease*, pneumonia and tuberculosis.

B. Toxic reactions
Toxic reactions are caused by exotoxins, endotoxins, and volatile organic compounds and may cause shortness of breath.

1. Exotoxins
Exotoxins are toxic substances excreted by Gram-positive and Gram-negative bacteria (Mouton, *et al.*, 1987, p. 72). They can cause local cell and tissue damage. Exotoxins cause little or no symptoms of fever, in contrast with endotoxins.

2. Endotoxins
Endotoxins are toxic substances which are released from the cell wall when Gram-negative bacteria are damaged or destroyed. A critically high exposure to endotoxins can cause fever, so-called Monday morning fever, dry cough, shortness of breath, and leucocytosis. The vital capacity and the diffusion capacity of the lungs are reduced immediately. In case of chronic exposure, endotoxins can cause chronic bronchitis

and an increased risk of allergic reactions. Moreover, relations have been demonstrated between exposure to endotoxins and the occurrence of a cough, breathing problems, irritation of the eyes, and fatigue (see Table 3.3).

Table 3.3 The effects on health caused by critical and chronic exposure to endotoxins[11].

immediate exposure	chronic exposure
- symptoms of fever, dry cough, shortness of breath, Monday morning blues - leucocytosis - decline in the FVC_1 FEV_1, and in the flow volume variables - decline in the diffusion capacity	- chronic bronchitis - possibly increased risk of allergic reactions on exposure to allergens

3. Volatile organic compounds

Volatile organic compounds (VOCs) can be generated when products are converted by micro-organisms, in organic waste for instance. When inhaled VOCs may affect the nerve system.

C. Allergic reactions

Specialist literature documents several cases of allergic reactions after inhalation of (fractions of) bacteria. In general, humidifiers or air conditioning can be the source of infection. Possible diseases are humidifier fever and extrinsic allergic alveolitis (EAA)*.

3.1.2 Fungi

Possible health effects after exposure to fungi and their decomposition products:

1. Infections: specific infections like Aspergillosis[12] seldom occur in individuals with a normal defence system.
2. Allergic effects, like asthma and extrinsic allergic alveolitis by spores of fungi.
3. Non-specific effects by fungi and metabolites, which can cause stuffed-up noses, soar throats, skin disorders, and allergic reactions.

Decomposition products of fungi which can affect health:

A. Glucans

Glucans are components of the cell wall of fungi. Little is yet known about their effect and their mechanism. Relations between exposure to glucans and occurrence of irritation to eyes, nose, and upper bronchial tubes are documented.

B. Volatile organic compounds

Volatile organic compounds can be generated when products, in organic waste for instance, are converted by micro-organisms - bacteria as well as fungi.

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[11] From van Amelsvoort and Heederik, 1994, p. 9, in: Douwes *et al.*, 1993.

[12] Of the approximately 180 known species of Aspergillus about six are potentially pathogenic, among which the A. fumigates and the A. flavus are most widespread. A. fumigates is abundantly present in compost heaps (Mouton *et al.*, 1987, p. 413).

C. Mycotoxins
A large number of risks at oral exposure of mycotoxins are documented. It could cause a wide variety of affections like for instance St. Anthony's fire. Little information, however, is available about the possible effects after exposure to mycotoxins in the air.

3.1.3 Protozoa

Protozoa are unicellular organisms. They mainly feed on bacteria and dissolved organic substances. A number of species of protozoa are able to make cysts, making them difficult to counter. Fragments of the protozoa can quite easily be spread through air, and in this way they can cause allergic reactions.

3.1.4 Viruses

Viruses are parasitic organisms smaller than a cell. They differ in size, morphology, chemical composition, `host cells', and effect on their `host cells'.

Viral infection is possible:
1. By respiration: the most common virus infections, like the flu, start this way.
2. Through the digestive tract: spread of virus infections through the oral-faecal tract is probably the second most important way.
3. Through the skin: the virus then enters by way of an insect bite for instance (dengue), or an open wound.
4. Through the urogenital organs: sexual intercourse in particular is an important way of infection for various viruses.
5. Through the conjunctiva*: a number of viruses, like the adeno and herpes virus can cause an inflammation of the eye.

3.1.5 Other agents

A number of biological agents of animal or vegetable origin can also be the cause of health complaints. This concerns allergic reactions in particular, but toxic effects are equally possible.

1. Allergic reactions
Allergic reactions to a considerable number of agents of vegetable or animal origin are documented. On the workplace some substances can be abundantly present, and high exposure to them can cause allergic reactions, as for instance the exposure to tobacco, garlic, cinnamon and chilli peppers.

2. Toxic reactions
A number of biological agents of vegetable origin have toxic qualities. Wood dust is the most important of them.

3.2 Legislation and policy

The Netherlands know few specific rules for those biological agents on the workplace which can be detrimental to health.

Internationally, too, legislation concerning most substances does not exist. Some rules of thumb are applied to substances like endotoxins, fungi, and wood dust. Only for dust Maximum Acceptable Concentrations (MAC) are formulated.

3.2.1 Bacteria

A. Bacteria

No MAC standards are set for exposure to bacteria. For Gram-negative bacteria that contain endotoxin a guideline of 10^3 cfu/m^3 per 8 hours is suggested (Leeuwinga, 1994).

B. Toxic substances

1. Exotoxins
Theoretically some hygienic limits for exposure to exotoxins floating in air could be set, based on NOAEL: No Observed Adverse Effect Level. Considering the huge diversity of exotoxins and the lack of research data about the effects of exposure to exotoxins floating in air, setting standards is not possible for the time being. In cases of exposure, for considerations of health the attempt to eliminate exposure completely according to van Amelsvoort and Heederik (1994, p.9) is the only acceptable solution. If this is realizable is the question.

2 Endotoxins
No MAC standards are set in the Netherlands to the exposure to endotoxins. The National Health Council is preparing advisable limits to exposure to endotoxins on the workplace. Internationally the limit of 100 ng/m^3 per 8 hours is applied.

Fungi
MAC standards are not set for fungi either. Rules of thumb are used by the study group on measuring methods of the Dutch Society for Labour and Industrial Medicine (NVAB, Nederlandse Vereniging voor Arbeids- en Bedrijfsgeneeskunde), and the Dutch Society for Labour Hygiene (NVvA, Nederlandse Vereniging voor Arbeidshygiëne). Levels of fungi above 10^4 cfu/m^3 or above 500 cfu/m^3 for single species are considered unacceptable. Because of their unimportance, levels of saprophyte fungi under 100 cfu/m^3 will not be taken into account[13].

Protozoa
Based on the available data it is impossible to set standards founded on hygienic considerations to exposure to protozoa floating in air.

Viruses
The very large differences in the ways viruses survive in different conditions, and the large variation in personal sensibility between members of staff, makes it unfeasible to formulate standards for exposure. Elimination of potential sources, or a decrease in the risks of infection, must be policy.

[13] In: van Yperen en Rutten, 1996, p. 22. From: Leeuwinga *et al.*, 1994.

