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Cleaner Technology Projects in Denmark 1997

Summaries of all Project Reports and Working Reports on clearner technology published by the Danish Environmental Protection Agency in 1997

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Contents

Preface

This Working Report contains summaries of all Project Reports (*Miljøprojekter*) and Working Reports (*Arbejdsrapporter*) on cleaner technology published by the Danish Environmental Protection Agency (EPA) in 1997.

The projects were carried out under the Danish Environmental Protection Agency's Action Plan for Cleaner Technology 1993-97, the main objective of which is to ensure the implementation of results from previous Action Plans, to continue research and development activities, e.g. substitution of environmentally harmful substances and materials, and to shift focus from production *processes* to *products*.

Conscious efforts to minimise environmental impacts are becoming competitive parameters for the industry. The implementation of cleaner technology has proven to entail savings in operation costs and lower costs of production, and these results are communicated through the project reports.

Cross-references are given to projects that form part of major programmes, or where previous or subsequent projects deal with the same topic.

Since the Working Reports are only published in limited edition, some reports may not be available. However, the reports can be found at the Danish Environmental Protection Agency's homepage www.mst.dk in PDF format. Moreover, the Working Reports can be borrowed from EPA's library.

The Environmental Projects are sold through EPA or *Miljøbutikken*, or they can be borrowed from public libraries.

In each summary is given the name of the author(s) and the project institution(s) for further reference. It should be noted, though, that the authors might have changed position since then.

This summary report is also available in Danish.

Environmental Aspects of PVC

Environmental Aspects of PVC

Miljørapport nr. 313, 1997, Miljøstyrelsen

The recent years focus, on PVC and the substances' environmental- and health risk effects, has caused a need for clear and transparent information about the substance through its entire life cycle. This report gives an account of a comprehensive Danish study with important international contributions.

The aim of the project has been to bring about information on PVC and its environmental- and health effects as a foundation for future evaluations and use of the substance. Therefore, the report does not contain actual conclusions and recommendations. In addition, the project group has chosen to only to a limited extent to incorporate comparisons with other substances, instead they refer to other studies (here amongst Environmental Project no. 131, 1995).

On the contrary, in this project great emphasis is put on the environmental- and health effects of e.g. phthalate softeners and new knowledge on these additives is included in the project. The evaluation of these substances is therefore prioritised instead of a detailed account of the use of led- and cadmium stabilisers, whose environmental effects are well known.

PVC is a thermo-plastic material that contains 57 % chlorine and 43 % hydrocarbon – measured in weight. In order to stabilise the material during the production process heat stabilisers are added. Other additives are used to give the material special properties depending on what it is going to be used for.

The primary raw materials are mineral oils, natural gas, and sodium chloride that are converted to ethylene and chlorine and by syntheses to vinyl-chloride monomers (VCM). VCM polymerises to PVC. PVC is not produced in Denmark. The total energy consumption is 66, 80 MJ/kg, including transport. 37,24 MJ/kg are used as fuel whilst 29,56 MJ/kg are bound in the material.

In the production emissions of chlorine, mercury, ethylene-di-chloride (EDC, hydrochloric acid and vinyl chlorides and more) can take place. It is most important to control the emission of VCM and EDC due to the health risks. With regards to the environment it is important to control the emission of chlorine substances.

When PVC is used in consumer products additives must be added, including pigments and softeners. When seen from a toxicological and an eco-toxicological perspective the most important stabilisers are lead, cadmium and certain organic connections. Cadmium is no longer used as a stabiliser in Denmark.

Softeners are weight wise the largest group of additives. First and foremost DEHP is used. DEHP is not acutely poisonous in aquatic environments, but can be acutely poisonous for aquatic organisms and can have long-term harmful effects on the aquatic environment. DEHP is potentially biodegradable in aerobe conditions if the temperature is high. DEHP can be accumulated in sediments and soil where the temperature is relatively low. Screening analysis show a week xen-oestrogen affect. DEHP is realised to the air and water through production, use and deposition.

DIDP can be poisonous for aquatic organisms and is bio accumulative. CICP is potentially degradable but is possibly degraded slower than DEHP.

In the use phase the environmental impact is dependent on whether the PVC is soft or hard. In normal use the stabilisers are bound to the material and do not constitute a problem. In the cleaning of for example vinyl floors or textiles some softener might be released. In packing a certain migration of softener to the product will occur if there has been direct contact with a product containing fat. Phthalate softeners are found in different concentrations in the environment, especially in aquatic environments. Sufficient knowledge on how they are transferred is not existent.

In Denmark the majority of waste is incinerated. Normally approx. 74 % of PVC-material's energy contents is used (29,52 MJ/kg). Herein the energy consumption of transportation is not included. In the incineration of PVC sulphuric acid is produced. Due to the smoke-gas' environmentally harmful impact, chalk is usually used for neutralisation. Heavy metals from pigments and stabilisers can be leached to the environment. The slag that contains calcium chloride, heavy metals and dioxins is deposited. It has been calculated that two-thirds of the chlorine that is created by waste incineration stems from PVC-products. Precisely the chlorine-contents make it difficult to deposit. The chlorine ions mobilise the heavy metals and the residual product must therefore be treated as 'problematic waste'.

PVC is a recyclable product and to some extent one can lower the waste quantities by sorting out the waste. It is also questioned whether it is desirable to collect and re-cycle PVC containing cadmium, instead of promoting an out-phasing of this. PVC is degraded very slowly – if at all – in nature. Softeners are released from the products and this can well be an important source of leaching to soil and water. The further fate of softeners in the earth is not very well described.

The project report is written in English. A follow-up group with representatives from the environmental authorities in Sweden, Norway, Germany, Holland and Belgium has contributed with information and comments.

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Environmental Impacts and Resource Consumption for 3 Graphic Products in a Life-cycle Perspective

Miljøeffekter og ressourceforbrug for 3 grafiske produkter i et livscyklusperspektiv

Miljørapport nr. 341, 1997, Miljøstyrelsen

Resource consumption and environmental impacts have been systematically mapped and assessed from cradle to grave for three graphic products: a newspaper, a weekly magazine and a commercial. On this basis it has been possible to establish a basis for future references and an overview of the facts and point out the areas with the biggest possibilities to reduce the environmental impacts.

The main goals of the project have been to state the resource consumption, the energy consumption and the outer and inner environmental relations in order to identify the areas with the largest consumption and thereby elucidate where the efforts should be made to reduce the consumption. The project includes a number of recommendations to make the graphical products as environmentally friendly as possible. It is not possible to follow all the recommendations today they are meant as suggestions to a future graduate and positive development in this area.

More than 98 % of the printed matter is paper. The paper is the dominating factor for the graphic product both in relation to resource consumption and environmental impacts. The major consumption and impacts originate from the energy consumption from the paper production. The printing is the second most important factor. The printing inks do not contribute considerably to the chosen effect categories except regarding consumption of oil and natural gas and generation of hazardous waste. Environmental, resource and waste profiles have been calculated and plotted for the three products. The importance of the paper and the printing is quickly seen. The visited paper mills mainly use non-renewable fuels.

The discharge of AOX from the production of paper mass is insignificant at the visited newsprint mill. For the mill producing paper for commercials the AOX discharge exceeds the standards set in the Nordic Swan eco-label. Four simulations have been performed showing that the weight of the printed matter is the most important factor in relation to consumption of resources and environmental impacts that it is possible to change immediately. Fewer and lighter printed matters will, everything else being equal, cause less consumption of resources and environmental impacts.

The major recommendations for the three graphic products are:

- The printed matter is printed on a paper quality as light as possible.
- The printed matter is printed on a paper quality with minimum energy consumption, maximum consumption of renewable fuels and maximum content of re-cycled fibres. Often an integrated mass and paper mill will use less energy as the surplus energy from the mass production can be used to dry the paper.
- Only paper qualities fulfilling the demands from the Nordic Swan eco-label on paper or the like is used.

- The graphic product fulfils the demands stated in the Nordic Swan eco-label on graphic products or the like.
- The tree stems from woods conducted on a sustainable basis e.g. by following the Swedish criteria, /3/.
- The fuel consumption should, as much as possible, be covered by renewable fuels such as hydropower, wood etc.
- The paper contains as many re-cycled fibres as possible. This implies less energy consumption and less consumption of new filler.
- The paper mill has implemented an environmental management system and has worked out environmental, resource and waste profiles for the paper qualities produced.
- The paper mill has a biological wastewater treatment plant in order to reduce the discharge of AOX, organic matter, nitrogen and phosphorus considerably.
- The produced paper qualities fulfil the demands stated in the Nordic Swan eco-label or the like.

For substances, where we for the time being are lacking data, resources should be used to search for toxic and eco-toxic data at more sources than done in this project. Emission of substances classified as potentially very eco-toxic or toxic should be reduced, if necessary by treatment. Furthermore one should consider substitution with less harmful substances.

Work should be done to improve the awareness of the environment among the buyers and users of the graphical products. Tests should also be made on how the products effect the flora and fauna and whether the extraction is conducted on a sustainable basis e.g. by following the Swedish criteria, /3/.

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Environmental Impact Assessment of Urban Renewal in Vesterbro

Miljøvurdering i Byfornyelsen

Miljørapport nr. 347, 1997, Miljøstyrelsen

The main purpose of the project was to analyse and develop the opportunities for the city's administrative unit to adopt an environmental management strategy for urban renewal where environmental targets are identified and where environmental initiatives are demonstrated with a view to effective follow-up measures. In addition, the project's goal was to collect and systemise all accessible knowledge on environmental measures.

The City of Copenhagen in co-operation with the Copenhagen Agency of Environmental Protection and the local-government bodies carried out the project from January 1994 to April 1995.

The project is underpinned by the wish to contribute to the attainment of the national and local-authority targets for minimising resource consumption and environmental impacts within the building and construction sector.

Against the background of earlier initiatives, this project has dealt with the local authority's opportunities to adopt an environmental management strategy for urban renewal where more attention is focused on the identification of overall targets for environmental initiatives rather than on the identification of individual environmental initiatives.

The project has been rooted in the assumption that the local authority is responsible for setting targets for environmental initiatives in urban renewal programmes, based on overall environmental targets and priorities in the city.

The project deals with environmental initiatives in urban renewal in Copenhagen, but it will also be possible to use its primary results for urban renewal in a more general context in Denmark's other local authorities and for Copenhagen's environmental initiatives in relation to new construction work.

In connection with the initial design of buildings, the developers choose a range of environmental measures, which are of major significance to the consumption of electricity, heat-and water in the operating stage.

The project has therefore emphasised an attempt to affect the choice of environmental measures in the design stage. The first step in the environmental effort must be to ensure that the building is designed in an environmentally optimum manner.

The occupants subsequently have a significant influence on actual energy consumption. Against the background of the project, figures for the consumption the building should have after renovation can now be reported to the occupants.

The primary results of the project can be formulated in the following proposal for environmental initiatives in urban renewal:

- A permanent working committee for environmental impact assessment should be set up to revise targets and recommendations and, in addition, take an innovative approach

to measures aimed at achieving more effective environmental initiatives in construction work (renovation and new building projects).

- The local authority should identify overall environmental initiative targets for the consumption of electricity, heat and water -as well as targets for waste -management and natural areas.

- The local authority should formulate recommendations with regards to the environmental initiatives that should represent an environmental standard in urban renewal programmes.

Set against the background of a specification of the potential (possibilities) of environmental improvements, these targets express an estimate of that part of the potentate, which is actually attainable.

This estimate has been made on the basis of rough financial calculations of the profitability of the individual environmental measures, specified as intervals for payback periods.

The potential of environmental improvements has been determined as a total optimum urban-renewal strategy when using the most environmentally compatible technology seen in relation to an average conventional urban renewal strategy in Copenhagen.

In conjunction with the design of the building, it is the client and the project designers who are responsible for assessing and choosing the environmental measures that are best suitable for the building project concerned.

To affect the environmental initiatives in the design stage, it is proposed with reference to the local authority's targets and recommendations that the client be required to provide proof of the environmental initiatives in the design stage by describing the expected consumption of electricity, water and heat and the environmental measures taken during the building project. This requirement is a precondition for obtaining the local authority's commitment of its support for the building project.

The aim is to encourage the client and the designers to make the optimum choice of environmental initiatives in the individual building project. Furthermore, the proof may offer the local authority more in-depth knowledge of the type of environmental measures chosen in the urban renewal programme.

In addition to the proof of environmental initiatives in the design stage, it is proposed to recommend that the client, in the statutory operation and maintenance scheme, incorporate a special plan for the environmental initiatives in the operating stage, including user instructions for the occupants.

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Methods on Reduced Use of Chemicals in Forests

Metoder til reduceret kemikalieanvendelse i skov

Miljørapport nr. 348, 1997, Miljøstyrelsen

The background for this project work is "The Danish Action Plan of 1986 for the Reduction of Pesticides Use", which means the political demand to reduce the total Danish agriculture's use of pesticides by 25% before January 1991, and by 50% by the end of 1996.

In general, the use of pesticides in the forestry is modest, but in the 30-40,000 ha where Christmas trees and greenery are produced, the consumption of herbicides as well as insecticides has been very large and consequent throughout approx. twenty-five years. A number of late discovered environmental problems are the consequence.

It is an obvious thought to reduce herbicides by replacing total spraying of the full crop area with a partial control of weeds which grow in close vicinity to the crop, and which have the greatest influence on its growth. In this way the remaining part of the vegetation is spared to benefiting the wild fauna, the aesthetic element of the landscape, the microclimate, reduced nitrate leaching, etc.

Technically, the simplest method of partial chemical weed control is to band spray over the plant rows, and this practise has been followed in the present investigation of the production and vegetative consequences of partial weed control (section 2), and at the estimation of the implemental possibilities under various terrain conditions (section 3).

In trials with the three species Abies nordmanniana, Abies procera and Fagus silvatica, the production conditions are compared with: 1) full treatment (100%), 2) wide band spraying (67%), 3) narrow band spraying (33%), and 4) untreated for control (0%). The latter is totally unrealistic in practice.

The trials show that for the first two years after planting it is possible to reduce the annual use of the current soil herbicides by one third compared to the normal consumption without noticeable losses with regards to growth and prosperity of the plantation.

Furthermore, the trials show that band spraying cannot "stand alone", since the development of weeds in the space between the rows gradually prevails and the weeds become too high. Supplementary measures must be carried out with an interval of one to two years.

In this case one could imagine:

1. A full spraying with low dosages of leaf herbicides, which do not need to have a mortal effect on the weeds.

2. Mechanical measures, such as harrowing, mowing/cutting, or rolling are also possibilities.

3. Establishment of cover crops in the space between the bands (e.g. low species of white clover) must be assumed to have a weed controlling effect, but could imply an

increased risk of frostbite (spring night frost) and they are of course - as the weed plants – a water competitor.

Use of band spraying in practise will cause an increased labour force in the cleaning area. The possible savings on the herbicide expenditures can hardly compensate for the increased costs of special spraying equipment, supplementary measures and the increased work performance. Therefore, the motivation must come from the agriculturist's raising concern for environmental problems and on the background of the possibilities this project has shown.

The work concerning reduction of the pesticide use by means of spraying technology development has included three subjects: 1) Development of spraying technique, 2) technique for screened spraying in forestry and 3) implementation of new technology for accurate application of pesticides.

Band spraying is technically possible in forestry by use of knapsack sprayers. PTO-driven band sprayers can be used in cultures on former agriculture land, but heavy demands are made on the accuracy of the planting and on maintenance of the spraying equipment. To most producers the extra costs of band spraying will exceed the savings on the chemicals.

With several growers a combination of mechanical cleaning and band spraying is used with good results. In this way both a reduction of the use of chemicals and a more gentle treatment is obtained than by mechanical treatment alone, but the positive effect of the vegetation as regards leaching, coverage and shelter of flora and fauna is lost. An economic gain will not be obtained by a combination of band spraying and mechanical cleaning.

Various pieces of equipment have been developed for screened application of herbicides in cultures of Christmas trees, and the method must be characterised as implemented in practice. However, a great deal of effort is still carried out to further develop the equipment. A tool for treatment of several rows at the same time is wanted. Several growers are working to meet this requirement. Drive dependent dosage by means of the simple Hardimatic equipment is very common in practice. On the other hand, only very little interest in, and need for, advanced information technological steering systems for forestry sprayers are noted.

The project has contributed to acknowledgement and increased knowledge of possibilities to reduce the use of environmentally harmful weed-control agents in practice.

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Mechanical Weed Control in Plantations on Former Agricultural Fields

Mekanisk renholdelse af kulturer plantet på agerjord

Miljørapport nr. 353, 1997, Miljøstyrelsen

The Danish Research Centre for Forest and Agriculture has carried out a number of investigations into methods for reducing the use of pesticides in forestry and the decorative greenery business. The purpose was to demonstrate the effective and economical results which can be gained by using three different harrow types for weeding of newly planted trees on former agricultural fields and compare the principles with chemical weed control and no treatment at all. Another purpose was to study whether there is a need for developing new machines or improving machines for mechanical weed control.

Two investigations were made with mechanical weed control in tree plantations on former agricultural fields. One trial with noble fir on sandy soil and one trial with common oak on clay soil. The experiments were running for three years. The effects from three different tractor-mounted harrows on survival and height growth of the trees were compared with no treatment at all (control) and weeding with a herbicide.

Only 13 percent of the noble fir in the control plot survived. All the other treatments gave a very satisfactory and significantly better survival with more than 90 percent surviving trees. In all the mechanical treatments and in the chemical treatment the trees had a significantly better height growth.

On the clay soil all of the common oaks in the trial had a satisfactory survival rate. Even the oaks that did not get any treatment at all had a survival rate of 89 percent. Only one of the treatments, the HPH Skovharve caused a significantly better survival with a survival rate of 98 percent. None of the mechanical treatments gave the oaks a significantly better height growth than the untreated tress.

The mechanical treatments only caused small damages to the trees. One harrow, the Einböck Langfingerharve, caused significantly more small damages to the noble fir than the other harrows. The LOFT Spaderulleharve caused significantly more damages to the oaks than the other harrows. None of the injuries were considered essential for the future survival and growth of the trees.

The costs of weeding with the HPH Skovharve and the LOFT Spaderulleharve are exactly the same as long as the row spacing fits the harrows. The costs of weeding with the Einböck Langfingerharve are lower than the other methods because this harrow is wider.

All the empirical experiences that were gained during the research period showed that careful planning is essential for the successful application of mechanical weeding in new plantations. The layout of the planting must fit the tools and the machinery that are to be used later on. Because none of the harrows known today can handle weeds that are bigger than 5 or perhaps 10 centimetres, inspections must be made frequently to determine when to weed.

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Employee Participation in the Implementation of Cleaner Technology

Medarbejderdeltagelse ved indførelse af renere teknologi

Miljørapport nr. 354, 1997, Miljøstyrelsen

The project Employee Participation in the Implementation of Cleaner Technology (MIRT) has had as its aim to examine how employees can actively participate in the prevention of environmental problems at the source and also to carry out a study of which conditions promote or impede employee participation in the environmental efforts of the companies.

In all five companies the employees have been a major resource for the environmental effort, and some employees have actively contributed to the implementation of the various activities, just as they have been interested in obtaining influence and in integrating the work environment in the environmental efforts.

The employees have - as a resource with knowledge about environmental problems and with ideas about solutions - taken part in the formulation of the environmental policy, the setting up of targets and selection of fields of efforts, the preparation of plans of action and the implementation of solutions. The active employee participation in these fields has contributed to the creation of continuous environmental improvements, just as the preventive environmental work to a higher degree than is usually the case has been rooted in all the nooks and crannies of the companies.

In the environmental groups the employees have generally been engaged and motivated in order to take part in the reduction of the environmental effects of the company. But the involvement has been closely connected to the work environment, the support from the management and the traditions of the company, among other things with regard to employee participation in changes. Influence on the organisation of the work promotes motivation of the employees - also in environmental questions. No member of the personnel of the five companies has demanded cash reward for participation in the environmental efforts, but the management has to provide the necessary hours. Apparently the best form of reward has been that the ideas of the environmental groups have been taken seriously and that the suggested environmental improvements have been carried out.

On the shop floor environment often equals both external environment and work environment. The employees have had a legitimate interest in ensuring the connection between work environment and the external environmental efforts so that environmental improvements did not lead to deterioration of the work environment. In companies that already had a good work environment it was a matter of integrating environmental and work environmental work; whereas the employees in a single company had a "give and take" attitude because of a number of pressing work environmental problems. The intimate connection between environment and work environment has supported employee participation as a central pivotal point of the environmental effort, just as the employees have had an interest in influencing this field.

Below are outlined some general conditions of the promotion of employee participation in the environmental effort:

- Continuous process
- Adapted approach
- Learning process
- Communication
- Flexibility

The five companies - Gabriel, HL-filet, Kompan, Skjern Paper Mill and Tican Slaughterhouse - have all chosen different approaches to the preventive environmental work. Two of the companies have implemented cleaner technology and have completed most of the main activities in a preventive environmental effort, whereas three of the companies during the course of the project have implemented a certified environmental management system according to BS 7750. The companies have also chosen different ways in doing this as the employees of two of the companies have contributed to the implementation, whereas relatively few employees were involved in the system construction in the third company, but later environmental groups were set up in each section.

In the light of the experiences from the project the following conclusions can be summed up:

- Employees are an essential resource for the environmental efforts and can contribute to all main activities in pollution prevention;
- A comprehensive approach must include both work environment and external environment and can anchor an environmental management system in the organisation;
- There is no single right approach, because the companies have different conditions for environmental efforts based on employees;
- Environmental improvement is a continuous learning process with interaction between practical experiences and inspiration from new, untraditional approaches;
- A flexible organisation can delegate responsibility to either an environmental group or to the health and safety committee;
- Setting aside time, delegation of responsibility and competence, prompt replies to proposals and so forth are necessary conditions of the active participation of the employees;
- Participation of all employees depends on the fact that their interest in a work environment and a stimulating job is considered;
- Increased environmental awareness and change of work routines and habits concerning a "good environmental housekeeping" can be created through internal environmental communication on key figures, results, etc.

A further presentation and documentation of the practical experiences from the project can be found in the three company reports and in the pamphlet and manual about Employee Participation in Preventive Environmental Work (Medarbejderdeltagelse i forebyggende miljøarbejde).

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Soil Cover as an Alternative to Chemical Control

Jorddækning som alternativ til kemisk ukrudtskontrol

Miljørapport nr. 359, 1997, Miljøstyrelsen

This report is concerned with soil cover methods to control unwanted vegetation in greenery and forest growth areas. Cover materials should be considered as an alternative to chemical control. In the introductory passages, known materials and establishment methods are described with regards to effect, consequence and economy. This information is illustrated in figure 3 and appendix 2.

Chips of different qualities and plant covers might be interesting methods in small, scattered stands, but they are too expensive in big stands.

When the project was established straw seemed to be very promising but already in the preliminary phase of the project it proved to be unsuitable. However, the price of straw covering is moderate and the effect reasonable, but the insulating effect of the material increases the risk of spring night frosts significantly, which is not acceptable for e.g. Nordmann's fir (in addition, mice are attracted to straw which causes dramatic damages in other stands).

On the basis of the above it was decided to ignore straw as a possibility in the further work. Instead tests were carried out with a number of plastic materials, which were not as environmentally attractive as straw but less damaging than the soil herbicides that have been used so far. Later the test plan was complemented with straw covering around the plant rows. The revised test plan can be found on page 30.

The test was carried out at Vordingborg on light as well as heavy soil and in both cases in Nordmann's fir stands.

The first year, the tests showed a good effect of all the tested treatments against weed. Already in the second growth season the weed grew through the plant holes in the cover materials. The problem was particularly large with Fibertex and UCO-Agrotekstil.

In certain periods the temperature was measured 10 cm above the surface of the treatments in question. The black cover materials caused increased temperatures, which again caused an early bursting; especially in 1992. In situations with quiet clear whether in the spring period, it was observed that the temperatures above the plastic and both types of cloth corresponded to the temperatures above effective chemical control. The temperatures above the untreated were 1-3°C below this. And the temperatures above the straw were (-3°C below the untreated. However, spring night frost damages were not found in the straw covered plots in the test, which is probably due to the mild location and the fact that only covering in rows was used.

Damages that occurred in the tests were estimated on the basis of a scale, which is normally used in connection with chemical control. Fibeztex and UCO-Agrotekstil can be penetrated by precipitation and was applied in approx. 4m wide rows. It turned out that the wind could make the cloth move because of the wide rows and, consequently, some of the small plants were covered or partially ruined. Chemical control resulted in scattered plant loss in connection with a moist spring followed by a dry summer in I994.

Soil covered with plastic and cloth has higher moisture content in dry periods than soil that has been treated with chemical control, which again has higher moisture content than untreated.