Dust
In the Netherlands the MAC standard for nuisance dust is 10 mg/m^3 per 8 hours, and for troublesome respirable dust 5 mg/m^3 per 8 hours. Inhalable dust (the entire quantity of dust) is defined as that portion of the dust which can be inhaled through mouth and/or nose. Respirable dust is that portion of inhalable dust which penetrates to the alveoli.

Allergens
No standards are set, yet, for allergens either. Concerning grain dust an advisable limit of 0.2 mg/m^3 per 8 hours is proposed.

CHAPTER 4 WASTE AND HEALTH, CASE-STUDY EVALUATIONS

This chapter evaluates studies dealing with health effects of different types of activities that are related to waste. The complete list of studies can be found in Appendix I. Terms with an asterisk (*) are explained in Appendix III.

As becomes clear from the list (see Table 4.1) not much literature on this subject is available from economically less developed countries. The majority of the studies is from industrialized countries, and deal in particular with compost and paper plants. The studies from economically less developed countries mostly deal with waste pickers at dump sites.

Each study is summarized by mentioning the objectives of the study and the research methodology. The conclusions are elaborated in the text and are compared, if possible, with other research results. Also, recommendations, if relevant for this study, for improvements in practice are given.

Table 4.1 Number of studies analysed in Chapter 4.

	industrialized countries	economically less developed countries
waste water	1	-
plastic	1	-
paper	4	1
mixed wastes	3	4
composting	4	

4.1 Industrialized countries

In the United States of America studies have been undertaken in waste water (no. 1), plastic (no. 2) and waste dumps (no. 8 and 9). The study from Canada (no. 7) has been undertaken near a waste dump. The studies from Sweden have both (no. 3 and 5) been undertaken in paper mills, and the studies from the Netherlands have been undertaken in paper mills (no. 4 and 6) and in composting installations (no. 10, 11 and 12). Study no. 13 has been undertaken in composting installations in Denmark.

4.1.1 Wastewater

The reason for including a waste water research is that household waste can contain excreta, which may lead to similarities in effects.

Table 4.2 Wastewater

study number	1
objective of the study	to investigate the relation between Norwalk agent or rotaviruses and the excess episodes of gastrointestinal illness previously detected among recently hired wastewater workers
research methodology	work observation, air-sampling and analysis of paired sera
number of respondents	48 waste workers and a control group (number not mentioned)
main conclusion	no evidence was found

The only conclusion that can be drawn from this study is that inexperienced wastewater exposed workers had higher levels of the antibody to Norwalk agent than the experienced group and the controls. However, no evidence was found that associated the rotavirus antibody levels with wastewater exposure.

Epidemiological studies conducted on the agricultural use of wastewater[14] concluded that crop irrigation with untreated wastewater causes significant excess infection with intestinal nematodes in both consumers and farm workers. The latter are likely to have more intense infections, particularly of hookworms, especially if they work barefoot in the fields than those not working in wastewater irrigated fields. They also concluded that cholera, and probably also typhoid, can be effectively transmitted by the irrigation of vegetables with untreated wastewater.

Blum and Feachem[15] (1985, in: Mara & Cairncross, 1989, p. 74) have extensively reviewed the existing epidemiological literature on the transmission of disease associated with use of excreta as fertilizer on agricultural lands. One conclusion they made was that the fertilization of rice paddies with excreta may lead to excess schistosomiasis infection* among rice farmers.

Numerous studies have investigated the diseases that can be transmitted through human excreta (IRCWD Report no. 4/85, p. 8). It is clear that excreta, from individuals who overtly suffer from, or are carriers of enteric infections, pose a risk to human health. They contain variable levels of pathogens which may be transmitted if personal hygiene is insufficient and if excreta are not properly disposed of. Excreta provide the breeding ground for insects which are transmitters of pathogens, both excreta related and non excreta related.

[14] From: Mara and Cairncross, 1989, p. 69, in: Shuvall *et al.*, 1986, Waste Water Irrigation in Developing Countries: Health Effects and Technical Solutions.

[15] Health Aspects of Nightsoil and Sludge Use in Agriculture and Aquaculture. Part III: An Epidemiological Perspective, 1985, from: Mara and Cairncross, 1989, p. 74.

4.1.2 Plastic

Table 4.3 Plastic

study number	2
objective of the study	to investigate seven cases of possible Naphthalene Di-Isocyanate[16] related occupational asthma
research methodology	medical questionnaires, pulmonary function tests, spirometry was performed and monitoring of breathing was monitored through peak flow metres and air sampling
number of respondents	26 production workers and 20 administrative personnel
main conclusion	it is suggested that there is an association but it is not proven

The association suggested in the study between the use of NDI and the outbreak of asthma cannot be proven. Reasons given in the study are that: several employees who worked at the plant when NDI was used were no longer employed at the time of the study. Also, the substance that led to the outbreak was no longer in use at the factory at the time of the survey.

Ventilation is recommended. If exposure cannot be controlled, protective clothing should be worn by the workers.

According to a study on plastic waste (Lardinois & van de Klundert, 1995, p. 82) when determining health (and environmental) effects it is important to differentiate between the various types of plastics. Most polymers (macromolecules) are considered non-toxic (PVC is an important exception). Polyethylene (PE) and polypropylene (PP), are inert materials, but it should be realized that polymers are not completely stable. Under the influence of light, heat or mechanical pressure they can decompose and release hazardous substances. For example, the monomers from which polymers are made may be released and may effect human health. Both styrene (which is used to make polystyrene, PS) and vinyl chloride (used to make PVC) are known to be toxic.

The environmental effects of plastics also differ according to the type and quality of additives that have been used:

1. Some flame retardants may pollute the environment.
2. Pigments or colorants may contain heavy metals that are highly toxic to humans, such as chromium (Cr), copper (Cu), cobalt (Co), selenium (Se), lead (Pb) and cadmium (Cd) are often used to produce brightly coloured plastics. Cadmium is used in red, yellow and orange pigments. In most industrialized countries these pigments have been banned by law.

[16] Naphthale di-isocyanate, an important component of polyurethane, is used in the production of rubber and plastic.

3. The additives used as heat stabilizers frequently contain heavy metals such as barium (Ba), tin (Sn), lead and cadmium, sometimes in combination.

4.1.3 Paper

Table 4.4 Paper

study number	3	4	5	6
objective	to examine the relation between working in a pulp and paper mill and the occurrence of several malignancies	to measure the level of paper dust exposure for labourers in a hygienic paper mill	to investigate the relation between exposure to soft paper dust and pulmonary diseases	to investigate the relation between exposure to soft paper dust and pulmonary diseases
methodology	retrospective study of causes of death of deceased persons	personal measurements and dust samples are compared with results of an earlier study	cross-sectional study, using questionnaires, physical examinations, pulmonary function studies and chest radiographs	an exposed group and a control group working in the same factory, but in different depart-ments, are being comparedred
number of respondents	4,070 men of whom 619 were paper mill workers	is not being mentioned	13 non-smoking men with heavy exposure to paper dust and 14 unexposed men	46 male workers of the processing department and a control group of 40 white collar workers
conclusion	no relation can be proven	no conclusion can be made	no conclusion can be made	no conclusion can be drawn

The studies that investigated the relation between the occurrence of illnesses and cause of death (no. 3, 5, 6), and the working environment cannot prove the existence of this relationship. However, some significant differences related to the functioning of the pulmonary are found (no. 5, 6) such as (no. 5) among the exposed there was an increased lung elastic recoil pressure compared with the controls and (no. 6) significantly more persons with positive late and delayed intradermal test reactions are found in the exposed group.
In Study no. 4 the types of fungi found in the dust samples of the study undertaken in 1988 are very different compared to the study undertaken in 1982, so no conclusions can be made.

It is recommended (no. 4) that the emission of paper dust has to be limited at the source and the spreading of paper dust in the working place should be prevented. Also, standardization of measurements of fungal spores in the air is necessary.

4.1.4 Mixed wastes

The following three studies deal with the influence of waste dumps on the health of people living in the neighbourhood of waste dumps[17].

Table 4.5 Mixed wastes

study number	7	8	9
Objective	to investigate whether cancer incidence among persons who lived near a waste dump was higher than the average	to investigate the connection between a compost site and the outbreak of allergic bronchopulmonary aspergillosis	to assess the health risks related to toxic waste exposure (pesticides, tanning chemicals, PCBs)
Methodology	three zones near the site were selected, cases of cancer in these zones were identified from the Tumour Registry and statistically analysed	case-study of one patient, medical checks and samples on the dump and in the house of the patient	five dumps were selected, questionnaire surveys, review of local cancer incidence patterns and measuring of persistent chemicals in exposed persons
number of respondents	no details are given	one respondent	of only one dump details are given and this research included 4000 persons
Conclusion	no conclusions can be made	suggestions are made but a relation between exposure and illness can not be proven	interpretation of the findings is difficult

A difficulty of all the three studies is that there is no detailed environmental information available on what kind of (toxic) materials are present at the dumpsite, which is essential to start this kind of research. Another difficulty with these toxic substances is that effects mostly occur long after contamination has taken place, so the link is hard to proof.

To undermine multiple causative factors in the occurrence of cancer and being exposed to toxic waste dumps, a large group of respondents and controls have to be selected, and the research has to last many years.

[17] Although they deal with public health and not with occupational health, it was considered useful to include them here for comparison purposes.

4.1.5 Composting

Table 4.6 Composting

study number	10	11
Objective	to assess the possible health risks of bacteria	to indicate which biological organisms are found in the composting device
methodology	measurement and sample taking on employees and on fixed locations	measurement on fixed locations for two days
number of respondents/ number of samples	17 fixed test locations in the company, and measurement on an unspecified number of employees, divided in eight groups	none
conclusion	increase of complaints under employees seems likely: a causal relation however, cannot be established	a sharp increase in the levels of micro-organisms and endotoxins is recorded on the second day of the research

Table 4.7 Composting

study number	12	13
objective	to indicate the levels of exposure, and the effects on health of the biological agents in three waste-processing companies	to investigate the working environment in resource recovery and composting plants
methodology	three different companies were selected where measurements have been carried out on fixed locations and on employees for six days	cross-sectional analysis of six resource recovery plants and four composting plants, samples were made, medical examinations and analysis of the waste, this paper deals only with the preliminary results
number of respondents	not stated	not mentioned, 619 samples were taken
conclusion	very high levels of biological agents have been recorded in these companies, an assessment of possible health risks cannot be made	the results indicate that if only recycled waste of good quality, e.g. presorted materials, is sorted and if reception halls for unsorted waste are separated from the plants, concentrations of airborne micro organisms can be decreased considerably

These four researches have focused on the occurrence of bacteria and fungi in composting plants. On the one hand, the levels of dust in the workshop were taken in consideration; on the other hand, the occurrence of chemicals and biological substances were measured by taking samples of dust.

Dust. 31% of the dust samples (no. 3) contained a level equal to or under the detection limit: the Maximum Acceptable Concentration (MAC) was not exceeded. In Study no. 5 exposure to potentially toxic substances frequently exceeded the limits. Moreover, employees indicated that dust caused them more inconvenience in summer than in winter. A literature study on the composting of garden waste (van der Waart and Mennes, 1993, p. 15) mentions the occurrence of both long-term and peak emissions of dust. Problems for the employees, therefore, are not to be thought of as non-existent.

Endotoxins. All researches recorded high levels of endotoxins, often above the internationally agreed limits. Measurements carried out on employees recorded higher levels than measurements on fixed locations. The conclusion may be drawn that measurements on employees give more realistic results than measurement on fixed locations: the former research method, therefore, is to be preferred.

Bacteria. Levels of bacteria (no. 3) are high in each of the three plants: the highest level can be found in the composting hall. Van der Waart and Mennes (1993) conclude that micro-organisms involved in composting in general are not a cause of illness. Only in cases of strongly weakened resistance they can be the cause of serious infection. These organisms, however, may be a possible cause of allergies and asthma

From a literature study (Ault and Schott, 1994) on **Aspergillus** it has become clear that the risks of Aspergillosis in the workplace for healthy workers are negligible. A properly operated composting facility with proper moisture and pH-levels, aeration, and/or turning and mixing should not normally present an elevated health risk for Aspergillosis if the suggested management practices listed further down the page are followed.

The hazards of **toxins** like endotoxin and exotoxin in green composting are not considered as real[18].

According to van der Waart and Mennes (1996) the levels of **toxic substances** like dioxins, pesticides and other organics in waste are generally low.

To which extent green composting may cause environmental harm strongly depends on company management (van der Waart and Mennes, 1996, p. 23). It also strongly depends on the substances which are present in the compost whether it forms a hazard for the environment or for the labourers working with the compost. For instance, the level of heavy metals in compost forms a danger for the environment but not as much for the labourers. As long as standard guidelines concerning company management are wanting, no emission can be predicted or precluded with any certainty, and for this reason the effects on health are difficult to assess. Moreover, international standards of the maximum permitted levels of bacteria, exotoxins, endotoxins (for which internationally agreed limits are set), and fungi are wanting as well.

The following recommendations[19] are give to reduce the exposure to fugitive dust and spores in composting plants:

1. Siting of the composting activities. Study no. 8 recommended that composting sites should be located more than two miles from residential areas in order to minimize potential microbial contamination of the environment.

2. The design and construction. Ault *et al.*(1993) mention that:
   - Buildings can be designed and constructed to reduce spore emissions to the atmosphere.
   - Certain machinery operations which generate high volumes of dust outdoors or indoors may need to be enclosed, physically separating the worker from the source of dust.
   - Earthen surfaces may be paved for the control of dust and composting process wastewater may be disposed to sanitary sewers or septic tanks, or reintroduced into the compost materials.

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[18] From: van der Waart and Mennes, 1993, p. 178, in: Duijm, 1992, Biobakken en Volksgezondheid. Bericht aan de GGD's van Drenthe, Friesland en Groningen.