Based on the high growth of the stand, it seems that the treatments have had no effect on the stand. However, straw cover seems to have had a positive effect on the growth but the test has very limited security on this point.

Concerning prevention of wear damages on Christmas trees, only chemical control was completely satisfactory. Plastic cover complemented with chemical control showed an acceptable result.

The test showed that UV-stabilised black 100µ, thick plastic applied in rows with subsequent planting though the plastic is still the only technically and economically realistic alternative to chemical weed control within the group of soil cover. In Christmas tree and greenery stands the method should be complemented with mechanical or chemical control or use of over plants to prevent wear damages and shade.

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Weed control by Sheep Grazing in Christmas Tree Plantations

Regulering af uønsket vegetation i pyntegrøntskultur ved afgræsning med får

Miljørapport nr. 362, 1997, Miljøstyrelsen

In this project the possibility of controlling weed in Christmas-tree plantations by sheep grazing was investigated. The investigation, among other issues, includes a study of different sheep breed's food preferences in Christmas-tree plantations, the application of different grazing strategies and a calculation of costs in connection with weed control in Christmas-tree plantations by sheep grazing.

The production of decorative greenery is a growing source of income for the forestry. So far the production has been characterised by a huge consumption of herbicides. In the past years a number of restrictions on the usage of herbicides have been imposed and, at the same time, the producers of decorative greenery have become more conscious of the environment.

The use of herbicides has decreased and many producers of decorative greenery are becoming interested in alternative production methods with the use of fewer chemicals. This tendency will probably spread in harmony with the consumers increasing demand for cleaner production methods. With this in mind it was investigated whether it is possible to introduce weed control in Christmas-tree plantations by grazing.

The results of the investigation show that sheep grazing is not a miracle solution to the weed problem but provided good quality of the sheep, the right breed and skilled managers to take care of the animals, the method is a realistic alternative to traditional methods of weed control.

Sheep grazing will, after a few years, induce a dense mat of water-consuming grass and therefore the method should be combined with mechanical and chemical weeding at fixed intervals i.e. 2-3 years.

During the grazing period it is necessary to inspect the plantations daily for bites and browsing on the trees and also to make sure that the sheep are healthy and in good condition. The management costs are therefore a critical point in the overall economy of the method. The results from the project indicate that forest districts should operate with a stock number of at least 100 sheep in order to keep management costs per sheep low and make the method competitive to traditional methods of weed control.

The most suitable sheep for use in Christmas-tree plantations of Caucasian fir and Noble fir are the improved meat breeds. Good results were achieved in the project with the use of Shropshire, Oxforddown, Dorset, Leicester and Suffolk, whilst breeds such as Texel and the Nordic shorttailed group i.e. Gute, Gotland, Spael, Island and Finnsheep have a tendency to nipple the trees. Shropshire seems to be the most consistently reliable of the breeds.

A successful use of the method depends on the quality of the animals and the management. One of the main problems is that Christmas-tree experts are rarely also experts in sheep-husbandry. Therefore, special courses have been started, where forestry-workers are taught

fundamental sheep-management and the specific knowledge required when combining sheep and Christmas trees.

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Insecticide Reduction by Combating the Pine Weevil

Insekticidreduktion ved bekæmpelse af nålesnudebillen

Miljørapport nr. 365, 1997, Miljøstyrelsen

The pine weevil, Hylobius abietis, is one of the most influential damaging insects within forestry. The gnawing of the insect on the root collar of many pine species results in a weakening of the plants and, at worse, considerable plant death. In an attempt to reduce the number of insecticides applied against the pine weevil, a number of experiments on Norwegian spruce, sitka spruce and larch have been carried out in the period of 1991-1993. This report describes the results of these experiments.

Two types of experiments were carried out:

1) An experiment with four non-chemical methods of prevention was carried through: plant plates, 'struten', plant stocking and BE-MA fibres which all were put on the plants when planting.
2) Furthermore, an experiment was established where the liquid quantity of a standard remedy permethrine was attempted reduced in relation to a normal dose. For this, a precise dosing spray equipment was used. Six different liquid quantities were applied as treatment, but in the same concentration of the insecticide.

The experiments with the non-chemical protection methods showed that they did not consist of a sufficiently durable material as they weathered during l-2 years. This is not appropriate, as the pine trees require protection against the pine weevil for at least three years after planting. Moreover, several of the protection methods were difficult to mount on the applied plants because the equipment was developed in Sweden where they are applied as container plants. In Denmark, however, larger bare-rooted spruces (2/2) are used in forestry and thereby also in these experiments. Furthermore, several of the protection methods damaged the plants and several of the methods were not designed to be effective enough to protect the plants from the pine weevil. Finally, it should be mentioned that the costs, as to application of the non-chemical protection methods, exceeded, by far, the costs of controlling the pine weevil by means of chemical pesticides.

The results of the experiments with a reduced quantity of insecticide were, on the other hand, more suggestive as it appeared from the test results that the usual dose of approx. 25ml spray liquid per plant may be reduced to 10-15ml, i. e. a reduction of 40-50%, without any changes in the extent of weevil attacks on the Norway spruce. The situation is however; more problematic for the small larch plants where very little control was independent of quantity of spray liquid. The effect of the synthetic pyrethroides may be expected up to two years after spraying.

Besides the experiments, an investigation in the form of a literature study with reference to study the possibility of developing a warning system for pine weevils was carried out. The investigation showed that the possibility of setting up a warning system for pine weevils seemed to be present. But it should be stressed that this, among other things, requires changes of the growing practice and thorough investigation of the population dynamic of the pine weevil. Furthermore, it should be emphasised that the establishment of a warning system will be extremely time-consuming for the forestry.

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Evaluation of the Information System for Cleaner Technology

Evaluering af informationssystemet om renere teknologi

Miljørapport nr. 368, 1997, Miljøstyrelsen

In order to promote the use of cleaner technology, the Danish Council for Recycling and Cleaner Technology has since 1996 contributed to developing an information system for cleaner technology. The system is called Rentek. Due to the fact that the use of the system is still not widespread, it was decided in 1995 to launch an inquiry into the system. This project describes the evaluation of the project.

The evaluation of the information system had three main objectives:

- To launch an inquiry into existing and potential users' need of knowledge about cleaner technology, and to examine how far this need is met today.
- To make an assessment of the content and form of the trade modules in the information system.
- To make suggestions for a future version of an information system considering content and organisation.

Rentek is only used in 10% of the municipalities in Denmark and in few counties and environmental and food controls. The existing users - who are primarily environmental case officers in the municipalities – are generally satisfied with the system regarding background knowledge and overview of the trades, detailed information about the production processes, and as a reference work in the environmental regulation of the companies. But still they lack more exhaustive and precise information about environment and cleaner technology. Moreover, the users find the information system technologically outdated with regard to hardware and software, just as the user interface is bothersome to work with.

66% of the 45 interviewed potential users had not heard about the information system. Rentek is not widespread because the decentralised authorities do not work with cleaner technology, as it could be expected from the intentions in the Environmental Protection Act. Almost 25% of the interviewed municipal case officers never work with cleaner technology and less than 50% work with cleaner technology less than once a month.

The assessment of the trade modules in the information system was that there are some critical aspects of the content. With regards to the focusing of the information system especially the following aspects are stressed:

- Focus is placed more on process technology than on cleaner technology.
- Cleaner technology is regarded narrowly as optimising machines rather than good environmental housekeeping.
- The information system is directed backwards primarily dealing with well-known technologies rather than technological innovations.
- The environmental perspectives of the product life cycle are generally absent.

The assessment of the trade modules also contains suggestions for improvement of the content, and in this connection it stresses the necessity of a better guarantee for quality. In addition, a number of specific proposals for the improvement of the structure and the user

interface in the information system are given. Just as it is pointed out how the use of cross-references can be improved in a relatively simple manner.

Considering the target groups, it can be established that the content of Rentek has been too general to meet the demands of knowledge of the industry. The primary target group of Rentek is the environmental authorities and the network of the companies in a broad sense. The purpose of the information system must be to strengthen the advisory competence of these intermediary groups with regards to guiding the companies on environmental questions with emphasis on cleaner technology. The suggested changes will, however, make Rentek more interesting for the companies as a user group.

In connection with the drawing up of a future information system, two approaches are examined: the new possibilities via the Internet and also the possibilities of a closer integration of an information system in cleaner technology activities as well as in the dissemination efforts.

The development of the effort for cleaner technology in Denmark has technology been dynamic and has changed from concentrating on technical demonstration projects through diffusion by environmental management and trade consultant schemes to an increasing integration in the preventive environmental world of the companies, in environmental regulation, etc.

Strategically we therefore suggest that the information system to a higher degree is integrated into cleaner technology activities via:

- A co-ordination between the preparation and updating of trade requirements about least polluting technology
- A connection to the trade efforts about environmental management and cleaner technology
- A co-ordination between the product oriented environmental policy and computer tools for life-cycle assessment.
- An inclusion of technological innovations, good environmental housekeeping, key figures, practical examples and so forth.
- A guarantee for a general survey of project activities and centres of knowledge.

Though the information efforts about cleaner technology have improved, it is still possible to make further progress. Therefore, it is suggested that the information system be used as a means to strengthen communication. This could be done by increasing focus on learning and communication in preference to informing users and report writing, by differentiating communication according to target groups and by establishing a common technological platform so that knowledge can be made available through various media. The participation of the users as suppliers of knowledge is a guarantee of quality.

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Environmental Assessment of Textiles

Environmental Assessment og Textiles

Miljørapport nr. 369, 1997, Miljøstyrelsen

Within the entire textile and clothing industry there exists an increasing interest for taking environmental care into account when producing textile products. This is a result of the increasing demand for products, for which it can be documented that the most relevant environmental and health issues have been considered.

This report presents a scientifically documented tool, which can be of use for the textile and clothing industry when working seriously and structured with the environmental and health issues for the selected fibres and textile products.

Based on a life cycle screening the report presents the environmental key features for the production of textile products made of cotton, wool, viscose, polyester or acrylic fibres. In addition recommendations for good environmental practice in every step of the life cycle of the textiles are presented. The recommendations are primarily based on the evaluation of the environmental and health impacts during the life cycle of the textiles, and secondarily on an evaluation of criteria and recommendations for textiles listed in other relevant papers.

The fibres analysed in this report are primarily selected because the fibres together dominate the market for textile apparel products and are often used to produce the same kind of products either pure or in blends.

The study covers single-layer textile products made of the five types of fibres. Carpets are not covered by the work. However, several of the textile processes described and assessed in the study are used to produce many different kinds of textile products. Therefore the results can be broadly utilised.

The report is structured in the following chapters:

Chapter 1 gives an introduction to the project. The methodology used in the project is described shortly including limitations, data sources and considerations concerning choice of functional unit.

The environmental parameters for the five selected fibres vary according to different processes and substances utilised both in pre-production and production of the textile products. However, differences do not only concern the environmental parameters. The properties of the fibres make environmental assessment of textile products rather complex as the properties do have essential impact on the maintenance and durability of the products concerned. Therefore a brief introduction to the variation in technical properties of the selected fibres is given in chapter 2.

Chapter 3 covers the description from extraction of raw materials to the fibres ready for further processing. The extraction of raw materials for the 5 selected fibres differs basically as the origin of the fibres are either animals (wool), plants (cotton and viscose) or fossil fuels (polyester and acrylic fibres). In addition, the production of cotton and wool can also be based on organic principles. Assessments of the environmental and health impacts of different processes are presented.

Chapter 4 describes the many different processes that transform the fibres to textile products. The processes most commonly used are described and the accessible

environmental input and output data are listed as are environmental and health impacts of the different processes.

In Chapter 5 the environmental impact of the user's phase is discussed. In addition, a short description of the reutilization, recycling and disposal of textiles is presented.

In chapter 6 the environmental key features for every step in the life cycles of the selected textiles are summarised. Moreover, recommendations for good environmental practice are listed.

Within the processes utilised for the production of the fibres and the textiles several chemical substances are used. Because it has been particularly difficult to get data on environment and health for the production of the man-made fibres (viscose, polyester and acrylic fibres) a screening of some of the substances utilised in the production of the fibres has been made. For substances of which relevant data were available an environmental and health assessment has been performed. Since the analysis has been based on a screening of substances and on the basis of available data it is by no means a complete result of the potential effects of the chemicals in use. The results of the assessments are presented in Annex A and summaries are given for the relevant fibres in chapter 3.

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The Environmental Account

Miljøregnskabet

Miljørapport nr. 370, 1997, Miljøstyrelsen

This is a model to state and report the companies' environmental performances. The purpose of the environmental account is to give the interested parties and the public in general an insight into the environmental affairs of the company. The environmental account is to give information about: The capability of the company to comply with environmental obligations, how the company administrates public demands and to which extent the company allocates funds to invest in cleaner technology, changes of production processes, product development and further education of the employees, in order to prevent environmental damages.

There has been a need to develop some guidelines on how to publicise environmental information in a qualified and structured form at the level of the company, since the concept "Environmental Account" is often used about an account of a process, a product, a company or another definable entity's effect of the external and internal environment.

The target-group of the project has been defined as interested parties, which have an economical interest in the company; e.g. suppliers, investors, insurance companies, banks and mortgage credit institutions. Other interested parties are Customers, neighbours, employees and environmental authorities.

The common denominator for both of the target groups, when it comes to the financial annual account and the environmental account is that both types of target groups have a interest in information on how the company administrates its values and resources, seen from an economic perspective.

The environmental administration includes decision-making upon:

- Limits on consumption of resources
- Possibilities of recycling
- Reductions of emission
- Product- and production development
- Concerns of the nature and environment
- Health- and security improvements

When you look upon the life cycle of the company, the environmental administration has an impact on the public administration.

On the basis of this, the target groups are referred to as financial interested parties, in this report.

The goal is that the interested parties will have two information sources:

- A financial account, which describes the financial position of the company
- An environmental account, describing the environmental position of the company

Both sources of information must be used when the general classification of risk of the company is evaluated.

The project of the environmental account contains 6 phases:

- Phase 1 is an initial investigation of special characteristics of the environmental accounts, clarification of which environmental information there generally should be given to the interest groups of the company, and which environmental information there specifically should be given to financial interest groups.

- Phase 2 is an outline of the frames of an environmental account.

- Phase 3 is an adjustment of the internal registration systems of the participating companies to the requirements in connection with the external environmental account.

- Phase 4 is an adjustment of the final model of the environmental account, on the basis of the experiences made in phase 3.

- Phase 5 is a testing of the capability of revising the model and an international hearing.

- Phase 6 contains a reporting of the project.

One of the objections often made against the environmental accounts is that the costs of collecting information are too high compared to the potential advantages. However, the increasing demand of getting more environmental information, and the fact that the environment has become a part of national and international legislation, indicate that the environmental accounts are here to stay. It is a fact that the costs of collecting information can be high, and therefore the use of information already collected by the local, regional and national authorities should be intensified.

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Environmental Revision in the Public Laboratory Sector

Miljøteknisk revision i den offentlige laboratoriesektor

Miljørapport nr. 371, 1997, Miljøstyrelsen

The aim of the project has been to map and analyse the environmental impact from a model laboratory within the public laboratory sector with the object of producing new knowledge and information on the potential pollution, which the laboratory sector causes. At the same time the project aims at increasing the employees' attention to the connection between processes and consumption, the outer environment and the work environment.

The project focuses on consumption of energy, water, chemicals, and other raw materials, plus waste products: solid waste, discharge water, and emissions to the air. Furthermore, focus has been on the work environment, especially the indoor climate.

The Department of Forensic Genetics, University of Copenhagen located at Rigshospitalet, Copenhagen, has been used as model laboratory. The department has a suitable size and seems to be a reasonable representative for a number of similar institutes at universities, institutions of higher education, hospitals, and clinics, plus non-public laboratories of analysis within the private sector, e.g. the medical industry.

For practical reasons, the study has been split up into two phases. A descriptive Phase 1, which aims at describing the processes in progress, and registering the total environmental load from the laboratory. Later, a Phase 2 is to be carried out, a phase, which will include implementation of as many as possible of the suggested changes pointed out in Phase 1. This report includes Phase 1.

The consumption of energy, water, and chemicals is recorded and is being compared with the environmental load with respect to emissions, discharge water, and different kind of solid waste. An account is made of the details concerning buildings and installations, recording energy and water.

The laboratory processes that are carried out are described with special reference to the impact on the environment from the chemicals used and from the consumption of throwaway products. The used chemicals are evaluated toxicologically with reference to a work environment evaluation and to the impact on the outer environment.

Furthermore, some indoor climate measurements have been made, and an occupational medicine study on indoor climate has been implemented, with special reference to the indoor climate.

The report briefly describes the Teilum building, in which the Department of Forensic Genetics is located, as one among several scientific institutes. A description is given of technical installations and a description of the functions of the seven laboratories of clinical immunology located at the institute.

A systematic description of the use of chemicals, energy, and water is made. Waste, discharge water, and emissions are being described.

Indoor climate measurements have been made, with measurements of thermal conditions. An increasing temperature during working hours was found in the PCR laboratory, a strong heat load that could reach an inexpedient 28 degrees centigrade. The emission of heat comes from non-central refrigerating plants.

Measuring of deposited dust in the Enzyme laboratory and in the Blood group laboratory showed unacceptably high values compared to the applying limits for work environment. In the Blood group laboratory dust was found in the form of starch powder. Since starch is not used in this laboratory the finding indicates that infiltration of dust from one lab to another may take place.

Measuring of airborne micro-organisms in the form of bacteria and fungi spores in the Enzyme laboratory showed growth of several bacteria causing sickness, but no growth of fungi. The level of airborne bacteria was found to be acceptable for the working environment, but did not fulfil the demands for clean spaces.

Finally, to map the employees' health and their own experience of the indoor climate and the working environment, an occupational medicine questionnaire-study was made. All employees participated in the study and answered the questions. The study confirmed that the temperature in the PCR-laboratory was unacceptably high, increasing during the working day.

From this study with the Department of Forensic Genetics, University of Copenhagen, as a test laboratory it is possible to draw some general conclusions that could be used within laboratories of similar and related fields. In spite of many years' attention to the energy consumption in the Danish society, it is still possible, as shown, to decrease the energy consumption, especially the consumption by refrigerating/freezing plants and by illumination installations.

When designing laboratories it is important to contemplate the indoor climatic conditions, especially disadvantages concerning an increasing temperature during the working day. Generally, it will prove practical to replace radioactive methods with non-radioactive colouring methods, like it has been done at the Department of Forensic Genetics.

A lot of chemicals potentially damaging to the environment are being used at the Department of Forensic Genetics, and in the laboratory sector in general. A model for pointing out the environmentally damaging substances has been drawn up. The toxicity of the substance, allergy inducing effects, and destructive effects on the ozonelayer, acidifying effects, eutrophic effects, photo oxidant forming effects, the frequency of use of the substance and the size of the total annual consumption are included in the model. It is pointed out that screening makes it possible to seek in standard toxicological works and databases for information about the environmentally damaging effects of a majority of chemical substances.

The model lined up shows that at the Department of Forensic Genetics the following substances should be sought replaced for the sake of the outer environment: ammonia, natriumhypochlorit and phenol. Correspondingly, the model shows that further eight substances should be sought replaced for the sake of the work environment.

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Cleaner Technology in Bus Companies

Renere teknologi i busselskaber

Arbejdsrapport nr. 3, 1997, Miljøstyrelsen

This report contains the results of the work with selected action areas within the bus operation industry with a view of reducing the bus companies' environmental impact and resource consumption. The action areas were chosen in a previous project, in which the environmental impacts when preparing and maintaining the busses of the bus company "Århus Sporveje", were mapped out. The report primarily aims at traffic companies whose activities are similar to those of Århus Sporveje, i.e. busses.

The report focuses on the following action areas:

- Recycling of water from external washing of busses with the possibility of making use of rain water
- Reduction of the consumption of motor oil and coolant
- Reduction of the fuel consumption for the bus working
- Recycling of refuse to a higher degree
- Substitution of cleaning materials

The most important results and conclusions for each action area are listed below.

At the beginning of the project it was expected that a concept for the recycling of wash water with the possibility of using rainwater as additional water would be developed. It was also expected that the sustainability of the concept should be demonstrated. However, the use of rainwater as additional water was given up at an early stage, as it was considered uneconomical. After having obtained offers for the establishment of a recycling plant on the basis of a specification of requirements, it turned out that the sketched recycling concept was not competitive with an already existing English recycling plant according to price, as the plant had to be delivered and build up as a turnkey plant. However, the existence of the English plant was unknown to the participants of the project at its outset.

Nevertheless, the English concept turned out to cause problems under Danish conditions in spite of many years' work experience from hundreds of plants in England. However, the problems were solved gradually, primarily because of the extraordinary efforts that were made by the Operations Manager at Århus Sporveje.

The conclusion of a survey at Århus Sporveje's Station NORD is that an abnormal large consumption of motor oil under operation is caused by the following factors:

- The engines are overfilled with motor oil (even though it was not proven in the actual case)
- The tolerances in the engines are relatively large (mostly seen in engines of an earlier date)
- Lack of tightness in the engines, which causes oil spillage.

Ten years ago the consumption of coolant dropped drastically because silicone tubes for the flexible connections in the cooling/heating system were taken into use instead of rubber tubes. At that time the consumption dropped to the level, which is normal today.

About 20 different tubes, e.g. 40 connections for metal tubes in varying dimensions forms part of the cooling/heating system of an ordinary city bus. An investigation shows that spillage of coolant primarily takes place during the driving because of lack of tightness by the tube connections and in the cooler.

A common notion is that the bus' fuel consumption above all depends on the driver's attitude to economising on fuel and to environmental conditions. Several bus companies consider it a good idea to encourage drivers to attend fuel economical driving courses. However, the results of the courses are only short-lived. It is therefore necessary to arrange brush-up courses for the drivers at regular intervals.

Tools for learning fuel economical driving are flowmeters or driving computers, which indicate the bus' actual fuel consumption while driving. In this way the driver will learn which ways of driving that result in fuel consumption above and under average, respectively.

According to DTI's (the Danish Technological Institute) Motor Section, tires and treads with a lower rolling friction can easily be developed. Today such tires are marketed for cars, but not for busses and trucks, which is due to the fact that so far no bus company or any firm of hauliers has taken any interest in the tires.

Furthermore, it was discussed in the project's reference group to use small busses at the times of the day with few passengers. The report contains a description of advantages and disadvantages of using small busses and an evaluation on whether such action is appropriate in reality.

Århus Sporveje decided to participate in a refuse disposal system after having considered the advantages of the system. Economically hardly any advantage was derived from the system, but by leaving the refuse disposal to an external professional firm, working hours are saved and the refuse disposal is taken care of in a proper manner.

Advertising streamers are solely made of PVC, which is considered incombustible refuse. The local refuse disposal plant refuses to burn PVC due to the risk of dioxin contamination. It is said that certain companies do not wish to use advertising on busses as long as PVC foil is used for the purpose. A survey among suppliers of PVC foil shows that the foil industry expects to be able to offer a PVC-free foil within two years.

Århus Sporveje has become a positive feed back on the cleaning materials that are used today. As the participating parties considered a change to other cleaning materials a problem for the cleaning personnel, it was not possible to launch an investigation into this matter.

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Visibility of Environmental Properties of Products

Synliggørelse af produkters miljøegenskaber

Arbejdsrapport nr. 4, 1997, Miljøstyrelsen

When some companies make environmental considerations in product development they are led by two aims: The minimisation of environmental impact and to increase the competitive power of the product through improving the visibility of the environmental properties. In this pilot project, a method named "Environmental QFD" has been developed and tested: a method which may be used to identify the environmental properties that will be able to increase the competitive power of the product in marketing, without neglecting the most important environmental impacts.

In the pilot project the method has been developed and then tested in a development project, in which a new concept for cabin cooling for cars is developed. The main elements of the method are two known methods. From the environmental area it is Life Cycle Assessment (LCA), which is used for analysing the environmental impact of a product throughout its entire life. From the area of quality it is Quality Function Deployment (QFD), which is used to clarify what objectives the parties interested in the life of the product have, how they are weighed, and which of these must constitute the main focus with regards to the development project.

The pilot project has made it possible for companies producing and marketing mechanical and electromechanical products to use a method in which LCA and QFD are integrated in connection with decisions concerning the size and focus of their environmental effort to their advantage. Hereby the environmental effort is provided with the best starting point through reduced risk of wrong efforts concerning both development and marketing.

Environmental OFD has turned out to be a strong instrument for gathering the development and marketing functions and the environmental specialists. Traditionally, these three areas are working with each their objective. Here Environmental QFD works as "a common language", where all areas may deliver results and watch them being used in the other areas.

The result of this pilot project is now used by ClimCon A/S. The company uses it in their development work. Furthermore the pilot project has given results that are to be elaborated in future product generations.