[19] Mentioned in the analysed studies in Paragraph 4.1 and from the following literature studies: Van der Waart and Mennes, 1993, and Ault *et al.,* 1994.

- Placement of planted berms and windbreaks may change ambient wind direction, directing it to flow away from nearby homes.

3. Facility operation practices:
   - Waste needs to be presorted before handed over to the composting plant because this contains less micro-organisms than waste not presorted (no. 5).
   - Workers should not enter the installation while the piles are turned because (no. 3) indoor concentrations of micro-organisms seemed to increase.
   - Better ventilation is required (no. 10, 11).
   - Percolate (van der Waart and Mennes, 1993) is advised to be removed through pipelines when it is contaminated with organic substances (no. 7).
   - An alternative for the use of compressed air is also required because this air is recorded to contain many spores and bacteria (no. 5).
   - Van der Waart and Mennes (1993) mention the importance of careful procedures with dusty processes, of taking the effect of the wind into account, and of the presence of proper screens on the premises. Furthermore, dust from the open-air areas of the premises must be prevented to blow about, for instance by moistening the paths.

4. Engineering and administrative controls. Ault et al. (1994) mention:
   - The use of proper building ventilation.
   - Changing the work assignment like job rotation and reduced task times, to minimize the length of time of the employees' potential exposure to Aspergillus spores.

5. The use of personal protective equipment, like respirators (no. 5).

4.2 Economically less developed countries

The studies undertaken in India have been done at a paper mill (no. 14), among waste picking children (no. 16), municipal dumping ground workers (no. 17) and adult waste pickers (no. 18). The study undertaken in Thailand (no. 15) has been done among waste pickers and their community.

4.2.1 Paper

Table 4.8 Paper

study number	14
objective of the study	to study the environmental conditions of workers in some paper mills (and the work they did) and to use this information as the basis for the design of safe plants
research methodology	samples were collected in three paper mills in South India
number of samples	not mentioned
main conclusion	*elaborated in text*

An elaboration of the conclusions made in the study are that:
- Screening of bamboo chips causes the dispersion of dust in various places in the chipper house.
- Mercaptans lead to offensive odour problems in the digester house.
- Exposure to chlorine gas in the bleach liquor preparation plant may cause symptoms ranging from slight irritation of the upper respiratory tract to fits of severe coughing.
- Severe exposure to talc dust can cause symptomatic severe pulmonary diseases.
- The handling and crushing of lime gives rise to high concentrations of dust.
- Exposure to coal dust may lead to simple or complicated coal workers' pneumoconioses.
- The conditions in some lime kilns, recovery burners and salt cake mixers cause high exposure to nuisance particulates.

It is recommended for the dispersion of bamboo dust, chlorine gas, talc, lime dust and coal dust to be properly controlled and for preventive measures to be taken. No information is given on what kind of measures could be taken.

4.2.2 Mixed wastes

All following four studies deal with people working with waste, as waste pickers on dump sites (no. 15 and 18), as waste pickers on the streets (no. 16) and as municipal dumping ground workers (no. 17).

Table 4.9 Mixed wastes

study number	15	16
objective of the study	to identify the dimensions of the public health risks to waste pickers and their community	to investigate the health status of waste picking children
research methodology	cross-sectional descriptive study utilizing field surveys and measurements, medical examinations, inventory of the demographic, socio-economic, health related and environmental characteristics in this community were examined, and health complaints and injuries were inventoried	comparative study of a descriptive nature, six different slums were selected, medical checks performed by doctors in different centres were used and waste picking children and control group were interviewed
number of respondents	for each check up different numbers of respondents were examined, and also different ratio waste pickers/non-waste pickers, 297 waste pickers were interviewed	100 children, not being mentioned is how many of these are the control group
main conclusion	association between the diseases and illnesses checked for and waste picking cannot be proven	a link can not be demonstrated

Table 4.10 Mixed wastes

study number	17	18
objective of the study	to analyse the occupational health hazards faced by municipal dumping ground workers	to carry out a baseline survey of the socio-economic, health and environmental aspects of solid waste recycling
research methodology	various dumping sites were visited by six interviewers, respondents were interviewed, medical examinations were undertaken	a random sample of the waste pickers was interviewed by a questionnaire, stool examinations were carried out, water quality analysis and air monitorings were carried out
number of respondents	100	205, 56% female, 44% male, 65% in the age group between 11 to 35 years
main conclusion	the workers suffer from many illnesses, which they claim are related to the work they perform	waste pickers were diagnosed and the water and air quality of the working and living environment was analysed but no relation was made with solid waste recycling

All four studies examine the relation between working with waste and health, but none of them can prove its existence.

Outcomes of studies no. 15, 16, 17, and 18 were that:

1. The overall respiratory illness score for children of waste picking parents was not different from those of non-waste picking parents (no. 15).
2. There was no association between below normal pulmonary function performance and waste picking and current/past smoking (no. 15).
3. There was no significant relationship between the HIV infection/HBV infection and waste picking (no. 15).
4. Waste picking was not associated with abnormal lung function among respondents (no. 15).
5. More of the waste pickers reported past health problems than the control group (no. 16)[20].
6. Waste pickers showed to be in a worse state of malnutrition than the control group (no. 16).
7. In relation to the average for height for age both groups were normal, indicating that neither suffered from chronic malnutrition. However, the waste pickers showed a slightly worse average (no. 16).
8. Many of the waste pickers suffer from chronic backache and many complained of general weakness. Also coughs were a chronic problem (no. 17, 18).
9. Many suffered from injuries, like cuts and pin pricks (no. 17, 18).

[20] In study no.16 the control group lived under better circumstances than the waste pickers, and it is therefore difficult to relate the reported health problems to waste.

10. Eye infections and other eye problems were highly prevalent (no. 17, 18).
11. A few night shift labourers of a dumping ground complained to suffer from severe hallucinations due to the environment they work in (no. 17).
12. Many of the waste pickers suffer from intestinal protozoa and helminths (no. 15, 16).
13. The dumps and waste bins are infested with stray dogs and rats, and bites from dogs and rats are quite common (no. 18).
14. Diarrhoea is extremely common among all waste pickers (no. 18).
15. Many of the waste pickers complained of having one or more attacks of jaundice in the last year[21] (no. 18).
16. Many waste pickers suffer from skin diseases (no. 17).

A literature study on waste pickers (Baldisimo, Lohani and Evans, 1988, p. 25) concludes that working and living conditions in the dumpsites are detrimental to health and are unsafe. Waste pickers suffer from respiratory diseases, skin diseases, parasitism and intestinal disorders.

Several studies also mention that the sense of self esteem among waste pickers is rather low, especially among female waste pickers (Huysman, 1994, pp. 88-89): "they are looked down upon, abused and considered easy sexual targets."