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Environmental Management in a Local Government Activity – a Water Purifying Plant

Miljøstyring i en kommunal forsyningsvirksomhed - renseanlæg

Arbejdsrapport nr. 6, 1997, Miljøstyrelsen

With a view to minimising the resource consumption of Herning Centralrenseanlæg (Herning Purifying Plant) an environmental management system was developed. The system integrates and structures the environmental actions in accordance with current plans and demands in the field and supports the present work routines. This report describes the elements of the environmental management system and how the system was established. Furthermore, the environmental statement for 1994 is presented in the report.

Environmental management in Herning Water Purifying Plant is a continuing process, which aims at combining the day-to-day operations with the management of the plant whereby the operational objectives (quantitative objectives) are directly implemented in the single operations. An important condition of a successful outcome is a process monitoring strategy for the plant, which makes it possible to treat all the environmental data from the purifying plant on a daily basis.

The Environmental Management covers nearly all aspects of the plant, including raw materials (waste water, chemicals, drinking water, energy), finished products (mud and cleaned waste water), residuals (sand, grease, ore ready for roasting, packaging) work environment and organisation.

The environmental management system contains the following elements:

- A short description of the purifying plant and a review of the environmental aspects.
- The formulation of a general environment policy with guidelines and operational objectives.
- The design of an environmental management system which identifies fields of responsibility and environmental objectives.
- The establishment of procedures and system checks for the optimising of the daily operations.
- potential actions
- The establishment of procedures and system checks for a yearly environmental statement.
- The appointment of an accountant and the drawing up of procedures for the audit.

It is important to motivate and make use of the employees on all levels at the purifying plant. Meetings regarding employee participation are held approximately 10 times a year. In the report the division of work and the organisation chart are described. It is the responsibility of the operations manager to ensure that the environmental policy is respected through the delegation of responsibility and the determination and control of the general operational strategy.

At weekly meetings the operations manager follows up on central operation parameters. Dependent on the distance between the actual achievements and the operational objectives

and the established requirements, adjustments of the strategy for single operations, the whole plant, or the operational objectives are made. Dependent on the difference between the operational objectives and the state of affairs, the external accountant is called in.

In the review of the environment a general survey of the consumption of water and recycling of the purifying plant's chemical and energy consumption is made. In addition, the plant's mud quality control, the residual control and how the residuals are discharged are reviewed. Moreover, the work environment of the plant is examined.

Proposals for water, energy and chemical minimising in the operations are presented together with the expected results of the environmental efforts. In addition, the work environment problems are described and, in this connection, proposals for the improvement of the work environment are given. After having reviewed the environmental statement, five main action areas were reached:

- An expansion of the total hydraulic capacity of the post-clearing tanks in order to reduce the overflow in connection with the pre-clearing.
- An improvement of the work environment in the central building edifice.
- The final draining: A reduction of the impact on the work environment, a reduction of the polymer consumption and an increase of the dry matter content in the drained mud.
- The establishment of digesting tanks, a gas generator and a gas engine.
- Various modernisation and reconstruction of the plant

An important tool to see the broader perspective and to stimulate the motivation is information technology combined with training and techniques for measuring. In the recent years these three elements have been of high priority in Herning Water Purifying Plant. The process monitoring system DORA, which makes it possible to calculate mass balances and process key figures in combination with set points, has been introduced. The data is structured in the process reports, which gives an overview of the process with a view to evaluating, and hence, establishing a general operation strategy for the plant.

Once a year an environmental statement is made. The statement gives an account of the environmental actions that have been made in the course of the year and the results achieved in this connection. At the end of the report the purifying plant's environmental statement for 1994 is presented.

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Analysis of tin consumption and emissions with focus on organotin

Massestrømsanalyse for tin med særlig fokus på organiskeforbindelser

Arbejdsrapport nr. 7, 1997, Miljøstyrelsen

The aim of this project is to present a detailed statement of the consumption and the emissions of tin to the environment in Denmark on the basis of 1994 figures. The statement particularly focuses on the diffusion of organotin compounds.

The knowledge, which this report is based on, is acquired through information from the Danish National Agency of Statistics and data from private companies and governmental institutions.

The total tin consumption in manufactured goods in Denmark in 1994 is estimated at 740-1,280 tonnes. The turnover of tin in the society was somewhat higher as there also was an import/re-export of tin for packaging, copper-tin alloys, and solders in electronics and auto radiators.

In total, the consumption of metallic tin was 640-1,000 tonnes tin. The most significant fields of consumption were tinplated containers (33% of total consumption), solder used in electronics, plumbing and sheet metal joining, auto radiators, and container seaming (32%), and copper-tin alloys (bronze) used in switches, valves and bearings (10%). Apart from uses of copper-tin alloys it was characteristic that tin was used in consumer products which were disposed of with municipal solid waste and there was hardly no recycling of tin from discarded consumer products.

The total tin consumption with chemical compounds in 1994 was 27-43 tonnes Sn. Organotin compounds constituted the main part. Organotin compounds are defined as compounds that contain one or more organic functional groups attached to the tin atom with a relatively stable tin-carbon bond. The compounds are dependent on the number of tin-carbon bonds divided into four classes: the mono-, di- tri- and tetraorganotins. Tetraorganotins are not used in Denmark.

The major use of mono- and diorganotin compounds was for UV and heat stabilisers in PVC. The main uses of tin-stabilised PVC were transparent rooflight sheets, tarpaulins, bottles and packaging. The consumption of tin stabilisers has had a downward trend due to substitution of PVC packaging with other materials.

Beside this, diorganotin compounds were used in low concentrations as catalysts for silicone, polyurethane foam and for a broad range of glues and paints. The total consumption with these uses is relatively small, but diorganotin compounds are used in a range of semi-manufactured goods for consumer products such as electronics, footwear, vehicles, and furniture.

Triorganotin compounds are used as a biocide in antifouling paint and as fungicides in surface and vacuum preservation of wood. In 1994 only a single organotin pesticide was used in Denmark.

Inorganic tin compounds were used for electroplating tin-lead alloys in the electronic industry and electroplating of tin or tin-nickel on equipment for the food industry, scientific instruments etc. Moreover inorganic compounds were used for glass and ceramic glazes.

There are only a few available measurements of tin emissions in Denmark. Emissions from the different sources are consequently estimated from emissions factors from the literature. The total emission to the air is estimated at O.5-6 tonnes Sn. The main sources were production of iron and steel, glass, cement, ceramics, and castings, burning of coal and oil and incineration of municipal solid waste.

No data on organotin emission to the air was available but a modest emission from solid waste incineration and glass production is expected.

The discharge of tin to the aquatic environment is the result of municipal wastewater, release of organotin from antifouling paints on ships, and emission of organotin from shipyard activities.

The emission of organotin from antifouling paints can either be estimated as the emission from ships built or repaired in Denmark or as the total emission from vessels to the Danish waters. Based on the consumption of antifouling paint in Denmark, the emission is estimated at 2.9-3.8 tonnes Sn/year. Danish vessels are estimated to be responsible for 12-35% of this emission.

Based on preliminary studies of organotin in municipal waste water it is estimated that triorganotin in waste water constituted at most 5% of the total triorganotin discharge to the aquatic environment while at least 95% directly or indirectly was due to the use of antifouling paint.

Discharges of organotin with wastewater from shipyards have been significantly reduced due to effective wastewater treatment. But it is still unclear to what extent organotin is emitted with aerosols from spray painting and dust from sand blasting. The present information indicates that these activities could contribute significantly to the total discharge of organotin compounds to the aquatic environment.

Release of organotin to soil is the result of municipal waste water sludge on agricultural soil (O.1-0.9 tonnes SNP), leaching and spill of wood preservatives (0.4 - l.4 tonnes SNP), use of pesticides (0.02 tonnes SNP) and emissions of dust and aerosols with antifouling paint from ship yards (0.03-0.3 tonnes Sn). The compounds that are released may be degradation products as the organotin compounds are degraded within and at the surface of the products where they are used.

There is hardly any recycling of tin with used products. In 1994, 220-270 tonnes tin was re-cycled with scrap - principally from manufacturing of products. The scrap was exported. Indirectly organotin was re-cycled with transparent PVC sheets, but compared to the total consumption of organotin compounds recycling was rather insignificant.

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Cleaner Technology Projects 1995

Renere teknologiprojekter 1995

Arbejdsrapport nr. 8, 1997, Miljøstyrelsen

This report includes summaries of all environmental projects and work reports concerning cleaner technology, published in 1995, a total of 41 reports.

The reports have been carried out due to the action plan for cleaner technology 1993-97 made by the National Agency of Environmental Protection in Denmark (Miljøstyrelsens Handlingsplan for Renere Teknologi 1993-97), which main goals are: To secure the implementation of the results from the former action plans, to continue the research- and development activities, e.g. substitution of environmentally damaging substances and materials, and to move the focus from production processes to products.

In 1995 the focus has mainly been set on projects which make an effort in the area of cleaner technology either from selected industries, within particular product areas or for extremely damaging substances. A number of projects constitute part of a larger and total evaluation of the spreading of cleaner technology. The evaluation is concentrated on six main areas, which were granted subsidies earmarked cleaner technology, in the period from 1987 to 1992.

A common theme of the evaluation projects is that the efforts for cleaner technology will become beneficial, and that intensified initiatives will take place in some areas. A lot of the projects suggest that in the light of new knowledge and through new experiences, it will be possible to bring the rest of the industries up to the same level.

Another theme developed through the projects is the co-operation between industries and authorities e.g. when it comes to environmental management. The final report of four Environmental Management Projects (Miljøstyringsprojekter), initiated in 1993, has been epoch marking when it comes to implementation and certification of environmental management systems. This work will also continue.

Finally, methods and tools are developed in the projects, which can be used broadly to value the environmental impact and find the target area where a reduction is needed the most, and where it will have the most beneficial effects on the environment. In this process models to calculate and evaluate environmental impacts, as well as national- and operating economical consequences are used to an ever-increasing extent. Environmental economy is a new area, which must be developed, and in which there is need for further research.

Cross-references are given for the projects, which are part of important examinations or if a preceding or following project exists.

This collection of reports will also be made in English.

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Elimination of Organically Loaded Waste Water from Organic Batch Production

Elimination af organisk belastet spildevand fra organisk batchproduktion

Arbejdsrapport nr. 18, 1997, Miljøstyrelsen

The general purpose of the present report is to design and produce a functional Full-scale plant for recovery of minimum 14 tonnes of organic solvents and reduction of A/S GEA's consumption of water by 2,000-3,000 m³ per year. The plant is constructed on the basis of knowledge from the first part of the project, which describes the conversion of the vacuum pumps from operation with water to oil. In the first part of the project the plant was tested in pilot scale with success. This report deals with the design and the production of the full-scale plant.

The project can be divided into three sections:

- The dimensioning, design and control of the full-scale plant
- The physical construction, tests and evaluations of the plant
- The reporting on the co-operation between the participating parts

The dimensioning and design of the plant are based on a number of compromises and limitations, which are the results of theoretical, physical, and economical possibilities and limits. Hitherto, every single technical element of the plant has been well known, while the combination of and the interaction between the single parts had to be examined. For the construction of the plant the following materials were used: 1 km of rustproof and acid-proof pipes, approximately 100 valves, pilot wires, pumps and other equipment.

The tests with the plant have turned out successfully. The over-all impression of the plant can be described as follows:

As compared with earlier disposal of approx. 16.5 tonnes of solvents per year to waste water and air, approx. 15 tonnes of solvents per year are now expected to be collected. The remaining 1.5 tonnes are disposed to the air. The collected solvents are expected to be re-cycled in processes where the quality of solvents is not critical. A recycling percentage of maximum 80% is expected.

The vacuum pumps have successfully been converted from operation with water to oil. The water consumption of 2,000-3,000 m³ per year has been eliminated completely.

Moreover, it is also estimated that the plant can eliminate and collect solvents with low and medium steam pressures satisfactorily. The disposal of solvents to air at maximum production is less than 2 kg per ton.

The plant can deal with single productions of solvents with high steam pressure. However, the plant cannot deal with many productions in which there are solvents with high steam pressure simultaneously, as the disposal of solvents to air would be to excessive.

The efficiency of the plant is dependent on a number of conditions. Most important for obtaining good results are the kettle's and pipe system's air-tightness under vacuum. If the tightness is improved, the disposal of solvents would drop accordingly and, to a higher extent, it could be used for productions with solvents with high steam pressures. If the air oozes in to the kettle and the pipe system, the disposal of solvents will increase.

From an economic point of view, the operations with the new plant will mean a cost saving in the operating costs of DKK 70,000 per year. The cost saving is a result of reduced expenses for water, drainage, and waste water charges. The recycling of solvents reduces the need for purchase and waste disposal. However, increased energy consumption for cooling of coolant and purchase of oil for the pumps mean increased costs.

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Environmental Management – Data from Public Registers and the Application of GIS

Miljørigtig projektering – data fra offentlige register og GIS

Arbejdsrapport nr. 20, 1997, Miljøstyrelsen

The purpose of this report is to chart how environmental data can be collected from public and private registers and how to adjust them under the frames of a GIS (Geographic Information System) for the use of environmental management. The project provides a GIS based tool for efficient utilisation of public registers' data and project data in the assessment of environmental impacts from construction and building projects.

To evaluate the scale of an environmental impact requires as a reference level, a detailed knowledge of the existing environmental status of a given site so that projected impacts can be assessed as accurately as possible.

This project consists of two parts. The former deals with the essential aspects of establishing a framework in the form of a Geographic Information System GIS) where geographical related data are transformed into co-ordinate referenced objects with associated attributed data.

The following categories have been identified as relevant for a successful GIS application:

- Project environment
- Nature (flora, fauna, monuments)
- Regional development, regional community planning
- Proprietary rights
- Topography and techniques (topographic maps, transmission plans)

Project data may comprise data from existing public and private registers and also data generated during the actual project. A "Standard list on data requirements and data registers" has been prepared for existing data, in which each of the above 4 categories (nature, topography etc.) deal with a number of main topics with themes on geographical reference and map- /register names.

For each map-register name a data description has been made that describes what the register belongs to, it's contents and geographical coverage, and how the data can be exchanged with the relevant register.

The project furthermore deals with the use of register data and GIS illustrated by urban planning in a disused industrial area in Herning (demonstration project no. 7) and renovation and extension of Kasted waterworks near Århus (demonstration project no. 16). A visual presentation, which can be run on a computer under Windows, has been made illustrating the use of GIS in the Kasted waterworks project.

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Environmental Management of Sewer Renovation in Herning

Miljørigtig projektering af kloakfornyelse i Herning

Arbejdsrapport nr. 21, 1997, Miljøstyrelsen

In the years to come large amounts of money will be invested in renovation and sewer renewal with a view to improve the environmental state of the ground water. The purpose of this project is to help assuring that the sewer renewal will be completed with concern for the environment, and that the choice of materials, systems, disposal etc. are made on the basis of an overall technical-, economical- and environmental assessment.

The present work report forms part of a succession of work reports under phase 2 of the frame project Environmental Management in Project Design.

The aim of the project is to promote the application of cleaner technologies in building- and construction projects through a development of standard methods for environmental management in project design.

Testing of practical use of the methods established in a guide to "Environmental Management in Project Design" (Håndbog i Miljørigtig Projektering) and participation in further development of these methods has been the main aims of the partial project. The partial project was implemented in connection with a sewer renovation project.

Elucidation of different sewer renovation methods and on the basis of selection of materials and systems regarding an actual location in Herning Municipality has formed a secondary aim of the project.

The methodology of Environmental Management in Project Design is based on an overall assessment of environmental-, health- and resource impacts and environmental effects during the plant's life span from recovery of raw materials to final disposal. The environmental aspect involves parameters such as functioning, aesthetics, quality, technology, and economy.

The project embraces two levels: A general level covering sewer renovation in general, and a rather specific level relating to the location in question.

On the basis of surveys, an environmental programme and an environmental plan for sewer renovation as part of the environmental measures in Herning Municipality have been established. Further, a general environmental policy and general environmental objectives for sewer renovation have been determined in close co-operation with Herning Municipality. Based on this Herning Municipality has identified a number of co-ordinate environmental impacts, which are considered principal:

- Energy consumption and work environment in connection with production of goods
- Consumption of raw material resources
- Energy consumption in connection with the construction phase
- Work environment and inconvenience to the citizens in connection which the construction phase
- Re-use of materials in connection with the construction phase
- Sewage load on receiving waters

Life span and disposability / re-use of sewage pipes form a constituent part of the priorities.

The project has been finalised in proper interaction between client and consultant, according to which the environmental policy and ends for sewer renovation established by Herning Municipality has formed the basis of the consultant's contributions to environmental management in project design. The project has been instrumental in Herning Municipality's incorporation of environmental management in project design into the municipal action plan on sewer renovation.

Likewise, the drawing up of environmental requirements has been accomplished in co-operation with Herning Municipality and the local section of the Danish Contractors' Association. The tender documents lay down the actual requirements to the contractor's environmental management procedures and documentation hereof, the environmental requirements in connection with the work performance as well as the delivery quality. Incorporation of environmental requirements in the tender documents will form part of a current development implying presumably progressive environmental requirements.

Experience gained from the project shows the necessity of availability of sufficient environmental data with regards to materials and methods:

Spreading of environmental management in project design demands simple, intelligible, and operational methods. Eventually, it must be stressed that assistance from environmental experts bearing on each individual project is highly important.

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Environmental Management of a Redevelopment Building in Copenhagen

Miljørigtig projektering af en byfornyelsesejendom i København

Arbejdsrapport nr. 22, 1997, Miljøstyrelsen

Based on a redevelopment project an analysis model for environmental management is tested and further developed. It is used in advisory- and managing phases where public financial aid is given according to the Danish law on publicly funded urban renewal (Lov om offentlig byfornyelse), chapter II.

This demonstration project was conducted in the initial project design phases of an urban renewal project for an apartment building rejected in Nørrebro in Copenhagen. The property concerned is an approximately 100-year-old five-story apartment building owned by the co-operative building association A/B Sankt Hans Torv 30 - Nørre Alle 1.

The demonstration project is part of the City of Copenhagen's decision regarding the urban renewal of the Ahorns Street block and will comprise primarily modernisation and renovation of the building's climate barrier. The project has thus concentrated on the replacement of the roof, the reparation of the facade, and the replacement or reparation of all windows. Beyond this, the City decision makes the individual modernisation of dwellings in the building in terms of the layout of the bathroom/toilet and the replacement of kitchens.

The main objectives of the project are:

- To test and to contribute to the further development of the environmental assessment model for construction projects that has been used in early consulting and project design phases where financial support is given according to the Law on publicly funded urban renewal, Chapter II.
- To test and to contribute to the further development of the manual with associated tools produced in another part of the project.

Initially, a general survey was made including an identification of the limitations inherent in the project and an evaluation of their significance. An important limitation in this project was the demand of the authorities with respect to the Law on publicly funded urban renewal.

Another important element is the description and assessment of the building's most important environmental effects in its entire life cycle. Included here are the use of resources in the form of energy and water, as well as environmental impacts in the form of emissions to air, soil, and water.

The Life cycle's phase 1 is the mining and production of the raw materials, for example, shale, lime, and wood. Phase 2 is the preparation and production of roof slate, mortar and windows. Phase 3 is the activity of urban renewal. Phase 4 is the operational period of the building after urban renewal, and finally phase 5 is the demolition and removal of the materials added during renewal. The assessment showed that the operational phase of the building is going to have the greatest environmental impact in the complete life cycle of the renovation.

On the basis of the general survey, an environmental programme, including an assessment of various environmental impacts and a setting of priorities, was prepared. The environmental objectives that the project should try to live up to with regard to the local area, the building's form and function, and the techniques applied were also set forth in collaboration with the co-operative building association.

The five environmental objectives for the project were defined as follows:

- Environmental impact during the construction phase must be kept at a minimum.
- A good work environment must be ensured.
- The consumption of energy and resources in the operational phase must be minimised.
- Building materials with low energy and resource consumption in term of the material's entire life cycle must be used.
- The building elements chosen must be able to be reused, salvaged or re-cycled, to as great an extent as possible after their use in the building.

Furthermore, the environmental programme includes a description of the measures that are necessary to deal with environmental impacts and thereby to effectuate the environmental targets. With regards to the reduction of heating, electricity, and water consumption, for example, measures could be: Use of water-saving faucets and toilets, installation of individual consumption meters, insulation of the primary building parts, replacement of windows, etc.

With regards to construction techniques the most important criteria is to identify materials that are based on renewable and sufficient resources, and that have long lives and long maintenance intervals.

On the basis of the work with environmental management in project design in connection with the renovation of an urban renewal property, the following conclusions were made:

- Practical implementation of the environmental management of project design has some limitations especially with regards to "soft" parameters such as landscape, aesthetics, city environment, cultural inheritance, etc.
- The current law and the City Architect's Office have set up a number of barriers limiting the extent to which environmental management can be used in project design. A fall in the number of degrees of freedom is the result, as cultural inheritance usually takes priority over environmental considerations.
- A comparative environmental assessment is lacking: More specifically an environmental accounting, so to speak of whether it is more correct environmentally to demolish a building and construct a new or to renovate the old building.
- A higher level of comfort in dwellings can lead to an increase in environmental effects as a consequence of increased consumption of resources.
- The choice of material by co-operative building associations can, in some cases, also be a correct choice in terms of environmental impact.

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Environmental Management of Urban Renewal and Dwelling Improvement in Kolding

Miljørigtig projektering af boligforbedring og byfornyelse i Kolding

Arbejdsrapport nr. 23, 1997, Miljøstyrelsen

This demonstration project, DP 12, forms part of the outline project Environmental Management in Project Design, the purpose of which is to contribute to a combination of theoretical method development and practical testing of a project design practice which is developed during the decision-making process of project planning. The demonstration project is linked to a project on urban renewal and dwelling improvement in an area in Kolding located near the river.

The purpose of DP 12 was, among other things, to ensure that the planning of a distinctive project on urban renewal and dwelling improvement includes the use and testing of and participation in the further development of the tools, in particular the manual "Håndbog i miljørigtig projektering", which ensure that overall assessments are carried out during project planning by means of method description.

The main element of the project is the property "Solgården", a five-storey letting property with approximately 80 flats that was constructed in 1939-40.

The urban renewal project consists of several project elements:

- Urban renewal in the area
- Dwelling improvements in the property "Solgården"
- An experimental project comprising an area of 1000 m2 of solar cells built into the property, partly on the roof and partly on the balconies
- A rational fitting of lifts in the eight stairways

The framework for the urban renewal project was defined prior to the commencement of DP 12. This framework consists of the objectives laid down by the Kolding Municipal Council and in the relevant legislation for the urban renewal effort. This has resulted in a demonstration project based on the 18 specific items in the decision-making proposal ("Forslag til beslutning") for urban renewal, which was adopted by Kolding Municipal Council.

Certain priorities have been set up on the basis of the developer’s objectives, input and output assessments and assessments of the environmental impact, effects and measures, resulting in the following objectives for various items:

- Yard clearance and establishment of car parks and gardens
- Renewal of the roof
- Renewal of the heating system
- Renewal of the water supply system
- Establishment of solar energy facilities on the roof
- Renewal of electric installations
- Renewal and refitting of bathrooms

- Renewal and refitting of kitchens
- Establishment of a waste disposal system
- Solving existing earth pollution problems

The input and output assessments of the 18 specific items listed were primarily based on the life cycle phases:

- Construction and amendments
- Operation and maintenance
- Demolition and disposal

The subsequently performed detail assessment also includes assessments within the phases "Extraction of raw material" and "Manufacture of building and construction materials".

An environmental programme, in which, among other things, the specific targets were specified, has been prepared on the basis of the results of the inventory.

An environmental activity plan for the further integration of environmental considerations in the project has been prepared on the basis of the environmental programme. Among other things, this plan sets out that a subsequent detail assessment of the following items should be carried out:

- Whether or not the renewal of the bathrooms should be carried out in the conventional manner (on site) or by means of prefabricated elements.
- Whether or not the roofing material applied should be made of bitumen carton or PVC film.

The detail assessments are carried out as a comparison of the options throughout all the life cycle phases. The five checklists, which were prepared during Part Project 5, have formed the basis for the assessment. As the comparison includes environmental hazards, which are not directly comparable, we have strived to carry out a comparison of quantifiable part elements and subsequently a subjectively weighed overall assessment has been made.

The experiences gained from the implementation of this demonstration project were that the system for environmentally desirable project design which is drawn up in the manual "Håndbog i miljørigtig projektering" is a good way of incorporating the environmental aspects of the project phase assessments and decisions. This also applies to an urban renewal and dwelling improvement project of this type, even if the framework for the scope of the project, including the location and design of the building, was predetermined.

The environmental assessments form part of the overall evaluation basis for a project, and experience shows that these are not given as much emphasis as e.g. aspects relating to time and finances. Furthermore, it has become apparent that the legislation covers many of the environmental considerations we have found to be important, especially in the following life cycle phases: "Construction and amendments" and "Operation and maintenance".

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Environmental Management of Railway Installations

Miljørigtig projektering af jernbaneanlæg

Arbejdsrapport nr. 24, 1997, Miljøstyrelsen

This report describes two independent projects within the frame project Environmental Management in Project Design. The first project deals with environmental management in connection with the renovation of a railway bridge. The other project describes the experience DSB (The Danish Railways) has drawn from four different construction projects, which were carried out in the period between 1991-1996.

Chapters 2 to 5 on General Inventory, Environmental Programme, Environmental Activity Plan, Environmental Assessments, Tender and Supervision cover the bridge renovation. The chapters consist of documents or descriptions of procedures with summaries of the documents produced as part of environmental management in Project design. The chapters can thus be regarded as separate documents.

Chapter 6 covers experience from the design and performance of the renovation of a bridge.

The bridge renovation activity was carried out in accordance with the method description in "Guide on Environmental Management in Project Design". As part of the General Survey, various ways of securing passage on the site were evaluated on the basis of a cradle-to-grave analysis.

Because of the location of the bridge it was concluded that the main environmental impacts would be inconvenience to neighbours in the form of noise, dust, odours, traffic load, health hazards for the workers carrying out the work and, lastly, soil contamination from the clean-up of red lead on the existing bridge rails.

The project's environment policy was based on DSB 's corporate environment policy. The environmental objectives were decided on for the most serious environmental impacts, and success criteria were set up for the project.

Environmental assessments for two alternative worksite locations were carried out, five different surfacing materials, and two methods for repairing the bridge rails.

The environmental assessments formed the basis for the preparation of the tender documents. The tender documents set out the environmental requirements, and it proved necessary, during the supervision phase, to hold the contractor to these requirements.

The problems relating to environmental factors were thus so limited that an experienced environmental engineer could relatively easily oversee them. The preparation of general mapping, environmental programme and environmental plan were thus very resource consuming considering the size of the project.

The preparation of environmental assessments, on the other hand, is considered relevant in that they improved the client's decision-making basis. The client thus found that the environmental assessments, coupled with the environmental requirements in the tender documents, benefited the environment.

The renovation of the railway bridge was thus a success in relation to the environmental objectives set. No complaints have been received from either neighbours or authorities.

Chapter 7 includes feedback on Guide on Environmental Management in Project Design, based on DSB's own experience from four major civil engineering projects. The feedback is built up around nine selected themes:

- Comments on the structure of the guide
- Environmental management in the design phase of civil engineering projects
- Action in relation to the magnitude of the projects organisation of environmental work
- The organisation of the environmental work
- Realisation of environmental objectives
- Check lists for civil engineering projects
- The environmental plan
- The client's role
- Health and safety at the workplace

The feedback confirms the need for the guide and the principle that designers and environmental officers must co-operate closely on the design work from start to finish.

DSB's experience shows that civil engineering projects often require a broader interpretation of environmental impacts than that suggested in the guide in its present form.

DSB points out that the guide is intended for building projects. Special sections on civil engineering projects or possibly a separate booklet would improve the chances of achieving environmental management in the design phase of civil engineering projects.

The feedback pinpoints that it is important for all civil engineering projects to be subjected to environmental screening, irrespective of their size, as a basis for determining the level of detailing that should be used in the environmental management in the design phase. DSB sees a risk in that the guide's intentions will not be met on small projects unless the designer adapts the guide's method description and decides on the right level of detailing for the project in question.

Experience has shown that the objective of environmental management in project design will only be met if a project is carried out in accordance with the environmental predetermined objectives. It is necessary to follow up on the designer's intentions, both in the tender documents and by supervision.

Lastly, DSB points out that importance must also be attached to health and safety considerations in the design work, but that these require different treatment than environmental considerations. It may be necessary to enter into an open dialogue concerning possible areas of conflict between the two parts.

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Environmental Management of a Motorway

Miljørigtig projektering af motorvej

Arbejdsrapport nr. 25, 1997, Miljøstyrelsen

The purpose of this project is to test and contribute to further development of the analysis model for construction projects, elaborated under the pre-project Environmental Management in Project Design. Another purpose is to elaborate environmental requirements, which can be included in the tender material for the road, the section Vejen – Lunderskov and to create a paradigm for implementation of Environmental Management in Project Design in connection with future road projects.

This project has been made under the framework project "Environmental Management in Project Design". By means of development of a method for Environmental Management in Project Design the project shall contribute to promote cleaner technology within building and construction projects.

The project has been carried through in connection with the main project for a section of approx. 10 km of the road Esbjerg - Kolding, elaborated by the Danish Road Directorate.

Considering that the projecting of the section in question was in the main project phase at the start of the project, it was chosen, when preparing the project, first to make an inventory, an analysis and a more detailed environmental assessment of the immediately coming activities in order to elaborate proposals to environmental initiatives, which could be included in the tender material for the soil and drainage works.

Subsequently, the process was re-started due to the general mapping and environmental estimates that were made. In addition, the recommendations on how Environmental Management of a motorway project can be carried out.

The analyses and assessments, made in chapter 2 and 3, are thus only proposals to Environmental Management in Project Design of future roads, as they can only, in a limited extent, be related to the road project in question.

The environmental assessments are in the project described in a phase development, including:

- The planning and programme phase, chapter 2
- The disposition proposal phase, chapter 3
- The main project phase, chapter 4
- The construction phase, chapter 5
- Finally chapter 6 contains a description of the experiences with Environmental Management in Project Design.

The general mapping of the environmental impacts in connection with construction and operation of roads is described in tables, including:

- Environmental impacts
- Effects
- Assessment method

- Inventory result
- Means

As part of the general inventories the relevant legislation and the rules in the Danish Planning Act about environmental assessment of certain types of building and construction projects have been investigated.
Furthermore proposals have been made for subjects/areas, which are recommended to be included in future environmental assessments.

In the project it has been assessed that current road rules, norms, directions and standards can result in a number of indirect environmental effects in addition to the environmental impacts, which can result in direct environmental effects.

The implementation of the project has demonstrated that it is important that employees with environmental background are involved in the projecting progress in co-operation with construction engineers.

The experiences from the project show the importance of the availability of satisfactory environmental data with regards to material and methods.

Propagation of environmental management in project design requires that simple and easy methods, which are usable, can be assigned.

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Environmental Management of an Office Block in Copenhagen

Miljørigtig projektering af kontorhus i København

Arbejdsrapport nr. 26, 1997, Miljøstyrelsen

This report describes an independent project within the frame project Environmental Management in Project Design. The project deals with environmental management in connection with the construction of a new domicile for the Society of Engineers.

It is a comprehensive project to carry out a qualified environmental assessment of a large building project and at the same time keep the general view of what is considered as a significant environmental impact and what is considered as a less significant impact. DP 8 has followed the principle in the "Guide to Environmental Management in Project Design", edition C, and used the checklists to carry out the general environmental survey of the building project.

To be able to work systematically with the environmental survey the environmental impacts have been categorised in the following three main groups:

- Impacts on the use of resources
- Impacts on health
- Impacts on nature

The specific environmental survey is based on input - output checklists where all relevant input and output between the environment and the building is specified. By using the input and output checklists it is possible to encircle the environmental impacts caused by the specific building project.

The task has been to point out the environmental impacts, which represent some significant differences between the three alternative building projects, some differences which might have decisive influence on the choice of project. The experience by using the guidebook, edition C, has demonstrated that it is necessary to define a methodology that provides an environmental basis for making a decision on which project to choose from between alternative projects. The guidebook, edition C does not describe this specific problem in detail.

In the present work report, a method for comparative environmental impact assessment has been developed for the use of environmental assessment of building projects in the very early stages of planning and design of the building, where only few binding decisions concerning design and construction of the buildings have been taken.

It has not been possible on the basis of the environmental survey to conclude that one of the three alternatives was significantly environmentally superior. But the environmental assessment has through a systematic survey provided a basis for the building owner to make a qualified decision on which project corresponds to the owners ambition for the building project.

A detailed environmental survey has been carried out for the chosen domicile project on Kalvebod Brygge. On the basis of that survey a number of environmental objectives have been described and the design and construction of the building are obligated to, as best as possible, to comply with these objectives.

Five overall objective have been selected:

- Reduction in consumption of scarce resources and not to use harmful and unhealthy building materials
- Reduction in consumption of energy in the operation of the building
- Establishing a good indoor climate and work environment
- Minimising environmental impacts in the construction phase
- Visibility of the environmental effort

On the basis of the overall objectives a number of environmental targets have been put up. For instance - not to use building materials containing PVC and to lower the energy consumption for heating by 20 % in the operation phase.

An Action Plan has been prepared including a description of the organisation and the activities that should ensure accomplishment of the environmental objectives described in the Environmental Programme.

The strategic frame of the Guide to Environmental Management in Project Design for environmental assessment is sensible and inspiring. The builder and the engineers are forced to work systematically with the environmental aspects. The ambition in the guidebook is very high and it can cause some difficulties to fulfil the requirement for documentation of every environmental action taken in the building project. It is important that the guidebook provides simple, distinct and operational methodology and tools applicable to the building sector. The crucial point must be to start up the practical and specific work of environmental management in project design and work in consideration to significant environmental issues in building projects rather than trying to cover all environmental aspects theoretically and methodically right from the beginning.

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Environmental Management of a Road Bridge Crossing a Railway

Miljørigtig projektering af en vejbro

Arbejdsrapport nr. 27, 1997, Miljøstyrelsen

This report is part of a succession of work reports in phase 2 of the frame project "Environmental Management". The result of phase 2 is "A Guide to Environmental Management" which consists of method descriptions, guidelines, environmental data and examples. In connection with the development of the guide, the principles of environmental management are tested in a number of concrete demonstration projects, including the present project, which deals with the environmental management of a road bridge crossing a railway.

Apart from the environmental impacts of the planning and construction of a bridge crossing a railway, the maintenance of the bridge is also described. The bridge is located in Hammerum as part of a new connecting road to the new highway from Herning to Århus.

The decision of location of the bridge and the fact that it has to be a bridge and not a tunnel was settled before this project started. Therefore, the environmental impacts of other alternatives have not been assessed. However, throughout the project period the environmental impacts concerning the location of the bridge have been assessed as well as mitigation measures have been suggested whenever relevant.

The environmental policy of the Vejdirektoratet (The Danish Directorate for Highway Engineering) was part of the overall priority plan.

This project was initiated in the planning phase carrying out a preliminary survey of the environmental impacts of the bridge. The survey was based on a map showing the location of the bridge and art VVM assessment (assessment of the impact on the environment) concerning the construction of the highway from Herning to Århus. The environmental statement has shown that the actual location of the bridge could cause ochredispersion and thereby increase the risk of pollution of the groundwater.

The overall selection of construction principle concerning the environmental impacts in the life cycle phases was evaluated for a concrete construction, a wooden construction and a steel construction, respectively. An overall assessment of environmental effects due to selected environmental impacts was made. The individual environmental effects were weighted by using an environmental score of each effect. The assessment concluded that compared to the alternative constructions, the concrete construction was connected with less environmental effects. The overall survey also concluded that the construction of the bridge and the selected location of the bridge result in health and safety impacts as a consequence of working by a railway which is in function and the selected building materials.

The overall survey has led to a list of environmental objectives at this stage of the project. The objectives are described in a preliminary environmental programme and action plan. The most important objectives were: To reduce the environmental effects due to the consumption of building materials and energy consumption; to reduce the emissions of noise and dust during the construction and maintenance period; and to optimise the safety precautions during construction and maintenance periods.

The survey is in this phase primarily concerned with the environmental impacts of the activities and the consumption of building materials and energy. Focus has been placed on the impacts that would result in the most important environmental effects including health and safety effects.

The aim of the survey was also to select the necessary mitigation measures to reduce the materials and energy consumption, to reduce the emissions and to reduce the health and safety effects. The priority measures were selected by use of a scoring system, which is also described in the report.

The survey points out that the major environmental impacts are: the material and energy consumption, selection of top layer of the road (asphalt), emissions from contractors' supplies and emissions from asphalt products. The largest energy consumption was found in the production of asphalt. The asphalt also causes the major health and safety effects. Mitigation measures to reduce the energy and material consumption, to reduce emissions from contractors' supplies and to improve the health and safety during the construction period were suggested. The subjects that need more attention in the design phase were listed. Some of these are selections of asphalt and the minimisation of emissions.

A revision of the environmental programme and action plan was carried out. The action plan at this stage included a detailed description of each environmental target and those who were responsible for each target.

Subjects evaluated at this phase of the process were the energy consumption, alternative top layers for the bridge, and surface coatings for the crash barrier. The environmental targets were described further and a set of demands for the contractors to meet the targets was listed.

The evaluation of three alternative top layers showed that the concrete layer would result in lower environmental effects than the asphalt layer and a layer of a synthetic material. The quality and the traffic security were not included in the evaluated parameters. The overall objectives of Vejdirektoratet regarding quality and traffic security meant that the asphalt layer was selected after all.

The demands to the contractor included requirements concerning documentation of maintenance quality of supplies, requirements concerning use of environmental friendly fuel for supplies and requirements concerning the plan for health and safety. A paradigm for the plan for health and safety was described.

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Environmental Management of Aalborg Technical College

Miljørigtig projektering af Aalborg Tekniske Skole

Arbejdsrapport nr. 28, 1997, Miljøstyrelsen

The present demonstration project on environmental management in project design is about the extension of Aalborg Technical College. The project is part of the building project phases called "project proposal" and "master project". The aim of the project is to gain experience within method development as well as testing in the field.

The building project comprises erection of a new wing (approx. 5,800 m2) of Aalborg Technical College. The new wing is connected with existing buildings situated at Øster Uttrup Vej 1 in Aalborg.

The leading principle of the project is to allot to the college's users a healthy teaching environment and a healthy indoor climate conditioned that the solution is optimised as to the environment.

The prerequisites of the projects take into consideration the actual economic frames and time limits of the project.

First of all a general inventory of a schoolhouse was prepared. This inventory was supplemented with existing experience as to life cycle assessments (LCA) of building activities and building materials. Moreover, the building programme and the architect's proposal were scrutinised together with the master proposal and the local conditions.

Concerning resource consumption and emissions from building materials it is generally assessed that extraction/production and operation and (up to a point) the disposal out is the phases above all contributing to the environmental impacts. With regards to materials e.g. cement, asphalt, concrete, plaster, and steel constructions have turned out to be amongst the building materials that lead to the highest waste of resources and energy consumption.

The Title number at Øster Uttrup Vej is very suitable for a schoolhouse as the character of the building site and its surroundings limit the possible applications of the site.

When scrutinising the building programme of the project the functional demands are crucial. Wishes and demands to the building as to resources and the environment are stated in brevity and in general outlines. When considering the pros and cons of the building proposals, economic conditions are taken into account together with the architectonic manifestations.

The architect's proposal integrates the environmental aspect in the architectonic manifestations rather than in proportion to the substance cycle as suggested in the building programme.

On the basis of the general inventory and the client's conditions a gross list was drawn up in order to itemise the environmental management in project design.

The prioritisation of environmental impacts was accomplished on the basis of the client's preferences, in particular in proportion to the operating phase that is worded in the environmental policy. Moreover, the possibilities of the master project as to degrees of

freedom of the building project have been considered. Orderisation of priorities has taken place in consultation with the client, consultants, and the architect.

The targets that have been put in order of priority embrace spheres that the client wants to be scrutinised thoroughly, namely:

- Drawing up of environmental targets, a.o. in relation to impacts on the surroundings during the building phase.
- Utilisation of daylight instead of artificial light.
- Utilisation of natural ventilation.
- Visible registration and measurement of resource consumption during operation.
- Selections of environmentally sound internal surfaces.
- Environmental inventory of selection and design of heat distribution system.
- Life cycle assessment of the weather screen.
- Environmental assessment of the project proposal.
- Preparation of plan for environmental targets stated in the tender material.

A number of possible means supplement the targets. Accordingly an environmental activity plan has been prepared. The activity plan describes in detail how each individual investigation is to be accomplished.

The environmental inventories described in the environmental activity plan are accomplished during the master project phase. The environmental inventories are based on experience and scrutiny of scientific literature. The inventories have brought about several proposals and recommendations as to means such as selection of materials, construction principles, surfaces, installations, organisation etc. Means have been presented to the client, consultants, and the architect.

Below is stated an example of environmental targets in tender material. The targets concentrate on minimum requirements as to the contractor's environmental management and documentation hereof and on supply of environmental information regarding selected materials and components. The example has been put before the client and the architect.

Decisions on a possible more advanced environmental inventory and embodying of environmental targets into the tender material have rested with the client. In due course they were to be accomplished under the auspices of the building project and in compliance with the existing narrow economic framework.

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Environmental Management of a Waterworks

Miljørigtig projektering ved renovering af vandværk

Arbejdsrapport nr. 34, 1997, Miljøstyrelsen

The demonstration project, DP16, forms a part of a number of demonstration projects under phase 2 of the outline project Environmental Management in Project Design. The primary result of phase 2 is "Håndbog i miljørigtig projektering" which contains methods, descriptions, guidelines, environmental data and examples. Under the demonstration project the principles of Environmental Management in Project Design have been tested and experience is continuously communicated to the outline project.

The purpose of the present demonstration project is:

- To test and assist with the further development of the methods for environmental management constructions/plants on a total modernisation of Kasted Waterworks
- To assist with a specification of the model in guidelines on procedure for the implementation of environmental study and assessment in the planning and programme phase of a construction/plant
- To test the usage of GIS (Geographical Information System) in connection with Environmental Management in Project Design
- To incorporate environmental assessments in connection with the operational phase (technical plants, the groundwater resource, water treatment, security etc.) in the project
- To incorporate exterior environment and working environment at the same level of other essential conditions in connection with the renovation of the waterworks

Apart from above mentioned experience will be gathered in with the superior mapping of environmental impacts, ranking of environmental impacts, environmental ail, preparation of environmental programme and preparation of an environmental plan for a total renovation of the waterworks.

Especially for this project the assessments are included in connection with the operational phase (technical plants, the groundwater resource, water treatment, security etc.) as an essential part, as this is a technical plant.

The project deals with a total renovation of Kasted Waterworks from the well field to the clean water storage and a possible extension of the elevated storage capacity and consequent possibility of better exploitation of the 3-point tariff.

Kasted Waterworks supplies app. 3.5 million m^3 a year, corresponding to app. 15% of the total water consumption in the Municipality of Aarhus. The waterworks was established in 1952 and till now only ordinary maintenance and 2 smaller extension of the filter plant has taken place. A thorough survey of the well field has been undertaken and the maximum pumping capacity is 3.7 million. m^3 a year.

The detail led survey of project proposal as well a main project is based on the detailed input-output statements, where the environmental impacts are quantified for each of the possible means.

During the project phases the communication of environmental conditions to the client had a high priority in order to make the client able to evaluate environmental conditions on equal form with financial situation, quality, aesthetics etc.

On the basis of superior inventory of the guidelines in the manual an environmental programme for the project was set up and an environmental plan comprising a time and activity list and a strategy for controlling the environmental effort.

An exact statement of the total reduction of the environmental impact of the project is of course difficult to prepare, but on the basis of the listed means and the purpose of the project the environmental result of the work with Environmental Management in Project Design can be described in text and figures as follows:

Material: Exclusive of the material consumption from the establishment of a new water treatment plant in Ristrup the total material reduction of the project is about 300 tonnes (covering the projects economic life) and apart from the selected membrane all the rest of the material is well known in connection with water treatment.

Energy: A reduction of app. 65 GJ/year (material and operation) of the energy consumption has been attempted. Furthermore the total outlets of C02, S02 and NOx has been reduced with app. 85 tonnes/year over an economic life of 50 years.

Water: A reduction of 67,000 m3/year of the water consumption has been attempted.

Health: In the future the effort is systematically concentrated about reducing the risk of deterioration of the drinking water quality. The project comprises an improvement of the working environment and the indoor climate at the waterworks, reducing the strain caused by heavy lifting, damp and noise.

Furthermore the strain on the external environment has been reduced as:

- The risk of discharge of ochre-containing rinsing water to streams is smaller
- Construction changes reducing the noise strain in the surroundings have been carried out.

In the project response to the manual has been prepared within:

- Method - ranking/score, the cyclic sequence, environmental effects and impacts, partners, survey of health effects and the life cycle supply.
- Help tools - gross lists, legislation, environmental data, GIS (Geographical Information System), application and working environment.
- Environmental programme/plan - contents.

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Environmental Management of Renovation of Teaching Rooms

Miljørigtig projektering ved renovering af undervisningsbygninger

Arbejdsrapport nr. 35, 1997, Miljøstyrelsen

The demonstration project, DPl3, forms part of a number of demonstration projects under phase 2 of the outline project Environmental Management in Project Design. The primary result of phase 2 is "Håndbog i miljørigtig projektering" (Guide to Environmental Management in Project Design) which contains methods, descriptions, guidelines, environmental data and examples. Under the demonstration project the principles of Environmental Management in Project Design have been tested, and experience is continuously communicated to the outline project.

The purpose of the present demonstration project is:

- To test and further develop the methods already outlined in the pre-project with regards to environmental management of building projects when applied to renovation and rebuilding projects.
- To assist with the concretization of the models through guidelines and procedures on how to submit environmental examinations and estimations in the planning – and programme phases for a building project.
- To gain experience from the work with Environmental Management in Project Design in connection with the environmental management and building maintenance system in the Danish Armed Forces
- To use the demonstration project as the basis for creating Environmental Management in Project Design in the Building Department of the Danish Armed Forces with consideration to the rest of the environmental management system in the Danish Armed Forces in general.

The project deals with the use of Environmental Management in Project Design in relation to renewal and modernisation of the music practice teaching room at the Royal Life Guards Barrach.

The project in itself is a work environment project as the project is carried out with the purpose of creating more space and reducing the sound level in the music practice room in such a way that the sound pressure on the musicians is lowered. The increased size of the room is created by including the adjoining rooms together and by removing an existing floor.

Environmental Management forms part of the project in the following phases

- Conceptual design
- Project proposal
- Detailed design

Environmental Management in project design is integrated in the design both by using the developed methods, but also by communicating the environmental effects of the chosen methods to the project manager in the Building Department of the Danish Armed Forces and consultants before conclusive project phases.

The environmental inventory was started at the beginning of the conceptual design - after the project programme was prepared. The general environmental inventory was prepared at the same time as the environmental strategy for the Danish Armed Forces was converted to environmental effects.

Starting from environmental inventory and environmental strategy converted to effects, the client's prioritisation and environmental objectives were elaborated.

With an offset in the general environmental survey an environmental programme for the project was made in accordance to the guidelines in the manual. An environmental plan comprising a time and activity list and a strategy for controlling the environmental effort was also made.

By the end of the detailed design period it was obvious that the listed environmental aim of the project was obtainable, namely:

The consumption of energy in operation and choice of material is minimised with 20% through the work with Environmental Management in Project Design. The 20 % are in accordance with the environmental strategy of the Ministry of Defence.

The use and reuse of material in the project is optimised considering the projects primary objective - lowering of the sound pressure. Furthermore material with environmental impact should be avoided.

In the construction phase it must be ensured that the laws of working environment are respected and that the work is carried out in such a way that the normal activities in the building can continue during the construction phase. In the operation phase an optimal reduction of the sound level must be established not only in the practice room, but also in relation to other activities in the building and in the courtyard

Problems with the indoor climate as a consequence of mechanical ventilation, sound lowering material, construction, surface treatment and narrow space conditions are minimised

In the project response to the manual has been prepared within:

- General - organisation, level of ambition, supply, supervision, operation and connection with environmental management/operational maintenance,
- Method - priority in relation to the project phases, handling of interested parties, survey of health effects and life cycle approach.
- Health tools - gross lists, the SfB system, working environment, legislation - tender and application.

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Environmental Management of Residential Constructions in Ballerup

Miljørigtig projektering ved renovering af boligbyggeri i Ballerup

Arbejdsrapport nr. 36, 1997, Miljøstyrelsen

Problems with the indoor climate and humidity at Lundegården I in Albertslund have resulted in a radical renovation of the buildings. This project deals with the environmental management of the renovation of a residential construction in Ballerup.

Lundegaarden I is a housing scheme with a total of 628 dwelling units. The scheme was completed in 1969.

The houses are attached, constructed in sandwich elements of concrete, supplemented with light elements as facades, roofs and internal walls. The roofs are flat clad in roof paper. The crawl way design is without any moisture membrane towards the soil. Each house is provided with a garden to which the light facade walls face. The heavy gables and facades, which only in some few houses have windows, are directed towards the local paths.

As for many projects, economy and functional and architectural requirements have more or less outruled the environmental requirements. In the housing scheme, Lundegaarden I, the problems connected to fungi have concerned the working method as well as the suggested solutions, so that environmental management in the project design in practice has been a supplement to the ordinary design.