An article by Campbell and Ault (1996, p. 8) mentions that solid waste, if not managed properly, provides excellent breeding locations and shelter for a host of disease-transmitting vermin and pests. It mentions that a survey carried out in Cairo found more than 50 species of rats, fleas, ticks, and flies. Of primary importance according to the study was the great prevalence of Xenopsylla cheopis, the type of flea responsible for carrying the plague. In addition to the disease-carrying animals and insects that frequent dump sites, ravens and seagulls scavenge at many sites. These birds carry zoonotic parasites, which are passed in their droppings. Discarded containers at these locations serve as breeding places for the mosquito Aedes aegypti, the principal carrier of dengue.

Recommendations are:

1. A health education campaign for waste pickers is highly recommendable, as well as a residential and environmental sanitation improvement program, and water supply improvements (no. 15, 17).
2. Toxic and hazardous waste from clinics and hospitals should be separated from the waste stream (no. 15).
3. Existing working conditions (no. 17) need to be improved drastically. This can be accomplished through:
    a. The elimination of hazardous duties
    b. Welfare measures have to be taken like housing facilities and transportation facilities
    c. A canteen, toilet and bathroom facilities and a restroom have to be built near the dumping grounds
    d. Personal protective equipment has to be handed to the workers
    e. Medical first aid kit facilities have to be present at the dumping grounds

[21] As the figure mentioned in the study was very high, it was suggested that it could not be fully relied upon. An explanation could be that traditional healers have a tendency to over-diagnose jaundice.

f. There is a need for a well equipped garage

There are also researchers who claim that waste pickers are better of than people living in the same slum who are without a job. They claim that waste pickers at least have an income (Kungskulniti, 1990, p. 64).

4.3 Conclusions

From the studies investigated it appears to be difficult to draw straight forward conclusions on the health effects of working with waste. Reasons are that the research methodology used is not sufficient, and the number of studies are small, so general conclusions are difficult to draw. A difficulty in the examinations of levels of dust and bacteria in composting installations is that there is no international agreement on the levels of allowable concentrations.

The following shortcomings were encountered:

1. Often the group of respondents was too small and a control group had not been used.
2. A control group has to live in the same circumstances as the respondents, e.g. if the control group lived under better circumstances than the waste pickers (for example no. 16) no relation can be proven between the health of the respondents and the work they perform.
3. Some studies rely too much on questionnaires and are not complemented by medical check-ups.
4. Sometimes biased conclusions were drawn, especially in the researches among waste pickers, e.g that the health of waste pickers is worse than the control group, when the methodology in the study is not sufficient to draw that conclusion.

CHAPTER 5 CONCLUSIONS

This chapter deals with the conclusions that can be drawn from the literature review and the case-studies.

The working document is divided into two parts, a literature review on health, occupational health and biological agents (Chapter 2 and 3), and a more practical part analysing case-studies on occupational health aspects of working with waste (Chapter 4).

At the start of the study three subjects for the study were formulated:

1. The occupational health aspects of waste collection and recycling.
2. Methods to assess working conditions and environmental pollution.
3. Strategies to improve the working conditions and reduce the environmental pollution.

With the knowledge gathered through the literature review and the case-study analyses, these three subjects will now be dealt with.

5.1 Occupational health aspects of waste collection and recycling

This aspect is dealt with through the use of case-studies, both from industrialized countries and economically less developed countries. The case-studies gathered and analysed focused on:
1. Waste water
2. Plastic
3. Paper
4. Mixed wastes
5. Compost

One general conclusion is that few studies are available that deal with the health aspects of working with waste. The case-studies that were available and which are evaluated in Chapter 4 could not give clear evidence of a link between working with waste and a possible danger to health.

A Dutch consultancy bureau, BKH advisors, did a literature study and consulted experts on the occupational health aspects of biological agents in the GFT[22] disposal (only focusing on industrialized countries). The aim of that report was to analyse the existing information on the topic and to give an overview of the state of the art on occupational health aspects in GFT disposal. They also come to the conclusion that at the moment it is not possible to give proof of links between waste and health. They also indicate that the quality of studies on the subject is low.

Concerning the methodology, the problem with identifying the hazards on a workplace and to link the health of waste pickers with the occupation they perform, is that in general it is difficult to prove that a certain exposure is the cause of a disease. Diseases can also be related to the home.

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[22] In Dutch it is a translation for 'vegetables, fruit and garden waste', which means the organic fraction of municipal waste.

In this sense, for the methodology of a research to investigate the link between the working environment and the occurrence of certain diseases, it is very important to have a control group. Only then is it possible to check whether the working environment is the cause of a certain disease, or that other factors also play a role in the cause of that disease, for instance the lack of sanitary facilities at home. Also the research has to be long-term. These are aspects that are absent in many of the case-studies that were analysed in Chapter 4.

Another problem complicating the research into occupational health effects of waste recycling and collecting is the fact that no generally applicable and accepted method to measure most kinds of biological agents is available yet, and for most of the substances international legislation does not exist. Some rules of thumb are applied to substances like endotoxins, fungi and grain dust. Only for dust Maximum Acceptable Concentrations (MAC) are formulated.

Furthermore most of the case-studies analysed in Chapter 4 are not gender differentiated. There was only one case-study that focuses on children involved in waste picking, and only a few literature studies focus on female waste pickers only.

The occupational risks that can be present in waste related activities involved in waste handling are:

1. Occupational accidents
2. Physical risks
3. Chemical risks
4. Ergonomic risks
5. Psychological risks
6. Biological risks
7. Others, such as bites from animals

Based on the literature used in this document, the occupational health risks of some waste handling and recycling activities are listed below. It is very important to distinguish health risks according to the type of work carried out, e.g. picking waste on a dump site may lead to different health risks from for instance working in a recycling enterprise, and the type of waste material used. Risks are therefore mentioned for waste pickers, itinerant waste buyers and recycling enterprises.

Risks that **waste picker**s at dump sites may run, are:

1. Injuries like cuts and pin pricks can be listed as occupational accidents.
2. Physical factors that may cause health problems for waste pickers are caused by the fact that they work outside under all sorts of weather conditions, exemplified by the fact that they complain of general weakness and colds.
3. No evidence of diseases caused by chemical factors has been found in the literature, but possible risks can be formed by toxic substances at dump sites.
4. Ergonomic risks are the heavy lifting exemplified in the fact that waste pickers suffer from chronic backache.
5. Psychological factors can be subdivided into low self esteem, hallucinations and the sexual harassments of female waste pickers.

6. Biological risks are exemplified by the fact that waste pickers suffer from intestinal protozoa, helminths, eye infections, skin diseases and diarrhoea.
7. Others. Waste pickers suffer from bites from dogs, rats, snakes and scorpions.

Risks that **itinerant waste buyers**[23] may run, are:

1. Occupational accidents are traffic accidents caused by the fact that they travel by bike or hand cart through the streets.
2. Physical risks are caused by the fact that they work outside under all sorts of weather conditions which may cause colds and fever.
3. Chemical risks are caused by the gases of the traffic that they are exposed to during the day which can cause headaches and lung problems.
4. Ergonomic risks can be caused by the heavy load they may have to transport.
5. Psychological factors that can influence the health of itinerant waste buyers can be caused by the fact that working with waste is looked down upon and is an occupation that is only for the 'underprivileged'.
6. Biological risks occur only when collecting organic waste or dirty non-organic or dry waste materials. Also air pollution can be a problem, which may cause lung problems and irritation of the eyes.