Lundegaarden I has had much public attention partly due to political reasons and partly to economic reasons. The design has thus not adhered slavishly to the normal phase distribution, since considerations of for example "demolition or not" have been taken simultaneously with the assessment of actual suggested solutions.

Prior to commencement, a technical audit was carried out to establish the actual extent of the mould problems.

In the environmental programme some environmental impacts were chosen and described in principle and prioritised. The indoor climate was the subject matter of the renovation project and it was given high priority. As an ultimate requirement the mould and moist problems should be removed.

As is common practice in connection with most renovation projects, the energy consumption should be reduced. Neighbour inconvenience would as a natural consequence be taken into consideration due to the large extent of the renovation work. The work environment and the solid waste problems were given higher priority due to the extensive mould attacks.

During the programme phase the "environmental management circle" was discussed several times - more or less systematically. Certain problems were elaborated, while others were subject to only a sporadic investigation. The systematics were always "inventory - assessment - documentation".

Four more or less parallel investigations were carried out. (I-IV).

In all investigations the evaluation parameters were consistent, regardless of the type and level of the investigations. The result has been that the considerations on indoor climatic problems currently have been supplemented with considerations on energy consumption, work environment, neighbour inconveniences and solid waste.

The technical investigation showed that the mould attack was very extensive. The consequences of this fact meant that the renovation of Lundegaarden I could be so comprehensive that a total demolition of the housing estate and reconstruction was a realistic alternative. The conclusion was that a renovation should be carried out. This was not due to considerations to the environment, but primarily to the architectural values of the housing estate.

When it was decided to aim at a renovation, which apparently would be very costly, it was considered to divide the renovation into two or more phases. The conclusion was that the renovation should be in one phase, as the environmental impact at more renovations would be heavier. The reasons are larger amounts of solid waste and inconveniences to the residents as well as destruction of the area and a poorer working environment in connection with repeated renovations.

For communication to the residents and politicians a preliminary design was prepared illustrating different solution models. The conclusion suggested a total renovation in which all building components should be removed and rebuilt - except of foundations and heavy external walls.

The Consultant's radical suggestion of an almost complete renovation of Lundegaarden I resulted in some critical remarks. Therefore, an external expert group was established to assess these and to investigate whether it would be possible to establish more economical renovation methods, which could ensure a satisfactory indoor climate.

The conclusion was that the original suggestion should be implemented. Among other things it was due to the lack of existing documented experiences in fungi damage establishing the extent of necessary and sufficient renovation measures. The Health Authorities could thus not accept solutions, which did not completely remove the micro fungus problems.

Environmental impact assessment on building components was already carried out in connection with the preparation of the building programme. Therefore the pilot project was primarily designed to investigate the environmental problems connected to an industrialised production as opposed to construction in situ.

The conclusion was that the industrialised construction - everything taken into consideration - would result in a better work environment, less neighbour inconveniences and less waste. This is primarily due to the fact that the industrial process is easier to manage than the craftsman methods.

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Environmental Management of a Worn-out Industrial Area in Herning

Miljørigtig projektering af udtjent industriområde i Herning

Arbejdsrapport nr. 37, 1997, Miljøstyrelsen

This report is part of a succession of work reports in phase 2 of the frame project "Environmental Management". The result of phase 2 is "A Guide to Environmental Management" which consists of method descriptions, guidelines, environmental data and examples. In connection with the development of the guide, the principles of environmental management are tested in a number of concrete demonstration projects, including the present project, which deals with the environmental management of a worn out industrial area.

The frame project is initiated by The Danish Environmental Protection Agency and The National Council for Recycling and Less Polluting Technologies and implemented under the management of The Danish Association of Consulting Engineers, F.R.I., in co-operation with the Danish Council of Practising Architects, PAR, The Danish Building Research Institute, The Danish Technological Institute and several builders' organisations.

In 1994 phase 1 was concluded by publishing The Danish Environmental Protection Agency's Environment Project No. 253 with basic guidelines for environmental management in project design.

A three-year long phase 2 encompasses further development and operationalization of methods of environmental management in project design. A public hearing in 1997 will conclude phase 2.

The most essential result of phase 2 is "Håndbog i Miljørigtig Projektering" (A guide to Environmental Management in Project Design) which consists of descriptions of methods, directions, environmental data and examples. While preparing the guide, principles of environmental management in project design were tested by a number of demonstration projects - including the present demonstration project on the conversion of a worn-out industrial area to an environmentally sustainable housing area in Herning Municipality. The project is also called DP7.

DP7 has been an integrated part of Byomdannelsesprojektet for Thrigesvejområdet (The City Conversion Project for the area around Thrige's Street) in Herning Municipality. The project is initiated to realise the political decision - presented in the Municipality Plan - of converting a worn-out industrial area to a sustainable housing area.

Parallel to DP7's project period, Herning Municipality has been preparing a masterplan in relation to The City Conversion Project In connection with DP7 an environmental programme and an environmental activity plan with the purpose of integrating the environmental programme into the masterplan were prepared.

The environmental programme and the activity plan sets out the framework and guidelines for coming projects in the area, including both demolition and construction projects.

The main environmental problem in DP7 was the fact that it is not possible to make environmental objectives outlined in the environmental programme legally binding in the masterplan or succeeding local plans. Planloven (The Danish Planning Law) does not allow

this opportunity. Therefore the environmental activity plan presents inspiration, goodwill and voluntariness as ways of realising The City Conversion Project.

Another main problem is a number of economic barriers to the realisation of The City Conversion Project. The primary barrier is the scope for making the future economically sustainable for the companies in the area. It is a barrier during the conversion and in the case that the companies move out. It was proposed to establish a development company to meet these barriers.

In the environmental activity plan the development company's environmental management is proposed to achieve the environmental objectives and targets outlined in the environmental programme. But in reality the development company can do as it wishes.

From an environmental point of view a phase 1 of The City Conversion Project can be initiated north of Tietgensgade (Tietgen's Street), if one company moves from the area or reduces noise nuisances from production activities. More environmental analysis is needed before initiating succeeding phases.

Guidelines for introducing environmental sound measures are also presented in the environmental programme - for example less polluting technology and recycling of building materials. Furthermore, there are a number of ecological measures listed. A community group that forms part of a local Agenda 21activities in Herning Municipality suggested these measures. The ecological measures have to be environmentally assessed in coming projects as they are not necessarily environmentally sound according to the principles presented in A Guide to Environmental Management in project design.

Environmental management in project design has been a relevant method in DP7, but the tools presented in "A Guide to Environmental Management" have not been of great help. The main reason is that DP7 has had an area focus and the guide is - at the present stage - primarily focused on buildings.

The town planners in Herning Municipality expressed that the environmental focus - introduced to The City Conversion Project by DP7 - has been an important and positive input into the traditional planning procedure.

One important experience from DP7's work is that consultants have to be very well prepared to present environmental management in project design to clients and especially the consequences that are different from traditional project design. A clear presentation of method and tools in "A Guide to Environmental Management in Project Design" will be an important element in making environmental management in project design a routine for the consultant and a standard demand from the client.

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Effects of Soil, Green Materials and Washing Water on the Processing of Sugar Beets for Sugar

Effekter af jord, grønt og vaskevand i oparbejdningen af sukkerroer til sukker

Arbejdsrapport nr. 38, 1997, Miljøstyrelsen

The aim of this pilot project is to clarify the maximum level of soil and green materials that can be accepted in the extraction of sugar from beets and the juice purification without causing negative consequences for the product quality. In addition, the project aims at illustrating the possibilities of applying beet washing water in the process instead of pure condensate, which is used today.

The sugar factories in Denmark receive approx. 3.5 mio. tons of dirty beets per year to be cleaned at the factories for soil, stones and green material. The soil is by far the largest problem. It amounts to approx. 300,000 tons per campaign. If sugar beets should be processed without a preceding cleaning at the factory, they must be effectively cleaned in the fields, but how clean should they be?

Today, at the factories the beets are cleaned by large consumption of water to approx. 0.2% remaining soil (level 0-0.5% on beet). This might be the basis for the claim, but in reality only very little is known as to how and to which extent soil and green material affect the processing of sugar beets and, consequently, a more correct formulation of the claims for cleaning in the fields would be:

- Cleaning to a level where processing conditions and/or product qualities (juice and pulp) are not worse than they are today.

Consequently, it was decided to perform tests with a controlled addition of soil and green material to the processing of sugar beets in a pilot plant with a capacity of 300 kg beet per hour. Furthermore, tests were made with addition of beet washing water to the processing, because this recycling of water "loaded" with sugar might be a relevant alternative to the use of pure condensate, as done today.

The pilot plant was built in 3 sections completely analogous to the construction in a factory (scale 1:1500):

- Beet wash and water treatment
- Juice extraction (slicing, diffusion and pressing)
- Juice purification

One experiment lasted approx. 24 hours (day-and-night working), and a total of 23 experiments were made: 6 references, 7 with addition of soil (up to 1% on beet), 1 with addition of green material (1% on beet), 1 with soil + green (1+1), 7 with wash water, and 1 with beets washed in the field.

The documentation of an experiment partly consisted of running samples and analyses from the operation and partly of samples/analyses from the end of the experiment (after 22 hours of operation), when all processes were supposed to be in equilibrium.

The effects of the impurities were documented on:

1. The products from the process: Pressed beet pulp and juice.
2. The actual processes: The extraction and the juice purification.

The relevant quality parameters in beet pulp are ash and hydrochloric acid insoluble ash (sand). The claims are max. 8% and max. 3.5% on dry substance, respectively. These critical border limits were reached already at soil levels of approx. 0.2% soil dry substance on cossets and, consequently, the claims on the purity of the beets - based on unchanged quality of fodder pills - are a remaining soil percentage of ≤ 0.2% on cossets.

Soil in the diffusion will deteriorate the juice quality, especially as a consequence of washing out sodium, potassium and amino nitrogen from the soil. In the process these components act as molasses agents, meaning that they reduce the crystallisation abilities of sugar, thus drawing more sugar into the molasses instead of producing white sugar. On the basis of the experiments the loss of molasses was calculated to be 0.011% per percent soil on the cossets.

Soil and especially green material caused a decrease in pH in the diffusion of 0.3 units and 0.5-0.9 units, respectively. This is an expression especially for an increased microbial decomposition of sugar to lactic acid, meaning a loss. In the juice purification there were indications of reduced filtering properties with the presence of soil, but the picture was not unambiguous.

Green material - but apparently not soil - gave a higher colour in 2nd carbonation juice than the reference, presumably as a consequence of the content of invert sugar (glucose and fructose), which may enter into Maillard-reactions with N-connections in the heated sugar juice.

To some extent, addition of wash water had the same effect as addition of soil, because the water soluble salts are found in wash water as well, and it has been calculated that addition of wash water, despite addition of extra sugar, approx. 0.15% on beet, causes a net loss of sugar to the molasses compared to the reference.

With the assumption that the process conditions for processing of sugar beets and product qualities (fodder pills and juice) should not be deteriorated compared to the present level, it could be concluded that if sugar beets should be led directly to processing without previous cleaning at the factory, they should be cleaned in the fields to a remaining soil percentage of approx. 0.2% on the beets.

The use of beet washing water as diffusion water instead of condensate, as done at present, will give an increased loss of sugar to molasses, and if wash water should replace condensate as recycling water to the diffusion, it has to be treated in order to remove salts, while the main part of the sugar is maintained.

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Testing the Cleaning of Beets in a Stationary Cleaning Station

Forsøg med roerensning på en stationær rensestation

Arbejdsrapport nr. 39, 1997, Miljøstyrelsen

In 1993 Danisco Sugar introduced the project "Clean Beets", the aim of which is to make the beets so clean that further cleaning in the factories becomes unnecessary. Two preliminary reports on the subject concluded that cleaning in the field is better than cleaning in the factory and that there is a need for developing new techniques for cleaning. Moreover, it was concluded that the amount of residual soil on clean beets should be no more than 0,2%. A development project with the aim of manufacturing a prototypical-cleaning machine for beets was therefore completed.

The project is part of a three year-long project, which includes the following three phases:

1994: The construction and testing of a stationary cleaning station
1995: The construction and testing of a mobile cleaning station
1996: The construction and testing of a prototype of cleaning station

The present report describes the testing of the stationary cleaning station (phase 1)

Introduction of extra mechanical cleaning of the beets in the field may fairly easily be implemented in the phase of loading and transporting beets to the factory. During the past 10 years a development in the use of so-called cleaner loaders for this extra cleaning has taken place abroad, but so far in Denmark the use has been limited. Commercial cleaner loaders typically remove 30-50% of the soil on the beets, and as a starting point it would be obvious to find techniques for improvements of this cleaning efficiency.

As part of the first stage of the development, work on improved techniques for cleaning of the beets in the field, a stationary module-built cleaning station was made. The station gives the possibility of testing the cleaning efficiency in single mechanical cleaning modules and in modules connected in series.

Three cleaning modules were used: Rollenrost, rubber fingers and axial rollers. Each of them could be combined with overlapping brushes. The axial rollers (always the last stage) were combined with water nozzles as well.

The cleaning station with a capacity of approx. 25 tons per hectare beets was built at Saunsøgaard where the beets are stored in the yard before transportation to the factory. At that capacity all beets passed the cleaning modules in one layer in such a way that there was always contact between cleaning module and beet.

A total of approx. 1200 tons beets were cleaned in the plant corresponding to approx. 50 tests. For each test the separated material was weighed and sorted out in order that separated soil, green material and root tips could be calculated as a percentage of the beet.

The harvesting conditions for beet lifting were generally good during the 1994 campaign and, consequently, the beets were relatively clean (7-15% soil on beets) on delivery to the cleaning station. During extreme years (very wet) and with extreme soil types (stiff clay) the soil level may be more than doubled.

The very first cleaning takes place during reloading and transport to the actual cleaning modules. Especially loose soil between the beets and looser soil on the beets are removed (by a rubbing effect). 53 % of totally removed soil was removed in the feed section for the cleaning modules where the residence time was approx. 5-7 times longer than in commercial cleaner loaders.

The comparison of the two mechanical cleaning modules: Rollenrost and rubber finger rollers showed equality as regards removal of soil, but the Rollenrost was more gentle to the beets and had a better removal of green material. Independently of type, in the first cleaning module approx. 24% of totally separated soil was removed, while the second cleaning module removed approx. 9%. The combination with brushes did not improve the cleaning essentially in any of the two modules.

The axial rollers, which were intended for a final cleaning of the firm soil in the root grooves appeared to have only a limited effect, since only approx. 9% of the total removed soil was removed in this third stage.

During the transportation by lift from cleaning station to lorry approx. 5% of total removed soil was removed.

It is seen that more than 80% of total removed soil is removed in the feed section, in the first cleaning module and in the lift, while less than 20% is removed in the two extra cleaning modules.

Correspondingly, it could be calculated that more than 60% of the root loss takes place during cleaning in a one-stage cleaning while 40% is lost in the two extra cleaning modules.

The use of water nozzles (at 7 bar) for cleaning of the beets in the third stage (in combination with the axial rollers) gave only a limited effect (residual soil 2.9% on dirty beets with water against 3.2% of residual soil on dirty beets without water) - primarily due to too short a contact time.

If all experiments are considered together, the cleaning of the beets in the cleaning station has given an improvement of 4 percentage points (from 83.7% to 87.4%) compared to dirty beets delivered from Saunsøgaard.

The residual soil percentage for cleaned beets was on an average 3.2% on dirty beets, corresponding to a removal of more than 50% of the soil on the beets before cleaning.

It may be concluded that the results from a multi-stage cleaning in 3 cleaning modules averaged 3.2% residual soil on dirty beets with acceptable losses of roots (2.7% on dirty beets). This is not a pronounced improvement compared to what commercial cleaner loaders may perform when the cleaning is optimised.

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Investigation of the Influence 3 Harvesting Modes Have on the Subsequent Cleaning of Beets

Undersøgelse af 3 optageprincippers indflydelse på den efterfølgende rensning af sukkerroer

Arbejdsrapport nr. 40, 1997, Miljøstyrelsen

The purpose of the experiments in 1996 was to investigate whether the harvesting principle influences the subsequent cleaning of the beets by brushes and compressed air (standard cleaning), and to find the amount of stone (and size distribution) to be lifted by each individual harvesting mode.

During the 1996 campaign field tests with 3 harvesting modes in Sweden and 2 in Denmark were made: Oppel wheels (TIM), belts (Armer), oscillating shares (Edenhall). Besides, the cleanability of 4 varieties lifted by Armer in 2 fields (light and heavy clay soils) in the neighbourhood of Danisco Seed were compared.

The harvesters were changed so that only one row was lifted, and the material was left on the soil behind the harvesters without any cleaning. For the investigations on amount of stone, a plastic film was unrolled on the soil behind the harvesters for deposit of the lifted material.

The beets were cleaned in a stationary cleaning station in the field on the day of harvesting, and the beets from each harvester were given the same cleaning. The first cleaning was done in a module with rubber finger rollers and the second cleaning in a module with brushes. In the module with brushes the beets were cleaned only once, and the second time by brushes and compressed air. For determination of residual soil the beets were blown clean by compressed air pistols. The residual soil is expressed as the percentage of clean beets without beet crowns.

Cleanability: The results are divided into 2 main groups based on the type of soil: Light clay soil and heavy clay soil.

- Generally there has been a high level of soil on the harvested beets (50-100% on clean beet). With regards to light clay soil, by standard cleaning the beets could be cleaned to a level of 2.7-5.3% residual soil on clean beet, and at heavy clay soil to 17.7-25.3% residual soil.
- In none of the two types of soil was seen any essential difference in cleanability of beets from oppel wheels (TIM), belts (Armer) or oscillating shares (Edenhall) was seen.
- On heavy clay soil the final soil is proportional to the starting soil. On light clay soil the final soil is independent of the starting soil.

Stones: Harvesting by belts (Armer) results in considerably fewer stones than harvesting by oppel wheels (TIM) and oscillating shares (Edenhall). Expressed in percent of beets it can be calculated that by oppel wheels 0-22% stone (>50 nun) on beets are drawn up (the highest level on stony fields in Sweden), by Armer 0-0,04% and by oscillating shares 3.5-10% on beet (measured on stony earth). The results show a considerably higher risk of

stones to the factory from oppel wheels than from belts (Assumption: Stones <50 mm are separated in beet harvesters).

Varieties: For each variety of beets the residual soil is nearly doubled by a change from light to heavy soil. It is not possible to distinguish between the varieties K1428 and D5502 and between Marathon and Lacta. However, there is a tendency that cleaning by Marathon and Lacta results in a lower residual soil than K1428 and D5502.

Cleanability: The tests have shown that the harvesting principle is of no importance for the residual soil (= cleanability in a standard cleaning).
Stones: From a stone point of view harvesting by belts (Armer) should be preferred to harvesting by oppel wheels.

Varieties: The effect on cleanability of changing the type of soil is greater than the effect of changing the variety of beet.

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Use of Fluid (air and water) in the Cleaning of Sugar Beets

Anvendelse af fluid (luft eller vand) til rensning af sukkerroer

Arbejdsrapport nr. 41, 1997, Miljøstyrelsen

In 1993 Danisco Sugar Development Center Nakskov introduced the project "Clean Beets", which aims at making sugar beets so clean that further cleaning in the factories becomes unnecessary. In this connection the fundamental conditions concerning the cleaning of beets were investigated, including the importance of the beet material and the consumption conditions with focus on fluid cleaning. This report deals with the application of fluid (compressed air or water) in the cleaning of sugar beats and focuses on experimental testing of energy and water consumption of the single beet.

The purpose of the investigations in 1996 was:

- To investigate and optimise the energy- and water consumptions for cleaning of sugar beets by air and by water, respectively.
- To investigate the influence of external conditions (type of soil, humidity of soil, variety of beet, etc.) on fluid cleaning.

For investigations on fluid cleaning under controlled conditions a test rig was developed and built where the parameters: time of exposure, pressure, nozzle diameter, and distance can be adjusted very precisely. In this test rig single beets are cleaned by air or by water. The results are expressed as specific energy/water consumptions, and wastes of energy and water, which would appear in practice, are disregarded.

For investigations on the optimal set-up of the parameters: time, pressure and nozzle diameter multiple level factorial experiments were carried out on beets from several fields. On the basis of the results, 2 models were made. In model 1 the residual soil is expressed as a function of time of exposure, pressure, and nozzle diameter, and in model 2 as a function of the same parameters including the type of soil. The specific energy consumption was calculated on the basis of time of exposure, pressure, and nozzle diameter and is indicated as the standard beet.

Residual soil as a function of the energy consumption shows a curve area in the form of an exponentially decreasing function, where the residual soil lies between 1% and 50% for an energy consumption of 10 kJ/beet and 0.2 kJ/beet, respectively. In order to obtain the most energy-economical cleaning, a correct set-up of the parameters is important. The type of soil and the consistency of the soil are also of great importance to the minimisation of residual soil.

Other parameters were investigated as well. Parameters that are most important to the subsequent mechanical construction are:

- The speed of the nozzle should be as high as possible (tested up to 6 m/s).
- The residual soil grows exponentially at a given cleaning when the distance between nozzle and beet increases. Distances below 50 mm are of lesser importance to the residual soil.

The main parts of the tests were made on beets dug up by hand. The beets were only exposed to a gentle mechanical pre-treatment.

Experiments with a manual pre-treatment of the beets show that there should be as little soil as possible on the beets before the cleaning by air, and the soil must not be too compressed.

Tests with cleaning of different varieties of beet show that the cylinder beet gives the smallest amount of residual soil for the lowest energy consumption. The energy consumption was measured effectively on the part of the beet containing soil.

A 3-row beet harvester lifts 13.3 beets per second. It is assumed that:

- 8 kJ per beet should be used for cleaning by air
- The efficiency of the compressor is 0.6
- The cleaning is effective (no waste)

The necessary installed effect on the harvester will then be 177 kW.

In January 1997 tests were made with water nozzles from KEW. Tests were made with 4 different nozzles at different pressures.

The tests with water on the test rig show that if the water consumption is between 40 and 70%, the residual soil will be between 5 and 1%. The energy consumption will be between 3.0 and 7.5 kJ/beet. Tests were made with pressures between 26 and 160 bar, where 160 bar results in a high-energy consumption. At a too high pressure (for a specific nozzle and distance) the water may damage the surface of the beet.

If the residual soil (1-50%) is illustrated as a function of the energy consumption (0.2-10 kJ/beet), a curve area like an exponentially decreasing function will appear.

More set-ups of time, pressure, and nozzle diameter may give the same energy consumption, but varying cleaning efficiencies.

The calculations show potentials (in the form of lower energy consumption for the same amount of residual soil) in using large nozzle diameters and higher pressures.

In order to avoid the use of too much energy for cleaning, a pre-cleaning is necessary. Tests have shown that the pre-cleaning should clean the beets to the lowest possible amount of residual soil and at the same time avoid compression of the residual soil.

The water tests indicate consumption of more than 40% water and between 3.0 and 7.5 kJ/beet.

The mentioned energy and water consumption are specific and effective. By upscaling to use in practice some waste of energy and water may take place due to the efficiency of the equipment and to the actual conditions.

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Examination of the Connection Between Varieties of Beets and the Amount of Cleaning

Undersøgelse af sammenhængen mellem roesorter og jordvedhæng

Arbejdsrapport nr. 42, 1997, Miljøstyrelsen

Danisco Sugar, Development Center Nakskov started in 1993 a project called "Rene Roer" (clean beets) which purpose was to ensure that the sugar beets were brought to the factories as clean as possible, and if possible so clean that further cleaning at the factory would be unnecessary. The purpose of this project is to point out the specie of beets, which has the best outer quality when it comes to the most optimal cleaning. Furthermore there is a wish to develop a method to measure the cleaning of the beets so that the choice of beets based on this criterion will be as objective as possible.

For the 1996 campaign at the locality Kristianssæde, Danisco Seed had sown 11 varieties of beet in test fields with approx. 150 beets each. Danisco Seed selected the varieties, and commercial sugar beets and fodder beets as well as non-commercial varieties were chosen for the experiments. During the weeks 40, 41, and 48 DC harvested the beets by hand, using a beet fork, and DC made various investigations on the external quality of the beets (cleanability, dimensions, shape, and location in the ground). During large parts of the harvesting periods the conditions were very moist, and this resulted in beets with a high amount of adherent soil. This resulted in a change of procedure in the fields, and the soil was beaten off the beets (dropping from approx. 1.5 m).

The locations of the beets in the ground were measured, leaves were cut off at the bottom of the stem, and each individual beet was marked in order to be able to follow it all the way through the cleaning process. Typically 5 beets per variety per day were treated.

At DC the following procedure took place:

- Measurement of leaf attachment diameter.
- Cleaning of the beets individually (with variations; but always with cleaning in modules with brushes as the main cleaning)
- Final cleaning by compressed air pistol
- Cutting off crowns and measurements of crown diameter and beet.
- The cleaning results are expressed as the percentage of residue soil in clean beets without crowns.

The results were:

- Of the 11 varieties investigated, the "football" beet and especially the "cylinder" beet differ markedly from the others as regards to shape and location in the ground. The cylinder beet has a "soil-repellent" form due to a high location in the ground, an outward arched shape from top to tail, small root grooves and root hairs mainly attached to the tail.
- Also, as regards cleanability, the cylinder beet differs positively from the others, because its shape gives good conditions for a low content of adherent soil, and it facilitates the cleaning conditions.

- Generally, the commercial varieties do not differ much as regards cleanability in the range of 0-200% starting soil. Final soil is generally proportional to starting soil.
- Differences between clean-ability for fresh beets and beets stored for 1-2 days could not be detected.
- The method used to measure cleanability, where beets are cleaned with brushes, is not yet optimised for all conditions (high/low soil tare and wet/dry soil), and the method must be further developed.

The conclusions were:

- Of the 11 varieties investigated, the cylinder beet has the most optimal shape as regards cleaning.
- The optimal method for evaluation of the cleanability has not been found. The applied method with brushes gives a rough estimate of the importance of the shape of the beet, but the method is influenced by soil - and harvesting conditions.
- The rough method should be supplemented with a method, which expresses the cleanability in the low range of soil tare (0-5% initial soil and < 1 % residual soil after cleaning). Cleaning by compressed air on a single-beet level in a newly developed pilot plant would be a possible method (to be investigated in 1997).

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Examination of Beet Lifting and Beet Cleaning in an Armer Salmon and in a TIM Beet Digger

Undersøgelse af roeoptagningen og –rensning i en Armer Salmon og en TIM roeoptager

Arbejdsrapport nr. 46, 1997, Miljøstyrelsen

Danisco Sugar initiated in 1993 a project called "Rene Roer" (clean beets) which purpose was to ensure that the sugar beets were brought to the factories as clean as possible, and if possible so clean that further cleaning at the factory would be unnecessary. In this phase of the project there has been focused on the possibilities of improving the cleaning conditions in the beet diggers partly by lifting the beets with as little adjacent soil as possible, and partly by installing extra cleaning modules in the harvesters.

During the 1995 campaign two experimental beet harvesters from Armer Salmon (Ireland) and TIM (Denmark) were tested in 4 fields in East-Denmark under different harvesting conditions and with different additional cleaning equipment.

Armer lifts the beets by drawing in the top, and the beets are fixed between two belts and led to topping and mechanical cleaning in the harvester. The beets are oriented and positioned fixed between the belts for further cleaning with brushes and/or air, and these cleaning methods were tested in the harvester.

TIM lifts the beets by squeezing and pushing up the beets from the earth by means of the so-called oppel wheels. This method results in large amounts of soil being lifted into the harvester, and the demands on an effective cleaning will be heavy. Harvesting by oppel wheels and a subsequent cleaning in star wheels are standard practice in Denmark.

The comparison of the two harvesting principles with subsequent cleaning in the cleaning devices mounted by the supplier showed that under ideal/good harvesting conditions as well as under good/hard harvesting conditions the TIM harvester produced beets with less residual soil than the Armer harvester.

The cleaning modules (brushes and air nozzles) for the Armer harvester were constructed and mounted at the harvester under great consideration of the initial construction of the harvester, i.e. at the belts where space was left over. No greater changes of the construction of the harvester were made in order to make allowance for orientation and single beet cleaning.

Consequently, the effect of the mentioned additional cleaning modules was minimal. For brushes as well as for compressed air it means that the contact times of 0.4 sec. and 0.07 sec., respectively, should be essentially increased in order to have some effect, and the cleaning should be more oriented to the places of the beet where the soil is actually found.

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Environmental Informative Labels

Miljøvaredeklarationer

Arbejdsrapport nr. 47, 1997, Miljøstyrelsen

The main purpose of the project is to make a qualified discussion about Environmental Informative Labels. Some see Environmental Informative Labels as an alternative to Eco-labels while others mean informative labels can be seen as a supplement to Eco-labels. In this report suggestions are made on how to direct the Environmental Informative Labels towards private consumers and professional users and which parameters in so doing should be used. Different ways of creating an Environmental Informative Label are also discussed in the report.

Environmental Informative Labels differ from Eco-labels in being neutral, i.e. Environmental Informative Labels do not contain recommendations, but communicate information and give the user the opportunity to evaluate and compare products. Environmental Informative Labels and Eco-labels can be expected to complement each other and address different consumer-groups.

The study has identified two target groups for Environmental Informative Labels: The professional users and the private consumers. These two groups have very different demands and consequently the study gives proposals on two different labels for the two target groups.

An Environmental Informative Label has to report the main environmental impacts of the product. Looking at the whole product life cycle “from cradle to grave can do this". Environmental Informative Labels therefore have to be based on life-cycle assessments (LCA). It was decided to design a generic label, i.e. an Environmental Informative Label for all types of products. The alternative is a different label for each product category, but this will confuse the users and make it impossible to compare products belonging to different product categories.

It was also decided that the labels must relate to a functional unit per year instead of just relating to the product. In this way, it is possible to compare products with different life spans.

First the relevant environmental indices were identified. Based on these, a proposal for an Environmental Informative Label for the professional users was prepared.

Finally, the proposal for an Environmental Informative Label for the private consumers was prepared. During this process, a number of environmental impacts were aggregated leading to a reduction in the number of indices.

The following indices were identified as relevant in Environmental Informative Labels: resource consumption, climate change, ozone layer depletion, acidification, photochemical ozone creation, eutrophication and oxygen depletion, waste storage, toxicity and unwanted chemicals.

In acknowledgement of the fact that working environmental impacts are very difficult to quantify over a life cycle, only chemical impacts are included under the indices: Toxicity and unwanted chemicals. Other impacts in the working environment, e.g. noise, ergonomics, repetitive monotonous work, are therefore not included.

The label for the professional users is based on the indices mentioned above. The impacts are stated for the part of the life cycle until the manufactures exit-gate, and for the whole life cycle. The point of stating the former is that buyers of intermediate products then get the opportunity of combining the information in the label with their own more specific information about the latter parts of the life-cycle.

In addition to the indices the label also contains more qualitative information related to the manufacturer:

- Name of product and manufacturer
- Information on life span and functional unit
- Environmental approval (authority and date)
- Environmental management systems, including environmental policy, quality management, etc.
- Relevant information on the working environment
- Directions for use, maintenance and disposal
- Persons responsible for preparing and verifying the label

The label for the private consumers has to be educational and comprehensible - also in rather busy situations. This is accomplished by using few but adequate indices.

Six indices are used in the proposal and they are the result of weighed aggregation of the ten most important indices out of the indices used in the label for the professional users.

Furthermore, the six parameters all relate to the yearly impact of an average person - the resulting unit of measure being Personal Equivalents. This normalisation supports the consumers' assessment.

The parameters are: energy consumption, consumption of material and resources, climate, air pollution, water pollution, waste and unwanted chemicals.

The project discusses some organisational and administrative problems in connection with different Environmental Informative Labelling systems.

In the near future it will be relevant to begin working on the establishment of an authorised method on how to prepare Environmental Informative Labels. At the same time it must be considered within which framework the administration, approval and control should be, and how the experts and the interested parties best can be involved in the preparation of regulations and directions.

Having some kind of control in the system spot checks or external verification will be necessary. Without any control it will be impossible for the users, the authorities and the competitors to see if the reported index values are calculated according to established rules.

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Life-span of Buildings and Building Materials

Bygningers og byggematerialers levetid

Arbejdsrapport nr. 48, 1997, Miljøstyrelsen

This report describes the results of a pre-project titled "Life-span of Building Materials" (Byggematerialers levetid). The purpose of the pre-project was to plan and test methods of registration in order to make a more substantial registration of the life-span of various building materials and building components possible in the future.

The report has been divided into 9 sections:

Section 1 contains a description of three different methods of registration, as well as an account of the choice of methods used in the project.

Section 2 describes four different concepts of life span and defines the project in relation to these concepts.

Section 3 states information about: Use of materials, types of buildings together with the various environmental impacts of the building components in order to make it possible to prioritise the choice of building components and materials.

Section 4 gives an account of the system structure, choice of building components and registration criteria.

Section 5 explains the different areas where it might be possible to make use of the changes.

Section 6 describes a system test of a concrete building component.

Section 7 presents the treatment and the interpretation of the results from the test.

Section 8 gives a description of further tests on two other building components.

Section 9 discusses the method of registration and the results of the data processing.

In addition to this, the report contains a bibliography and a number of appendices, which have made it possible to effectuate the registration.

On the basis of registrations, it is possible to conclude that the statistical method is very useful: To collect knowledge about the life-span of building materials, how the life-span is effected by various environmental conditions depending on constructive presentation of the building, as well as the relative distribution of materials used for the current building component.

There are a number of pre-conditions that have to be made in order to evaluate the results:

- A representative choice of materials
- The symptoms, which are the base for the estimation of the life-span, must be described precisely and in objective terms

- The number of registrated units must be comprehensive enough to make statistical calculations possible, within an acceptable uncertainty

- A large spreading within the particular categories must be considered when the results are evaluated.

- The method of registration should be explained by education and/ or the registrars should have a direct interest in the result of the registration.

The uncertainties, which have been found during the test project, are in connection with the following:

- A material where it has not been possible to predict the long-term development, since it has only been on the market for a very short period.

- Materials which only have been used on a inferior scale and therefore can be influated by the "law of the small numbers" (single results)

- Materials which have had an remarkable change during the development process by undergoing a product development

- Other materials have substituted materials, which according to experiences have a short life-span but to a wide extent. Because of this the remaining units have been subjected to exceptionally positive conditions

- A number of well-preserved units of a high age can influence the statistical calculations of the life-span period.

The general conclusions, which can be made from the test registration, are:

- The different characteristics of the materials will stand out quickly

- The general knowledge about the life span of materials should be adjusted the use and the influence they are subjected to.

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Data Quality and Statistical Analyses in Life-cycle Assessment

Datakvalitet og statistisk analyse i livscyklysvurdering

Arbejdsrapport nr. 49, 1997, Miljøstyrelsen

The purpose of this project is to describe and use methods to characterise data quality and to describe and use statistical analyses in life cycle assessment. Furthermore the project will identify areas with needs for further development and/or testing of methods. The use of the methods has been tested in a number of chosen cases.

This project includes:

- A systematic collection of information on statistical analyses and life cycle assessment
- Further development of a method to characterise data quality and test of the method on three selected cases
- Statistical analysis of data from three cases; in one case Taylor approximation has been used as well as simulation

The collection of information has been done by searching in available literature, in databases and by contact to people working with handling of high amounts of data and statistical analyses. The collected literature has been described under the headlines:

- Life-cycle assessment and environmental data
- Uncertainties on industrial and environmental data
- General statistical methods in relation to life cycle assessment
- Understanding/interpretation of uncertainties

Uncertainties in life-cycle assessment can be divided into three types: technical, methodological and epistemological uncertainties. The uncertainties can be introduced in different steps in the life cycle in relation to process data, system data, unit data, characterisation data and valuation data.

Different "roles of thumb" can be used in comparison and assessment of industrial data and hereby reduce the needs for complicated statistical calculations. The methodology requires comprehensive documentation like e.g. statistical assessment of existing data sets.

Principles from economic theory can be adapted in order to analyse data in life cycle assessment by using reliability analysis, validity analysis, dominance analysis and marginal analysis. These methods involve comprehensive and complex calculations and therefore, the need for automatised computation.

The collection of information has only resulted in data from one source: PWMI (European Centre for Plastics in the Environment) that has published data from the European plastic industry. Average data are available for e.g. consumption of raw material, energy consumption and different emissions. The gross energy consumption is given as a range, expressing the spread in the data as a consequence of different operational conditions in different countries.

The statistical methods can be divided in methods based on simulations and methods using exact calculations and approximations.

Simulations are described in relation to risk assessment in connection with public health investigations. The input parameters are described by statistical distributions and a response function can be determined by using relevant input parameters. The uncertainty on the response function (the output variable) can be determined by e.g. "Monte Carlo" simulations.

The variation of sums and differences can be determined by relatively simple formulas especially if the variable is not correlated.

Calculation of variation of products or ratios of two or more variables can be done by e.g. Taylor approximations.

Uncertainties on industrial data are often expressed as: "uncertainty means the variable is in the range with a confidence of 95 %", "the uncertainty is 10 %" or "the uncertainty is 2 MJ". The first statement is supposed to express confidence limits, the second statement is supposed to express a coefficient interval, and the third statement is supposed to express an absolute number, e.g. a spread.

A method to characterise data quality is described theoretically, and the method is tested in three cases.

In life-cycle assessment, the term environmental data expresses data from the considered process, system data expresses data on the flow of raw materials, energy and products, and unit data expresses information on the functional unit. In a complete life-cycle assessment o characterisation and valuation data are also included.

The data quality can be described by a data quality index describing the following parameters:

- Reliability of data
- Completeness of data
- Time-related correlation
- Geographical correlation
- Technological correlation

The individual parameters are assigned with a score between 1 (the best) and 5 (the worst).

The described method of characterising data quality might seem overwhelming. In praxis "Description of the case" and "Assessment of the data quality" can be included in the reporting and "Description of the data quality" can be placed in annex or omitted.

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Total Cost Assessment

Total Cost Assessment

Arbejdsrapport nr. 51, 1997, Miljøstyrelsen

This project describes the outcome of an international project concerning "Total Cost Assessment" (TCA). It highlights the possibilities and problems involved when making financial investments analyses with the aim of including environmental aspects. Inspired by the international project, a Danish TCA-project has been outlined to simplify this work even more. In this report a possible method is outlined and it is exemplified with two test cases.

The Danish TCA project has to be seen in context of the increasing trend of including economic incentives in environmental politics. The Danish TCA concept is meant as a tool for companies to make it possible to include a sufficient amount of environmental bound benefits and costs in their financial investment analyses in order to make choices on an improved basis.

In the US this approach has proved to benefit not only business economics but also the environment. In the process of developing this report it has not been an objective to prove this coincidence. However, nothing has been revealed that could prove this to be wrong.

Adjusting the TCA concept to Danish conditions the focus of the development has been to end up with a concept that:

- Helps the qualification of investment decisions in different divisions of the enterprises,
- Is rather simple and may be used without any particular business economic or computer knowledge,
- Has been adjusted to the need of small and medium sized enterprises in connection with investment speculations,
- Provides enterprises without systematic analysis routines access to an analysis and management tool to be used for qualification and calculation of expected financial consequences in connection with investment analyses. Enterprises that already have analysis routines may find it a supplementary tool that may contribute to higher qualification of the decision basis of management,
- As far as possible will be based on already existing information from the financial systems or accounts of the enterprises,
- May be used by the enterprises without further use of another calculation rate, timetable, etc. than what is normally used in connection with investment analyses,
- Gives access to stipulate special conditions in the spreadsheet of the product in question for the expected penetration curve and life cycle on the market.

The testing with the Danish TCA concept has proved to be very useful since it structures investment analyses and makes it easier to include environmental aspects in the analyses. Furthermore, the spreadsheet helps and makes it easy to simulate different scenarios.

In the end of the report a number of relevant issues are brought into focus. These issues are:

- When is it relevant to bring the Danish TCA into the decision making process
- Who is the user of TCA
- Does the use of TCA benefit the environment
- How to strengthen the use of TCA

However a final solution to these matters is not presented, but different approaches and solutions are suggested.

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Sustainability of the Present Environmental Strain with Persistent Chemical Compounds

Bæredygtighed af nuværende miljøbelastning med persistente kemiske stoffer

Arbejdsrapport nr. 52, 1997, Miljøstyrelsen

This project points out a method for assessment of the long time sustainability of the loss of persistent chemical compounds to the environment in Denmark. In this context sustainability is defined in so far as the concentration of these compounds in the environment must not be increased and if necessary they should be reduced. The environment is considered to include the top soil layer (exclusive city areas), ground water, the fresh water environment and the sea environment, which are those parts of the environment that may directly effect humans, plants and animals. Thus, air has not been considered and is in this context only included as a way of transport.

The methodology considerations are grounded in heavy metals. However it may also be used on persistent organic compounds, if knowledge exists that will make it possible to pay attention to the degradation of these compounds that will take place in depots and the environment, or if it is deemed acceptable not to consider this degradation.

The method is based on mass balances, as supplies to and removals from each of the relevant parts of the environment are calculated. Furthermore, transport between the different parts of the environment, and stock building in landfills and residual products used for road construction purposes and the like, are taken into account. With regards to the ground water there is, however, employed a methodology of dividing supplies with the net precipitation.

As part of the methodological considerations, it has been evaluated, which final depots for heavy metals, that exist in the Danish environment. It is estimated that lake and sea sediments should be regarded as final depots. On the contrary, it has been chosen not to regard landfills and soil as final depots, since all known mechanisms for retainment of heavy metals in soil are reversible, and it must be anticipated that heavy metals, given the necessary time, will be washed out by percolating water. With respect to landfills, it was assumed that very few landfills, if any, will continue leachate collection for more than 50-100 years after the landfill operations have stopped. From that time on, leachate will likely be allowed to find its own way into the environment.

The long-term consequences of continued stock building in the topsoil and other depots (including incineration clinkers used for constructions work etc.) was considered. The basic problem in this context is that release and transport of metals will vary considerably depending on geological conditions (e.g. sandy versus clayey soils) and the chemical occurrence of the metal. As an example, significant leaching of metals from incineration clinkers may likely require around 10.000 years or more, whereas complete release of metals from limebased residues from flue gas cleaning may take place in 500-5000 years.

As calculations otherwise would become extremely complex, the choice was made to include the long-term perspective distinguishing between the following two scenarios:

- The current situation, in which supplies to and removals from each compartment and transport to other compartments was estimated based on existing observations (this situation is not balanced, as stock building may take place in the top soil as well as in landfills/depots).

- A hypothetical future on the assumption that the current pattern of consumption and disposal of the substance in question could continue forever, leading to the situation that removals and transport to other compartments have increased to a level reflecting a balanced situation for all compartments (output equals input also with respect to landfills and other depots).

The methodology may be regarded as an overall evaluation based on average considerations. The methodology will provide an overview, but will not be able to cover local worst cases. In reality the methodology is only dealing with the top soil layer, ground water and the sea environment, since it is not possible, based on existing knowledge, to establish reliable calculations for the fresh-water environment.

The methodology has been tested by assessments and calculations for the heavy metal lead. The data fundament available for lead is assessed to be generally adequate except for data addressing the concentration of lead in percolating water and surface run-off. In addition to this, better data should be welcomed considering particle transport of lead in Danish streams, sedimentation of lead in lakes and transport in/out with water movements of the Danish internal marine waters. These data represent significant gabs in the existing knowledge on lead transport in the Danish environment.

The most important data requirements to undertake the assessments and calculations outlined here covers knowledge of:

- Mass flow in the society
- Mass flow within agriculture
- Previous assessments of the contribution to the Danish internal marine waters

The data fundament available for the heavy metals cadmium and copper is deemed to be of almost the same quality as for lead. For nickel, zinc, mercury, chromium and arsenic the available data are partly inadequate.

For other heavy metals as well as for persistent organic compounds, the data fundament available is deemed as being poor. A significant effort with respect to investigations and data collection will be necessary, if the assessments and calculations outlined here should be completed for such compounds.

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Cleaning and Recycling of Active Cleaning Baths in the Electroplating Industry

Rensning og genanvendelse af affedterbade i galvanoindustrien

Arbejdsrapport nr. 53, 1997, Miljøstyrelsen

Large volumes of alkaline cleaning baths are every year thrown out from the Danish metal finishing industry. From the electroplating industry alone 2,500 m3/year are disposed of. The baths are used for cleaning metal parts for oil, grease and dirt, often as pre-treatment before the final finishing process. The cleaning baths are continuously polluted during the operation and are normally disposed of when the content of pollutants gets too high. The possibilities of cleaning and recycling the cleaning baths to lower the environmental impacts are examined in this project.

When a cleaning bath is disposed of it still contains a good deal of active cleaning chemicals. The waste, however, is reduced if the bath is continuously treated and therefore only seldom needs replacement. Continuous purification of the baths also makes it possible to accumulate and re-cycle the drag-out chemicals, which means even greater savings in chemical consumption. At the same time it is possible by using this technique to reduce or even to eliminate the discharge of cleaning chemicals, oil and grease along with the wastewater.

In this project we have examined the possibilities of purifying the cleaning baths by ultra- and micro-filtration. This technique is commonly applied abroad, but has only been sporadically tested in Denmark, - with poor results. This project is focused on the combination between applied membranes and cleaning chemicals and on other important technical factors too.

Ultra- and micro-filtration retain large molecules like oil and grease whereas only fine membranes retain tensides. The inorganic salts are normally not retained. In practice this means that it is important to apply membranes, which are able to retain oil and grease but allow tensides and other cleaning chemicals to penetrate.

Screening tests have been made with 7 different cleaning chemicals; 3 for alkaline degreasing; 3 for electro-cleaning and 1 for pickling. Also, 1 different type of membrane has been tested, 1 micro-filtration membrane and 3 ultra-filtration membranes. Two of the membranes are of the hollow-fibre type while the others are of plate and frame.

The membranes are tested by filtration of a solution of pure cleaning chemicals in normal operation concentrations in order to examine if the membranes retain tensides and other organic chemicals. If so, the respective membranes are not suited for purification of cleaning baths containing these chemicals. Finally, there have also been made some tests on purification of polluted cleaning baths.

It was established during screening tests that the MF-membrane from K-flow can be applied in connection with most cleaning chemicals. Only 1 out of the 7 investigated chemicals was retained in a large amount. The UF-membranes can also be used for some applications, but surfactants are often partly retained. The finest UF-membranes generally retain more chemicals than coarse membranes. The efficiency of the membrane is obviously first of all determined by the size of the pores, and there is no evident difference

between hollow fibres versus plate and frame membranes. All of the tested membranes are made of polyphone/polyvinylpyrolidone (PES/PVP).

By alkaline degreasing approx. 80% of the oil is removed by each purification process. The investigated bath was treated 5 times during the first year of operation (approx. 1,500 operational hours) and it has not been disposed of. Previously, the bath was replaced twice a year. The average oil content has been considerably lower than before and thus resulted in less oil drag-out in wastewater. 25% of degreasing chemicals were saved in the first year of operation. Furthermore, our investigation indicated that additionally 30-50% of chemical savings are possible, if the content of tensides is kept at a suitable low concentration.

By electro cleaning about 90% of the oil is removed in each purification process. The investigated bath was treated 5 times during the first year of operation (approx. 1,450 operational hours) and it has not been disposed of. Previously, it was disposed of twice a year. 25% of degreasing chemicals were saved in the first year of operation, as the bath had not been disposed of. However, the content of tensides has been unnecessarily high in this period, and therefore additional savings on 30-40% of chemicals are possible, if the content of tensides is kept at a suitable low concentration.

Our investigations have established that the actual pickling cleaner is not polluted appreciably with oil. One single treatment of the bath lowered the oil content from 70 to 40 mg/l. In the future it is possible to stop further purification of the pickling cleaner, and to replace the bath only when the metal content has become too high.

Laboratory tests have confirmed that polymer MF-membranes and sometimes also UF-membranes are applicable when the chemical composition of the bath is matching the membrane. It is important that the surfactants are not retained and that fouling of the membranes is avoided. Therefore, chemicals containing silicate should be avoided.

An oil-absorbing filter was tested on a degreasing bath. Mechanical filtration is done through a filter bag of oil absorbing material. Preliminary tests show that only small quantities of tensides are removed in the filtration. Because the items were degreased in "tri" first, the contamination of the degreaser was very low. After this observation, it is now possible to prolong the lifetime of the degreasing bath just like that by factor 3. Previously the degreasing bath was disposed of routinely once a month, today it is once every third month. This has given the company vast chemical savings and minimised waste volume.

Summing up on the ABS-filter testing it is clear that it can be used for purification of certain cleaning baths. However, no measurements or analyses documents the ability of the filter to remove oil and grease, but practical experiences seem to stress the applicability of the filter or removal of oil and dirt in alkaline cleaning baths. The tests also show that the method cannot be used in connection with all types of cleaning baths. The method has low initiating costs and can be used with advantage by small companies.

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Environmental Management – Collection of Data from Manufacturers

Miljørigtig projektering – indhentning af data fra producenter

Arbejdsrapport nr. 54, 1997, Miljøstyrelsen

During the project a collection of documents has been developed which the project engineer can use when he approaches manufacturers of construction products to get information about the environmental effects of the product.