Risks that can occur in **recycling enterprises** depend on the type of material being recycled, but general risks are[24]:

1. Occupational accidents like cuts, accidents with machinery and fire risks e.g. due to faulty electricity connections.
2. Physical risks like the use of machinery in plastic recycling enterprises can cause hearing damage.
3. Chemical factors: these hazards depend upon which chemicals are used in the enterprises, but for example if in a plastic recycling enterprise the temperature of the plastic recycling machines is not appropriate/fine tuned/too high, hazardous gases may be released which may form a danger to the health of the workers.
4. Ergonomic problems in recycling enterprises are exemplified by workers complaining of backache from lifting heavy weights. Workers who do the sorting of recyclables complain of body aches of sitting in one position the whole day.
5. Psychological factors are exemplified by stress caused by payment on piece-rate basis.
6. Biological factors that may form health hazards are caused by dust causing all sorts of asthma and asthmatic diseases.

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[23] Itinerant waste buyers buy or barter waste materials with value directly from offices, households and shops. They deal mostly in bottles, paper, plastic and organic waste.

[24] Within the scope of this study it goes too far to elaborate risks for each waste material.

Box 5.1 A case-study in India

Part of a study into the recycling sector in Bangalore (by van Eerd, 1995) looked at working conditions in glass-cullet wholesale enterprises (see also the photos on the next pages). In these enterprises the majority of the labourers are women and children and the division of labour is strongly gender-related. The men are engaged in the loading and unloading of the cullets, the women and children do the sorting.

1. Occupational accidents.
   Because the work place is packed with glass cullets, which are not separated from the workers, there is a great risk of falling into the glass. The labourers often incur cuts. Women and children sort the cullets with their bare hands.
2. Physical risks.
   In cullet wholesale enterprises the workers mostly work outside and they complain to suffer from headaches, because during the warm period the sun gives a lot of reflection through the glass-cullets. During the rainy season they suffer from colds.
3. Chemical risks.
   The extent of chemical risks depends on the chemical substances that can be found among the cullets. In the enterprises included in the research also medical bottles were recycled. The bottles gathered were emptied on the floor of the workplace.
4. Ergonomic risks.
   Ergonomic risks are highly dependent on the job performed. The female labourers suffered from back-aches because they sit on the ground in one position for several hours. The men suffered from back-aches and body-aches because of the heavy carrying the whole day.
5. Psychological risks.
   In glass-cullet enterprises work is sometimes organized on piece rate which can cause stress to the labourers. Another factor is that working with waste is looked down upon. This is even more the case for female workers, because ‘respectable women’ do not work.
6. Biological risks.
   Biological risks are caused by the dirt and dust in the workplace.
7. Others.
   Not applicable.

Photos

Photo 1. Women sorting cullets in a wholesale enterprise in Bangalore.

© WASTE, Maartje van Eerd, 1995

Photo 2: Men loading cullets in a wholesale enterprise in Bangalore.

© WASTE, Maartje van Eerd, 1995

Photo 3: A man loading cullets on a truck in a wholesale enterprise in Bangalore.

The risks the case-studies focused on were mainly caused by biological agents, and some by chemical factors, physical factors and accidental accidents. Hardly none of the studies mentioned the ergonomic risks and only one study mentioned psychological factors that may play a role in working with waste.

5.2 Methods to assess working conditions and environmental pollution

Not much information has been found on methods for assessing waste related working conditions. General strategies for improving working conditions have been developed by Boleij *et al.,* the ILO and PRIA. Only van der Meer (WASTE) has applied general strategies to working with waste. It seems very useful that these strategies are tested out in waste collection and recycling activities. Information on participatory methods for assessing environmental pollution has not been obtained.

5.3 Strategies to improve the working environment and reduce environmental pollution

In the literature on working conditions and occupational health aspects of waste collection and recycling four different points of view are predominating, namely:

1. The point of view that the dangers of the work are relative and that waste picking is an income providing occupation that is essential to many of the poor in economically less developed countries. They claim that many waste pickers are better of than people living in the same slum who are without a job, because they at least have an income.
2. The point of view that working with waste is unhuman, and should be abolished as soon as possible.
3. The point of view that before valuing the work more research on the occupational health aspects of working with waste should be undertaken.
4. The point of view that waste forms a source of income, which is essential for many poor people and that low-cost measures to improve the working conditions are necessary and possible.

The last point of view (no. 4) can be elaborated for each waste activity, with the use of the 'four level strategy' (see Paragraph 2.6.2). Taking the cullet wholesale enterprises (see also Box 5.1) as an example, the four level strategy for each occupational risk mentioned in Paragraph 5.1 is listed in Box 5.2[25].

[25] The aim is not to elaborate a complete strategy, but to illustrate possible strategies by means of an example. Also, it is obvious suggested improvements should be tested in the field.

Box 5.2 Possible improvements in cullet wholesale enterprises

1. To reduce the risks of **occupational accident**s it is suggested to:
   Measures at source:
   - Make use of a sorting table
   - Avoid payment on piece rate basis
   - Make use of a wheelbarrow

   Personal protection:
   - Use gloves
   - Wear shoes
2. To reduce the **physical risk**s it is suggested to:
   Measures at source:
   - Build a roof over the working ground
   - Separate the sorting of glass from the storage of glass

   Personal protection:
   - Use safety glasses
3. To reduce the **chemical risk**s it is suggested:
   Measures at source:
   - Wash the materials before sorting
   - Separate chemical waste at source
4. To reduce the **ergonomic risk**s it is suggested to:
   Measures at source:
   - Make use of a wheelbarrow
   - Make use of a sorting table
5. To reduce the **psychological risk**s it is suggested to:
   Measures at source:
   - Raise awareness on the importance of the work (e.g. the environmental benefits of recycling)
   - Avoid payment on piece rate basis
6. To reduce the **biological risk**s it is suggested to:
   Measures at source:
   - Wash materials before sorting
   - Keep the working place clean
   - To wash hands before eating
7. To reduce **other risks**: not applicable

Experiments with possible strategies and measures should be executed in close collaboration with owners as well as employees. It is obvious that for example small-scale recycling enterprises will not adopt such a strategy without awareness raising campaigns and technical and financial support.

5.4 Recommendations for follow-up activities

The recommendations that are mentioned below are based on the information gathered through this desktop study. They are formulated for WASTE to be integrated in the Urban Waste Expertise Programme (UWEP).

A. Short-term recommendations:
- Literature research and interviews with resource persons in India.

A lot of information on the topic comes from India. Also a lot of the responses on the questionnaire came from organisations and persons active in the field of occupational health and waste collection and recycling in India. It is assumed that more information is

available in libraries in India, e.g. from the Centre for Science and Technology (CSE) in New Delhi. It is therefore recommended to do a similar literature study in India. While doing the literature study it is suggested to interview resource persons active in the field of occupational health, e.g. from PRIA in New Delhi and FOCUS in Calcutta, in order to obtain an idea of the different points of view on possible improvements, and existing knowledge.