The material consists of two parts:

- Material to be forwarded to the manufacturer/producer
- Guidelines to the project engineer

The guideline to the project engineer describes how to use the complete material when he approaches a manufacturer. It is desirable that the initial approach is carried out in a standardised way so that the manufacturer experiences a similar behaviour no matter who makes the approach. An annex explains how supplementary questions about environmental issues can be put to the manufacturer.

Apart from the actual procedure during the dialogue with the manufacturers, the guidelines to the project engineer also explain how he shall treat the answers from the manufacturer in combination with his general knowledge of environmental issues. The guideline also stresses that it is important that all project engineers use a similar approach to the manufacturers.

Some general environmental information can be drawn from the chapter "Environmental data", and normally the answers to the questions are to be related to information from this project in order to obtain optimal information.

Furthermore the guideline includes a list of environmental impacts and effects. The list informs of potential environmental impacts during the life cycle of a building. For each impact the most essential environmental effects are stated.

In case the first approach to a manufacturer does not result in sufficient information, guidelines for the formulation of supplementary questions have been prepared.

The supplementary questions have to be put specifically so that the problems/questions still outstanding are solved/answered and therefore standard formulations cannot be used. Instead the guidelines specify - for different groups of environmental impacts - the limitations and other conditions that must be explained so that the project engineer can compare the information with information about other construction products or manufacturers.

The material to be forwarded to the manufacturer consists of - apart from the letter of approach in the form of a standard letter - questions to the manufacturer about environmental issues regarding the company and the construction products as well as the environmental effects during the life cycle of the product. The questions are of a general character and in most cases they can be answered directly by the manufacturer. Nevertheless the answers will supply sufficient information for a project engineer with a

general knowledge of environmental issues to identify possible problematic issues. The questionnaires include instructions for completion as well as supplementary guidelines to assist the manufacturer in case of doubt about definitions.

The questions deal with a specification of the construction product and the company as well as the five stages in the life cycle of a construction product.

- Supplies of constituent materials and semi-products
- Production of the construction product
- Installation of the product
- Maintenance, cleaning, replacement
- Disposal

The manufacturer is naturally supposed to answer questions about installation, maintenance and disposal only to the extent of his influence and knowledge.

The supplementary guidelines to the manufacturer include:

- A glossary where a description of the most important terms that the manufacturer will meet during the completion of the questionnaire are explained.
- A list of material groups where the constituent materials of the product are divided into groups.
- A list of toxicity classes and environmental labelling where the relevant labelling schemes are given.
- A list of protective measures with examples of the meaning of the term.

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Wood Preservatives and Impregnated Wood

Træbeskyttelsesmidler og imprægneret træ

Arbejdsrapport nr. 57, 1997, Miljøstyrelsen

In the report a mass flow analysis has been carried out for wood impregnated with preservatives and for some of the most important substances. Regarding active substances arsenic, cobber, chrome, tributylene and creosote were chosen. As representative substances from the impregnation methods, pressure-, vacuum-, and surface impregnation were chosen. The substances' health- and environmental toxicity is shortly described at the same time as possible exposure situations are stated.

A couple of the substances, arsenic and creosote, are no longer used in Denmark, but since the report also deals with the development of the amount of waste in impregnated wood, and that these substances were previously used and are still imported in impregnated wood, they are included.

By comparing the collected information on production, import and export, use and disposal of wood impregnation substances and impregnated wood, a mass balance for 1992 has been made. The mass balance has been divided in two parts: one part for the impregnated wood, and the other for the used active substances.

The annual consumption of impregnated wood in Denmark is approx. 117.000 tons based on 1992 figures. The consumption is growing approx. 3% per year. The annual import and export of impregnated wood is roughly the same when calculate din weight, but do not correspond to each other with regards to the contents of impregnation substances and active substances.

Pressure- and vacuum impregnated wood has an estimated lifespan of more than 32 years.

It is estimated that in 1992 8.000 tons impregnated wood was disposed of. This figure must be used with caution since it is subject to a significant insecurity. Impregnated wood is primarily disposed of via waste incineration or in waste disposal sites. But an unknown quantity does end in private incineration or is re-cycled. With regards to the latter the lifespan is increased an unknown number of years.

It is estimated that 2.7 mill. Tons impregnated wood has accumulated in Denmark in 1992. This quantity is presently beginning decay to waste. Within the frame of this project it has not been possible to examine what matters and active substances the accumulated wood contains.

The dominating method of impregnation is pressure impregnation. Provided that the guidelines from the Environment Agencies for establishing and operating industrial impregnation plants (vacuum – and pressure impregnation) are respected, these only allow a very small amount of loss to the surroundings. However there is the de-steaming of fluctuant organic combinations (FOC) from vacuum impregnation. There will also be emissions of FOCs from the surface treatment matters that are solvent based.

It is approximated that in 1992 in the use phase, 1014 tons of metal from pressure impregnated wood was released to the environment, and that 33 tons active substances (≈

6,6 tons of metal) from vacuum impregnated wood was released. A very cautious estimate of the waste to the surroundings from surface treated wood is maximum 2 tons active substances in 1992.

The active substances in the impregnated wood that was consumed in Denmark in 1992 came partly from wood impregnate din Denmark and partly from imported wood or wood products. This gave the following picture of active-substance consumption, either used a lone or in combination with each other (figures are approximate figures): 222 tons chrome, 221 tons cobber, 50 tons arsenic, 110 tons creosote, 14,5 tons TBTN/TBTO (≈ 4,2 tons tin) and over 425 tons other active substances.

Active substances containing arsenic that were supplied to the Danish market in 1992 came almost exclusively from import. Correspondingly creosote was only found in imported wood since impregnation against wood destructive fungus and insects is forbidden in Denmark. With regards to the remaining substances, import and export has only a limited significance for the actual amount found in the used wood.

The health risk is largest in impregnated wood where there is a risk of exposure through breathing, where the active substances come in contact with the skin, or via the organic solvents in the production phase and by handling and working with the wood. If the work environment laws are followed the risk is though minimal.

The most important potential sources of pollution of the outer environment of the impregnation plant are the handling of chemicals, spillage, accidents or through washout. The latter can result in heavy local pollution. The more diffuse pollution, individual's handling of chemicals and washout from used impregnated wood can be alarming, but at present there is no general view of these situations. If the impregnated wood is used or stored in large quantities, a large accumulation of active substances in the environment from washouts and decomposed wood can be expected.

Impregnated wood must be treated as dangerous waste and be deposited at controlled waste disposal sites or burnt in controlled incineration plants.

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Third European Roundtable on Cleaner Production

Third European Roundtable on Cleaner Production

Arbejdsrapport nr. 58, 1997, Miljøstyrelsen

The object of The European Roundtable on Cleaner Production (ERCP) is to secure that round tables are held with regular intervals in different countries to promote cleaner production. This report consists of summaries from all technical ERCP 96 events, including statements and considerations for future ERCPs. The report also presents ERCP working groups, governing bodies and networks. Finally a summary of the participants' evaluations is presented.

The most essential ERCP 96 conclusions regarding technical issues can be summarised as follows:

- Cleaner Production promotion must, to a higher degree, be a demand-driven effort.
- Cleaner Production elevation depends very much on networking between actors and stakeholders and the existence of an innovative culture in industry and other sectors.
- Cleaner Production progress and results must be made more transparent through reporting, communication and development of adequate environmental performance indicators.
- Cleaner Production must be an integrated aspect of technology innovations, market efforts, developing policies and financial consideration.

Relocating initiative from suppliers (consultants and the academia) to the demand side highlights firstly the role of industry, agriculture, transportation and other sectors and secondly stakeholders like financial institutions, NGOs, consumers and authorities. In the future, action taken directly by these polluters and decisive actors will become necessary.

However, industry and the sectors are responsible for a commitment to sustainability and to realise high levels of environmental performance. This, of course, is possible only when supply and demand efforts are conveniently balanced. Environmental groups have an important role to play by constantly bringing awareness and new issues to the agenda. This is paving the way for constant challenges for industry and pushing forward commitments from industry to a Cleaner Production strategy. Green groups should perform a role as "watchdogs" and - parallel to this - go into more "constructive" and proactive initiatives even if this would call upon responsibilities and narrow down the space for the watchdog role.

The importance of financial institutions in creating a demand for Cleaner Production is also urgent. It should be ensured that the financial sector is being equipped to ask relevant questions regarding Cleaner Production. Financial analysts need to clarify relationships between environmental and economic performance criteria and understand the financial benefits of Cleaner Production. Finance personnel have to be trained to understand Cleaner Production. Also training of environmental experts in financial competencies is needed.

ERCP has an important role to play with regard to networking and the development of an innovative culture. As this fact is often underestimated in practice especially by industry and authorities, a dissemination of experiences is highly wanted. Experiences from industrial symbiosis in Kalundborg are an example of a productive business-to-business network. But networking should also be broader and include other stakeholders. Industry

must perceive green groups and green consumers as partners and not solely as opponents of innovation. Green groups have credibility in the public because they are independent of government and industry. They are often represented by individuals committed to social action and are gifted to reach many constituencies with their messages. Furthermore, business opportunities gained in the process of networking with them are often underestimated by authorities and industries. A well-known example is Greenpeace's Brent Spar campaign. The lessons for industry as well as authorities were that it is no longer enough to ensure social approval for environmental decisions from official governmental authorities alone. It is necessary to consult a growing range of environmental "stakeholders".

Accounting for the lack of transparency and the need for indicators and communication of the results of Cleaner Production, it is first and foremost important to communicate results internally in a company. At the operational level pollution control measures could supply operators with direct environmental performance feedback to floor personnel in different working processes. At organisational level aggregated data could be utilised to measure current performance against defined goals. Furthermore it is important to give stakeholders adequate information. This is a new and difficult task in, for example, the financial sector.

Finally, regarding the integration of Cleaner Production in other efforts, the need for integrated Cleaner Production solutions in developing countries was underlined. The environmental problems faced by the developing countries should not be seen merely as those traditionally associated with industrialisation and urbanisation. They embrace those related to issues such as deforestation, land degradation, water availability and quality, bio-diversity, energy utilisation, air pollution and green house gas emissions. These elements of the environmental challenge are clearly related to overpopulation, widespread poverty, institutional weakness and a shortage of financial resources. Therefore general policies, not exclusively environmental policy, but also policies for industrial innovations, development of small and medium-sized companies (SMEs) and agriculture market policies, must take Cleaner Production aspects into account alongside with poverty reduction, population planning and development of human resources.

Another important issue is the market effects on the development of Cleaner Production. EU market policies and subsidies have a huge influence on products and processes being promoted. Consequently, the influence of existing market policies on environmental improvements should first be evaluated. Then it should be evaluated if it is possible, proactively, to let market policies work in favour of environmental progress.

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Minimisation of the Discharge of Chemicals and Water Coming from Photo Processes in Graphic Industries

Minimering af kemikalie- og vandudledning fra fotoprocesser i grafiske virksomheder

Arbejdsrapport nr. 60, 1997, Miljøstyrelsen

The purpose of this project is to give a survey of the amount of chemicals and waste water discharged from the graphical industries, which come from photo processes, and to describe the equipment of the photo processes available on the market today, which are used for cleaning and re-circulation of the waste water. Another purpose is to describe what the technological development of the graphic industry will mean for the outlet of wastewater from the industry.

When you talk about the graphic industry you talk about industries as e.g. paper-printing houses, printing shops, reprographic printing houses and serigraphic printing houses. The investigation is based on information from Danmarks Statistik, a questionnaire study among 33 companies in the graphic industry and specialist literature.

Since the questionnaire study is data on very slender grounds, it has not been possible to calculate the average fixed water consumption for companies with and without water wasting plant. Even though the data groundwork is slender there are however a number of tendencies, which can be drawn from this without talking about statistical secure tendencies.

The water consumption of the companies varies a lot. The reason could be that there are not installed measures to measure the use of water at the single processes, but the answers have been given from an estimate made by the companies taking part in the investigation.

The variations of the chemical use among the companies are very small, which could mean that there is a bigger consciousness of the chemical consumption than of the water consumption.

There exists four different types of plants for wastewater and chemicals and minimising of outlets:

- Plants that re-circulate wash water from picture-processing machines/ or plates and in this way a saving of water is obtained.

- Plants that re-circulate the wash water from the development of pictures and/ or plates and reduces the concentration of silver in the outlet wash water, hereby a saving of water and a reduction of the silver outlet are obtained.

- Plants, which re-circulate the wash water from picture-processing machines and paper and reuses part of the wastewater in the production of fixing solution. This leads to a saving of water is obtained and a total elimination of the outlet of wastewater to the sewerage system.

- Plants that function as the above mentioned and furthermore are equipped with internal systems for re-circulating developing and/ or fixing solutions and by this savings are made on developing- and/ or fixing chemicals.

According to information from the suppliers it can be concluded that more than 350 water- and chemical wasting plants have been sold. Approx. 40 of these plants have been installed in the newspaper and daily paper industries. Furthermore a few plants have been sold to hospitals, dentists, veterinary hospitals and photo shops. The price of the plants varies from approx. 6.000 to 40.000 DKK.

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Charting of the Air Pollution of Marine Engines

Kortlægning af marinemotorers luftforurening

Arbejdsrapport nr. 61, 1997, Miljøstyrelsen

Focus on environmental consciousness has spread to the marine-sector. For several years demands for reductions and emissions have been discussed. ISO has been working on standards for how the emissions of motors should be measured and IMO are stating the maximum value for the NOx-emission. This report describes the test and emission measurements that have been made on three marine engines.

The project was carried out by DTI Energi/Motorteknik i co-operation with MAN B & W Diesel A/S, Alpha Diesel (MBD-F) and MAN B & W Diesel A/S, Holeby Diesel (MBD-H).

MBD-F produces propelling motors and MBD-H produces generating motors. There are several technical differences depending on if the motors are used for propellant force or if they are used for generating force. In the report a motor type 28/32 H is measured as a generating motor and motors type 23/30A and type 28/32A are measured as propellant motors.

The emission measurements have been carried out on the three marine engines according to ISO 8178.

Measurements were carried out for three different values of the inlet air temperatures and for the inter-cooled air temperature in order to evaluate their influence on the emission. On this basis it was possible to compare the results with the formulas for NO_x correction stated in ISO 8178. The conclusion drawn was that the influence depends on the engine and that the formulas in ISO 8178 are insufficient to compensate for the change.

The reference-measurements show that the IMO- (International Maritime Organisation) requirements concerning the emission of NOx is followed by the measured motors in the standard-versions, but the requirements of EPA (Environmental Protection Agency) about the emission of NOx cannot be kept. The EPA requirements of the CO emissions, HC and particles are kept. The requirements to the marine-sector that can be expected from EPA and from the EU, mean in particular a tightening of the NOx-emission. Single measurements with changed adjustment show that the engines have potential to meet the EPA demand for 1999-2000.

Based on the experience from this project, MAN B&W Diesel A/S, Alpha Diesel decreased the emission from the main engine in a local ferry in the Oslofjord. The main object was to reduce NO_x emission without increasing fuel consumption. A NO_x reduction of 18 % was achieved, measured and weighed with respect to the ISO 8178 loads without any increase in fuel consumption.

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Processing of Waste Products from Biological Gas Plants

Forædling af restprodukter fra biogasanlæg

Arbejdsrapport nr. 63, 1997, Miljøstyrelsen

With reference to an evaluation of the possibilities for establishing a biological gas plant in Copenhagen the report includes quality demands with regards to the bio-products that result from the treatment of organic household waste in the biological gas plant. The demands are set with reference to work report no. 32 from the Environment Agency "Depositing of compost and biological gas in refuse collection. A preliminary study of the market conditions."

Further focus is put on the possibilities of adjusting the bio-products according to potential receivers wishes and needs. Environmental and economical evaluations are also made of the conditions surrounding production and depositing of processed bio-products.

The primary products from the biological gas plant, as predicted they will be in Copenhagen are:

- Degassed biomass
- Liquid manure
- Scrubber liquid

These products are preferably deposited either directly or as processed products. The products are evaluated on their chemical and the physical properties and can be compared with products on the market.

The chemical composition of degassed biomass can be compared to a mixture of pig slurry and cattle dung. The potassium contents are though only a fourth of that in slurry.

Liquid manure is best comparable with diluted pig manure.

With regards to the scrubber liquid the highest nutritional value is in the nitrogen that is bound as nitrate and the product is best comparable to Chilean nitrate.

The bio-products are subject to certain legal demands that are described in the Ministry of Environment's departmental order on the use of waste products in farming. Besides the legal demands the purchaser of the products also has quality demands. The products are meant to be used as fertilisers, soil improvement or growth media so they can replace or supplement the use of imported fertilisers and sphagnum.

Based on a questionnaire amongst 100 potential purchasers – gardeners, municipalities, farms, garden centres and forestry – the estimated use of different types of natural manure is calculated at almost 20.000 tons per annum. In order to receive the bio-products the receivers demand a possibility to assess the properties and the manorial value. This can be solved by making a targeted declaration of the products, which in general must describe whether the product is user-friendly, well convertible and competitive with regards to price, heavy metal contents and contents of human infection seeds. The demands are again dependent on where the products are going to be used. As a common demand it is demanded that the bio-products observe the limits on harmful substances as decided in the Environmental Control's departmental order nr. 823 of the 16th of September 1996.

The bio-products are not at first suitable for what they are needed for, therefore it can in certain circumstances be advantageous to treat the end products so they are adjusted to the user's needs. Amongst other things it might be necessary to dry the solid fraction since many users demand that the product must be user friendly (i.e. dry). With regards to the liquid manure it might be necessary to add further nutrients in order to obtain a positive market value.

In order to fulfil the consumers' demands it will be necessary to establish some kind of own-control combined with a tightened industry control. This could lead to the establishment of an Industry Secretariat that could be built up according to the already existing rules from the State. An important part of this solution would be determining parameters, analysis methods and testing frequency as success criteria.

The bio-products are covered by three departmental orders: the manure order, slurry order and the Plant Directorate's supervision order. The former demands that the products are reported to the Plant Directorate for approval and whether the labelling is in agreement with the order. The slurry order makes demands on the frequency of testing and analysis. In addition, demands are given for what information must be included in the labelling of a product.

Calculations show that post-treatment of the bio-products can increase earnings by 170-180 DKr. Per ton waste compared to the prices that are calculated in the original proposal for the biogas plant in Copenhagen. This income increase corresponds to approx. 11%. The calculations are based on a model where the depositing of the different bio-products is estimated in relation to the expectations of a future market.

The calculations further show that there is the largest economical advantage in the production and sales of processed waste products if these can be disposed of. Whether it is possible to dispose of processed waste products form a biogas plant cannot be determined before the products are on the market.

It is therefore still an open question whether processed surplus products from waste treatment can be disposed of on the market at the same prices as can be obtained for equivalent products produced by new raw materials.

Author/ institution
Biogas Copenhagen

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Chalk from Aggersund

Aggersund dybdekridt

Arbejdsrapport nr. 72, 1997, Miljøstyrelsen

The pilot-project has been carried out by Agersund Kalkværk and Dankalk A/S. The purpose of the report is to examine whether investing in cleaner and more energy-saving technology will make it possible to produce competitive and environmentally friendly final products, which can be disposed of to desulphurizing of waste gasses from power stations with oil and coal heating, and which can be used as fill material for several industries in Denmark and on the export-markets.

Today the chalk is primarily used as agricultural lime and as an additive for animal fodder. However, during the last 30 years Dankalk A/S has extended its activities to include the industrial sector in which the kiln-dried limestone is used as fill material for rubber, carpet treatment, asphalt, adhesive cement, putty, ceramic and paint industry. The annual excavation of limestone at Aggersund is over 500,000 tons.

A negative development in the demand for limestone products within the agricultural sector during the 1980's gave the limestone quarry the incentive to look for new markets and new products.

A law dated 5. April 1989 on limitation of emission from coal-fired power plants exposed a new demand for limestone products for cleaning exhaust gasses. Initially Dankalk A/S tried to enter this market with kiln dried pulverised limestone but was rejected because of too many impurities in the product from an excessive content of Silisium (SiO_2). It was then decided to develop and test limestone products in a pilot plant with the purpose of making new developed limestone products to meet the demands for desulphurisation of exhaust gasses, cleaning water, neutralising acids etc. Along with this enterprise considerations would be made whether it was possible to achieve the incentive to carry out final and large investments in new methods and cleaner technology.

Raw material investigations were performed to analyse the fineness and extension of the raw material i.e. to find the boundaries for raw material with a high content of calcium carbonate.

The deposit at Aggersund is a soft, fine-grained and smudging limestone chalk. The raw material is firm and coherent but still porous.

The investigations showed that the upper layer limestone contains too many impurities to make it feasible to exploit this part of the deposit. The main conclusion was that the usable raw material with an acceptable high content of calcium carbonate must be extracted from level - 6 to - 20 which means that the best limestone is below the ground water table.

Aggersund Dybdekridt is used as a desulphurization absorbent in the form of "crumbles". Crumbles are precipitated chalk having undergone an upgrading process in hydrocyclones during which, among other things, 99 percent of the flint has been removed.

Residuals from the processing are re-cycled into agricultural lime so that all raw materials are used.

The combination of new and known technology in the process has reduced the energy consumption for the whole production process, especially the change from previous kiln-

dried limestone into a non-thermal dewatering process using a membrane filterpress. Furthermore the initial tests using the crumbles show big energy savings for the end users.

Crumbles is less abrasive than coarse, crystalline limestone the use of which means longer life and lower operating costs for desulphurization process components in oil- and coal fired power plants.

Characteristics like high reactivity and porosity of the new semi-manufactured products have resulted in a high rate of transformation for upgrading processes in which the products go through a water phase. By the same token the quality of residuals like gypsum is increased because of lower content of residual calcium.

Crumbles may be transported in an ordinary truck or a coaster as they are an environmental friendly and easily handled product. The transportation to the end user by sea furthermore contributes to a lower energy consumption and consequently less pollution and less loads on highways. A typical coaster cargo equals to 40 truckloads.

Tests have been performed at three coal-fired power plants using crumbles from Dankalk to desulphurized exhaust gasses.

Overall the tests have shown many advantages and few drawbacks:

- Unproblematic suspension, feed and adjustment
- Improved adjustment than with dry limestone as crumbles are dissolved at feed point and are more reactive than limestone
- Lower content of residual calcium carbonate in the gypsum
- Cleaner gypsum
- High reactivity of the Dankalk a/s chalk saves a 500 kW recirculation pump with the same gypsum quality
- Gypsum particle grain size is smaller which makes dewatering and waste water cleaning more difficult but not impossible

The pilot project and tests at oil- and coal fired power plants have shown that the new product from Dankalk A/S has lived up to expectations and will be accepted by future users.

Based on these facts the board of DLG has granted the necessary funds for a full-scale project for production of "deep-chalk" products.

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Educational Material for the UMIP Method

Undervisningsmateriale til UMIP-metoden

Arbejdsrapport nr. 76, 1997, Miljøstyrelsen

This report contains educational material concerning UMIP. UMIP stands for Development of environmentally friendly industrial products (Udvikling af Miljøvenlige Industriprodukter) and is a method of applying the life-cycle idea as a basis for the development of environmentally friendly industrial products.

The aim of the UMIP programme was:

- To develop methods for evaluation of complex industrial products
- To develop guidelines for construction of environmentally friendly industrial products
- To develop a database and a PC tool to support the evaluation of the environment
- To implement methods and tools in the associate companies

The educational material contains assignments for the UMIP Method. Moreover, it gives suggestions on to how an educational course can be realised and which assignment to use in the course.

The aim of the educational material is to supplement the UMIP Method books with assignments and teaching instructions that can be used when teaching the UMIP Method. The purpose is to illustrate the educational material and to facilitate the approach to the UMIP Method.

The assignments cover the environmental evaluation method and its application in the product development. Moreover, they cover examples of how to apply environmental evaluations for other purposes.

The educational material only deals with the UMIP Method and does not discuss other methods for life-cycle assessments. It could therefore be relevant to include other life-cycle assessment methods in the educational course in order to give the students an overview of the area. This matter, however, lies beyond the frames of this educational material.

The educational material primarily contains assignments for the book “Miljøvurdering af Produkter” (Environmental Assessment of Products) by Wensel, and therefore has the same target group as the book. The book is especially aimed at the environmental specialist, whose job is to estimate the environmental impact of products. The environmental specialist can be employed in the company or be an external advisor.

The user should have a technical and chemical educational background that corresponds to that of an engineer or another relevant university degree. He or she should be well informed about environmental issues, but does not necessarily need any practise in environmental assessment or in product development. Some parts of the environmental assessment method require an environmental-chemical and an eco-toxicological expertise of the user. However, external advisors can do these parts.

Both the book “Miljøvurdering af produkter” and the educational material is suited for educating students who study at engineering academies, technical universities, and scientific faculties.