B. Medium-term recommendations:

Workshop

It is recommended to organise an international workshop (e.g. in India) for key persons to:

1. Exchange expertise on the subject
2. Identify major issues and problems
3. Formulate strategies
4. Discuss possibilities for cooperation between the different participants of the workshop on the subject

Field studies to assess working conditions

For field studies it is advised to use the list of occupational risks as formulated in Paragraph 5.1, and the four level strategy as formulated in Paragraph 2.6.2. The aim of the study is to make an inventory of all risks that are present in the working place, and to formulate strategies for improving the working conditions.

C. Long-term recommendations

Based on the field studies, the literature study in India, the interviews with key persons and the international workshop long-term recommendations can be formulated. At this moment it is already possible to conclude that:

- Financial and technical assistance is necessary, in particular for small-scale waste entrepreneurs, individuals as well as enterprises, that thrive in difficult economic circumstances and have limited financial returns.
- Awareness raising on the risks present in the working place both for employers as employees, and on possible changes they themselves can introduce to reduce these resources.

ANNEX 1 ANALYSED CASE-STUDIES

The corresponding numbers of the studies in the tables of Chapter 4 are:

1. Scott Clark, C. *et al*. Serologic Survey of Rotavirus, Norwalk Agent and Prototheca Wickerhamii in Wastewater Workers. AJPH, Vol. 75, No. 1. pp. 83-85. January 1995.

2. Fuortes, L.J. *et al.* 1989. An Outbreak of Naphthalene Di-Isocyanate-Induced Asthma in a Plastics Factory In: Archives of Environmental Health, Vol. 50, No. 5. pp. 337-340.

3. Wingren, G. *et al.* 1991. Mortality Pattern Among Pulp and Paper Mill Workers in Sweden: A Case-Referent study.

4. Smeets, H. 1989. Opwaaiend Papierstof, Bedrijfshygiënisch Onderzoek naar de Blootstelling aan Papierstof van Werknemers in een Hygiënisch Papierwaren Fabriek.

5. Järvholm, B. *et al*. 1988. Lung Function in Workers Exposed to Soft Paper Dust. In: American Journal of Industrial Medicine Vol. 14. pp. 457-464.

6. Heederik, D. *et al.* 1987. Pulmonary Function and Intradermal Tests in Workers Exposed to Soft-Paper Dust. In: American Journal of Industrial Medicine 11. pp. 637-645.

7. Goldberg, M. *et al*. 1995. Incidence of Cancer among Persons Living Near a Municipal Solid Waste Landfill Site in Montreal, Quebec. In; Archives on Environmental Health, Vol. 50, No. 6. pp. 416-424.

8. Kramer, M.N. *et al*. 1989. Allergic Bronchopulmonary Aspergillosis from a Contaminated Dump Site.

9. Heath, C.W. Jr. 1983. Field Epidemiologic Studies of Populations Exposed to Waste Dumps. In: Environmental Health Perspectives. Vol. 48. pp. 3-7.

10. Verkuilen, K. 1995. Blootstelling aan Biologische Agentia bij een Afvalverwijderingsbedrijf.

11. Leeuwinga *et al*. 1994. Blootstellingsmetingen naar Biologische Factoren in een Composteringsinrichting.

12. Amelsvoort, L.G.P.M. *et al*. 1993. Blootstelling aan Biologische Agentia bij Werknemers in de Huisvuilverwerking.

13. Nersting, L. *et al*. Biological Health Risk Associated with Resource Recovery, Sorting of Recycle Waste and Composting. 1991. In: Grana 30. pp. 454-457.

14. Gautam, S.S. *et al.* 1979. Occupational Environment of Paper Mill Workers in South India.

15. Kungskulniti, N. *et al.* 1991. Solid Waste Scavenger Community: An Investigation in Bangkok, Thailand. In: Asia-Pacific Journal of Public Health Vol. 5, No. 1. pp. 54-65.

16. Hunt, C. 1994. A Comparative Study of the Health Status of Children Involved in Waste Picking in the City of Bangalore, India.

17. Your Clean City at Whose Cost. The Forum for Environmental Concern. (year of the study is not given).

18. A Rapid Assessment Survey of the Health and Environmental Impacts of the Solid Waste Recycling. 1996. Direct Initiative for Social and Health Action, Calcutta, in collaboration with PRIA and CSME.

2. Fungal skin infections

Fungal infections of the skin and the scalp are associated with inadequate hygiene and the best prevention is water and soap. Warm and humid conditions increase susceptibility.

3. Bacterial skin infections

a. Impetigo and secondary skin infections
Oozing lesions with crust formation are typical for bacterial skin infections. The infection is often secondary to primary lesion, e.g. fungal infection, scabies or insect bite. Infected insect bites may lead to a condition called *multiple skin sepsis*. All infections of the skin can be dangerous because of the possibility of generalised infection. Impetigo is a very contagious primary skin infection usually caused by streptococci and staphylococci.

b. Erysipelas
Erysipelas is an acute streptococcal infection of the skin and the underlying layers.

c. Abscesses
Deficiencies in general hygiene, not sterile syringes and various minor injuries are probably one explanation for the common occurrence of abscesses in economically less developed countries.

d. Wound infections
Wounds and wound infections are common in economically less developed countries. Tetanus infection is in most cases acquired through wounds.

e. Tropical ulcer
Tropical ulcer (TU) is a common, acute or chronic skin disease that effects mainly children and young adults in tropical and subtropical areas. Infection is the likely cause of TU. Malnutrition, trauma, poor personal hygiene, poor sanitation and exposure to mud or slow moving water may contribute to the disease.

f. Cancrum oris
Cancrum oris is caused by the same bacteria that are present in early tropical ulcers. It affects mainly malnourished children.

g. Skin manifestations of the treponematoses
One type of skin manifestation of the treponematoses is syphilis. Yaws is another disease. It is found in tropical South American countries as well as in West and Central Africa. It transmits through direct contact from infective lesions.

4. Miscellaneous skin conditions

a. Eczema
Eczema along with allergic skin reactions form a notable part of the skin ailments in economically less developed countries.

b. Cracking of the feet
Walking barefoot subjects the feet constantly to trauma and leads to thickening of the skin in the exposed areas. New trauma and the skin-drying effect of walking barefoot cause cracking of the feet. The cracks may be painful and predispose the feet to deep infections.

c. Effects of the sun
Sunburn and prickly heat are common complaints.

d. Skin changes in nutritional deficiencies
Pellagra is caused by a deficiency of nicotinic acid. *Kwashiorkor*, a protein-energy malnutrition, presents itself sometimes with a flaky paint rash.

e. Cutaneous manifestations of HIV infection
Cutaneous manifestations of HIV infection are common. The most common skin changes are various bacterial, fungal and viral infections and severe scabies.