Some of the assignments are small and easily done and are intended for the use in classes or for inspiring the student in his or her homework. Other assignments are complex and time-consuming and can be used as assignments for homework or for lengthy teamwork. The majority of the assignments are designed for teamwork and they are made in a way that the students can participate in discussions. Only few of the assignments are solely calculations.

The examples in the assignments are, as far as possible, taken from existing environmental evaluations (that is publications of the National Agency of Environmental Protection, the UMIP database, and from the UMIP Method's Collection of Examples.) The data are, however, to some extent, simplified to make the assignments more clear.

Suggestions to solutions in the assignment book are to be considered possible solutions. Often the solution of an assignment is based on the consensus, which is reached by the students and the teacher through a discussion. The solutions are therefore not exhaustive and should not be considered "the only truth".

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Noise from Shooting Ranges, Emission Catalogue for Shot Cartridge (Principal Report)

Støj fra skydebaner, emissionskatalog for haglpatroner (hovedrapport)

Arbejdsrapport nr. 77, 1997, Miljøstyrelsen

The purpose of working out an emission catalogue for shot cartridges in relation to cleaner technology is to reduce the noise pollution around the shooting ranges by choosing cartridges with a lower value of departure. Furthermore large financial and environmental savings can be achieved by using comparatively noiseless cartridges, which will mean fewer and smaller baffle walls around the shooting ranges.

The Danish Trap Shooting Union (Dansk Flugtskydningsforbund) has participated in the project, and the union has contributed in carrying out the tests by offering suitable shooting facilities and by procuring weapons and the necessary amount of cartridges.

DELTA Akustik & Vibration has proposed this project in connection with the publication of guides no. 1 and no. 2 from 1996 about noise from shooting ranges, made by the Danish Environmental Protection Agency (Miljøstyrelsen). The reason was that the Army had made the test results, which were available, in August 1989, and it was therefore important to find out if these results were still current, and if there is a big difference in the noise level depending on the types of cartridge and the cartridge manufacturers.

A large spread on the noise level of the cartridges would probably result in the noise level becoming an important argument when selling cartridges for trap shooting.

In co-operation with the Danish Trap Shooting Union, DELTA Akustik & Vibration has made a programme of measurement based on types of munitions and covering about 98% of the Danish market for trap shooting cartridges. This includes both steel shot cartridges and lead shot cartridges though lead shot cartridges are only allowed to be used in a limited amount of shooting ranges. The programme of measurement also contains different combinations of types of munitions, compositions of weapons, angles of elevation and heights of elevation.

A large number of measurements have been carried through, which makes the amount of documents enclosed very heavy and only interesting for some readers. The report has therefore been divided in a principal report and in an appendix report, in which all the background material will be found. All the presentations of problems, test results and comments are summarised in the principal report.

The report includes an examination of the following:

In chapter 3 the object is described, meaning which type of cartridges have been tested, and which weapons have been used.

In chapter 4 the used method of measurement is described.

Chapter 5 concerns the programme of measurement determined for the test, which types of measurement have been carried through, and which combinations of weapons and

cartridges have been used.

In chapter 6 is described where and how the actual execution of measurements has occurred.

Chapter 7 contains the entire test results as well as treatment of the degree of accuracy, the comments on the test results and the examination of the test.

In the final comments in chapter 8, a conclusion of the entire project is given, and it is compared with the expectations from before the beginning of the project. The conclusion is that the difference in the level of noise from the various types of cartridges, is not as big as expected. The theory about finding cartridges, which make less noise than those from the previous test, has turned out to be correct. The very noisy cartridges, which were used before, seem to have been removed from the market. This might be a result of development with concerns for the environment, or an explanation could be that the laws to reduce the pollution of lead on the shooting ranges have made effect.

The results of the investigation also show that the environmental impact in the form of noise pollution coming from shooting ranges has been reduced remarkably during the last decade. It should be considered to make tests like this every second year in order to make sure that the manufacturers keep up the good work, and in order to prevent the positive development from going the other way.

The less noisy cartridges mean less need for ramparts around the shooting ranges that will result in both financial and environmental advantages, since the noise pollution will be reduced and the money for ramparts will be saved.

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Noise from Shooting Ranges, Emission Catalogue for Shot Cartridge (Appendix Report)

Støj fra skydebaner, emissonskatalog for haglpatroner (Bilagsrapport)

Arbejdsrapport nr. 78, 1997, Miljøstyrelsen

This is the appendix report to the work report (Arbejdsrapport) no. 77, 1997, which purpose was to work out an emission catalogue for shot cartridges in relation to cleaner technology in order to reduce the noise pollution around the shooting ranges.

The Danish Trap Shooting Union (Dansk Flugtskydningsforbund) has participated in the project, and the union has contributed to carrying out the tests by offering suitable shooting facilities and by procuring weapons and the necessary amount of cartridges.

DELTA Akustik & Vibration has proposed this project in connection with the publication of guides no. 1 and no. 2 from 1996 about noise from shooting ranges, made by the National Agency of Environmental Protection in Denmark (Miljøstyrelsen). The reason was that the Army had made the test results, which were available, in August 1989, and it was therefore important to find out if these results were still current, and if there is a big difference in the noise level depending on the types of cartridge and the cartridge manufacturers.

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A large number of measurements have been carried through, which makes the amount of documents enclosed very heavy and only interesting for some readers. The report has therefore been divided in a principal report and in an appendix report, in which all the background material will be found. All the presentations of problems, test results and comments are summarised in the principal report.

The appendices of the report have been organised in the following way:

- Appendix no. 1-110 contains transcripts of test results, odd appendix numbers, and raw data, even appendix numbers for all 55 tests.

- Appendices no. 111-115 are data sheets concerning time signals for a typical weapon/cartridge combination.

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PVC in Construction and Demolition Waste

Kortlægning af PVC i bygge- og anlægsaffald fra nedbrydning og renovering

Arbejdsrapport nr. 79, 1997, Miljøstyrelsen

This report presents the activities performed and the results achieved in the completion of the project "PVC in construction and demolition (C & D) waste". The objective of the report is to determine the total amount of PVC in C & D-waste and to estimate the current rate of recycling.

The background of the project is based upon the need to produce a general survey of the total amount of PVC in C & D-waste in Denmark. Previous investigations have registered the amount of PVC in waste from production of building materials and construction, but satisfactory data for the amount of PVC in demolition and renovation have not existed prior to these investigations.

Two different methods have been applied in the assessment of the total amount of PVC in C & D-waste:

- The first method is founded on information regarding the unit amount of PVC in the existing building stock in Denmark compared to information regarding rates of demolition and renovation.

- The second method is founded on information regarding the consumption of building materials containing PVC in Denmark in the 1970s and 1980s, assuming that these are the building materials being disposed of today. This information is compared to topical information regarding the registered amount of PVC-waste. The conclusive results are primarily based on the latter method.

The total amount of PVC in C & D-waste in Denmark is estimated to be represented in the interval between 9.000-18.000 tonnes per year with a likely amount between 11.000-14.000 tonnes per year. The current rate of recycling is found to be 10-15% .

The total spillage in installation constitutes of 1.000 tonnes per year of, which approximately 24 % is estimated to be re-cycled today.

Throughout the report the weight of the PVC-compound includes various types of filling materials.

The PVC-resin net weight therefore totals a considerable lower fraction, typically 40 % to 50 %, of the PVC-compound for soft PVC-products and 80 % to 90 % for the hard PVC-products.

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Use of Compost in Green Belts 1990-95

Anvendelse af kompost i grønne områder 1990-95

Arbejdsrapport nr. 80, 1997, Miljøstyrelsen

This is an appendix report containing examples of the use of compost within the park and the landscape sectors (the green belts). The examples have been divided on the basis of typical tasks within the sectors and describe practical experiences - not tests of cultivation. Most of the examples are based on usage in the period 1990-95 in Denmark, but a few are based on the usage in the period 1987-89. The report is a follow-up to the work report (Arbejdsrapport) no. 40, 1990, made by the Danish Environmental Protection Agency (Miljøstyrelsen).

The report describes approx. 75 located uses of compost (first of all garden/park compost) coming from 25 different compost plants with reference to 45 interviewees. The information has been procured from phone interviews in the period from July 1994 to January 1996, and a third part is furthermore based on the author's inspection of the stands. The interviews have been focused on the people with the best knowledge on the area, with regards to usage as well as later care and growth, and there has been made an effort to get information about at least two growing seasons from the same stand.

The experiences have been compiled in the principal report where they are compared with information from the literature. The principal report gives some suggestions on the use of compost for the various tasks within the park and the landscape sectors.

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Residual Products from Smoke-Gas Cleansing in Connection with Waste Incineration

Restprodukter fra røggasrensning ved affaldsforbrænding 3

Arbejdsrapport nr. 92, 1997, Miljøstyrelsen

This report is the product of an explanatory report aimed at providing an updated survey of the methods that are used in the treatment and deposition of the solid residual products that are found in smoke-gas cleansing at the waste incineration plants. The survey includes the newest results from Danish and international examinations.

Another aim has been to carry out an evaluation of the common methods' environmental, technical and economical aspects. Finally the aim has been to recommend which methods are seemingly best suited to Danish conditions. In addition, areas were pointed at that are in need of further research and development.

The completed collection of knowledge has been done through literature reviews, personal contact to a number of companies and individuals both at home and abroad, and through participation in the WASCON 94 conference that constitutes an international forum for the presentation of research results within the treatment and deposition of residual products from waste incineration.

The report starts of in chapter 2 with a short description of the smoke-gas cleansing processes, the actual residual products' physical and chemical properties and the substance leaching from untreated residual products. This chapter forms the background for the rest of the project.

In chapter 3 an overview of the different disposition possibilities is given together with their mutual connection.

In chapters 4 and 5, a detailed account of the different techniques of treating residual products is given with the aim to reduce substance leaching from them thereby making them more depositive.

In chapter 4 different methods of stabilising and solidifying residual products by means of cement casting, addition of different chemical stabilisation substances and heat treatment, are described and evaluated.

In chapter 5 different treatment methods, which originate from a forced leaching of the residual product's contents of soluble salts and heavy metals and in the environmentally less problematic salts, are described.

In chapter 6 deposition, including some of the relatively few experiences those are available from full-scale disposition of the residual products.

The report concludes with a summarisation and conclusion of the revised methods' advantages and disadvantages. Based on the finalised survey, the following recommendations with regards to the future handling of products from smoke-gas products in Denmark, are given:

Due to the insecurity of the technical and economical possibilities of utilising the smoke-gas products it is recommended that the as the first priority treatment and deposition methods must be established, which allow an environmentally safe and sustainable deposition. This must though not hinder at parallel experiment with different types of utilisation, since utilisation is always favourable to deposition.

With regards to the dry/ semi-dry products and fly ask it is recommended that the first step in the treatment is to remove the majority of the apparent soluble salts for example through a aqueous extraction. The removal of the salts will reduce the potential pollution and in many circumstances have a positive effect on the subsequent stabilisation with reference to reducing the potential leaching of trace elements/ heavy metals. This does though naturally count for treatment methods that are intended for substances with a high salt concentration. In many circumstances it is recommendable that residual products from the wet process mixed with fly ash are treated in the same way.

Through the cleansing of the liquid phase for trace elements it must be ensured that the saline, cleaned waste water from the extraction of a residual product is subsequently lead to a marine receiver, or as a second priority, to a waste-water treatment plant.

Methods for the chemical stabilisation of the leached remnants must be developed, which ensure that the latter together with the sludge from the cleansing can be deposited near the coast in correspondence with a strategy based on controlled slippage. If the remnants are to be processed so as to be usable it must be ensured that all secondary residual products can be used or disposed of as previously described. In the light of good international and Danish examination results one should consider to let the stabilisation with phosphor become part of the remnant treatment.

Provided that it is not possible to gain so good a remnant quality as to recommend controlled leaching, it is recommended that use a deposition strategy that corresponds to the collection and treatment of percolate.

In the future with regards to having to avoid removing already deposited dry/semi-dry or wet smoke-gas products from controlled waste disposal sites with percolate collection, experiences with forced in-situ leaching should be gathered. It is recommended that these experiences can also be used in the projection of new residual-products disposal sites.

The environmental and depositive properties of the sludge from the wet process (without mixed-in fly ash) should be examined since the data on this is insufficient. The possibilities of, through treatment, making the sludge more suitable for deposition or use, should be examined.

It is recommended that a protocol is laid down for the testing and evaluation of the environmental quality of processed and unprocessed residual products. In the first part of the test one could carry out a pH statistical leaching where L/S = 100 litres/kg and pH = 4,5,6,7 and 8. Consequently one could carry out a leaching test under more realistic conditions that simulate the long-term scenario conditions (e.g. a column or batch test).

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Recycling of Chemicals, Energy and Water in the Textile Industry

Kemikalie-, energi- og vandforbrug i tekstilindustrien

Arbejdsrapport nr. 95, 1997, Miljøstyrelsen

The aim of the project is to clarify the potential for membrane filtration as a separation technique in connection with the recycling of the chemical contents, energy contents and water in different types of process water from textile printing houses and textile colours.

Results that are referred to in collected literature and laboratory and pilot test carried out in this project show that the environmental as well as the economic potentials for membrane filtration in the recycling of chemicals, energy and water in the textile industry's different process water types is large.

Seven chosen process water types from seven industry-typical processes have been treated with a membrane palette of 31 different membranes in total. The majority of the membranes in the pilot tests have been sorted in spiral-designed elements.

The process water from the pre-treatment of cotton can, aided by ultra-filtration, be separated in a permeate containing recyclable detergent, sodium hydroxide and energy and in addition in a concentrate with a very high COD that potentially can be used as an energy source.

The dye bath from the reactive colouring of cotton can, aided by specially chosen nanofiltration membranes, be separated in a permeate containing sodium chloride that can be re-cycled in the colouring, and in addition in a concentrate with a very high COD- and colour contents, which must be disposed of by for example using its energy contents. It has only been possible to carry out these tests in the laboratory.

Both rinse/wash water from the leaching after a reactive pressure of cotton, and from process water from the colouring of polyester and polyamide, can aided by nanofiltration membranes be separated in a recyclable permeate with energy contents and a concentrate with a high COD- and colour contents, which must be disposed of by for example using its energy contents.

Process water from the stonewash of denim goods can, aided by a two-step treatment with firstly nanofiltration membranes and secondly reversed osmosis membranes, be separated in a recyclable permeate with energy contents and a concentrate with a very high COD- and colour contents, which must be disposed of by for example using its energy contents.

Process water from pigment printing of cotton goods can, aided by tubular ultrafiltration membranes, be separated from the latex contents that make the water type very difficult to handle in traditional membrane filtration plants. In the concentrate from the ultrafiltration latex precipitates in lumps that resemble chewing gum. The permeate is regarded as upgradeable to recyclable water by reversed osmosis. This reversed osmosis step has not been tested.

The process water types are very different in composition and the results from the tests also show very different membrane results, and it can be concluded that it is relatively easier to

treat single water types than mixed wastewater consisting of a large number of different water types.

The tests show very different fouling speeds. Some water types only need rinsing with warm water to obtain a total restitution of the membrane, while others need frequent and thorough cleaning procedures to maintain the product flux.

In all of the treated process water types there was, aided by chemical datasheets, identified chemicals, which potentially could cause problems for the membranes. A consequent laboratory screening of the membranes acquitted roughly half, the rest are attempted replaced.

To be able to assess the economic potential of the concept, the actual price level of the traditional product with the purchasing of water and the payments to the waste water discharge in Ringkøbing County (22 DKK/m³) can be compared to the calculated price level of the concept with membrane filtration, recycling of chemicals, energy, water and anaerobe out rotting of concentrates, which amounts to approx. 17 DKK/m³. This result shows therefore that compared to traditional production there for the majority of water types will not be increased costs connected to the implementation of the membrane filtration concept, and that there most probably could be an economical gain.

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Substitutes for Potent Greenhouse Gasses

Substitutes for Potent Green House Gases

Arbejdsrapport nr. 101, 1997, Miljøstyrelsen

This report examines the use of potent green house gases and other non-environmental friendly substances. The report evaluates what has been done in Denmark and other countries to reduce the use of these substances and which plans there are made for further improvements in the future.

In recent years the consumption of potent green house gases in Denmark has increased, whilst at the same time the consumption of CFCs, HCFCs and other substances, depleting the ozone layer, is approaching zero.

CFCs (halogenated chlorofluorocarbons), HCFCs (hydrochlorofluorocarbons), HFCs (hydrofluorocarbons), PFCs (fluorocarbons) and SF6 (sulphur hexafluoride) are all artificial substances, which were not found in nature until recently.

Furthermore, as these substances are relatively stable, their lifetime in the atmosphere is long. This applies in particular to the halogenated substances: CFCs, PFCs and SF6. The CFCs and HCFCs are ozone-depleting substances, which are subjected to an international convention, the Montreal Protocol, to guarantee of elimination of these substances. Except essential uses, Danish and EU legislation has now prohibited the use of CFCs. Additionally, the use of HCFC is decreasing in Denmark and will be brought to a complete stop before year 2002.

Especially the consumption of HFC-substances has increased. These substances are used as substitutes for CFCs and HCFCs for certain purposes, especially for refrigeration and blowing of polyurethane foam. However, it should be mentioned that more environmentally friendly alternatives have been introduced, e.g. hydrocarbons in aerosol cans, cyclopentane for district heating pipes and hydrocarbons, ammonia and water in various types of refrigeration systems.

Because HFCs, PFCs and SF_6 contain neither chlorine nor bromide, these substances will not contribute to any depletion of the ozone layer. However, they are contributing to the green house effect. The regulation of green house gases will be conducted by the United Nation Climate Convention, yet details of such regulation are not finally settled. This topic will be discussed during the 3rd Meeting of the Parties of the Climate Convention in Kyoto, Japan in December 1997.

In 1995 the Danish consumption of HFC substances was approximately 740 tonnes, where the corresponding amount of SF_6 was about 17 tonnes. If the entire amount of these substances was released to the atmosphere, the resulting impact would correspond to an increased emission of green house gases, corresponding to approximately 1.5 million tonnes of CO2. The HFCs, the PFCs and SF_6 are registered on the Danish EPA's list of 100 substances, non-desirable in the future.

In recent years various technologies have been discussed at conferences and seminars, in technical magazines and in daily newspapers. Many questions have been asked about how to find the most suitable technology, environmentally safe and safe to use. Examples worth

mentioning are modern household refrigerators using two kinds of refrigerants, viz. HFC-134a and hydrocarbon (isobutane).

Such discussions will continue many years from now. This is not only a matter between industry on the one side and green organisations on the other. This subject is being discussed very actively between people within different industrial branches, and discussions are often influenced by commercial interest.

It must be recognised that continuos development is taking place within the various technology areas mentioned in this report. Hence, some of the information value might appear slightly out of date. Should any relevant information not be considered in this report, DTI Energy would appreciate to receive further details of such information. This will be included in the final edition, which will be prepared at the end of 1998.

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Replacement of Powerful Greenhouse Gasses

Erstatning af kraftige drivhusgasser - Statusrapport

Arbejdsrapport nr. 102, 1997, Miljøstyrelsen

In recent years a sharp increase in the Danish consumption of the powerful greenhouse gasses HFC, PFC and SF_6 has taken place at the same time as CFC, HCFC and other ozone layer destructive substances are getting close to zero. These substances are used as a substitute for CFC and HCFC, which are especially used in the cooling and formation of PU-foam. HFCs, PFCs and SF6 do not contribute to the destruction of the ozone layer since the substances do not contain chlorine or bromine. On the other hand these substances do contribute to the greenhouse effect and have a long life span in the atmosphere. This report aims at establishing knowledge that can be used to evaluate the practical technical, economical and safety possibilities of phasing out the use of powerful greenhouse gasses within certain areas of use. Using this knowledge, different suggestions of areas where there is a need of the Cleaner Technology efforts, are given.

The detailed aim of the project is to describe:

- HFCs, PFCs and SF_6 use and respective figures of consumption
- Emission of HFC, PFC and SF_6 to the surroundings/ accumulation in the product
- The possibility of alternative technology and how far we have got with this development. Possible implementation in Denmark or abroad.
- Estimated costs of introducing alternative technology and other barriers for introducing alternative technologies (availability of machines, energy consumption, safety rules, standards etc.)
- The need for a possible Cleaner Technology effort and a description of this.

Contacting relevant industrial companies and industrial organisations in Denmark and abroad collects the information. The information is also collected from environmental organisations. Further information is collected in connection with professional conferences about cooling technique and PU-foam.

This status report is written in 1997, and a final report will be written in 1998 where a total evaluation of the technical possibilities of substituting powerful greenhouse gasses and a examination of the individual consumption uses will be given. In the reports recommendations on effort areas for Cleaner Technology will be provided.

In Denmark the industry consumed in 1995 approx. 740 tons HFC, approx. 17 tons SF_6 and 1,5 tons PFC.

HFC is especially used in the refrigerating industry. The substances are used both as a cooling agent in household fridges and freezers and as isolation foam (polyurethane foam) in the cabinets. In addition the substance is found in commercial fridges (in supermarkets for example), in industrial fridges (process cooling in the food industry), and in mobile fridges that are installed in cars, trains, planes, ships and containers including air-conditions. Further the substance is found in flexible foam plastic (foam rubber), in fire extinguishers and as a propellant in aerosol containers and foghorns.

PFC substances are only used in cooling-agent mixtures, but even though DTI Energy has not come across other areas of use, small amounts can be used in laboratories.

SF_6 is used in some sound isolated double-glazed windows in a mixture with argon that fills the gap out between the two glasses. SF_6 is used as a protective gas in the production of light metal, as isolator gas in certain installations and as a tracing agent in connection with spreading tests in the atmosphere. Finally SF_6 can be used in car tyres.

Many activities have been launched to develop new technology that will substitute HFCs. Many results have made, of which many are good.

The Environmental Control is working on three different projects:

- The development of ammonia-fridges, including new collection methods
- Development of slush-ice generators
- Cooling containers with natural cooling agents

The Energy Control has supported the following projects:

- Supermarket fridges with ammonia and indirect cooling
- Water vapour compression systems
- Energy saving commercial fridges and freezers with isobutene
- Cooling with natural cooling agents in the hotel industry
- Farm milk fridges with ammonia

The report concludes with the following recommendations:

- That there as soon as possible is started a Cleaner Technology project on the substitution of SF_6 in noise isolative windows. This should happen in collaboration with for example two manufacturers.
- That a Cleaner technology project is started on the substitution of powerful greenhouse gasses in cooling containers. This should happen in close collaboration with a relevant industry. The project should consist of two parts, where the first is the development and testing of a new cooling system that uses CO_2-cooling agents. The second part is the development and testing of a new isolation concept where vacuum isolation is used. Two containers will be built that will be tested in practice.
- That further efforts are made in commercial cooling. Ammonia or hydrocarbons can be used with direct or indirect cooling.
- That a homepage on the Internet is created so that the results that are gathered in Denmark can be shared with the rest of the world. The homepage must contain links to other relevant homepages.
- To prioritise those areas where there already is Danish production and know-how. In this way an optimal synergy is ensured that can secure an effective development of new products without powerful greenhouse gasses.

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Logbook for Raw Cotton Materials

Logbog for bomuldsråvarer

Arbejdsrapport nr. 105, 1997, Miljøstyrelsen

The report describes the processes that a cotton material is exposed to before it reaches the dyeworks, including cotton cultivation and harvest, spinning, knitting, weaving and transportation. A number of parameters within the different process steps can influence the raw cotton material's properties and thereby the necessary pre-treatment. Special focus is given to these parameters, which are recommended in a forthcoming logbook.

The pre-treatment is meant to prepare the material to the subsequent colouring-, printing- and/or aftercare processes by removing natural substances and auxiliary substances, which have been added in previous processes (spinning, deletion, weaving, knitting).

The pre-treatment consists of leaching, decoction, bleaching, erasing and mercerisation. In these part-processes liquid solutions consisting of a number of base- and auxiliary chemicals as acids, bases, salts, oxidation and reduction substances, enzymes, detergents, foam-dampening substances, stabilisation substances and complex creators, are used.

The pre-treatment is responsible for between 50 and 75 % of the dyeworks' environmental impact measured as COD, and between 25 to 40 % of all water usage.

An example of a logbook scheme with descriptive text is described and evaluated, like the possibilities of and barriers to implementing such a system are discussed. Finally the cost-saving potentials of implementing the logbook system are evaluated.

Based on the report it is concluded that there will be a number of practical and psychological barriers to and difficulties with working with a logbook system. But in return, it is not impossible since the information needed is factual information that are known at a given time in the process, but not necessarily corresponded on to the next step in the production chain.

When the pressure from the final steps in the production chain become sufficiently large, it must be expected that a system like the described will be implemented. At the same time it will aid the textiles manufacturers in their documentation work in connection with the implementation of environmental declarations and labels.

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