ANNEX 3 TERMS AND DISEASES

Terms and diseases in Chapter 3 and 4 that need further explanation are described in this appendix.

Rotavirus:

The single most important causal agent of acute watery diarrhoea leading to severe dehydration. Rotavirus is characterized by vomiting, fever and profuse watery diarrhoea. It can be spread by faecal-oral contact.

Extrinsic allergic alveolitis (Hypersensitivity pneumonitis):

Generic term for specific lung diseases, such as Farmer's and Pigeon-fancier's lung. Occurs after sensibilisation with organic or biological material. No allergic disposition required. Symptoms: four to eight hours after exposure fever, muscular pain and malaise occur, sometimes accompanied by difficult breathing and tightness of the chest. May be caused by exposure to fungi or bacteria.

Aspergillosis:

Aspergillosis is a chronic serious disorder whereby the aspergillus fungus grows in the lung. The invasive aspergillosis whereby the fungus grows from the lung into other organs is seldom. This type of aspergillosis only occurs in humans suffering from a malfunctioning immune system.

Aspergillosis disease entities are:

a. Extrinsic (allergic) asthma
b. Allergic Bronchopulmonary Aspergillosis (ABPA)
c. Hypersensitivity pneumonitis (HP)
d. Invasive aspergillosis

Conjunctiva:

The mucous membrane that covers the front of the eye and lines the inside of the eyelid.

Spirometry:

Pulmonary function test: the air blown out is measured.

Detection limit:

Minimum detectable concentration.

Lung elastic recoil pressure:

Measure that indicates the suppleness of the lung.

Intradermal test reaction:

Skin test to detect allergies.

Legionnaires' disease:

The principal feature of legionnaires' disease is pneumonia and the infection is acquired by the inhalation of fine water droplets carrying legionella pneumophila.

Schistosomiasis:

It is an infection caused by larvea that penetrate the skin of the human host (it is also called Bilharzia).

ANNEX 4 NAMES AND ADDRESSES OF PERSONS AND ORGANIZATIONS

This is a list of persons and organizations involved in occupational health and/or waste recycling that responded to the mailing, or provided useful information.

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ANNEX 5 INFORMATION ON UWEP

Urban Waste Expertise Programme (UWEP), enabling communities and micro-enterprises to improve their urban environment.

Many large cities in the South experience major problems regarding urban solid and liquid waste management. For a variety of reasons the public sector cannot cope with the growing magnitude of this environmental health problem. Attention has therefore shifted to the formal private sector enterprises as the panacea. The role of community efforts and small and micro-enterprises has been neglected or considered marginal. Yet they do play an important role in the collection, re-use and resource recovery of large amounts of 'waste' materials. The poverty of large parts of the urban population causes many of them to survive on the picking and sorting of waste. Others run small workshops reprocessing waste into useful new materials or products. The environmental sanitary conditions, however, are often appalling for those employed in these workshops and for those living in the unserviced low-income areas or close to industrial settlements. Women and children are worst off in this waste business: they perform the dirtiest, lowest paid jobs.

Based on an analysis of the general urban waste problems, some basic problems have been defined:

- Micro-entrepreneurs and communities often lack access to information, authorities, funds and/or technical means to improve their business (products, working conditions) and environment.
- The capabilities of micro-entrepreneurs and communities to participate in urban waste management are not considered a serious option. Authorities and donors do not include these actors in their funding or waste policies tackling urban waste problems.

UWEP has a duration of six years covering the period from 1995-2001, and is funded by the Dutch Ministry for Development Cooperation. UWEP aims at:

- Generating additional employment in waste handling through small and micro-enterprise involvement
- Improving the environmental conditions for low-income communities

The programme wants to develop local expertise by means of research and pilot projects, workshops, training and exchange visits and a continuous dissemination of documented knowledge and expertise generated in the programme. The programme also wants to promote waste policies which aim at integration of small and micro-enterprises in the existing waste management systems through regional meetings and policy conferences with local authorities and development organizations.

Present activities 1995-1996

UWEP's inception phase is from 1995 to 1997. Eleven research projects have been determined and many research & documentation activities have been launched. Many local researchers and organizations collaborate with WASTE in doing research into innovative cases. The main topics covered by the Inception Phase are:

- Neighbourhood based collection and treatment of household excreta, the scale level, the operational requirement and community participation in the management
- Innovative small enterprises in solid waste collection in Latin America
- Working conditions, pollution and financial viability of small-scale plastics enterprises
- Scale levels of technology for organic waste handling, and marketing of compost
- Opportunities for small enterprises in hospital waste management
- Opportunities for small and micro-enterprise and community involvement in the collection of harbour and ship waste
- Existing and potential links between formal, informal private and municipal waste management systems
- Development of an environmental-economic waste system analysis, to quantify the economic contribution of small-scale enterprises and communities

These activities take place in three regions: Latin America (Peru, Brazil, Panama, Colombia, Costa Rica), Africa (Egypt, Mali, Ghana) and Asia (Pakistan, India, Nepal, the Philippines).

Besides these research activities a Programme Policy Committee - PPC - staffed by renowned people from India, Colombia and Ghana has been established. The PPC has the final responsibility for the implementation of all the programme activities. In workshops PPC, UWEP partners and WASTE discuss Annual Plans, the second phase of UWEP and the involvement of partners. The results of the research activities in the Inception Phase and the plans and themes for the next phase will be discussed in the Partner Meeting scheduled to take place in May 1997.

UWEP's implementation phase will start after the Partner Meeting. In a selected number of cities UWEP will implement pilot projects. UWEP will select cities on their potential to improve the current waste management system and the opportunity to assign roles to small and micro enterprises and communities.

At the end of the programme, the activities that have been developed are envisaged to lead to five distinguishable results:

- Appropriate waste related knowledge has been generated and customized for dissemination both at practical and policy levels for professionals, policy makers and implementors.
- Expertise has been gained by professionals from the South responding to the demand from organizations in the South employing such activities, and from the authorities, development agencies developing micro-enterprise and community related waste policies.

- Organizations in the South have gained access through local sources to appropriate waste related knowledge and expertise.
- Governments and donor agencies have been subject to promotion of micro-enterprise and community oriented waste policies.
- Organizations in the South have received assistance to develop proposals for improvement and to channel these through governments and donor agencies.

ANNEX 6 TESTS TO DETERMINE THE HEALTH EFFECTS FROM MICRO-ORGANISMS

Some tests, which are mentioned in the case- studies, to determine certain health effects form micro-organisms are listed in this appendix.

To determine the effects on the lung function the following parameters can be measured:

FEV_1: forced expiratory volume in 1 second
(F)VC: vital lung capacity
P(E)FR: peak (expiratory) flow rate

Peak flow rates are used to locate obstructions in the upper bronchial tubes. To this end the employees must blow into the Peak Flow Rating device before, during, and after their work.

To detect allergies the following tests can be applied:

Provocation test: a lung test which assesses the reaction to inhaling allergens or histamines.

Skin prick test: a skin test which assesses the reaction to specific allergens.

Serology: a blood test which measures antibodies for instance.

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